Appendices

APPENDICES:

APPENDIX A
PLANT SURVEYS

A1 - PACIFIC MISSILE RANGE FACILITY BARKING SANDS BOTANICAL SURVEY

(NAVFAC PAC 2006a)

Pacific Missile Range Facility
Barking Sands Botanical Survey Report
May 2006

INTRODUCTION

Botanical surveys were last conducted at Barking Sands in 2000 by Char and Associates (for Belt Collins). They used a walk through reconnaissance method, surveying the installation in four days. While the Navy has not conducted additional botanical surveys since that time, the installations base was classified for the Navy's Conservation Mapping Project. This survey, which was conducted from February 13-17, 2006 for the 2007 INRMP update, did not duplicate the Char survey. Rather, the survey focused on the native dominant Nohili dunes and updating any dramatic changes to the installation vegetation.

Nohili dunes (Photo 1), which are located on the northern third of the installation, rise up to 100 ft/30m above sea level. The dune vegetation is contiguous with that found at Polihale State Park to the immediate north, which provides habitat for two federally endangered plants – lau`ehu (*Panicum niihauense*) (Photo 2) and `ohai (*Sesbania tomentosa*) (Photo 3). Critical habitat was designated by the USFWS in 2003 for *P. niihauense* at both Polihale S.P. and unoccupied sections of Barking Sands. This designation restricts adverse modification to the constituent elements of the species. Threats to the species recovery are listed as: competition with non-native species, destruction from off-road vehicles, naturally occurring catastrophic events, and reduced vigor due to low genetic representation.

This survey was comprised of a 100% survey was conducted at Nohili dunes, and the coastal dunes south to the runway to determine whether these species currently occur on Navy land. A walk through reconnaissance was conducted in the other areas of the base in search of dramatic changes in the vegetation.

METHODS

The 100% survey covered all of Nohili dunes, except where kiawe forest was impassible on the eastern, inland portion of the dunes. Using a compass and Trimble Geo Explorer XM GPS, 20m transects were walked through Nohili Dunes and along the dune vegetation north of the airport runway. An inventory of all the plant species observed in Nohili dunes is presented in Table 1. The dunes south of the airport runway were not surveyed as they are narrower and were adequately covered for endangered species detection during the conservation mapping project. While the survey was conducted, seeds from native dune vegetation such as naupaka and pohinahina were collected and immediately spread into sparsely vegetated areas. This effort should assist the plants in recruiting to areas where driving had occurred in the past.

The rest of Barking Sands was surveyed using a walk through or windshield survey to account for significant changes in the vegetation. The only area that has been dramatically altered is where the THAAD facility was built on the southern part of the base. A`ali`i-nama scrub was cleared for this project and the area was paved and fenced.

RESULTS

While the dunes contain native dominant vegetation that appears contiguous with Polihale State Park, no federally listed species were found during the survey. Pohinahina-naupaka dune vegetation was abundant throughout Nohili dunes on the seaward slopes of all the dunes. `Akoko is locally abundant seaward of the launch pad area, but very sparse elsewhere. Other common natives include aki`aki grass, beach morning glory vines, and hunakai vines. There are also large patches of wind-swept kiawe, most commonly on the mauka side of the dunes. Char (2000) found nama in Nohili dunes but none was observed during this survey.

Golden crown beard (*Verbesina encelioides*) (Photo 4) is new invasive species on Nohili dunes since the 2000 survey. Other alien species found were a few ironwoods along the beach, one sourbush and two small patches of swollen-fingergrass. Koa haole is also locally abundant seaward of the launch pad (Photo 5), with small patches elsewhere.

It was recommended in the 2001 INRMP that the removal of the long thorn kiawe be implemented – which has occurred in some areas of the installation. Details on this will be provided in a separate report.

A monk seal juvenile and sea turtle were observed on the beach during this survey and photos were provided for the report.

DISCUSSION AND RECOMMENDATIONS

Barking Sands, particularly Nohili Dunes, represents a pohinahina-naupaka dune ecosystem that has become rare in the Hawaiian Islands. Areas that support native plant dominated communities, like Nohili Dunes and a`ali`i nama scrub should be protected from further development.

Beach vegetation:
For security reasons, driving has been prohibited on the beach since late 2001, except by base security personnel. This significant decrease in vehicle traffic has allowed the native dune vegetation such as beach morning glory, pohinahina and pa`u-o-hi`iaka (*Jacquemontia ovalifolia*) to flourish and expand. Many plants were observed sending runners out over old tire tracks on the beach. This rebound in vegetation is positive as it encourages healthier native dune vegetation, ultimately resulting in reduced erosion. As much as possible, security personnel should utilize to the same routes on the beach, never driving over existing vegetation, to allow the vegetation to continue spreading.

Native and rare plants:

Two federally listed endangered species, *Panicum niihauense* and *Sesbania tomentosa,* are found at Polihale State Park which is on the north, adjacent boundary of Barking Sands. *Panicum niihauense* is a perennial bunchgrass found on calcareous sand dunes and rocky knolls. The last population, numbering between five and twenty-three individuals, is found at Polihale State Park just north of the Barking Sands boundary. *Sesbania tomentosa* is an erect to prostrate shrub, sometimes a small tree up to 6m tall. It is listed as endangered with less than 3,000 plants remaining. It is found on calcareous beaches, sand dunes, rocky ridges and slopes and on lava pockets, on all islands except Niihau and Lanai.

Nama is a described as a species of concern by the USFWS. It was observed during earlier surveys in Nohili dunes, but not observed during this survey. Char had also observed nama in fairly high concentrations in the southern dunes which she classified as “aalii-nama scrub”. During the conservation mapping project and these surveys on the southern dunes, very few nama plants were found. Akulikuli (*Sesuvium portlacacastrum*) and golden crown beard appear to have replaced the nama in most areas, as *S. portulaca* was described as sparse by Char (2000) and golden crown beard was not observed at all.

Invasive species:
Golden crown beard is new invasive species on the dunes since the 2000 survey. It grows to 5 feet tall, and while common in disturbed areas on all the Hawaiian Islands, it has recently begun to take over many areas that were previously native dominant. Golden crown beard presents a significant problem of habitat degradation for seabirds and native plants from decrease of potential nesting habitat and inhibition of native plant growth. Efforts should be made to control this species.

Long thorn kiawe (*Prosopis juliflora*) was observed and mapped during the Conservation Mapping Project. It is on the state noxious weed list and the Navy has been collaborating with the Kauai Invasive Species Committee (KISC) on removal of this species. A separate report will be provided on this project for incorporation into the INRMP update. This effort, and other like it, should be continually funded to assure eradication of this species on the installation.

REFERENCES

DoN. 2001. Integrated Natural Resources Management Plan, Pacific Missile Range Facility, Hawaii.

Wagner, W.L., D. R. Herbst and S. H. Sohmer. 1999. Manual of the Flowering Plants of Hawaii, revised edition, two volumes. University of Hawaii Press and Bishop Museum Press, Honolulu, Bishop Museum Special Publication; 97.

Table 1 – Nohili dunes species composition

SCIENTIFIC NAME	COMMON NAME	FAMILY	STATUS

Cassytha filiformis	Kaunaoa pehu	Lauraceae	Indigenous
Casuarina equisetifolia	Ironwood	Casuarinaceae	Alien
Chamaesyce celastroides var. stokesii	Akoko	Euphorbiaceae	Endemic
Chamaesyce celastroides var. celastroides	Akoko	Euphorbiaceae	Endemic
Chloris barbata	Swollen finger grass	Poaceae	Alien
Cynodon dactylon	Bermuda grass	Poaceae	Alien
Dodonaea viscosa	Aalii	Sapindaceae	Indigenous
Heliotropium anomalum	Hinahina	Boraginaceae	Indigenous
Ipomea imperata	Hunakai	Convolvulaceae	Indigenous
Ipomea pes-caprae	Beach morning glory	Convolvulaceae	Indigenous
Leucaena leucocephala	Koa haole	Fabaceae	Alien
Pluchea carolinensis	Sourbush	Asteraceae	Alien
Prosopis pallida	Kiawe	Fabaceae	Alien
Scaevola sericea	Naupaka	Goodneiaceae	Indigenous
Sesuvium portlacacastrum	Akulikuli,portulaca	Aizoaceae	Indigenous
Sida fallax	Ilima	Malvaceae	Indigenous
Sporobolous virginicus	Akiaki	Poaceae	Indigenous
Verbesina encelioides	Golden crowd beard	Asteraceae	Alien
Vitex rotundifolia	Pohinahina	Verbenaceae	Indigenous

Photo 1 – Nohili dunes

Photo 2 – Lae`ehu (*Panicum niihauense*), in foreground, at Polihale State Park

Photo 3 – Ohai (*Sesbania tomentosa)* at Polihale State Park

Photo 4 – Golden crown beard (*Verbesina encelioides)*

Photo 5 – Koa haole (*Leucaena leucocephala*) in foreground, at Nohili dunes near launch pad.

A2 - THE STATUS OF *WILKESIA HOBDYI* (ASTERACEAE) U.S. NAVY PACIFIC MISSILE RANGE FACILITY MAKAHA RIDGE, KOKEʻE, KAUAʻI, HAWAIʻI

(Wood 2006)

The Status of *Wilkesia hobdyi* (Asteraceae)
U.S. Navy Pacific Missile Range Facility
Makaha Ridge, Koke`e
Kaua`i, Hawai`i

Prepared for Helber Hastert & Fee, Planners

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SUMMARY: During the period of April 17–21, 2006 the author conducted a floristic survey around the U.S. Navy Pacific Missile Range Facility (PMRF) at Makaha Ridge, Kaua`i, Hawai`i in order to evaluate the conservation status of *Wilkesia hobdyi* H. St. John, a Federally Listed Endangered plant only known to occur on Kaua`i (USFWS 1999).

A previous survey conducted by Char & Associates (2000) described several different plant communities occurring at the Makaha facility including sparse *Cliff Vegetation*; *Pine Plantings/Mixed Scrub*; and *Ruderal Vegetation.* The most significant plant occurrence documented during the Char survey included three colonies of *Wilkesia hobdyi* on the north facing *Cliff Vegetation* of the facility, consisting of approximately 50 individuals.

During this April 2006 survey, the cliff regions of the Makaha facility were explored using roping techniques. Eleven colonies of *Wilkesia hobdyi* were documented around the PMRF property boundaries, totaling 214 individuals. In addition, two large colonies of another Endangered plant species were discovered (i.e., *Spermolepis hawaiiensis* [Apiaceae]).

METHODS: The general objectives of the survey were to locate any groupings of *Wilkesia hobdyi* at the PMRF Makaha site and to map and describe their distribution and abundance. Methods include two field researchers walking the perimeter of all cliffs along the facility boundaries; using binoculars for general observations; and incorporating the use of climbing/rappelling ropes to access the cliffs. Transect rappels were done every 200–400 ft (60–120 m) whereby a climbing line was secured to a metal post or solid tree in order to safely rappel and inventory vegetation. Rappels ranged between 100–300 ft (30–90 m) drops using one or two lengths of 10.2 mm × 60 m climbing lines. Figure-eights and locking jumar were used for descending.

Assents were made with jumar ascenders -including one attached to the climbing harness with a webbing line and the other secured to the climber's right leg with extended webbing line. Helmets were used for safety along with carabiners with locking screw-gates. An assistant remained at the top and supervised all rappels.

Herbarium voucher collections were made in order to document regional floristic records of common and rare plant taxa and for general species identifications. Data for each specimen was entered into the National Tropical Botanical Garden (PTBG) herbarium database. Specimens are being curated primarily at the Bishop Museum (BISH) and the PTBG herbaria.

PMRF MAKAHA FLORA. The PMRF Makaha Ridge site is a 244.7-acre U.S. Navy operations facility for missile tracking and is leased from the State of Hawai`i. The region is approximately 7 miles north of the PMRF at Barking Sands and overlooks the Mana Plain (US Navy 2001). It ranges between 1000–1875 ft (303–568 m) elevation and is a headland or prominent ridge which towers over the steep precipitous basaltic cliffs of the Na Pali and looks westward over the Pacific Ocean.

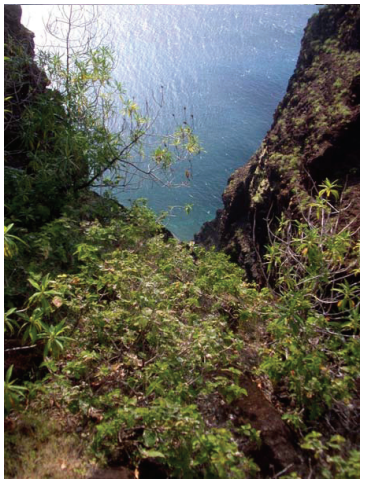
The flora around the Makaha facility is composed of some 114 species of vascular plants from 42 families. Of these species, 77 are dicotyledons, 26 are monocotyledons, ten are pteridophytes, and one represents a gymnosperm. Thirteen of those taxa are endemic species known only from the Hawaiian Islands, 14 are indigenous, three are considered Polynesian introductions and the remaining 84 are non-native naturalized species (see Table 2).

PMRF MAKAHA NATIVE SPECIES. Within the boundaries of the Makaha facility, thirteen endemic species (confined to only Hawai`i) are currently known to occur and include: *Artemisia australis* (ʻāhinahina), *Bidens sandwicensis* (koʻokoʻolau), *Carex wahuensis, Gahnia beecheyi, Pteridium aquilinum* var. *decompositum, Acacia koa* (koa), *Scaevola gaudichaudii* (naupaka kuahiwi), *Eragrostis variabilis* (kāwelu), *Panicum torridum* (hākonakona), *Doryopteris decipiens* (kumuniu), *Selaginella arbuscula* (lepelepe a moa), *Spermolepis hawaiiensis,* and *Wilkesia hobdyi* (dwarf iliau). Besides *Spermolepis hawaiiensis,* and *Wilkesia hobdyi* which are listed as Endangered by the U.S. Government (USFWS 1999), the other eleven endemics are quite common with the majority of them occurring on many of the other high islands of Hawai`i.

The fourteen indigenous species on property include: *Cyperus polystachyos, Leptecophylla tameiameiae* (pūkiawe), *Dianella sandwicensis* (ʻukiʻuki), *Sida fallax* (ʻilima), *Cocculus orbiculatus* (huehue), *Myoporum sandwicense* (naio), *Digitaria setigera* (kūkaepuaʻa), *Psilotum nudum* (moa), *Psydrax odorata* (alaheʻe), *Dodonaea viscosa* (ʻaʻaliʻi), *Chrysopogon aciculatus* (mānienie ʻula), *Heteropogon contortus* (pili), *Solanum americanum* (pōpolo), and*Waltheria indica* (ʻuhaloa). All of these indigenous taxa are common and can also be found occurring naturally in other archipelagos of Oceania.

Three common species that are considered potential Polynesian introductions were seen on property and include: *Cordyline fruticosa* (ti), *Ludwigia octovalvis* (kāmole), and *Oxalis corniculata* (ʻihi ʻai).

***MYOPORUM SANDWICENSE* (NAIO) DRY CLIFF COMMUNITY.** At the Makaha PMRF site, *Wilkesia hobdyi* occurs in a *Myoporum sandwicense* (naio) dry cliff community. Char (2000) describes this "Cliff Vegetation" and states that "low shrubs of naio or false sandalwood (*Myoporum sandwicense*), 2 to 4 feet (0.6 to 1 meter) tall, and rounded clumps of kawelu (*Eragrostis variabilis*), a bunch grass, are the most frequently observed native species on the cliffs". The high frequency of the *Myoporum* which can often exceed non-native species is still prevalent, yet evidently, there has been a decrease in the abundance of the *Eragrostis variabilis* as even after recent winter rains the author observed very little of this species around the cliffs. Approximately 70 to 100 plants were seen during the entire survey.



As the result of recent rains sections of the cliffs during this survey had a 10 to 20% cover of grasses and herbs along with a 5% cover of shrubs. Native shrubs associated with the *Myoporum sandwicense* (naio) dry cliff community include: *Artemisia australis* (ʻāhinahina), *Dodonaea viscosa* (ʻaʻaliʻi), and *Sida fallax* (ʻilima);

non-native shrubs include *Indigofera suffruticosa* (indigo), *Lantana camara* (lākana), *Opuntia ficus-indica* (pānini), and *Verbena litoralis* (vervain).

Native grasses include: *Eragrostis variabilis* (kāwelu), *Heteropogon contortus* (pili), and the previously unreported *Panicum torridum* (kākonakona) which is an ephemeral species that comes up after rains; non-native grasses include *Bothriochloa pertusa* (pitted beardgrass), *Vulpia bromoides* (brome fescue), *Bromus hordeaceus* (soft chess), *Setaria parviflora* (yellow foxtail), and *Melinis repens* (Natal redtop).

The only native herb observed around the cliffs was *Spermolepis hawaiiensis*, a Federally Endangered species that is an annual and seems to only appear around the spring months after rains. A discussion of this species is included in the Rare Plant section of this report; non-native herbs include: *Ageratum conyzoides* (maile hohono), *Anagallis arvensis* (scarlet pimpernel), *Boerhavia coccinea, Polycarpon tetraphyllum, Centaurium erythraea* (bitter herb), *Ciclospermum leptophyllum* (fir-leaved celery), *Conyza bonariensis* (hairy horseweed), *Cyanthillium cinereum* (little ironweed), *Daucus pusillus* (carrot family), *Erodium cicutarium* (pin clover), *Gamochaeta purpurea* (purple cudweed), *Plantago lanceolata (*narrow-leaved plantain), and *Ageratina riparia* (Hāmākua pāmakani).

Native pteridophytes (ferns) include: *Doryopteris decipiens* (kumuniu), *Selaginella arbuscula* (lepelepe a moa), and *Psilotum nudum* (moa); non-native pteridophytes include: *Pityrogramma calomelanos* (silverfern), and *Adiantum raddianum* (maidenhair fern).

The main threats to the PMRF Makaha dry cliff community include: habitat degradation by feral goats and competition with non-native plant taxa especially *Lantana camara*, *Indigofera suffruticosa*, *Opuntia ficus-indica*, *Verbena litoralis*, *Bothriochloa pertusa*, *Setaria parviflora*, and *Melinis repens*. Additional threats to the rare native species include reduced reproductive vigor as the result of limited numbers of existing individuals.

***Pinus elliottii* (slash pine) dry shrubland/grassland.** During this *Wilkesia* survey, the author traversed the west facing upper headland at the end of Makaha Ridge. Sections of this area are typically covered in 5% *Pinus elliottii* (slash pine) which average ca. 7 m in height; shrubs of *Lantana camara* or trees of *Grevillea robusta* (silk oak) will often cover around 20–30% of an area and *Schizachyrium condensatum* or *Andropogon glomeratus* (beardgrass) can have a 25%

cover, with the remaining 40–50% being bare exposed soil, highly disturbed by goats, with small and large boulders unanchored by any top-soil and just lying upon the surface.

Foote et al. (1972) describe the substrate as silty clay loam soils of the Niu and Puu Opae series. The author observed the substrate of these sections to be rough granular decomposed basalt with many large brown-black boulders on hardpan of varying colors including yellow-gold, gray and red. In some areas bare ground can be 100% for many hundreds of square meters. Char (2000) referred to this community as Pine Plantings/Mixed Scrub and gives a summary of the adjacent *Eucalyptus* plantings to the southeast which can reach 70–80 ft (21–24 m) tall.

In the headland region ca. 100 m east of cliff, the author visited a grove of native *Acacia* that grew like the *Acacia koaia* described by Hillebrand (1888), with a twisting low-stature. This grove had 20 healthy living trees and five individuals that recently died (UTM 0424853 – 2447350). Several *Psydrax odorata* (alahe‘e) still grew in this community and the native grass *Chrysopogon aciculatus* (mānienie ‘ula) can be common in shady less eroded areas.

Endangered Plant Species of Makaha PMRF. As previously mentioned, two Federally Listed as Endangered Species were observed during this floristic cliff survey including *Wilkesia hobdyi* H. St. John and *Spermolepis hawaiiensis* C. F. Wolff. The following data gives a summary of each of those species and an overview of their distribution and abundance.

Asteraceae

Wilkesia hobdyi H. St. John.

The Hawaiian endemic genus *Wilkesia,* along with *Argyroxiphium* and *Dubautia* form a natural assemblage of species that has very likely evolved from a single introduction to the Hawaiian Islands (Carr and Kyhos 1981) and together form what is commonly called the silversword alliance. Currently there are 30 species within this group which falls into the subtribe Madiinae of the tribe Heliantheae.

Wilkesia is composed of two species, including *W. hobdyi* (dwarf iliau) which is confined to the cliffs of northwestern Kaua`i, and the more common *Wilkesia gymnoxiphium* A. Gray, which is taller, usually single stemmed and found throughout many of Kaua`i’s northwestern valleys. Unlike *W. hobdyi* which branches freely from the base and is polycarpic (flowering and fruiting many times), *W. gymnoxiphium* is a monocarpic species which will most often die after

flowering and fruiting. The genus is named in honor of Captain Charles Wilkes (1798–1877), commander of the United States Exploring Expedition (Wagner et al. 1990)

First collected in 1968 on Polihale Ridge by State Forester R. Hobdy, *Wilkesia hobdyi* was not formally described until 1971 by H. St. John. *W. hobdyi* is a 1 m tall perennial shrub which branches from the base. Leaves are narrow lance shaped and form rosettes at the tips of each branch with veins that are oriented longitudinally. The inflorescence can range from 20–50 cm long and is extremely glandular. These resinous secretions are why members of the Madiinae are commonly called tarweeds. The copious quantities of resin that exude through highly developed trichomes of *Wilkesia* can entrap insects (Carr 1985) and one can often find many species of arthropods deathly attached.

The flowers are disposed in whirls along the axis and composed of cream-colored 5-lobed disk florets of 40–200 per head. Kyhos (unpublished) self-pollinated several individuals of *W. gymnoxiphium* yet the fruit were without embryos. In contrast, cross-pollination of this species yielded abundant fruits with embryos. *W. hobdyi* is probably pollinated by insects and is most likely self-incompatible (Carr 1985). Flowering has been observed in June, September, October, and December, and fruits have been collected primarily during the months of November to January. Fruits may be dispersed when they stick to the feathers of birds. Hybridization with *W. gymnoxiphium* may be occurring (Sakai et al. 1995).

Wilkesia hobdyi grows on coastal dry cliffs or very dry ridges. Although most literature describes its elevational range from 275–400 m (902–1312), the author has observed this species to range between 152–457 m (500–1500 ft). *W. hobdyi* is commonly associated with other cliff species such as *Artemisia australis, Wilkesia gymnoxiphium, Nototrichium sandwicensis, Lipochaeta connata, Lobelia niihauensis, Bidens sandwicensis, Psydrax odorata*, *Myoporum sandwicense, Sida fallax, Dodonaea viscosa,* and *Eragrostis variabilis*.

Currently the author is aware of only ten populations of *Wilkesia hobdyi* with a total of ca. 759–809 individuals. These populations occur along the northwestern region of Kaua`i including the dry cliffs of Ha`ele`ele (70 plants); Polihale (250–300 plants); Ka`aweiki (100 plants); Miloli`i to Mahua`iki Point (70 plants); Makaha (214 plants); Honopu (10 plants); Kalalau (20 plants); Pohakuao (10 plants); Hanakoa (10 plants); and Waiahuakua (5 plants) (Wagner et al. 1990; Wood 2000; Wood & LeGrande 2002; Wood pers. obs.). The greatest immediate threat to the survival of this species is habitat disturbance and browsing by feral goats.

CONSERVATION STATUS OF *WILKESIA HOBDYI* AT MAKAHA PMRF. During the period of April 17–21, 2006 the author observed and mapped eleven colonies of *Wilkesia hobdyi* on cliffs within and adjacent to the Makaha PMRF boundaries (see Table 1 & Map 1). These colonies ranged between 1320–1680 ft (402–512 m) elevation and totaled 214 individuals. 126 of those individuals were within the facility boundaries and the remaining 88 were just outside. No seedlings were observed. All plants were confined to vertical regions and most were seen clustered in small groupings. None of the *W. hobdyi* were in flower or fruit, nor were any observed on the western facing cliffs.

Table 1. GIS coordinates (UTM NAD 83); elevation; and number of plants in 11 colonies of *Wilkesia hobdyi* around north-northeast facing cliffs of Makaha PMRF (see Map 1).

Colony # and Coordinates	Elevation	# of Plants	Within PMRF Boundary
#1. (0424653 – 2448194)	1320 ft	7	No
#2. (0424818 – 2448013)	1400 ft	1	Yes
#3. (0424895 – 2447946)	1420 ft	30	Yes
#4. (0425073 – 2447907)	1400 ft	40	Yes
#5. (0425148 – 2447873)	1450 ft	5	Yes
#6. (0425169 – 2447894)	1400 ft	10	No
#7. (0425300 – 2447854)	1400–1500 ft	10	No
#8. (0425387 – 2447816)	1400–1500 ft	50	No
#9. (0425443 – 2447679)	1400–1500 ft	50	Yes
#10. (0425645 – 2447519)	1680 ft	10	No
#11. (0424384 – 2447219)	1000 ft	1	No

APIACEAE

Spermolepis hawaiiensis C. F. Wolff

Spermolepis hawaiiensis is a small ephemeral annual herb of around 5–20 cm in height. It is endemic to the Hawaiian Islands and is Federally Listed as Endangered (USFWS 1999). A member of the parsley family (Apiaceae), *S. hawaiiensis* has finely dissected leaves and small white flowers arranged in loose, compound umbel-shaped inflorescences arising from leaf axils.

Spermolepis hawaiiensis is known from the islands of Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii. Previously thought to be extinct on Kaua`i (Wagner et al. 1990), recent field research has shown that it is still extant in the Waimea Canyon (200 plants); Koai`e Canyon (200 plants); Poomau Canyon (1000 plants); Hipalau Valley (50 plants); Ka`aweiki Ridge (200 plants); Nuololo Aina (10 plants) and Hanapepe's Kapahili Gulch, (50 plants) (Wood pers. obs). With the addition of this recent documentation of ca. 700 individuals of *S. hawaiiensis* in Makaha, the author is aware of seven populations on Kaua`i totaling around 2410 reproducing individuals.

The primary threats to *Spermolepis hawaiiensis* on Kauai are habitat degradation by feral animals, erosion, and competition with non-native plant taxa.

During this research the author documented two significant colonies of *Spermolepis hawaiiensis* on north facing, precipitous slopes around the PMRF Makaha site (see Map 1). The first colony occurred along the north-northeast facing cliffs over Makaha Valley and was in association with *Wilkesia hobdyi*. This colony contained approximately 500 individuals which grew at elevations between 1300–1500 ft (ca. 396–457 m). Its western most boundary was UTM NAD 83 coordinate 0424940 – 2447991; and its eastern-most coordinate was 0425727 – 2447477, and the colony of *Spermolepis* ran a distance of ca. 975 m. The second colony occurred on steep north facing valley walls to the south of the PMRF Helicopter Landing Zone. This grouping contained around 200 individuals and occurred around 1150 ft (350 m) elevation

around the UTM coordinate of 0424707 – 2447026. No plants were observed on the western facing cliffs.

Both colonies were vigorous, most likely as the result of record rainfall on Kaua`i during February and March of 2006. Plants were in flower and early fruit and the author made seed collections which were accessioned at the National Tropical Botanical Garden (NTBG), Lawa`i, Kaua`i for cultivation (NTBG ACC. # 060363).

RECOMMENDATIONS. The author observed several large social groupings of 20–30 goats (*Capra hircus*) in the area. Captain Cook brought goats to Hawai`i during his first voyage and they remain a significant factor in the deterioration of native plant communities in Hawai`i and throughout the many insular ecosystems of Oceania. There are many examples of invasive species altering the evolutionary pathway of native species by competitive exclusion, niche displacement, hybridization, introgression, predation, and ultimately extinction (Mooney & Cleland 2001).

Soil erosion as a result of the goat-browsing damage at the Makaha PMRF site continues to remain a serious issue that should be addressed and portends a clear and present danger to the stability of the surrounding substrate at the PMRF Makaha site and the remaining native components of the area.

It is recommended that a review of this *erosion issue* be made soon and include experts in fields of soil conservation; horticulture; Hawaiian botany; and environmental protection. Several items for discussion could include:

- the evaluation of funds available for environmental protection and restoration
- deciding if re-establishing native species for erosion control is a priority
- reviewing techniques for protecting fauna, flora, and soil stability from grazing animals
- the hiring of a horticulturalist to begin growing selected species in nursery
- creating a landscape design that could encourage the return of native forest and seabirds

MAP 1. PMRF RARE PLANT TAXA; MAKAHA, KAUA`I, HAWAI`I

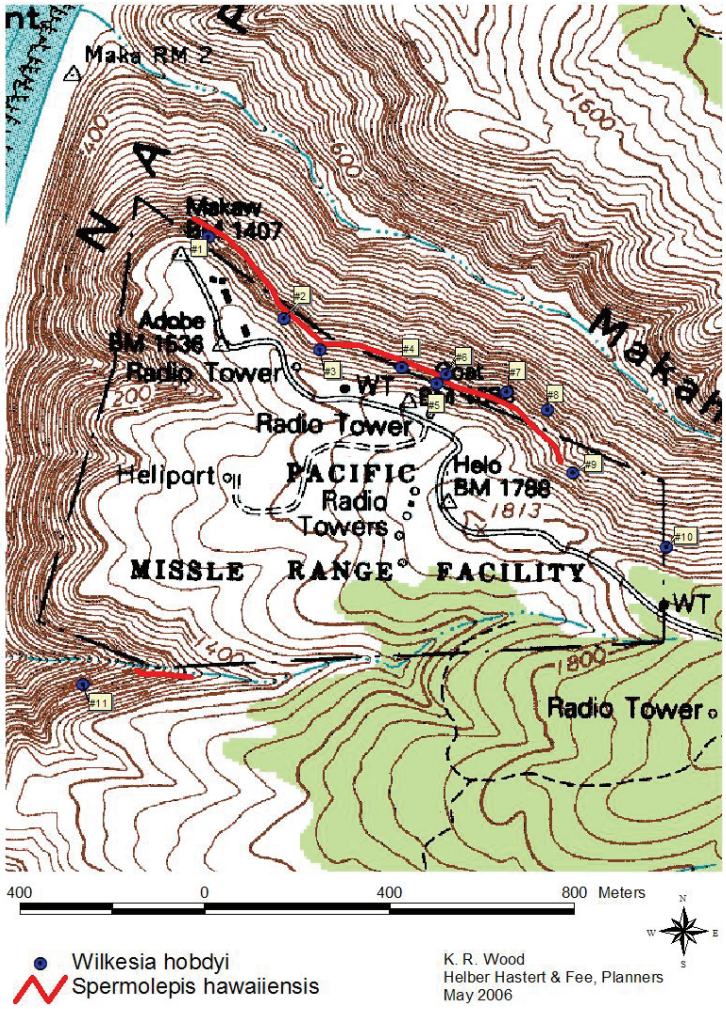


TABLE 2. CHECKLIST OF VASCULAR PLANTS FOR MAKAHA RIDGE PMRF, KAUA`I, HAWAI`I

1000–1875 FT (303–558 M) ELEVATION

Data Collection: Char 2002; Wood 2006

Symbols:

end=Endemic
ind=Indigenous
nat=Naturalized
E=Endangered
SIE=Single Island Endemic
Note: Species are listed alphabetically by genus

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS
Fabaceae	Acacia	confusa Merr.	Formosa koa	nat
Fabaceae	Acacia	koa A.Gray	koa	end
Asteraceae	Acanthospermum	australe (Loefl.) Kuntze	spiny-bur, Paraguay bur, kūkaehipa,'ihi kūkae hipa, pipili	nat
Pteridaceae	Adiantum	hispidulum Sw.	rough maidenhair fern	nat
Pteridaceae	Adiantum	raddianum C.Presl		nat
Asteraceae	Ageratina	riparia (Regel) R.M.King & H.Rob.	Hāmākua pāmakani, spreading mist flower	nat
Asteraceae	Ageratum	conyzoides L.	maile hohono, maile honohono, maile kula	nat
Asteraceae	Ageratum	houstonianum Mill.	maile hohono, maile honohono, maile kula	nat
Primulaceae	Anagallis	arvensis L.	scarlet pimpernel, poor man's weatherglass	nat
Asteraceae	Artemisia	australis Less.	ʻāhinahina, hinahina, hinahina kuahiwi	end
Asteraceae	Bidens	pilosa L.	Spanish needle, beggartick, kī, kī nehe, kī pipili, nehe	nat
Asteraceae	Bidens	sandwicensis Less.	koʻokoʻolau	nat SIE
Blechnaceae	Blechnum	appendiculatum Willd.		nat
Nyctaginaceae	Boerhavia	coccinea Mill.		nat
Poaceae	Bothriochloa	pertusa (L.) A.Camus	pitted beardgrass	nat
Poaceae	Bromus	hordeaceus L.	soft chess	nat
Asteraceae	Calyptocarpus	vialis Less.		nat
Cyperaceae	Carex	wahuensis C.A.Mey.		end

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS
Casuarinaceae	Casuarina	cunninghamiana Miq.		nat
Gentianaceae	Centaurium	erythraea Raf.	bitter herb, European centaury	nat
Fabaceae	Chamaecrista	nictitans (L.) Moench var. glabrata (Vogel) H. S. Irwin & Barneby	partridge pea, laukī	nat
Euphorbiaceae	Chamaesyce	hirta (L.) Millsp.	hairy spurge, garden spurge, koko kahiki	nat
Euphorbiaceae	Chamaesyce	hyssopifolia (L.) Small	spurge	nat
Poaceae	Chloris	barbata (L.) Sw.	swollen fingergrass, mauʻu lei	nat
Thelypteridaceae	Christella	parasitica (L.) Lév.		nat
Poaceae	Chrysopogon	aciculatus (Retz.) Trin.	mānienie ʻula, piʻipiʻi, pilipili ʻula, golden beardgrass	ind?
Apiaceae	Ciclospermum	leptophyllum (Pers.) Sprague ex Britton & Wilson	fir-leaved celery	nat
Asteraceae	Cirsium	vulgare (Savi) Ten.	bull thistle, pua kala	nat
Menispermaceae	Cocculus	orbiculatus (L.) DC.	huehue, hue, hueʻie, ʻinalua	ind
Asteraceae	Conyza	bonariensis (L.) Cronquist	hairy horseweed, ilioha, ʻawīʻawī, pua mana, lani wela (Niʻihau)	nat
Agavaceae	Cordyline	fruticosa (L.) A.Chev.	kī, ti	pol
Fabaceae	Crotalaria	incana L.	fuzzy rattlepod, kūkaehoki, kolomona (Niʻihau)	nat
Fabaceae	Crotalaria	pallida Aiton	smooth rattlepod, pikakani, kolomona (Niʻihau)	nat
Asteraceae	Cyanthillium	cinereum (L.) H.Rob.	little ironweed	nat
Poaceae	Cynodon	dactylon (L.) Pers.	Bermuda grass, mānienie, mānienie haole	nat
Cyperaceae	Cyperus	polystachyos Rottb.		ind

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS
Apiaceae	Daucus	pusillus Michx.	American carrot	nat?
Fabaceae	Desmanthus	pernambucanus (L.) Thell.	slender mimosa, virgate mimosa	nat
Fabaceae	Desmodium	incanum DC.	Spanish clover, kaʻimi	nat
Fabaceae	Desmodium	sandwicense E.Mey.	Spanish clover, chili clover, pua pilipili, kīkānia pipili, pilipili ʻula (Niʻihau)	nat
Fabaceae	Desmodium	triflorum (L.) DC.	tick trefoil, tick clover	nat
Liliaceae	Dianella	sandwicensis Hook. & Arn.	ʻukiʻuki, ʻuki	ind
Poaceae	Digitaria	ciliaris (Retz.) Koeler	Henry's crabgrass, kūkaepuaʻa	nat
Poaceae	Digitaria	setigera Roth ex Roem. & Schult.	kūkaepuaʻa, mauʻu kūkaepuaʻa, itchy crabgrass	ind
Sapindaceae	Dodonaea	viscosa Jacq.	ʻaʻaliʻi, ʻaʻaliʻi kū makani, ʻaʻaliʻi kū ma kua, kūmakani	ind
Pteridaceae	Doryopteris	decipiens (Hook.) J.Sm.	kumuniu, ʻiwaʻiwa, manawahua	end
Asteraceae	Emilia	fosbergii Nicolson	pualele (Niʻihau)	nat
Asteraceae	Emilia	sonchifolia (L.) DC. Var. javanica (N.L.Burm.) Mattf.	Flora's paintbrush	nat
Poaceae	Eragrostis	variabilis (Gaudich.) Steud.	kāwelu, ʻemoloa, kalamālō	end
Asteraceae	Erigeron	karvinskianus DC.	daisy fleabane	nat
Geraniaceae	Erodium	cicutarium (L.) L'Hér. ex Aiton	alfilaria, pin clover	nat
Myrtaceae	Eucalyptus	sp.		
Cyperaceae	Gahnia	beecheyi H.Mann		end
Asteraceae	Gamochaeta	purpurea (L.) Cabr.	purple cudweed	nat
Proteaceae	Grevillea	robusta A.Cunn. ex R.Br.	silk oak, silver oak, he oak, ʻoka kilika, haʻikū keʻokeʻo	nat
Poaceae	Heteropogon	contortus (L.) P.Beauv. ex Roem. & Schult.	pili, lule, pili grass, twisted beardgrass, tanglehead	ind?
Poaceae	Hyparrhenia	rufa (Nees) Stapf		nat
Asteraceae	Hypochoeris	glabra L.	smooth cat's-ear	nat

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS
Asteraceae	Hypochoeris	radicata L.	hairy cat's-ear, gosmore	nat
Fabaceae	Indigofera	suffruticosa Mill.	indigo, ʻinikō, ʻinikoa, kolū	nat
Verbenaceae	Lantana	camara L.	lākana, lāʻau kalakala, lanakana (Niʻihau), mikinolia hihiu, mikinolia hohono, mikinolia kukū	nat
Epacridaceae	Leptecophylla	tameiameiae (Cham. & Schlecht.) C.M.Weiller	pūkiawe, ʻaʻaliʻi mahu, kānehoa, kāwaʻu (Lānaʻi, Maui), maiele, maieli, puakeawe, puakiawe, pukeawe, pūpūkiawe	ind
Fabaceae	Leucaena	leucocephala (Lam.) de Wit	koa haole, ēkoa, lilikoa	nat
Onagraceae	Ludwigia	octovalvis (Jacq.) P.H.Raven	primrose willow, kāmole, alohalua, kāmole lau liʻi, kāmole lau nui	pol?
Fabaceae	Macroptilium	lathyroides (L.) Urb.	wild bean, cow pea	nat
Fabaceae	Medicago	lupulina L.	black medick, nonesuch	nat
Meliaceae	Melia	azedarach L.	chinaberry, pride-of-India, bead tree, ʻīnia, ʻilinia	nat
Poaceae	Melinis	repens (Willd.) Zizka	Natal redtop, Natal grass	nat
Fabaceae	Mimosa	pudica L. var. unijuga (Duchass. & Walp.) Griseb.	sensitive plant, sleeping grass, pua hilahila	nat
Myoporaceae	Myoporum	sandwicense A.Gray	naio, naeo, naieo, bastard sandalwood	ind
Nephrolepidaceae	Nephrolepis	multiflora (Roxb.) F.M.Jarrett ex C.V.Morton		nat
Oleaceae	Olea	europaea L. subsp. cuspidata (Wall. ex G.Don) Cif.	olive, ʻoliwa, ʻoliwa haole	nat

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS
Poaceae	Oplismenus	hirtellus (L.) P.Beauv.	basketgrass, honohono kukui, honohono, honohono maoli	nat
Cactaceae	Opuntia	ficus-indica (L.) Mill.	pānini, pāpipi	nat
Oxalidaceae	Oxalis	corniculata L.	yellow wood sorrel, ʻihi ʻai, ʻihi ʻawa, ʻihi maka ʻula, ʻihi mākole	pol?
Oxalidaceae	Oxalis	debilis Kunth	pink wood sorrel, ʻihi pehu	nat
Poaceae	Panicum	maximum Jacq.	Guinea grass	nat
Poaceae	Panicum	torridum Gaudich.	kākonakona, hākonakona (Niʻihau)	end
Poaceae	Paspalum	fimbriatum Kunth	Panama paspalum, fimbriate paspalum, Colombia grass	nat
Poaceae	Pennisetum	clandestinum Hochst. ex Chiov.	Kikuyu grass	nat
Arecaceae	Phoenix	hybrid		nat
Euphorbiaceae	Phyllanthus	debilis Klein ex Willd.	niruri	nat
Pinaceae	Pinus	elliottii Engelm.	slash pine	
Pteridaceae	Pityrogramma	calomelanos (L.) Link	silverfern, silverback fern	nat
Plantaginaceae	Plantago	lanceolata L.	narrow-leaved plantain, English plantain, buckhorn	nat
Plantaginaceae	Plantago	major L.	broad-leaved plantain, common plantain, laukahi, kūhēkili	nat
Asteraceae	Pluchea	carolinensis (Jacq.) G.Don	sourbush, marsh fleabane	nat
Caryophyllaceae	Polycarpon	tetraphyllum (L.) L.		nat
Portulacaceae	Portulaca	oleracea L.	pigweed, ʻākulikuli kula, ʻākulikuli lau liʻi, ʻihi	nat
Myrtaceae	Psidium	cattleianum Sabine	strawberry guava, waiawī ʻulaʻula	nat

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS
Myrtaceae	Psidium	guajava L.	common guava, kuawa, kuawa ke'oke'o, kuawa lemi, kuawa momona, puawa	nat
Psilotaceae	Psilotum	nudum (L.) P.Beauv.	moa, moa nahele, pipi, 'o'omoa, upright whiskfern	ind
Rubiaceae	Psydrax	odorata (G.Forst.) A.C.Sm. & S.P.Darwin	alahe'e, 'ōhe'e, walahe'e	ind
Dennstaedtiaceae	Pteridium	aquilinum (L.) Kuhn var. decompositum (Gaudich.) R.M.Tryon		end
Rubiaceae	Richardia	brasiliensis Gomes		nat
Euphorbiaceae	Ricinus	communis L.	castor bean, pā'aila, ka'apehā, kamākou, kolī, lā'au 'aila	nat
Goodeniaceae	Scaevola	gaudichaudii Hook. & Arn.	naupaka kuahiwi	end
Poaceae	Schizachyrium	condensatum (Kunth) Nees	little bluestem, beardgrass	nat
Selaginellaceae	Selaginella	arbuscula (Kaulf.) Spring	lepelepe a moa	end
Poaceae	Setaria	parviflora (Poir.) Kerguélen	yellow foxtail, perennial foxtail, mau' Kaleponi	nat
Malvaceae	Sida	fallax Walp.	'ilima	ind
Solanaceae	Solanum	americanum Mill.	glossy nightshade, pōpolo, 'olohua, polopolo, pōpolohua (Ni'ihau)	ind?
Asteraceae	Sonchus	oleraceus L.	sow thistle, pualele	nat
Rubiaceae	Spermacoce	assurgens Ruiz & Pav.	buttonweed	nat
Apiaceae	Spermolepis	hawaiiensis C.F.Wolff		end E
Asteraceae	Sphagneticola	trilobata (L.) Pruski	wedelia	nat
Poaceae	Sporobolus	indicus (L.) R.Br.	West Indian dropseed, smutgrass	nat

FAMILY	GENUS	SPECIES	COMMON NAME	STATUS
Myrtaceae	Syzygium	cumini (L.) Skeels	Java plum, jambolan plum	nat
Verbenaceae	Verbena	litoralis Kunth	vervain, ōwī, oī, ha'uoi (Ni'ihau), ha'uōwī (Ni'ihau)	nat
Poaceae	Vulpia	bromoides (L.) S.F.Gray	brome fescue	nat
Sterculiaceae	Waltheria	indica L.	'uhaloa, 'ala'ala pū loa, hala 'uhaloa, hi'aloa, kanakaloa	ind?
Asteraceae	Wilkesia	hobdyi H.St.John	dwarf iliau	end E SIE
Asteraceae	Youngia	japonica (L.) DC.	Oriental hawksbeard	nat

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A3 - PACIFIC MISSILE RANGE FACILITY MAKAHA RIDGE BOTANICAL SURVEY

(NAVFAC PAC 2006b)

Pacific Missile Range Facility
Makaha Ridge Botanical Survey Report
May 2006

INTRODUCTION

Botanical surveys were conducted most recently on Makaha Ridge Navy property in 2000 by Char and Associates (for Belt Collins). For this 2007 INRMP update, Ken Wood was subcontracted to conduct the botanical survey at Makaha Ridge. His survey focused on the cliffs, where threatened and endangered plants are known to occur. In his report, he also provided a species list for the rest of Makaha Ridge, so one was not duplicated here.

This survey report is entirely focused on a walkthrough survey of the areas on April 21, 2006, where erosion is the most severe and making recommendations on erosion control.

METHODS

Areas where soil erosion was seen to be the most severe were surveyed for species composition and possible solutions. A walk through reconnaissance method was used.

RESULTS and DISCUSSION

Several large social groupings of up to 100 goats (*Capra hircus*) were seen at Makaha Ridge. Soil erosion as a result of the goat-browsing damage at the Makaha PMRF site continues to be a serious issue for the stability of the surrounding substrate, buildings, native vegetation, and nene (*Branta sandvicensis*).

This goat issue appears to persist at Makaha Ridge due to a variety of factors, including perceived lack of need. This issue may be addressed by fencing experimental plots which exclude the goats from several areas at Makaha Ridge. This simple demonstration would likely show the rebound of the vegetation in those excluded areas, and perhaps the recruitment of more native plants. The naio (*Myoporum sandwicense*) appears to be less appealing to the goats, as it is often the only remaining vegetation on the coastal cliff communities where kawelu (*Eragrostis variabilis*), `ahinahina (*Artemisia australis*), a`ali`i (*Dodonaea viscose)*, ilima (*Sida fallax)*, pili (*Heteropogon contortus*), and kakonakona (*Panicum torridum*) would have thrived in the past.

It is recommended that a review of this erosion issue be made with internal and external Navy biologists, biologists and horticulturists. Issues to be tackled include:

- How best to control goats
- How best to protect native plant communities
- How best to protect nene
- How best to protect infrastructure.

Solutions may include working with a soil conservationist to study the substrate, hiring a nursery/horticulturist to grow native plants for outplanting, hiring someone to hunt the goats, install fencing to protect certain areas of the installation before others, etc.

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Photo 1 – Erosion at Makaha Ridge, makai of buildings

Photo 2 – Erosion and suggested demonstration plot site

A4 - PACIFIC MISSILE RANGE FACILITY KŌKE‘E BOTANICAL SURVEY

(NAVFAC PAC 2006c)

Pacific Missile Range Facility
Kokee Botanical Survey Report
May 2006

INTRODUCTION

Botanical surveys were last conducted on Kokee Navy property in 2000 by Char and Associates (for Belt Collins). They used a walk through reconnaissance method, surveying all areas in one day. Importantly, their property line and resulting survey area was defined as the fenceline. However, it was ascertained during the Navy Conservation Mapping Project that the actual property boundary extends considerably outside the fenceline. As described by Char, inside the fenceline is mostly landscaped and developed, containing maintained grass and nursery-grown non-native species. Outside the fenceline, there is primarily intact native forest that is contiguous with the surrounding state land. This survey, which was conducted from April 17-19, 2006 for the 2007 INRMP update, did not duplicate the Char survey. Rather, the survey focused on the native dominant forest outside the fenceline and updating any dramatic changes to the installation vegetation.

METHODS

This survey update focused primarily on the species composition of the native forest outside the fenceline (Photos 1 and 2). As the species within the landscaped areas were described in the 2001 INRMP, those areas were not resurveyed. The area was surveyed using a rigorous walk-through method, with zig-zag transects going back and forth along the natural contours of the terrain.

Species were identified using Wagner, et al 1999 and the field assistance of botanical expert Ken Wood (National Tropical Botanical Garden). The species list provided in Table 1 does not include plants found in the landscaped areas as they are provided in earlier reports.

RESULTS

Kokee A-E are comprised of mostly intact koa-ohia mesic native forest that is contiguous with Kokee State Park. Contour transects were conducted through the forested areas of all the parcels. However, conservatively, this should be classified as a walk-through survey, resulting in less than 100% coverage.

No federally listed plant species were observed on the Kokee A, B, C, D or E parcels.

Kokee A

The forest at Kokee A is intact koa-ohia mesic native forest. The overstory is koa (*Acacia koa*) and ohia lehua (*Metrosideros polymorpha*), along with silk oak (*Grevillea robusta*). Mid-canopy species are halapepe (*Pleomele aurea*), u`ahiapele (*Melicope*

barbigera) and strawberry guava (*Psidium cattleianum*). Ground cover is primarily pukiawe (*Styphelia tameiameiae*), maile (*Alyxia oliviformus*), *Carex meyenii*, *Carex wahuensis*, ohelo (*Vaccinium sp.*) and kawelu/lovegrass (*Eragrostris variabilis*). Blackberry (*Rubus sp*.) thickets can be found around the forest edge at the fenceline, of this parcel, as in the others (Photo 3).

The road up to Kokee A is lined with firetree (*Myrica faya*), however, the forest inside is still fairly intact native forest.

As described in earlier surveys, the area inside the fenceline is landscaped, and mostly paved. Non-native and planted species line the fenceline.

Kokee B

Most of Kokee B property is contained within the fenceline, and is landscaped and paved. However, outside the fence, the boundary contains remnant native forest similar to the other Kokee properties. The predominant species observed here was hame (*Antidesma platyphyllum*). Other native species observed were manono (*Hedyotis terminalis*), ala`a (*Pouteria sandwicensis*), kolea (*Myrsine lanaiensis*), naupaka kuahiwi (*Scaevola procera*), *C. meyenii*, maile, koa and ohia.

Kokee C

Kokee C is entirely landscaped and paved and the fenceline is the property boundary.

Kokee D

Kokee D contains remnant, native forest outside of the fenceline which is bordered by a thick boundary of blackberry and firetree. On the east side of the installation, the forest is more intact; the west side contains several areas that have been previously cleared, resulting in abundant weeds. Kokee D (and E) contains a healthy, native forest with koa, kauila (*Alphitonia ponderosa*) (Photo 4), ohia, olopua (*Nestigis sandwicensis*) overstory. It also contains large iliahi/sandalwood (*Santalum freycinetianum*) trees. The overstory is also comprised of natives such as *M. barbigera*, mokihana (*Melicope anisata*), kolea (*Myrsine lanaiensis*), *Myrsine alyxifolia*, ahakea (*Bobea brevipes*) (Photo 5), olapa (*Cheirodendron trigynum*), *Pouteria sandwicensis*, hoawa (*Pittosporum sp.*) and kauila (*Alphitonia ponderosa*). The midstory is also comprised of natives, such as laukea (*Clayoxylon sandwicense*), a`ia`a (*Streblus pendulinus*), maile, maua (*Xylosma hawaiiense*), a`e (*Zanthoxylum dipetalum*), pilo (*Coprosma kauaensis*), `aiea (*Ilex anomala*) and manono. Ground cover is also almost entirely native and consists of uluhe (*Dicranoptorus linearis*), uki (*Gahnia beecheyi*), *Peperomia sp*. and ferns in the genus *Dryopteris* and *Microlepia*.

On the west side of "D", two large ohe`ohe (*Tetraplasandra kavaiensis*) were observed emerging from the blackberry and `uluhe understory.

Other agencies have conducted surveys in adjacent areas to Navy property that have yielded several individual federally listed `akoko (*Chamaesyce halemanui*). However, none were found during this survey on Navy property.

One small patch of Asian melastome (*Melastome candidum*) (Photo 7), an invasive species was found near the roadside at Kokee D (UTM). This species is one that conservationists have targeted removal of in the Kokee area. It is near the property border and may not even be on Navy property. However, it is recommended that the Navy facilitate access by the Kauai Invasive Species Committee (KISC) or state biologists to eradicate this population.

Kokee E

Kokee E also contains intact native forest with the same species observed as Kokee D. It appears to contain fewer sandalwood trees however. It also contains the non-native paperbark (*Melaleuca quinquenervia*) which was not observed in the other Kokee areas. As with the other parcels, the vegetation inside the

DISCUSSION

The Kokee sites represent predominantly koa-ohia mesic native forest that is contiguous with the surrounding state forest. Efforts should be continued to avoid development or other negative impacts to the forest.

One small patch of *M. candidum*, an invasive species, was found near the roadside at Kokee D. This species is one that conservationists have targeted removal of in the Kokee area. It is near the property border and may not even be on Navy property. However, it is recommended that the Navy facilitate access by the Kauai Invasive Species Committee (KISC) so that state biologists can destroy this plant before it spreads to surrounding areas. The Navy should continue to be good stewards of the Kauai environment by avoiding spread or introduction of invasive species to the installations via mowers or other means.

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Table 1. Kokee plant list (does not include landscaped areas).

SCIENTIFIC NAME	COMMON NAME	FAMILY	STATUS
Acacia koa	Koa	Fabaceae	Endemic
Alphitonia ponderosa	Kauila	Rhamnaceae	Endemic
Alyxia oliviformus	Maile	Apocynaceae	Endemic
Antidesma platyphyllum	Hame	Euphorbiaceae	Endemic
Bobea brevipes	`Ahakea	Rubiaceae	Endemic
Carex meyenii	NCN	Cyperaceae	Indigenous
Carex wahuensis	NCN	Cyperaceae	Indigenous
Charpentiera elliptica	Papala	Amaranthaceae	Endemic
Cheirodendron trigynum	Olapa	Araliaceae	Endemic
Clayoxylon sandwicense	Laukea	Euphorbiaceae	Endemic
Coprosma kauaensis	Pilo	Rubiaceae	Endemic
Dianella sandwicensis	Uki uki	Liliaceae	Indigenous
Dicranoptorus linearis	Uluhe	Gleicheniaceae	Indigenous
Dodonaea viscosa	A`ali`i	Sapindaceae	Indigenous
Dryopteris fusco-atra	`I`i	Dryoteridaceae	Endemic
Dryopteris glabra	Kilau	Dryoteridaceae	Endemic
Eragrostris variabilis	Kawelo/lovegrass	Poaceae	Endemic
Gahnia beecheyi	Uki	Cyperaceae	Endemic
Grevillea robusta	Silk oak	Proteaceae	Alien
Hedyotis terminalis	Manono	Rubiaceae	Endemic
Ilex anomala	`Aiea	Aquifoliaceae	Indigenous
Melaleuca quinquenervia	Paperbark	Myrtaceae	Alien
Melastome candidum	Asian melastome	Melastomataceae	Alien
Melicope anisata	Mokihana	Rutaceae	Endemic
Melicope barbigera	U`ahiapele	Rutaceae	Endemic
Metrosideros polymorpha	`Ohia	Myrtaceae	Endemic
Microlepia strigosa	Palapalai	Dennstaedtiaceae	Indigenous
Myrica faya	Firetree	Myoporaceae	Alien
Myrsine alyxifolia	NCN	Myrsinaceae	Endemic
Myrsine lanaiensis	Kolea	Myrsinaceae	Endemic
Nestigis sandwicensis	Olopua	Oleaceae	Endemic
Passiflora mollissima	Banana poka	Passifloraceae	Alien
Peperomia sp.	Ala`ala`wai nui	Piperaceae	Native
Pittosporum glabrum	Hoawa	Pittosporaceae	Endemic
Pleomele aurea	Halapepe	Agavaceae	Endemic
Pouteria sandwicensis	Ala`a	Sapotaceae	Endemic
Psidium cattleianum	Strawberry guava	Myrtaceae	Alien
Psychotria greenwelliae	Kopiko	Rubiaceae	Endemic
Psychotria mariniana	Kopiko	Rubiaceae	Endemic
Rubus sp.	Blackberry	Rosaceae	Alien
Santalum freycinetianum	`Iliahi/sandalwood	Santalaceae	Endemic
Scaevola procera	Naupaka kuahiwi	Goodenaceae	Endemic

Streblus pendulinus	A`ai`a	Moraceae	Indigenous
Styphelia tameiameiae	Pu`kiawe	Epacridaceae	Indigenous
Tetraplasandra kavaiensis	Ohe`ohe	Araliaceae	Endemic
Vaccinium sp	Ohelo	Ericaceae	Endemic
Wilkstroemia furcata	Akia	Thymelaeceae	Endemic
Xylosma hawaiiense	Maua	Flacourtaceae	Endemic
Zanthoxylum dipetalum	A`e	Rutaceae	Endemic

Photo 1 – Native forest understory at Kokee

Photo 2 – Native forest at Kokee

Photo 3 – Native/non-native forest edge (blackberry thicket in foreground with koa and halapepe in background.

Photo 4 – Kauila (*Alphitonia ponderosa*), dominant canopy tree

Photo 5 – Ahakea (*Bobea brevipes*)

Photo 6 – Asian melastome *(Melastome candidum)* from Kokee "D"

A5 - PACIFIC MISSILE RANGE FACILITY KAMOKALA MAGAZINE BOTANICAL SURVEY

(NAVFAC PAC 2006d)

Pacific Missile Range Facility
Kamokala Magazine Botanical Survey Report
May 2006

INTRODUCTION

Botanical surveys were conducted most recently on Kamokala Navy property in 2000 by Char and Associates (for Belt Collins). They used a walk through reconnaissance method for the areas below 300 foot elevation. Char deemed the cliffs (Photo 1) to be too dangerous to traverse, and so they were surveying using only binoculars.

This survey, which was conducted on April 20, 2006 for the 2007 INRMP update, did not duplicate the Char survey. As a relatively safe route was found, this survey focused on the areas not surveyed by Char above the magazines and updating any dramatic changes to the installation vegetation. The stream (Photo 2) bank was also traversed.

METHODS

Using the same flagged survey transects as were used for the fauna surveys, the koa haole scrub forest area above the magazines was surveyed primarily for rare, native and incipient weed species.

RESULTS

The Mana Plain and low cliffs to the east of it are very weedy – Kamokala Magazine is no exception. However, several native, dryland species were still found, including wiliwili (*Erythrina sandwicensis*), a`ali`i (*Dodonaea viscosa*), pili (*Heteropogon contortus*) and lance fern (*Doryopteris decora*). Lance fern (Photo 3) is a new addition to the native species list from the Char survey, however, it is not considered to be rare. It is likely this species was missed by Char as the 2000 survey did not extend to the koa haole scrub above the magazine.

The usually dry stream was running due to recent heavy rains. The banks were thick with bufflegrass (*Cenchrus ciliaris*) and kukui (*Aleurites moluccana*).

DISCUSSION

The vegetation at Kamokala Magazine consists largely of koa haole scrub forest, with scattered wiliwili and kiawe trees. A narrow band of ruderal vegetation occurs around the paved areas, including roadsides. Both of these vegetation types are unchanged from when Char conducted her survey in 2000.

No threatened or endangered species were found during the survey. All of the plants found during the survey, including the natives, can be found at similar elevations on the northwest coast of Kauai and the other Hawaiian Islands. The site has not been further developed since the 2000 survey.

Invasive species such as golden crown-beard have been established in this area for at least a decade and their eradication is unlikely. As there are no rare species or habitats here, focusing on areas such as Barking Sands, Kokee and Makaha Ridge would be a better use of limited resources.

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Table 1. Kamokala partial plant list

SCIENTIFIC NAME	COMMON NAME	FAMILY	STATUS
Abutilon incanum	Hoary abutilon	Malvaceae	Alien
Abutilon grandifolium	Hairy abutilon	Malvaceae	Alien
Acacia farnesiana	Klu	Fabaceae	Alien
Aleurites moluccana	Kukui	Euphorbiaceae	Polynesian Intro
Cenchrus ciliaris	Bufflegrass	Poaceae	Alien
Dodonaea viscosa	A`ali`i	Sapindaceae	Indigenous
Doryopteris decora	Lance fern	Pteridaceae	Endemic
Erythrina sandwicenis	Wiliwli	Fabaceae	Endemic
Heteropogon contortus	Pili	Poaceae	Indigenous
Ipomea indica	Koali awa	Convolvulaceae	Indigenous
Lantana camara	Lakana	Verbenaceae	Alien
Leonotis nepetifolia	Lion's Ear	Lamiaceae	Alien
Leucaena leucocephala	Koa haole	Fabaceae	Alien
Opuntia ficus-indica	Prickly pear, Panini	Cactaceae	Alien
Peperomia leptostachya	Ala`ala`wainui	Piperaceae	Indigenous
Plumbago zeylanica	Ilie`e	Plumbaginaceae	Indigenous
Portulaca pilosa	NCN	Portulacaceae	Alien
Portulaca oleraceae	NCN	Portulacaceae	Alien
Prosopis pallida	Kiawe	Fabaceae	Alien
Rhynchelytrum repens	Natal redtop	Poaceae	Alien
Sida fallax	Ilima	Malvaceae	Indigenous
Solanum americanum	Popolo	Sapindaceae	Indigenous?
Verbesina encelioides	Golden crown-beard	Asteraceae	Alien
Waltheria indica	Uhaloa	Sterculiaceae	Indigenous

Photo 1 – Kamokala cliffs

Photo 2 – Kamokala Stream

Photo 3 – Lance fern (*Doryopteris decora*) at Kamokala.

A6 - BOTANICAL SURVEY OF BARKING SANDS

(CHAR 2000a)

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APPENDIX A-1

BOTANICAL SURVEY OF BARKING SANDS

FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP) PACIFIC MISSILE RANGE FACILITY (PMRF) BARKING SANDS, KAUAI, HAWAII

Prepared for:

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680 Ala Moana Boulevard
Honolulu, Hawaii 96813

Prepared by:

Winona P. Char
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June 2000

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Contents

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BARKING SANDS: INTRODUCTION

The Pacific Missile Range Facility at Barking Sands consists of 1,991 acres (806.19 hectares) located on the Mana Plain. The long, narrow property extends from Nohili Point on the north to Kokole Point on the south, a distance of about eight miles (13 kilometers). It is bounded on the west by the Pacific Ocean and on the east by agricultural lands—sugarcane fields, aquaculture ponds, and hybrid seed corn and sunflower fields. Polihale State Park is located to the north of Nohili Point. The Kauai County landfill and the Hawaii National Guard rifle range are located to the south of the property. Elevation on the facility ranges from sea level to 25 feet (7.5 meters), with some of the larger dunes on the north end of the station rising to 100 feet (30 meters) above sea level.

The majority of the site is developed with large, open, grassy lawn areas bordering the airfield and buildings. About 600 acres are undeveloped. The undeveloped areas are scattered throughout the facility and support mostly kiawe-koa haole scrub vegetation. Native plant dominated communities are the aalii-nama scrub found on the southern half of the station and the pohinahina-naupaka dune vegetation found at Nohili Point. Three other vegetation types occupy smaller areas on the facility.

Field studies to assess the botanical resources and to update the March 1988 Natural Resources Management Plan for the Barking Sands facility were conducted on December 20, 28, 29, and 30, 1999. A team of two botanists was used to gather the data contained in this report. The primary objectives of the field survey were to:

1) Provide a general description of the vegetation on the site;

2) Inventory the flora; and

3) Search for threatened and endangered species as well as species of concern.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the general area. Topographic maps as well as recent, colored photographs taken from a helicopter were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points.

A walk-through survey method was used. Notes were made on plant associations and distribution, substrate types, past and present disturbances, drainage, exposure, topography, etc. Plant identifications were made in the field. Plants, which could not be positively identified, were collected for later determination in the herbarium, and for comparison with the recent taxonomic literature.

The species recorded are indicative of the season ("rainy" vs. "dry") and the environmental conditions at the time of the survey. A survey taken at a different time of the year and under varying environmental conditions would no doubt yield slight variations in the species list, especially of the weedy, annual plants.

DESCRIPTION OF THE VEGETATION

Six vegetation types are recognized on the undeveloped portions of the project site; the undeveloped areas cover roughly 600 acres (240 hectares) of the Barking Sands facility. Kiawe-koa haole scrub occupies roughly 400 acres (160 hectares) and is found throughout the facility. This scrub vegetation varies from tall, dense forests in the more protected areas along the inland portion of the facility to low, windswept thickets along the oceanfront. Aalii-nama scrub covers about 100 acres (40 hectares) and is found on the southern half of the property. The other vegetation types together cover roughly 100 acres (40 hectares). Pohinahina-naupaka dune vegetation occurs on the seaward facing slopes of the sand dunes at Nohili Point. Strand vegetation occurs as a narrow band along the coastline and is poorly developed in most places. Ruderal vegetation is found along the roadways and also on areas that are infrequently maintained. Drainage-way/wetlands vegetation is found along and in the two drainage ditches which cross the site and also the ditch that runs along a portion of the mauka (inland) boundary.

An inventory of all the plants recorded on the facility is presented in the checklist at the end of the report.

Kiawe-Koa Haole Scrub

Kiawe (*Prosopis pallida*), native to Peru, Colombia, and Ecuador, was introduced into Hawaii in 1828. The seeds are very hard and pass through the digestive tract of livestock, and in this way they were quickly spread throughout the islands. Today, kiawe is a dominant component of the vegetation in dry, lowland, disturbed habitats. It is a fairly large tree with furrowed bark and wide-spreading crown. The branches bear slender, stipular spines one-quarter to one-half inch (0.3 to 1.7 centimeters) long (Neal 1965; Wagner *et al.* 1990).

Koa haole, native to tropical America, was first observed in Hawaii in 1837 (Wagner *et al.* 1990). It is abundant in low elevation, dry, disturbed sites throughout the main Hawaiian Islands and, like kiawe, it is a member of the pea or legume family (*Fabaceae*). Koa haole is a shrub to small tree.

Kiawe trees and koa haole shrubs are present in about equal numbers throughout most of the scrub vegetation. The tallest and densest scrub cover is found in the area behind the Nohili Point sand dunes, between Nohili Road and the sugarcane fields. In this more protected area, the kiawe trees are from 30 to 45 feet (9 to 14 meters) tall and the tree canopy cover is closed in most places, that is, the crowns of the trees interlock. Koa haole cover is somewhat patchy with the shrubs occurring primarily along the margins of the tree cover or in areas where the canopy is more open; the shrubs are from 5 to 12 feet (1.5 to 4 meters) tall. Guinea grass (*Panicum*

maximum), 2 to 3 feet (0.6 to 1 meter) tall, is locally abundant with smaller, scattered clumps of lantana shrubs (*Lantana camara*), 2 to 3 feet (0.6 to 1 meter) tall.

On the southern half of the property, from the end of the runway near Waieli Drive to just south of the gate to the housing area, the kiawe-koa haole scrub is more open, with scrub cover 30 to 50 percent. Kiawe trees vary in height from 20 to 30 feet (6 to 9 meters), and koa haole is from 5 to 12 (1.5 to 4 meters) tall. Lantana shrubs are abundant and form dense thickets, 5 to 7 feet (1.5 to 2 meters) tall, in the open areas between the trees. Wild basil shrubs (*Ocimum gratissimum*) are also abundant in some open areas. Kupala (*Sicyos pachycarpus*), an endemic member of the gourd or squash family (*Cucurbitaceae*), was abundant at the time of this survey in December. The kupala is an annual vine, coming up during the wetter months from about November through February; it probably would not be present during the dry summer months or would be very rare.

In the area around Majors Bay and the new comfort station, agave (*Agave sisalana*) plants are abundant in the kiawe-koa haole scrub. The agave forms a huge rosette of long, thick, stiff, straight leaves; each leaf is tipped with a purple to dark black spine. The larger rosettes are about 10 feet (3 meters) tall. Flowers are borne on long stalks, 20 to 25 feet (6 to 8 meters) tall.

Aalii-Nama Scrub

The aalii-nama scrub is found on the southern half of the property, from about the housing area to the antenna fields. The best example of this vegetation type is found in the area around the sewage stabilization pond.

Native plants are the dominant components in this vegetation type. Aalii shrubs (*Dodonaea viscosa*) are abundant, forming an open, patchy cover, 5 to 8 feet (1.5 to 2 meters) tall. Nama (*Nama sandwicensis*) is abundant and forms low, rounded cushions between the aalii and other shrubs; the nama is an annual to short-lived perennial herb, which is more abundant during the wetter parts of the year. Other native plants which are common to occasional in this vegetation type include naupaka (*Scaevola sericea*), ilima (*Sida fallax*), uhaloa (*Waltheria indica*), alena (*Boerhavia repens*), pohinahina (*Vitex rotundifolia*), and akiaki (*Sporobolus virginicus*). The pololei fern (*Ophioglossum polyphyllum*) is frequently encountered, growing in low lying areas on the sandy substrate and forming fairly large colonies.

Kiawe is found scattered throughout the aalii-nama scrub as individual trees or small stands of trees. Clumps of buffelgrass (*Cenchrus ciliaris*) and Guinea grass as well as lantana shrubs are found under and around the kiawe. Koa haole shrubs tend to occur along the edges of the aalii-nama scrub where it has been disturbed.

Pohinahina-Naupaka Dune Vegetation

This vegetation type occurs on the seaward facing slopes of the large dunes at Nohili Point. Pohinahina *(Vitex rotundifolia),* a woody, much-branched, sprawling shrub with bluish-purple flowers, forms low mats, 1 to 3 feet (0.3 to 1 meter) tall. Scattered here and there are low thickets

of naupaka *(Scaevola sericea),* 2 to 4 feet (0.6 to 1 meter) tall. Akoko *(Chamaesyce celastroides),* a succulent shrub belonging to the spurge family with milky sap, is locally abundant, especially in the area of the launch pads ("Lapa, BM 89" on the topographic maps). Closer to the beach, mats of akiaki grass, pohuehue or beach morning glory vines *(Ipomoea pes-caprae),* and hunakai vines *(Ipomoea imperata)* are common to abundant. Other native plants found here include ilima, alena, kaunaoa pehu *(Cassytha filiformis),* nama, akulikuli *(Sesuvium portulacastrum),* and aalii.

Scattered throughout the native dune vegetation are small, low, windswept patches of kiawe and koa haole scrub. A few clumps of buffelgrass, Bermuda grass *(Cynodon dactylon),* sourbush *(Pluchea carolinensis),* and *Portulaca pilosa* are occasionally encountered. Inland of the pohinahina-naupaka dune vegetation is dense kiawe-koa haole scrub.

In some places, the dune vegetation has been impacted by off-road vehicles (ORV). The plants help to bind the sand and stabilize the dunes. Loss of plant cover will lead to destabilization of the dunes and movement and loss of sand through wind erosion.

Strand Vegetation

The strand vegetation occurs as a narrow band along the coastline and is bordered on the mauka (inland) side by weedy fields (ruderal vegetation), or, in most places, by kiawe-koa haole scrub. Along the northern half of the facility, the strand vegetation consists of a few scattered low shrubs of naupaka and pohinahina as well as koa haole and Indian fleabane *(Pluchea indica);* the woody components are 2 to 3 feet (0.6 to 1 meter) tall and windswept. Along the seaward side, mats of akiaki grass are abundant. Other plants observed occasionally in this area are ilima, buffelgrass, pauohiiaka *(Jacquemontia ovalifolia),* akulikuli, Australian saltbush *(Atriplex semibaccata),* uhaloa, Bermuda grass, *Portulaca pilosa,* and hunakai.

On the southern half of the facility, from Waieli Drive to the end of the housing area, the strand vegetation is somewhat patchy and occurs as scattered clumps behind the sandy beaches. The two native species that are most frequently observed on this portion of the strand are the pohuehue or beach morning glory and akiaki grass. Introduced species such as buffelgrass, Bermuda grass, golden crown-beard *(Verbesina encelioides)* and Australian saltbush are common. Patches of low, windswept kiawe are also common. Individual trees to small stands of ironwood *(Casuarina equisetifolia)* are found scattered along the coastline. A few saplings and large trees of algaroba *(Prosopis juliflora)* are found here. Unlike the kiawe, this species of *Prosopis* has longer spines that are one-half to 2 inches (1 to 5 centimeters) long. The bluish-green leaflets are larger and fewer in number; and the trees form rounded hummocks, 10 to 30 feet (3 to 10 meters) tall, branching close to the ground with the lower branches running along the ground for some distance. The plants tend to be more prolific than kiawe and have large clusters of pale yellowish brown pods.

From the southern end of the housing area to the end of the property by the antenna fields, the strand vegetation consists of dense thickets of the long-spined algaroba. A few pockets of native

strand vegetation are found in some places. These contain shrubs of naupaka, pohinahina, and aalii; low mats of akiaki, hunakai, and pohuehue; and a tangle of kaunaoa pehu vines.

Drainageway/Wetlands

This vegetation type occupies only a small area on the facility, but is utilized by various waterbirds. During this survey, the endangered Hawaiian Moorhen or Alae ula and the Hawaiian Coot or Alae keokeo were observed in the two ditches which cross the Barking Sands facility.

Large mats of seashore paspalum *(Paspalum vaginatum)* line the ditches, often forming floating mats. Along the lower banks of the ditches, there are dense thickets of Indian fleabane and tall, solid mats of California grass *(Brachiaria mutica).* A narrow band of koa haole shrubs and scattered trees of kiawe and milo *(Thespesia populnea)* is found along the top of the banks. Where the drainage ditches cross onto the beach area, a few components of the strand vegetation are found; these include pohinahina, Australian saltbush, naupaka, and akulikuli.

Ruderal Vegetation

Ruderal vegetation is found alongside the paved and unpaved roads which transect the facility; some of these areas are mowed regularly, others infrequently. Ruderal vegetation also occurs on disturbed, overgrown parcels.

The most abundant species along the roadside are buffelgrass, which forms low, lumpy clumps, and Bermuda grass, which forms a low, somewhat thick mat. Weedy, mostly annual species, which are associated with this vegetation type include Spanish needle *(Bidens pilosa), Portulaca pilosa,* lovegrass *(Eragrostis amabilis),* Cuba jute *(Sida rhombifolia),* buttonweed *(Spermacoce assurgens),* crabgrass *(Digitaria* sp.), and several spurges—hairy spurge *(Chamaesyce hirta),* graceful spurge *(C. hyericifolia),* prostrate spurge *(C. prostrata),* and *C. hyssopifolia.* In places, golden crown-beard and false mallow *(Malvastrum coromandelianum)* are locally abundant.

Also included in the ruderal vegetation is the "daisy field" vegetation type recognized in the earlier Botanical Consultants survey (1985). The "daisy field" vegetation type is found in areas that have been cleared and a dense cover of golden crown-beard, a member of the daisy family, develops. Golden crown-beard is an early invader (pioneer) of disturbed sites. Other weedy species as well as a few native species that prefer more open habitats soon replace it; these more closely resemble the components that characterize the ruderal vegetation. A large open parcel near the northern drainage ditch supports low clumps of buffelgrass and Bermuda grass; the site appears to be infrequently bladed. Scattered here and there are koa haole and lantana shrubs which have been reduced to low stubs, 2 to 6 inches (5 to 15 centimeters) tall. Patches of golden crown-beard are locally abundant. A few native plants associated with the strand vegetation can also be found here and include nama, hunakai, alena, ilima, pauohiiaka, naupaka, and pohuehue.

RARE PLANTS

The pololei fern, formerly *Ophioglossum concinnum,* was a candidate endangered species in the earlier studies (Botanical Consultants 1985; The Traverse Group, Inc. 1988). The fern is a small, perennial species with paddle-shaped fronds, 3 to 5 inches (8 to 13 centimeters) long. Fertile fronds bear a simple, spiked structure, which contains numerous sulphur-yellow, dust-like spores. The fronds die back during the dry summer months, but with the following rainy season, the somewhat tuberous, underground rhizmones send up new fronds. The fern is associated with the aalii-nama scrub vegetation, but has also been found in the mowed, grassy lawn of the old Japanese cemetery and in the strand vegetation. During the biological studies for the Exoatmospheric Discrimination Experiment (EDX) Launch Facilities at Barking Sands, *Ophioglossum* plants were found in open areas adjacent to the kiawe-koa haole scrub vegetation (U.S. Army 1990).

In 1992, the U.S. Fish and Wildlife Service proposed that the *Ophioglossum* along with 12 other plant species be listed as an endangered species. In 1993, the Service removed the fern from its proposal. Scientific studies indicated that this species was not an endemic species, but part of the more widely distributed and common *Ophioglossum polyphyllum* complex.

Nama sandwicensis was added as a species of concern in 1999 (U.S. Fish and Wildlife Service 1999). Species of concern do not receive legal protection under the State and Federal Endangered Species laws; use of the term does not mean that the species will eventually be listed as threatened or endangered. Species of concern are plants for which more biological and/or taxonomic information is needed; biological information includes population numbers, numbers of individuals, threats, and reproductive biology. The nama is considered to be a low priority species. It has a wide distribution range, occurring in sandy soils or raised limestone reefs on Hawaii, Maui, Molokai, Lanai, Oahu, Kauai, Lisianski, and Laysan (Wagner *et al.* 1990). On the Barking Sands facility, it is one of the major components in the aalii-nama scrub. It can also be found in smaller numbers in the pohinahina-naupaka scrub at Nohili Point and in the ruderal vegetation.

Other than the nama, there are no other threatened and endangered species or species of concern (U.S. Fish and Wildlife Service 1999) on the Barking Sands facility.

DISCUSSION AND RECOMMENDATIONS

Six vegetation types are recognized on the undeveloped portions of the Barking Sands facility. Introduced plants are the dominant components in four of the vegetation types; these are the kiawe-koa haole scrub (which occupies most of the undeveloped areas), ruderal vegetation, drainageway/wetland vegetation, and strand vegetation. Native plants dominate two vegetation types, the aalii-nama scrub and the pohinahina-naupaka dune vegetation.

A total of 119 species have been recorded from the Barking Sands site. Of these 96 (81 percent) are introduced and 23 (19 percent) are native. Of the natives, 18 are indigenous, that is, they are

native to the Hawaiian Islands and elsewhere. Five species are endemic, that is, they are native only to the Hawaiian Islands. These endemic species are nama *(Nama sandwicensis),* pauohiiaka *(Jacquemontia ovalifolia* ssp. *sandwicensis),* kupala *(Sicyos pachycarpus),* kauanaoa *(Cuscuta sandwichiana),* and akoko *(Chamaesyce celastroides).* The U.S. Fish and Wildlife Service consider the nama a species of concern.

The areas that support native plant dominated communities or vegetation types should be protected and managed. The Nohili Point sand dunes should be off-limits to off-road vehicles. Signage should be placed along the edges of the dune and any vehicles caught on the dunes should be escorted off the facility. There is a large bowl area on the southern end of the dunes where the naupaka shrubs and other vegetation has been damaged. Replanting of this area with naupaka shrubs to stabilize the dune was recommended in the 1988 Natural Resources Management Plan (The Traverse Group, Inc. 1988). This is still a good recommendation and should be followed through.

No further development should take place in the aalii-nama scrub vegetation on the makai (seaward) side of the main road. The aalii-nama scrub is largely intact and is perhaps one of the best examples of this vegetation type in the islands. A cooperative program could be set up with the U.S. Fish and Wildlife Service or perhaps The Nature Conservancy of Hawaii for management of this area. Introduced plants such as kiawe, koa haole, buffelgrass, and *Pluchea,* etc., should be removed.

The long-spined algaroba *(Prosopis juliflora)* appears to be restricted to the narrow band of strand vegetation on the southern half of the property. It should be removed before it spreads inland.

The trees are large, mature, and produce many seeds. A carpet of old seedpods can be found under most of the larger plants. There have been recent sightings of smaller plants along the coastline to the south of the facility. The Kauai branch of the State Department of Agriculture should be contacted for information on eradicating the plants; the department is currently mapping the distribution and numbers of the *Prosopis.*

Previous to its discovery on Kauai, *Prosopis juliflora* was only known from a small population on Oahu at Sand Island and vicinity. The first naturalized collection was made in 1978 (Wagner *et al.* 1990).

The plant material should not be disposed of in a landfill since the seeds could germinate. The sites where the plants occurred should also be periodically monitored for any new seedlings. Many members of the pea family such as the *Prosopis* have seeds that can lay dormant in the soil for a long period of time.

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BARKING SANDS PLANT SPECIES LIST

The following checklist is an inventory of all the plants observed during the field studies. The plant names are arranged alphabetically by families within each of three groups: Ferns, Dicots and Monocots. The taxonomy and nomenclature of the flowering plants, Dicots and Monocots, follow Wagner *et al.* (1990). The few recent name changes for the flowering plants follow those reported in the Hawaii Biological Survey series (Evenhuis and Miller, eds. 1995-1998; Evenhuis and Eldredge, eds., 1999). An asterisk (*) before a plant name indicates that the species was not recorded in the earlier studies for the facility (Botanical Consultants 1985; the Traverse Group, Inc. 1988).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:

   E = endemic = native only to the Hawaiian Islands.

   I = indigenous = native to the Hawaiian Islands and also elsewhere.

   I? = questionably indigenous = data not clear if dispersal by natural or human-related mechanisms, but weight of evidence suggests probably indigenous.

   X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact, that is, Cook's discovery of the islands in 1778.

   X? = questionably introduced = date of introduction unclear; may be indigenous or of Polynesian introduction.
4. Presence (+) or absence (-) of a particular species within each of six vegetation types recognized on the project site (see text for discussion):

   k = Kiawe-Koa Haole Scrub

   a = Aalii-Name Scrub

   p = Pohinahina-Naupaka Dune Vegetation

   s = Strand Vegetation

   d = Drainageway/Wetlands

   r = Ruderal Vegetation

TABLE 1: SPECIES LIST—BARKING SANDS

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE					
			K	A	P	S	D	R
FERNS								
OPHIOGLOSSACEAE (Adder's-tongue fern family)								
Ophioglossum polyphyllum A. Braun	pololei	I	-	+	-	-	-	-
FLOWERING PLANTS								
DICOTS								
ACANTHACEAE (Acanthus family)								
Asystasia gangetica (L.) T. Anderson	Chinese violet, coromandel	x	+	-	-	-	-	+
AIZOACEAE (Fir-marigold family)								
Sesuvium portulacastrum (L.) L.	akulikuli	I	-	-	+	+	-	-
AMARANTHACEAE (Amaranthus family)								
**Alternanthera sessilis* (L.) DC	sessile joyweed	x	-	-	-	-	-	+
Amaranthus spinosus L.	spiny amaranth, pakai kuku	x	-	-	-	-	-	+
**Amaranthus viridus* L.	slender amaranth, pakai	x	-	+	-	-	-	-
ANACARDIACEAE (Mango family)								
Schinus terebinthifolius Raddi	Christmas berry	x	-	+	-	-	-	-
ASCLEPIADACEAE (Milkweed family)								
**Calotropis procera* (Aiton) W.T. Aiton	small crown flower	x	-	-	-	+	-	-
ASTERACEAE (Daisy family)								
Bidens cynapiifolia Kunth	West Indian beggar's tick	x	+	-	-	-	-	-
Bidens pilosa L.	Spanish needle, ki, ki nehe	x	+	+	+	-	-	+
Conyza bonariensis (L.) Cronq.	hairy horseweed, ilioha	x	+	+	-	-	-	-
**Gaillardia pulchella* Foug.	blanket flower, melekuli wai kahuli, waikahuli	x	-	+	-	-	-	-
**Galinsoga parviflora* Cav.	galinsoga	x	-	-	-	-	-	+

TABLE 1: SPECIES LIST—BARKING SANDS *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE					
			K	A	P	S	D	R
DICOTS *(continued)*								
xGamochaeta purpurea (L.) Cabr.	purple cudweed	x	-	-	-	-	-	+
**Heterotheca grandiflora* Nutt.	telegraph plant	x	-	-	-	-	-	+
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	x	+	-	+	-	+	+
**Pluchea* x *fosbergii* Cooperr. & Galang	pluchea hybrid	x	-	-	-	-	-	+
Pluchea indica (L.) Less.	Indian fleabane, Indian pluchea	x	+	+	-	+	+	+
**Sonchus oleraceus* L.	sowthistle, pualele	x	-	+	+	+	-	+
Tridax procumbens L.	coat buttons	x	-	+	-	-	-	-
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard	x	+	+	+	+	+	+
Xanthium strumarium var. *canadense* (Mill.) Torr. & A.Gray	cocklebur, kikania	x	-	-	-	+	-	+
BORAGINACEAE (Borage family)								
**Heliotropium procumbens* var. *depressum* (Cham.) Fosb.		x	-	-	-	-	-	+
CACTACEAE (Cactus family)								
Opuntia ficus-indica (L.) Mill.	panini, papipi	x	+	-	-	-	-	-
CAPPARACEAE (Caper family)								
**Cleome gynandra* L.	wild spider flower, hohohina	x	-	+	-	-	-	+
CASUARINACEAE (She-oak family)								
Casuarina equisetifolia L.	ironwood, paina	x	-	-	+	+	+	-
CHENOPODIACEAE (Goosefoot family)								
Atriplex semibaccata R. Br.	Australian saltbush	x	-	-	+	+	+	+
**Chenopodium carinatum* R. Br.		x	-	+	-	-	-	+
Chenopodium murale L.	aheahea	x	+	-	+	+	-	+

TABLE 1: SPECIES LIST—BARKING SANDS *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE					
			K	A	P	S	D	R
DICOTS *(continued)*								
CONVOLVULACEAE (Morning glory family)								
Ipomoea imperata (Vahl) Griseb.	hunakai	I	-	-	+	+	-	+
Ipomoea indica (J. Burm.) Merr.	koali awa, koali awahia	I	+	-	-	-	-	-
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	x	+	-	-	-	-	+
Ipomoea pes-caprae ssp. *Brasiliensis* (L.) Ooststr.	pohuehue, beach morning glory	I	-	-	+	+	-	+
Jacquemontia ovalifolia ssp. *Sandwicensis* (A. Gray) K. Robertson	pauohiiaka	E	-	-	-	+	-	+
Merremia aegyptia (L.) Urb.	hairy merremia, koali kua hulu	x?	+	-	-	-	-	-
CUCURBITACEAE (Gourd family)								
Cucumis dipsaceus Ehrenb. ex Spach	wild cucumber, hedgehog gourd	x	+	-	-	+	-	-
Momordica charantia L.	wild bittermelon	x	+	+	-	-	-	-
Sicyos pachycarpus H. & A.	kupala	E	+	-	-	-	-	-
CUSCUTACEAE (Dodder family)								
Cuscuta sandwichiana choisy	kaunaoa	E	-	-	-	+	-	-
EUPHORBIACEAE (Spurge family)								
Chamaesyce celastroides (Boiss.) Croizat & Degener	akoko	E	-	-	+	-	-	-
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	x	-	+	-	-	-	+
**Chamaescyce hypericifolia* (L.) Millsp.	graceful spurge	x	-	-	-	-	-	+
**Chamaesyce hyssopifolia* (L.) Small		x	-	-	-	-	-	+
**Euphorbia cyathophora* J.A. Murray	wild poinsettia	x	-	+	-	-	-	-
Ricinus communis L.	castor bean, koli	x	+	-	-	-	-	+
FABACEAE (Pea family)								
Acacia farnesiana (L.) Willd.	klu	x	+	+	-	-	-	+
**Alysicarpus vaginalis* (L.) DC	alysicarpus	x	-	-	-	-	-	+

TABLE 1: SPECIES LIST—BARKING SANDS *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE					
			K	A	P	S	D	R
DICOTS *(continued)*								
Crotalaria pallida Aiton	smooth rattlepod, pikakani	x	-	-	-	-	-	+
Desmanthus pernambucanus (L.) Thellung	Slender mimosa	x	+	-	-	-	-	+
Desmodium incanum DC	Spanish clover, kaimi	x	-	-	-	-	-	+
*Indigofera suffruti*cosa Mill.	Indigo, iniko	x	+	-	-	-	-	-
Leucaena leucocephala (Lam.) de Wit	Koa haole	x	+	+	+	+	+	+
**Macroptillium atropurpureum* (DC) Urban		x	-	-	-	-	-	+
**Macroptillium latyroides* (L.) Urb.	wild bean, cow pea	x	+	-	-	-	-	-
**Medicago polymorpha* L.	Bur clover	x	-	-	-	-	-	+
Pithecellobium dulce (Roxb.) Benth	opiuma	x	+	-	-	-	-	-
**Prosopis juliflora* (Sw.) DC	Algaroba, mesquite	x	-	-	-	+	-	-
Prosopis pallida (Humb. & Bonpl. Ex Willd.) Kunth	Kiawe, algaroba	x	+	+	+	+	+	+
GOODNEIACEAE (Goodenia family)								
Scaevola sericea Vahl	naupaka kahakai, naupaka, beach naupaka	I	-	+	+	+	+	+
HYDROPHYLLACEAE (Waterleaf family)								
Nama sandwicensis A. Gray	nama	E	-	+	+	-	-	+
LAIMACEAE (Mint family)								
**Hyptis pectinata* (L.) Poit.	Comb hyptis	x	-	-	-	-	+	+
Leonotis nepetifolia (L.) R. Br.	Lion's ear	x	+	+	-	-	-	+
Ocimum gratissimum L.	Wild basil	x	+	-	-	-	-	-
Stachys arvensis L.	Staggerweed	x	-	-	-	-	-	+
LAURACEAE (Laurel family)								
**Cassytha filiformis* L.	Kaunaoa pehu	I	+	-	+	+	-	-
MALVACEAE (Mallow family)								
Abutilon grandifolium (Willd.) Sweet	hairy abutilon, mao	x	+	-	-	-	-	+
Malva parviflora L.	Cheeseweed	x	-	-	-	-	-	+

TABLE 1: SPECIES LIST—BARKING SANDS *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE					
			K	A	P	S	D	R
DICOTS *(continued)*								
Malvastrum coromandelianum (L.) Garcke	false mallow, hauuoi	x	+	-	-	-	-	+
Sida fallax Walp.	ilima	I	+	+	+	+	-	+
Sida rhombifolia L.	Cuba jute	x	-	-	-	-	-	+
**Thespesia populnea* (L.) Sol. Ex Correa	milo	I?	-	-	-	-	+	-
MYRTACEAE (Myrtle family)								
**Syzygium cumini* (L.) Skeels	Java plum	x	-	-	-	-	+	+
NYCTAGINACEAE (Four-o'clock family)								
Boerhavia coccinea Mill.		x	+	+	-	+	-	+
Boerhavia repens L.	alena	I	-	+	+	+	-	+
Mirabilis jalapa L.	four-o'clock, marvel of Peru, nani ahiahi	x	+	+	-	-	-	-
PASSIFLORACEAE (Passion flower family)								
Passiflora foetida L.	running pop, pohapoha	x	-	+	-	+	-	+
Passiflora suberosa L.	huehue haole	x	+	-	-	-	-	-
PHYTOLACCACEAE (Pokeweed family)								
Rivina humilis L.	coral berry	x	+	-	-	-	-	-
POLYGONACEAE (Buckwheat family)								
Antigonon leptopus Hook. & Arnott	Mexican creeper	x	+	-	-	-	-	-
PORTULACACEAE (Purslane family)								
Portulaca oleracea L.	pigweed, akulikuli kula, ihi	x	+	-	-	+	-	-
Portulaca pilosa L.		x	-	+	+	+	-	+
RUBIACEAE (Coffee family)								
**Spermacoce assurgens* Ruiz & Pav.	buttonweed	x	-	-	-	-	-	+

TABLE 1: SPECIES LIST—BARKING SANDS *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE					
			K	A	P	S	D	R
DICOTS *(continued)*								
SAPINDACEAE (Soapberry family) *Dodonaea viscosa* Jacq.	aalii, aalii ku makani	I	+	+	+	+	+	-
SOLANACEAE (Nightshade family) **Solanum americanum* Mill.	popolo, glossy nightshade	I?	+	+	-	-	-	-
Solanum lycopersicon var. *cerasiforme* (Dunal) Spooner, Anderson & Jansen	currant tomato, wild tomato	x	+	-	+	-	-	-
STERCULIACEAE (Cacao family) *Waltheria indica* L.	uhaloa, hialoa, kanakaloa	I?	+	+	+	+	-	+
VERBENACEAE (Verbena family) *Lantana camara* L.	lantana, lakana	x	+	+	-	-	-	+
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, owi, oi	x	-	-	-	-	+	+
Verbena litoralis Kunth	weed verbena, owi, oi	x	+	-	-	-	-	-
Vitex rotundifolia L.f.	pohinahina, kolokolo kahakai, beach vitex	I	-	+	+	+	-	-
ZYGOPHYLLACEAE (Creosote bush family) *Tribulus terrestris* L.	puncture vine, goat head	x	-	-	-	+	-	+
MONOCOTS								
AGVACEAE (Agave family) *Agave sisalana* Perrine	sisal, malina	x	+	-	-	+	-	-
ARECACEAE (Palm family) *Phoenix* sp.	date palm	x	+	-	-	+	-	-
CYPERACEAE (Sedge family) **Bilboschoenus maritimus* ssp. *Paludosus* (A. Nels.) T. Koyama	kaluha	I	-	-	-	-	+	-

TABLE 1: SPECIES LIST—BARKING SANDS *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE					
			K	A	P	S	D	R
MONOCOTS *(continued)*								
Cyperus rotundus L.	nutgrass, nut sedge	x	-	+	-	-	-	+
Fimbristylis cymosa R. Br.		I	-	+	-	+	-	-
LILIACEAE (Lily family)								
Aloe vera L.	aloe	x	-	-	-	+	-	-
POACEAE (Grass family)								
Bothriochloa sp.		x	-	-	-	-	-	+
Brachiaria mutica (Forssk.) Stapf.	California grass	x	+	-	-	-	+	+
Cenchrus ciliaris L.	buffelgrass	x	+	+	+	+	+	+
Cenchrus echinatus L.	common sandbur, ume, alu	x	-	-	-	+	-	-
Chloris barbata (L.) sw.	swollen fingergrass, mau lei	x	-	-	+	-	-	+
**Coix lachryma-jobi* L.	Job's tears	x	-	-	-	-	+	-
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	x	+	+	+	+	-	+
Dactyloctenium aegyptium (L.) Willd.	beach wiregrass	x	-	+	-	+	-	-
Digitaria insularis (L.) Mez ex Ekman	sourgrass	x	-	-	-	-	-	+
**Digitaria setigera* Roth	kukaepuaa, itchy crabgrass	I?	-	-	-	-	-	+
Digitaria sp.	crabgrass	x	+	-	-	-	-	-
Eleusine indica (L.) Gaertn.	wiregrass, goosegrass	x	-	-	-	-	-	+
Eragrostis amabilis (L.) Wight & Arnott	lovegrass	x	-	+	+	-	-	+
Melinis minutaflora P. Beauv.	molasses grass	x	+	+	-	-	-	-
Melinis repens (Willd.) Zizka	Natal redtop, Natal grass	x	-	+	-	-	-	+
Panicum maximum Jacq.	Guinea grass	x	+	+	-	-	-	+
Paspalum conjugatum Bergius	Hilo grass, mauu Hilo	x	-	-	-	-	-	+
**Paspalum vaginatum* Sw.	seashore paspalum	x	-	-	-	-	+	-
**Setaria verticillata* (L.) P. Beauv.	bristly foxtail, mauu pilipili	x	+	+	-	-	-	-
Sporobolus virginicus (L.) Kunth	akiaki, beach dropseed	I	-	+	+	+	-	-

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APPENDIX A-2
BOTANICAL SURVEY OF MAKAHA RIDGE

FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP)
PACIFIC MISSILE RANGE FACILITY (PMRF)
BARKING SANDS, KAUAI, HAWAII

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June 2000

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Contents

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MAKAHA RIDGE: INTRODUCTION

The Makaha Ridge project site consists of 244.7 acres (89.07 hectares) of land leased from the State of Hawaii. The site is located at the end of Makaha Ridge and is dissected by a number of gullies and a few deep gulches. Kauhao Valley is found along the southern boundary, the almost vertical Na Pali cliffs occur along the western (makai) boundary, and the precipitous cliffs of Makaha Valley mark the northern boundary. Elevation on the eastern (mauka) boundary near the water tank and access road is 1,875 feet (568 meters) and about 1,000 feet (303 meters) along the cliffs facing the ocean.

Operation facilities comprise the Makaha Ridge Tracking Station, The majority of the site, approximately 85 percent, is undeveloped. Barren to very sparsely vegetated eroded areas are found along the cliffs and in the gulches. Rows of pine trees planted for erosion control and reforestation purposes are found within a dense, mixed scrub vegetation which covers much of the undeveloped portions of the project site. One endangered species, the dwarf iliau *(Wilkesia hobdyi),* is known from the cliff areas of Makaha Ridge.

Field studies to assess the vegetation on the Makaha Ridge site were conducted on 16 and 17 December 1999; a team of two botanists was used for the survey. The primary objectives of the survey were to:

1) provide a general description of the vegetation on the site;

2) inventory the flora; and

3) search for threatened and endangered species as well as species of concern.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the general area. Topographic maps of the facility, soil maps, and photographs of the site taken from a helicopter were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries, and reference points.

A walk-through survey method was used. For the cliffs and deep gulches, binocular observations were made. Notes were made on plant associations and distribution, substrate types, topography, exposure, and drainage disturbances. Plant identifications were made in the field; plants which could not be positively identified were collected for later determination in the herbarium, and for comparison with the recent taxonomic literature.

The species recorded are indicative of the season (“rainy” vs. “dry”) and the environmental conditions at the time of the survey. A survey taken at a different time of the year and under varying environmental conditions would no doubt yield slight variations in the species list, especially of the weedy, annual plants.

DESCRIPTION OF THE VEGETATION

There has been no comprehensive botanical survey of the entire site to our knowledge. Only a limited botanical study was made for two sites during the evaluation of potential locations for the Mountaintop Sensor Integration and Test Program Facility. The sites were roughly 50 feet wide by 50 feet long (15 meters x 15 meters). One site was located on an existing asphalt-paved area with a few concrete pads, and the other on mostly barren, exposed soil. Introduced grasses and mostly weedy herbs and small shrubs were found (Char 1992).

In the studies for this Integrated Natural Resources Management Plan, three vegetation types are recognized on the undeveloped areas. An inventory of all the plants found during the field studies is presented in the checklist at the end of the report.

Cliff Vegetation

The rugged and spectacular cliffs of the Na Pali coastline and the steep valley walls are composed of thin-bedded lavas of the Napali Formation which have been eroded by running water (Macdonald and Abbott 1970). In some places, rocky outcrops of denser, harder material can be found along the weathered cliff face.

Vegetation on these steep areas is very sparse to sparse, 1 to 5 percent plant cover, with the plants occurring in small patches scattered across the cliff face usually on ledges or long, narrow terraces. Cliff vegetation is also found on severely eroded portions of the ridge top.

Low shrubs of naio or false sandalwood *(Myoporum sandwicense),* 2 to 4 feet (0.6 to 1 meter) tall, and rounded clumps of kawelu *(Eragrostis variabilis),* a bunch grass, are the most frequently observed native species on the cliffs. Other native species that occur here in smaller numbers include pili grass *(Heteropogon contortus),* aalii *(Dodonaea viscosa),* çahinahina *(Artemisia australis),* golden beardgrass or pilipili ula *(Chrysopogon aciculatus),* and alahe *(Psydrax odorata).* Plants of the dwarf iliau *(Wilkesia hobdyi),* an endangered species, are found on rocky outcrops facing Makaha Valley. A more detailed discussion of *Wilkesia* is found in the "Endangered Plants" section of this report.

Some of the more frequently observed introduced plants found on the cliffs include low shrubs of lantana *(Lantana camara);* clumps of Natal redtop grass *(Melinis repens)* and pitted beardgrass *(Bothriochloa pertusa);* and scattered tussocks of gold fern *(Pityrogramma calomelanos).* In places where the weathered substrate material is partially shaded and damp, seedlings of brome fescue *(Vulpia bromoides)* form small, yellow-green carpets.

Pine Plantings/Mixed Scrub

This vegetation type covers the most area on the Makaha Ridge site where it occurs primarily on the areas with soils of the Niu and Puu Opae series. These are silty clay loam soils and slopes may vary from 12 to 40 percent (Foote *et al.* 1972).

In most places, there are rows or scattered clumps of pine trees *(Pinus* af. *radiata),* which were planted for erosion control. Also abundant are silk oak trees *(Grevillea robusta);* this species is also used for reforestation and has become naturalized (Wagner *et al.* 1990). The pine and silk oak trees are 30 to 40 feet (9 to 12 meters) tall; on deeper soils on parts of the study site, the trees may reach 50 feet (15 meters) in height. A mixed scrub composed primarily of lantana shrubs and molasses grass *(Melinis minutiflora)* with scattered shrubs of guava *(Psidium guajava)* forms a dense matrix between the trees. In some places, lantana forms a dense, prickly thicket, 3 to 7 feet (1 to 2 meters) tall, making surveying slow and difficult.

A few variants of this vegetation type can be recognized on the project site. On the ridge around the helicopter landing site, there are large, barren, eroded areas. The vegetation cover is patchy, about 40 to 50 percent. Tree cover is open to very open with most of the plant cover consisting of low, rounded clumps of lantana, 2 to 3 feet (0.6 to 1 meter) tall, and mats of molasses grass. In this more open scrub, clumps of kilau fern *(Pteridium aquilinum)* are locally abundant. Mats of golden beardgrass and tufted clumps of little bluestem grass *(Schizachyrium condensatum)* are common.

On the southern portion of the property, the unnamed gulch supports a large planting of *Eucalyptus* trees, 70 to 80 feet (21 to 24 meters) tall. The lower slopes of this gulch support rather dense thickets of guava, 16 to 20 feet (5 to 6 meters) tall. In places, alahee shrubs *(Psydrax odorata)* are abundant. Koa trees *(Acacia koa)* are occasional in this area.

Besides the alahee and koa mentioned above, other native plants which can be found associated with the pine plantings/mixed scrub include: shrubs of naupaka kuahiwi *(Scaevola gaudichaudii),* naio, and pukiawe *(Styphelia tameiameiae);* huehue vine *(Cocculus orbiculatus);* sedges such as *Gahnia beechyii* and *Carex wahuensis;* and ukuuki *(Dianella sandwicensis),* a member of the lily family with dark blue berries.

Ruderal Vegetation

Ruderal or weedy wayside vegetation is found on areas which have been disturbed, but are infrequently maintained. It is usually associated with the dirt roads and the interface area where the grassy lawns adjoin barren, eroded sections or pine plantings/mixed scrub.

The vegetation consists of a mixture of various grasses and weedy, mostly annual herbaceous species. A few small lantana shrubs are also scattered through this vegetation type. Molasses grass, Natal redtop, and pitted beardgrass are the most frequently observed grasses. Among the herbaceous species, the following are usually widespread: narrow-leaved plantain *(Plantago lanceolata),* Spanish clover *(Desmodium incanum),* black medick *(Medicago lupulina),* broad-leaved plantain *(Plantago major),* virgate mimosa *(Desmanthus virgatus),* sensitive plant *(Mimosa pudica),* and fuzzy rattlepod *(Crotalaria incana).* Other species such as maile hohono *(Ageratum houstonianum),* spiny bur *(Acanthospermum australe),* daisy fleabane *(Erigeron karvinskianus),* and primrose willow *(Ludwigia octovalvis)* are more restricted in distribution and were encountered only once during the survey.

ENDANGERED PLANTS

The dwarf iliau *(Wilkesia hobdyi),* a Federal and State endangered species, occurs on the cliffs overlooking Makaha Valley (Hawaii Heritage Program database, The Nature Conservancy of Hawaii). The largest colony consists of 40 plus plants. The two smaller colonies contain about to two to four plants (see map attached). All three colonies were observed to have a few flowering plants. The plants are found on the denser, harder rock outcrops with nearly vertical faces, and out of the reach of the goats which frequent the area. At least 30 goats were observed on or near the cliff areas during our field studies.

Common associates observed growing with the *Wilkesia* on the Makaha Ridge site include natives such as ahinahina *(Artemisia australis),* kawelu *(Eragrostis variabilis),* naio *(Myoporum sandwicense),* pili grass *(Heteropogon contortus),* kilau fern *(Pteridium aquilinum),* and aalii *(Dodonaea viscosa).* Introduced plants include lantana *(Lantana camara),* Natal redtop *(Melinis repens),* silk oak *(Grevillea robusta),* brome fescus *(Vulpia bromoides),* gold fern *(Pityrogramma calomelanos),* and molasses grass *(Melinis minutiflora).*

Wilkesia hobdyi, a member of the daisy or sunflower family *(Asteraceae),* is a shrub about 2 feet (0.6 meter) tall, which branches somewhat profusely from the base. Each branch bears a tuft of narrow leaves one-half inch (1.3 centimeters) wide and about 3 to 6 inches (7.5 to 15 centimeters) long. The flower heads occur in clusters 10 to 18 inches (25 to 45 centimeters) long. Each flower head is cream colored and about .75 inch (2 centimeters) in diameter (Wagner *et al.* 1990; U.S. Fish and Wildlife Service 1995).

Wilkesia hobdyi was listed as endangered in 1992 by the U.S. Fish and Wildlife Service. Current population estimates range between 420 to 510 individuals (U.S. Fish and Wildlife Service 1999). Five populations are known. The Polihale Ridge population is estimated to contain between 250 and 300 plants. The Kaaweiki Ridge population consists of about 100 individuals. A third population on the cliff face in Waiahuakua Valley contains 10 to 50 individuals. The Makaha Ridge population is estimated to be about 50 plants and the Pohakuao population contains about 10 plants (U.S. Fish and Wildlife Service 1995).

The greatest threat to the survival of this species is browsing by goats. The goats eat the plants, and their activity in the area also accelerates erosion and facilitates the encroachment of introduced species such as molasses grass and lantana. Other threats include invasion and competition from weedy species and landslides (U.S. Fish and Wildlife Service 1995, 1999).

DISCUSSION AND RECOMMENDATIONS

Maintained, grassy lawns and a few landscape plantings are found around the buildings and other structures on Makaha Ridge. On the undeveloped portions of the site, which covers most of the ridge, three vegetation types are recognized. The cliffs and severely eroded areas support sparse to very sparse cliff vegetation. About 50 plants of the dwarf iliau *(Wilkesia hobdyi),* an endangered species, are found on the cliffs facing Makaha Valley. A large portion of ridge top supports plantings of pine trees and a dense scrub composed primarily of lantana, molasses grass, and scattered guava shrubs; silk oak trees are also common in this vegetation type. Weedy

ruderal vegetation is found on disturbed, infrequently maintained areas and occupies only a small portion of the site.

A total of 100 plant species were inventoried on the site. Of these, 76 (76 percent) are introduced or alien species, 3 (3 percent) are originally of Polynesian introduction, and 21 (21 percent) are native. Of the natives, 12 are indigenous, that is, they are native to the Hawaiian Islands and elsewhere. Nine plants are endemic, that is, they are native only to the Hawaiian Islands. These endemic species are the kilau *(Pteridium aquilinum* var. *decompositum)* and kumuniu *(Doryopteris decipiens)* ferns; the kawelu *(Eragrostis variabilis),* a bunch grass; two members of the sedge family, *Carex wahuensis* and *Gahnia beechyii;* three small to medium size shrubs—ahinahina *(Artemisia australis),* naupaka kuahiwi *(Scaevola gaudichaudii),* and dwarf iliau *(Wilkesia hobdyi);* and koa trees *(Acacia koa),* which are occasional in the pine plantings/mixed scrub.

With the exception of the *Wilkesia,* all the other native species can be found in similar environmental habitats throughout the main Hawaiian Islands. These other species are not considered threatened and endangered or species of concern (U.S. Fish and Wildlife Service 1999).

Soil erosion does not appear to be a problem on the developed areas. The areas around the buildings and other structures are grassed over and landscaped as soon as possible to prevent soil loss.

However, the large number of goats is of concern. The grassy lawns and landscape plantings, which are irrigated, are browsed by the goats during periods of dry weather. During our survey, it was not uncommon to observe 4 to 6 goats on the lawn area. On the undeveloped portions of the site, goat-browsing damage is especially evident in the area around and makai of the helicopter pad. Goat trails are common on the cliff areas and only the nearly vertical rock outcrops keep the goats from reaching the *Wilkesia hobdyi* plants.

Given the proximity of the sensitive radar and antenna structures and personnel on the site, hunting with rifles may not be an option. It is recommended that the goat population be reduced by trapping or some other similar means.

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MAKAHA RIDGE PLANT SPECIES LIST

The following checklist is an inventory of all the plants observed during the field studies. The plant names are arranged alphabetically by families within each of four groups: Ferns, Gymnosperms, Dicots, and Monocots. The taxonomy and nomenclature of the Ferns follow Lamoureux (1988), while the Gymnosperms are in accordance with St. John (1973). The flowering plants, Dicots and Monocots, follow Wagner *et al.* (1990). The few recent name changes for the flowering plants follow those reported in the Hawaii Biological Survey series (Evenhuis and Miller, eds. 1995-1998); Evenhuis and Eldredge, eds. 1999).

For each species, the following information is provided:

1. **Scientific name with author citation.**

2. **Common English and/or Hawaiian name(s), when known.**

3. **Biogeographic status. The following symbols are used:**

   E = endemic = native only to the Hawaiian Islands.

   I = indigenous = native to the Hawaiian Islands and also elsewhere.

   I? = questionably indigenous = data not clear if dispersal by natural or human-related mechanisms, but weight of evidence suggests probably indigenous.

   P? = questionably a Polynesian introduction = may have been introduced by the Polynesians migrating to the Hawaiian Islands or possibly introduced shortly after Western contact, that is, Cook's discovery of the Hawaiian Islands in 1778.

   X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact.

4. Presence (+) or absence (-) of a particular species within each of three vegetation types recognized on the study site (see text for discussion):

   c = Cliff Vegetation

   p = Pine Plantings/Mixed Scrub

   r = Ruderal Vegetation

TABLE 1: SPECIES LIST—MAKAHA RIDGE

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE		
			K	M	C
FERNS					
BLENCHNACEAE (Blenchum family)					
Blechnum occidentale L.	Blechnum	X	-	+	-
HEMIONITIDACEAE (Gold fern family)					
Pityrogramma calomelanos (L.) Link	gold fern	X	+	+	+
HYPOLEPIDACEAE (Bracken family)					
Pteridium aquilinum var. decompositum (Gaud.) Tryon	kilau, kilau-pueo	E	+	+	+
NEPHROLEPIDACEAE (Swordfern family)					
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy swordfern, okupukupu	X	-	+	-
SINOPTERIDACEAE (Cliffbrake family)					
Doryopteris decipiens (Hook) J. Sm.	kumuniu, iwaiwa	E	+	-	-
THELYPTERIDACEAE (Downy woodfern family)					
Christella parasitica (L.) Levl.	Woodfern, oakfern	X	-	+	+
GYMNOSPERMS					
PINACEAE (Pine family)					
Pinus sp. (P. *radiata* D. Don?)		X	-	+	-

TABLE 1: SPECIES LIST—MAKAHA RIDGE *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE		
			k	m	c
FLOWERING PLANTS					
DICOTS					
APIACEAE (Carrot family)					
Ciclospermum leptophyllum (Pers.) Sprague	fir-leaved celery	X	+	-	-
ASTERACEAE (Daisy family)					
Acanthospernum australe (Loefl.) Kuntze	spiny-bur, kukaehipa	X	-	-	+
Ageratum conyzoides L.	maile hohono	X	-	-	+
Ageratum houstonianum Mill.	maile hohono	X	-	-	+
Artemisia australis Less.	ahinahina, hinahina	E	+	-	-
Bidens pilosa L.	Spanish needle, ki, ki nehe	X	-	-	+
Calyptocarpus vialis Less.		X	-	-	+
Cirsium vulgare (Savi) Ten.	bull thistle, pua kala	X	+	+	+
Conyza bonariensis (L.) Cronq.	hairy horseweed, ilioha	X	+	-	+
Cyanthillium cinereum (L.) H. Rob	little ironweed	X	-	+	-
Emilia fosbergii Nicolson	Pualele	X	+	-	+
Emilia sonchifolia (L.) DC	purple pualele	X	-	-	+
Erigeron karvinskianus DC	daisy fleabane	X	-	-	+
Gamachaeta purpurea (L.) Cabr.	purple cudweed	X	-	-	+
Hypochoeris glabra L.	smooth cat's ear	X	+	-	-
Pluchea carolinensis (Jacq.) G. Don	pluchea, sourbush	X	-	-	+
Sonchus oleraceus L.	sowthistle, pualele	X	-	-	+
Sphagneticola trilobata (L.) Pruski	Wedelia	X	-	+	+
Wilkesia hobdyi St. John	dwarf iliau	E	+	-	-
Youngia japonica (L.) DC	oriental hawsbeard	X	-	-	+
CACTACEAE (Cactus family)					
Opuntia ficus-indica (L.) Mill.	panini, papipi	X	+	+	-

TABLE 1: SPECIES LIST—MAKAHA RIDGE *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE		
			k	m	c
DICOTS *(continued)*					
CASUARINACEAE (She-oak family)					
Casuarina cunninghamiana Miq.	River-oak casuarina	X	-	+	-
EPACRIDACEAE (Epacris family)					
Styphelia tameiameiae (Cham. & Schlechtend.) F.v. Muell.	pukiawe, maiele	I	-	+	-
EUPHORBIACEAE (Spurge family)					
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	+	-	-
Chamaesyce hyssopifolia (L.) Small		X	+	-	-
Phyllanthus debilis Klein ex Willd.	niruri	X	+	-	-
Ricinus communis L.	castor bean, koli	X	-	-	+
FABACEAE (Pea family)					
Acacia koa A. Gray	koa	E	-	+	-
Chamaecrista nictitans (L.) Moench	partridge pea, lauki	X	-	+	+
Crotalaria incana L.	fuzzy rattlepod, kukaehoki	X	-	-	+
Crotalaria pallida Aiton	smooth rattlepod, pikakani	X	-	-	+
Desmanthus pernambucanus (L.) Thellung	virgate mimosa, slender mimosa	X	+	+	+
Desmodium incanum DC	Spanish clover, kaimi	X	-	+	+
Desmodium sandwicense E. Mey.	Spanish clover, chili clover, pua pilipili	X	-	-	+
Desmodium triflorum (L.) DC	three-flowered beggarweed	X	+	-	-
Indigofera suffruticosa Mill.	indigo, iniko	X	+	-	+
Leucaena leucocephala (Lam.) de Wit	koa haole	X	-	-	+
Macroptilium latyroides (L.) Urb.	wild bean, cow pea	X	+	-	-
Medicago lupulina L.	black medick, nonesuch	X	-	-	+
Mimosa pudica var. *unijuga* (Duchass. & Walp.) Griseb.	sensitive plant, pua hilahila	X	-	-	+

TABLE 1: SPECIES LIST–MAKAHA RIDGE (cont.)

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE		
			k	m	c
DICOTS (continued)					
GOODNEIACEAE (Goodenia family)					
Scaevola gaudichaudii Hook. & Arnott	naupaka kuahiwi	E	-	+	-
MALVACEAE (Mallow family)					
Sida fallax Walp.	Ilima	I	-	+	-
MELIACEAE (Mahogany family)					
Melia azedarach L.	Chinaberry, pride-of-India, inia	X	-	+	-
MENISPERMACEAE (Moonseed family)					
Cocculus orbiculatus (L.) DC	huehue, hue	I	-	+	-
MYOPORACEAE (Naio family)					
Myoporum sandwicense A. Gray	Naio	I	+	+	-
MYRTACEAE (Myrtle family)					
Eucalyptus sp.	eucalyptus, gum tree, eukalikia	X	-	+	-
Psidium cattelianum Sabine	strawberry guava	X	-	+	-
Psidium cattelianum var. litorale (Raddi) Fosb.	Waiawi	X	-	+	-
Psidium guajava L.	guava, kuawa	X	-	+	-
Syzygium cumini (L.) Skeels	Java plum	X	+	+	-
NYCTAGINACEAE (Four-o'clock family)					
Boerhavia coccinea Mill.		X	-	-	+
OLEACEAE (Olive family)					
Olea europaea ssp. Cuspidata (Wall. Ex G. Don) Ciferri	olive, oliwa	X	-	+	-

TABLE 1: SPECIES LIST—MAKAHA RIDGE (cont.)

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE		
			k	m	c
DICOTS (Continued)					
ONAGRACEAE (Evening primrose family)					
Ludwigia octovalvis (Jacq.) Raven	Primrose willow, kamole	P?	-	-	+
OXALIDACEAE (Wood sorrel family)					
Oxalis corniculata L.	Yellow wood sorrel, ihi ai	P?	+	+	+
PLANTAGINACEAE (Plantain family)					
Plantago lanceolata L.	Narrow-leaved plantain	X	+	-	+
Plantago major L.	broad-leaved plantain, laukahi	X	+	-	+
PORTULACACEAE (Purslane family)					
Portulaca oleracea L.	Pigweed, akulikuli kula, ihi	X	-	-	+
PRIMULACEAE (Primrose family)					
Anagallis arvensis L.	Scarlet pimpernel	X	-	-	+
PROTEACEAE (Protea family)					
Grevillea robusta A. Cunn. ex R. Br.	Silk oak, oka kalika	X	+	+	-
RUBIACEAE (Coffee family)					
Psydrax odorata (G. Forster) A.C. Smith & S.P. Darwin	Alahee, walahee	I	+	+	-
Richardia brasiliensis Gomes		X	-	-	+
Spermacoce assurgens Ruiz & Pav.	Buttonweed	X	-	-	+
SAPINDACEAE (Soapberry family)					
Dodonaea viscosa Jacq.	Aalii	I	+	+	+

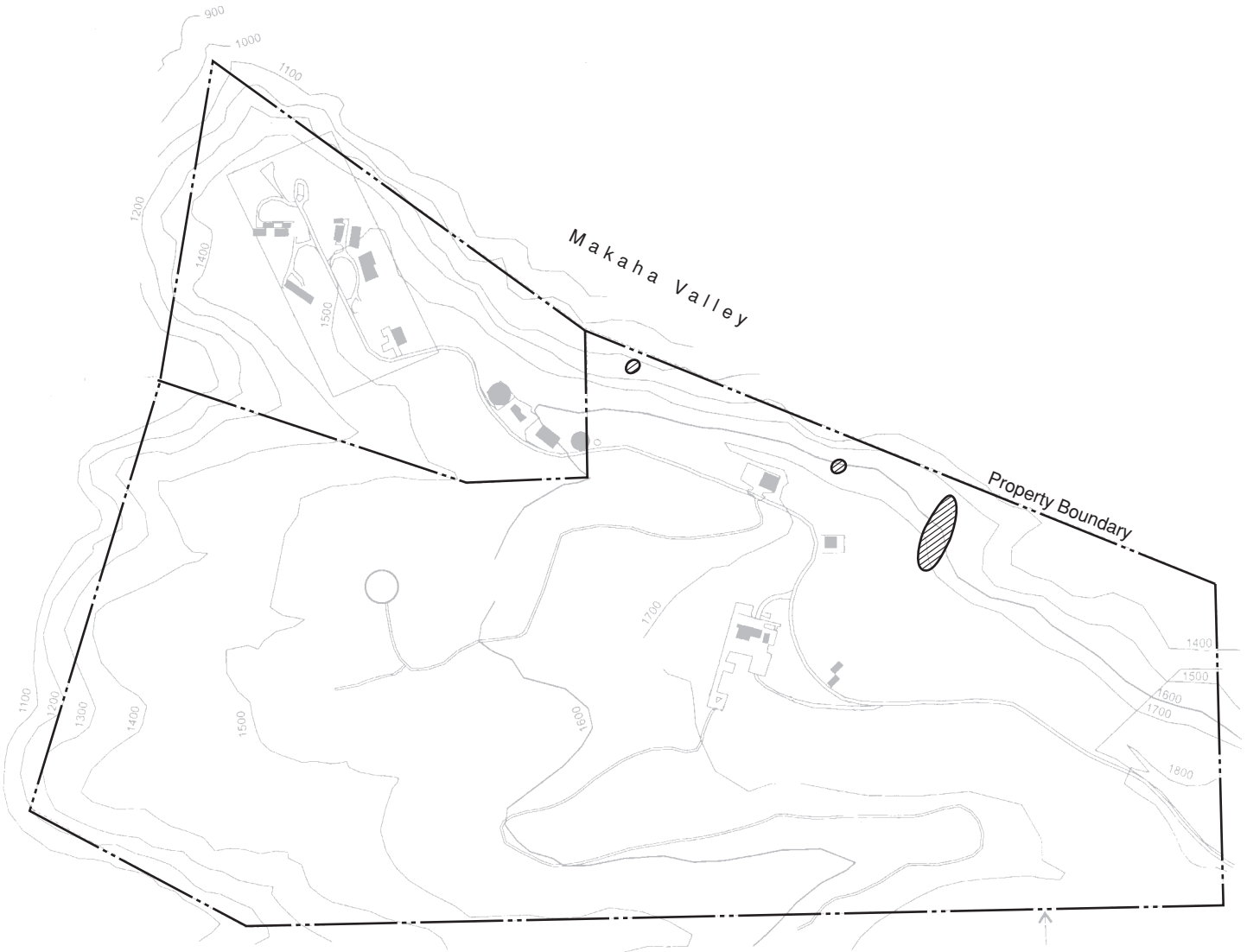
TABLE 1: SPECIES LIST—MAKAHA RIDGE *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE		
			k	m	c
DICOTS *(continued)*					
SOLANACEAE (Nightshade family)					
Solanum americanum Mill.	Popolo, glossy nightshade	X	-	-	+
STERCULIACEAE (Cacao family)					
Waltheria indica L.	uhaloa, hialoa, kanakaloa	I?	+	+	+
VERBENACEAE (Verbena family)					
Lantana camara L.	lantana, lakana	X	+	+	+
Verbena litoralis Kunth	weed verbena, owi oi	X	-	-	+
MONOCOTS					
AGVACEAE (Agave family)					
Cordylina fruticosa (L.) a. Chev.	ti, ki	P	-	+	-
CYPERACEAE (Sedge family)					
Carex wahuensis C.A. Mey.		E	-	+	-
Cyperus polystachyos Rottb.		I	-	-	+
Cyperus sp.		X	-	-	+
Gahnia beechyii H. Mann		E	-	+	-
LILIACEAE (Lily family)					
Dianella sandwicensis Hook. & Arnott	ukiuki, uki	I	-	+	-
POACEAE (Grass family)					
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	X	+	+	+
Chrysopogon aciculatus (Retz.) Trin.	golden beardgrass, pilipiliula	I?	+	+	-
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	-	-	+

TABLE 1: SPECIES LIST—MAKAHA RIDGE *(continued)*

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE		
			K	M	c
DICOTS: POACEAE *(continued)*					
Digitaria ciliaris (Retz.) Koeler	Crabgrass	X	-	+	+
Digitaria pentzii Stent	pangola grass	X	-	-	+
Digitaria sp.	Crabgrass	X	-	-	+
Eragrostis variabilis (Gaud.) Steud.	Kawelu, emoloa, kalamalo	E	+	-	-
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schultz	pili, pili grass	I?	+	-	-
Hyparrhenia rufa (Nees) Stapf	thatching grass, jaragua	X	-	+	-
Melinis minutaflora P. Beauv.	molasses grass	X	+	+	+
Melinis repens (Willd.) Zizka	Natal redtop, Natal grass	X	+	+	+
Oplismenus hirtellus (L.) P. Beauv.	basket grass, honohono kukui	X	-	+	-
Panicum maximum Jacq.	Guinea grass	X	-	-	+
Paspalum fimbriatum Kunth	Panama paspalum, fimbriate Paspalum	X	-	-	+
Pennisetum clandestinum Chiov.	Kikuyu grass	X	-	-	+
Schizachyrium condensatum (Kunth) Nees	little bluestem, beardgrass	X	+	+	-
Setaria gracilis Kunth	yellow foxtail, mauu Kaleponi	X	-	+	+
Sporobolus indicus (L.) R.Br.	Indian dropseed	X	-	-	+
Vulpia bromoides (L.) S.F. Gray	brome fescue	X	+	-	-

1999.82.0603/006-3 k1/30/01



Source: Char & Associates 2000.

0 200 400
SCALE IN METERS

0 300 600 1200
SCALE IN FEET

NORTH

LEGEND

Wilkesia hobdyi Population

Figure 1
LOCATION OF ENDANGERED DWARF ILIAU (*Wilkesia hobdyi*) AT PMRF MAKAHA RIDGE
APPENDIX A-2: MAKAHA RIDGE BOTANICAL SURVEY

Integrated Natural Resource Management Plan
Pacific Missile Range Facility

A8 - BOTANICAL SURVEY OF KOKEE SITES

(CHAR 2000c)

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APPENDIX A-3

BOTANICAL SURVEY OF KOKEE SITES

FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP) PACIFIC MISSILE RANGE FACILITY (PMRF) BARKING SANDS, KAUAI, HAWAII

Prepared for:
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June 2000

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Contents

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KOKEE SITES: INTRODUCTION

The Kokee sites, which is located within Kokee State Park, is comprises 22.9 acres (9.3 hectares) of separate parcels and rights-of-way. Five parcels (A through E) are almost located in a straight line paralleling the parks entrance road. Total distance between Parcels A and E is slightly less than a mile. The Kokee sites are operated jointly by PMRF and NASA. The buildings and structures were originally part of the Kokee Tracking Station operated by NASA, who holds the lease from the State of Hawaii. The Navy operates facilities on the Kokee sites as part of its range operation.

An assessment of the botanical resources found on the five parcels was conducted on 06 December 1999 by the principal investigator. Only a reconnaissance-level survey was made. Brief notes were made on the maintained, landscaped areas on each of the parcels. A walk-through survey was made along the outside of the fence line for Parcel A and inside the fence line for Parcels B through E. Dense, tall thickets of prickly Florida blackberry *(Rubus argutus)* come right up to and over the perimeter fence lines on Parcels B through E. Native koa-ohia mesic forest occurs along the outside of the fence.

The primary objectives of the survey were to:

1) provide a general description of the vegetation within the fenced areas of each parcel; and

2) search for threatened and endangered species as well as species of concern immediately adjacent to the outside of the perimeter fence line.

DESCRIPTION OF THE VEGETATION

The plant names used in this report follow Wagner *et al.* (1990) for the native and naturalized species, and St. John (1973) for the ornamental plants. The few recent name changes follow those recorded in the Hawaii Biological Survey series (Evenhuis and Miller, eds., 1995-1998; Evenhuis and Eldredge, eds., 1999). No comprehensive species list was compiled for this report.

Parcel A

Parcel A (3.79 acres [1.53 hectares]) is the most southerly of the parcels and is located at an elevation of 3,710 feet (1,131 meters). It houses the Tracking and Command (T&C) Building, the Training and Administration Building, and the Logistics Building. The area in the vicinity of the T&C Building and the Administration Building has been graded and paved with asphalt. There are a few planter boxes with tree fern or hapuu *(Cibotium glaucum)* and *Anthurium* cultivars.

Grassy lawns are found around the other buildings. The main lawn grasses are Kikuyu grass *(Pennisetum clandestinum)* and narrow-leaved carpetgrass *(Axonopus fissifolius)*. Weedy patches are scattered throughout the lawn areas, especially along the edges of the lawns. Dandelion *(Taraxacum officinale),* cocksfoot *(Dactylis glomerata),* and smutgrass *(Sporobolus africanus)* are common. A few small firetrees *(Myrica faya)* are found in the lawn near the Logistics

Building. By the guard house at the entrance there are plantings of green and colored ti leaf *(Cordyline fruticosa)* and hydrangea shrubs *(Hydrangea macrophylla).*

Along the outside of the fence line, the vegetation is periodically maintained and there is a grassy strip 3 to 5 feet (1 to *2* meters) wide. The grassy strip is composed largely of Kikuyu grass with plants of hairy cat's ear *(Hypochoeris radicata),* narrow-leaved plantain *(Plantago lanceolata),* weed verbena *(Verbena litoralis),* and daisy fleabane *(Erigeron karvinskianus)* common to locally abundant. Outside of the grassy strip, there are dense prickly Florida blackberry *(Rubus argutus)* thickets, 3 to 5 feet (1 to 2 meters) tall. Native plants commonly to occasionally observed in the area bordering the grassy strip include koa *(Acacia koa),* ohia or ohia lehua *(Metrosideros polymorpha),* pukiawe *(Styphelia tameiameiae),* aalii *(Dodonaea viscosa),* ohia ha *(Syzygium sandwicensis),* ukiuki *(Dianella sandwicensis),* and pilo *(Coprosma waimeae).*

In the forested area bordering the access road, there are large patches of ukiuki. A few trees of halapepe *(Pleomele aurea)* and kauila *(Alphitonia ponderosa)* can also be observed among the koa and ohia trees in this area.

Parcel B

Parcel B is located about 1,400 feet (428 meters) north of Parcel A, across Highway 550 and covers 1.24 acres (0.5 hectare). The power plant, fuel storage, and electric substation are located here. The site is mostly paved, but there is a small lawn behind the power plant with Kikuyu grass and plantings of ti leaf and a few trees of plum *(Prunus cerasifera* x *salicina),* avocado *(Persea americana),* and pear *(Pyrus communis).* To the south of the power plant, there is a semi-wooded slope inside the fence line. This area contains a few trees of koa, ohia, and fire tree, and shrubs of pilo, aalii, and pukiawe. A few plum trees and ti have been planted here. Ground cover is Kikuyu grass with scattered patches of Glenwood grass *(Sacciolepis indica),* molasses grass *(Melinus minutiflora),* and Dallis grass *(Paspalum dilatatum).*

Outside the fence line on the north side, there is a grassy lawn and more plum, avocado, and banana *(Musa* x *paradisiaca)* plantings; this area is maintained. The rest of the area immediately adjacent to the outside of the fence is largely dense blackberry thickets and Kikuyu grass mats. Trees and shrubs found on this side of the fence include koa, pilo, ohia, avocado, hala pepe, aalii, pukiawe, ohia ha, kauila, and hame *(Antidesma platyphyllum).* Besides the blackberry and firetree, other invasive, introduced species observed in or around the site include strawberry guava *(Psidium cattleianum),* banana poka *(Passiflora mollissima),* and karakanut *(Corynocarpus laevigatus).*

Parcel C

Parcels C, D, and E are surrounded by a common fence line; the entrance gate is located on the access road to the south of Parcel C.

Parcel C (0.38 acre [0.15 hectare]) includes the Boresight Tower, Facilities Building, and a microwave antenna. Much of the parcel supports asphalt paving, the rest is open, grassy lawn. The area immediately adjacent to the outside of the fence is covered by low thickets of blackberry or lumpy mats of Kikuyu grass with scattered plants of firetree and firethorn *(Pyracantha angustifolia),* another invasive species.

Parcel D

Parcel D (5.33 acres [2.16 hectares]) contains the SCAMP Antenna and Transmitter Building, and the AN/FRS-16 Radar Building. The areas around the buildings are either paved or support grassy lawns of Kikuyu grass. To the northeast of the AN/FRS-16 building, the hillside supports a small forested section composed primarily of introduced tree species—silk oak *(Grevillea robusta)* and firetree. A few koa trees and shrubs of pukiawe and naupaka kuahiwi *(Scaevola gaudichaudiana)* are found here. Ground cover is composed of molasses grass with a few clumps of ricegrass *(Paspalum scrobiculatum).*

There are dense thickets of blackberry, scattered mats of Kikuyu grass, and stands of koa and ohia trees in the areas immediately adjacent to the perimeter fence.

Parcel E

Parcel E covers 5.27 acres (2.13 hectares). It houses the Unified S-Band (USB) Building and antenna, the Spacecraft Automatic Tracking Antenna receiver antenna (SATAN), and the Very Long Baseline Interferometry (VLBI) Facility.

The areas around the buildings and antenna have been graded and paved. Lawn areas support Kikuyu grass and various weedy species such as dandelion, narrow-leaved plantain, clover *(Trifolium repens),* and green kyllinga *(Kyllinga brevifolia).* A few pear, plum, and apple *(Malus* sp.) trees are planted in the lawn areas. Around the front of the USB building, there is a planting of hybrid roses *(Rosa* cultivar) and akulikuli lei *(Lampranthus glomerata).*

Much of the area immediately adjacent to the outside of the fence is densely forested, so there are fewer areas with dense blackberry thickets or deep mats of Kikuyu grass. Koa and ohia along with firetree are abundant. Other trees found here in smaller numbers include hame, ohia ha, kauila, hala pepe, and sandalwood or iliahi *(Santalum freycinetianum).* A few trees of the introduced paperbark *(Melaleuca quinquenervia)* also occur here. Shrubs include pukiawe, pilo, manono *(Gouldia terminalis),* aalii, kopiko *(Psychotria* sp.), mokihana *(Pelea anisata),* kolea *(Myrsine* sp.), and the introduced strawberry guava and lantana *(Lantana camara).*

Approximately 6.89 acres (2.79 hectares) comprise undeveloped Parcel F and associated rights-of-way.

DISCUSSION AND RECOMMENDATIONS

Graded and asphalt-paved areas cover large portions of the five surveyed Parcels A through E. Unpaved portions support Kikuyu grass-dominated lawns with scattered, weedy, mostly annual species. A few fruit trees and ornamental plants are found planted around buildings or in the lawns. No threatened and endangered species or species of concern (U.S. Fish and Wildlife Service 1999) are found within the fenced areas of the five parcels. This is not unexpected since these areas are landscaped and maintained.

On Parcel A, a narrow Kikuyu grass-covered strip is maintained around the outside of the perimeter fence. On Parcels B through E, the area outside of the fence line is mostly covered by dense blackberry thickets with scattered patches of koa-ohia mesic forest.

A complete walk around the fence on the outside of Parcel A was made; no threatened and endangered species or species of concern were found. A walk around the outside of the fence lines for Parcels B through E was not attempted due to impenetrable blackberry thickets. However, a survey from inside the fence was made. While no threatened and endangered species or species of concern were observed, we can not say with certainty that there are no rare plants present immediately adjacent to the fence lines around Parcels B through E.

If portions of the fence line around Parcels B through E need to be replaced at some time, then it is recommended that a more thorough survey be conducted. It is also recommended that the invasive plants found on the parcels be removed. This includes the firetree, banana poka, and especially the firethorn. The larger firethorn plants on the site are the seed source for the smaller infestations on and outside the parcels.

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A9 - BOTANICAL SURVEY OF KAMOKALA MAGAZINES

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APPENDIX A-4

BOTANICAL SURVEY OF KAMOKALA MAGAZINES

FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP)
PACIFIC MISSILE RANGE FACILITY (PMRF)
BARKING SANDS, KAUAI, HAWAII

Prepared for:
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June 2000

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Contents

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KAMOKALA MAGAZINE: INTRODUCTION

Kamokala Magazine, a part of the Pacific Missile Facility (PMRF) on Kauai, is located on 88.9 acres (35.99 hectares) of land leased from the State of Hawaii. It is located on the lower end of Kamokala Ridge. Elevation ranges from 125 feet (38 meters) along the lower boundary to about 775 feet (235 meters) at the top of the ridge. Two narrow valleys border the site; Nahomalu Valley to the north and Kaawaloa Valley to the south.

Only the area below the 300-foot (91-meter) elevation was surveyed; the ten magazine tunnels are located at about this elevation. Above the 300-foot contour, the slopes become very steep and there are large rock outcrops, which cover about 50 percent of the surface. Large boulders often fall from the slopes above, landing on the road and loading areas in front of the tunnels. The security guards who patrol the magazine area reports that this problem is particularly severe after heavy rains. Boulders the size of a Volks-wagon Beetle have fallen from the ridge above.

Field studies to access the botanical resources on the Kamokala Magazine site were conducted on 28 December 1999 by a team of two botanists. The primary objectives of the field studies were to:

1) provide a general description of the vegetation on the site;

2) inventory the flora; and

3) search for threatened and endangered species as well as species of concern.

Prior to undertaking the field studies, topographic maps and soil maps were examined to determine terrain characteristics, access, boundaries, and reference points. The soil maps (Foote *et al.* 1972) use a photobase, aerial photographs from 1965, and provide an overview of vegetation cover patterns as well as soil types.

A walk-through survey method was used for the area below the 300-foot elevation. For the steep slopes above the magazine tunnels, binocular observations were made. Notes were made on plant associations and distribution, substrate types, drainage, exposure, disturbances, topography, etc. Plant identifications were made in the field; plants which could not be positively identified were collected for later determination in the herbarium, and for comparison with the recent taxonomic literature.

The species recorded are indicative of the season (“rainy” vs. “dry”) and the environmental conditions at the time of the survey. A survey taken at a different time of the year and under varying environmental conditions would no doubt yield slight variations in the species list, especially of the weedy, annual plants.

DESCRIPTION OF THE VEGETATION

Two vegetation types are recognized on the project site. Koa haole scrub/forest covers the majority of the site. On the steeper slopes above the road and magazine tunnels, koa haole forms an open, patchy scrub, 6 to 12 feet (2 to 4 meters) tall. Below the road, the koa haole becomes a dense forest, 20 to 25 feet (6 to 8 meters) tall, with scattered kiawe trees, 30 to 45 feet (9 to 14 meters) tall. Ruderal or weedy wayside vegetation occurs as a narrow band along the roadsides and around structures.

An inventory of all the plant species observed during the field studies is presented in the checklist at the end of the report.

4.1 KOA HAOLE SCRUB/FOREST

The very steep slopes above the magazine tunnels are mapped as "WJF," Waiawa extremely rocky clay, 30 to 80 percent slopes, on the soil maps (Foote *et al.* 1972). These are well-drained, very shallow, extremely rocky soils found on the uplands of Kauai. Rock outcrops cover 25 to 50 percent of the surface. Runoff is rapid and the erosion hazard is severe.

On the Kamokala site, rock outcrops cover about 50 percent of the surface. Vegetation cover is about 50 percent and consists primarily of koa haole shrubs *(Leucaena leucocephala),* 6 to 12 feet (2 to 4 meters) tall, which form an open, patchy scrub. Scattered along the lower slopes are small stands of wiliwili *(Erythrina sandwicensis)* and scattered individuals of kiawe *(Prosopis pallida);* tree cover is about 15 to 20 percent and tree height ranges from 20 to 30 feet (6 to 9 meters). Ground cover is a mixture of grasses, small shrubs, and herbaceous species in the areas with shallow soil. Guinea grass *(Panicum maximum)* is the most commonly encountered grass with smaller patches of bristly foxtail *(Setaria verticillata),* sourgrass *(Digitaria insularis),* Natal redtop *(Melinis repens),* and *Bothriochloa* sp. Small shrubs and herbaceous species include virgate mimosa *(Desmanthus pernambucanus),* klu *(Acacia farnesiana),* hairy abutilon *(Abutilon grandifolium), Portulaca pilosa,* false mallow *(Malvastrum coromandelianum),* and barleria *(Barleria cristata);* lion's ear *(Leonotis nepetifolia)* is abundant on the lower slopes. *Parmelia* sp., a grayish-white foliose lichen, is abundant on some of the exposed rock faces. Also associated with the rock outcrops and ledges are a few native plants which include ilima *(Sida fallax),* pili grass *(Heteropogon contortus),* iliee *(Plumbago zeylanica),* alaala wai nui *(Peperomia leptostachya),* hoary abutilon or mao *(Abutilon incanum),* and aalii *(Dodonaea viscosa).*

Below the magazine tunnels and road on the south and west portions of the site, the soil type is mapped as "rRU," rubble land (Foote *et al.* 1972). Rubble land occurs at the base of very steep to percipitous slopes. On the Kamokala site, there are places where boulders cover 70 to 80 percent of the surface. Koa haole shrubs form a tall dense forest with scattered trees of wiliwili and kiawe on the somewhat gently sloping terrain. Soil between the boulders support robust clumps of Guinea grass, 3 feet (1 meter) tall. The white-flowered barleria shrub and virgate mimosa are also locally abundant among the boulders. In more open areas, sourgrass and buffel grass *(Cenchrus ciliaris)* form somewhat large patches. A few large Chinese banyan *(Ficus microcarpa)* and be-still tree *(Cascabela thevetia)* occur along the lower boundary.

On the north side of the site (Nahomalu Valley), the soil type is mapped as "KOYE," Kekaha extremely stony silty clay loam, 0 to 35 percent slopes (Foote *et al.* 1972), and also supports dense koa haole forest with scattered trees of kiawe and wiliwili. The terrain is nearly level to gently sloping. A barbed wire fence line runs parallel to the access road. North of the fence the property is used for grazing cattle. As a result, ground cover is patchy with scattered, low clumps of Guinea grass, 6 inches to a foot (15 centimeters to 0.3 meter) tall. Areas with bare soil are common. The intermittent stream which passes along the valley floor is dry and boulder-strewn. A few Java plum *(Syzygium cumini)* and kukui *(Aleurites moluccana)* trees as well as kiawe and wiliwili line the stream.

4.2 RUDERAL VEGETATION

This vegetation type occupies only a small area on the property and is associated with the roadsides, loading areas, and other sites which are occasionally mowed or trimmed back. It consists of low mats of grasses and weedy, mostly annual herbaceous species. Buffel grass is the most abundant grass with smaller sections along the road supporting patches of Bothriochloa sp. swollen fingergrass *(Ghloris barbata),* and Bermuda grass *(Cynodon dactylon).* Weedy herbaceous species commonly observed here include hairy spurge *(Chamaesyce hirta),* false mallow, Spanish needle *(Bidens pilosa), Heliotropium procumbens,* and purple cudweed *(Gamachaeta purpurea).*

Where the soil is stonier or where the pavement borders a rocky shelf, the ruderal vegetation supports low clumps of Guinea grass, 6 inches to about 1 foot (15 centimeters to 0.3 meter) tall. Koa haole and lantana *(Lantana camara)* shrubs which have been cut back to almost ground level also occur here. Lion's ear is locally abundant in some places.

DISCUSSION AND RECOMMENDATIONS

The vegetation on the magazine site consists largely of koa haole with scattered trees of wiliwili and kiawe. A narrow band of ruderal vegetation occurs along the paved areas or around structures. Seventy species were inventoried during the field studies. Of these, 58 (83 percent) are introduced or alien; one (1.5 percent) is of early Polynesian introduction; and 11 (15.5 percent) are native. Of the natives, 10 are indigenous, that is, they are native to the Hawaiian Islands and elsewhere. These species are the ilima *(Sida fallax),* koali awa *(Ipomoea indica),* kakalaioa *(Gaesalpinia bonduc),* hoary abutilon *(Abutilon incanum),* alaala wai nui *(Peperomia leptostachya),* iliee *(Plumbago zeylanica),* aalii (*Dodonaea viscosa*), popolo (*Solanum americanum*), uhaloa (*Waltheria indica*), and pili grass (*Heteropogon contortus*). One species, the wiliwili *(Erythrina sandwicensis),* is endemic, that is, it is native only to the Hawaiian Islands.

None of the plants is a threatened and endangered species or a species of concern (U.S. Fish and Wildlife Service 1999). All of the plants can be found in similar lowland environments throughout the Hawaiian Islands. The wiliwili is locally common in dry forests, up to 1,980 feet (600 meters) elevation, on leeward slopes of all the main islands (Wagner *et al.* 1990). An easily accessible and very large population of wiliwili (numbering in the hundreds) is found along Kokee Road (Route 550) between 600 and 1,000 feet (180 to 300 meters) elevation.

Except for the roads, loading areas in front of the tunnels, and some structures near the north gate, the site is not developed. The steep slopes which cover most of the site and the occasional falling boulders and rockslides limit use of the property. The present use of the site as a magazine area does not appear to have any adverse effects on the surrounding vegetation.

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KAMOKALA MAGAZINES PLANT SPECIES LIST

The following checklist is an inventory of the plants observed during the field studies. The plant names are arranged alphabetically by families within each of two groups: Dicots, and Monocots. The taxonomy and nomenclature of the flowering plants are in accordance with Wagner *et al.* (1990). The few recent name changes for the flowering plants follow those reported in the Hawaii Biological Survey series (Evenhuis and Miller, 1995-1999).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   - E = endemic = native only to the Hawaiian Islands.
   - I = indigenous = native to the Hawaiian Islands and also elsewhere.
   - I? = questionably indigenous = data not clear if dispersal by natural or human-related mechanisms, but weight of evidence suggests probably indigenous.
   - P = Polynesian = plants originally of Polynesian introduction prior to Western contact, that is, Cook's discovery of the Hawaiian Islands in 1778.
   - X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact.
   - X? = questionably introduced = date of introduction unclear or very early, could possibly be indigenous or perhaps of Polynesian introduction.
4. Presence (+) or absence (-) of a particular species within each of five vegetation types recognized within the study area (see text for discussion):
   - k = Koa Haole Scrub/Forest
   - r = Ruderal Vegetation

TABLE 1: SPECIES LIST—KAMOKALA MAGAZINE

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE	
			K	r
FLOWERING PLANTS:				
DICOTS				
ACANTHACEAE (Acanthus family) *Barleria cristata* L.	Barleria	X	+	-
AMARANTHACEAE (Amaranthus family) *Amaranthus spinosus* L.	spiny amaranth, pakai kuku	X	-	+
APIACEAE (Carrot family) *Daucus pusillus Michx.*	American carrot	X	-	+
APOCYNACEAE (Dogbane family) *Cascabela thevetia* (L.) Lippod	be-still tree	X	+	-
ASTERACEAE (Daisy family) *Ageratum conyzoides L.*	maile hohono	X	-	+
Bidens pilosa L.	Spanish needle, ki, ki nehe	X	+	+
Calyptocarpus vialis Less.		X	-	+
Emilia fosbergii Nicolson	pualele	X	+	-
Gamachaeta purpurea (L.) Cabr.	purple cudweed	X	-	+
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	X	-	+
Sonchus oleraceus L.	sowthistle, pualele	X	-	+
Tridax procumbens L.	coat buttons	X	-	+
Verbesina encelioides (Cav.) Benth, Hook.	golden crown-beard	X	-	+
BORAGINACEAE (Borage family) *Heliotropium procumbens var. depressum* (Cham.) Fosb.		X	-	+
CACTACEAE (Cactus family) *Opuntia ficus-indica (L.) Mill.*	panini, papipi	X	+	-

TABLE 1: SPECIES LIST—KAMOKALA MAGAZINE (continued)

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE	
			K	r
DICOTS (continued)				
CONVOLVULACEAE (Morning glory family) *Ipomoea indica* (J. Burm.) Merr.	koali awa, koali awahia	I	+	-
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X	+	-
Merremia aegyptia (L.) Urb.	hairy merremia, koali kua hulu	X?	+	+
CUCURBITACEAE (Gourd family) *Momordica charantia* L.	wild bittermelon	X	+	+
EUPHORBIACEAE (Spurge family) *Aleurites moluccana* (L.) Willd.	kukui, tutui	P	+	-
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	-	+
Chamaesyce hypericifolia (L.) Millsp.	Graceful spurge	X	-	+
Phyllanthus debilis Klein ex Willd.	Niruri	X	+	-
Ricinus communis L.	castor bean, koli	X	-	+
FABACEAE (Pea family) *Acacia farnesiana* (L.) Willd.	Klu	X	+	-
Caesalpinia bonduc (L.) Roxb.	kakalaioa, hikikolo	I	+	-
Crotalaria pallida Aiton	smooth rattlebox, pikakani	X	+	+
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	X	+	+
Erythrina sandwicensis Degener	wiliwili	E	+	-
Indigofera suffruticosa Mill.	indigo, iniko	X	+	-
Leucaena leucocephala (Lam.) de Wit	koa haole	X	+	+
Prosopis pallid (Humb. & Bonpl. ex Willd.)	Kiawe	X	+	-
LAMIACEAE (Mint family) *Hyptis pectinata* (L.) Poit.	comb hyptis	X	+	-
Leonotis nepetifolia (L.) R. Br.	lion's ear	X	+	+

TABLE 1: SPECIES LIST—KAMOKALA MAGAZINE (continued)

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE	
			K	r
DICOTS (continued)				
MALVACEAE (Mallow family)				
Abutilon grandifolium (Willd.) Sweet	hairy abutilon, mao	X	+	-
Abutilon incanum (Link) Sweet	mao, hoary abutilon	I?	+	+
MALVACEAE (continued)	Cheeseweed	X	-	+
Malva parviflora L.				
Malvastrum coromandelianum (L.) Garcke	false mallow	X	+	+
Sida fallax Walp.	ilima	I	+	-
Sida rhombifolia L.	Cuba jute	X	-	+
MORACEAE (Mulberry family)				
Ficus microcarpa L. fil.	Chinese banyan	X	+	-
MYRTACEAE (Myrtle family)				
**Syzygium cumini* (L.) Skeels	Java plum	X	+	-
NYCTAGINACEAE (Four-o'clock family)		X	-	+
Boerhavia coccinea Mill.				
PASSIFLORACEAE (Passion flower family)	huehue haole	X	+	-
Passiflora suberosa L.				
PIPERACEAE (Pepper family)				
Peperomia leptostachya Hook & Arnott	alaala wai nui	I	+	-
PLUMBAGINACEAE (Loadwort family)	iliee, hiliee, ilihei	I	+	-
Plumbago zeylanica L.				

TABLE 1: SPECIES LIST—KAMOKALA MAGAZINE (continued)

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE	
			K	r
DICOTS (continued)				
PORTULACACEAE (Purslane family) *Portulaca oleracea* L.	pigweed, akulikuli kula, ihi	X	+	+
Portulaca pilosa L.		X	+	+
PROTEACEAE (Protea family) *Grevillea robusta* A. Cunn ex R. Br.	silk oak, oka kalika	X	+	-
SAPINDACEAE (Soapberry family)	Aalii	I	+	-
Dodonaea viscosa Jacq.	popolo, glossy nightshade	I?	-	+
Solanum americanum Mill.				
SOLANACEAE (Nightshade family) *Capsicum frutescens* L.	chili pepper, nioi	X	+	-
Solanum lycopersicum var. cerasiforme (Dunal) Spooner, Anderson & Jansen	currant tomato, wild tomato	X	+	-
Solanum seaforthianum Andr.	blue potato vine	X	+	-
STERCULIACEAE (Cacao family) *Waltheria indica* L.	uhaloa, hialoa, kanakaloa	I?	+	+
VERBENACEAE (Verbena family) *Lantana camara* L.	lantana, lakana	X	+	+
MONOCOTS:				
COMMELINACEAE (Spiderwort family) *Commelina benghalensis* L.	hairy honohono	X	+	-

TABLE 1: SPECIES LIST—KAMOKALA MAGAZINE (continued)

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPE	
			K	r
MONOCOTS (continued):				
POACEAE (Grass family)				
Bothriochloa sp.		X	+	+
Cenchrus ciliaris L.	Buffelgrass	X	+	+
Chloris barbata (L.) Sw.	swollen fingergrass, mau lei	X	-	+
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	-	+
Digitaria insularis (L.) Mez ex Ekman	Sourgrass	X	+	+
Digitaria sp.	Crabgrass	X	-	+
Eragrostis amabilis (L.) Wight & Arnott	Lovegrass	X	-	+
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.	pili, pili grass	I?	+	-
Panicum maximum Jacq.	Guinea grass	X	+	+
Panicum maximum var. trichoglume Eyles ex Robyns	green panicgrass	X	+	+
Setaria gracilis Kunth	yellow foxtail, mauu Kaleponi	X	-	+
Setaria verticillata (L.) P. Beauv.	bristly foxtail, mauu pilipili	X	+	-

A10 - VEGETATION MAPS FROM NAVY CONSERVATION MAPPING

(NAVFAC PAC 2005)

PMRF VEGETATION MAP

SCALE: NONE

BARKING SANDS: A

BARKING SANDS: B

MATCHLINE "A"

MATCHLINE "B"

PANICUM NIHAUENSE (CRITICAL HABITAT)

LEGEND

ABBREV	DESCRIPTION	NATIVE/NON-NATIVE
AG	AGAVE	NON-NATIVE
AGD	AGRICULTURE	NON-NATIVE
AK	AKIAKI	NATIVE
AL	ALGAROBA (LONG THORN KIAWE)	NON-NATIVE
ANS	AALII-NAMA SCRUB	NATIVE
AS	AALII SCRUB	NATIVE
BLT	BLACKBERRY, LANTANA THICKET	NON-NATIVE
BT	BLACKBERRY THICKET	NON-NATIVE
C, BF	CLIFF, BOULDER FIELD	NON-NATIVE
ERD	ERODED, BARE SOIL	NON-NATIVE
G,H,S	GRASS, HERB, SHRUB	NON-NATIVE
>25% W	GREATER THAN 25% WIL/WIL	NATIVE
HICC	HAWAIIAN MXD SHRUB COASTAL CLIFF	NATIVE
I	IPOMOEA	NON-NATIVE
K	KIAWE	NON-NATIVE
KHS, <25%W	KOA HAOLE SCRUB, LESS THAN 25% WIL/WIL	NON-NATIVE
KHS, F	KOA HAOLE SCRUB, FOREST	NON-NATIVE
KKHS	KIAWE KOA HAOLE SCRUB	NON-NATIVE
KKHS, AG	KIAWE KOA HAOLE SCRUB WITH AGAVE	NON-NATIVE
KKHS, AL	KIAWE KOA HAOLE SCRUB WITH ALGAROBA	NON-NATIVE
KNN	MIXED KOA, NON-NATIVE FOREST	NATIVE
KOF	KOA OHIA MIXED MONTANE MESIC FOREST	NATIVE
LS	LANDSCAPED	NON-NATIVE
MSCC	MXD SHRB DRY CSTL CLIFF	NON-NATIVE
MSCC K	MXD SHRB DRY CSTL CLIFF WITH KOA	NATIVE
N	NAUPAKA	NATIVE
NI	NAUPAKA/IPOMEOA	NATIVE
NNO, BLT	NON-NATIVE MIX-OAK, BLACKBERRY, LANTANA	NON-NATIVE
P	PURE MIXED SHRUB	NON-NATIVE
P NO N	POHINAHINA	NATIVE
PG	PILI GRASS	NATIVE
PND	POHINAHINA-NAUPAKA DUNE	NATIVE
R	RUDERAL	NON-NATIVE
WL KH	WETLAND VEG W/KOA HAOLE	NON-NATIVE
	PANICUM NIHAUENSE (CRITICAL HABITAT)	

KEY MAP

A SEE SHT 1

B SEE SHT 1

C SEE SHT 2

D SEE SHT 2

Sheet 1 of 3

Plot Date: 19 Aug 2004

LEGEND

ABBREV	DESCRIPTION	NATIVE/NON-NATIVE
AG	AGAVE	NON-NATIVE
AGR	AGRICULTURE	NON-NATIVE
AN	AN LAN	NATIVE
AL	ALGAROBA (LONG THORN KIAWE)	NON-NATIVE
ANS	AALII-NAMA SCRUB	NATIVE
AS	AALII SCRUB	NATIVE
BLT	BLACKBERRY, LANTANA THICKET	NON-NATIVE
BT	BLACKBERRY THICKET	NON-NATIVE
C, BF	CLIFF, BOULDER FIELD	NON-NATIVE
ERD	ERODED, BARE SOIL	NON-NATIVE
G,H,S	GRASS, HERB, SHRUB	NON-NATIVE
>25% W	GREATER THAN 25% WILIWILI	NATIVE
HCC	HAWAIIAN MXD SHRUB COASTAL CLIFF	NATIVE
I	IPOMOEA	NON-NATIVE
K	KIAWE	NON-NATIVE
KHS, <25%W	KOA HAOLE SCRUB, LESS THAN 25% WILIWILI	NON-NATIVE
KHS, F	KOA HAOLE SCRUB, FOREST	NON-NATIVE
KKHS	KIAWE KOA HAOLE SCRUB	NON-NATIVE
KKHS, AG	KIAWE KOA HAOLE SCRUB WITH AGAVE	NON-NATIVE
KKHS, AL	KIAWE KOA HAOLE SCRUB WITH ALGAROBA	NON-NATIVE
KNN	MIXED KOA NON-NATIVE FOREST	NATIVE
KOF	KOA OHIA MIXED MONTANE MESIC FOREST	NATIVE
LS	LANDSCAPED	NON-NATIVE
MSCC	MXD SHRB DRY CSTL CLIFF	NON-NATIVE
MSCC K	MXD SHRB DRY CSTL CLIFF WITH KOA	NATIVE
N	NAUPAKA	NATIVE
NI	NAUPAKA/IPOMEOA	NATIVE
NNO, BLT	NON-NATIVE MIX-OAK, BLACKBERRY, LANTANA	NON-NATIVE
P	PISMIXED SHRUB	NON-NATIVE
P NO N	POHINAHINA	NATIVE
PG	PILI GRASS	NATIVE
PND	POHINAHINA-NAUPAKA DUNE	NATIVE
R	RUDERAL	NON-NATIVE
WL KH	WETLAND VEG W/KOA HAOLE	NON-NATIVE

PANICUM NIHAUENSE (CRITICAL HABITAT)

MATCHLINE "B"

MATCHLINE "C"

KEY MAP

A SEE SHT 1

B SEE SHT 1

C SEE SHT 2

D SEE SHT 2

BARKING SANDS: C

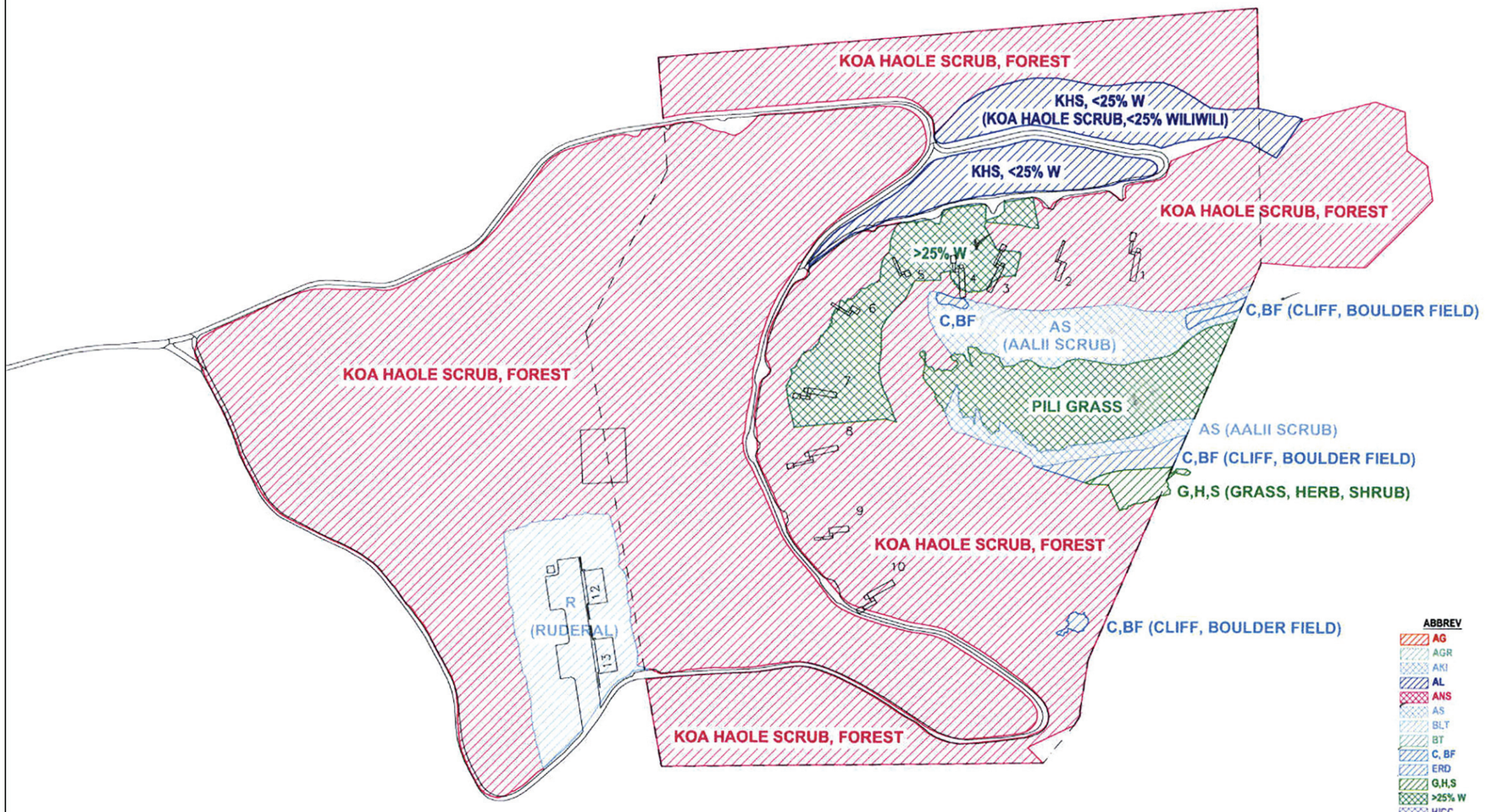
BARKING SANDS: D

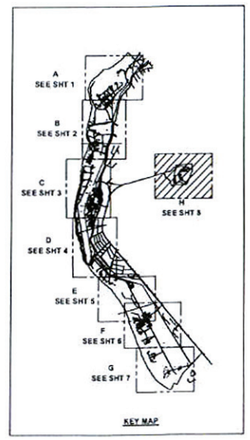
PMRF VEGETATION MAP

SCALE: NONE

Sheet 2 of 3

Plot Date: 19 Aug 2004





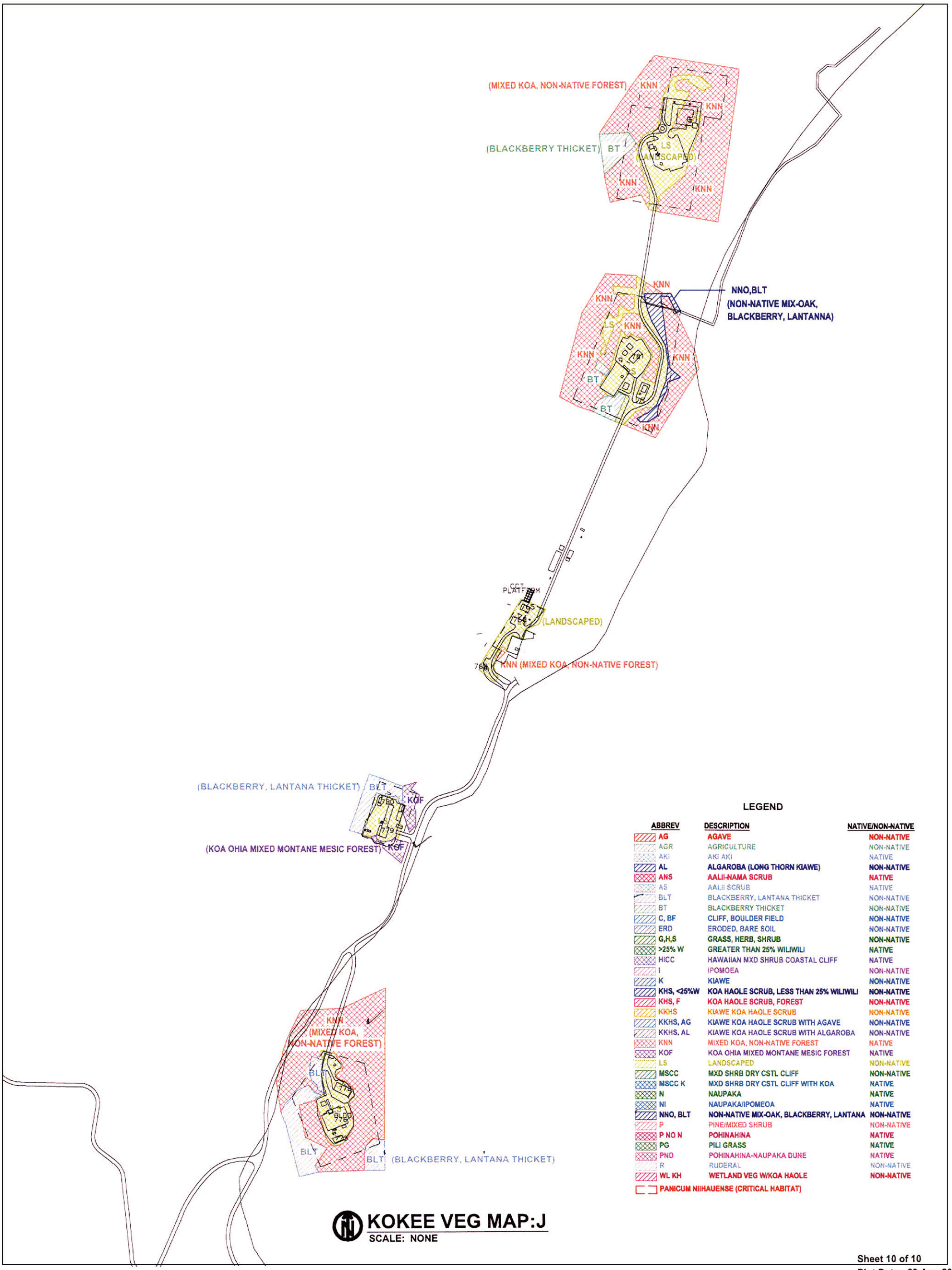
KAMOKALA RIDGE VEG MAP:H

SCALE: NONE

LEGEND

ABBREV	DESCRIPTION	NATIVE/NON-NATIVE
AG	AGAVE	NON-NATIVE
AGR	AGRICULTURE	NON-NATIVE
AKI	AKI AKI	NATIVE
AL	ALGAROBA (LONG THORN KIAWE)	NON-NATIVE
ANS	AALII-NAMA SCRUB	NATIVE
AS	AALII SCRUB	NATIVE
BLT	BLACKBERRY, LANTANA THICKET	NON-NATIVE
BT	BLACKBERRY THICKET	NON-NATIVE
C, BF	CLIFF, BOULDER FIELD	NON-NATIVE
ERD	ERODED, BARE SOIL	NON-NATIVE
G,H,S	GRASS, HERB, SHRUB	NON-NATIVE
>25% W	GREATER THAN 25% WILIWILI	NATIVE
HICC	HAWAIIAN MXD SHRUB COASTAL CLIFF	NATIVE
I	IPOMOEA	NON-NATIVE
K	KIAWE	NON-NATIVE
KHS, <25%W	KOA HAOLE SCRUB, LESS THAN 25% WILIWILI	NON-NATIVE
KHS, F	KOA HAOLE SCRUB, FOREST	NON-NATIVE
KKHS	KIAWE KOA HAOLE SCRUB	NON-NATIVE
KKHS, AG	KIAWE KOA HAOLE SCRUB WITH AGAVE	NON-NATIVE
KKHS, AL	KIAWE KOA HAOLE SCRUB WITH ALGAROBA	NON-NATIVE
KNN	MIXED KOA, NON-NATIVE FOREST	NATIVE
KOF	KOA OHIA MIXED MONTANE MESIC FOREST	NATIVE
LS	LANDSCAPED	NON-NATIVE
MSCC	MXD SHRB DRY CSTL CLIFF	NON-NATIVE
MSCC K	MXD SHRB DRY CSTL CLIFF WITH KOA	NATIVE
N	NAUPAKA	NATIVE
NI	NAUPAKA/IPOMEOA	NATIVE
NNO, BLT	NON-NATIVE MIX-OAK, BLACKBERRY, LANTANA	NON-NATIVE
P	PINE/MIXED SHRUB	NON-NATIVE
P NO N	POHINAHINA	NATIVE
PG	PILI GRASS	NATIVE
PNO	POHINAHINA-NAUPAKA DUNE	NATIVE
R	RUDERAL	NON-NATIVE
WL KH	WETLAND VEG W/KOA HAOLE	NON-NATIVE
PANICUM NIIHAUENSE (CRITICAL HABITAT)		

Plot Date: 23 Aug 2004



LEGEND

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AGR	AGRICULTURE	NON-NATIVE
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AL	ALGAROBA (LONG THORN KIAWE)	NON-NATIVE
ANS	AALII-NAMA SCRUB	NATIVE
AS	AALII SCRUB	NATIVE
BLT	BLACKBERRY, LANTANA THICKET	NON-NATIVE
BT	BLACKBERRY THICKET	NON-NATIVE
C, BF	CLIFF, BOULDER FIELD	NON-NATIVE
ERD	ERODED, BARE SOIL	NON-NATIVE
G,H,S	GRASS, HERB, SHRUB	NON-NATIVE
>25% W	GREATER THAN 25% WILIWILI	NATIVE
HICC	HAWAIIAN MXD SHRUB COASTAL CLIFF	NATIVE
I	IPOMOEA	NON-NATIVE
K	KIAWE	NON-NATIVE
KHS, <25%W	KOA HAOLE SCRUB, LESS THAN 25% WILIWILI	NON-NATIVE
KHS, F	KOA HAOLE SCRUB, FOREST	NON-NATIVE
KKHS	KIAWE KOA HAOLE SCRUB	NON-NATIVE
KKHS, AG	KIAWE KOA HAOLE SCRUB WITH AGAVE	NON-NATIVE
KKHS, AL	KIAWE KOA HAOLE SCRUB WITH ALGAROBA	NON-NATIVE
KNN	MIXED KOA, NON-NATIVE FOREST	NATIVE
KOF	KOA OHIA MIXED MONTANE MESIC FOREST	NATIVE
LS	LANDSCAPED	NON-NATIVE
MSCC	MXD SHRB DRY CSTL CLIFF	NON-NATIVE
MSCC K	MXD SHRB DRY CSTL CLIFF WITH KOA	NATIVE
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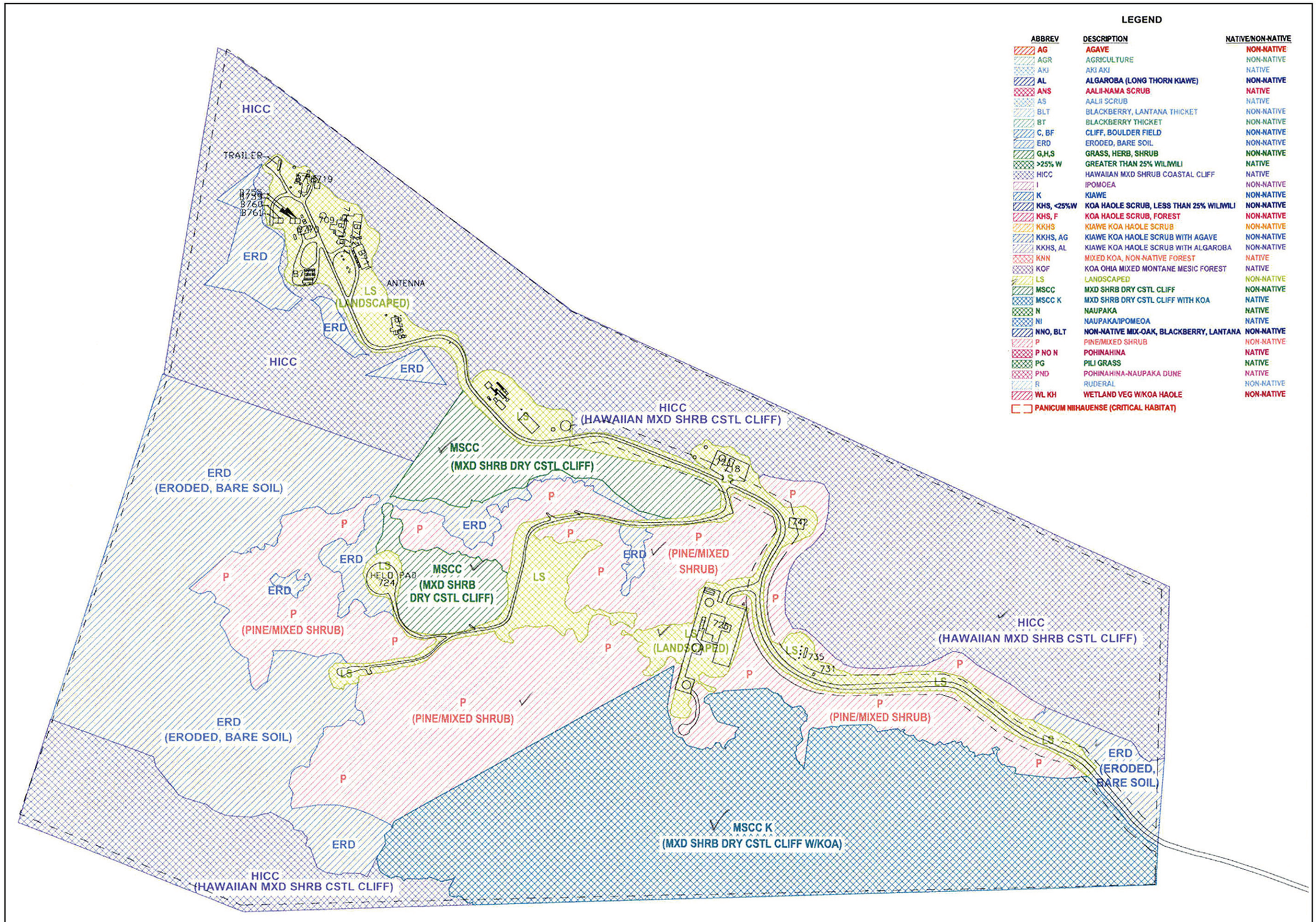
NI	NAUPAKA/IPOMEOA	NATIVE
NNO, BLT	NON-NATIVE MIX-OAK, BLACKBERRY, LANTANA	NON-NATIVE
P	PINE/MIXED SHRUB	NON-NATIVE
P NO N	POHINAHINA	NATIVE
PG	PILI GRASS	NATIVE
PND	POHINAHINA-NAUPAKA DUNE	NATIVE
R	RUDERAL	NON-NATIVE
WL KH	WETLAND VEG W/KOA HAOLE	NON-NATIVE

PANICUM NIIHAUENSE (CRITICAL HABITAT)

KOKEE VEG MAP:J

SCALE: NONE

Plot Date: 23 Aug 2004



LEGEND

ABBREV	DESCRIPTION	NATIVE/NON-NATIVE
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AGR	AGRICULTURE	NON-NATIVE
AKI	AKI AKI	NATIVE
AL	ALGAROBA (LONG THORN KIAWE)	NON-NATIVE
ANS	AALII-NAMA SCRUB	NATIVE
AS	AALII SCRUB	NATIVE
BLT	BLACKBERRY, LANTANA THICKET	NON-NATIVE
BT	BLACKBERRY THICKET	NON-NATIVE
C, BF	CLIFF, BOULDER FIELD	NON-NATIVE
ERD	ERODED, BARE SOIL	NON-NATIVE
G,H,S	GRASS, HERB, SHRUB	NON-NATIVE
>25% W	GREATER THAN 25% WILIWILI	NATIVE
HICC	HAWAIIAN MXD SHRUB COASTAL CLIFF	NATIVE
I	IPOMOEA	NON-NATIVE
K	KIAWE	NON-NATIVE
KHS, <25%W	KOA HAOLE SCRUB, LESS THAN 25% WILIWILI	NON-NATIVE
KHS, F	KOA HAOLE SCRUB, FOREST	NON-NATIVE
KKHS	KIAWE KOA HAOLE SCRUB	NON-NATIVE
KKHS, AG	KIAWE KOA HAOLE SCRUB WITH AGAVE	NON-NATIVE
KKHS, AL	KIAWE KOA HAOLE SCRUB WITH ALGAROBA	NON-NATIVE
KNN	MIXED KOA, NON-NATIVE FOREST	NATIVE
KOF	KOA OHIA MIXED MONTANE MESIC FOREST	NATIVE
LS	LANDSCAPED	NON-NATIVE
MSCC	MXD SHRB DRY CSTL CLIFF	NON-NATIVE
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NNO, BLT	NON-NATIVE MIX-OAK, BLACKBERRY, LANTANA	NON-NATIVE
P	PINE/MIXED SHRUB	NON-NATIVE
P NO N	POHINAHINA	NATIVE
PG	PILI GRASS	NATIVE
PND	POHINAHINA-NAUPAKA DUNE	NATIVE
R	RUDERAL	NON-NATIVE
WL KH	WETLAND VEG W/KOA HAOLE	NON-NATIVE
	PANICUM NIIHAUENSE (CRITICAL HABITAT)	

MAKAHA RIDGE VEG MAP:I

SCALE: NONE

Plot Date: 23 Aug 2004

APPENDIX B
ANIMAL SURVEYS

B1 - HERPETOLOGICAL AND MAMMAL SURVEYS OF PACIFIC MISSILE RANGE FACILITY

(NAVFAC PAC 2006e)

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Herpetological and Mammal Surveys at the Pacific Missile Range Facility

Introduction

Herpetological and mammal surveys were performed at PMRF during February and April, 2006. The surveys were performed for the update of the base Integrated Natural Resources Management Plan.

Small Mammal Sampling

Methods

Small mammals were sampled by trap lines of Victor snap traps. Traps were set up and baited in the afternoon and checked the following morning. Traps were baited with dried squid and peanut butter. Trap spacing was 15-20 meters. The abundance was expressed as the number of rats captured divided by the number of trapping nights to yield a capture percentage. One trap set for one night equals one trap night. So, 20 traps set for one night equals 20 trapping nights and 20 traps set for 2 nights equals 40 traps nights etc. Four rats captured on 20 trapping nights yields a catch rate of 20%: 4/20 x 100 = 20.

The following areas were sampled: forested section on PMRF main base ~100 meters south east of the vacation rentals area, Barking Sands dune area and two areas at the Kokee sites. A total of 179 trapping nights were recorded. The main base area was sampled for 83 trap nights, Barking sands had 48 trap nights and Koke'e ridge had 48 trap nights.

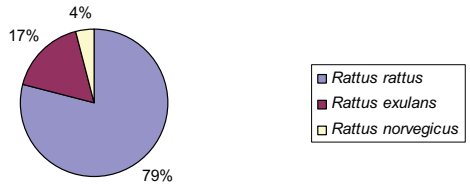
Results

Three rat species were documented, *Rattus rattus*, *Rattus exulans*, and *Rattus norvegicus*. The common house mouse, *Mus muscalus*, was also captured.

Rattus rattus (n = 19) was the most common rat species found, followed by *R. exulans* (n = 4) and *R. norvegicus* (n = 1) (chart 1). Three mice were captured.

Chart 1.

***Rattus* species diversity at PMRF, percentages of captures**

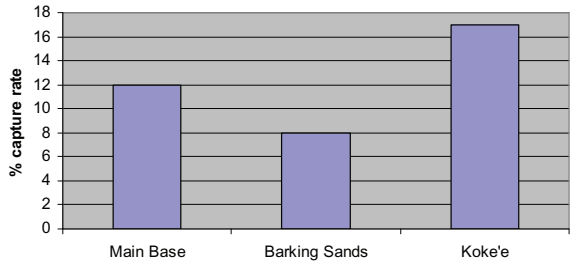


Rattus rattus was captured at all locations, *R. exulans* was only captured at the main base area and *R. norvegicus* was only captured at the Kokee sites. Mice were only captured at the main base area.

The Kokee sites had the highest capture rates (17%) followed by the main base area (12%) and Barking sands dunes area (8%) (chart 2.)

Chart 2.

Rat trapping capture rates at PMRF

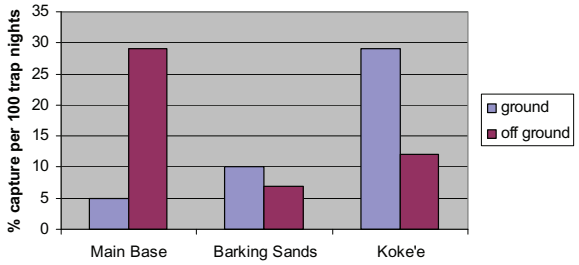


Of interest is that the capture rates of on ground vs off ground traps differed depending on locality. At the main base area, on ground traps had a 5% capture rate while the off ground traps had a 29% capture rate. At the Kokee sites these numbers were reversed, ground traps had a 29% capture rate while off ground traps had a 12% capture rate. At the Barking sands area, the rates were almost equal: on ground traps had a 10% capture rate and off ground traps had a 7% capture rate (Chart 3.).

Rattus rattus has two different color morphs and both were documented at PMRF. One morph is a dark black color dorsally and lighter black or grayish ventrally, the other morph is a brown dorsal and a cream colored vent (photos 1 and 2). The dark color morph was the most common and only one light colored/brown *R. rattus* was captured.

Chart 3.

Capture Rates for Rat Trapping at PMRF



Discussion

Rats were abundant in all areas sampled. Unfortunately this type of sampling cannot be used to estimate actual densities of rats. However, the catch rates (~10%) are consistent with high population numbers. As a general rule rat species are considered to have negative environmental impacts on pacific islands (Williamson, 1996), usually to native bird species. As such, rat control is generally warranted (when feasible) on any Pacific island.

The reason or reasons for the site specific catch rate variance between off-ground and on-ground traps is open to speculation: different environmental or microhabitat conditions,

differing intra/inter specific competition/interaction or it could just be some type of sampling bias.

Management Recommendations

The area sampled at the main base was within ~300 meters of the wedge-tailed shearwater colony. Rat densities near the colony are high and it is highly probable that rats are impacting the colony. *Rattus* species impacts on ground nesting sea birds have been clearly shown (Mcneill, 1994; Williamson, 1996) and the shearwater is protected under the Migratory Bird Treaty Act. Rat control in this area is warranted and can be economical if rodenticides are used during the shearwater breeding season. Snap traps are not recommended for rodent control. Reproduction data (number of eggs laid, hatching success and chick rearing success) should be collected to gauge the efficacy of rodent control efforts. Due to the high capture rates of off ground traps, the rodenticide bait stations should be set on ground and off ground, in the trees, for more complete coverage.

Reptile and Amphibian Sampling

Methods

Reptiles and amphibians were sampled during the day and the evening on timed transect surveys, daytime trapping with rodent glue boards ("sticky traps"), and night trapping with rodent glue boards.

Areas sampled include: PMRF main base, Makaha Ridge, and two areas at the Kokee sites.

Results:

The following species were documented:

Reptiles (all lizards)

Green Anole, *Anolis carolinensis*: Makaha Ridge
House Gecko, *Hemidactylus frenatus*: PMRF main base, Makaha Ridge
Mourning Gecko, *Lepidodactylus lugubrus*: PMRF main base, Makaha Ridge.
Snake-eyed Skink, *Cryptoblepharus poecilopleurus*: PMRF main base (close to beaches).
Metalic Skink, *Lampropholis delicata*: Kokee

Amphibians

Marine Toad, *Bufo marinus*: PMRF main base.

Discussion:

The most common reptile encountered was the House gecko. The mourning gecko was much less common.

The anole was found only at Makaha Ridge which was surprising. It was expected to find this species at PMRF main base on ornamental bushes and shrubs. On other Pacific islands it is very common in this habitat type (Vogt, pers. exp).

The metallic skink was only found at the Kokee sites where it was common. The trap capture rates were much higher on the forest/grass edge than in the forest interior (0.25/hr vs .06/hr). It was surprising that this species was not found on PMRF main base. The only skink found at PMRF main base was the snake-eye skink. This species was found close to the water which is it's the normal habitat (Mckeown, 1996). Capture rates for this species were low (0.02/hr) indicating low abundance.

Management Recommendations:

There are no management recommendations for reptiles and amphibians at this time.

Large Mammal Sampling

Methods

Large mammals (feral goats, feral pigs, deer and feral cats) were sampled by timed transect, visual surveys during the day. Animals and their sign (tracks and scat) were noted when observed. Areas sampled include: Makaha Ridge, the Kokee sites, PMRF main base areas, Barking sands dune area, and Kamokala magazine.

Feral goats at Makaha Ridge were sampled by direct counts. The road at Makaha Ridge was driven slowly and goats were counted when seen. Goat surveys were performed in the early morning and late afternoon. When spotted the sex and age of the goat was recorded.

Results

Blacktail deer, pig and cow sign (tracks, rootings or scat) was observed at Kamokola Magazine area. Pig sign was common at Koke'e ridge. Workers at Makaha Ridge report seeing pigs in the evenings. One deer was observed at Makaha ridge. Feral cat sign and the cats themselves were very common on PMRF main base and were present (but not as common) on all areas surveyed.

Makaha Ridge was surveyed for goats 4 times. The highest number counted was 68. This was on April 2, a Sunday. Sixty seven goats were counted on April 1 (Saturday). Both counts were done in the late afternoon after 17:00 pm. The two counts on weekdays,

March 31 and April 4, counted only 6 and 9 goats respectively. That numbers were much higher on the weekends is probably because of decreased human activity. The goats were easily observed and were literally grazing all over the mowed lawn areas of the base.

The age and sex (demographics) were recorded for 41 goats on the second survey (60% of the number observed). The demographic percentages (percent of the sample) were: males=34%, females=42% and kids=34%. The sex ratio was skewed towards females which is apparently normal for this species (Nowak, 1999).

Discussion

The weekend counts are probably close to the actual number of goats present at the Makaha Ridge installation. It is possible that some goats were missed during the count, but the majority were observed, in my opinion.

The area given for the Makaha ridge installation is 99 hectares. Therefore the goat density is 0.69 per hectare. This density is much higher than reported goat densities from other areas (Brennan et al, 1993; Nowak. 1999).

Goat densities on the Makaha Ridge installation are probably much higher than the surrounding areas due to no hunting allowed on base. The goats probably migrate to areas where they are not shot at and become concentrated on the installation. Given that 34% of the sample were kids, it appears that the density will increase in the future.

The effects of the high goat numbers are patently obvious. Erosion is widespread on the installation and will effect base operations (if it has not already). Bare earth is readily observed and base personnel report that the endangered Nene (Hawaiian goose) no longer nests on the installation due to goats impacting the nests (this species nests on the ground).

Pig and deer densities cannot be calculated with the survey methodology that was used and are much more difficult to estimate. Pig sign was very common on the Kokee sites. Deer sign was common at Kamokola Magazine. The effects of pigs and deer on the vegetation are difficult to ascertain at this point. Ungulates are known to have very negative effects on native Hawaiian plant species (Nowak, 1999), and it is assumed that this is happening where they occur on Kuaii.

The high numbers of feral cats at PMRF is cause for concern especially near the shearwater colony and in the Barking Dunes area. Cat presence near the shearwater colony should be easy to gauge by the presence of tracks in the sand. What prey base is sustaining the cats is open to speculation, but one assumes a combination of small rodents, birds and human food from garbage or people deliberately feeding the cats.

Management Recommendations

The goat herd at Makaha ridge needs to be either eradicated or greatly reduced. Due to the popularity of goat hunting on Kauai, population reduction by lethal means will probably be controversial. Discussions with Hawaii Department of Lands and Natural Resources biologist Thomas Kaiakapu, indicate that State personnel will be able to live-capture goats on Makaha Ridge for translocation to hunting areas. The costs would be borne by the state of Hawaii. It is highly recommended that the Navy pursue this.

Because this installation is not fenced, it will be re-colonized by goats from the surrounding area. Goats also have a very high fecundity and can recover from a 60% reduction in two years. Therefore, a goat translocation program will need to be a yearly management operation.

Because they occur at lower densities and are more nocturnal and secretive, pigs and deer are much harder to control or eradicate than goats. Especially in open unfenced areas that allow immigration. We recommend no management actions for deer and pigs in unfenced areas at this time.

Feral cat sign in the vicinity of the shearwater colony should be monitored during the breeding season. If tracks or scat are observed, USDA should be contracted to trap in the area. Predator control (rats and if need be cats) should be part of a shearwater management program during the breeding season.

Photo 1.

From left to right: 1. *Rattus exulans* 2. Light color morph of *Rattus rattus*. 3. Dark color morph of *Rattus rattus*.

Photo 2.

From left to right: 1. *Rattus exulans* 2. Light color morph of *Rattus rattus*. 3. Dark color morph of *Rattus rattus*.

References

Brennan, M., Moller, H., and J. P. Parkes. 1993. Indices of density of feral goats in a grassland/forest habitat, Marlborough, New Zealand. New Zealand Journal of Ecology (1993) 17(2): 103-106.

Dowding, J. E., and E. C. Murphy. 2001. The impact of predation by introduced mammals on endemic shorebirds in New Zealand: a conservation perspective. Biological Conservation 99: 47-64.

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B2 - PMRF BIRD SURVEYS

(NAVFAC PAC 2006f)

INTRODUCTION

The purpose of this report is to provide the results of bird surveys conducted to assist with the update of the November 2001 Integrated Natural Resources Management Plan (INRMP) for Pacific Missile Range Facility (PMRF), Kauai. Installations included are Barking Sands, Kokee Sites, Makaha Ridge and Kamokala Magazine. Surveys were conducted 13 - 17 February 2006 and 14 - 20 April 2006.

SITE DESCRIPTIONS

Pacific Missile Range Facility, Barking Sands

This installation is located along the Mana Plain on the western coast of Kauai and occupies 2,060 acres (834 hectares) of land (Fig. 1). There are four different habitat types throughout the installation: dune, wetland, kiawe forest and field habitats.

Kamokala Ridge Magazine

Kamokala Ridge Magazine lies approximately 1.5 miles (2.4 kilometers) inland of Barking Sands and occupies 89 acres (36 hectares) of leased State land (Fig. 2). Individual magazines are dug horizontally into the face of a steeply-sloping ridge. The area is dry and receives little rainfall.

Makaha Ridge

The installation ranges from 1,400 feet (427 meters) to 2,000 feet (610 meters) above sea level on a west-facing ridge north of Barking Sands (Fig. 3). The site occupies 244 acres (99 hectares). The installation includes part of the steep Na Pali cliffs except for the inland side where a road winds down the ridge from Kokee State Park.

Kokee Sites

This installation comprises five sites along Highway 550, which winds through Kokee State Park (Fig. 4). The total land area is approximately 23 acres (9 hectares). The buildings are surrounded by a fence, and the vegetation within the area consists of mowed grass. The property outside the fence does not, in general, extend beyond 98 feet (30 meters) with the vegetation outside the fence line consisting of a mixture of native and non-native forest species. The elevation of the Kokee Sites is approximately 3,600 feet (1097 meters). The area is wetter and cooler than Barking Sands.

SURVEY METHODOLOGY

Surveys were conducted following the Hawaiian Forest Bird Survey methods. These methods use the variable circular-plot (VCP) method (Reynolds et al. 1980) where all birds observed or heard during the count period were recorded and the type of observation (aural, visual or both) was noted. Additionally, at first detection the distance to the bird was estimated. Birds observed flying over the count station but not landing in the area were determined not to be using the habit and were not counted. Each count was conducted for 8 minutes.

The sizes, shapes and habitats of the Navy installations affected the manner in which the point count stations (for the VCP method) were set up. Initially, an attempt was made at Kamokala Ridge Magazine to place point count stations at approximately 328 foot (100 m) intervals along transect lines established to identify and measure the sub-habitats within the 89 acre (36 hectare) parcel (Fig. 2). However, due to the topography (steep ridges with valleys and relatively narrow draws) and the habitat (relatively low, dry scrub) the same birds (down in the draw, across to the next ridge, etc.) could be heard at all stations along a transect line. The strategy was changed to visiting the installation first to determine the types of birds and habitat in the area and then placing point count stations in areas to ensure the least amount of recording the same birds multiple times. Therefore, all point count stations are not randomly placed.

Barking Sands is a long, narrow installation, so point count stations were set up at least 492 feet (150 m) apart and in different habitat types (Fig. 1). Additionally, 3 (or 4) approximately 164 foot (50 meter) shorebird transects were surveyed along the beach of Barking Sands. At Makaha Ridge, point count stations were placed to cover as many of the habitat types as possible while reducing the potential for recording the same birds at different stations (Fig. 3). The Kokee facility is made up of 5 different sites that total 23 acres (9.3 hectares). The installations follow the Kokee State Park road (Hwy 550) in a generally north-south orientation. Native forests birds use habitats in and around the Kokee installations, so all counts stations were at least 492 feet (150 m) apart and within the installation boundary (Fig. 4).

NATIVE SPECIES SUMMARIES

Barking Sands

- **Wedge-tailed shearwaters (*Puffinus pacificus*)**

Wedge-tailed shearwaters are pelagic seabirds of the tropical and sub-tropical Pacific and Indian Oceans. They breed from Madagascar (Indian Ocean) to Revillagigedo Island (off Mexico) (Whittow 1997). Wedge-tailed shearwaters feed mainly on larval forms of several species of fishes driven to the surface by fish schools. Colors vary from grayish-brown to a sooty brown, with the lighter colored individuals found in the North Pacific. In the Hawaiian Islands, wedge-tailed shearwaters breed from Kure Island south to Maui.

Figure 5. Wedge-tailed shearwater

Wedge-tailed shearwaters breed from February through November. On Kauai, the earliest sightings recorded range from February 28 to March 12 (Whittow 1997). They are ground-nesting seabirds that dig burrows in the sand. The typical breeding /burrowing areas are low, flat islands and sandspits with little or no vegetation (Whittow 1997). They will use rock piles and ledges where there are areas that aren't suitable for excavating burrows (Whittow 1997). Most egg laying, on Kauai, is completed by June 25th, with a peak from 12-18 June (Whittow 1997). Hatching begins in late July, peaks from August 1-12 and ends by August 18 (Whittow 1997). Fledgling begins in early November and finishes by the end of November. In Hawaii, most birds return to their natal island to breed (Whittow 1997). The known predators of adult wedge-tailed shearwaters are rats, domestic dogs, and feral cats. On Kauai, nestlings have been taken by barn owls and mynas have been known to eat the eggs (Whittow 1997).

- **Newell's shearwater (*Puffinus auricularis newelli*)**

Newell's shearwaters are medium-sized seabirds that live in Hawaii. They are listed as threatened under the Endangered Species Act. Breeding mainly occurs on Kauai, but nesting has been recorded on the islands Molokai and Hawaii. They nest in burrows or deep rock crevices at higher elevations (500-2300 ft [600 – 1200m]) (Ainley, *et al*. 1997). Due to predation by pigs and cats, Newell's shearwaters are now restricted to steep slopes that exceed 65°. The breeding season for Newell's shearwaters is estimated to be April–November (www.fws.gov/pacificislands/wesa/.html). On Kauai, egg-laying occurs during the first two weeks of June. The estimated incubation period for Newell's shearwaters is 51 days (Ainley, *et al*. 1997) and fledglings leave their burrow in October. In 1995, the population was estimated at 84,000 (Ainley, *et al*. 1997).

Figure 6. Newell's shearwater

- **Laysan albatross (*Phoebastria immutabilis*)**

Laysan albatross are a small albatross (wing span 6.4 – 6.6 feet [195 – 203 cm]) whose breeding is largely confined to the Hawaiian archipelago. They are monogamous and typically begin pair bonding in November. Eggs are laid from mid-November through mid-December (Whittow 1993b). The eggs hatch from mid-June through mid-July leading to a mean incubation of 64.4 days. Fledging occurs during the middle of July. The total population in the Hawaiian Islands was estimated in 1990 at 2.5 million (Whittow 1993b).

Figure 7. Laysan albatross

- **Black-footed albatross (*Phoebastria nigripes*)**

Black-footed albatross is one of the smaller albatrosses with a wing span of 6.3 – 7.1 ft 193 – 216 cm). They breed concurrently with Laysan albatross. Like Laysan albatross, black-footed albatross lay one egg per breeding attempt. The mean incubation is 65.6 days with approximately 140 days until fledging (Whittow 1993a), which means that they are fledging in mid-July, as are the Laysan species. Black-footed albatross forage on the eggs of flying fish, squid and crustacean. In 1992, the total population estimate of black-footed albatross was 200,000 individuals (Whittow 1993a).

Figure 8. Black-footed albatross on Laysan Island, Hawaiian Islands National Wildlife Refuge

- **Black-crowned night heron (*Nycticorax nycticorax hoactli*)**

The black-crowned night heron is a medium-sized heron with a wide distribution across the North American continent, south through Mexico, Central America, the Caribbean and Hawaii. They are opportunistic feeders, eating items ranging from aquatic and terrestrial insects to lizards, snakes, eggs and plant materials (Davis 1993). Breeding occurs in Hawaii from May to June (Hawaii Audubon Society 2005).

Figure 9. Black-crowned night heron

- **Moorhen (*Gallinula chloropus sandvicensis*)**

Moorhens are a small, black waterbird that is federally protected under the Endangered Species Act (listed as endangered). Hawaiian moorhens were formerly found on all main Hawaiian islands except Lana'i and Kaho'olawe. Presently, they are now found only on O'ahu and Kaua'i (Bannor and Kiviat 2002; USFWS 2005). Breeding occurs year round, but peaks from March through August. They build nests by folding emergent vegetation into a platform. Hawaiian moorhens lay approximately 5-7 eggs in a nest, and have an incubation period of approximately 19-22 days (Bannor and Kiviat 2002). Hawaiian moorhens are very secretive and, thus, are hard to monitor (Engilis and Pratt 1993). They appear to be highly sedentary and it is not known whether or not they move between islands (Bannor and Kiviat 2002). On Kauai, moorhens are distributed in lowland wetlands and valleys. Moorhens also live in the irrigation canals on the Mana Plain on and near Barking Sands. In the past, winter counts have suggested a relatively stable population (Engilis and Pratt 1993; Bannor and Kiviat 2002). Numbers may peak coincident with increased rainfall (Engilis and Pratt 1993). There is no current population estimate due to the secretive nature of this species (USFWS 2005).

Figure 10. Hawaiian moorhen

- **Coot (*Fulica alai*)**

Coots are plump, chicken-like birds that inhabit wetlands around the world. Hawaiian coots are smaller in size than American coots (Brisbin and Mowbray 2002; USFWS 2005). Hawaiian coots historically occurred on all of the main Hawaiian Islands except for Lana'i and Kaho'olawe (USFWS 2005). Today, they are found on all of the main islands except Kaho'olawe and are most numerous on O'ahu, Maui and Kaua'i. Coots are a coastal plain inhabitant and prefer fresh water. They appear to be generalist foragers, but it has been reported that they eat seeds, leaves, the stems of aquatic plants and lagoon mollusks. Hawaiian coots normally breed from March to September (Engilis and Pratt 1993), but may breed during all months of the year. The incubation period is approximately 25 days, with fledging time unknown (Pratt and Brisbin 2002). The coot population on Kauai has fluctuated between approximately 300 and 1500 individuals in recent years (USFWS 2005).

Figure 11. Hawaiian coot

- **Hawaiian Stilt *Himantopus mexicanus knudseni*)**

Hawaiian black-necked stilts are slim, wading birds that are approximately 16 inches (40 cm) tall (Robinson *et al*., 1999). The are black above and white below, and have long, pink legs (USFWS 2005). Historically, they were known on all of the major Hawaiian islands except Lana'i and Kaho'olawe. Currently, they live on all of the islands except Kaho'olawe (USFWS 2005). The breeding season of the Hawaiian black-necked stilt normally runs from mid-February through late August, with peak nesting varying among years. They lay 3 or 4 eggs in a nest over a 4-5 day period, and have an incubation period of approximately 23-26 days (Robinson *et al*. 1999; USFWS 2005). Long-term census data suggests that populations statewide are stable or slightly increasing (USFWS 2005). On Kauai, the stilt population has fluctuated between 125 to 350 individuals over recent years (USFWS 2005).

Figure 12. Hawaiian stilt

- **Pacific golden plover (*Pluvialis fulva*)**

Pacific golden plovers are a medium-sized plover that, during the winter months, occupy upland and coastal habitats in the Hawaiian Islands (Johnson & Conners 1996). They leave Hawaii in April to migrate to Alaska to breed and return to Hawaii in August (Hawaii Audubon Society 2005).

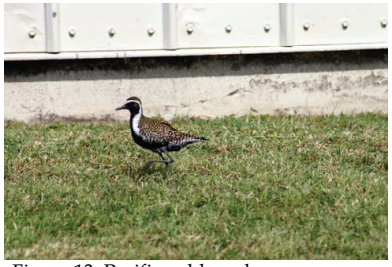

Figure 13. Pacific golden-plover

- **White-tailed tropicbird (*Phaethon lepturus*)**

White-tailed tropicbirds are a medium-sized, aerial seabird and are the smallest of the tropicbirds. On Kauai they nest at Waimea Canyon, Kilauea Point and alsong the Na Pali Coast. While out at sea, white-tailed tropicbirds forage on small surface-dwelling pelagic fish and squid (Lee & Walsh-McGehee 1998). In Hawaii, they nest from March through October and lay one egg. It is estimated that incubation lasts 40 days and that the time from hatching to fledging ranges between 70 and 80 days (Lee & Walsh-McGehee 1998). A 1990 estimate of the population around the Main Hawaiian Islands was 500 – 3000 pairs (Lee & Walsh-McGehee 1998).

Figure 14. White-tailed tropicbird (Picture from: http://www.justbirds.org/Seychelles)

Makaha Ridge

- **White-tailed tropicbird (*Phaethon lepturus*)**

Please see the above section.

- **Nene (*Branta sandvicensis*)**

The nene is a medium-sized goose that is the only native resident goose in Hawaii. On Kauai, populations of nene exist at Kilauea Point National Wildlife Refuge, Kipai Kai and Na Pali Coast (Banko, *et al*. 1999). On Kauai, nene typically breed and live in areas of managed grass below 984 ft (300m) elevation. However, some that were released along the Na Pali coast are moving to upland areas of managed grass in Kokee State Park and are sometimes seen in Alakai Swamp (Banko, *et al*. 1999). They eat leaves of grass and other plants, berries,

seeds, and flowers. Their primary predators on Kauai are: pueos, barn owls, rats, pigs, and dogs (Banko, *et al*. 1999). Nene egg-laying occurs from November – January with an average incubation period of 30 days. Mean fledging for goslings is at 10 – 14 weeks, however, the young stay with the parents for about one year. In 1997, the estimated population of nene on Kauai was 256 individuals (Banko, *et al*. 1999).

Figure 15. Nene or Hawaiian goose

- **Pueo or Short-eared owl (*Asio flammeus*)**

The short-eared owl is one of the world's most widely distributed medium-sized owls. The species in Hawaii is believed to have originated from Alaskan stock (Wiggens 2006). Pueo occur on all main islands, but are most common on Kauai, Maui and Hawaii (Hawaii Audubon Society 1997).

Kokee Sites

- **Nene (*Branta sandvicensis*)**

Please see the above section.

- **Kauai 'Elepaio (*Chasiempsis sandwichensis sclateri*)**

Kauai 'elepaio are a small monarch flycatcher that are widely distributed in good, forested habitat generally above 1,969 feet (600 meters) in elevation. They are most commonly observed above 3281 feet (1000 m) in wet ohia forest on the Alaka'i Plateau and Kokee State Park (VanderWerf 1998). Kauai 'elepaio are generalists and forage upon a wide variety of arthropods and slugs. They are a

monogamous flycatcher with breeding beginning January through February. Incubation of eggs typically occurs from March to June. The mean incubation is 18 days and the mean fledging occurs after about 16 days, however, immature 'elepaio stay in the natal territory for up to 10 months (VanderWerf 1998). 'Elepaio populations are severely affected by avian malaria and the pox virus. On Kauai, the primary predators of 'elepaio are introduced mammals (rats and cats). Additionally, barn owls and pueo have been recorded predating upon 'elepaio. In 1984 the estimated total population for Kauai was 40,000; there are no current population estimates (VanderWerf 1998).

Figure 16. Kauai 'elepaio (Photo courtesy of Jim Denny)

- **Kauai amakihi (*Hemignathus kauiensis*)**

Kauai amakihi are an olive green honey creeper that typically occurs above 1,968.5 ft (600 m) elevation. They live above Waimea Canyon and on the Na Pali Plateau, the Alakai Swamp, and the Makalena Mountains on Kauai. Kauai amakihi are one of the most common native birds on Kauai (Lindsey, *et al*. 1998). Their preferred habitat consists of forests dominated by ohia or a mix of koa and ohia. On Kauai, amakihi have been recorded consuming insects, grubs, caterpillars, nectar, berries or fruit. They may be most commonly observed gleaning for insects on the trunks and limbs of ohia and other trees. Kauai amakihi sing year round, but singing peaks March through May and most frequently in the early morning and early evening. Pairs form in February and March and they nest from March through July. The mean incubation period for amakihi is 14 days and the mean fledging is 18.8 days (Lindsey, et al. 1998). The population was estimated to be from 15,000 to 20,000 in the late 1980's (Lindsey, *et al*. 1998).

Figure 17. Kauai amakihi (Photo courtesy of Jim Denny)

- **Apapane (*Himatione sanguinea*)**

Apapane are well-known for their wide-ranging flights in search of localized ohia blooms. They are a small songbird with bright crimson plumage and black wings and tail. Apapane are largely limited to elevations above 4,101.0 ft (1250m) and are found in native ohia and koa forests (Fancy & Ralph 1997). They breed and winter in mesic and wet native forests dominated by ohia. Apapane are primarily nectivorous, but they will eat arthropods associated with foliage. Breeding pairs form January through March, with peak breeding occurring from February through June. The mean incubation period of apapane is 13 days and the mean time to fledging is 16 days (Fancy & Ralph 1997). Apapane are affected by the diseases avian pox and avian malaria. The population estimate of apapane living on Kauai in 1986 was approximately 30,000 (Fancy & Ralph 1997).

Figure 18. Apapane (Photo courtesy of Jim Denny)

- **'I'iwi (*Vestiaria coccinea*)**

'I'iwi are also known for their flights following localized ohia blooms. They are honeycreepers with brilliant vermillion plumage and black wings and tail. Originally, 'i'iwi were one of the most common forest birds on all of the forested islands from sea level to high elevations. Today, they are generally restricted to elevations greater than 4,101.0 ft (1250m) (Fancy & Ralph 1998). Like apapane, 'i'iwi are primarily nectivorous, but will eat arthropods (Fancy & Ralph 1998). On Kauai, the formation of pair bonds has been recorded to begin in mid-February. The mean incubation period is 14 days and mean time to fledging is 21-22 days (Fancy & Ralph 1998). 'I'iwi are also affected by avian malaria and predation by introduced mammals and owls. The populations estimate in 1981 in the Alakai swamp was approximately 5400 (Fancy & Ralph 1998).

Figure 19. 'I'iwi (Photo courtesy of Jim Denny)

RESULTS & DISCUSSION

Barking Sands

Sea/Shorebird Surveys

Brown boobies (*Sula leucogaster*) were regularly observed foraging offshore at Barking Sands. Other shorebirds that were commonly observed were sanderlings (*Calidris alba*), wandering tattlers (*Heteroscelus incanus*), ruddy turnstones (*Arenaria interpres*) and Pacific golden plovers (*Pluvialis fulva*). Laysan albatross (*Diomedea immutabilis*) still come to PMRF to attempt to nest during

their nesting season (November – July). During the February surveys, one black-footed albatross (*Diomedea nigripes*) was observed in the open grassy area near Building 265. While Newell's shearwaters (*Puffinus auricularis newelli*) were not recorded during the survey, they most likely fly over the installation on their way to and from their foraging area (the ocean) to their nesting area (higher elevations) and have the potential to "fall-out" (where, because of the attraction of bright lights, they become disoriented or exhausted and fall to the ground) on PMRF property. Another seabird, which has not been recorded on the installation, is the band-rumped storm-petrel (*Oceanodroma castro*), a candidate species for listing under the Endangered Species Act. There is also a potential for this bird to fall-out on this facility (Wood *et al*. 2002).

All Other Bird Surveys

Birds that were commonly observed throughout the base were; spotted doves (*Streptopelia chinensis*), zebra doves (*Geopelia striata*), northern mockingbirds (*Mimus polyglottos*), northern cardinals (*Cardinalis cardinalis*), red-crested cardinals (*Paroaria coronata*), house finches (*Carpodacus mexicanus*) and Japanese white-eyes (*Zosterops japonicus*). Wedge-tailed shearwaters (*Puffinus pacificus*) nest at the Beach Cottages and along the Nohili Dunes (Fig. 20). A wild turkey (*Meleagris gallopavo*) was recorded at Barking Sands for what appears the first time. The turkey showed up in late summer 2005.

Figure 21. Wild turkey at Barking Sands

Four endangered, endemic waterbirds utilize the wetland-type habitats found on Barking Sands. The Hawaiian coot (*Fulica alai*) and common moorhen (*Gallinula chloropus*) were most commonly observed along the ditches within Barking Sands. The black-necked stilt (*Himantopus mexicanus knudseni*) was most often recorded using the sewage treatment settling ponds and was occasionally

observed along the beach. One koloa (*Anas wyvilliana*) was recorded at the sewage settling ponds. For a list of all species recorded at Barking Sands, please see Table 1.

Kamokala Ridge Magazine

The most commonly observed birds at Kamokala Ridge Magazine were cattle egrets (*Bubulcus ibis*), chukars (*Alectoris chukar*), junglefowl (*Gallus gallus*), spotted doves, zebra doves, northern cardinals, and Erckel's francolins (*Francolinus erckelii*). No native species were recorded during this survey. The species recorded during this survey were consistent with previous surveys conducted on or around Kamokala Ridge Magazine (Bruner 2000). For a list of all species recorded at Kamokala Ridge, please see Table 2.

Makaha Ridge

As observed by Bruner (2000), Makaha Ridge is dominated by non-native species. Without a doubt, the most numerous introduced species encountered at Makaha Ridge in April, 2006 was the Japanese white-eye. At many of the point count stations it became very difficult to impossible to determine the number of Japanese white-eyes in the area because of overlapping vocalizations that effectively 'swamped' the observer with sound. Suffice it to say that Japanese white-eyes are very abundant at Makaha Ridge. The second-most abundant species was the common myna. Common mynas were observed most often around the man-made structures at Makaha Ridge. The introduced chukar (*Alectoris chukar*) was observed in the same locations (end of the road and along the cliffs) as noted by Bruner (2000). A group of approximately six endangered Hawaiian geese, or nene (*Branta sandvicensis*), were observed regularly on the installation. White-tailed tropicbirds (*Phaeton lepturus*), an indigenous seabird, were commonly seen flying along the valleys on either side of Makaha Ridge. For a list of all species recorded at Makaha Ridge, please see Table 3.

Kokee Sites

Variable circle plot methodology was used for this area because native forest birds are known to use the forest around the Kokee Sites. Because the area is so small (totals 23 acres), only seven (7) point count stations were placed through the area. Distance 5.0 Release Beta 5 (Laake, *et al*. 2005), a statistical program, was used to estimate the density (using the bootstrap method) of the native forest birds. Table 4 provides the results. In general, the results are not robust because there was not an adequate number of sampling stations. The information may be used as a gauge to understand the relative densities of the native forest birds. As noted in Bruner (2000), apapane (*Himatione sanguinea*) are

the most abundant native forest bird. The Kauai amakihi (*Hemignathus kauaiensis*) and 'elepaio (*Chasiempis sandwichensis*) were also observed during the survey in small numbers throughout the Kokee Sites. 'I'iwi (*Vestiaria coccinea*) were not observed during this survey. During the surveys, nene were observed flying over the Kokee Sites. In addition to this, juvenile nene were contained in a Department of Land and Natural Resources (DLNR) pen at Kokee Site C in preparation for a release effort. Band-rumped storm-petrels and Newell's shearwaters may fly over these sites (Wood, *et al*. 2003). For a list of all species recorded at the Kokee Sites, please see Table 5.

CONCLUSIONS & RECOMMENDATIONS

Barking Sands

Laysan albatross

Due to the Bird Air Strike Hazard (BASH) management occurring along the runway, a long-term albatross air hazard abatement program has been occurring at Barking Sands since 1988. The goal of the program is to eliminate Barking Sands as a nesting site for Laysan albatross, thus reducing the potential for a catastrophic bird strike at Barking Sands. Laysan albatross are discouraged from nesting along Barking Sands through adult and egg translocation and nest destruction. During the past breeding season USDA APHIS/WS accomplished a total of 422 hand captures and 665 vehicle dispersals from October, 2005 – May, 2006 (USDA/APHIS WS 2006). The eggs from nests were collected and kept in an incubator on base until it has been determined that the egg was viable. Once it was determined that the egg was viable, the egg was brought over to Kilauea National Wildlife Refuge (NWR) and given to an adult pair that had had an unsuccessful egg.

Recommendation: Continue the program with hand captures and vehicle dispersals along with the egg adoption at Kilauea NWR.

Comments on additional BASH/wildlife damage control program. The results of the bird surveys reflect the BASH efforts. For example, during the April surveys black francolins (*Francolinus francolinus*) were observed at a majority of the count stations. However, by the end of May, 108 individuals had been removed or dispersed. Chickens and black and Erckel's francolins are no longer commonly seen or heard around the base.

Wedge-tailed shearwaters:

At the nesting colony near the Beach Cottages, conservation and management actions began in FY06. In February, 2006 large, non-native trees were removed with the assistance of Kauai Invasive Species Committee (KISC) and the Public Works Center (PWC). Naupaka seedlings and native beach plant seeds (pohinahina, ilima, akiaki and naupaka) were introduced to the recently cleared area. In March, native plants donated by the USFWS refuge manager at Kilauea NWR were also planted. USDA APHIS/WS also conducts predator control around the Beach Cottage area. Feral cats are controlled by shooting, trapping (brought to the Kauai Humane Society) and by dispersing. Rodents are controlled by trapping and removal. In June, the number of active shearwater burrows was counted. There were 276 active burrows, providing an occupancy rate of 56%. Feral cat control has also expanded to large areas of Barking Sands as per the Chief of Naval Operations' "Policy Letter Preventing Feral Cat and Dog Populations on Navy Property", January, 2002.

Recommendation: Continue the nesting colony restoration efforts (at least 5 years total), by out-planting, installing artificial burrows and the removal of non-native plant species. Maintain the restored colony by removing detrimental, non-native plant species and continuing the predator control during the nesting season. Continue the current policy (post-9/11) of controlling access and preventing guests from bringing their dogs on to the installation. Continue education/outreach efforts for the shearwaters.

Seabirds:

Recommendation: Work with the DOFAW organization, Save Our Shearwaters, to retrieve and release birds (Newell's and wedge-tailed shearwaters and band-rumped storm-petrels) that have fallen out on the facility.

Makaha Ridge

Nene

According to personnel working at the facility and past banding efforts by the DLNR, nene nested along Makaha Ridge. Foraging goats (pigs and deer) have had an great impact on the habitat of Makaha Ridge. The goats remove a large amount of vegetation and have increased the rates of erosion on the facility and removed vegetation that nene used while nesting.

Recommendation: Fence the ridge and remove the ungulates.

Kokee Sites

Native Forest Birds

Recommendation: Curtail development. Reduce the potential to introduce non-native plant species and control any species that may have been introduced because of the facility operations. This area is important for both native forest birds and nene.

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Table 1. Birds observed at Barking Sands.

Common name	Scientific Name	Recorded During 2000 Survey	Recorded During 2006 Survey	Native	Regulatory Status
Laysan albatross	*Phoebastria immutabilis*	X	X	X	MBTA
Black-footed albatross	*Phoebastria nigripes*	-	X	X	MBTA
Brown booby	*Sula leucogaster*	-	X	X	MBTA
Wedge-tailed shearwater	*Puffinus pacificus*	-	X	X	MBTA
Cattle egret	*Bubulcus ibis*	X	X		MBTA
Black-crowned night-heron	*Nycticorax nycticorax*	X	X	X	MBTA
Koloa	*Anas wyvilliana*	X	X	X	ESA
Northern shoveler	*Anas clypeata*	X	X		MBTA
Common moorhen	*Gallinula chloropus*	X	X	X	ESA
Green-winged teal	*Anas crecca*	-	X		MBTA
Hawaiian coot	*Fulica alai*	X	X	X	ESA
Pacific golden-plover	*Pluvialis fulva*	X	X		MBTA
Black-bellied plover	*Pluvialis squatarola*	-	X		MBTA
Black-necked stilt	*Himantopus mexicanusknudsensi*	X	X		ESA
Wandering tattler	*Heterosceles incanus*	X	X		MBTA
Ruddy turnstone	*Arenaria interpres*	X	X		MBTA
Sanderling	*Calidris alba*	X	X		MBTA
Laughing gull	*Larus atricilla*	X	-		MBTA
Black francolin	*Francolinus francolinus*	X	X		
Erckel's francolin	*Francolinus erckelli*	X	X		
Ring-necked pheasant	*Phasianus colchicus*	X	X		
Wild turkey	*Meleagris gallopavo*	-	X		

Table 2. Birds observed at Barking Sands (continued).

Common name	Scientific Name	Recorded During 2000 Survey	Recorded During 2006 Survey	Native	Regulatory Status
Red junglefowl	*Gallus gallus*	X	X		
Rock dove	*Columba livia*	X	X		
Spotted dove	*Streptopelia chinensis*	X	X		
Zebra dove	*Geopelia striata*	X	X		
Barn owl	*Tyto alba*	X	-		
White-rumped shama	*Copsychus malabaricus*	X	X		
Hwamei	*Garrulax canorus*	X	X		
Common myna	*Acridotheres tristus*	X	X		
Northern mockingbird	*Mimus polyglottos*	X	X		
Japanese white-eye	*Zosterops japonicus*	X	X		
Northern cardinal	*Cardinalis cardinalis*	X	X		
Red-crested cardinal	*Paroaria coronata*	X	X		
Western meadowlark	*Sturnella neglecta*	X	USDA		
House finch	*Carpodacus mexicanus*	X	X		
House sparrow	*Passer domesticus*	X	X		
Chestnut munia	*Lonchura atricapilla*	X	X		
Nutmeg mannikin	*Lonchura punctulata*	X	-		
Skylark	*Alauda arvensis*	-	X		

Table 2. Birds observed at Kamokala Magazine.

Common name	Scientific Name	Recorded During 2000 Survey	Recorded During 2006 Survey	Native	Regulatory Status
Cattle egret	*Bubulcus ibis*	X	X		MBTA
Black-crowned night-heron	*Nycticorax nycticorax*	X	-		MBTA
Pacific-golden plover	*Pluvialis fulva*	X	-		MBTA
Chukar	*Alectoris chukar*	X	X		
Erckel's francolin	*Francolinus erckelii*	X	X		
Ring-necked pheasant	*Phasianus colchicus*	X	-		
Red junglefowl	*Gallus gallus*	X	X		
Rock dove	*Columba livia*	X	-		
Spotted dove	*Streptopelia chinensis*	X	X		
Zebra dove	*Geopelia striata*	X	X		
Barn owl	*Tyto alba*	X	-		
White-rumped shama	*Copsychus malabaricus*	X	-		
Hwamei	*Garrulax canorus*	X	X		
Common myna	*Acridotheres tristus*	X	X		
Northern mockingbird	*Mimus polyglottos*	X	X		
Japanese white-eye	*Zosterops japonicus*	X	X		
Northern cardinal	*Cardinalis cardinalis*	X	X		
Red-crested cardinal	*Paroaria coronata*	X	-		
House finch	*Carpodacus mexicanus*	X	-		
Chestnut munia	*Lonchura atricapilla*	X	-		
Nutmeg mannikin	*Lonchura punctulata*	X	-		

Table 3. Birds observed at Makaha Ridge.

Common name	Scientific Name	Recorded During 2000 Survey	Recorded During 2006 Survey	Native	Regulatory Status
White-tailed tropicbird	*Phaethon lepturus*	X	X	X	MBTA
Cattle egret	*Bubulcus ibis*	-	X		MBTA
Pacific golden-plover	*Pluvialis fulva*	X	X	X	MBTA
Nene	*Branta sandvicensis*	-	X	X	ESA
Chukar	*Alectoris chukar*	X	X		
Erckel's francolin	*Francolinus erckelii*	X	X		
Black francolin	*Francolinus francolinus*	-	X		
Ring-necked pheasant	*Phasianus colchicus*	X	X		
Red junglefowl	*Gallus gallus*	X	X		
Japanese white-eye	*Zosterops japonicus*	X	X		
Spotted dove	*Streptopelia chinensis*	X	X		
Zebra dove	*Geopelia striata*	X	X		
Hwamei	*Garrulax canorus*	X	X		
Common myna	*Acridotheres tristus*	X	X		
Northern mockingbird	*Mimus polyglottos*	X	X		
Northern cardinal	*Carninalis cardinalis*	X	X		
Red-crested cardinal	*Paroaria coronata*	-	X		
House finch	*Carpodacus mexicanus*	X	X		
Nutmeg mannikin	*Lonchura punctulata*	X	-		
Japanese bush warbler	*Cettia diphone*	-	X		

Table 4. Results of the native forest bird density estimate.

Common Name	Species	Estimated Density (hectare)	% CV	95% CI
'Elepaio	*Chasiempis sandwichensis*	0.9	106	0.03,27.7
Kauai amakihi	*Hemignathus kauaiensis*	0.9	57.1	0.27,3.1
Apapane	*Himatione sanguinea*	5.6	77.9	1.22,25.5

Table 5. Birds observed at Kokee Sites.

Common name	Scientific Name	Recorded During 2000 Survey	Recorded During 2006 Survey	Native	Regulatory Status
Pacific-golden plover	*Pluvialis fulva*	X	X	X	MBTA
Red junglefowl	*Gallus gallus*	X	X		
Spotted dove	*Streptopelia chinensis*	X	X		
Zebra dove	*Geopelia striata*	X	X		
Short -eared owl or Pueo	*Asio flammeus*	X	-	X	MBTA, STATE
Erckel's francolin	*Francolinus erckelii*	X	X		
White-rumped shama	*Copsychus malabaricus*	X	X		
Hwamei	*Garrulax canorus*	X	X		
Common myna	*Acridotheres tristus*	X	X		
Japanese white-eye	*Zosterops japonicus*	X	X		
Northern cardinal	*Carninalis cardinalis*	X	X		
'Elepaio	*Chasiempis sandwichensis*	X	X	X	
Kauai amakihi	*Hemignathus kauaiensis*	X	X	X	
Apapane	*Himatione sanguinea*	X	X	X	
'I'iwi	*Vestiaria coccinea*	X	-	X	
Red-crested cardinal	*Paroaria coronata*	-	X		
House finch	*Carpodacus mexicanus*	X	-		
Japanese bush warbler	*Cettia diphone*	-	X		
Nutmeg mannikin	*Lonchura punctulata*	X	-		

B3 - SURVEY OF AVIFAUNA AND FERAL MAMMALS

(BRUNER 2000)

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APPENDIX B

SURVEY OF AVIFAUNA AND FERAL MAMMALS

FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP) PACIFIC MISSILE RANGE FACILITY (PMRF) BARKING SANDS, KAUAI, HAWAII

Prepared for:
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16 February 2000

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CONTENTS

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INTRODUCTION

The purpose of this report is to summarize the findings of bird and mammal field surveys conducted at the Pacific Missile Range Facility (PMRF) and three other Navy sites on Kauai during December 1999 and January 2000. Also included are references to pertinent literature and unpublished reports. The objectives of the field survey and literature review were to:

1. Document what bird and mammal species actually occur on these sites. Note what other birds and mammals potentially could occur in this area given the types of habitat available.

2. Provide some baseline data on the relative abundance of each species at each site.

3. Note the presence or likely occurrence of any native fauna, particularly those that are listed as "Endangered" or "Threatened."

4. Determine the location of any special or unique resources important to native fauna.

SITE DESCRIPTIONS

Pacific Missile Range Facility, Barking Sands

A variety of habitats are available to wildlife at this facility. They include wetlands; open areas (lawns, beaches, and fields); second-growth forest; and residential property. Adjoining lands are developed in agriculture. Rainfall is limited in this region of the island. The beaches and ocean fronting the site are extensively used for recreation. The large sand dunes at the north end of the property are eroding due to vehicle and foot traffic.

Kamokala Ridge Magazine

This site is just inland and upslope from the north end of PMRF. Vegetation is dominated by introduced trees and brush. The topography is steep and adjoining stream drainages around the property likely flood during heavy rains. Agricultural lands front the site and steep, dry hillsides occur above the magazine.

Makaha Ridge

The property is at 2,000 to 1,400 feet above sea level on a dry, west-facing ridge. Steep cliffs front the seaward section and near vertical valley walls fall away on either side of the ridge. Introduced trees mixed with some native brush comprise the dominant vegetation. Large areas are barren and eroded. Small sections of lawn habitat adjoin the buildings and roadsides.

Kokee Sites

Five properties totaling approximately 23 acres alongside Highway 550 comprise the Kokee sites. A mixture of native and introduced trees surrounds each parcel. Lawn habitat exists along

roads and around buildings. The elevation in this area is approximately 3,600 feet, which results in more rainfall and cooler temperatures than Makaha Ridge, Kamokala Magazine or PMRF.

STUDY METHODS

PMRF, Barking Sands

This property was surveyed for birds and mammals on 20, 21, 22 December 1999 and briefly on 9, 22, 23 January 2000. All habitats were investigated. Walking and driving surveys were focused primarily in undeveloped lands.

Kamokala Ridge Magazine

A one-day (22 January 2000) was devoted to walking and driving Makaha Ridge. Two days (8 and 9 January 2000) were spent surveying this property. All habitats were investigated. Areas immediately upslope of the site were also surveyed.

Kokee Sites

Two days (22, 23 January 2000) were used to examine the five parcels at Kokee. Each site was completely walked and the adjoining forests were also surveyed. Surveys at all sites were focused primarily during morning and late afternoon hours when birds were most active and detectable. Evening observations were also made to look for owls, bats and other feral mammals.

A checklist of species either heard or seen at each site was kept. Estimates of relative abundance were also noted. Census data were taken in all habitats found on each property. Published and unpublished reports of birds known from this area of Kauai were also consulted in order to acquire a better perspective of the possible fauna that could occur in this region and their potential relative abundance (Pratt et al., 1987; Hawaii Audubon Society 1993; Bruner 1990a, 1990b, 1991, 1992, 1993, 1994, 1996, 1997). Observations of feral mammals were limited to visual sightings and evidence in the form of scats and tracks. No attempts were made to trap mammals in order to obtain data on their relative abundance and distribution. Such an effort was not possible or necessary within the scope and time constraints of these field surveys.

Scientific names of birds and mammals used in this report follow those given in Pyle (1997) and Honacki, *et al.* (1982). These sources give the currently accepted taxonomy for birds and mammals covered in this report.

RESULTS AND DISCUSSION

Avian

PMRF Barking Sands

Table 1 gives the species found on this survey and their relative abundance. This list conforms to data obtained on several earlier surveys at PMRF and nearby areas (Bruner 1990a, 1990b, 1991, 1993, 1994, 1997). Figures 1a and 1b show the approximate locations of census stations where

data for relative abundance estimates were obtained. Any rare species seen between stations were also tallied.

Of special concern are native and migratory species. Native birds recorded include endemic and indigenous waterbirds as well as seabirds. Migrants include shorebirds and ducks. Introduced birds were not surprisingly the most abundant. This is typical of the lowlands where most of the natural habitats have been altered by development and agriculture. Figure la notes the locations where Laysan albatross (*Phoebastria immutabilis*) were observed resting. Sites of two active albatross nests are also marked. The two shearwater nesting areas were unoccupied during the survey. The one at Nohili Point contained 88 nesting burrows. These nesting sites are also indicated in Figures la and 1b. Collapsed burrows and tracks of humans and dogs were observed at both shearwater colonies. Whether or not the disturbance occurred during or after the breeding season was not determined. A couple of shearwater eggs found at the dune site on the north end of PMRF had clearly been predated by rats. Again these eggs may have been abandoned or were infertile when predated.

The impact of potential disturbance and predation, however, should raise concern. The ditches around and across PMRF provide habitat for all four endangered and endemic waterbirds: Hawaiian coot (*Fulica alai*); common moorhen (*Gallinula chloropus*); black-necked stilt (*Himantopus mexicanus*); and koloa or Hawaiian duck (*Anas wyvilliana*). In addition, the indigenous non-endangered black-crowned night heron (*Nycticorax nycticorax*) also uses these wetlands as well as occasionally the exposed rocky intertidal. The number of waterbirds recorded (Table 1) was encouraging given the amount of wetlands on the facility. The sewage treatment settling ponds are attractive foraging grounds for stilts, coots, night herons and shorebirds. A male northern shoveler (*Anas clypeata*) was observed on the sewage pond on 9 January 2000. This species is one of the common migratory ducks that winters in Hawaii. An immature laughing gull (*Larus atricilla*) was observed on 22 January 2000. The gull was seen flying over PMRF and resting on a small island in the State of Hawaii sandpit ponds just mauka of PMRF. Gulls do not migrate to Hawaii but they occasionally show up as vagrants blown here by storms. They do not breed in Hawaii.

Kamokala Ridge Magazine

All birds tallied on the 22 January 2000 survey of this property are given in Table 2. Census stations were established along the road at distances great enough to avoid double-counting birds from the previous station. The only native species recorded was a black-crowned night heron seen alongside an irrigation ditch makai of the magazine fence line. The introduced species are those typically found in dry, second growth vegetation in coastal Kauai. Data presented in a 1993 survey on nearby lands (Bruner 1993) found a similar array of species. No particularly unusual or unique habitats utilized by native birds were found on the magazine property. Figure la shows location of site.

Makaha Ridge

Two days spent surveying the Makaha Ridge property and nearby lands yielded the data reported in Table 3. Figure 2 shows the location of census stations where data for relative abundance were gathered. Tallies of rare species seen between stations were also kept. The only native landbird recorded was the nene or Hawaiian goose (*Branta sandvicensis*). The migratory Pacific golden

plover (*Pluvialis fulva*) and an indigenous seabird, the white-tailed tropicbird (*Phaethon lepturus*), were also observed. Introduced birds dominated the site both numerically and in number of species. This was not unexpected given the elevation and predominance of introduced vegetation.

Erosion due to overgrazing by feral mammals has further degraded the habitats at this site. The introduced chukar (*Alectoris chukar*), a gamebird native to the Middle East, prefers dry rocky habitats usually above 1000 feet elevation (Pratt 1996). Their populations are often localized. At Makaha Ridge they were observed at the end of the road and on the rocky, dry cliffs.

Kokee Sites

Figure 3 indicates the location of the five parcels surveyed. Data obtained by walking each site on 22, 23 January 2000 are given in Table 4. This table indicates which parcel each species was seen or heard. The relative abundance estimates are for the area encompassed by all five parcels. These properties are so small and close enough to each other that to try to indicate relative abundance for every species at each parcel is unwarranted. Five native landbirds were observed on the survey (Table 4). The most abundant was the apapane (*Himatione sanquinea*). This species is probably the most common Hawaiian native forest bird. No endangered species were recorded. It is unlikely that the endangered forest birds would regularly frequent this area. The endangered nene (Hawaiian goose), Dark-rumped or Hawaiian petrel (*Pterodroma phaeopygia*) and threatened Newell's shearwater (*Puffinus newelli*) are known to occur at Kokee (Pratt et al. 1987, Bruner 1990a, 1992, 1996).

An unpublished Job Progress Report produced by the Department of Land and Natural Resources, Division of Forestry and Wildlife (Project No.4, Job No.3) covering the period of July 1998 to June 1999 gives a wealth of new data on dark-rumped petrels and Newell's shearwater. Seven grounded dark-rumped petrels were picked up at Kokee during 1998. Nine Newell's shearwaters were recovered at PMRF. Table 4 in this Job Progress Report indicates that the quadrant that includes Kokee and PMRF had the lowest percentage of "fallout" (grounded seabirds) but a higher percentage of grounded adults that hit power lines. Newell's shearwaters are also reported to have significantly declined on Kauai since Hurricane Iniki. The Job Progress Report examines the hypothetical causes, assumptions, and evidence for Newell's shearwater decline on Kauai.

Mammals

PMRF Barking Sands

Observations of mammals were obtained both during the day and on night surveys. Feral cats (*Felis catus*) and roof rats (*Rattus rattus*) were the most common species recorded. A total of 28 cats were tallied and 15 rats.

Three dogs (*Canis familaris*) were seen at the north end of the property in the regions of the large dunes. These animals did not have collars but may have belonged to someone using the beach fronting the dunes. The day they were seen, several vehicles were parked nearby on the beach. On two evenings the endangered and endemic Hawaiian hoary bat (*Lasiurus cinereus semotus*) was recorded. A group of four was observed foraging around the sewage treatment pond.

Another group of five was tallied just offshore of Recreation Area 1. This species is commonly seen on Kauai (Tomich 1986, Kepler and Scott 1990). Jacobs (1991, 1993) and Reynolds et al. (1998) provide additional information about the distribution and life history of this native mammal. No feral pigs (*Sus scrofa*) and black-tailed deer (*Odocoileus henionus*) were found on the survey. Pigs probably occur in this area but the deer may be a much less frequent visitor to the lowlands of PMRF.

The Hawaiian monk seal (*Monachus schauinslandi*) occasionally will haul out on the beaches in this region of the island. This endangered species must not be approached or disturbed. Pupping has also occurred as recently as 1999.

Kamokala Ridge Magazine

No feral mammals were sighted on the survey of this site. On occasion cats, rats, and pigs likely utilize this area. The Hawaiian hoary bat may also forage and even roost on the property. This species usually roosts solitarily in trees rather than in large numbers in caves like many other insectivorous bats. The black-tailed deer may occur in the area but are more abundant at higher elevation.

Makaha Ridge

Feral goats (*Capra hircus*) are abundant at this site. As many as 25 were seen in a single herd. They are relatively tame due to little or no hunting pressure. Three pigs were also seen over the course of the surveys of this property. Four black-tailed deer were seen on the morning of 9 January 2000. They were near the helicopter landing site. No cats or rats were observed but they undoubtedly occur in this area. No Hawaiian hoary bats were seen but this species may also forage and roost on the property or nearby.

Kokee Sites

One feral dog was seen on 23 January 2000 at Parcel D. The animal ran off when I approached by car. It appeared thin and frightened. Pig tracks were around all parcels. One black-tailed deer was seen on 23 January 2000 at Parcel E. Three endangered Hawaiian hoary bats were observed foraging above the forest at dusk on Parcel C on 22 January 2000. No cats or rats were tallied but they probably occur in this area.

CONCLUSIONS AND RECOMMENDATIONS

PMRF Barking Sands

This site supports a wide variety of introduced, native, and migratory birds. Four endangered waterbirds and the endangered Hawaiian hoary bat and monk seal can be found on the property. Two species of seabirds nest at PMRF. The wedge-tailed shearwater has two fairly large breeding colonies that were inactive at the time of this survey. Laysan albatross use open areas for resting and some attempt to nest. The four common migratory shorebirds that winter in Hawaii were observed on the beaches, around the sewage treatment pond and on lawns.

The ditches and drainage channels provide habitat for the native waterbirds. The emergent vegetation in the ditches and the overhanging shoreline brush provide cover for waterbirds. If these ditches are cleared of vegetation waterbird habitat would be reduced. Species such as the common moorhen and Hawaiian coot need the cover to avoid predators and for nesting. The Hawaiian duck is, likewise, a shy bird and will quickly take flight when disturbed or shelter against the shoreline brush. The drainage ditches may need to be cleaned periodically for flood control reasons, however, care should be taken when removing vegetation to ensure that any active nests of waterbirds are left undisturbed. The disturbance of wedge-tailed shearwater and Laysan albatross nests by people or predators will have a significant impact on nesting success.

The shearwater colonies are easily accessible to anyone utilizing the beaches that front these sites. The colony near Majors Bay is fairly well identified and marked. Never the less, it is easily accessed by predators and humans. The colony at the north end of PMRF is not marked or fenced. Predator access and human disturbance are a problem for this colony. Several burrows were collapsed from humans or dogs walking through the upper portions of the colony. This site should be fenced and marked to alert people to avoid entering the colony or allow their dogs access to the colony. Two albatross were on eggs during the course of the survey. Both nests were in Recreation Area One. One nest was close to the beach and was later found abandoned. The second nest was further back from the beach and in a patch of higher vegetation so that the nest and incubating bird were not visible from the beach access road. As of 23 January this nest was still active. Because shearwaters and albatross are ground nesters, they also are vulnerable to cats and rats that will take eggs and young chicks if the adults are away from the nest. An active trapping program for cats and rats should be concentrated around known albatross nesting areas and at the shearwater colonies during the breeding season.

Finally, the dunes at the north end of the property have been badly damaged by vehicles and foot traffic. The erosion of these dunes not only impacts the native plant communities but may eventually erode the area used by shearwaters. It might be possible to control access to the dunes by placing large boulders along the beachfront and other areas were vehicles might attempt to enter the area.

Kamokala Ridge Magazine

No particularly unique or important resources for native birds or mammals were found on this relatively small property. The drainage and irrigation ditches below the site are used by waterbirds.

Makaha Ridge

This property has been greatly altered by introduced vegetation and erosion caused by foraging goats, pigs and deer. The endemic and endangered nene can be seen on the lawn areas along with the migratory Pacific golden plover. White-tailed tropicbirds, a native seabird, can be seen flying along the cliffs. The control of feral herbivores by hunting would be an important first step in restoring this site. Introduced plants could be replaced with natives and in time the site might become attractive to native land birds such as apapane.

Kokee Sites

These small parcels are developed and contain little vegetation other than lawns. They are, however, surrounded by mixed native/introduced forest. The elevation and forest provide suitable habitat for native birds and the endangered Hawaiian hoary bat. Feral mammals such as dogs, pigs and deer occur in this area. Introduced mammals and vegetation degrade the habitat. These mammals need to be controlled by increased hunting pressure. The introduced trees like the Fire Tree can overrun the forest. This species is a problem in many Hawaiian forests. These trees can be controlled through cutting and removal of seedlings. The nene could use the lawn areas for foraging but would be at risk from ground predators such as dogs and cats. Regular predator control efforts should be maintained around all the Kokee Parcels.

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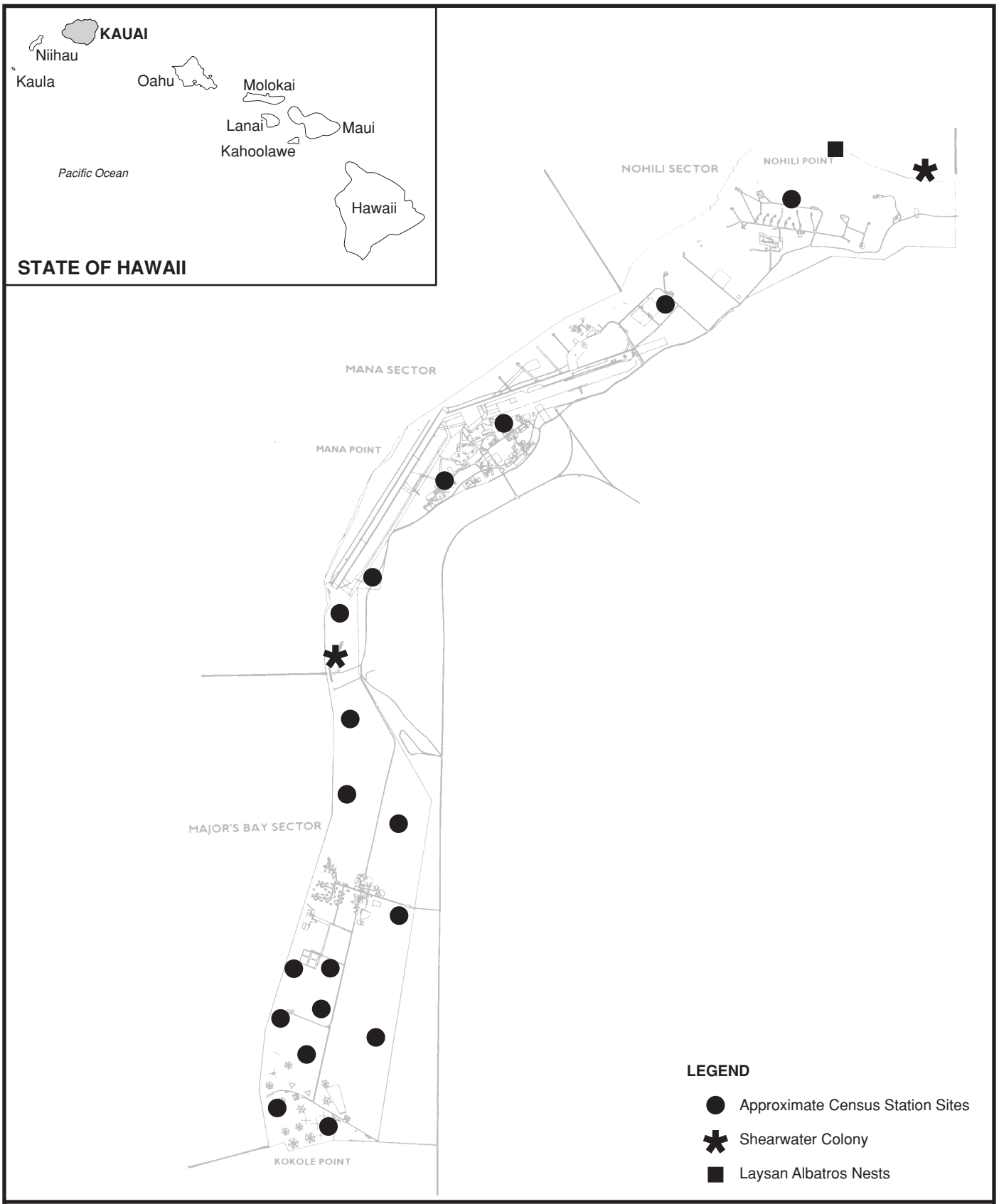
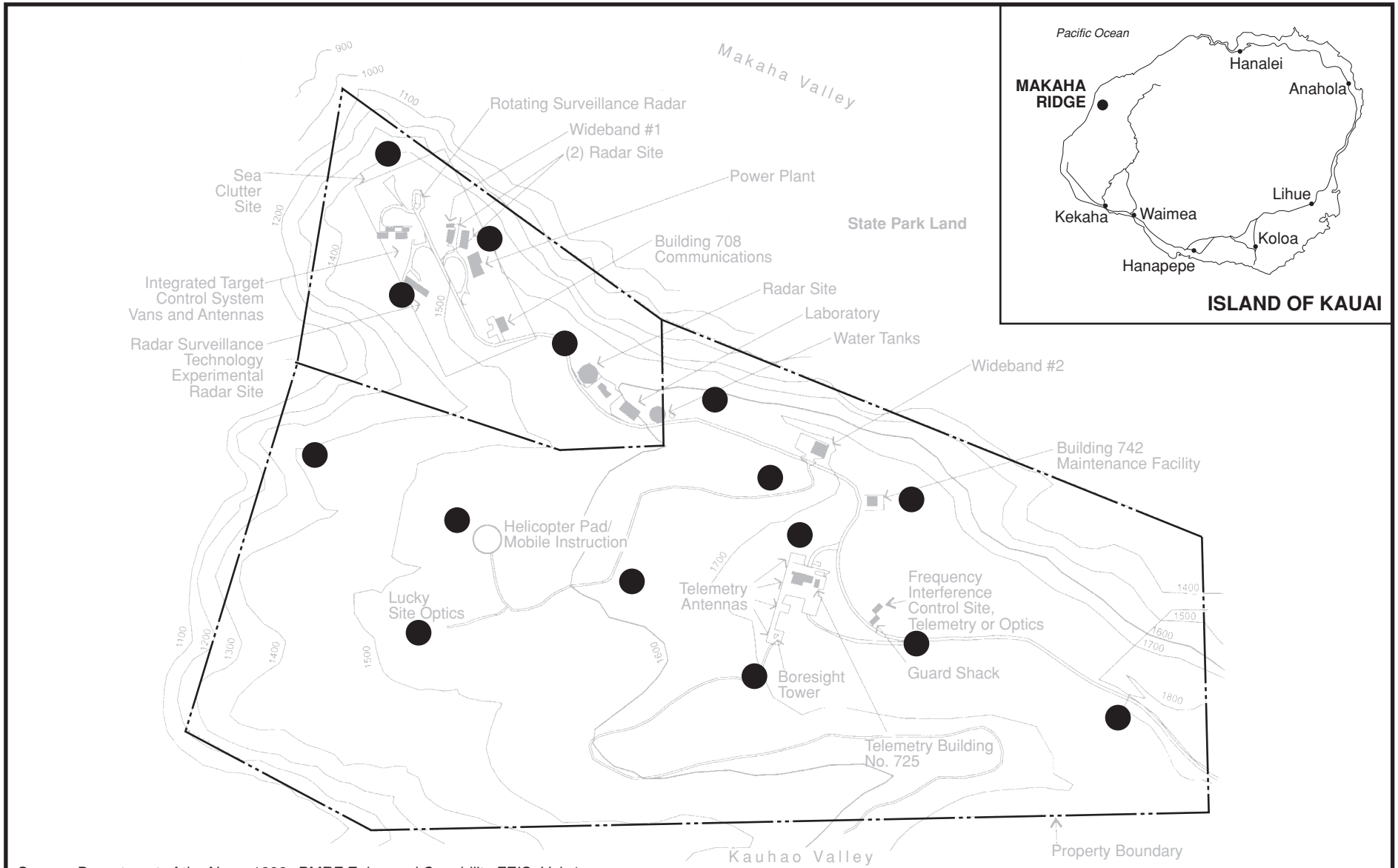


Figure 1
FAUNAL SURVEY SITES, BARKING SANDS
APPENDIX B: FAUNAL SURVEYS

Integrated Natural Resource Management Plan
Pacific Missile Range Facility



Source: Department of the Navy. 1998. *PMRF Enhanced Capability FEIS. Vol. 1.*

0 200 400
SCALE IN METERS

0 300 600 1200
SCALE IN FEET

NORTH

LEGEND

Existing Facilities/Landmarks

1200 Contour Lines (ft)

Approximate Census Stations

Note: All locations are approximate.

Figure 2
FAUNAL SURVEY SITES, MAKAHA RIDGE
APPENDIX B: FAUNAL SURVEYS

Integrated Natural Resource Management Plan
Pacific Missile Range Facility

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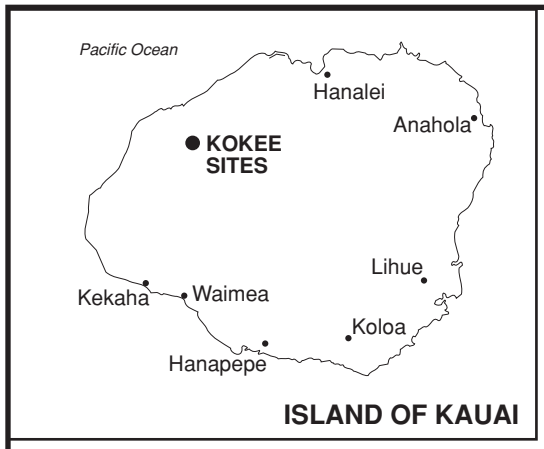

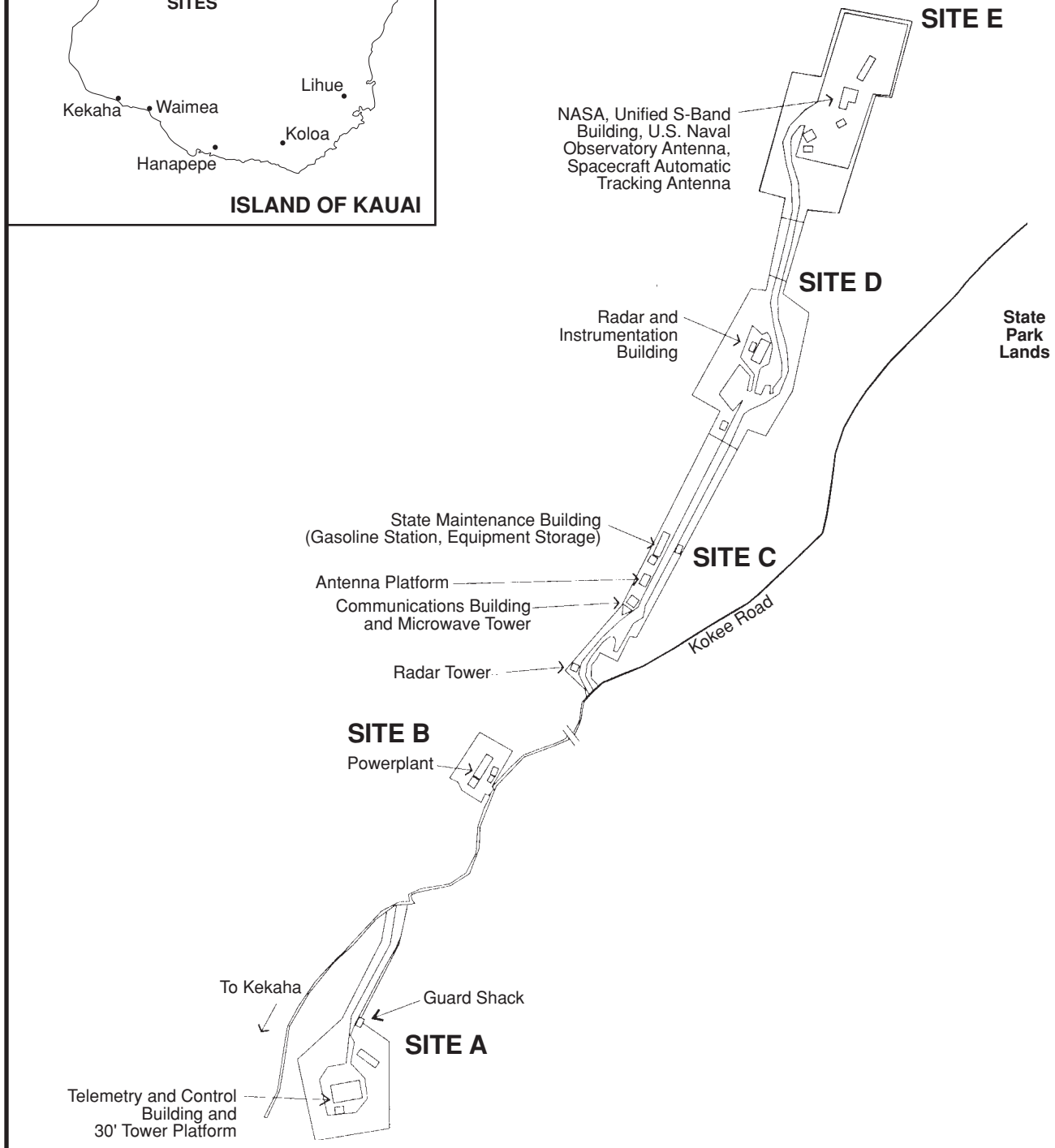

Source: Department of the Navy. 1998. *PMRF Enhanced Capability FEIS. Vol. 1.*

0 100 200
SCALE IN METERS

NORTH

0 175 350 700
SCALE IN FEET

Figure 3
FAUNAL SURVEY LOCATIONS, KOKEE SITES
APPENDIX B: FAUNAL SURVEYS

Integrated Natural Resource Management Plan
Pacific Missile Range Facility

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Table 1: Birds Recorded at Barking Sands

Birds recorded at PMRF on December 1999 and January 2000 surveys. Native seabirds and waterbirds are noted by an * and migratory birds with a +. Relative abundance estimates are based on data obtained at census stations, or in the case of rare species the total seen on all the surveys are given. Abundant = 10 or more per census station in appropriate habitat, Common = 5-9 per station, Uncommon = less than 5 per station, and Rare = may or may not have been recorded at a station, the number following R is the total tallied for the entire survey. All migratory species noted by a (+) are protected by the Migratory Bird Treaty Act.

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE
Laysan albatross*	*Phoebastria immutabilis*	U
Cattle egret	*Bubulcus ibis*	R = 6
Black-crowned night-heron*	*Nycticorax nycticorax*	R = 9
Koloa*	*Anas wyvilliana*	R = 5
Northern shoveler+	*Anas clypeata*	R = 1
Black francolin	*Francolinus francolinus*	U
Erckel francolin	*Francolinus erckelii*	R = 2
Red junglefowl	*Gallus gallus*	C
Ring-necked pheasant	*Phasianus colchicus*	R = 3
Common moorhen*	*Gallinula chloropus*	U
Hawaiian coot*	*Fulica alai*	U
Pacific golden-plover+	*Pluvialis fulva*	C
Black-necked stilt*	*Himantopus mexicanus*	C
Wandering tattler+	*Heteroscelus incanus*	U
Ruddy turnstone+	*Arenaria interpres*	U
Sanderling+	*Calidris alba*	R = 7
Laughing gull	*Larus atricilla*	R = 1
Rock dove	*Columa livia*	R = 12
Spotted dove	*Streptopelia chinensis*	A
Zebra dove	*Geopelia striata*	A
Barn owlx	*Tyto alba*	R = 2
White-rumped shama	*Copsychus malbaricus*	U
Hwamei	*Garrulax canorus*	U

Table 1: Birds Recorded at Barking Sands (Continued)

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE
Northern mockingbird	*Mimus polyglottos*	C
Common myna	*Acridotheres tristis*	C
Japanese white-eye	*Zosterops japonicus*	C
Northern cardinal	*Carninalis cardinalis*	C
Red-crested cardinal	*Paroaria coronata*	U
Western meadowlark	*Sturnella neglects*	U
House finch	*Carpodacus mexicanus*	A
House sparrow	*Passer domesticus*	C
Nutmeg mannikin	*Lonchura punctulata*	C
Chestnut mannikin	*Lonchura malacca*	A

Table 2: Birds Recorded at Kamokala Ridge Magazine

Birds recorded at Kamokala Ridge Magazine on 22 January 2000. Native birds are marked by an * and migratory species with a +. Relative abundance estimates come from data obtained at census stations and a drive/walk through of the property and nearby lands. Status i.e. Abundant, Common, Uncommon and Rare follow the numbers given in Table 1. All of the migratory birds noted by (+) are protected by the Migratory Bird Treaty Act. No Endangered or Threatened species were recorded.

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE
Cattle egret	*Bubulcus ibis*	R = 2
Black-crowned night-heron*	*Nycticorax nycticorax*	R = 1
Erckel francolin	*Francolinus erckelii*	U
Red junglefowl	*Gallus gallus*	C
Pacific golden-plover+	*Pluvialis fulva*	U
Spotted dove	*Streptopelia chinensis*	A
Zebra dove	*Geopelia striata*	C
Hwamei	*Garrulax canorus*	U
Northern mockingbird	*Mimus polyglottos*	C
Common myna	*Acridotheres tristis*	C
Japanese white-eye	*Zosterops japonicus*	A
Northern cardinal	*Carninalis cardinalis*	C
Red-crested cardinal	*Paroaria coronata*	U
House finch	*Carpodacus mexicanus*	C
Nutmeg mannikin	*Lonchura punctulata*	A
Chestnut mannikin	Lonchura malacca	C

Table 3: Birds Recorded at Makaha Ridge Tracking Station

Birds recorded at Makaha Ridge on 8, 9 January 2000. Native birds are marked by an * and migratory species with a +. Relative abundance estimates come from data obtained at census stations and a drive/walk through of the property and nearby mauka lands. Status i.e. Abundant, Common, Uncommon and Rare follow the numbers established in Table 1. All of the migratory birds noted by (+) are protected by the Migratory Bird Treaty Act. No Endangered or Threatened species were recorded.

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE
White-tailed tropicbird*	*Phaethon lepturus*	C
Erckel francolin	*Francolinus erckelii*	C
Chukar	*Alectoris chukar*	A
Red junglefowl	*Gallus gallus*	A
Ring-necked pheasant	*Phasianus colchicus*	R = 5
Pacific golden-plover+	*Pluvialis fulva*	U
Spotted dove	*Streptopelia chinensis*	C
Zebra dove	*Geopelia striata*	C
Hwamei	*Garrulax canorus*	R = 2
Northern mockingbird	*Mimus polyglottos*	C
Common myna	*Acridotheres tristis*	C
Japanese white-eye	*Zosterops japonicus*	A
Northern cardinal	*Carninalis cardinalis*	A
House finch	*Carpodacus mexicanus*	C
Nutmeg mannikin	*Lonchura punctulata*	A

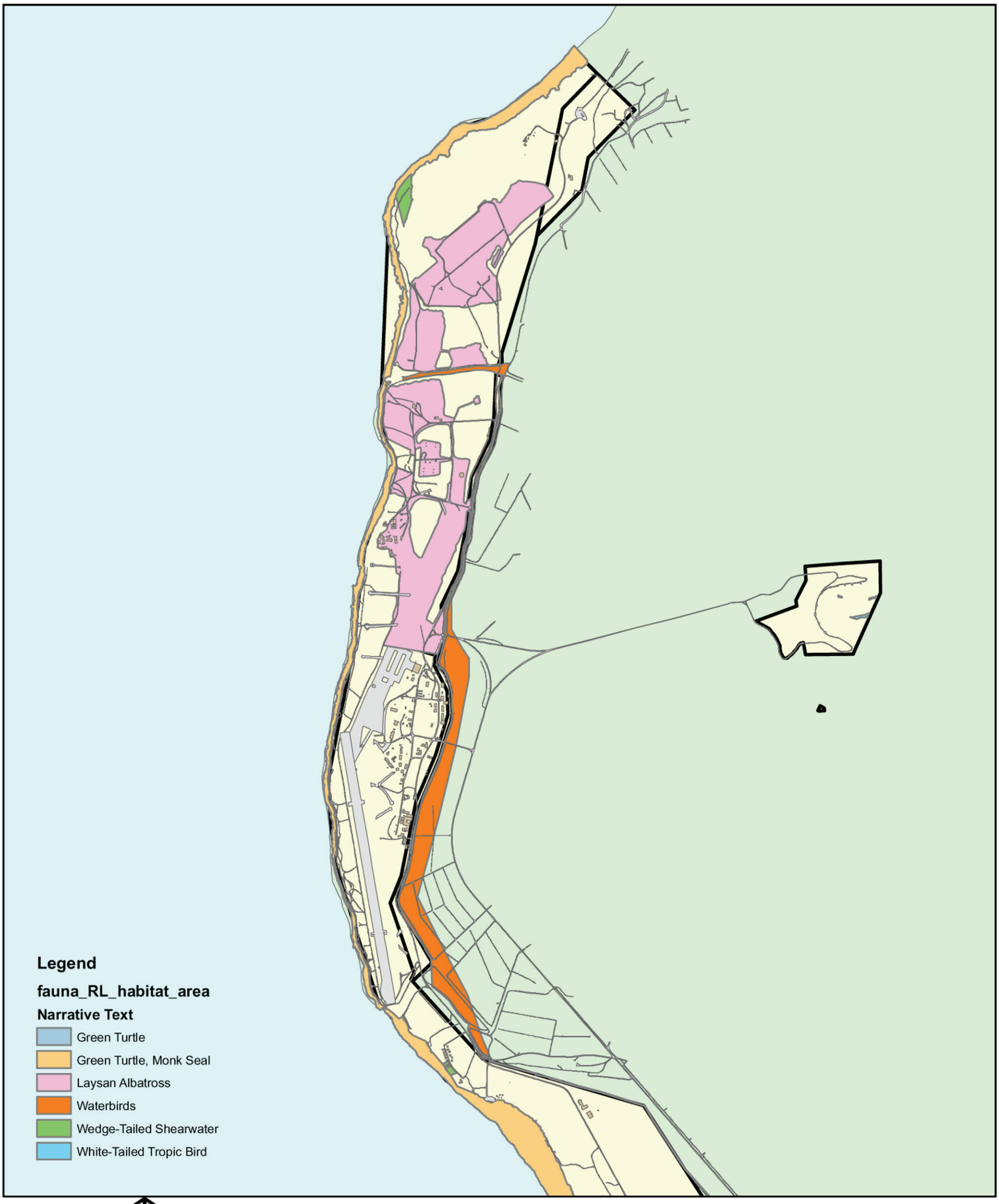
TABLE 4: Birds Recorded at Kokee Sites

Birds recorded at five parcels at Kokee on 22, 23 January 2000. Native birds are marked by an * and migratory species with a +. The parcels were observed as shown (A), (B), (C), (D), or (E). The relative abundance estimates are for combined data from all five parcels. The close proximity of the parcels and their small size did not warrant abundance estimates for each parcel. Status i.e. Abundant, Common, Uncommon, and Rare follow the numbers shown in Table 1. All of the migratory birds noted by (+) are protected by the Migratory Bird Treaty Act. No Endangered or Threatened species were recorded.

COMMON NAME	PARCELS	SCIENTIFIC NAME	RELATIVE ABUNDANCE
Red junglefowl	A, C, D, E	*Gallus gallus*	C
Pacific golden-plover+	A, C, D, E	*Pluvialis fulva*	C
Spotted dove	A, E	*Streptopelia chinensis*	R = 4
Zebra dove	A	*Geopelia striata*	R = 2
Short-eared owl*	E	*Asio flammeus*	R = 1
Elepaio*	E	*Chasiempis sandwichensis*	R = 1
White-rumped shama	D	*Copsychus malabaricus*	R = 1
Hwamei	A, E	*Garrulax canorus*	R = 2
Common myna	A, B, D, E	*Acridotheres tristis*	U
Japanese white-eye	A, B, C, D, E	*Zosterops japonicus*	A
Northern cardinal	A, B, C, D, E	*Carninalis cardinalis*	C
House finch	A, D, E	*Carpodacus mexicanus*	U
Kauai amakihi*	A, B, D, E	*Hemignathus kauaiensis*	U
Iiwi*	E	*Vestiaria coccinea*	R = 2
Apapane*	A, B, C, D, E	*Himatione sanguinea*	C
Nutmeg mannikin	A	*Lonchura punctulata*	R = 3

B4 - FAUNA MAPS FROM NAVY CONSERVATION MAPPING

(NAVFAC PAC 2005)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Laysan Albatross
Waterbirds
Wedge-Tailed Shearwater
White-Tailed Tropic Bird
N


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Laysan Albatross
Waterbirds
Wedge-Tailed Shearwater
White-Tailed Tropic Bird
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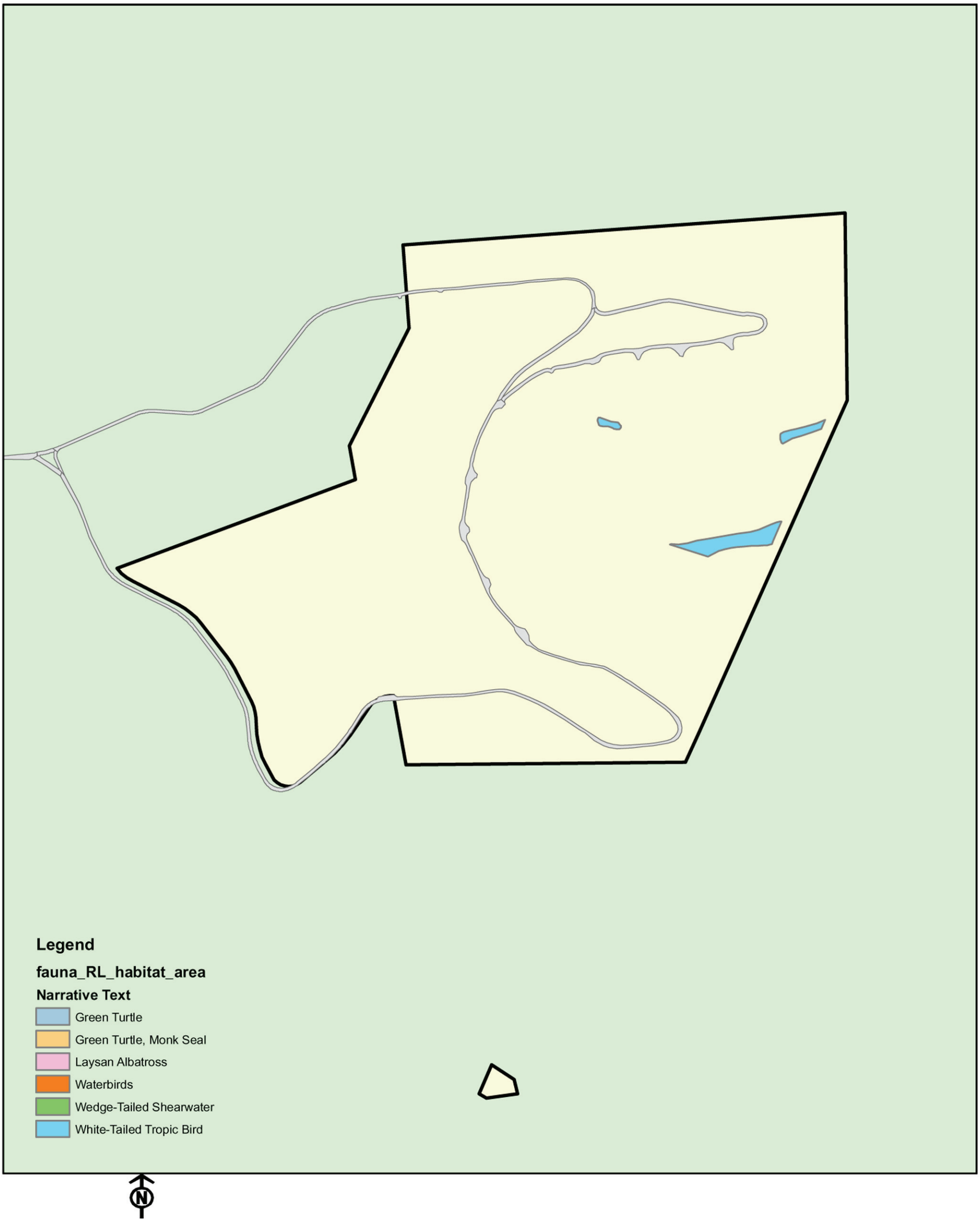
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White-Tailed Tropic Bird
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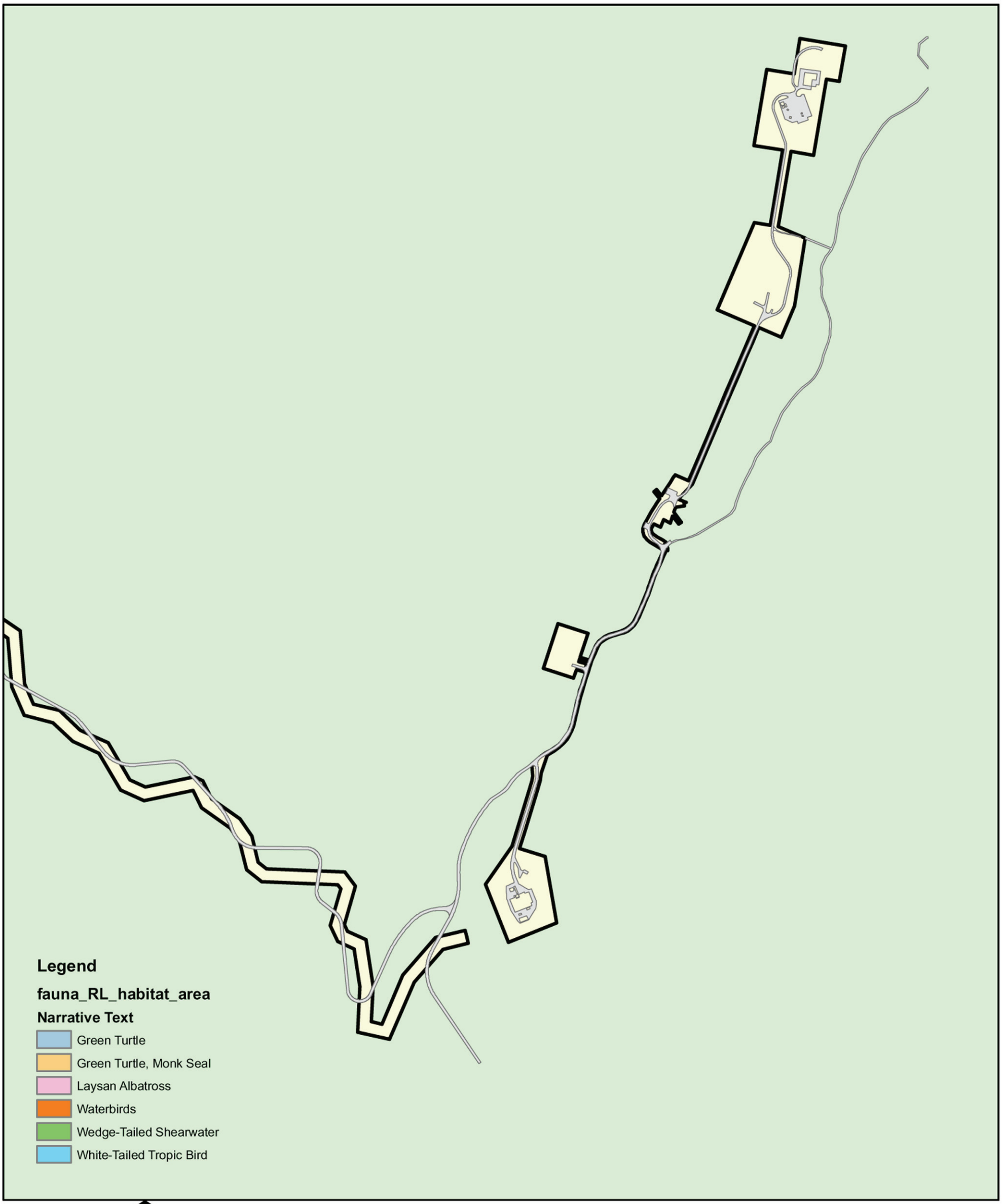
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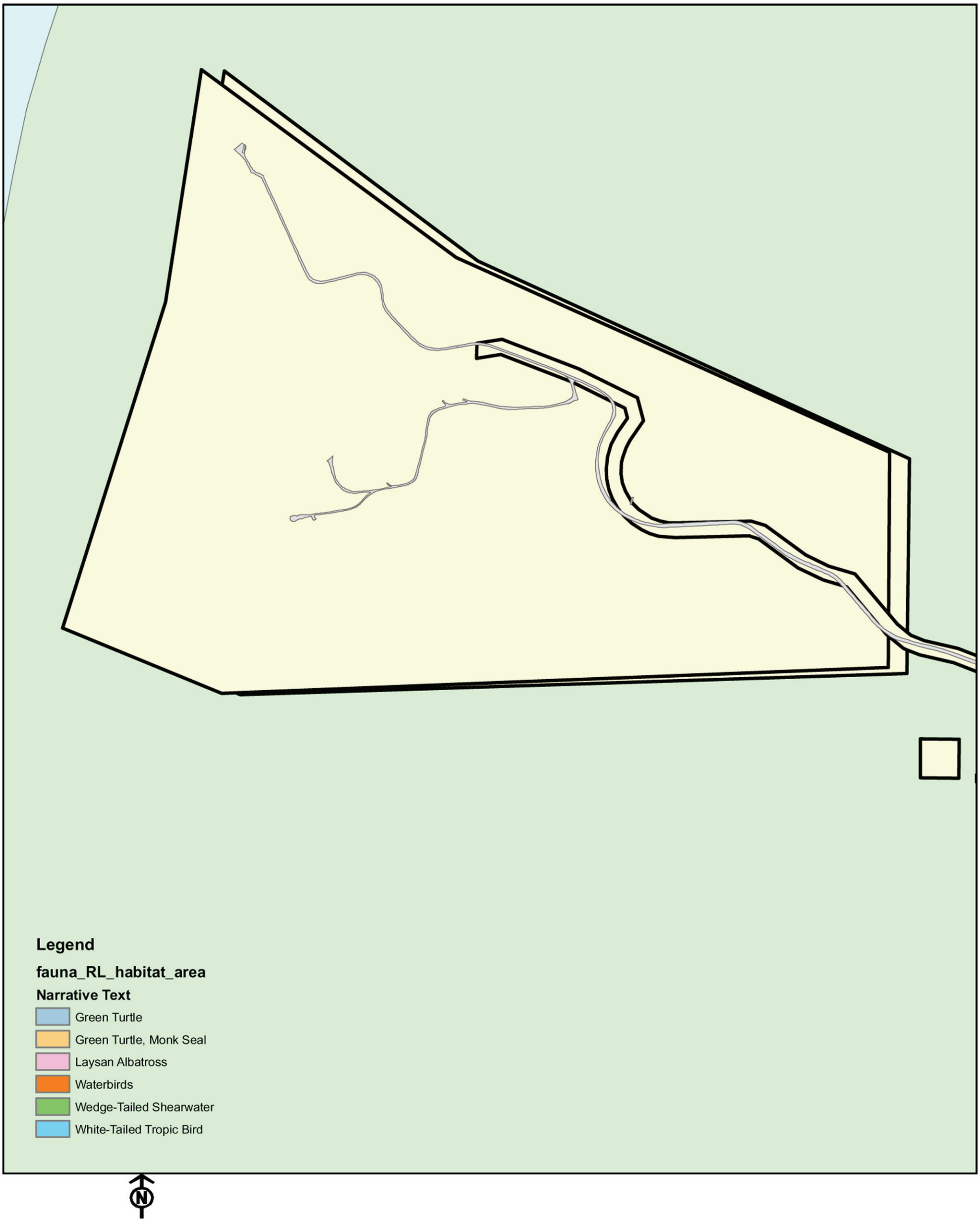
Laysan Albatross
Waterbirds
Wedge-Tailed Shearwater
White-Tailed Tropic Bird
N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Green Turtle, Monk Seal
Laysan Albatross
Waterbirds
Wedge-Tailed Shearwater
White-Tailed Tropic Bird
N

B5 - SUMMARY OF BIRD SPECIES OBSERVED AT PMRF

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Table 1: Bird Species Observed at Barking Sands

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Regulatory Status: Federal- and State-Listed Species					
Hawaiian duck	koloa	*Anas wyvilliana*	Yes, rare with a relative abundance of 5	Yes, one recorded.	See Section 3.3.1.1
Common moorhen	alae ula	*Gallinula chloropus sandvicensis*	Yes, considered uncommon.	Yes	See Section 3.3.1.1
Hawaiian coot	alae ke oke o	*Fulica alai*	Yes, considered uncommon.	Yes	See Section 3.3.1.1
Black-necked stilt	ae o	*Himantopus mexicanus knudseni*	Yes, considered common.	Yes	See Section 3.3.1.1
Hawaiian goose	nēnē	*Branta sandvicensis*	Yes, common	Yes	See Section 3.3.1.1
Short-tailed albatross		*Phoebastria albatrus*	No	No	See Section 3.3.1.1
Regulatory Status: State Listed Species					
Black-footed albatross		*Phoebastria nigripes*	No	Yes, 1 observed.	See Section 3.3.1.1
Regulatory Status: MBTA-protected					
Laysan albatross	moli	*Phoebastria immutabilis*	Yes, considered uncommon.	Yes	See Section 3.3.4.1
Brown booby		*Sula leucogaster*	No	Yes, regularly observed.	See Section 3.3.4.1
Wedge-tailed shearwater		*Puffinus pacificus*	No	Yes	See Section 3.3.4.1
Black-crowned night heron	auku u	*Nycticorax nycticorax hoactli*	Yes, rare with a relative abundance of 9.	Yes	See Section 3.3.4.1
Cattle egret		*Bubulcus ibis*	Yes, rare with relative abundance of 6.	Yes	See Section 3.3.4.1
Northern shoveler	koloa moha	*Anas clypeata*	Yes, rare with relative abundance of 1.	Yes	See Section 3.3.4.1

Table 1: Summary of Bird Species Observed at Barking Sands (Continued)

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Green-winged teal		*Anas crecca*	No	Yes	See Section 3.3.4.1
Pacific golden plover	kolea	*Pluvialis fulva*	Yes, considered common.	Yes, commonly observed.	See Section 3.3.4.1
Black-bellied plover		*Pluvialis squatarola*	No	Yes	See Section 3.3.4.1
Wandering tattler*	ulili	*Heteroscelus incanus*	Yes, considered uncommon.	Yes, commonly observed.	See Section 3.3.4.1
Ruddy turnstone	akekeke	*Arenaria interpres*	Yes, considered uncommon.	Yes, commonly observed.	See Section 3.3.4.1
Sanderling	hunakai	*Calidris alba*	Yes, rare with a relative abundance of 7.	Yes, commonly observed.	See Section 3.3.4.1
Laughing gull		*Larus atricilla*	Yes, rare with a relative abundance of 1.	No	See Section 3.3.4.1
Regulatory Status: HRS §183D-62					
Black francolin		*Francolinus francolinus*	Yes, considered uncommon.	Yes	Non-native gamebird
Erckel francolin		*Francolinus erckelii*	Yes, rare with a relative abundance of 2.	Yes	Non-native gamebird
Ring-necked pheasant		*Phasianus colchicus*	Yes, rare with a relative abundance of 3.	Yes	Non-native gamebird.
Wild turkey		*Meleagris gallopavo*	No.	Yes, one bird was noted in 2006 and considered uncommon.	Non-native gamebird.
Red junglefowl		*Gallus gallus*	Yes, considered common.	Yes	Non-native
Rock dove		*Columa livia*	Yes, rare with a relative abundance of 12.	Yes	Non-native

Table 1: Summary of Bird Species Observed at Barking Sands (Continued)

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Spotted dove		*Streptopelia chinensis*	Yes, considered abundant.	Yes	Non-native gamebird.
Zebra dove		*Geopelia striata*	Yes, considered abundant.	Yes	Non-native gamebird.
Barn owl		*Tyto alba*	Yes, rare with a relative abundance of 2.	Yes	Non-native
White-rumped shama		*Copsychus malbaricus*	Yes, considered uncommon.	Yes	Non-native
Hwa-mei		*Garrulax canorus*	Yes, considered uncommon.	Yes	Non-native
Common myna		*Acridotheres tristis*	Yes, considered common.	Yes	Non-native
Northern mockingbird		*Mimus polyglottos*	Yes, considered common.	Yes	Non-native
Japanese white-eye		*Zosterops japonicus*	Yes, considered common.	Yes	Non-native
Northern cardinal		*Cardinalis cardinalis*	Yes, considered common.	Yes	Non-native
Red-crested cardinal		*Paroaria coronata*	Yes, considered uncommon.	Yes	Non-native
Western meadowlark		*Sturnella neglects*	Yes, considered uncommon.	Yes	Non-native
House finch		*Carpodacus mexicanus*	Yes, considered abundant.	Yes	Non-native
House sparrow		*Passer domesticus*	Yes, considered common.	Yes	Non-native
Chestnut munia		*Lonchura atricapilla*	Yes	No	Non-native

Table 1: Summary of Bird Species Observed at Barking Sands (Continued)

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Nutmeg manikin		*Lonchura punctulata*	Yes, considered common.	Yes	Non-native
Skylark		*Alauda arvensis*	No	Yes	Non-native
Chestnut manikin		*Lonchura malacca*	Yes, considered abundant in 2000.	No	Non-native

Note: Relative abundance estimates are based on data obtained at census stations, or in the case of rare species the total seen on all the surveys is given. Abundant = 10 or more per census station in appropriate habitat, Common = 5-9 per station, Uncommon = less than 5 per station, and Rare = may or may not have been recorded at a station; the number following Rare is the total tallied for the survey.

Hawai'i Revised Statutes (HRS) Section (§) 183-D62 "Taking, injuring, or destroying wild birds prohibited." In addition, the following game species listed in Hawai'i Adminstrative Rules § 13-122-6 protects game birds with hunting of these species governed by Title 13 DLNR Subtitle 5, Forestry and Wildlife, Part 2 – Wildlife Chapter 122.

Source: Reference NAVFAC PAC, 2006f.

Table 2: Bird Species Observed at Mākaha Ridge Tracking Facility

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Regulatory Status: Federal-and State Listed Species					
Hawaiian goose	nēnē	*Branta sandvicensis*	Yes, common	Yes	See Section 3.3.1.1
Regulatory Status: MBTA-protected Species					
White-tailed tropicbird	koa e kea	*Phaethon lepturus*	Yes, common	Yes	See Section 4.3.4.1
Pacific golden-plover	kōlea	*Pluvialis fulva*	Yes, uncommon	Yes	See Section 3.3.4.1
Cattle egret		*Bubulcus ibis*	No, common	Yes	See Section 3.3.4.1
Regulatory Status: HRS §183D-62					
Chukar		*Alectoris chukar*	Yes, abundant	Yes	Non-native game bird
Erckel francolin		*Francolinus erckelii*	Yes, common		Non-native game bird
Black francolin		*Francolinus francolinus*	No	Yes	Non-native game bird
Ring-necked pheasant		*Phasianus colchicus*	Yes, rare – 5 observed	Yes	Non-native game bird
Red junglefowl		*Gallus gallus*	Yes, abundant	Yes	Non-native
Japanese white-eye		*Zosterops japonicus*	Yes, abundant	Yes	Non-native
Spotted dove		*Streptopelia chinensis*	Yes, common	Yes	Non-native game bird
Zebra dove		*Geopelia striata*	Yes, common	Yes	Non-native game bird
Hwa-mei		*Garrulax canorus*	Yes, rare 2 observed	Yes	Non-native
Common myna		*Acridotheres tristis*	Yes, common	Yes	Non-native
Northern mockingbird		*Mimus polyglottos*	Yes, common	Yes	Non-native
Northern cardinal		*Carninalis cardinalis*	Yes, abundant	Yes	Non-native
Red-crested cardinal		*Paroaria cornonata*	No	Yes	Non-native
House finch		*Carpodacus mexicanus*	Yes	Yes	Non-native

Table 2: Summary of Birds Species Observed at Mākaha Ridge Tracking Facility *(continued)*

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Nutmeg mannikin		*Lonchura punctulata*	Yes, abundant	No	Non-native
Japanese bush warbler		*Cettia diphone*	No	Yes	Non-native

Note: Relative abundance estimates are based on data obtained at census stations, or in the case of rare species the total seen on all the surveys is given. Abundant = 10 or more per census station in appropriate habitat, Common = 5-9 per station, Uncommon = less than 5 per station, and Rare = may or may not have been recorded at a station; the number following Rare is the total tallied for the survey.

Hawai'i Revised Statutes (HRS) Section (§) 183-D62 "Taking, injuring, or destroying wild birds prohibited." In addition, the following game species listed in Hawai'i Adminstrative Rules § 13-122-6 protects game birds with hunting of these species governed by Title 13 DLNR Subtitle 5, Forestry and Wildlife, Part 2 – Wildlife Chapter 122.

Source: NAVFAC 2006f and Bruner 2000.

Table 3: Bird Species Observed at Kōkeʻe Sites

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Regulatory Status: Federal- and State listed Endangered Species					
Hawaiian goose	nēnē	*Branta sandvicensis*	No	Yes, observed flying over sites, pen of juveniles on site	See Section 3.3.1.1
Regulatory Status: MBTA-protected					
Pacific golden plover	kōlea	*Pluvialis fulva*	Yes	Yes	See Section 3.3.4.1
Regulatory Status: HRS §183D-62					
Red junglefowl		*Gallus gallus*	Yes, common	Yes	Non-native species
Spotted dove		*Streptopelia chinensis*	Yes, rare, 4 observed	Yes	Non-native game bird
Zebra dove		*Geopelia striata*	Yes, rare, 2 observed	Yes	Non-native game bird
Erckel's francolin		*Francolinus erckelii*	No	Yes	Non-native gamebird
White-rumped shama		*Copsychus malabaricus*	Yes, rare, 1 observed	Yes	Non-native species
Hwa-mei		*Garrulax canorus*	Yes, rare, 2 observed	Yes	Non-native species
Common myna		*Acridotheres tristis*	Yes, uncommon	Yes	Non-native species
Japanese white-eye		*Zosterops japonicus*	Yes, abundant	Yes	Non-native species
Northern cardinal		*Carinalis cardinalis*	Yes, common	Yes	Non-native species
Kauaʻi elepaio	*ʻelepaio*	*Chasiempis sandwichensis*	Yes, rare, 1 observed	Yes	Native species
Kauaʻi amakihi	*ʻamakihi*	*Hemignathus kauaiensis*	Yes, uncommon	Yes	Native species
Apapane	*ʻapapane*	*Himatione sanguinea*	Yes, common	Yes	Native species
Iiwi	*ʻiʻiwi*	*Vestiaria coccinea*	Yes, rare, 2 observed	Yes	Native species

Table 3: Summary of Birds Species Observed Kōke'e Sites *(continued)*

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Red-crested cardinal		*Paroaria coronata*	No	Yes	Introduced species
House finch		*Carpodacus mexicanus*	Yes, uncommon	Yes	Introduced species
Japanese bush warbler		*Cettia diphone*	No	Yes	Introduced species
Nutmeg mannikin		*Lonchura punctulata*	Yes, rare, 3 individuals observed		

Note: Relative abundance estimates are based on data obtained at census stations, or in the case of rare species the total seen on all the surveys is given. Abundant = 10 or more per census station in appropriate habitat, Common = 5-9 per station, Uncommon = less than 5 per station, and Rare = may or may not have been recorded at a station; the number following Rare is the total tallied for the survey.

Hawai'i Revised Statutes (HRS) Section (§) 183-D62 "Taking, injuring, or destroying wild birds prohibited." In addition, the following game species listed in Hawai'i Adminstrative Rules § 13-122-6 protects game birds with hunting of these species governed by Title 13 DLNR Subtitle 5, Forestry and Wildlife, Part 2 – Wildlife Chapter 122.

Source: NAVFAC PAC 2006f and Bruner 2000.

Table 4: Bird Species Observed at PMRF Kamokala Ridge Magazine

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Regulatory Status: MBTA					
Black-crowned night-heron		*Nycticorax nycticorax*	Yes	No	See Section 3.3.4.1
Cattle egret		*Bubulcus ibis*	Yes	Yes	See Section 3.3.4.1
Pacific golden plover	kōlea	*Pluvialis fulva*	Yes	No	See Section 3.3.4.1
Regulatory Status: HRS §183D-62					
Chukar		*Alectoris chuckar*	Yes	Yes	Non-native game bird
Erckel's francolin		*Francolinus erckelii*	Yes	Yes	Non-native game bird
Ring-necked pheasant		*Phasianus colchicus*	Yes	No	Non-native game bird
Red junglefowl		*Gallus gallus*	Yes	Yes	Non-native species
Rock dove		*Columbia livia*	Yes	No	Non-native species
Spotted dove		*Streptopelia chinensis*	Yes	Yes	Non-native game bird
Zebra dove		*Geopelia striata*	Yes	Yes	Non-native game bird
Barn owl		*Tyto alba*	Yes	No	Non-native species
White-rumped shama		*Copsychus malabaricus*	Yes	No	Non-native species
Hwa-mei		*Garrulax canorus*	Yes	Yes	Non-native species
Common myna		*Acridotheres tristis*	Yes	Yes	Non-native species
Northern mockingbird		*Mimus polyglottos*	Yes	Yes	Non-native species
Japanese white-eye		*Zosterops japonicus*	Yes	Yes	Non-native species
Northern cardinal		*Cardinalis cardinalis*	Yes	Yes	Non-native species

Table 4: Summary of Bird Species Observed at Koke'e Sites *(continued)*

Common Name	Hawaiian Name	Latin Binomial	Recorded During 2000 Survey	Recorded During 2006 Survey	Comments
Red-crested cardinal		*Paroaria coronata*	Yes	No	Non-native species
House finch		*Carpodacus mexicanus*	Yes	No	Non-native species
Chestnut munia		*Lonchura atricapilla*	Yes	No	Non-native species
Nutmeg mannikin		*Lonchura punctulata*	Yes	No	Non-native species

Hawai'i Revised Statutes (HRS) Section (§) 183-D62 "Taking, injuring, or destroying wild birds prohibited." In addition, the following game species listed in Hawai'i Adminstrative Rules § 13-122-6 protects game birds with hunting of these species governed by Title 13 DLNR Subtitle 5, Forestry and Wildlife, Part 2 – Wildlife Chapter 122.

Source: NAVFAC PAC 2006e and Bruner 2000.

Table 5: Summary of Bird Species Observed on Ka‘ula Island

Common Name	Hawaiian Name	Latin Binomial	Comments
Regulatory Status: MBTA			
Black-footed albatross	ka‘upu	*Diomedea nigripes*	See Section 3.3.1.1
Laysan albatross	mōlī	*Diomedea immutabilis*	See Section 3.3.4.1
Wandering Tattler	‘ūlili	*Heteroscelusin canus*	See Section 3.3.4.1
Gray-backed tern	pakalakala	*Stern lunata*	See Section 7.3.4.1
Sooty tern	‘ewa ‘ewa	*Sterna fuscata*	See Section 7.3.4.1
White tern	manu-o-kū	*Gygis alba*	See Section 7.3.4.1
Blue-gray noddy		*Procelsterna cerulea*	See Section 7.3.4.1
Brown noddy	noio kōhō	*Anous stolidus*	See Section 7.3.4.1
Black noddy	noio	*Anous minutus*	See Section 7.3.4.1
Wedge-tailed shearwater	‘ua‘u kani	*Puffinus pacificus*	See Section 3.3.4.1
Christmas Island shearwater	—	*Puffinus nativatis*	See Section 7.3.4.1
Bulwer’s shearwater (petrel)	‘ou	*Bulweria bulwerii*	See Section 7.3.4.1
Bonin Island petrel	—	*Pterodrom hypoleuca*	See Section 7.3.4.1
Red-tailed tropicbird	koa‘e‘ula	*Phaethon rubricauda*	See Section 7.3.4.1
White-tailed tropicbird	koa‘e kea	*Phaethon lepturus*	See Section 4.3.4.1
Masked booby	‘a	*Sua dactylatra*	See Section 7.3.4.1
Brown booby	‘a	*Sula leucogaster*	See Section 3.3.4.1
Red-footed booby	‘a	*Sula sula*	See Section 7.3.4.1
Great frigate bird	‘iwa	*Fregata minor*	See Section 7.3.4.1
Ruddy turnstone	‘akekeke	*Arenaria ininterpres*	See Section 3.3.4.1
Pacific golden plover	kōlea	*Pluvialis fulva*	See Section 3.3.4.1
Regulatory Status: MBTA			
Barn owl	—	*Tyto alba*	
Japanese white eye	—	*Zosterops japonicus*	
House finch	—	*Carpodacusm exicanus*	
Mockingbird	—	*Mimus polyglottos*	
Nutmeg manikin	—	*Lonchura punctulata*	

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Table 6: Bird Species Population Counts, Ka‘ula Island

Common Name	Hawaiian Name	Latin Binomial	Aug. 1932	Aug. 1971	Jan. 1976	Sept. 1976	Aug. 1978	Mar. 1979	Jun. 1979	Apr. 1980	Jun. 1993	Nov. 1998
Regulatory Status: MBTA-protected												
Black-footed albatross	ka‘upu	*Diomedea nigripes*	1 old egg	—	100	—	—	75	—	2	4	10
Laysan albatross	mōlī	*Diomedea immutabilis*	—	—	150	—	—	100	9	33	44	60
Wandering Tattler	‘ūlili	*Heteroscelusin canus*	—	—	5	1	1	1	—	—	—	ND
Gray-backed tern	akalakala	*Sterna lunata*	Not common	2,860	—	250	50	300	4,110	1,467	35	
Sooty tern	‘ewa ‘ewa	*Sterna fuscata*	Rather common	16,800	2,500	1,000	2,500	50,000	28,850	83,680	27,255	
White tern	manu-o-kū	*Gygis alba*		10	10	200	10	—	9	12	9	—
Blue-gray noddy		*Procelsterna cerulea*	Small colony	—	—	300	—	—	—	—	—	1
Brown noddy	noio kōhō	*Anous stolidus*	Most numerous	6,700	—	7,000	10,000	1,000	10,560	3,950	5,778	—
Black noddy	noio	*Anous minutus*	—	100	20	100	200	—	—	207	6	—
Wedge-tailed shearwater	ua‘u kani	*Puffinus pacificus*	2, many burrows	4,000	—	4,000	100	—	1,415	980	400	200
Christmas Island shearwater	—	*Puffinus nativatis*	—	450	—	250	100	25	20	60	18	ND

Table 6: Bird Species Population Counts, Ka‘ula Island (Continued)

Common Name	Hawaiian Name	Latin Binomial	Aug. 1932	Aug. 1971	Jan. 1976	Sept. 1976	Aug. 1978	Mar. 1979	Jun. 1979	Apr. 1980	Jun. 1993	Nov. 1998
Buller’s shearwater	ou	*Bulweria bulwerii*	Several	100	—	100	50	—	100	580	100	ND
Bonin Island petrel	—	*Pterodroma hypoleuca*	1 old egg	—	—	—	—	—	—	—	—	ND
Red-tailed tropicbird	koa‘e‘ula	*Phaethon rubricauda*	rather common	950	—	450	100	40	276	209	146	15
White-tailed tropicbird	koa‘e kea	*Phaethon lepturus*	—	3	1	1	1	2	—	22	—	15
Masked booby	‘a	*Sua dactylatra*	Rather common	1,000	300	1,200	200	400	236	202	567	350
Brown booby	‘a	*Sula leucogaster*	Very common	1,700	50	1,000	50	200	212	169	397	60
Red-footed booby	‘a	*Sula sula*	Not common	1,300	100	150	200	400	344	222	1,333	1,200
Great frigate bird	‘iwa	*Fregata minor*	Very common	950	250	800	250	250	134	435	701	650
Ruddy turnstone	‘akekeke	*Arenaria ininterpres*	—	50	5	20	4	24	1	7	1	12
Pacific golden plover	kōlea	*Pluvialis fulva*	Several	—	10	14	1	2	—	22	—	15
Regulatory Status: not protected – non-native, introduced species												
Barn owl	—	*Tyto alba*	—	1	3	3	1	6	4	2	7	3
Japanese white eye	—	*Zosterops japonicus*	—	—	2	3	—	—	—	—	3	ND
House finch	—	*Carpodacusm exicanus*	—	6	15	40	20	6	—	1	1	8

Table 6: Bird Species Population Counts, Ka‘ula Island (Continued)

Common Name	Hawaiian Name	Latin Binomial	Aug. 1932	Aug. 1971	Jan. 1976	Sept. 1976	Aug. 1978	Mar. 1979	Jun. 1979	Apr. 1980	Jun. 1993	Nov. 1998
Mockingbird	—	*Mimus polyglottos*	—	—	—	2	—	—	—	—	—	ND
Nutmeg manikin	—	*Lonchura punctulata*	—	—	—	20	—	—	—	—	—	ND

— = no data ND = not detected

B6 - WEDGE-TAILED SHEARWATER SURVEY POPULATION SUMMARY

(HEBSHI 2007)

PACIFIC MISSILE RANGE FACILITY
WEDGE-TAILED SHEARWATER POPULATION SURVEY
PROJECT SUMMARY REPORT

FINAL

Prepared for:

United States Navy
NAVFAC Pacific
Environmental Planning

Prepared by:
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1.0 Objectives

This report was developed by Aaron Hebshi under contract with the United States Navy to monitor the Wedge-tailed Shearwater (*Puffinus pacificus*) colony at Pacific Missile Range Facility (PMRF) on Kaua`i. The specific objectives were:

- Determine the geographic coverage of the shearwater colony
- Estimate burrow occupancy rate and shearwater breeding population size
- Estimate reproductive success
- Install permanent monitoring plots

This initial work was performed to establish baseline measurements for which future monitoring can be compared against.

2.0 Background

Wedge-tailed Shearwaters are common seabirds which breed along the coastal strand and on offshore islets around the main Hawaiian Islands. They nest primarily in burrows in the ground, sometimes one meter deep or more, but may also nest under vegetation or in rock crevices. The nest contains a single egg, and both parents incubate the egg and feed the nestling. Breeding commences at a predictable time each year according to the following phenology: Egg lay – 2nd week of June through end of June; Chick hatch – end of July through early August; chick fledge – mid November through early December. On Oahu, Shallenberger (1973) showed that 86% of eggs were laid by 25th of June. Variation in phenology among colonies across Hawaii is no more than five days (Hebshi, in prep).

Because of introduced predators (cats, dogs, rats, mongoose), shearwaters are becoming increasingly rare at on-island sites except where active predator control programs exist (e.g, Kaena Point, Oahu, and Kilauea Point National Wildlife Refuge, Kaua`i). Mongoose-free Kaua`i has the largest number of on-island colonies, including the one at PMRF. The colony at PMRF has continued to exist despite incidences of high predator activity and human disturbance. In 2006, a predator control program was resumed and an educational sign was posted. The habitat of the colony is primarily open sand with sparse vegetation, due to recent vegetation clearing efforts by Navy personnel and the Kauai Invasive Species Committee (KISC), but a small area of the colony on the northern and landward edges are overgrown with thick kiawe brush. Nesting also occurs in the boulder rip rap at the seaward edge of the colony.

3.0 Methods

3.1 Determination of geographical coverage of colony using GPS

On 29 August 2006, Vanessa Pepi, Fish and Wildlife Biologist for NAVFAC Pacific, delineated the perimeter of the colony with a handheld GPS, (Trimble GeoExplorer CE, using 3D Real-Time Differential Correction with a horizontal precision minimum of 5m). The central portion of the colony is bounded on three sides by a wooden fence, which was also delineated. The coordinates were collected (NAD 1983, State Plane, Hawaii

Zone 4) and the shapefile is attached as Appendix A. Because Wedge-tailed Shearwaters nest in discrete colonies, as they are attracted by conspecifics (Whittow 1997), few, if any, nests would have been missed.

3.2 Population census and occupancy rate

On June 21st 2006, the number of breeding pairs was estimated through a burrow count conducted by V. Pepi, A. Hebshi, Sharon Reilly, Joseph Corbett and a school group from Camp Malama Kaua`i (two teachers – Dinah Chao and Jennifer Hoof - and seven 4th graders). For 78% of the colony, all burrows were counted, and the contents of each burrow were assessed to determine the number of nests, as defined by the presence of an egg. Occupancy rate was determined by the number of nests divided by the total number of burrows. For the remaining 22% of the colony, time constraints required us to count only the number of burrows, which was then multiplied by the occupancy rate to calculate estimated nest numbers. Nests within the boulder rip rap were difficult to count due to the substrate's labyrinthine nature, and some nests may have been missed. Because of this, the population census would be expected to slightly underestimate the actual number of nests in the colony.

3.3 Installation of permanent monitoring plots and determination of reproductive success

On October 4th 2006, V. Pepi and A. Hebshi installed permanent monitoring plots. A list of random coordinates was created *a priori* using the GIS data collected in August. The first set of coordinates was programmed into the GPS, which was used to navigate towards the coordinates. If the coordinates fell outside the colony or were in a location too difficult to monitor (e.g., thick vegetation, road), the coordinates were removed and the next set on the list was chosen and the procedure was repeated until a point was selected. At each selected point, a 3-foot PVC pipe was hammered into the ground, numbered, and flagged. The point was used as the center of a 2m radius circular plot. 15 of these plots were installed.

Reproductive success was estimated in two ways. First, a number of active burrows were flagged during the June 21st survey. During the October 4th survey, a small, eight burrow sample was taken of these flagged burrows and assessed for occupancy. Second, the colony-wide occupancy rate collected on June 21st was compared to the occupancy rate in the monitoring plots measured on October 4th.

3.4 Power Analysis

Minitab™ Statistical Software was used to calculate the differences in mean burrow occupancy rates and chick counts that would be statistically detectable based on data from the monitoring plots. A power analysis can be used to determine one of the three parameters if the values for the other two are known: sample size, confidence interval, and statistically detectable difference in means. The standard deviation must also be known, and this was estimated from the data.

4.0 Results

4.1 Colony area

The total colony area was calculated to be 7401m^2. The core colony area within the fenced area was calculated to be 1722m^2. Figure 1 shows the colony's geographical extent and the delineated fence line.

4.2 Population size estimate

Due to time constraints on the June 21st survey, counts of occupied burrows were not conducted for the entire colony. In the portion of the colony in which occupied-burrow counts were conducted, 226 occupied burrows were found. In the remaining area, the number of burrows was counted and multiplied by the occupancy rate of 56%. In this area, 90 burrows were counted, producing an estimate of 50 (90 X 56%) occupied burrows, for a total of 276 (226 + 50) occupied burrows, or 276 breeding pairs.

4.3 Occupancy rate

Occupancy rate on June 21st was estimated at 56% based on 194 burrows with 108 occupied (including one with an egg) – from within the fenced area. Occupancy rate may have varied in different areas of the colony, but this variation was not determined. Occupancy rate on October 4th within the monitoring plots (see below) was 44%.

4.4 Monitoring plot results and statistical power

15 monitoring plots were installed; however, 2 fell outside the delineated colony area. The remaining 13 resulted in an area of 163.2m^2 being sampled (2.2% of total colony area). The number of chicks counted in the plots was 14 (mean = 1.08 chicks/plot; SD = 1.19). The number of burrows counted in the plots was 32 (mean = 2.46 burrows/plot; SD = 1.85).

Extrapolating to the whole colony, the monitoring plots produced a burrow count estimate of 1089. Multiplying this by the occupancy rate, determined from the June 21st survey, results in a population estimate of 610 breeding pairs. This estimate is more than twice the estimate based on the June 21st census (276 breeding pairs).

The 95% Confidence Interval (CI) for the number of chicks per plot is 0.43 - 1.73. The ability with 95% confidence to detect a significant change in chick counts would require a difference in means of 1.19 chicks per plot (Table 1). This translates to a 110% change in chick counts before the change can be statistically detected. The 95% CI for the number of burrows per plot is 1.45 - 3.47 burrows per plot. The ability with 95% confidence to detect a significant change in burrow density would require a difference in means of 1.85 burrows per plot (Table 1). This translates to a 100% change in burrow counts before the change can be statistically detected.

If the size of the plots was increased to a 3m radius (equivalent to a sample-size increase of 15 plots in the power analysis), the ability to detect a significant change in chick and burrow numbers would increase to 74% and 67%, respectively. That means that a 74% change in chick counts and a 67% change in burrow counts would be statistically detectable.

Table 1. Summary statistics and statistical power of the monitoring scheme with 2m radius plots.

	Average (StDev) per plot	95% Confidence Interval	Colony-wide estimate and 95% Confidence Interval	% change detectable (95% level)
Chicks	1.08 (1.19)	(.43, 1.73)	636 (255, 1019)	110%
Burrows	1.85 (2.46)	(1.45, 3.47)	1089 (854, 2044)	100%

4.5 Reproductive success

Seven out of eight, or 87.5% of burrows that had eggs on the June 21st survey still had chicks by Oct 4. Time constraints on the October 4th survey limited our ability to recheck most of the flagged burrows known to be active on the June 21st survey. Occupancy rate measured in the monitoring plots was 14/32, or 44%. Therefore, a drop-off in occupancy from 56% during the first visit translates to a reproductive success of 79%

Table 2. Key demographic parameters estimated for 2006.

Colony area	7401 m^2
Occupancy rate (June 21)	56%
Occupancy rate (October 4)	44%
Reproductive Success (two estimates)	87.5%, 79%
Population Size	276 breeding pairs

5.0 Discussion and Recommendations

The measurement of the colony area included the road area and some dense vegetation not suitable for nesting; therefore the area calculation was artificially inflated. The important aspect of this measurement, though, is the northern and eastern colony boundary, of which continued measurement will indicate whether the colony is expanding or not.

There was a marked difference between the colony-wide population count and the estimate determined from the monitoring plots. This was likely due to the fact that the extrapolation from the monitoring plots to the whole colony included areas of the colony (e.g., the road, thick vegetation – see figure 1) that were specifically excluded from monitoring plot sites (i.e., the monitoring plots were not a true random sample of the colony). Therefore, the monitoring plots will be more useful in detecting a change in the population size rather than determining absolute population size unless re-calibration through full burrow counts is conducted every few years. Regardless, it is recommended that the monitoring plot size be increased to a 3m radius in order to be able to detect a biologically meaningful change in population size.

The two estimates of reproductive success, 87.5% and 79%, suggest that nestling survival was high and comparable to other colonies protected from predation. In a 2003 study (Hebshi, in prep), fledging success ranged from 77% to 100% at 8 colonies protected from predation, while at Kaena Point, a colony heavily predated by cats during that year, fledging success was only 52%.

It is recommended that the permanent plots be monitored one or two times each year to detect changes in population size and occupancy rates/reproductive success. If one trip is conducted, it should be done so in October. If two trips are conducted the first should be done in late June or early July and the latter in October. Two trips would allow the estimation of reproductive success, whereas one trip would only allow the estimation of burrow occupancy rates. Colony delineation should be conducted every year at best to document expansion or contraction of the colony. Full burrow counts can be conducted every few years to recalibrate the population size estimate determined from the monitoring plots.

6.0 References

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Figures
Figure 1 – Colony area
Appendices
Appendix A – Shapefile – electronic copy only
Appendix B – Photolog

Figure 1

Wedge-tailed shearwater Nesting Colony at the Beach Cottages, Barking Sands, PMRF, Kauai, Hawaii

Photo 1: Wedge-tailed Shearwater adult

Photo 2: Camp Malama Kauai teachers and students searching for shearwater nests in the boulder rip-rap area of the colony

Photo 3: More searching…

Photo 4: Wedge-tailed Shearwater adult on an egg

Photo 5. Student finding and counting Wedge-tailed Shearwater nest

Photo 6. Shearwater inside its burrow

B7 - WEDGE-TAILED SHEARWATER CONSERVATION AT BARKING SANDS, PACIFIC MISSILE RANGE FACILITY, KAUA‘I, HAWAI‘I

(NAVFAC PAC 2008)

WEDGE-TAILED SHEARWATER CONSERVATION
AT
BARKING SANDS, PACIFIC MISSILE RANGE FACILITY
KAUA'I, HAWAI'I

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July 2008

INTRODUCTION

Wedge-tailed shearwaters (*Puffinus pacificus*) are pelagic seabirds of the tropical and sub-tropical Pacific and Indian Oceans. They breed from Madagascar (Indian Ocean) to Revillagigedo Island (off Mexico) (Whittow 1997) and feed mainly on larval forms of several species of fishes driven to the surface by foraging fish schools. They are the largest of the tropical shearwaters with an average overall length of 16.9 inches (43 cm) and an average body mass of 13.8 oz (390g) (Whittow 1997). Feather colors vary from grayish-brown to a sooty brown, with the lighter colored individuals in the North Pacific. No sexual dimorphism has been documented. It is speculated that there may be little migration of the tropical Pacific population (Whittow 1997).

In the Hawaiian Islands, wedge-tailed shearwaters breed from Kure Island south to Maui Island from February through November. They are ground-nesting seabirds that dig nearly horizontal or gently-sloping burrows into the sand or similar substrate. Typical breeding /burrowing areas are low, flat islands and sandspits with little or no vegetation (Whittow 1997). Around the main Hawaiian Islands, wedge-tailed shearwaters nest on low, flat, sandy beaches. There are usually no tall, woody plants in the nesting area as this impedes ingress and egress of birds to and from the burrow (Whittow 1997). In general, the majority of burrows are in sand or soil, but there is variation. They will use rock piles and ledges where there are areas that aren't suitable for excavating burrows (Whittow 1997).

Breeding begins at four years of age, and they are monogamous with the successful rearing of a nestling. Birds begin arriving at the nesting colonies from late February to early March. They lay one egg and, on Kauai, the first egg has been recorded from June 6-10. For Kauai, most egg laying is completed by June 25th with a peak occurring June 12-18 (Whittow 1997). Hatching begins in late July, peaks from August 1-12 and ends by August 18 (Whittow 1997). Fledging begins in early November and finishes by the end of the month. In Hawaii, most birds return to their natal island to breed (Whittow 1997).

Dogs (*Canis familiaris*), cats (*Felis domesticus*), small Indian mongoose (*Herpestes auropunctatus*) and rats (*Rattus* sp.) have contributed to the reduction and/or extirpation of seabirds from many Pacific Islands (Smith et al. 2002). The known predators of adult wedge-tailed shearwaters in Hawaii are rats, domestic dogs, and feral cats. Nestlings have been taken by barn owls and mynas, rats and mongoose will eat the eggs (Whittow 1997). Eradicating cats from seabird colonies is a conservation priority, because it has been proven that removing cats causes positive effects (Keit & Tershy 2003).

The observations of wedge-tailed shearwaters around the Beach Cottages at Barking Sands, Pacific Missile Range Facility (PMRF) on Kauai have increased since 2002. This may, in part, be due to increased security at Barking Sands since the events of September 11, 2001, which had decreased the numbers of people that are allowed access. Also, dogs are no longer allowed to be brought on to the installation. There are two fenced enclosures (fenced on 3-sides with the side to the ocean open) within the Beach Cottages area that have been designated as nesting colonies and posted with signs; one has a wooden fence and the other has hogwire. There is one cottage between the fenced areas. The wedge-tailed shearwater colony at this location was not being regularly managed prior to 2006 and both fenced areas were choked with non-native trees, shrubs and grasses, thereby forcing the shearwaters to look for suitable nesting spots nearby. Shearwaters are regularly using the boulder riprap along the shore and have been excavating burrows underneath some beach cottages (in some cases, undermining the foundation). In 2005, the shearwaters began using the road behind the fenced area to congregate and began nesting activities within the ruderal vegetation across the road.

In 2005, the Navy established the following short-term goals for managing the wedge-tailed shearwater colony at the Beach Cottages. This report provides progress on the listed goals.

- Provide a revised information sheet on wedge-tailed shearwater biology and habits to guests staying at the Beach Cottages.
- Discourage burrow excavations on the mowed grassy areas at the Beach Cottages.
- Flag active burrows in areas where people regularly walk.
- Improve the nesting habitat within the fenced areas to encourage nesting in the "approved" locations.
- Resume predator control around the colony.
- Determine the geographic coverage of the nesting colony.
- Determine the burrow occupancy rate and shearwater breeding population size.
- Estimate reproductive success.

- Install permanent monitoring plots.

METHODS

Population Monitoring:

The first set of recent data at the Beach Cottage nesting colony was collected during the 2006 breeding year (Hebshi 2007). Following the protocols developed for the monitoring plots in 2006, surveys were conducted on July 9, 2007 and October 11, 2007. A total of 16 plots of 3m (9.8 feet) radius each were monitored by recording the total number of burrows and the number of occupied burrows within each plot. Plot 11 had to be shifted 3 meters to ensure that there was no overlap with Plot 15 due to the increase plot size. Minitab Release 14 Statistical Software was used to calculate the descriptive statistics.

Habitat Restoration:

In February 2006, all of the trees [kiawe (*Prosopis pallida*), long thorn kiawe (*Prosopis juliflora*), and ironwoods (*Casuarina equisetifolia*)] were cut down and treated with a systemic herbicide (Garlon) within the wooden-fenced exclosure with the assistance of the Public Works Center (PWC) and the Kauai Invasive Species Committee (KISC). The area was then cleared of big debris and native species were planted [30 naupaka (*Scaevola taccada*), 3 a'ali'i (*Dodonea viscosa*), 2 ilima (*Sida fallax*), and 1 nama (*Nama sandwicensis*) with the last three attempted as transplants]. In March 2006 an additional 5 naupaka, 4 ilima, 3 'akia (*Wikstroemia oahuensis*), 3 nehe (*Lipochaeta succulenta*), and 3 'ulei (*Osteomeles anthyllidifolia*) were planted.

The Naval Facilities Engineering Command (NAVFAC) Pacific contracted with the National Tropical Botanical Garden (NTBG) to grow 10 naio (*Myoporum sandwicensis*) , 15 a'ali'i, 20 ilie'e (*Plumbago zeylanica*), 20 nanea (*Vigna marina*), 200 kawelu (*Eragrostis variabilis*), and 20 naupaka for outplanting at Barking Sands in 2007. The NTBG grew a few extra plants, therefore a total of 306 were planted from December 11 – 14, 2007. Planting occurred as close to the end of the nesting season as possible to (1) avoid disturbing adult birds, eggs and nestlings and (2) ensure that the plants have the majority of the wet season to become established. The specific species of plants were selected because they are known to survive within the dune environment of western Kauai. As no subsequent watering is planned, the plants must be able to thrive without supplemental watering in that environment.

Predator Control:

Predator control activities conducted by the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (APHIS-WS) continued in 2007 at PMRF. Work involved trapping and other methods of animal control at both the Beach Cottages and northern dunes sites to help increase the survival of wedge-tailed shearwaters.

RESULTS

Population Monitoring:

As suggested by Hebshi (2007), the sampling area of the monitoring plots was increased from 2 meters to 3 meters. The same colony area of 7,401 m^2 (1.8 acres) calculated in 2006 was used again in 2007. A total of 16 plots were monitored, leading to a total area sampled in 2007 of 452.8 m^2 (0.11 acres). However, Plots 4 and 8 remain outside of the previously measured colony boundaries and were removed from the analysis (Figure 1). Therefore, 14 plots were used for analysis in 2007 comprising 396.2m^2 (0.098 acres), 5.4% of the entire colony. Tables 1 and 2 provide information on the total number of burrows (occupied and unoccupied) within these plots and the mean number of burrows (occupied and unoccupied) per plot. The colony-wide estimate was calculated for both parameters and is included in Tables 1 and 2.

Table 1. Summary statistics of July 9, 2007 for the 14, 3m radius plots.

	Sum	Total Mean	Std. Dev.	95% Confidence Interval	Colony-wide Estimate
Burrows	59	4.21	2.39	2.83 – 5.59	1102
Occupied	48	3.43	1.91	2.33 – 4.53	897

Table 2. Summary statistics of October 11, 2007 for the 14, 3m radius plots.

	Sum	Total Mean	Std. Dev.	95% Confidence Interval	Colony-wide Estimate
Burrows	60	4.29	2.52	2.83 – 5.75	1121
Occupied	27	1.93	2.40	0.54 – 3.32	504

Burrow occupancy rates for July and October, 2007, were 81.4% and 45%, respectively. The overall reproductive success was 56%, however, occupancy rates (and thus, success) varied throughout the plots (Table 3a & b). Data

provided in Table 3b demonstrate that the plots with the highest occupancy rate occurred in the original, wooden-fenced nesting area. If Plots 2, 6, 7, 12, and 13 are removed, there are 9 plots left within the fenced area. Within this fenced area, 48 burrows were counted (mean = 4.21 burrows/plot; SD = 2.35); of these 25 were occupied (mean = 2.8 occupied/plot; SD = 2.64). The reproductive success within the fenced area was 69.4%.

Table 3a. July, 2007 individual plot occupancy rates.

Plot No.	No. of Burrows	No. Occupied	Occupancy Rate (%)
1	5	4	80
2	1	1	100
3	2	2	100
5	7	7	100
6	1	1	100
7	4	4	100
9	8	6	75
10	8	5	62.5
11	4	3	75
12	5	5	100
13	2	1	50
14	5	4	80
15	5	3	60
16	2	2	100

Table 3b. October, 2007 individual plot occupancy rates.

Plot No.	No. of Burrows	No. Occupied	Occupancy Rate (%)
1	6	6	100
2	1	0	0
3	3	3	100
5	6	5	83.3
6	1	1	100
7	5	0	0
9	11	7	63.6
10	4	0	0
11	4	1	25
12	3	1	33.3
13	2	0	0
14	5	1	20
15	5	2	40
16	4	0	0

Habitat Restoration:

The species planted during 2006 had a moderate survival success rate (over 50% of the naupaka planted survived). While none of the akia, nehe, and ulei planted in March 2006 survived, ilima is thriving, with large, flowering plants interspersed throughout the colony. Non-native grasses (mostly a species of foxtail) are the dominant ground cover within the colony area.

Predator Control:

Table 4 provides information on animals removed, released or dispersed around the wedge-tailed shearwater colonies at Barking Sands. Cats caught in traps are released to the Humane Society.

Table 4. Number of target animals removed from Barking Sands.

	Cats	Cats (released or dispersed)	Dogs (released or dispersed)	Rats (Norway & Polynesian)	Mice
FY06	24	66	0	74	213
FY07	30	41	5	43	77

DISCUSSION & RECOMMENDATIONS

Population Monitoring:

As with the 2006 data, the measurement of the colony area includes the road and some dense vegetation not suitable for nesting, which leads to an artificially inflated area of the nesting colony. However, it is interesting to note that there was evidence of digging by wedge-tailed shearwaters in Plot 8 in July (outside the measured colony), but there was no evidence of a burrow in October.

As observed, the nesting activity and reproductive success within the original, wooden-fenced area was higher than outside the fenced area in 2007. Table 5 provides a comparison between 2006 and 2007. In 2007, a larger area was sampled, making it difficult to determine whether there was an increase in the number of excavated burrows and nesting attempts. However, direct observation within the colony indicated an increased use (e.g., excavating attempts) throughout the wooden-fenced area.

Table 5. Comparison of October 2006 and 2007 data (unless otherwise stated).

	# Plots	Total Area Sampled (% of colony)	Sum of Burrows	Sum Occupied	Mean burrows/plot
2006	13	163.2m² (2.2%)	32	14	1.85
2007	14	396.2m² (5.4%)	60	27	4.29
	Mean occupied/plot	**Summer occupancy rate**	**Oct. Occupancy rate**	**Reproductive Success**	**Estimated Population Size**
2006	1.08	56%	44%	79%	276 breeding pairs
2007	1.93	81.4%	45%	56%	209 breeding pairs

Habitat Restoration:

Habitat restoration within the wooden-fenced area was continued in December, 2007. With the removal of the large trees in 2006, the non-native grasses and golden crownbeard (*Verbesina sp.*) have increased. Both of these are so ubiquitous throughout western Kauai that they may only be controlled within this area. KISC has provided assistance after the initial tree removal by removing and treating re-sprouts of the kiawes and ironwoods with herbicide. Through direct observation, more areas within the wooden-fenced area are being used by wedge-tailed shearwaters.

The native plant species planted this year were selected to provide ground cover (prevent non-natives from sprouting) or to provide habitat relief and general cover for the shearwaters when they are in residence. Specifically, kawelu, a native bunch grass, was planted because this species is well suited to the environment, secures the sand, and is not overly taxed by the activities of burrowing seabirds. This species grows taller than the majority of the non-native grasses and is hoped to become the dominant grass within the exclosure.

Progress towards meeting short-term goals:

- Provide a revised information sheet on wedge-tailed shearwater biology and habits to guests staying at the Beach Cottages.

The revised information sheet was provided to Beach Cottage guests before the 2005 nesting season and is still being used.

- Discourage burrow excavations on the mowed grassy areas at the Beach Cottages.

Excavations are being discouraged by extensive watering of the mowed grasses (to maintain a dense mat).

- Flag active burrows in areas where people regularly walk.

Active burrows are flagged and protected.

- Improve the nesting habitat within the fenced areas to encourage nesting in the "approved" locations.

Increased use of the wooden-fenced area has occurred. The cottage between the fenced areas will be removed in early 2008 and the wooden- fenced area will be expanded. Restoration should be continued and expanded to include the new area. The hog wire fenced area will be removed as target shearwater habitat, cleaned of debris, and planted with grass.

- Resume predator control around the colony.

Predator control resumed in 2006, continued in 2007 and contracted for 2008.

- Determine the geographic coverage of the nesting colony.

Determined in support of the project contracted to Aaron Hebshi in 2006 and detailed within the 2007 report, "Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report."

The geographic coverage of the nesting colony should be mapped using Geographic Positioning System (GPS) notation in 2009.

- Determine the burrow occupancy rate and shearwater breeding population size.

Determined in support of the project contracted to Aaron Hebshi in 2006 and detailed within the 2007 report, "Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report".

A full colony burrow count should occur in June or July and October of 2009 and the breeding population size determined.

- Estimate reproductive success.

Determined in support of the project contracted to Aaron Hebshi in 2006 and detailed within the 2007 report, "Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report".

The reproductive success was estimated using the permanent monitoring plots in 2007 and will continue in 2008. The reproductive success should be calculated in 2009 using the full-colony count information.

- Install permanent monitoring plots.

Determined in support of the project contracted to Aaron Hebshi in 2006 and detailed within the 2007 report, "Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report".

The permanent monitoring plots were established in 2006 and used in 2007. They will be used again in 2008. Following the full colony burrow count and mapping of the extent of the colony in 2009, additional permanent monitoring plots should be established.

LITERATURE CITED

Hebshi, A. 2007. Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report. Prepared for United States Navy, NAVFAC Pacific, Environmental Planning: 8pp.

Keitt, B. S. and B. R. Tershy. 2003. Cat eradication significantly decreases shearwater mortality. Animal Conservation 6:307-308.

Smith, D. G., J. T. Polhemus, and E. A. Vanderwerf. 2002. Comparison of managed and unmanaged wedge-tailed shearwater colonies on Oahu: effects of predation. Pacific Science 56(4):451-457.

Whittow, G. C. 1997. Wedge-tailed shearwater (*Puffinus pacificus*). *In* The Birds of North America, No. 305 (A. Poole and F. Gill, eds): 19pp.

DESCRIPTIVE FIGURES

Figure 1. Wedge-tailed shearwater colony as mapped in August, 2006.

Figure 2. Wedge-tailed shearwater colony at the Beach Cottages after the removal of large trees in February 2006 (from Google Earth December 2007).

Figure 3. Wedge-tailed shearwater colony at the Beach Cottages before the planting effort in December, 2007.

Figure 4. KISC assisting with the planting effort in December, 2007.

Figure 5. New plantings of ilie'e at the Beach Cottages colony.

Figure 6. Planting kawelu (a native bunch grass) at the Beach Cottages colony.

Figure 7. The foreground shows non-native grasses, native ilima and a newly planted a‘alii.

B8 - WEDGE-TAILED SHEARWATER CONSERVATION AT BARKING SANDS, PACIFIC MISSILE RANGE FACILITY, KAUAʻI, HAWAIʻI CY 2008

(NAVFAC PAC 2009a)

WEDGE-TAILED SHEARWATER CONSERVATION
AT
BARKING SANDS, PACIFIC MISSILE RANGE FACILITY
KAUA'I, HAWAI'I

CY 2008

Prepared by:
Vanessa E. Pepi
EV22
NAVFAC Pacific

February 2009

INTRODUCTION

Wedge-tailed shearwaters (*Puffinus pacificus*) are pelagic seabirds of the tropical and sub-tropical Pacific and Indian Oceans and are protected under the Migratory Bird Treaty Act (MBTA). They breed from Madagascar (Indian Ocean) to Revillagigedo Island (off Mexico) (Whittow 1997) and feed mainly on larval forms of several species of fishes driven to the surface by foraging fish schools. They are the largest of the tropical shearwaters with an average overall length of 16.9 inches (43 cm) and an average body mass of 13.8 oz (390g) (Whittow 1997). Feather colors vary from grayish-brown to a sooty brown, with the lighter colored individuals in the North Pacific. No sexual dimorphism has been documented. It is speculated that there may be little migration of the tropical Pacific population (Whittow 1997).

In the Hawaiian Islands, wedge-tailed shearwaters breed from Kure Island south to Maui Island from February through November. They are ground-nesting seabirds that dig nearly horizontal or gently-sloping burrows into the sand or similar substrate. Typical breeding /burrowing areas are low, flat islands and sandspits with little or no vegetation (Whittow 1997). Around the main Hawaiian Islands, wedge-tailed shearwaters nest on low, flat, sandy beaches. There are usually no tall, woody plants in the nesting area as this impedes ingress and egress of birds to and from the burrow (Whittow 1997). In general, the majority of burrows are in sand or soil, but there is variation. They will use rock piles and ledges where there are areas that aren't suitable for excavating burrows (Whittow 1997).

Breeding begins at four years of age, and they are monogamous with the successful rearing of a nestling. Birds begin arriving at the nesting colonies from late February to early March. They lay one egg and, on Kauai, the first egg has been recorded from June 6-10. For Kauai, most egg laying is completed by June 25th with a peak occurring June 12-18 (Whittow 1997). Hatching begins in late July, peaks from August 1-12 and ends by August 18 (Whittow 1997). Fledging begins in early November and finishes by the end of the month. In Hawaii, most birds return to their natal island to breed (Whittow 1997).

Dogs (*Canis familiaris*), cats (*Felis domesticus*), small Indian mongoose (*Herpestes auropunctatus*) and rats (*Rattus* sp.) have contributed to the reduction and/or extirpation of seabirds from many Pacific Islands (Smith et al. 2002). The known predators of adult wedge-tailed shearwaters in Hawaii are rats, domestic dogs, and feral cats. Nestlings have been taken by barn owls and mynas, rats and mongoose will eat the eggs (Whittow 1997). Eradicating cats from seabird

colonies is a conservation priority, because it has been proven that removing cats causes positive effects (Keit & Tershy 2003).

The observations of wedge-tailed shearwaters around the Beach Cottages at Barking Sands, Pacific Missile Range Facility (PMRF) on Kauai have increased since 2002. This may, in part, be due to increased security at Barking Sands since the events of September 11, 2001, which had decreased the numbers of people that are allowed access. Also, dogs are no longer allowed to be brought on to the installation. There is now one wooden-fenced enclosure (fenced on 3-sides with the side to the ocean open) within the Beach Cottages area that has been designated as a nesting colony and posted with signs. There were two fenced-off areas, but in December 2007/January 2008, the hog-wire fenced area was removed and bulldozed, the cottage between the two areas was removed and the wooden-fenced colony area was expanded. The wedge-tailed shearwater colony at this location was not being regularly managed prior to 2006 and both fenced areas were choked with non-native trees, shrubs and grasses, thereby forcing the shearwaters to look for suitable nesting spots nearby. Shearwaters are regularly using the boulder riprap along the shore and have been excavating burrows underneath some beach cottages (in some cases, undermining the foundation). In 2005, the shearwaters began using the road behind the fenced area to congregate and begin nesting activities within the ruderal vegetation across the road.

There are numerous threats impacting Hawaii's coastal ecosystems and there are few seabird nesting colonies on the Main Hawaiian Islands. The colonies that are successful on the Main Islands are ones that are managed (predator control and habitat restoration) such as Kilauea National Wildlife Refuge, Kauai and Kaena Point, Oahu. Barking Sands has the largest wedge-tailed shearwater colony on the West Side of Kauai.

In 2005, the Navy established the following short-term goals for managing the wedge-tailed shearwater colony at the Beach Cottages. This report provides progress on the listed goals.

1. Provide a revised information sheet on wedge-tailed shearwater biology and habits to guests staying at the Beach Cottages.

2. Discourage burrow excavations on the mowed grassy areas at the Beach Cottages.

3. Flag active burrows in areas where people regularly walk.

4. Improve the nesting habitat within the fenced areas to encourage nesting in the "approved" locations.

5. Resume predator control around the colony.

6. Determine the geographic coverage of the nesting colony.

7. Determine the burrow occupancy rate and shearwater breeding population size.

8. Estimate reproductive success.

9. Install permanent monitoring plots.

2008 PROGRESS TOWARDS MEETING SHORT-TERM GOALS AND PROPOSED 2009 ACTIONS

1. Provide a revised information sheet on wedge-tailed shearwater biology and habits to guests staying at the Beach Cottages.

The revised information sheet was provided to Beach Cottage guests before the 2005 nesting season and is still being used.

2. Discourage burrow excavations on the mowed grassy areas at the Beach Cottages.

Excavations are being discouraged by extensive watering of the mowed grasses (to maintain a dense mat).

3. Flag active burrows in areas where people regularly walk.

Active burrows are flagged and protected.

4. Improve the nesting habitat within the fenced areas to encourage nesting in the "approved" locations.

Please see Appendix A for a more detailed description of habitat restoration. Increased use of the wooden-fenced area has occurred. The cottage between the fenced areas was removed in early 2008, the hog wire-fenced area was bulldozed, and the wooden- fenced area was correspondingly expanded. Construction of an additional cottage may occur in the area where the hog wire fence was. To prevent nesting in that area, matting was

placed on the ground to cover it. The matting used was the same that used by USFWS Refuges at French Frigate Shoals during a construction project.

5. Resume predator control around the colony.

Predator control resumed in 2006, continued through 2007and 2008 and is contracted for 2009.

6. Determine the geographic coverage of the nesting colony.

The nesting colony area was mapped during the project contracted to Aaron Hebshi in 2006 and detailed within the 2007 report, "Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report."

The geographic coverage of the nesting colony will be mapped using Geographic Positioning System (GPS) notation in the summer of 2009. Areas around Majors Bay will be included within the mapping effort.

7. Determine the burrow occupancy rate and shearwater breeding population size.

This goal was determined in support of the project contracted to Aaron Hebshi in 2006 and detailed within the 2007 report, "Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report". Please see Appendix A for a more detailed description of the population monitoring in 2008 and recommendations for 2009.

A full colony burrow count will occur in July 2009 and the breeding population size determined.

8. Estimate reproductive success.

This goal was determined in support of the project contracted to Aaron Hebshi in 2006 and detailed within the 2007 report, "Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report". Please see Appendix A for a more detailed description of the population monitoring in 2008.

The reproductive success was estimated using the permanent monitoring plots in 2007 and 2008. The reproductive success will be re-calibrated in 2009 using the full-colony count information

9. Install permanent monitoring plots.

This goal was etermined in support of the project contracted to Aaron Hebshi in 2006 and detailed within the 2007 report, "Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report".

The permanent monitoring plots were established in 2006 and used in 2007 and 2008. Please see Appendix A for a more detailed description of the population monitoring in 2008. Following the full colony burrow count and mapping of the extent of the colony in 2009, additional random, permanent monitoring plots will be established.

LITERATURE CITED

Hebshi, A. 2007. Pacific Missile Range Facility wedge-tailed shearwater population survey project summary report. Prepared for United States Navy, NAVFAC Pacific, Environmental Planning: 8pp.

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APPENDIX A: POPULATION MONITORING & HABITAT RESTORATION

METHODS

Population Monitoring:

Recent data collection at the Beach Cottage nesting colony was occurred during the 2006 (Hebshi 2007) and 2007 (Pepi 2008) breeding years. Following the protocols developed for the monitoring plots in 2006, surveys were again conducted on July 2, 2008 and October 8, 2008. A total of 14 plots of 3m (9.8 feet) radius each were monitored by recording the total number of burrows and the number of occupied burrows within each plot. Plots 7 and 13 were lost due to the bulldozing of the second colony area and removal of the cottage between the two colonies. Plot 2 was intact, but bulldozing occurred near that plot and no nesting activity was observed. Minitab Release 15 Statistical Software was used to calculate the descriptive statistics.

Habitat Restoration:

A description of efforts prior to 2008 is found in the July 2008 report (Pepi 2008). The Naval Facilities Engineering Command (NAVFAC) Pacific contracted with the National Tropical Botanical Garden (NTBG) to grow 20 naio (*Myoporum sandwicensis*) , 15 a'ali'i, 20 ilie'e (*Plumbago zeylanica*), 20 nanea (*Vigna marina*), 200 kawelu (*Eragrostis variabilis*), and 20 naupaka for outplanting at Barking Sands in 2008. Planting occurred as close to the end of the nesting season as possible to (1) avoid disturbing adult birds, eggs and nestlings and (2) ensure that the plants have the majority of the wet season to become established. The specific species of plants were selected because they are known to survive within the dune environment of western Kauai.

Predator Control:

Predator control activities conducted by the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (APHIS-WS) continued in 2007 at PMRF. Work involved trapping and other methods of animal control at both the Beach Cottages and northern dunes sites (and

subsequently, the entire base) to help increase the survival of wedge-tailed shearwaters.

RESULTS

Population Monitoring:

The same colony area of 7,401 m² (1.8 acres) calculated in 2006 was used in 2007 and 2008. In 2008, a total of 14 plots were monitored, leading to a total area sampled in 2008 of 395.8 m² (0.098 acres). However, Plots 7 and 13 were lost as a result of demolition activities in the area and Plots 4 and 8 remain outside of the previously measured colony boundaries and were not included within the analysis (Figure 1). Twelve plots were used for analysis in 2008 comprising 339.3 m² (0.084 acres), 4.6% of the entire colony. Tables 1 and 2 provide information on the total number of burrows (occupied and unoccupied) within these plots and the mean number of burrows (occupied and unoccupied) per plot. The colony-wide estimate was calculated for both parameters and is included in Tables 1 and 2. A correction factor (x0.43) was used to more accurately translate the results from the monitoring plots into a colony-wide estimate. The correction factor is derived from the plots and full-colony census data from the 2006 survey (Hebshi 2007).

Table 1. Summary statistics of July 2, 2008 for the 12, 3m radius plots.

	Sum	Total Mean	Std. Dev.	95% Confidence Interval	Colony-wide Estimate	Estimate x corr. factor
Burrows	41	3.42	2.54	1.81 – 5.03	894	388
Occupied	34	2.83	2.29	1.38 – 4.28	740	321

Table 2. Summary statistics of October 8, 2008 for the 12, 3m radius plots.

	Sum	Total Mean	Std. Dev.	95% Confidence Interval	Colony-wide Estimate	Estimate x corr. factor
Burrows	48	4.00	2.49	2.42 – 5.58	1046	454
Occupied	39	3.25	2.01	4.52 – 4.52	850	369

Burrow occupancy rates for July and October, 2008, were 82.9% and 81.3%, respectively. The overall reproductive success was 98.1%, however, occupancy rates (and thus, success) varied throughout the plots (Table 3a & b).

If Plots 2 and 12, are removed from the calculations, there are 10 plots left within the fenced area. Within this fenced area, 45 burrows were counted (mean = 4.5 burrows/plot; SD = 0.73); of these 37 were occupied (mean = 3.7 occupied/plot; SD = 0.57). The reproductive success within the fenced area was 82.2%.

Table 3a. July, 2008 individual plot occupancy rates.

Plot No.	No. of Burrows	No. Occupied	Occupancy Rate (%)
1	2	2	100
2	0	0	0
3	3	3	100
5	6	6	100
6	0	0	0
9	9	8	89
10	4	2	50
11	4	4	100
12	4	2	50
14	2	2	100
15	5	3	60
16	2	2	100

Table 3b. October, 2008 individual plot occupancy rates.

Plot No.	No. of Burrows	No. Occupied	Occupancy Rate (%)
1	4	3	75
2	0	0	0
3	4	4	100
5	6	5	83.3
6	1	1	100
9	9	7	77.8
10	7	6	85.7
11	4	3	75
12	3	2	66.7
14	2	2	100
15	4	3	75
16	4	3	75

Habitat Restoration:

The NTBG grew a few extra plants (as "back up"), therefore approximately 315 individuals were planted December 10 - 13, 2008.

After reviewing the success of out-planting in December 2007 and conferring with NTBG, it was determined that supplemental watering is required for the kawelu and nanea. All of the kawelu died and only one nanea survived in 2008. During the demolition of the beach cottage and expansion of the original fenced area in January 2008, NAVFAC Pacific requested that the outside spigot of the then soon-to-be-demolished beach cottage be left in place. There is now a permanent source of water within the colony. A drip watering system will be set up where the kawelu and nanea are planted. The rest of the plants will not receive supplemental watering as there is at least approximately 50% success on survival.

Predator Control:

Table 4 provides information on animals removed, released or dispersed around the wedge-tailed shearwater colonies at Barking Sands. Cats caught in traps are released to the Humane Society.

Table 4. Number of target animals removed from Barking Sands.

	Cats	**Cats (released or dispersed)**	**Dogs (released or dispersed)**	**Rats (Norway & Polynesian)**	**Mice**	**Barn Owls (removed or dispersed)**	**Pueo (dispersed)**
FY06	24	66	0	74	213	20	6
FY07	30	41	5	43	77	39	14
FY08	9	59	6	0*	0*	23	45

*Rats and mice were not recorded within the trapping area.

DISCUSSION & RECOMMENDATIONS

Population Monitoring:

The measurement of the colony area includes the road and some dense vegetation not suitable for nesting. In addition, significant changes to the colony area occurred in January 2008. These factors most likely lead to an artificially inflated area of the nesting colony.

It is worth noting that nesting activity was observed farther outside the mapped areas this year. Wedge-tailed shearwaters were heard vocalizing at night in the vegetation surrounding the Majors Bay parking lot.

As observed, the nesting activity and reproductive success within the wooden-fenced area is changing. Table 5 provides a comparison from 2006 through 2008.

In 2008, a smaller area was sampled due to construction, the removal of the hog-wire protected area and the expansion of the wooden-fenced area. However, direct observation within the colony indicated an increased use (e.g., excavating attempts) throughout the wooden-fenced area. Table 5 indicates that there is a potential increase in the number of birds using the area, along with an increase in the overall reproductive success of the colony.

Table 5. Comparison of October 2006, 2007 and 2008 data (unless otherwise stated).

	# Plots	Total Area Sampled (% of colony)	Sum of Burrows	Sum Occupied	Mean burrows/plot
2006	13	163.2m² (2.2%)	32	14	1.85
2007	14	396.2m² (5.4%)	60	27	4.29
2008	12	339.2m² (5.4%)	48	39	4.0
	Mean occupied/plot	**Summer occupancy rate**	**Oct. Occupancy rate**	**Reproductive Success**	**Estimated Population Size**
2006	1.08	56%	44%	79%	276 breeding pairs
2007	1.93	81.4%	45%	56%	209 breeding pairs
2008	3.25	82.9%	81.3%	98.1%	369 breeding pairs

As stated above, the number of wedge-tailed shearwaters using the area appears to have increased as a result of the actions taken over the past several years. At this point, wedge-tailed shearwaters appeared to be negatively impacted by owl (both barn and pueo) predation and human interactions (burrows being crushed and being run over by cars).

The following are recommendations to alleviate these impacts:

- Continue to have USDA is remove barn owls and haze the pueo from the area;
- Provide additional educational material to guests staying at the beach cottages, to include but not limited to:

  - Information on watching for burrows and what happens when a burrow is crushed;
  - Locations where burrows are most likely occur (the beach side of the fenced area);
  - When driving behind the fenced area, drive slowly to avoid running over the birds;

- Turn the street light off that is behind the fenced area (the light attracts the birds and they congregate at the base of the pole, which is next to the road and increases potential for the birds to be run over);
- Consider blocking off the road behind the fenced area to vehicle traffic during the night while the birds are in residence;
- Consider installing a few boardwalks from the grassy area down to the beach flats (the berm) where the birds are most likely to dig burrows; and
- Consider installing a viewing boardwalk on the beach side of the fenced area to reduce burrow crushing;

Habitat Restoration:

Habitat restoration within the wooden-fenced area was continued in December, 2008. KISC continues to provide assistance after the initial tree removal by removing and treating re-sprouts of the kiawes and ironwoods with herbicide.

The native plant species planted this year were selected to provide ground cover (prevent non-natives from sprouting) or to provide habitat relief and general cover for the shearwaters when they are in residence. Specifically, kawelu, a native bunch grass, was planted again because this species is well suited to the environment, secures the sand, and is not overly taxed by the activities of burrowing seabirds. This species grows taller than the majority of the non-native grasses and is hoped to become the dominant grass within the exclosure.

DESCRIPTIVE FIGURES

Wedge-tailed shearwater Nesting Colony at the Beach Cottages, Barking Sands, PMRF, Kauai, Hawaii

Figure 1. Wedge-tailed shearwater colony as mapped in August, 2006.

Figure 2. February 2006 - The colony in during the removal of the trees.

Figure 3. February 2006 – Primary photo point at the southwest side of the colony.

Figure 4. March 2006 - The colony after the large tree removal (SW side).

Figure 5. December 2007 – The colony almost two years after clearing.

Figure 6. December 2008 – The colony almost three years after clearing.

Figure 7. July 2008 – Wedge-tailed shearwaters at the nesting colony.

B9 - KA‘ULA ISLAND SHIP-BASED SEABIRD AND MARINE MAMMAL SURVEYS, 21-22 JULY 2009

(PEPI *ET AL* 2009)

KAULA ISLAND SHIP-BASED SEABIRD AND MARINE MAMMAL SURVEYS 21-22 July 2009

Prepared for Commander, Pacific Fleet
2 November 2009

Citation: Pepi, V.E., A. Kumar, M.E. Laut, J. Hallman, J. Kim, and A.D. Anders. 2009. Kaula Island ship-based seabird and marine mammal surveys, 21-22 July 2009. Prepared for Commander, Pacific Fleet. NAVFAC Pacific. 29 pp.

BACKGROUND

Purpose

To monitor the seabird populations of Kaula Island while maintaining military readiness.

Owner Information

Territorial Executive Order 173 of 13 December 1924 set aside Kaula Island for public purposes under the jurisdiction of the United States Lighthouse Service. In 1939, the U.S. Coast Guard (USCG) assumed control of Kaula (Elmer and Swedberg 1971, Balazs 1979). In 1952, the Department of the Navy obtained permission to use Kaula Island as a munitions target, and the Navy received control of the island from USCG in 1965 (Elmer and Swedberg 1971).

Property Description

Kaula is a small, uninhabited islet near the islands of Niihau and Kauai in the Hawaiian Archipelago (Figure 1; latitude: 21°39’29” North, longitude: 160°32’39” West; Palmer 1936). It is located 20 nautical miles (37 kilometers [km]) west-southwest of Niihau and approximately 60 nautical miles (111 km) southwest of the Pacific Missile Range Facility (PMRF), Kauai. Kaula has an area of approximately 136 acres (55 hectares), with a summit elevation of 540 feet (ft) (164.6 meters [m]) (Palmer 1936). The island is crescent-shaped, with a curving crest line approximately 5,500 ft (1,676 m) in length (Figure 2). The terrain drops steeply from the crest at a mean slope of 36° (Palmer 1936), and steep V-shaped ravines have been cut by ephemeral streams on the windward slopes, such that the island has little level terrain (Elmer and Swedberg 1971). The northern horn of the island extends 2,500 ft (762 m) from the summit and ends at an approximate elevation of 280 ft (85 m), while the southern horn extends 3,000 ft (914 m) from the summit and ends at an approximate elevation of 100 ft (30 m) (Palmer 1936). The southeastern tip (1000 ft) of the island is currently used by the U.S. Navy as a range for inert ordnance and aircraft gunnery (Figure 2). During a 1971 survey, a freshwater source was recorded approximately 1,000 ft (305 m) from the impact area with a flow rate of approximately 1 pint (0.47 liters) per hour (Elmer and Swedberg 1971).

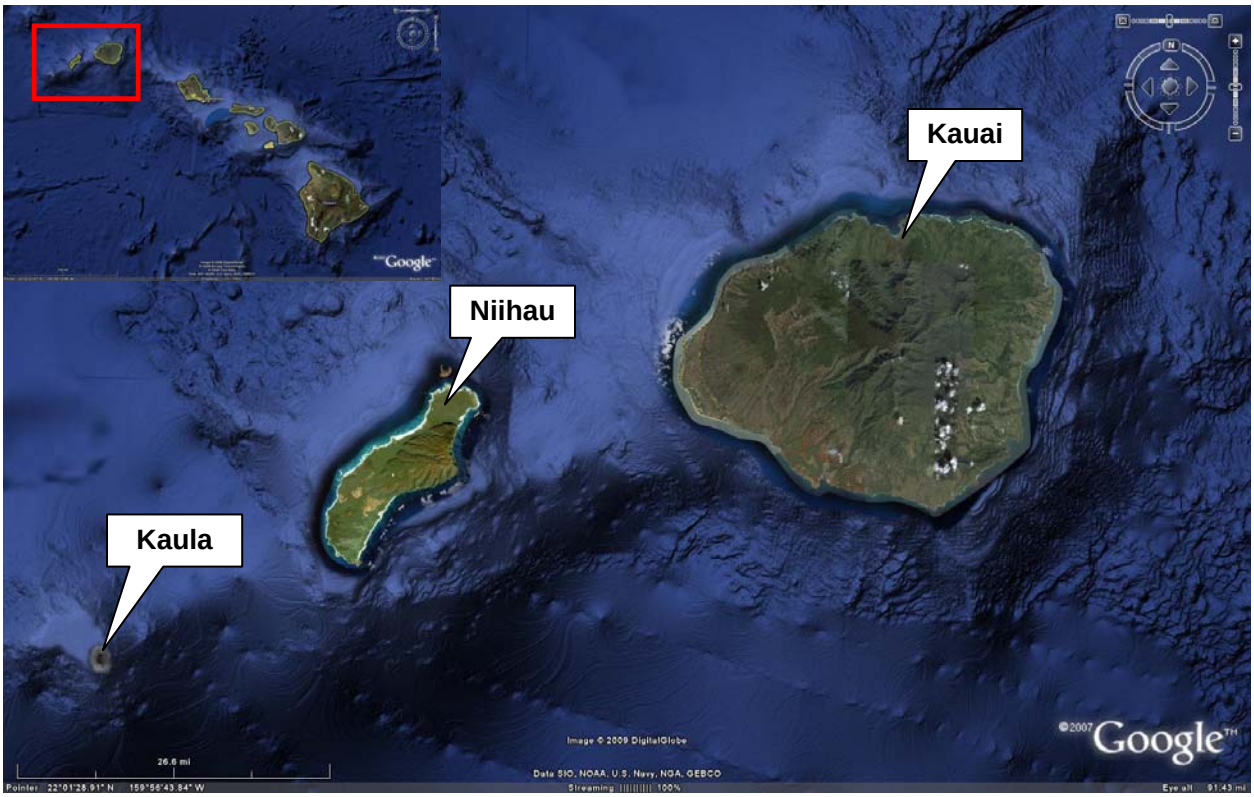

Figure 1. Location of Kaula Island relative to the main Hawaiian Islands (inset) and Kauai and Niihau (imagery from Google Earth).

Figure 2. Aerial imagery of Kaula Island (Walker and Associates).

Prior Use

Kaula Island is associated with Hawaiian culture and is assumed to have been visited in the past by Hawaiians for fishing and bird collection, but there is no evidence of regular human habitation (Elmer and Swedberg 1971). Three archeological sites were described by Bryan (1939): two sites were originally speculated to be heiaus and one site a shelter cave; however, the heiau sites have been noted to be of questionable origin (Bryan 1939, Elmer and Swedberg 1971, DON 1976a).

The U.S. Lighthouse Service established an automatic gas light near the summit of Kaula Island on August 18, 1932. Lighthouse Service personnel were able to land on the west side of the island during steady trade wind weather, and an ascent trail was built from a wave-cut bench near sea level to the lighthouse site near the summit (Palmer 1936). The gas light provided 480 candlepower and was visible for a distance of up to 27 miles in clear conditions. Two gas tanks on the west side of the island supplied fuel to the main and backup light via 1,500 ft-long pipes. The lighthouse on Kaula was operated until 1947.

Following World War II, USCG used Kaula Island as a radar navigation target. After receiving permission to use the island for munitions training, in 1952 the Navy designated the southeastern tip (1000 ft) of the island as a practice range for air-to-surface and surface-to-surface weapons delivery (Elmer and Swedberg 1971, DON 1976a). Both live and inert ordnance was used during training missions through 1980. From 1981 through 2009, munitions training by the Navy at Kaula has been restricted to inert ordnance delivery and aircraft gunnery (Walker 1983, 1984).

In 1977, Kaula Island was designated as a Seabird Sanctuary by the State of Hawaii Department of Land and Natural Resources.

Survey History and Species Observations

Terrestrial Species

The first formal biological surveys of Kaula Island were conducted in August 1932 (Table 1; Caum 1936). E.L. Caum, a botanist with the Hawaiian Sugar Planters' Experiment Station, and H.S. Palmer, a professor of geology at the University of Hawaii, were provided access and transportation to Kaula by the U.S. Lighthouse Service (Caum 1936, Palmer 1936). Although Caum did not quantify population sizes of the plant or bird species he observed on Kaula, he provided complete species lists, including 15 plant and 16 bird species (Tables 2 and 3; Caum 1936). Caum indicated that plant cover was extensive across areas of the island where plants were able to grow, but that many areas of the island had no plant cover, and all species that occurred on the island were those that could tolerate arid conditions and strong winds. Four of the 15 plant species (27%) observed by Caum were species non-native to Hawaii (Table 2; Caum 1936). Bird species observed by Caum included 12 species of seabirds (two Procellariiformes species, five Pelecaniformes species, and five tern species) and two species of migratory shorebirds (Table 3). Breeding by two additional Procellariiformes species on the island – a black-footed albatross (*Phoebastria nigripes*, formerly *Diomedea nigripes*) and Bonin petrel

(*Pterodroma hypoleuca*) - was assumed based upon the presence of an abandoned egg and a single chick of these species, respectively (Caum 1936).

Following the 1932 surveys, four decades passed before avian surveys were again conducted on Kaula. In August 1971, biologists from the U.S. Fish and Wildlife Service (USFWS), State of Hawaii Department of Land and Natural Resources (DLNR), and U.S. Navy visited Kaula to assess the effects of munitions training exercises on nesting birds and document the status of the breeding seabird populations (Table 1; Elmer and Swedberg 1971). Elmer and Swedberg noted that ordnance had reduced the training impact area on the southeastern tip of the island (approximately 8% of the island area) to rubble. There was no evidence of nesting by seabirds in the impact area. The team also discovered indication of three explosions outside of the impact area and evidence of one fire that may have been started by a flare (Elmer and Swedberg 1971). A complete avian survey throughout the remaining 92% of the island indicated an estimated total of 98,022 individual birds of 19 species, including 15 seabird species, one migratory shorebird species, and three species of visiting landbirds (Table 3). Elmer and Swedberg (1971) indicated that "most of the (seabird) species…were incubating eggs or rearing young." As with the 1932 survey, a single abandoned albatross egg (species not identified) was observed on Kaula in 1971 (Elmer and Swedberg 1971).

The second complete botanical survey and next avian survey conducted on Kaula took place in January 1976, outside of the breeding period for most central Pacific seabird species (Table 1; DON 1976a). During these surveys, biologists from USFWS, Hawaii DLNR, and the U.S. Navy found thirteen plant species not observed by Caum (1936). Of these, seven were species not native to Hawaii. All of the nine native plant species observed by Caum in 1936 were also observed during the 1976 survey. A total of 27 plant species were documented during this second botanical survey, with 12 species (44%) being non-native, including five introduced grass species and two introduced composites (Asteraceae) (DON 1976a). Avian surveys conducted in 1976 indicated the presence of approximately 3,521 individuals of 16 bird species, including black-footed and Laysan albatrosses (*Phoebastria immutabilis*), five Pelecaniformes species, three tern species, three migratory shorebird species, and four visiting landbird species (DON 1976a). Although albatrosses, booby (*Sula*) species, and sooty terns *(Sterna fuscata*) nest during the month of January in the Hawaiian Archipelago, most of the other 12 seabird species observed on Kaula during previous (August) surveys would not have been actively nesting, and thus not necessarily present on the island, at the time of the January 1976 survey.

Eight additional avian surveys were conducted on Kaula Island by USFWS, Hawaii DLNR, and U.S. Navy biologists from 1976 through 1998, with survey dates ranging from March through November (Table 1; DON 1976b, Walker 1979, DON 1980, Walker 1983, Walker 1984, Walker 1993, Telfer 1998), months that span the peak breeding periods for the majority of central Pacific seabird species. No new seabird or shorebird species were observed during these later surveys, although two additional visiting landbird species were seen (Table 3). Throughout the 11 avian surveys conducted on Kaula from 1932 through 1998, a total of 18 seabird species were observed (although the Bonin petrel (*Pterodroma hypoleuca*) was seen only in 1932, such that the identification of the single chick of this species may have been incorrect) (Table 3). Of the 17 seabird species observed in multiple years, all were observed breeding on the island during one or more surveys except the black noddy (*Anous minutus*) and white tern (*Gygis alba*) (Caum

1936, Elmer and Swedberg 1971, DON 1976a, DON 1976b, Walker 1979, DON 1980, Walker 1983, Walker 1984, Walker 1993, Telfer 1998). Based on the number of white terns observed and their breeding habitat preferences, however, it may be that white terns have used Kaula for nesting, but have nested on the steeper unvegetated slopes not accessed by biologists during their surveys. Throughout all of the avian surveys conducted, three migratory shorebird species have been observed, and a total of six landbird species have been seen, all apparently visitors except for a small breeding population of barn owls (Table 3; Caum 1936, Elmer and Swedberg 1971, DON 1976a, DON 1976b, Walker 1979, DON 1980, Walker 1983, Walker 1984, Walker 1993, Telfer 1998).

One additional botanical survey has been conducted on Kaula Island, in 1998. Although this survey was informal, based upon opportunistic observations of plant species on the island during avian surveys, the biologists reported a total of 25 species – only two fewer than the number observed during the January 1976 botanical survey (Tefler 1998). One new plant species, milo (*Thespesia populnea*), a plant introduced historically to Hawaii by Polynesians, was observed in 1998, bringing the total number of plant species seen on Kaula to 30 (Table 2). Of these, 14 species (47%) are not native to Hawaii. Both the January 1976 and November 1998 botanical surveys reported an increase in the number of non-native plant species relative to those present in 1932 (DON 1976a, Telfer 1998), and three of the indigenous plant species observed by Caum in 1932 were not seen in 1998 (Table 2; Tefler 1998).

Following the land-based avian and botanical surveys conducted from 1932 through 1998, in January 2009 the Navy contracted a private company, Hawaii Aviation, to obtain aerial imagery of Kaula Island from a small airplane to conduct seabird surveys via high-resolution digital images. Aerial color images were obtained on 18 January, and aerial infrared imagery was shot on 21 January 2009. Due to altitude restrictions and capabilities of the photographic equipment used, however, resolution of the digital images was not high enough to accurately estimate seabird population sizes or assess species presence or absence.

None of the plant or bird species observed on Kaula Island from 1932 through 1998 are federally threatened or endangered. Summaries of all botanical and avian survey personnel and data from 1932 through 1998 are provided in Tables 1 through 3.

Non-native Predators

Introductions of non-native rodents to islands during centuries of exploration and colonization have been recognized as a conservation problem worldwide (Atkinson 1985, Campbell and Atkinson 1999, Campbell and Atkinson 2002). Polynesian rats (*Rattus exulans*) and house mice (*Mus musculus*) were observed on Kaula Island in 1971, but were described as being present “not in large numbers” (Elmer and Swedberg 1971). “A few” Polynesian rats were again reported during the March 1979 survey (Walker 1979), and “a very few” Polynesian rats were seen during the November 1998 survey. House mice have not been reported on Kaula since 1971, but it is unclear whether they continue to inhabit the island. Although Polynesian rats have been observed on Kaula only in small numbers, this species has been known to have detrimental effects on seabird populations, particularly smaller seabird species. As of 2009, USFWS, Hawaii DLNR, and the U.S. Department of Agriculture are undertaking a joint project to aerially apply

rodenticide to Lehua Island, a 312-acre island near Kaula that has also been designated a Hawaii State Seabird Sanctuary (Orazio et al. 2009).

Barn owls (*Tyto alba*) have been recorded during multiple surveys on Kaula Island, with the species discovered nesting on the island in 1979, 1980, 1984, and 1993 (Walker 1979, DON 1980, Walker 1984, Walker 1993). Based on contents of caves in which barn owls were roosting or nesting, the favored prey item of this species was gray-backed terns (*Sterna lunata*), despite the relatively low abundance of this tern species on the island (Walker 1979). During the 1993 survey, barn owl nests were located and the contents (eggs and chicks) destroyed to prevent additional depredation on seabirds (Walker 1993).

Nearshore Marine Species

A nearshore marine survey was conducted in August 1971 by two Hawaii DLNR aquatic biologists (Table 1; Elmer and Swedberg 1971). The two biologists noted that the water around the island was clear, aside from the waves breaking against the cliffs. The deep blue of the water immediately offshore indicated that water depth dropped off sharply, and no shallows were evident (Elmer and Swedberg 1971). The terrace along the full length of the island on the eastern, concave side averaged approximately 30 feet (9 meters) in width and contained numerous tide pools. Large grapsid crabs (Grapsidae) were common, and periwinkles (*Littoraria intermedia*, formerly *Littorina pintado*), purple sea urchins (*Podophora atrata*), and limpets (opihi; *Helicioniscus exaratus*) were attached to the seaward faces of the terrace. Amphipods were found in the more stagnant pools, and a single goby species (*Bathygobius fuscus*) was found in the pools in which waves constantly replenished the water (Elmer and Swedberg 1971). The terrace on the northeast end of Kaula was described as being similar to those found on both sides of Hanauma Bay, Oahu (Elmer and Swedberg 1971). Two National Oceanic and Atmospheric Administration (NOAA) marine mammal surveys not associated with the on-island plant and seabird surveys at Kaula Island have included the waters surrounding the island (Mobley et al. 2000, Baird et al. 2003). Both surveys recorded spinner dolphins (*Stenella longirostris*) and bottlenose dolphins (*Tursiops truncates*) near Kaula (Mobley et al. 2000, Baird et al. 2003).

Table 1. Survey dates and personnel, Kaula Island, Hawaii, 1932-2009.*

Date	Agency	Survey personnel	Title
16-19 Aug 1932	University of Hawaii	Harold S. Palmer	Professor of Geology
	Hawaiian Sugar Planters' Experiment Station	Edward L. Caum	Botanist
17-18 Aug 1971	U.S. Fish and Wildlife Service	Eugene Kridler	Wildlife Administrator
	Hawaii Dept of Land and Natural Resources	Ronald Walker	District Biologist
		David Woodside	Non-Game Biologist
		Thomas Telfer	Wildlife Biologist
		Richard Kaneyama	Aquatic Biologist
		Michael Fujimoto	Aquatic Biologist
		Ralph Daehler	District Forester
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		J.S. Elmer	Operations & Readiness Officer
		H.W. Mixter	Escort
20-21 Jan 1976	U.S. Fish and Wildlife Service	Palmer Sekora	Refuge Manager
	Hawaii Dept of Land and Natural Resources	Ronald Walker	Wildlife Branch Chief
		David Woodside	Non-Game Biologist
		Thomas Telfer	Wildlife Biologist
		Kenji Ego	Fisheries Branch Chief
		Michael Fujimoto	Aquatic Biologist
		Ralph Daehler	District Forester
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		Yoshito Doi	Photographer
		Scott Wood	Escort
14-15 Sep 1976	U.S. Fish and Wildlife Service	Fred Zeillemaker	Biologist
	Hawaii Dept of Land and Natural Resources	Ronald Walker	Wildlife Branch Chief
		David Woodside	Non-Game Biologist
		Thomas Telfer	Wildlife Biologist
		Kenji Ego	Fisheries Branch Chief
		Henry Sakuda	Marine Section Chief
		Ralph Daehler	District Forester
		Robert Hommon	State Archaeologist
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		John Walter	Special Asst for Ecology
		Holden	Asst Operations Officer
		Unknown	Escort
7 Mar 1978	U.S. Fish and Wildlife Service	Eugene Kridler	Wildlife Administrator
		Kimberly Wright	Special Agent
	Hawaii Dept of Land and Natural Resources	Timothy Burr	Wildlife Biologist
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		C.C. Gage	Officer-in-Charge
		Phil Hinkle	Investigating Officer
		Becker	Public Affairs Officer
		Thomas Morrison	Legal Counsel
		Myers	Photographer
		Wykoff	Corpsman

21-22 Aug 1978	U.S. Fish and Wildlife Service	John Sincock	Wildlife Biologist
		Darrell Herbst	Botanist
		James Bartee	Special Agent-in-Charge
	Natl Oceanic and Atmospheric Administration	Robert Iversen	Marine Biologist
		John Naughton	Marine Biologist
	Hawaii Dept of Land and Natural Resources	Ronald Walker	Wildlife Branch Chief
		Thomas Telfer	Wildlife Biologist
		Ralph Daehler	District Forester
	University of Hawaii	Andrew Berger	Professor of Zoology
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		Unknown	Escort
6-8 Mar 1979	U.S. Fish and Wildlife Service	Vernon Byrd	Wildlife Biologist
		Darrell Herbst	Botanist
	Natl Oceanic and Atmospheric Administration	Robert Iversen	Marine Biologist
		John Naughton	Marine Biologist
	Hawaii Dept of Land and Natural Resources	Ronald Walker	Wildlife Branch Chief
		Thomas Telfer	Wildlife Biologist
	University of Hawaii	George Balazs	HIMB Marine Biologist
		David Grooms	Geophysics Graduate Student
	U.S. Navy	Scott Hamilton	Environmental Protection Spec
		George Tullos	Air Operations
		Jay M. Davidson	Public Affairs Officer
		D. K. Mashayekhi	Medic
		Chas. J. Galbreath	Escort
19-20 Jun 1980	U.S. Fish and Wildlife Service	R. Shallenberger	Refuge Manager
	Natl Oceanic and Atmospheric Administration	Gene Nitta	Marine Biologist
	Hawaii Dept of Land and Natural Resources	Ronald Walker	Wildlife Branch Chief
		Thomas Telfer	District Wildlife Biologist
		Ralph Daehler	District Forester
	University of Hawaii	Michael Garcia	Geologist
	Honolulu Magazine	Victor Lipman	Writer
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		Unknown	EOD Specialist
		Craig Swedberg	Assistant
16-18 Apr 1984	U.S. Fish and Wildlife Service	Stewart Fefer	Wildlife Biologist
		Mark Rouzon	Wildlife Biologist
		Cameron Kepler	Wildlife Biologist
	Natl Oceanic and Atmospheric Administration	Gene Nitta	Marine Biologist
	Hawaii Dept of Land and Natural Resources	Ronald Walker	Wildlife Branch Chief
		Thomas Telfer	Wildlife Biologist
		Marie Morin	Wildlife Biologist
	U.S. Navy	Unknown	U.S. Navy Representative
1-2 Jun 1993	U.S. Fish and Wildlife Service	Scott Johnson	Wildlife Biologist
		Kathleen Viernes	Wildlife Biologist
	Hawaii Dept of Land and Natural Resources	Ronald Walker	Wildlife Program Manager

		Thomas Telfer	Wildlife Biologist
		Thomas Kaiakapu	Wildlife Biologist
	KITV	Gary Sprinkle	Reporter
		Sonny Ahuna	Cameraman
	U.S. Navy	Tim Sutterfield	Fish and Wildlife Biologist
		Mike Nahoopii	Kahoolawe Project Officer
		Ken	EOD Specialist
16-17 Nov 1998	U.S. Fish and Wildlife Service	Ronald Walker	Wildlife Biologist
	Hawaii Dept of Land and Natural Resources	Thomas Telfer	Branch Wildlife Manager
		David Smith	Branch Wildlife Manager
		Alan Silva	Wildlife Management Asst
	U.S. Navy	Sean Cole	EOD Specialist
18, 21 Jan 2009	Hawaii Aviation	Unknown	Pilot
	(civilian contractor for U.S. Navy)	Unknown	Photographer
20-24 Jul 2009	U.S. Fish and Wildlife Service	Megan Laut	Fish and Wildlife Biologist
(Ship-based survey)		Jiny Kim	Wildlife Biologist Student Trainee
	Hawaii Dept of Land and Natural Resources and University of Hawaii	Jessica Hallman	Kauai Endangered Seabird Recovery Project Avian Technician
	U.S. Navy	Vanessa Pepi	Supervisory Fish & Wildlife Biologist
		Anurag Kumar	Marine Resources Specialist

*1932-1979 information from DON (1980).

Table 2. Results of botanical surveys conducted on Kaula Island, Hawaii, 1932-1998.*

Family	Common Name	Species Name	Origin	Caum 1932	DON 1976	Telfer 1998
Gramineae	'Ume'alu	*Cenchrus echinatus*	Introduced		x	x
	Swollen finger grass	*Chloris inflata*	Introduced		x	x
	Kukaipua'a	*Digitaria setigera*	Introduced		x	x
	Jungle rice	*Echinochola colonum*	Introduced		x	x
	Kakonakona	*Panicum torridum*	Endemic		x	x
	Bristly foxtail	*Setaria verticillata*	Introduced		x	x
		Panicum lanaiense (rcrded by Caum (1939) easy to mistake for *P. torridum*)	Introduced	x		
Chenopodiaceae	Australian salt bust	*Atriplex semibaccata*	Introduced		x	x
	Alaweo	*Chenopodium oahuense* (formerly *Chenopodium sandwicheum*)	Endemic	x	x	x
Amaranthaceae	Slender amaranth	*Amaranthis viridis*	Introduced	x	x	x
Nyctaginaceae	Alena	*Boerhavia diffusa*	Indigenous	x	x	
Portulacaceae	'Ihi	*Portulaca lutea*	Indigenous	x	x	
	Purslane	*Portulaca oleracea*	Introduced	x	x	x
	'Ihi	*Portulaca villosa* (formerly *Portulaca caumii*)	Endemic	x	x	x
Capparaceae	Maiapilo	*Capparis sanwichiana*	Endemic	x	x	x
Leguminosae	Koa haole	*Leuceana leucocephala*	Introduced		x	x
Zygophyllaceae	Nohu	*Tribulus cistoides*	Indigenous	x	x	x
Euphorbiaceae	'Akoko	*Chamaesyce celastroides* (formerly *Euphorbia celastroides*)	Endemic	x	x	x
Malvaceae	'Ilima	*Sida fallax*	Indigenous	x	x	x
	Milo	*Thespesia populnea*	Polynesian Intro			x
Cactaceae	Pa nini	*Opuntia megacantha*	Introduced	x	x	
Plumbaginaceae	'Ilieo	*Plumbago zeylanica*	Indigenous		x	x
Convulvulaceae	Sweet koali 'ai	*Ipomoea carica*	Indigenous		x	x
	Koali 'awania	*Ipomoea congesta*	Indigenous		x	x
	Koali 'awa	*Ipomoea indica*	Indigenous	x		
Boraginaceae	Nena	*Heliotropium curassavicum*	Indigenous	x	x	x
Solanaceae	'Ohelo kai	*Lycium sandwicense*	Indigenous		x	x
	Popolo	*Solanum nigrum*	Indigenous	x	x	x
Asteraceae	Horseweed	*Erigeron canadensis*	Introduced		x	x
	Pualele	*Sonchus oleraceus*	Introduced		x	x
Total number of species				15	27	25

* From Caum (1936), DON (1976a), and Telfer (1998). None of the species observed are listed under the U.S. Endangered Species Act.

Table 3. Results of avian surveys conducted on Kaula Island, Hawaii, 1932-1998.*

Common Name	Scientific Name	Aug 1932	Aug 1971	Jan 1976	Sep 1976	Mar 1978	Aug 1978	Mar 1979	Jun 1980	Apr 1984	Jun 1993	Nov 1998
Black-footed albatross	*Phoebastria nigripes*	1 old egg	-	100	-	75	-	75	-	2	4	10
Laysan Albatross	*Phoebastria immutabilis*	-	1 old egg	150	-	100	-	100	9	33	44	60
Wedge-tailed shearwater	*Puffinus pacificus*	many burrows	4,100	-	4,000	-	800	-	1,415	980	400	200
Christmas shearwater	*Puffinus nativitatis*	-	450	-	250	-	100	25	20	60	18	-
Bonin petrel	*Pterodroma hypoleuca*	1 chick	-	-	-	-	-	-	-	-	-	-
Bulwer's petrel	*Bulweria bulwerii*	several	100	-	100	-	50	-	100	580	100	-
Red-tailed tropicbird	*Phaethon rubricauda*	common	950	-	450	60	100	40	276	209	146	15
White-tailed tropicbird	*Phaethon lepturus*	-	3	1	1	-	1	2	-	-	-	1
Masked booby	*Sula dactylatra*	common	1,000	300	1,200	125	200	400	236	202	567	350
Brown booby	*Sula leucogaster*	common	1,700	50	1,000	75	60	200	212	169	397	60
Red-footed booby	*Sula sula*	uncommon	1,300	100	150	85	200	400	344	222	1,375	1,200
Great frigatebird	*Fregata minor*	common	950	250	800	400	250	250	134	155	701	650
Pacific golden plover	*Pluvialis fulva*	several	-	10	14	-	1	2	-	21	-	15
Ruddy turnstone	*Arenaria interpres*	-	50	5	20	-	4	24	1	7	1	12
Wandering tattler	*Heteroscelus incanus*	-	-	5	1	-	1	1	-	-	-	-
Gray-backed tern	*Sterna lunata*	uncommon	2,800	-	250	1,250	50	300	4,110	1,467	35	-
Sooty tern	*Sterna fuscata*	common	16,800	2,500	1,000	130,000	2,500	50,000	28,850	83,680	27,255	200
Blue-gray noddy	*Procelsterna cerulea*	small colony	-	-	200	-	-	-	-	-	-	1
Brown noddy	*Anous stolidus*	most numerous	67,700	-	7,000	7,000	10,000	1,000	10,560	3,950	5,778	-
Black noddy	*Anous minutus*	-	100	20	100	75	200	-	-	207	6	-
White tern	*Gygis alba*	uncommon	10	10	200	40	10	-	9	12	9	-
Barn owl	*Tyto alba*	-	1	3	3	-	1	6	4	2	7	3
Japanese white eye	*Zosterops japonicus*	-	-	2	3	-	-	-	-	-	3	-
House finch	*Carpodacus mexicanus*	-	6	15	40	-	20	6	-	1	1	8
Northern cardinal	*Cardinalus cardinalus*	-	2	-	7	-	-	-	-	-	-	-
Mockingbird	*Mimus polyglottos*	-	-	-	2	-	-	-	-	-	-	-
Nutmeg mannikin	*Lonchura punctulata*	-	-	-	20	-	-	-	-	-	-	-
Total estimated number of birds			98,022	3,521	16,811	139,285	14,548	52,831	46,280	91,959	36,847	2,785
Total number of species		16	19	16	24	12	19	17	15	19	19	15

* See Table 1 for detailed survey dates, agencies, and personnel. None of the species observed are listed under the U.S. Endangered Species Act.

SHIP-BASED SEABIRD AND MARINE MAMMAL SURVEY 21-22 JULY 2009

Avian surveys on Kaula Island from 1932 through 1998 were conducted on land, with biologists transported to Kaula via ship and small boat or helicopter and remaining on island for up to three days (Caum 1936, Elmer and Swedberg 1971, DON 1976a, DON 1976b, Walker 1979, DON 1980, Walker 1983, Walker 1984, Walker 1993, Telfer 1998). Following the establishment of Kaula as a munitions target, all parties visiting Kaula were accompanied by a U.S. Navy Explosive Ordnance Disposal escort (Table 1). Due to increasing concerns by the Navy regarding the potential for injury to personnel visiting Kaula by unexploded ordnance, bird aircraft strikes, and steep, unstable terrain, access to the island for land-based surveys has not been granted since 1998. In January 2009, the Navy contracted a private company to obtain aerial imagery of Kaula Island via small airplane in order to conduct seabird surveys using high-resolution digital images. The resolution of the imagery obtained during those flights, however, was not high enough to accurately assess seabird species abundance or presence on the island.

Methods

In order to conduct additional seabird surveys on Kaula Island in the absence of direct access to land, on 21-22 July 2009 avian surveys were conducted via vessel platform, with surveys for marine mammals conducted concurrently. Five biologists, including four seabird observers and one marine mammal observer, carried out the surveys:

Personnel:	Position:	Agency:
Megan Laut	Fish and Wildlife Biologist	U.S. Fish and Wildlife Service
Jiny Kim	Wildlife Biol. Student Trainee	U.S. Fish and Wildlife Service
Jessica Hallman	Avian Technician, Kauai Endangered Seabird Recov Project	Hawaii Dept. Land and Natural Resources, and University of Hawaii
Vanessa Pepi	Supervisory Fish & Wildlife Biol.	U.S. Navy – NAVFAC Pacific
Anurag Kumar	Marine Resources Specialist	U.S. Navy – NAVFAC Atlantic

The platform used for the Kaula Island ship-based survey was the Research Vessel *White Holly*, based in Sausalito, California. The R/V *White Holly* is 133 ft (40.5 m) in length and is capable of sleeping a scientific crew of 12. It has an observation deck above the bridge, placing observers approximately 24 ft (7 m) above the surface of the water (Figures 3 and 4).

The R/V *White Holly* departed Kewalo Basin on Oahu on 20 July at 16:20, arriving at Kaula Island at 09:20 on 21 July. Because Kaula is crescent-shaped, with steep slopes and very little level terrain, dividing the island into survey sections of equal size viewable via ship was not possible; instead, the island was divided for avian survey purposes into north, northwest, southwest, and east quadrants, with section boundaries defined by the island's terrain (Figure 5). From the shipboard vantage point, the top of the island was difficult to survey.

On the morning of 21 July, a pilot study was performed to test potential seabird survey methods. Because the R/V *White Holly* was able to approach Kaula to within approximately 650 ft (200 m), the method settled upon was the identification and counting of all individual birds within a survey quadrant using handheld 7x50 binoculars. During the surveys of 21 and 22 July, the ship

circumnavigated the island at approximately 2 to 4 knots and maintained a constant distance of 748 ft (228 m) from the coastline. Observations were conducted from the platform above the bridge (approximately 24 ft (7 m) above the water surface). Each biologist participated in all surveys, with four serving as observers and the fifth recording data.

Surveys were carried out by first counting birds on the ground, and then conducting “mop-up” counts of birds in the air. For seabirds present in small numbers, each observer was assigned one or more species to count. For species present in large numbers (e.g. sooty terns), two observers counted simultaneously, and the mean and standard deviation of the counts were calculated. From the distance of the observation deck on the R/V *White Holly*, it was often not possible to distinguish between the two white-colored booby species (masked boobies (*Sula dactylatra*) and red-footed boobies (*Sula sula*)); for this reason, these two species were combined during counts, and an estimate of the number of individuals of these species combined is presented. Because wedge-tailed shearwaters are primarily nocturnally active at the breeding colony, this species was counted specifically during sunset/crepuscular surveys.

Observers also opportunistically photographed examples of seabird species present on the island, examples of nesting locations, the condition of the terrain, and examples of ordnance observed. All marine mammal sightings during the survey periods were also recorded. Surveys were conducted during daylight hours until dusk on 21 July, and from dawn to dusk on 22 July, with periodic breaks taken to avoid observer fatigue. Sunrise and sunset times during the third week in July were approximately 06:00 to 19:15. Sea state conditions were between Beaufort 1 and 3 on the leeward side of Kaula Island and between 3 and 6 on the windward side during the survey period.

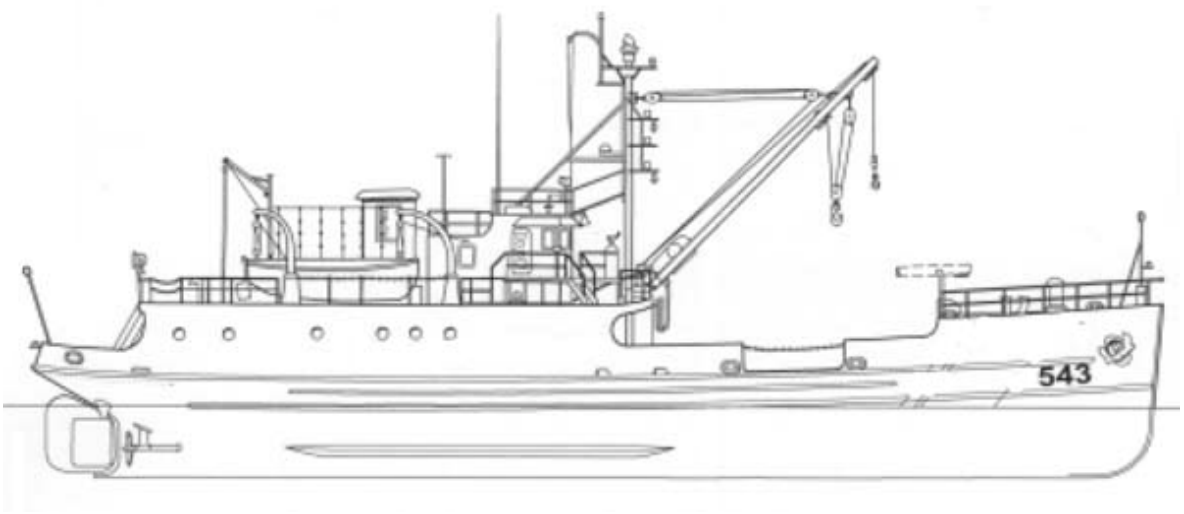

Figure 3. Profile of the R/V *White Holly*, the vessel used to conduct the July 2009 ship-based seabird and marine mammal surveys at Kaula Island.

Figure 4. View of Kaula Island from the observation deck of the R/V *White Holly*.

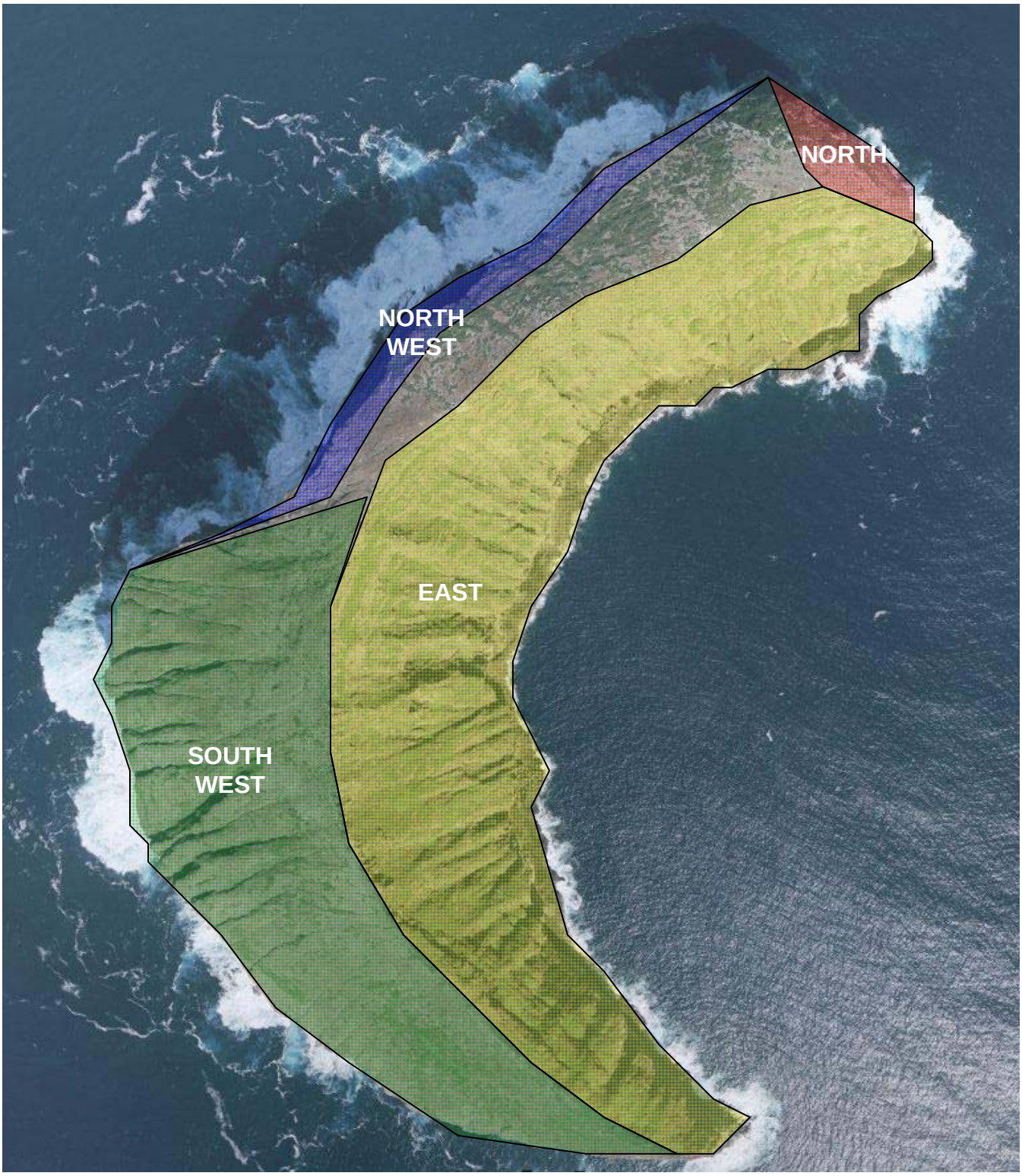

Figure 5.Survey quadrants defined on Kaula Island for the 21-22 July 2009 seabird surveys.

Results

Seabirds

A total of 11 avian species were observed at Kaula Island from the observation deck of the R/V *White Holly* during the 21-22 July 2009 surveys (Table 4). Species included two Procellariiformes (wedge-tailed shearwater (*Puffinus pacificus*) and Bulwer's petrel (*Bulweria bulwerii*), five Pelecaniformes species (red-tailed tropicbird (*Phaethon rubricauda*), masked booby, brown booby (*Sula leucogaster*), red-footed booby, and great frigatebird (*Fregata minor*)) and four tern species (gray-backed tern, sooty tern, brown noddy (*Anous stolidus*), and white tern) (Figures 6-9). All species observed in 2009 had been recorded during the 1932 -1998 surveys (no new seabird species were observed in 2009). Sooty terns were present in the greatest numbers, followed by masked and red-footed boobies, brown noddies, and great frigatebirds. (Table 1 and Figure 10). Sooty terns were observed primarily on the southwestern slope of the island (Figure 11), masked and red-footed boobies in the stream-carved ravines (Figure 12), and brown noddies on the cliffs. Great frigatebirds were seen nesting on the northern slope of the island (Figure 13). Seabirds were not nesting on the southeastern tip (1000 ft) of the island used by the Navy as a munitions training target (Figure 14).

Because complete counts of individual birds across the entire island were not possible from the observation deck of the ship (all individual birds across the top of the island may not have been visible), and some species present may not have been seen from the ship (including Christmas shearwaters and other nocturnal Procellariiformes, migratory shorebirds, and visiting landbirds), a complete species list and estimates of the numbers of individuals of each species observed are not directly comparable to results of past surveys. However, relative numbers of individuals of the species seen in 2009 can be compared to survey results from past years. Figure 15, below, indicates the relative abundance of species observed during the June surveys of 1980 and 1993, the survey periods most comparable to the July 2009 surveys in terms of species' breeding phenology. During all three survey years, sooty terns were by far the most abundant species. Brown noddies were observed in greater numbers in 1980 and 1993 than in 2009, and masked and red-footed boobies in smaller numbers in 1980 and 1993 than in 2009; however, this difference is likely a function of the low visibility of brown noddies and high visibility of booby species from the observation deck of the ship, rather than an indication of any actual changes in population sizes over time.

In terms of absolute species abundance during the 2009 surveys, 6,169 sooty terns were estimated to be present on Kaula Island (Table 4). This number is lower than the numbers detected in June 1980 and 1993 (28,850 and 27,255, respectively); however, sooty terns complete their annual breeding cycle in late summer, with fledged juveniles and adults leaving the island during this period, as seen in the sooty tern survey results of August 1978 and September 1976, in which 2,500 and 1,000 sooty terns, respectively, were counted on Kaula (Table 3). Similar patterns can be seen for red-tailed tropicbirds and the three *Sula* species when comparing July 2009 survey results to June, August, and September survey results of previous years (Tables 3 and 4). The numbers of brown noddies observed in 2009 were low relative to similar months in previous years; however, as mentioned above, this may be due to the relatively low visibility of this species from a ship-based platform rather than to changes in population

sizes. Similarly, the low numbers of wedge-tailed shearwaters observed in 2009 may be due to the fact that this burrow-nesting species is active nocturnally at the breeding colonies, such that daytime observations from a ship platform are likely not comparable to surveys conducted on land. Additional ship-based surveys at Kaula Island in future years would aid in determining whether seabird population sizes are changing or remaining stable.

Table 4. Seabird species observed, and the means, standard deviations, and ranges of numbers of individuals counted at Kaula Island during 21-22 July 2009 ship-based surveys.

Common name	Scientific name	Mean # observed	Standard deviation	Minimum	Maximum
Wedge-tailed shearwater	*Puffinus pacificus*	16	8	7	21
Bulwer's petrel	*Bulweria bulwerii*	1	0	1	1
Red-tailed tropicbird	*Phaethon rubricauda*	31	32	8	53
Masked booby/red-footed booby	*Sula dactylatra, S. sula*	820	286	494	1,026
Brown booby	*Sula leucogaster*	112	132	19	205
Great frigatebird	*Fregata minor*	131	45	71	170
Gray-backed tern	*Sterna lunata*	1	0	1	1
Sooty tern	*Sterna fuscata*	6,169	1,043	5,435	7,363
Brown noddy	*Anous stolidus*	711	656	270	1,465
White tern	*Gygis alba*	10	2	8	11
Totals		**8,001**	**--**	**6,313**	**10,315**

Figure 6. Juvenile brown booby (*Sula leucogaster*) off of Kaula Island, 22 July 2009.

Figure 7. Juvenile red-footed booby *(Sula sula*) off of Kaula Island, 21 July 2009.

Figure 8. Juvenile great frigatebird (*Fregata minor*) off of Kaula Island, 21 July 2009.

Figure 9. Adult sooty tern (*Sterna fuscata*) off of Kaula Island, 21 July 2009.

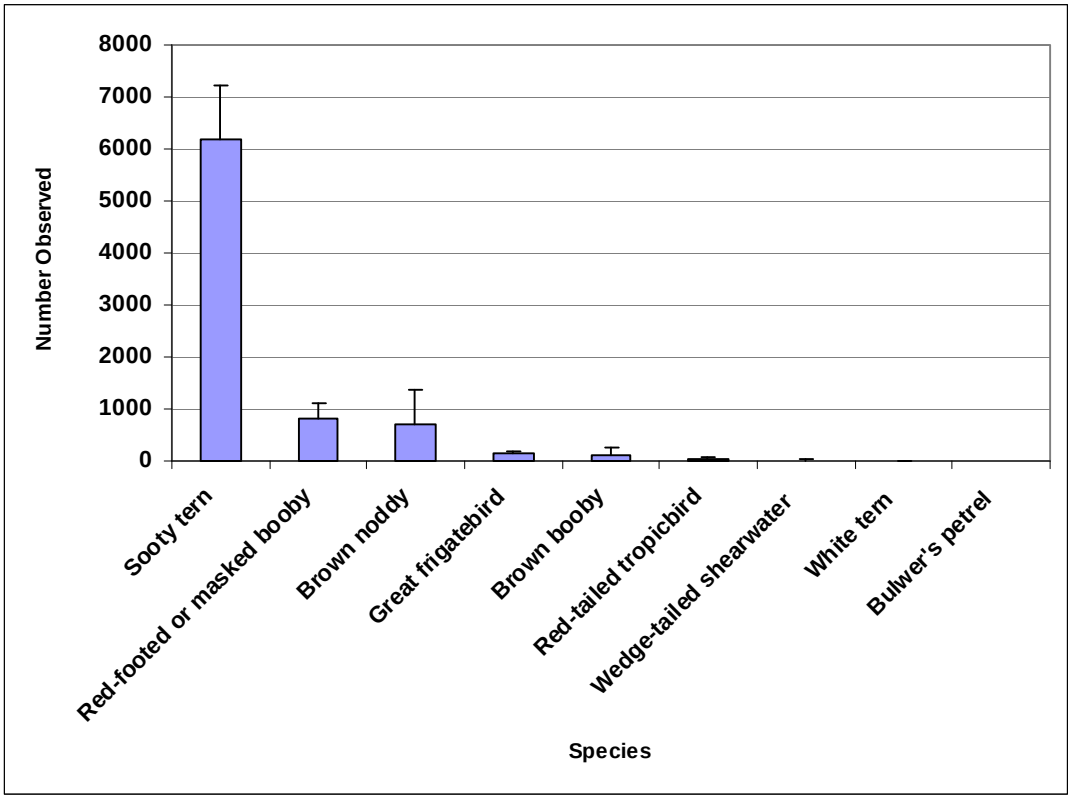

Figure 10. Numbers of individuals of seabird species observed during the 21-22 July 2009 Kaula Island ship-based surveys.

Figure 11. Sooty terns (*Sterna fuscata*) on southwestern slope of Kaula Island, 22 July 2009.

Figure 12. Masked and red-footed boobies (*Sula dactylatra* and *S. sula*) in ravines of Kaula Island, 21 July 2009.

Figure 13. Great frigatebird (*Fregata minor*) adults and juveniles on northern slope of Kaula Island, 22 July 2009.

Figure 14. Munitions training target area at southeastern end of Kaula Island, 22 July 2009. No birds were observed nesting in this area.

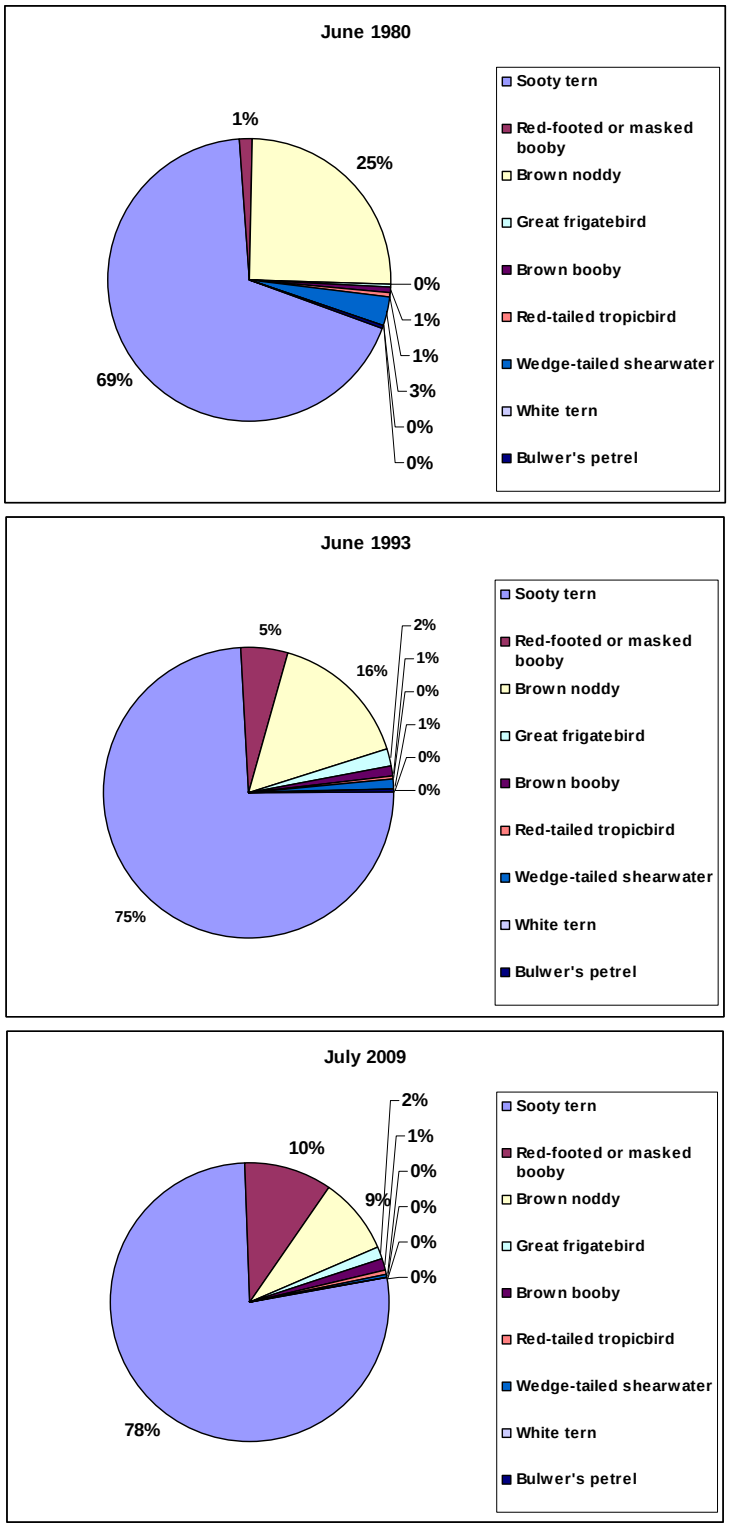

Figure 15. Relative species abundance of seabirds observed during the June 1980, June 1993, and July 2009 Kaula Island surveys. The 1980 and 1993 surveys were conducted on land, while the 2009 survey was conducted from a ship platform.

Marine Mammals

During the course of the 21-22 July 2009 survey effort, four species of marine mammals were observed near Kaula Island, including three species of odontocetes and one species of pinniped (Table 5). Bottlenose dolphins (*Tursiops truncatus*) and spinner dolphins (*Stenella longirostris*) were all sighted off of the northwest coast of the island within 820 ft (250 m) of the coastline. The spotted dolphins (*Stenella attenuata*) were sighted during transit to the survey area off of the southeast coast of Kaula within 4.9 miles (8 km) of the coastline. Hawaiian monk seals were observed hauled out on two separate ledges on the leeward (western) side of the island (Figures 16 and 17). Figure 18 indicates sea surface temperatures and chlorophyll *a* concentrations near Kaula Island in July 2009.

Table 5. Marine mammals observed during Kaula Island surveys of 21-22 July 2009.

Common name	Scientific name	Number Observed
Spotted dolphins	*Stenella attenuata*	6
Bottlenose dolphin	*Tursiops truncatus*	12
Spinner dolphins	*Stenella longirostris*	15-20
Hawaiian monk seal	*Monachus schauinslandi*	6

Figure 16. Hawaiian monk seals observed on one of two ledges on the western side of Kaula Island, 22 July 2009.

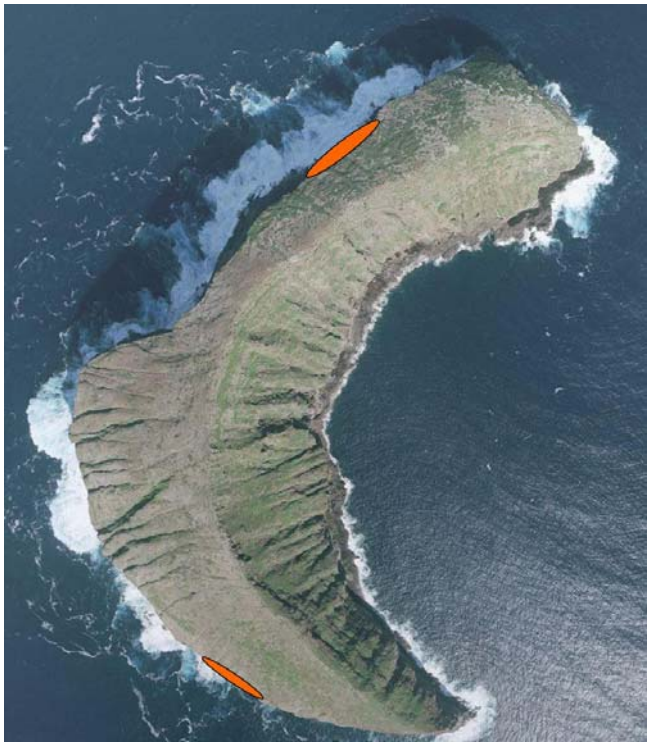

Figure 17. Locations of ledges (indicated in orange) on which Hawaiian monk seals were observed hauled out on Kaula Island, 21-22 July 2009.

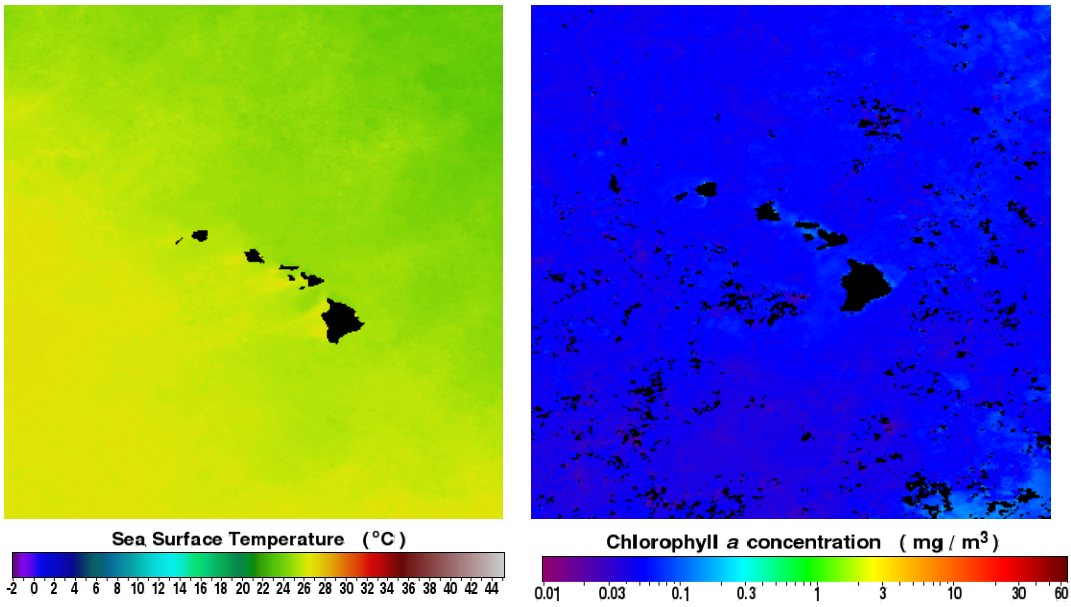

Figure 18. Sea surface temperature and chlorophyll *a* concentration (an index of primary productivity) during the month of July 2009 (figures accessed 27 July 2009 at http://oceancolor.gsfc.nasa.gov/).

RECOMMENDATIONS FOR FUTURE MONITORING

Because breeding cycle phenologies of the seabird species that occur on Kaula Island lead to changes in the numbers of individual birds on the island throughout the year, it is recommended that the specific month in which surveys are conducted at Kaula remain as consistent as possible between years (i.e. that ship-based surveys in future years are conducted during the month of July). Too, because breeding phenology varies between species, a second ship-based survey conducted during the winter months each year (e.g. November, December, or January) would be useful in quantifying the abundance of additional seabird species, such as black-footed and Laysan albatrosses, on Kaula Island. A total of five years of July surveys, and two years of winter surveys within that five-year time period, would allow for assessment of population status and an initial indication of changes in population sizes over time.

Although land-based surveys of the seabirds breeding on Kaula would provide more accurate species lists and population estimates, and would allow for more accurate assessments of the population trends of species over time, ship-based surveys are a more useful alternative than is a complete lack of avian surveys at Kaula Island. Access to a vessel such as the R/V *White Holly*, permission to approach the island to within 750 ft (228 m) of the coastline, participation in surveys by biologists from multiple agencies, and a consistent protocol for surveys between years will all contribute to a viable seabird monitoring program at Kaula Island in future years.

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APPENDIX C
SURVEY OF MARINE AND FISHERIES RESOURCES

C1 - SURVEY OF MARINE AND FISHERY RESOURCES

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SURVEY OF MARINE AND FISHERY RESOURCES

FOR

AN INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP) FOR THE PACIFIC MISSILE RANGE FACILITY (PMRF) BARKING SANDS (BS), KAUAI, HAWAII

PHASE II-2006

MARINE and FISHERY RESOURCES

FINAL REPORT

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Pacific Missile Range Facility

October 2006

Revised
June 2007

1.0 INTRODUCTION

The U.S. Navy's Pacific Missile Range Facility (PMRF) at Barking Sands (BS) Kauai, is the world's largest instrumented, multi-environmental military test range capable of collecting data on the performance of a variety of weapons systems that operate underwater, on the water's surface, in the atmosphere and in space. Some land-based activities also occur. PMRF provides fully instrumented test ranges as well as unique infrastructure and facilities to support and cooperate with other governmental agencies including the Department of Energy (DoE), National Aeronautics and Space Administration (NASA), Defense Special Weapons Agency, and the Missile Defense Agency.

An Integrated Natural Resources Management Plan (INRMP) is required under the federal Sikes Act Improvement Amendments (SAIA) of 1997 (P.L. 105-85). This Congressional legislation requires military installations to prepare and implement a plan for the management, conservation and rehabilitation of their natural resources, while still supporting the installation's military mission. The study area for the INRMP consists of areas owned and controlled by PMRF as well as the marine region directly offshore of the facility out to the 20 meter (m) (60 foot) depth contour (the 60-foot depth was chosen as an outer boundary as most reef structure in Hawaii occurs within this depth range.) These include all the waters shown in Figures 1-3.

In 2000, the Commander of the Pacific Missile Range Facility (PMRF) requested the preparation of an Integrated Natural Resources Management Plan (INRMP) intended to address the ten elements listed in the Sikes Act Improvement Amendments (SAIA) as follows:

1. Fish and wildlife management, land management, forest management, and fish and wildlife-oriented recreation;
2. Fish and wildlife habitat enhancement or modification;
3. Wetland protection, enhancement and restoration, where necessary for support of fish, wildlife, or plants;
4. Integration of, and consistency among, the various activities conducted under the plan;
5. Establishment of specific, natural resource management goals and objectives and time frames for proposed action;
6. Sustainable use by the public of natural resources to the extent that the use is not inconsistent with the needs of fish and wildlife resources;
7. Public access to the military installation that is necessary or appropriate for the sustainable use of natural resources, subject to requirements necessary to ensure safety and military security;
8. Enforcement of applicable natural resource laws (including regulations);
9. No net loss in the capability of the installation's lands to support the military mission of the installation; and
10. Such other activities as the Navy has determined are appropriate.

The SAIA also requires the INRMP to comply with the requirements of the National Environmental Policy Act (NEPA). Accordingly, appropriate NEPA documentation was prepared for the INRMP, and pertinent agency consultations were completed. The resulting INRMP, published in 2001, is presently undergoing an update in areas where substantive change has/may have occurred. In particular, as a result of tightened security (e.g., restricted access to the shoreline) following the events of 09/11/2001, a *de facto* marine reserve was created along parts of the PMRF/BS waterfront. In order to more accurately address any changes to marine resources that might have occurred in response to the changes in shoreline access, the marine surveys conducted in 2000 for the 2001 INRMP were repeated as closely as possible in 2006 by the same team of marine biologists. Such replication by the same investigators should provide the best possible data to determine the changes in marine resources community structure that may have occurred as a result of restricted access across the base to the shoreline since 9/11/01. The present report contains all of the information contained in the initial report prepared in 2000, as well as new data and observations obtained in 2006.

2.0 OBJECTIVES

The overall objective of an INRMP is to establish a sound rationale for establishment of specific natural resource management goals and objectives, time frames, and budgets for proposed actions. The plans are to be updated every five years. Specific objectives of an INRMP are to maintain, develop and implement an ecosystem-based conservation program that:

- Provides a baseline source of natural resource ***information***;
- Provides the basis for formulating the Naval Base's natural resources ***budget***;
- Provides for ***conservation and rehabilitation*** of natural resources in a manner that is consistent with the military mission;
- ***Integrates and coordinates*** all PMRF natural resources management activities;
- Provides for sustainable ***multi-purpose uses*** of natural resources;
- Provides for ***public access*** for use of natural resources, ***subject to safety and military security*** considerations.

The present document addresses these topics with respect to the marine resources offshore of PMRF based on field observations of the same areas in both 2000 and 2006 The area of investigation is defined as the shorelines and nearshore environments *per se*, and do not consider the setting of the various streams or ditches that flow from the watershed into the ocean, which are outside of the Navy's control. The bulk of the work consists of item number one in providing a baseline source of information of the natural resource setting of the marine habitats.

We have divided the contents of the report into three sections. The first section is a presentation of a physical and biotic zonation pattern which differentiates the major habitat types found off the PMRF coastline. The overview includes descriptions of the biota and fishery components of the area. The second section provides as overview of the threatened and endangered species. The third section which serves as a summary based on the information in the previous sections provides recommendations for activities that will fulfill the objectives of the INRMP.

3.0 METHODS

The field surveys at PMRF were conducted on April 22-25, 2000 and August 17-18, 2006. All fieldwork for both surveys was carried out by divers using SCUBA equipment, working out of a 26-foot boat. The survey was conducted as a rapid ecological assessment (REA). Several techniques were employed for the surveys designed to maximize results within a minimum time. The first method, used only during the April 2000 survey, consisted of towing investigators along the side of the boat in water depths shallow enough to clearly observe the bottom. Such tows allowed for relatively rapid coverage of the entire length of the study area, and were valuable in providing information of overall habitat types and community assemblages, and relative differences between habitats and communities.

The second method of investigation consisted of SCUBA dives at several areas that investigators agreed were the regions of primary concern (from information obtained during the tow surveys). The dive sites were selected based on the greatest relative abundance of biotic assemblages and greatest vertical relief (biotic composition is generally a function of vertical relief). Such criteria for the selection of sites were judged to be the most important as the areas with the greatest biotic composition would likely have the highest potential for impacts from shoreline activities. Because this was an REA for comparative purposes, intensive quantitative surveying techniques employing transects, quadrats, etc. were not employed. Rather, investigators during point-to-point underwater swims at each dive site evaluated abundance and other characteristics of marine communities. Investigations were limited to a maximum depth range of 20 meters (m). To the best extent possible, the same areas were surveyed in this manner in 2000 and 2006.

4.0. PHYSICAL and BIOTIC ZONATION OF PMRF

The coastal area covered in this study extends offshore from the landside boundaries of PMRF, which are defined by the southern edge of Polihale State Park south to Kokole Point (Figures 1-3). Continuous white sand beaches comprise most of the shoreline along the length of the study area; landward of the beaches and Nohili dune area lies the Mana Coastal Plain, which is a low, flat area. The Range occupies a narrow band along the coastline; the remainder of the Mana Plain includes a shrimp farm and a variety of agricultural activities. Owing to the low elevation of the plain, groundwater and irrigation water must be continually pumped from areas of the plain previously planted in sugarcane and now in mixed agricultural use. Discharges of water pumped from active agricultural and

fallow sugarcane fields are located off of the Kawaiele Pumping Station, and near Nohili Point (Figure 1). Water pumped into the drainage discharges (e.g., ditches) has a salinity of approximately 10‰ (Nance, personal communication) indicating that is approximately 1/3 seawater and 2/3 freshwater from groundwater and irrigant leachate. Discharge water consistently has been noted to contain high loadings of terrigenous particulates (red mud) that has historically washed from the cultivated fields.

The quantity and quality (with respect to terrigenous loads) of ditch water input appears to be a function of local rainfall and runoff. Aerial photographs of the Nohili area reveal that discharge of turbid water from the ditch can vary greatly in volume and composition. During periods of low discharge, the plume is nearly undetectable, while at other times the plume, distinctly visible as opaque turbid water, extends for hundreds of meters up the coast. As a result, the marine habitats in the vicinity of the two discharges are routinely exposed to substantial suspended terrigenous sediment loads. Sampling of discharge water from Nohili Ditch as part of the Zone of Mixing monitoring requirements for aquaculture discharges that were collected concurrently with the 2001 INRMP study revealed turbidity values of 30-50 nephelometric turbidity units (ntu). However, approximately 20 m seaward, wave energy caused substantial mixing of plume water and ocean water, resulting in turbidity of 1-2 ntu. Visible particulate material was also contained primarily in a surface layer of low salinity water, resulting in little or no settlement of terrigenous sediment on the reef surface. No changes have been noted to discharge from Nohili Ditch since 2000.

Owing to both the shape of the Island of Kauai, and the lack of any barrier reef structure, the shoreline region is nearly continually scoured by the force of breaking waves. The essentially circular shape of Kauai results in exposure from swells emanating from both the north and the south Pacific; hence the nearly continual wave action. The entire region offshore of PMRF is directly exposed to long-period swells generated by storms in both the north (winter) and south (summer) Pacific. In addition, the south and western coastal areas of Kauai were impacted by extremely large surf during Hurricanes Iwa (1982) and Iniki (1992). As a result of these physical processes, the nearshore areas at the monitoring sites are subjected to extreme stress from wave impact and scouring of sediment from wave action. As in many locations in the Hawaiian Islands, the composition of coral reef communities is structured primarily in response to physical forces of breaking waves (Dollar 1982, Dollar and Tribble 1993). Such is definitely the case off the PMRF.

The general marine topography of the nearshore region off of PMRF consists of four distinct sectors that are separated by distinct physiographic and biotic structure. The first three of these sectors are differentiated by distinctly different structure of the nearshore area, extending from the shoreline to a depth of approximately 15 m. The fourth sector is considered the offshore sector, and extends along most of the entire length of PRMF within the depth range of 15 to 20 m. For ease of identification, we have labeled these sectors; 1) Nohili sector, which extends from the northern end of the property to approximately the location of Nohili Ditch (Figure 1); 2) Mana Point Sector, which extends from southward to the southern part of Mana Point (Figure 2), and 3) Majors Bay Sector, which extends to the southern boundary of PMRF at Kokole Point (Figure 3). The surveys of fish, macroalgae and

macroinvertebrates (other than corals) are summarized in Table 1 (fish) and Table 2 (macroinvertebrates and algae).

4.1 Nohili Sector

Off of the Nohili area, from the northern end of the PRMF property to approximately Nohili ditch (approximately the northern quarter of the study area), the shoreline consists predominantly of a limestone bench which is emergent at low tide. The limestone bench fronts extensive sand dunes that comprise the shoreline beach (Clark 1990) (Figure 1). Moving seaward from the reef bench, a second zone occurs at a depth of 2-5 m which is the primary region that absorbs the impact of breaking waves. As a result of the near constant wave impact, the bottom in this area is characterized by a relatively smooth limestone bottom devoid of most vertical relief, as well as biotic assemblages. At a depth of approximately 5 m, the flat bottom grades into a zone characterized by numerous deep, rubble-filled channels separating massive limestone fingers. These fingers are the remnants of fossil reef platforms which appear to be highly eroded into a karst-like topography. Such erosion results in numerous outcrops, ledges and caves (Figures 4 and 5). Vertical relief of the reef structures up to 3 m in height, resulting in a substantially more complex substratum than at the other zones.

Part of the substratum appears to be a fossilized reef of finger coral (*Porites compressa*) that remains as broken blocks scattered around one area of the bottom (Figure 5). The occurrence of the fossil reef of *P. compressa* is curious in that there are essentially no living colonies of this species presently on the reef. The presence of the large fossilized blocks suggests that the physical oceanographic conditions must have been quite different at some point in earlier geological history than at present. Owing to it's relatively fragile skeletal structure, *Porites compressa* usually requires relatively calm waters to sustain growth beyond the initial settlement stage. Calm water conditions for long period of time (ca. 50-100 years) that would be required for the accumulation of skeletal structure observed on the fossil reef does not appear to the case today along this west facing shoreline of Kauai.

Because the vertical relief afforded by the eroded reef structures provides abundant solid surfaces above the bottom (and shifting sediment), settlement of benthos, particularly reef corals is substantially higher than anywhere else in the study area (Figure 6). Quantitative transect data from three stations within the Nohili sector conducted as part of the Kekaha Sugar Mill ZOM monitoring revealed that total coral cover ranged between 32% and 39% of bottom cover (Marine Research Consultants 1997). The most abundant species were *Porites lobata*, *Pocillopora meandrina* and *Montipora patula*. Other species encountered on transects included *Porites compressa, Montipora capitata*, and *Pavona varians*. During both the 2000 and 2006 surveys, several additional corals were noted in the Nohili sector, including *Porites evermanni, Pavona varians, P. duerdeni, Leptastrea purpurea, Montipora flabellata* and *M. verrilli*. Coverage by these corals was small as a percentage of total live coral, with *P. lobata* and *P. meandrina* comprising the majority of cover. There were no substantial differences in coral community structure in the Nohili sector between the 2000 and 2006 surveys.

It was also noted that there were numerous man-made materials on the reef surface in the Nohili sector. These materials ranged from fouled fishing nets (Figure 6) to a variety of metal objects that appeared to be remnants of ordnance or test materials related to operations, possibly emanating from PMRF (Figure 7).

The topographical complexity created by the eroded reef channels provides considerable shelter for many fish and motile invertebrate species. In the 2000 survey 78 species of fishes were recorded over a 30-minute period of observation in the Nohili sector (Table 1). Estimates of fish standing crop ranged from 80 to 150 g/m^2 with an overall mean estimated biomass of 110 g/m^2. In the 2006 survey of the Nohili sector, a similar 30-minute survey yielded 72 species of fish and the estimated standing crop ranged from 50 to 350 g/m^2, with overall mean standing crop estimated at 175 g/m^2 (Table 1). Hence, while the total number of species observed in 2006 was slightly lower than in 2000, the standing crop of fish was substantially higher in the latter survey. As the Nohili sector contains the most abundant fish populations, in terms of both numbers of species and biomass, the documented increases in biomass suggest that the overall abundance of fish stocks has increased between 2000 and 2006.

Table 2 presents the results of the invertebrate and macroalgal surveys in 2000 and 2006 for the Nohili sector. In 2000, three major species of algae were observed, along with ten invertebrate species. In the 2006 survey, six major algal and ten macroinvertebrate species were seen. Hence, there appears to be no substantive change in these benthic communities between the two surveys.

Species of commercial and recreational interest encountered in the Nohili sector in both surveys include the menpachi (*Myripristes amaena*), nohus (*Scorpaenopsis dibolus* and *S. cacopsis*), several species of jacks or papio, the toau (*Lutjanus fulvus*), mu (*Monotaxis grandoculis*), five goatfish species (weke - *Mulloides flavolineatus*, weke'ula - *M. vanicolensis*, moano - *Parupeneus multifasciatus*, malu - *P. pleurostigma*, munu - *P. bifasciatus*), nenue (*Kyphosus bigibbus*), palukaluka - *S. rubroviolaceus*) and a number of surgeonfish species (palani, pualu, manini, ma'i'i'i, na'ena'e, kole, kala, etc). Commercially important species seen in 2006 but not encountered in 2000 in the Nohili sector include the aweoweo (*Heteropriacanthus cruentatus*), uku (*Aprion virescens*), uhu uli'uli (*Scarus perspicillatus*), and a solitary ~2 kg knifejaw (*Oplegnathus punctatus*), which is a species common to the Northwestern Hawaiian Islands, but rarely encountered in the high Hawaiian Islands.

Among the commercially important invertebrates seen in the Nohili sector on both surveys was the octopus or he'e (*Octopus cyanea*) and in 2000 only the slipper lobster or 'ula'papa (*Paribaccus antarcticus*). Observed only in 2006 were the black-lipped pearl oyster or pa (*Pinctada margaritifera*) and the spiny lobster or 'ula (*Panulirus marginatus*). The alga, limu kohu (*Asparagopsis taxiformis*) was present in both surveys; in the April 2000 survey, kohu was locally abundant in large patches of 0.5 to 8 square meters. In 2006, the alga was patchier in distribution, and occurred primarily as large clumps rather than in widespread meadows (Figure 7). Other invertebrates of note with respect to marine resources that

occurred in the Nohili sector were the Crown-of-thorns starfish (*Acanthaster planci*). Several starfish were observed actively feeding on coral in the area, and several recently bleached colonies were noted that likely resulted from starfish predation (Figure 8). It is important to note, however, that the abundance of *Acanthaster* off PMRF was not atypical of most reefs in Hawaii.

4.2 Mana Point Sector

Along the central portion of PMRF, the intertidal shoreline bench is less well-formed and the shoreline consists of a sandy slope that grades into a flat limestone subtidal bench similar to that described in the Nohili sector (Figure 2). However, unlike the Nohili region, where the offshore region beyond the flat bench is characterized by high relief in the form of eroded fossil reef structure, the reef in the central area consists of a series of elongated low limestone mounds that often take on the shape of sloping-sided knolls or hummocks that are separated by channels filled with white sand. The knolls are oriented perpendicular to the shoreline, and rise from the sandy bottom one to three meters (Figure 9). The tops of the knolls form reef platforms that are predominantly flat with little structural relief other than low depressions and channels that are filled with coarse white sand. Hence vertical relief is far less in this area than in the Nohili sector.

An exception to the structure described above occurred in the area directly off of Nohili Ditch at the juncture of the Nohili and Mana sectors. A small ravine in the reef platform is traversed by a series of cables that are either fixed to the bottom or suspended above the bottom (Figure 10). Many of these cables that are elevated off the bottom provide settling surfaces for corals. It is likely that the elevated cables provide a preferred settling location owing to the lessened effects of sand scouring resulting from wave action. Several piles of rock are also present on the reef surface that are likely the remnants of cable-laying operations. All of these man-made items appear to be resulting in enhancing the physical complexity of the marine habitats and do not appear to be resulting in any negative effects.

The predominant biotic assemblage on the reef platform in the Mana sector is a low algal turf composed of various species of benthic marine algae. The surface of the knolls are pitted by bioerosion, mostly as a result of the boring action of several species of sea urchins (predominantly *Echinometra matheai* and *Echinistrephus aciculatus*). As in the Nohili sector, *Asparagopsis taxiformis* (limu kohu) was the most abundant macroalgae, covering large areas of the tops of the reef knolls (Figure 7). In 2000, one dominant algae and two macroinvertebrate species were seen, while in 2006 four dominant macroalgal and six macroinvertebrate species were found in this zone (Table 2).

In the Mana sector, living coral corals are generally sparsely distributed, and occur predominantly as flat encrustations on the flat bottom. The continual wave action results in scouring of sand on the tops of the knolls appears to be a limiting factor for coral growth on the reef platforms. Solitary colonies of *Porites lobata* and *Pocillopora* spp. are the most abundant corals occurring on the knolls (Figure 9). Hence, coral cover in the Mana sector is substantially lower than in the Nohili area.

As with corals, fish were correspondingly less abundant on the flat limestone platforms of the Mana sector compared to the Nohili sector. Where small depressions and undercutting were encountered in the hard bottom, a number of fishes were seen. In 2000, 30 species of fishes were encountered in the Mana Point survey. These fishes had an estimated standing crop ranging from 40 to 70 g/m^2 and had an estimated mean biomass of 50 g/m^2. In the 2006 survey of this area, 55 species of fishes were recorded having an estimated standing crop ranging from 50 to 400 g/m^2 with a mean of 70 g/m^2 (Table 1).

Fish species of commercial and recreational interest seen in both (2000 and 2006) surveys include the menpachi, toau, moano, munu, pualu, maiko'iko, ma'i'i'i, na'ena'e, manini, umaumalei and kala. Additionally in the 2000 survey, weke and ulua aukea (*Caranx ignobilis*) were encountered but not seen in the most recent field effort. The 2000 survey noted he'e, 'ula (*Panulirus marginatus*), and limu kohu while in the 2006 survey 'ula (*Panulirus penicillatus*) and limu kohu were seen. Fishes seen only in the 2006 survey included aweoweo, moano kea and palukaluka. Thus, the data indicate that while the estimated sanding crops of fish are not particularly high in the Mana sector owing to the scarcity of appropriately scaled shelter, there are substantial increases in both number of fish species observed and biomass in 2006 relative to 2000.

4.3 Major's Bay Sector

The southernmost sector of the PMRF consists of a slight indentation in the coastline that is commonly called Major's Bay or Waiokapua Bay (Figure 3). The Bay terminates to the south at Kokole Point, and to the north by Mana Point. The nearshore region of Majors Bay differs substantially from the two northern sectors in that there is little solid reef structure within the nearshore area within the 20 m depth contours (Figure 3). Rather, nearly the entire bottom consists of shifting sands. Results of quantitative transects, conducted at selected areas within this region where at least some hard bottom was encountered revealed coral cover of less than 2% bottom cover.

Results of surveys of fish communities in Majors Bay reveal that in 2000, 22 species of fishes were noted, having an estimated mean standing crop of 10 g/m^2 (range 2 to 30 g/m^2). In 2006, 30 species of fishes were recorded having a mean overall biomass (or "standing crop") of 10 g/m^2 (range from 1 to 80 g/m^2) (Table 1). Hence, while average biomass remained essentially constant during the two surveys, the number of fish species observed increased in 2006 relative to 2000. The algal and macroinvertebrate survey in Majors Bay did not record any present in the 2000 survey but in 2006 noted four macroalgal and eight macroinvertebrate species present (Table 2).

Fish species of commercial and recreational interest seen in the Majors Bay area in both surveys included weke, moano, malu, palani, ma'i'i'i and na'ena'e. In the 2000 survey were also seen the toau, parrotfish or pohuhanuhu (*Calotomus carolinus*) and pualu. In the

2006 survey were seen a small school of bonefish or o'io (*Abula glossodonta*), a solitary uku and several juvenile 'ula.

4.4 Offshore Sector

This offshore zone, or biotope, is essentially continuous along the northern region of PMRF seaward of the Nohili and Mana sectors described above. The predominant physical structure of the area is a flat, pitted limestone surface (Figure 11). The seaward extent of this biotope is defined by the limestone shelf break encountered at 20 to 25 m in depth (Figure 12). This shelf break ranges from a vertical face to a 20 degree slope dropping away into sand at about 25 to 30 m of water. There are occasional potholes in the limestone flat that range from 1 to 5 m in diameter and up to 3 m in depth (Figure 12). These potholes are spaced from 20 to 80 m apart and thus are not a common feature.

The predominant coral found in this zone is *Pocillopora eydouxi*, which occurs as single large branching colonies (Figure 12). These fragile branching forms are able to grow to heights of up to 1 m because of the lack of wave forces at depth. Other corals found on the platform are primarily smaller species which have a collective coverage of about 5% of bottom cover. Coral species seen include *Pocillopora meandrina*, *P. eydouxi, Porites lobata, Pavona varians, P. duerdeni, Montipora flabellata, M. patula, M. verrilli, M. capitata, Leptastrea purpurea* and *Fungia scutaria*. Also present along the shelf break is the black coral (*Antipathes dichotoma*) and wire coral (*Cirrhipathes anguina*) (Figure 12).

The general lack of cover and shelter sites for organisms is a prominent feature of the deep, offshore plain. Thus, fishes and macroinvertebrates are concentrated in the areas of available shelter, such as on the 20-m shelf break. The exposed nature of the substratum enables a better delineation of many otherwise cryptic species. The results of the fish survey carried out in the deep, low coral coverage biotope in both surveys (2000 and 2006) are given in Table 1. In 2000, 61 species of fishes were recorded having an overall mean estimated biomass of 50 g/m^2. In 2006 less emphasis was given to this offshore biotope because of it's distance from the shoreline; however, the low level of survey effort in this biotope resulted in 62 fish species seen again having an estimated mean standing crop of 50 g/m^2. In 2000, 17 species of macroinvertebrates were seen and in the limited 2006 survey two macroalgal and eleven macroinvertebrate species were recorded.

A number of fish species of commercial and recreational interest were seen in the offshore biotope on both surveys; these included the omilu (*Caranx melampygus*), opelu (*Decapterus macarellus*), la'i (*Scombroides lysan*), uku, toau, mu, weke'ula, moano and the moano kea (*Parupeneus cyclostomus*). In the 2000 survey the butaguchi (*Caranx cheilio*) was seen and in the 2006 survey the weke and malu were encountered. Commercially important macroinvertebrates seen on both surveys include the he'e and in the 2006 survey, the 'ula'papa was also recorded.

Discussions with fishermen familiar with the resources fronting PMRF indicate that those

waters are well-known for the commercial catches of akule or bigeye scad (*Selar crumenophthalmus*) which is done using nets, papios (members of the jack family), threadfin or moi (*Polydactylus sexfilis*), opelu, uku, goatfishes and surgeonfishes all of which are caught by a variety of methods by both commercial and recreational fishers.

5.0 THREATENED AND ENDANGERED SPECIES

5.1 Marine Mammals

There are routine sightings of the endangered Hawaiian monk seal (*Monachus schauinslandi*) both in nearshore waters and hauled out on beaches all around Kauai, including the vicinity of PMRF. In addition, it has been documented that at least one monk seal pup was born at PMRF within the past 15 years

During the winter breeding season from December through May endangered humpback whales (*Megaptera novaeangliae*) are present in coastal waters, primarily within water depths of 300 m of the main Hawaiian Islands, including the areas off PMRF. Non-listed protected marine mammals that may be found in the coastal waters of Kauai include spinner dolphins (*Stenella longirostris*), spotted dolphins (*S. artenuata*), bottlenose dolphins (*Tursiops truncatus gilli*), false killer whales (*Psuedorca crassidens*), pilot whales (*Globicephala macrorhynchus*), melon headed whales (*Peponocephala electra*) and pygmy killer whales (*Feresa attenuata*). There are other species of small cetaceans that may be present in coastal waters but are generally cryptic and not often observed.

During the course of the fieldwork notes were taken on all threatened and endangered species seen offshore of the PMRF. Two small pods of spinner dolphins(*Stenella longirostris*) were seen in the southern part of the site in 2000, and have also been observed numerous times in the area during other fieldwork. In 2006, a similar pod was also seen near the central portion of PMRF. During both years, these pods were moving in a northwest direction along the ~25 m isobath. Spinner dolphins are known to rest in bays and other protected waters around the Hawaiian Islands and there are several schools known to occur around Kauai. Shallenberger (1981) notes that the largest groups occurred between Nawiliwili and Waimea during that study. It was his opinion that rather than a number of small distinct schools, there are only two or three schools that are distinct, and each of these is made up of smaller discrete groups. The smaller groups are sometimes found by themselves and at other times they are aggregated into larger schools. Thus the two small pods seen in this survey probably are part of a larger group. Shallenberger (1981) notes that the small groups are believed to be tightly knit cohesive social units that do not usually break up.

Hawaiian spinner dolphins appear to have a well-defined home range and can be found with a high degree of regularity in the same area. They are the most inshore of the Hawaiian cetaceans, spending considerable time close to shore in waters 15 m or less in depth (Shallenberger 1981). Shallenberger (1981) notes that the typical diurnal activity pattern or cycle for spinner dolphins is an early morning period of school movement and high activity (sexual, spins, head slaps, etc.), followed by a calm period which lasts for most

of the day. In the late afternoon high activity recommences during which time the smaller groups may join together and head seaward presumably to feed during the night. Prey consumed by Hawaiian spinner dolphins are primarily mesopelagic fish and epipelagic squid suggesting the use of offshore feeding areas.

5.2 Hawaiian Green Sea Turtles

Because of declining populations the green sea turtle (*Chelonia mydas*) was granted protected status, as threatened, under the federally mandated Endangered Species Act in 1977-78. The endangered hawksbill turtle (*Eretmochelys imbricata*) also occurs in Hawaiian waters, but is considered rare compared to the green turtle. Green turtles as adults are known to forage and rest in the shallow waters around the main Hawaiian Islands. Reproduction in the Hawaiian population occurs primarily in the Northwest Hawaiian Islands within the Papahānaumokuākea Marine National Monument. Adults migrate to the isolated NWHI in the summer, when reproduction takes place, and return to the main Hawaiian Islands in late summer or early fall. Nesting occurs on sandy beaches above the high tide mark; upon hatching, juvenile green turtles enter the sea where they presumably take up a pelagic existence until attaining a carapace length of about 30 cm. At this size, young turtles take up residence in the nearshore habitats around the main Hawaiian Islands.
In the nearshore habitat, green turtles will rest during the day along ledges or in caves in coastal waters at depth usually from 12 to 25 m. Under the cover of darkness, turtles will travel inshore to shallow subtidal and intertidal habitats to forage on selected species of marine algae (limu) (Balazs et al., 1987). They routinely haul out on the beachfront at the outfall of Nohili Ditch to bask during daylight hours, but only false nesting has been observed in recent years, and those events have been rare, less than one such event annually.

The normal range of these daily movements between resting and foraging areas is believed not to exceed 1 km (Balazs 1980, Balazs et al., 1987). Thus, the preferred green turtle habitat in Hawaiian waters appears to have the presence of suitable resting areas (caves, depressions, ledges and undercuts), located within a kilometer of abundant algal pastures situated in shallow water.

Visual reconnaissance of the nearshore area off Nohili Point noted numerous turtles on the surface in the 2000 survey, particularly off the mouth of Nohili Ditch. Underwater observations identified an elongated depression approximately 20 m x 60 m in dimension within an area of numerous caves and undercuts directly offshore of Nohili Ditch (described above as the area of cable crossings). Four turtles, all less than 75 cm in carapace length were observed underwater in resting behaviors within the depression. Ten years ago, fifteen turtles were counted in this area ranging in size (carapace length) from 40 to 80 cm (Brock 1990). In the August 2006 survey two juvenile green turtles were seen in this same depression (estimated straight-line carapace lengths ~ 60 cm). Only one turtle was seen on the surface shoreward of the depression, fronting the Nohili Ditch in 2006. [It should be noted that seasonal periodicity in sea turtle populations within the MHI is typical, and

observations at Nohili Ditch reflect the same summer declines. The overall populations have been documented to be increasing throughout the state.]

The emergent limestone bench fronting Nohili Point has a diverse assemblage of macrothalloid algal species, many of which are forage species for green turtles. Preferred algal species by green turtles (per Balazs et al., 1987) on the bench fronting Nohili Point include limu lipuupuu (*Dictyospheria versluysii*), limu pahalahala (*Ulva fasciatus*), limu kala-lau-nunui (*Sargassum echinocarpum*), limu kala (*S. obtusifolium*), *Acanthophora specifera*, limu pepe-iao (*Amansia glomerata*), limu manauea (*Gracilaria coronopifolia*), limu huna (*Hypnea spp.*), limu huluilio (*Jania sp.*) Limu mane'one'o (*Laurencia nidifica*), limu palaewawae (*Laurencia sp.*) Spyridia filamentosa, and limu loloa (*Pterocladia capillacea*). In addition, large pastures of limu kohu (*Asparagopsis taxiformis*) were noted on the offshore reef bench throughout the Nohili Point area.

In the August 2006 survey of the area north of Nohili Ditch, two green turtles were seen resting on the bottom in a depression at 15 m depth about 250 m from shore. These turtles had an estimated straight -line carapace length of 50 and 60 cm respectively and neither appeared to have any obvious tags or tumors present.

Observations of the intertidal area off Nohili ditch in 1989 conducted at dusk during high tide revealed a concentration of green turtles foraging on the seaward edge of the shoreline bench (Brock 1990). During a fifteen minute interval nine turtles were observed foraging within 50 m of either side of the ditch discharge directly inshore of the offshore resting habitat. Only one turtle was observed beyond 50 m from the discharge up to a distance of approximately 200 m from either side of Nohili Ditch.

The apparent lack of turtles foraging on the bench at distances more than 50 m from the Ditch may be related to the distribution of limu loloa (*Pterocladia capillacea*) that was abundant on the shoreline bench in the vicinity of Nohili Ditch in 1989. On rocky intertidal coasts, *P. capillacea* occurs as a well-developed band in the lower intertidal from about mean low tide (zero) to about -30 cm. These algal bands are best developed in areas receiving some freshwater input. On the beach fronting the Nohili study site, *P. capillacea* is found from a point commencing about 80 m north of the ditch discharge to the southern terminus of the limestone bench (about 450 m to the south of the ditch). *Pterocladia* is of the preferred forage genera of green turtles (Balazs 1980); the foraging turtles encountered in this survey appeared to be feeding primarily on the band of *Pterocladia*.

While Nohili Ditch discharges turbid fresh water at the shoreline within the boundary of the PMRF, observations and past studies from other locales suggest that this is not a detrimental factor affecting turtle behavior, and may actually be a favorable condition for turtles compared to areas without such discharge. During the dredging of swimming lagoon entrance channels at West Beach, Oahu, green sea turtles apparently vacated offshore resting habitat (about 1 km offshore) in favor of resting habitat about 250 m directly fronting the construction work. The reason(s) for this shift are unknown, but at face value, it appears that the turbidity generated by the dredging was at least not a detriment to turtles inhabiting

the area, and may have even provided a more suitable resting habitat as a result of the increased protection from predation offered by the lowered visibility of the turbid water (Brock, personal observations).

Within Pearl Harbor, Oahu, a well-utilized green turtle resting habitat is the crevice between the channel floor and the former discharge pipe from the Fort Kamehameha Sewage Outfall. The crevice provides a narrow space that numerous small turtles squeeze into during the daylight hours, even though the turbidity of the water is generally so high that visibility is less than one foot. As with the Nohili area, the resting habitat under the sewage pipe lies adjacent to a foraging area on the Fort Kamehameha reef flat that contains high standing crops of preferred algal forage species (Dollar, personal observation).

The combination of a desirable nesting beach, foraging habitat, and resting habitat all situated within a small geographical area combine to provide an ideal "complete habitat" for green sea turtles. The suitability of the forage area is enhanced by the combination of ideal intertidal physiography (limestone bench) and the abundance of preferred forage species of algae that are a response to nutrient subsidies provided by the freshwater discharge from Nohili Ditch.

It appears that any impacts associated with the operation of PMRF and threatened and endangered species would occur on the sand beaches. Green sea turtles have been noted to use the beach for nesting (oviposition of eggs). Compaction of beach sand by foot or vehicular traffic can either destroy the nests or preclude the successful emergence of hatchlings (Mann 1977). If nesting occurred during the period of reduced access to the PMRF beaches, the lower incidence of foot and vehicular traffic could result in higher potential hatchling success. Similarly, the use of lights directed at nesting beaches could be a deterrent to hatchlings (Carr and Ogren 1960, Mortimer 1981). It might also be argued that light impinging on the foreshore could deter turtles from foraging in this area at night. Reduced access to PMRF beaches may have resulted in less light interference with nesting and hatchling behavior. However, Brock (1987) noted that green turtles foraged on the intertidal bench at Paradise Cove, West Beach, Oahu, during the evening under floodlights with a Hawaiian luau going on nearby for several hundred people. These observations suggest that green turtles may habituate to nearby human activities. Similar evidence of such habituation has been noted by the authors at the Hawaii Kai Marina in East Oahu (Brock 1989), and within Kailua Bay in Kailua-Kona, on the Island of Hawaii (Dollar, personal observation).

The controlled access of the public to the beach resources at PMRF has probably served to conserve and protect the green turtles in the Nohili Point area. Such limitations on access, which have been in place in some form prior to increased control since 9/11, serves to reduce possible poaching and/or disturbance to resident turtles or seals. The results of the present survey in 2006, as well as past work, have shown that green turtles reside primarily in the waters just off the Nohili Ditch and forage on algal resources present on the intertidal bench within the influence of the ditch discharge. These data suggest that the operation of the facility to date has not served to deter, and may even enhance, turtle behavior in the

marine habitats at PMRF. The absence of nesting activity in the vicinity of Nohili Ditch appears to be due to natural conditions that the turtles find unsuitable, and does not appear to be due to human presence, traffic, or intervention.

6.0 Nohili Ditch and Kawaiele Diltch Outfalls

With respect to aquatic and marine resources, statements by a DLNR staffer have been made that Nohili and Kawaiele ditches are polluting coastal waters through organic loading and increased turbidity. Nutrient discharges from ditch discharge has been assumed responsible for fish kills, and for promoting conditions that could lead to toxic algal blooms. A solution offered to amend these perceived conditions is to restore the wetlands at the terminus of the ditches to serve as natural biofilters.

While restoration of wetlands may be a worthwhile effort, it must be stated by the authors that a valid justification for such an action does not include alleged "pollution" of coastal waters by ditch discharge. Extended study of the reefs off the ditch discharges indicate that the exposed open coastal nature of the receiving waters results in very rapid dilution and dispersal of the freshwater plumes. In addition, most of the particulate material that reaches the ocean is contained in a surface plume of lower density water, resulting in little contact with the ocean bottom. In fact, coral communities were most abundant in the vicinity of the Nohili discharge, and no terrigenous materials were noted to accumulate on the reef surface. Should the ditches drain to enclosed basins or embayments, the effects to receiving waters might be considerably different than what is observed in the high energy open coastal shoreline system found at PMRF.

Rather than causing toxic algal blooms the freshwater discharge at Nohili appears to be at least partially responsible for the preferred turtle foraging habitat by stimulating filamentous algae growth on the nearshore reef bench. Similarly, several documented cases indicate that turtles utilize turbid water for resting habitat, and may even prefer such conditions over clear water. As a result, altering the flow of freshwater to the nearshore zone could result in lessening the high desirability of the area for green sea turtles in terms of both foraging and resting habitats. Discharge of turbid waters from the drainage ditches does not represent a unique situation on Kauai, as numerous rivers throughout the Island drain to the ocean.

7.0 DISCUSSION/RECOMMENDATIONS

The decline in fishing activities in the waters fronting the PMRF is evident in the 2006 fish survey data. Inspection of Table 1 shows many species of commercial and recreational interest seen in both surveys are more abundant in 2006 than they were in 2000. Examples include the locally-esteemed goatfishes, the weke and the weke'ula. Also apparent in Table 1 is the appearance of important commercial and recreational species in the 2006 survey that were not seen in the earlier 2000 survey. Among this group of new species are the o'io or bonefish (*Abula glossodonta*), nohu (*Scorpaenopsis cacopsis*), kumu (*Parupeneus porphyreus*), aweoweo (*Heteropriacanthus cruentatus*), papio (*Carangoides orthogrammus*),

golden trevally or pa'opa'o (*Gnathanodon speciosus*) and the knifejaw (*Oplegnathus punctatus*). Not evident in Table 1 is the fact that the mean sizes of many of these favored species are larger in 2006 than in 2000. For example, the average size of brick soldierfish or menpachi (*Myripristes amanea*) is about 20 cm (~8 inches) fork length in the 2006 survey, whereas the average size in the 2000 survey was about 14 cm (5.5 inches). Weke and weke'ula both showed a similar increase in average size from about 22 cm (9 inches) fork length in 2000 to about 30 cm (12 inches) fork length in 2006. These increases in abundance and mean sizes of fishes suggest a decrease in fishing pressure along this section of coast since the 2000 survey.

The potential for impacts to threatened and endangered species by the actual activities at PMRF within the nearshore ocean are considered minimal. As none of the primary activities (e.g., launching of missiles) takes place on the beaches or within the nearshore ocean, there is essentially no means for direct impacts to occur. Rather, indirect activities associated with decreased access to beaches and the nearshore ocean afforded by the facility appear to be the most important factor with respect to management of natural resources.

As discussed previously, the beaches of PMRF are observed haul out areas for both Hawaiian green sea turtles and monk seals. In the past, these beaches have rarely been utilized for nesting and pupping. These breeding activities are relatively infrequent for beaches in the main Hawaiian Islands; management actions should strive to limit human disturbances, particularly vehicular activities, to the greatest extent possible. Hence, the increased restrictions to access of beaches at PMRF since 9/11 would be expected to result in an even more suitable habitat for turtles, although this has not be realized. Educational opportunity, through appropriate signage and supportive materials is in the planning stages, to be implemented as part of an overall Natural and Cultural Resources management measure. (Burger, personal communication)

With respect to the offshore resources, the results of this study indicate several possible actions. Boat traffic in the area is substantial in terms of fishing boats and commercial vessels carrying people from Port Allen and Kikiaola Harbors to the Na Pali coast. The combination of relatively high populations of turtles and seals in the region, and appreciable boat traffic could raise the potential for boat impact with these animals. Limitation of speed is beyond the authority of PMRF, but the development of a distance envelope from the shoreline in which boats cannot travel, might be possible to mitigate such problems.

Inspection of the reefs indicated that there are no apparent problems with anchor damage and only minor accumulation of debris (including fishing gear and metal from flight activities) Local commercial fisherman operating from boats generally work fishing grounds relatively far from shore that are beyond the range of PMRF management.

Resource managers often focus on several key target species of commercial and/or recreational interest with the idea that their local abundance and individual sizes are a reflection of fishing activity. Fishing activities have been allowed in the waters fronting PMRF for many years except when range activities dictate closure of the waters offshore of the

facility. This public use pattern was in place at the time of the 2000 survey of the marine communities present offshore of the PMRF and the fishing public did use these marine resources. The events of September 11, 2001 resulted in increased security at all US installations as well as at public transportation facilities. Increased security at PMRF reduced public use of the shoreline and associated fishing activity. Despite the restrictions onshore, there have been no changes in access to waters directly offshore of PMRF, and fishing is allowed except during specified operations (such closures are publicly announced). However, much of the fishing public is under the mistaken assumption that "you cannot fish in the waters fronting PMRF". In addition, the distance to PMRF from the nearest boat launch facilities is not substantially greater than the distance to Niihau (~9 km). As a result, many of the resource users are forgoing the PMRF area in favor of Niihau, where diving and fishing are known to be excellent. These two factors may have resulted in decreased use of the fishery resources offshore of the PMRF since the September 2001 event.

Although beach access from the shore-side along most of Barking Sands is prohibited, the public perception that fishing is restricted in the waters fronting the PMRF since September 2001 has led to a decrease in fishing pressure resulting in the PMRF being a *de facto* preserve. Although Pearl Harbor has always had restricted access since the US Navy's arrival in the early 1900's, restrictions on public use of aquatic resources under the Navy's jurisdiction were similarly increased following 9/11. The restrictions in Pearl Harbor also resulted in significant increases in aquatic resources (especially species of commercial and recreational interest, (Brock, personal observations). The State of Hawaii has nine formal marine preserves (or Marine Life Conservation Areas ' MLCD's) in the high Hawaiian Islands. These range in size from the Pupukea MLCD on Oahu (25 acres) to the Hulopoe-Manele MLCD on Lana'i Island (309 acres). As noted above, Pearl Harbor is a de facto preserve with about 5,189 acres comprising the inner harbor, thus making it the largest preserve in the high Hawaiian Islands. PMRF is similarly a de facto preserve and is situated along ~15 km of coastline. If the 20 m (60-foot) isobath were considered to be an outer limit of this de facto preserve, the PMRF preserve occupies about 3,165 acres making it the second largest in the high islands.

Because inshore or coral reef fishery resources are severely depleted in the high islands and the State of Hawaii has only conferred protection on 1,252 acres in the nine existing MLCD's, maintaining PMRF's security restrictions will continue to provide a *de facto* preserve for fishery resources. Although not a preserve by way of direct government policy, by continuing current security procedures the waters offshore of PMRF will insure that the aquatic resources remain and flourish, and may serve as a source of propagules to recruit to marine communities elsewhere away from PMRF.

However, we also recommend consideration of expansion of beach access for pole and hand-thrown net fishing, to include a two-pole limit, walk-in access (within security requirements), and voluntary creel count reporting. By opening a few thousand feet of previously-closed shoreline to pass holding fishermen/women, in combination with voluntary reporting of catch, the findings may prove useful as a monitor on long-term impact on resident populations.

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TABLE 1. Summary of fish species encountered in the waters fronting PMRF in April 2000 and August 2006 in the four sectors or ecological zones recognized in this study. Qualitative estimates of abundance for each species are X ' present but not common, C=common, A=abundant.

FAMILY *Species*	SURVEY STATIONS/DATES							
	NOHILI POINT		MANA		MAJOR'S BAY		OFFSHORE	
	2000	2006	2000	2006	2000	2006	2000	2006
MYLIOBATIDAE(Eagle Rays)						X		
Aetobatis narinari								
ALBULIDAE (Bonefishes)								
Albula glossodonta						X		
MURAENIDAE(Moray Eels)								
Gymnothorax undulatus	X				X			X
G. flavimarginatus	X						X	
G. meleagris	X							
G. steindachneri						X		
Conger cinerus	X							
SYNODONTIDAE (Lizardfishes)								
Saurida gracilis						X		
Synodus variegatus	X							X
HOLOCENTRIDAE (Squirrelfishes)								
Myripristis amaena	C	A	C	A				
Sargocentron diadema	C	C						
S. xantherythrum	C	C						
S. punctatissimum	X	C			X			
AULOSTOMIDAE (Trumpetfishes)								
Aulostomus chinensis	X	X		X				
SCORPAENIDAE (Scorpionfishes)								
Scorpaenopsis diabolus	X			X				
S. cacopsis		X						
SERRANIDAE (Groupers)								
Pseudanthais thompsoni							X	X
Cephalopholis argus	C							
PRIACANTHIDEA (Bigeyes)								
Heteropriacanthus cruentatus		C		X				
CIRRHITIDAE (Hawkfishes)								
Cirrhitus pinnulatus	X	X					X	
Paracirrhites arcatus	C	C		C		X	C	C
P. fosteri	X	X		X			X	X
Cirrhitops fasciatus		X		X		X	X	X
APOGONIDAE (Cardinalfishes)								
Apogon kallopterus	X	C		C		C	C	C
MALACANTHIDAE (Tilefishes)								
Malacanthus brevirostris						X		X
CARANGIDAE (Jacks, Trevallys)								
Carangoides orthogrammus		X						
Caranx melampygus	X	X		X			X	X
C. cheilo							X	
C. ignobilis			X					
Decapterus macarellus	C						X	C
Scomberoides lysan							X	X
Gnathanodon speciosus				X				

TABLE 1. Continued (2)

FAMILY *Species*	SURVEY STATIONS/DATES							
	NOHILI POINT		MANA		MAJOR'S BAY		OFFSHORE	
	2000	2006	2000	2006	2000	2006	2000	2006
LUTJANIDAE (Snappers)								
Aprion virescens		X				X	X	X
Lutjanus fulvus	X	C	X	C	X		X	X
L. kasmira	C	A	C	C		A		C
LETHRINIDAE (Emperors)								
Monotaxis grandoculus	X	C		C			X	X
MULLIDAE (Goatfishes)								
Mulloidichthys flavolineatus	C	A			C	C		C
M. vanicolensis	C	A	C				X	C
Parupeneus multifasciatus	C	C	X	C	X	X	C	X
P. bifasciatus	X		X	X				X
P. cyclostomus	X			X			X	X
P. pleurostigma	X	X		C	X	X		X
P. porphyreus						X		
KYPHOSIDAE (Rudderfishes)								
Kyphosus bigibbus	C	C		A				
CHAETODONTIDAE (Butterflyfishes)								
Chaetodon auriga		X					X	
C. kleinii							C	C
C. fremblii	X							
C. unimaculatus	X	X						
C. lunula	X			X		X		
C. miliaris	X	X		X		C	X	C
C. multicinctus	C						X	
C. ornatissimus	X	X		X				
C. quadrimaculatus	X	X	X	X			X	
Forcipiger flavissimus	X	X					X	X
Heniochus diphreutes							C	X
Hemitaurichthys polylepis							X	X
POMACANTHIDAE (Angelfishes)								
Holocanthus arcuatus							X	X
Centropyge potteri							X	X
C. fisheri							X	
OPLEGNATHIDAE (Knifejaws)								
Oplegnathus punctatus		X						
POMACENTRIDAE (Damselfishes)								
Abudefduf abdominalis	A	C	C	C	X			
A. sordidus				X				
Chromis agilis							C	C
C. ovalis	C							
C. vanderbilti	A	A	A	A	A	A	A	A
C. hanui		C					X	C
C. verator							C	C
Dascyllus albisella	C				X		C	C
Plectroglyphidodon johnstonianus				X			X	X
P. imparipennis			X	X	X			
Stegastes fasciolatus	X	X	X	C				
LABRIDAE (Wrasses)								
Bodianus bilunulatus	X	X		X	X		X	X
Coris venusta	X	X	X		X	C		
C. flavovittatus	X							X

TABLE 1. Continued (3).

FAMILY *Species*	SURVEY STATIONS/DATES							
	NOHILI POINT		MANA		MAJOR'S BAY		OFFSHORE	
	2000	2006	2000	2006	2000	2006	2000	2006
LABRIDAE (Wrasses)								
C. gaimard	X		X					X
Anampses cuvieri	X		X					
Halichoeres ornatissimus		X	X	X			X	X
Gomphosus varius	X	C		C				
Labroides phthirophagus	X	X		X		X	X	
Stethojulis balteata	C							
Thallasoma duperry	C	C	C	C	C	C	C	C
T. ballieui	X							
T. trilobatum	X		X					
T. purpureum		X						
Xyrichtys pavo						X		
Cheilinus rhodochrous							X	
Pseudocheilinus tetrataenia							X	
P. octotania		X						
Pseudojuloides cerasinus							X	X
Chelio inermis					X	X		
SCARIDAE (Parrotfishes)								
Calotomas carolinus		X			X			
Chlorurus forsteni								
Scarus perspicillatus		C					X	X
S. sordidus	X	X				X		
S. psittacus	X	C		C				
S. rubroviolaceus	X	C		X			X	X
BLENNIIDAE (Blennies)								
Exalias brevis				X				
Plagiotremus goslinei	X			X				X
P. ewaensis							X	
ZANCLIDAE (Moorish Idol)								
Zanclus cornutus	X	X		X			X	X
ACANTHURIDAE (Surgeonfishes)								
Acanthurus achilles	X							
A. dussumieri	C	C	C	C	X	X	X	X
A. blochii	C	C	X	C	X			X
A. leucopareius	C	A	C	C				
A. nigrofuscus	C	A	C	A	C	C	C	C
A. nigroris	X			X			X	
A. olivaceus	X	C	X	A	X	C	C	C
A. triostegus	C	A	C	A				
A. xanthopterus	X	A					X	X
A. glaucoparius		X						
Ctenochaetus strigosus	C	C		C			C	X
C. hawaiiensis		C						
Naso hexacanthus		C					X	C
N. lituratus	C	C	X	C			X	X
N. unicornis	X	C	X	C				
N. brevirostris		C					X	C
Zebrasoma flavescens	X	C		C				
BALISTIDAE (Triggerfishes)								
Melichthys niger	C	C					C	C
M. vidua			X	X			X	X
Rhinecanthus rectangulus	X	X	X	X	X	X		X
Sufflamen bursa	X	X		X			X	X

TABLE 1. Continued (4).

FAMILY *Species*	SURVEY STATIONS/DATES							
	NOHILI POINT		MANA		MAJOR'S BAY		OFFSHORE	
	2000	2006	2000	2006	2000	2006	2000	2006
BALISTIDAE (Triggerfishes)								
S. fraenatus	X	X				X	X	X
Xanthichthys auromarginatus							X	X
X. mento								X
MONACANTHIDAE (Filefishes)								
Cantherhines dumerili		X				X		
C. sandwichensis	X	X	X	X				
OSTRACIIDEA (Trunkfishes)								
Ostraion meleagris	X	X			X			X
TETRAODONTIDAE (Puffers)								
Canthigaster jactator	X	X	X	C	X		X	X
C. rivulata				X				
C. cornata	X	X				X	X	
Number of Species:	87	75	36	58	28	33	67	65
Biomass (g/m^2)								
Range	80-150	50-350	40-70	50-400	2-30	1-80		
Mean	110	175	50	70	10	10	50	50

TABLE 2. List of dominant macroalgae and exposed macroinvertebrates encountered in the waters fronting PMRF in April 2000 and August 2006 in the four sectors or ecological zones recognized in this study. Presence of a species in a zone/sector is denoted with an "X." Note that corals are not listed in this table.

Species	SURVEY STATIONS/DATES							
	NOHILI POINT		MANA		MAJOR'S BAY		OFFSHORE	
	2000	2006	2000	2006	2000	2006	2000	2006
ALGAE								
Amansia glomerata	X	X		X				
Asparagopsis taxiformis	X	X	X	X				
Corallinan sp.								X
Cladymenia pacifica						X		
Desmia hornemannii	X	X						X
Halimeda opuntia				X		X		
Jania sp.		X				X		
Peysonellia rubra		X						
Porolithon onkodes		X		X				
Toypiocladia sp.						X		
PHYLUM PORIFORA (Sponges)								
Chondrosia chucalla						X		
Dactylospongia sp.						X		
PHULUM CNIDARIA								
Halocordyle disticha						X		
PHYLUM MOLLUSCA								
Conus lividus	X			X			X	X
C. distans							X	
C. ebreus	X	X						
C. imperialis							X	
C. marmoratus	X							
C. leaopardus	X						X	
C. miles							X	X
C. miliaris							X	
Cyprea tigris		X						
Pinctata margaritifera		X						X
Spondylus tenebrosus	X	X					X	X
Octopus cyanea	X	X	X				X	
PHYLUM ANNELIDA								
Loimia medusa							X	
Spirobranchus gigantea		X				X		
PHYLUM ARTHROPODA								
Paribaccus antarticus	X							X
Panulirus marginatus		X	X			X		
P. penicillatus				X				
PYLUM ECHINODERMATA								
Echinothrix diadema		X					X	
E. calamaris				X		X	X	X
Echinometra mathaei							X	
Eucidaris metularia							X	
Echinostrephus aciculatus		X		X			X	X
Tripnestes gratilla				X			X	X
Holothura atra	X					X		X
H. whitmaei						X		
Actinopyge mauritiana	X	X		X				
Linckia multiflora	X							X
L. diplax							X	
Culcita novaeguineae							X	X
Number of Species:	**13**	**16**	**3**	**10**	**0**	**12**	**17**	**13**

FIGURE 1. Aerial photograph of Nohili sector of Pacific Missile Range Facility (PMRF). Northern boundary of the Facility is located at approximately the top margin of the photo. For the purposes of the Integrated Natural Resources Management Plan, the nearshore marine habitat is divided into three sectors. The Nohili sector extends from the northern boundary to Nohili Ditch. Note well-defined sand channel system oriented perpendicular to the shoreline south of Nohili Point. North of Nohili Point, reef topography consists of a more solid reef platform.

FIGURE 2. Aerial photograph of Mana Point sector of Pacific Missile Range Facility (PMRF). Northern boundary of the sector is off Nohili Ditch at top margin of photo. Southern boundary of sector is marked by termination of offshore mound and channel reef system that curves to the shoreline at bottom right corner of photo. .

FIGURE 3. Aerial photograph of Majors Bay (Waiakapua Bay) sector of Pacific Missile Range Facility (PMRF). Southern boundary of Facility in near the bottom of photo at Kokole Point. Note lack of offshore reef structure throughout Bay that differentiates this sector from the Nohili and Mana sectors. Bottom composition throughout Majors Bay is predominantly sand.

FIGURE 4. Reef platform in Nohili sector of PMRF shoreline. Bottom photo shows highly eroded reef surface that is unique feature of the area located near the northern boundary of PMRF. Water depth in both photos is approximately 10 m.

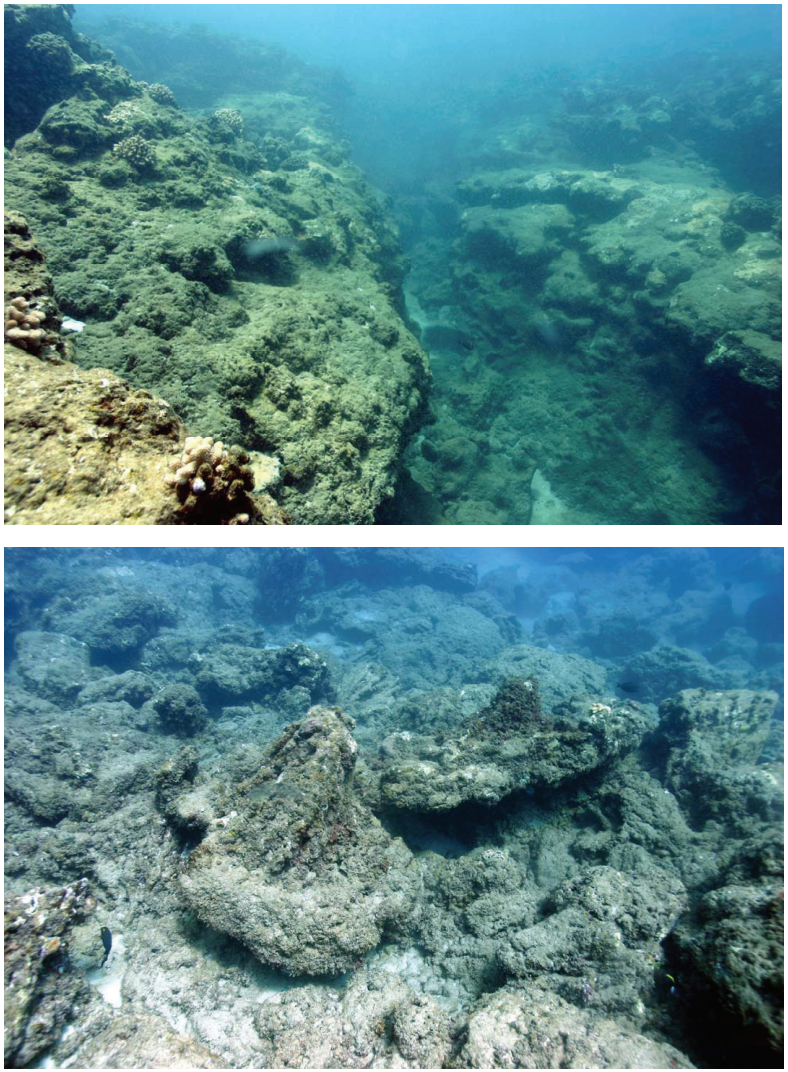
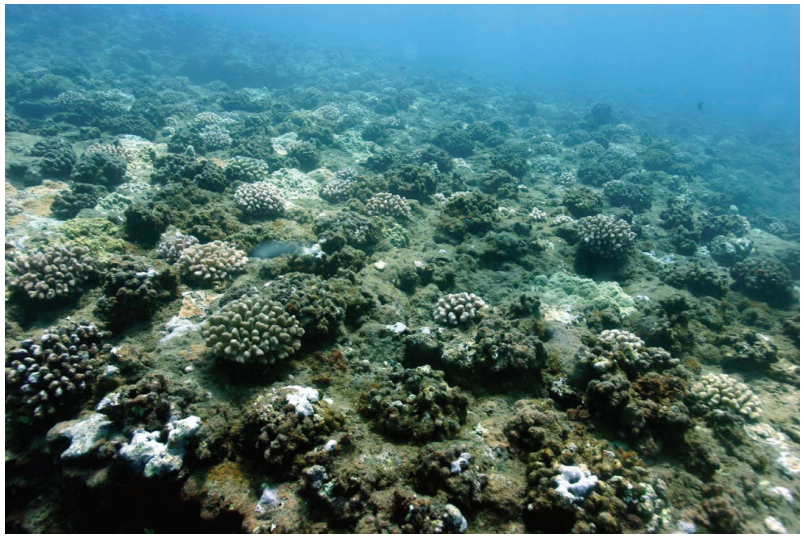


FIGURE 5. Reef platform in Nohili sector of PMRF shoreline. Top photo shows channels and undercut ledges that provide ideal fish habitat. Bottom photo shows toppled and overgrown heads of *Porites* that do not resemble living coral colonies in the region. Water depth in both photos is approximately 10 m.



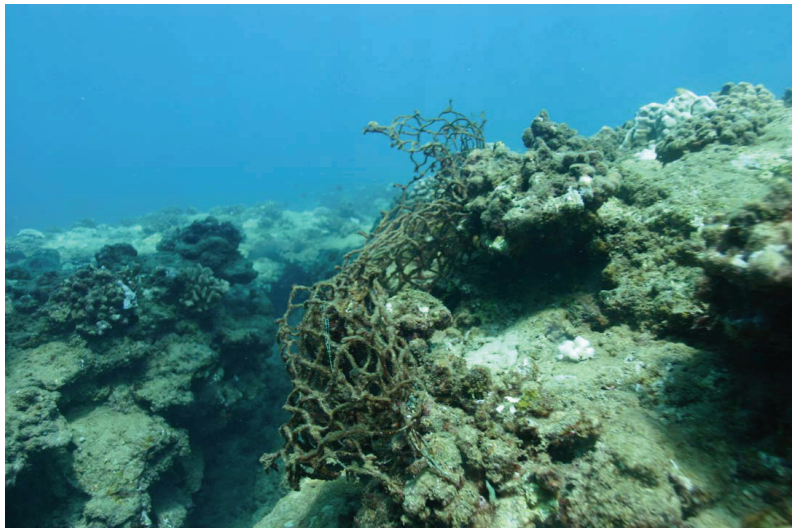
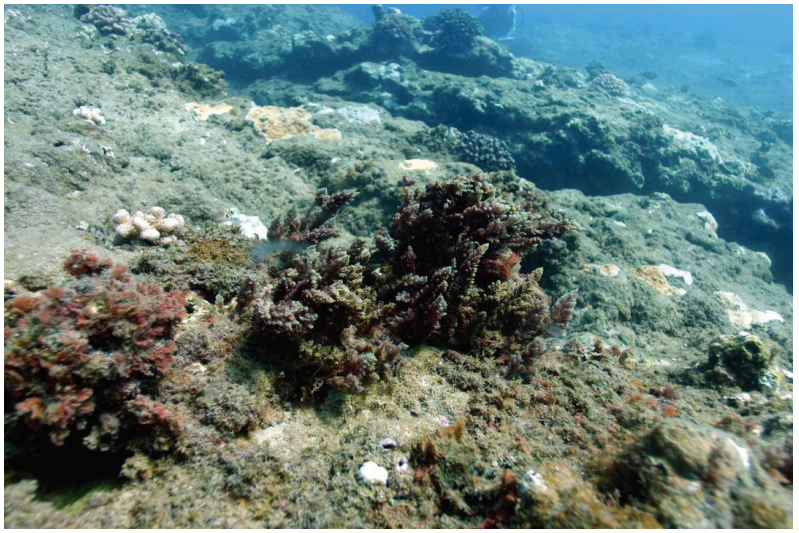


FIGURE 6. Top photo shows surface of reef in Nohili sector with particularly high coral cover for the entire PMRF area. The predominant species if *Pocillopora meandrina*. Bottom photo shows a section of fishing net fouled on the reef in the Nohili sector. Observations of such marine debris originating from fishing activity were rare throughout the PMRF area. Water depth in both photos is approximately 7 m.



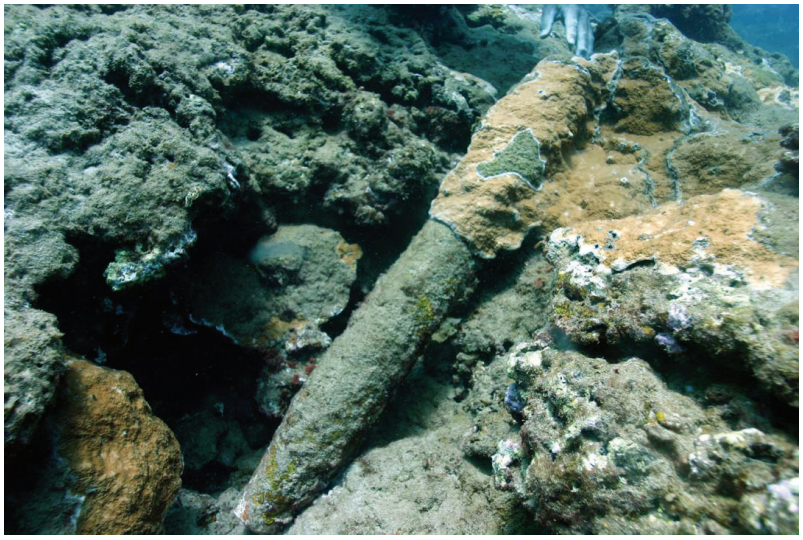


FIGURE 7. Top photo shows red alga limu kohu (*Asparagopsis taxiformis)* on reef surface of Nohili sector of PMRF. This alga was commonly observed in the Nohili and Mana Plain sectors during both the 2000 and 2006 surveys. Bottom photo shows remnant of ordnance on reef surface partially overgrown with coral *Montipora patula*. Remnant materials from activities on PMRF were common throughout the reef in the Nohili sector. Water depth in both photos is approximately 8 m.

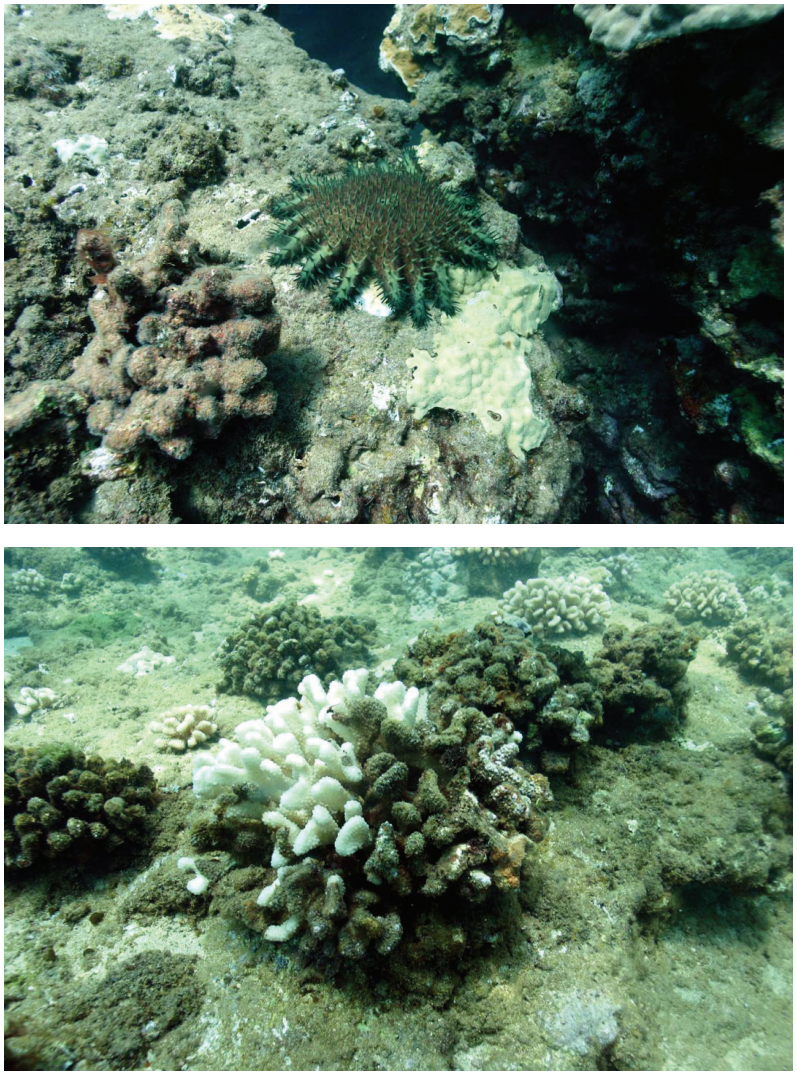


FIGURE 8. Top photo shows Crown-of-thorns starfish (*Acanthaster planci*) feeding on colony of *Montipora patula* in the Nohili sector of PMRF. Bottom photo shows bleached and overgrown colony of *Pocillopora meandrina* that was likely recently killed by Crown-of-thorns.

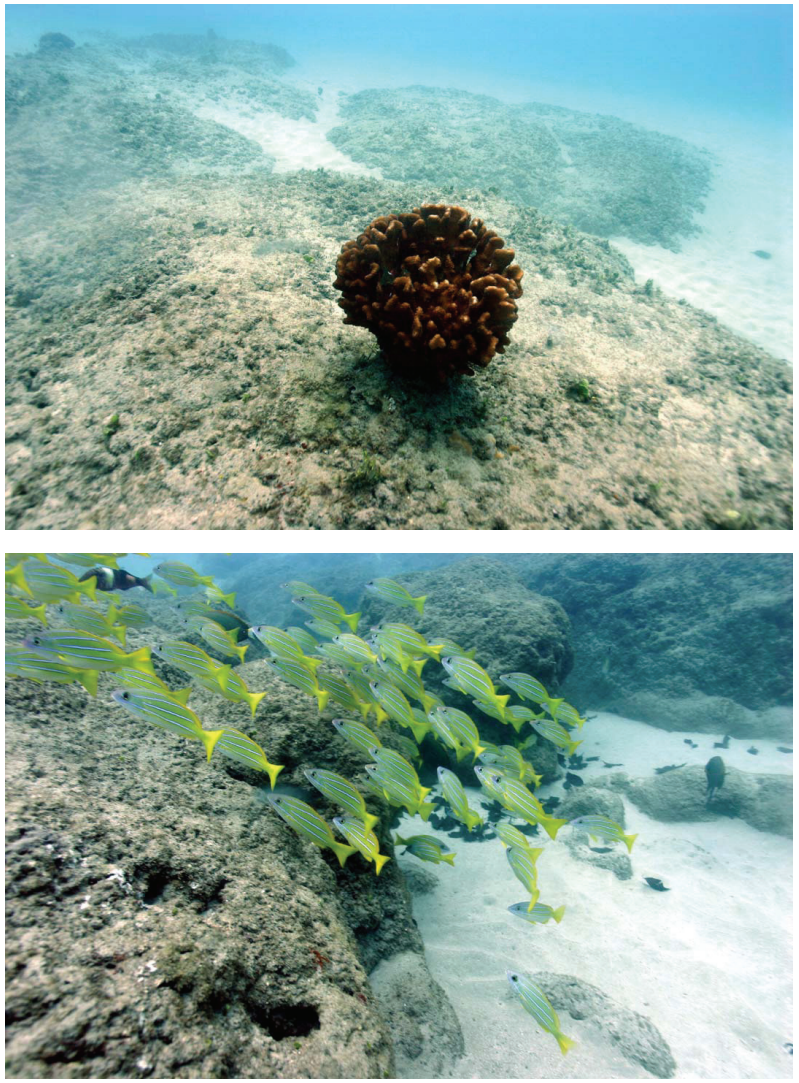
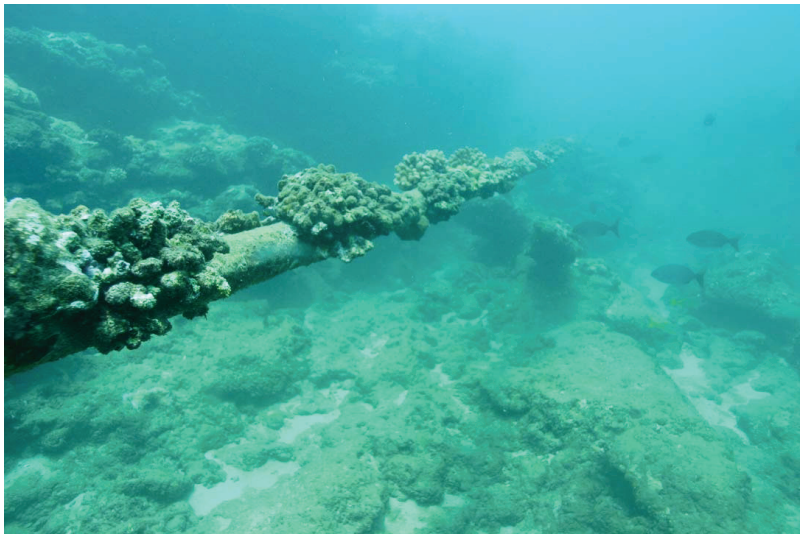


FIGURE 9. Two photos of limestone elongated limestone knolls and sand floor in the Mana Point sector of PMRF. Coral colony in upper photo is *Pocillopora eydouxi*. School of fish in lower photo are the introduced blue-lined snapper or ta'ape (*Lutjanus kasmira*). Water depth in both photos is approximately 10 m.



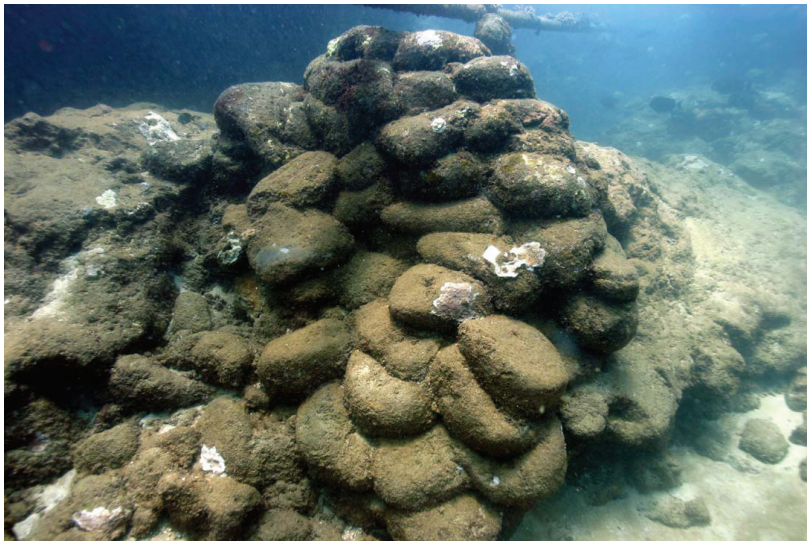
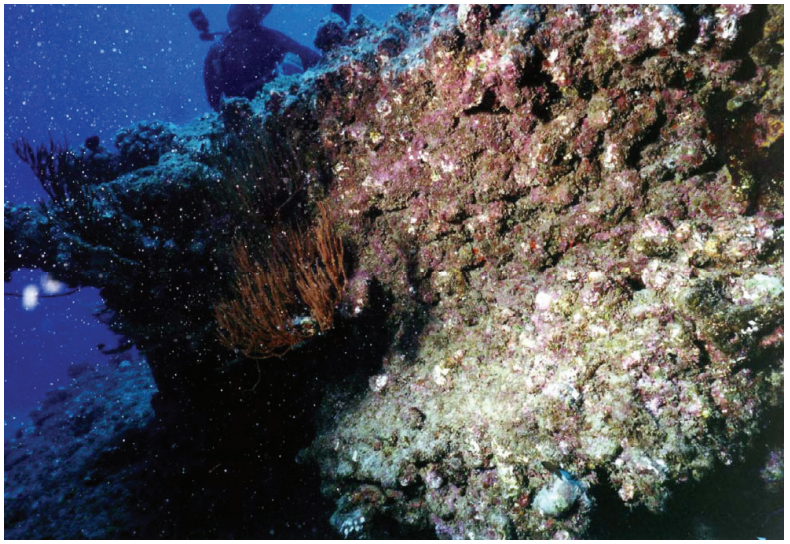


FIGURE 10. Underwater cables and supporting rock pile located in Mana Point sector of PMRF shoreline. Numerous cables running offshore are colonized by corals. Water depth in both photos is approximately 8 m.



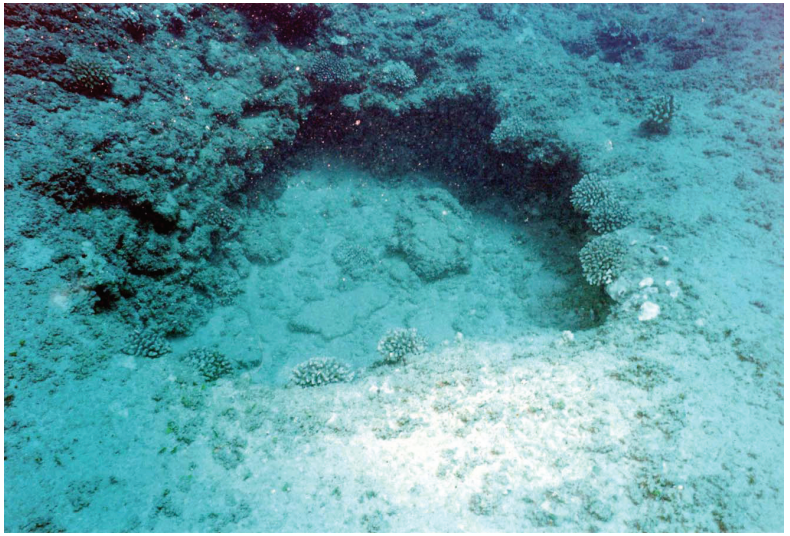


FIGURE 11. Top photo shows drowned shoreline ledge at depth of 20 m that marks the seaward margin of the offshore reef along the length of the PMRF shoreline. Red coral in upper photo is *Antipathes* spp. Bottom photo shows sinkhole in offshore reef platform.

C2 - SURVEY OF MARINE AND FISHERY RESOURCES

(DOLLAR and BROCK 2000)

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APPENDIX C

SURVEY OF MARINE AND FISHERY RESOURCES

FOR THE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP) PACIFIC MISSILE RANGE FACILITY (PMRF) BARKING SANDS, KAUAI, HAWAII

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INTRODUCTION

The U.S. Navy (Department of Defense) Pacific Missile Range Facility (PMRF) is the world's largest instrumented, multi-environmental military test range capable of collecting data on the performance of a variety of weapons systems that operate underwater, on the surface, in the atmosphere and in space. PMRF provides fully instrumented test ranges as well as unique infrastructure and facilities to support and cooperate with other governmental agencies including the Department of Energy (DoE), National Aeronautics and Space Administration (NASA), Defense Special Weapons Agency, and the Ballistic Missile Defense Organization.

The Commander of the Pacific Missile Range Facility (PMRF) is preparing an Integrated Natural Resources Management Plan (INRMP) intended to address the ten elements listed in the Sikes Act Improvement Amendments (SAIA) as follows:

1. Fish and wildlife management, land management, forest management, and fish and wildlife-oriented recreation;
2. Fish and wildlife habitat enhancement or modification;
3. Wetland protection, enhancement and restoration, where necessary for support of fish, wildlife, or plants;
4. Integration of, and consistency among, the various activities conducted under the plan;
5. Establishment of specific, natural resource management goals and objectives and time frames for proposed action;
6. Sustainable use by the public of natural resources to the extent that the use is not inconsistent with the needs of fish and wildlife resources;
7. Public access to the military installation that is necessary or appropriate for the sustainable use of natural resources, subject to requirements necessary to ensure safety and military security;
8. Enforcement of applicable natural resource laws (including regulations);
9. No net loss in the capability of the installation's lands to support the military mission of the installation; and
10. Such other activities as the Navy has determined are appropriate.

The SAIA also requires the INRMP to comply with the requirements of the National Environmental Policy Act (NEPA). Accordingly, appropriate NEPA documentation will be prepared for the INRMP recommendations, and pertinent agency consultations will be completed.

The INRMP is required under the federal Sikes Act Improvement Amendments (SAIA) of 1997 (P.L. 105-85). This Congressional legislation requires military installations to prepare and implement a plan for the management, conservation, and rehabilitation of their natural resources,

while still supporting the installation's military mission. The SAIA requires the INRMP to be prepared in cooperation with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the appropriate State natural resources agencies. To accomplish this, the Navy intends to consult with the following agencies:

- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- State Department of Land & Natural Resources (e.g., Divisions of Aquatic Resources and Forestry and Wildlife, and the Division of State Parks)
- State Dept. of Business, Economic Development & Tourism (e.g., CZM Program and Ocean Resources Branch)

The study area for this Integrated Natural Resources Management Plan (INRMP) consists of areas owned and controlled by PMRF as well as the marine region directly offshore of the facility out to the 60 foot (20 m) depth contour. These include all the waters shown in Figure 1.

OBJECTIVES

The overall objective of the INRMP is to establish a sound rationale for establishment of specific natural resource management goals and objectives, time frames, and budgets for proposed actions. The plans are to be updated every five years. Specific objectives of an INRMP are to maintain, develop, and implement an ecosystem-based conservation program that:

- Provides a baseline source of natural resource ***information***;
- Provides the basis for formulating the Naval Base's natural resources ***budget***;
- Provides for ***conservation and rehabilitation*** of natural resources in a manner that is consistent with the military mission;
- ***Integrates and coordinates*** all PMRF natural resources management activities;
- Provides for sustainable ***multi-purpose uses*** of natural resources;
- Provides for ***public access*** for use of natural resources, ***subject to safety and military security*** considerations.

The present document addresses these topics with respect to the marine resources offshore of PMRF. These confines are defined as the shorelines and nearshore environments *per se*, and do not consider the setting of the various streams or ditches that flow from the watershed into the ocean. The bulk of the work consists of item number one in providing a baseline source of information of the natural resource setting of the marine habitats. We have divided the contents of the report into three sections. The first section is a presentation of a physical and biotic zonation pattern which differentiates the major habitat types found off of PMRF. The overview includes descriptions of the fishery components of the area. The second section provides an overview of the threatened and endangered species. The third section which serves as a summary

based on the information in the previous sections provides recommendations for activities that will fulfill the objectives of the INRMP.

METHODS

Marine community structure as represented in this report can be defined as the abundance, diversity, and distribution of benthos (bottom dwelling organisms), including stony and soft corals, marine plants (algae), motile benthos such as echinoderms, pelagic species such as reef fish, and federally protected endangered and threatened species. When considering environmental changes caused by changes in land use or changes in non-point input of water of altered composition, benthic communities, and reef corals in particular, are probably the most useful biological assemblages for direct evaluation of environmental impacts to the offshore marine environment. Because corals are generally long-lived, immobile, and can be significantly affected by exogenous input of sediments and other potential pollutants, these organisms must either tolerate the surrounding conditions within the limits of adaptability or die.

Divers using SCUBA equipment and working out of a 26-foot boat conducted the field surveys at PMRF on April 22-25, 2000. Because of the limited time available, and the large area to be covered, the survey was conducted as a rapid ecological assessment. Several techniques were employed for the surveys designed to maximize results in the limited time available. The first method consisted of towing investigators along the side of the boat in water depths shallow enough to clearly observe the bottom. Such tows allowed for relatively rapid coverage of the entire length of the study area, and were valuable in providing information of overall habitat types and community assemblages, and relative differences between habitats and communities.

The second method of investigation consisted of SCUBA dives at several areas that investigators agreed were the regions of primary concern (from information obtained during the tow surveys). The dive sites were selected based on the greatest relative abundance of biotic assemblages and greatest vertical relief (biotic composition is generally a function of vertical relief). Such criteria for the selection of sites were judged to be the most important as the areas with the greatest biotic composition would likely have the highest potential for impacts from shoreline activities. Because of time constraints, intensive quantitative surveying techniques employing transects, quadrats, etc. were not employed. Rather, investigators during point-to-point underwater swims at each dive site evaluated abundance and other characteristics of marine communities. Investigations were limited to a maximum depth range of 20 meters (m).

While no explicit quantitative surveys were carried out for the present project, one of the authors (S. Dollar) has previously carried out repetitive quantitative surveys in the area as part of the required compliance for the National Pollution Discharge Elimination System (NPDES) permit for the Zone of Mixing of the Kekaha Sugar Mill Discharges. These surveys involved quantitative transects that enumerated benthos and fish at ten sites off of the sugar mill discharges, including the Nohili and Kawaiele discharges within the boundaries of PRMF, and were conducted annually from 1994 to 1997 (Marine Research Consultants 1994, 1995, 1996, 1997). In addition, the second author (R. Brock) conducted a detailed evaluation of the green sea turtle abundance off PMRF in 1990 in conjunction with planning for the Kauai Test Facility (Brock 1990). The results of all of these previous surveys are utilized in the evaluation of marine resources for the present report.

PHYSICAL and BIOTIC ZONATION OF PMRF

The coastal area covered in this study extends offshore from the landside boundaries of PMRF, which are defined by the southern edge of Polihale State Park south to Kokole Point (Figure 1). A continuous white sand beach comprises most of the shoreline along the length of the study area; landward of the beaches lies the Mana Coastal Plain, which is a low flat area. The missile range facility occupies a narrow band along the coastline; the remainder of the Mana Plain is presently planted in sugarcane. Owing to the low elevation of the plain, groundwater and irrigation water must be continually pumped from areas of the plain planted in sugarcane. Discharges of water pumped from sugarcane fields are located off of the Kawaiele Pumping Station, and near Nohili Point (Figure 1). Water pumped into the drainage discharges (e.g., ditches) has a salinity of approximately 10‰ (Nance, personal communication) indicating that it is approximately 1/3 seawater and 2/3 freshwater from groundwater and sugarcane irrigant leachate. Discharge water consistently has been noted to contain high loadings of terrigenous particulates (red mud) that washes from the sugar cane fields.

The quantity and quality (with respect to terrigenous loads) of ditch water input appears to be a function of local rainfall and runoff. Aerial photographs of the Nohili area reveal that discharge of turbid water from the ditch can vary greatly in volume and composition. During periods of low discharge, the plume is nearly undetectable, while at other times the plume, distinctly visible as opaque turbid water, extends for hundreds of meters up the coast. As a result, the marine habitats in the vicinity of the two discharges are routinely exposed to substantial suspended terrigenous sediment loads. Sampling of discharge water from Nohili Ditch during the present study revealed turbidity values of 30-50 nephelometric turbidity units (ntu). However, approximately 20 m seaward, wave energy caused substantial mixing of plume water and ocean water, resulting in turbidity of 1-2 ntu. Visible particulate material was also contained primarily in a surface layer of low salinity water, resulting in little or no settlement of terrigenous sediment on the reef surface.

Owing to both the shape of the Island of Kauai, and the lack of any barrier reef structure, the force of breaking waves nearly continually scours the shoreline region. The essentially “round” shape of Kauai results in exposure from swells emanating from both the north and the south Pacific; hence the nearly continual wave action. The entire region offshore of PMRF is directly exposed to long-period swells generated by storms in both the north (winter) and south (summer) Pacific. In addition, the south and western coastal areas of Kauai were impacted by extremely large surf during Hurricanes Iwa (1982) and Iniki (1992). As a result of these physical processes, the nearshore areas at the monitoring sites are subjected to extreme stress from wave impact and scouring of sediment from wave action. As in many locations in the Hawaiian Islands, the composition of coral reef communities is structured primarily in response to physical forces of breaking waves (Dollar 1982, Dollar and Tribble 1993). Such is definitely the case off the coastline of PMRF.

The general marine topography of the nearshore region off of PMRF consists of four distinct sectors that are separated by distinct physiographic and biotic structure. The first three of these sectors are differentiated by distinctly different structure of the nearshore area, extending from the shoreline to a depth of approximately 15 meters. Each of these sectors is characterized by different zones between the shoreline and the edge of the reef at a depth of approximately 12 meters. The fourth sector is considered the “offshore” sector, and extends along most of the

entire length of PRMF within the depth range of 15 to 20 meters. For ease of identification, we have labeled these sectors:

1) Nohili sector, which extends from the northern end of the property to approximately 300 m south of Nohili Ditch;
2) Mana Point Sector, which extends from southward to the southern part of Mana Point,
3) Majors Bay Sector, which extends to the southern boundary of PMRF at Kokole Point, and
4) Offshore sector, within the 15 to 20 m depth contour.

Nohili Sector

Off of the Nohili area, from the northern end of the property to approximately 300 m south of the Nohili ditch (approximately the northern quarter of the study area), the shoreline consists predominantly of a limestone bench which is emergent at low tide and stands fronting sand dunes (Clark 1990). Moving seaward from the reef bench, a second zone occurs at a depth of 2-5 m which is the primary region that absorbs the impact of breaking waves. As a result of the near constant wave impact, a relatively smooth limestone bottom devoid of most vertical relief, as well as biotic assemblages characterizes the bottom in this area. At a depth of approximately 5 m, the flat bottom grades into a zone characterized by numerous deep, rubble-filled channels separating massive limestone fingers. These fingers are the remnants of fossil reef platforms which appear to be highly eroded into a karst-like topography. Such erosion results in numerous outcrops, ledges and caves (Figure 2.). Vertical relief of the reef structures up to 3 m in height results in a substantially more complex substratum than at the other zones.

Part of the substratum appears to be a fossilized reef of finger coral (*Porites compressa*) that remains as broken blocks scattered around one area of the bottom (Figure 3). The occurrence of the fossil reef of *P. compressa* is curious in that there is only sparsely distributed small living colonies of this species presently on the reef. The presence of the large fossilized blocks suggests that the physical oceanographic conditions must have been quite different at some point in earlier geological history than at present. Owing to its relatively fragile skeletal structure, *Porites compressa* usually requires relatively calm waters to sustain growth beyond the initial settlement stage. Calm water conditions for long periods of time (ca. 50-100 years) that would be required for the accumulation of skeletal structure observed on the fossil reef does not appear to the case today along this west facing shoreline of Kauai.

Because the vertical relief afforded by the eroded reef structures provides abundant solid surfaces above the bottom (and shifting sediment), the settlement of benthos, and particularly reef corals, is substantially higher than anywhere else in the study area. Quantitative transect data from three stations within the Nohili sector conducted as part of the Kekaha Sugar Mill ZOM monitoring revealed that total coral cover ranged between 32% and 39% of bottom cover (Marine Research Consultants 1997). The most abundant species were *Porites lobata*, *Pocillopora meandrina* and *Montipora patula*. Other species encountered on transects included *Porites compressa, Montipora verrucosa*, and *Pavona varians*. During the present investigation, several additional corals were noted in the Nohili sector, including *Porites evermanni, Pavona varians, P. duerdeni, Leptastrea purpurea, Montipora flabellata* and *M. verrilli*. Coverage by these corals was small as a percentage of total live coral, with *P. lobata* and *P. meandrina* comprising the majority of cover.

The topographical complexity of the biotope of channels provides considerable shelter for many fish and motile invertebrate species. In one 30 minute period, the following fishes were seen including the variegated lizardfish or 'ulae (*Synodus variegtus*), conger eel or puhi uha (*Conger cinerus*), three moray eel species including the puhi paka (*Gymnothorax flavimarginatus*), puhi oni'o (*Gymnothorax meleagris*) and puhi laumilo (*Gymnothorax undulatus*), squirrelfishes or ala'ihi (*Sargocentron diadema, S. xantherythrum* and *S. punctatissimum*), trumpetfish or nunu (*Aulsostomus chinensis*), menpachi or u'u (*Myripristes amaenus*), scorpionfish or nohu (*Scorpaenopsis diabolus*), cardinalfish or upapalu (*Apogon kallopterus*), hawkfishes including po'opa'a (*Cirrhitus pinnulatus*), hilu piliko'a (*Paracirrhites forsteri*), and piliko'a (*Paracirrhites arcatus*), introduced snappers or ta'ape (*Lutjanus kasmira*) and to'au (*Lutjanus fulvus*), emperor or mu (*Monotaxis grandoculis*), chub or nenue (*Kyphosus bigibbus*), goatfishes including weke (*Mulloides flavolineatus*), weke'ula (*Mulloides vanicolensis*), malu (*Parupeneus pleurostigma*), munu (*Parupeneus bifasciatus*), moano kea (*Parupeneus cyclostomus*) and moano (*Parupeneus multifasciatus*), butterflyfish or lauhau (*Chaetodon quadrimaculatus*), kikakapu (*Chaetodon lunula, C. multicinctus, C. fremblii, C. ornatissimus* and *C. multicinctus*), lau wiliwili (*Chaetodon milaris*), lau wiliwili nukunuku 'io'io (*Forcipiger flavissimus*), sergeant major or mamo (*Abudefduf abdominalis*), damselfishes (*Chromis vanderbiliti, C. ovalis, Stegastes fasciolatus*), alo'ilo'i (*Dascyllus albisella*), wrasse (*Labroides phthirophagus*), a'awa (*Bodianus bilunulatus*), hilu (*Coris flavovittata*), hinalea 'akilolo (*Coris gaimard*), awela (*Thalassoma trilobatum*), opule (*Anampses cuvier*), hinalea luahine (*Thalassoma ballieui*), hinalea lauwili (*Thalassoma duperrey*), hinalea i'iwi (*Gomphosus varius*), omaka (*Stethojulis balteata*), parrotfishes or uhu (*Scarus sordidus, S. psittacus*), redlip parrotfish or palukaluka (*Scarus rubroviolaceus*), and the moorish idol or kihikihi (*Zanclus cornutus*).

As a group the surgeonfishes are well represented in the Nohili sector. Species commonly seen include the manini (*Acanthurus triostegus*), maikoiko (*A. leucoparieus*), na'ena'e (*A. olivaceus*), palani (*A. dussumieri*), pualo (*A. blochii* and *A. xanthopterus*), paku'iku'i (*A. achilles*), ma'i'i'i (*A. nigrofuscus*), maiko (*A. nigroris*), kole (*Ctenochaetus strigosus*), lau'ipala (*Zebrasoma flavescens*), umaumalei (*Naso lituratus*), kala (*Naso unicornis*), filefish or o'ili'lepa (*Cantherhines sandwichiensis*), triggerfishes or humuhumu mimi (*Sufflamen fraenatus*), humuhumu 'ele'ele (*Melichthys niger*), huuhumu lei (*Sufflamen bursa*), boxfish or moa (*Ostracion meleagris*), and the tobies (*Canthigaster jactator* and *C. cornata*). Other fish species seen in the biotope of channels include the papio or omilu (*Caranx melampygus*), the blue spotted grouper or roi (*Cephalopholis argus*) and the mackeral scad or opelu (*Decapterus macarellus*).

Several macroalgal species were encountered in this area including *Amansia glomerata, Desmia hornemannii* and limu kohu *Asparagopsis taxiformis.* Limu kohu was locally abundant at scales of 0.5 to 8 square meters; this local abundance is related to the Spring season when this species is known to be more abundant (Figure 4). Macroinvertebrates seen in this biotope include the rock oyster (*Spondylus tenebrosus*), cone shells (*Conus marmoratus, C. lividus, C. ebreus* and *C. leopardus*), sea urchins (*Echinometra mathaei, Echinothrix calamaris, E. diadema*), sea cucumbers (*Holothuria atra* and *Actionpyge mauritana*), sea star (*Linckia multiflora*), the slipper lobster or ula'papa (*Paribaccus antarcticus*) and the octopus or he'e (*Octopus cyanea*).

Discussions with several local fishermen indicate that many of the species above are frequently caught along with the aweoweo (*Priacanthus cruentatus*), other jack or papio species as well as a number of the species caught further south along the sand beach (see above). The standing crop

of fishes is estimated to range between 80 to 150 g/m^2 with the mean in the vicinity of 110 g/m^2 in this biotope.

Mana Point Sector

Along the central portion of PMRF, the intertidal shoreline bench is less well-formed and the shoreline consists of a sandy slope that grades into a flat limestone subtidal bench similar to that described in the Nohili sector. However, unlike the Nohili region where the offshore region beyond the flat bench is characterized by high relief from a karstian eroded fossil reef, the reef in the central area consists of a series of elongated low limestone mounds that often take on the shape of sloping-sided knolls or hummocks that are separated by channels filled with white sand. The knolls are oriented perpendicular to the shoreline, and rise from the sandy bottom one to three meters (Figure 5). The tops of the knolls form reef platforms that are predominantly flat with little structural relief other than low depressions and channels that are filled with coarse white sand (Figure 4). Hence vertical relief is far less in this area than in the Nohili sector. The surface of the knolls are pitted by bioerosion, mostly as a result of the boring action of several species of sea urchins. A ubiquitous feature of the reef platforms is a veneer of sandy sediment that appears to be in a state of continual resuspension as a result of wave surge.

The predominant biotic assemblage on the reef platform is a low algal turf composed of various species of benthic marine algae. As in the Nohili sector, *Asparagopsis taxiformis* (limu kohu) was the most abundant macroalgae, covering large areas of the tops of the reef knolls (Figure 4).

In the Mana sector, living corals are generally sparsely distributed, and occur predominantly as flat encrustations on the flat bottom. The continual wave action results in scouring of sand on the tops of the knolls and appears to be a limiting factor for coral growth on the reef platforms. Results of quantitative transect surveys indicated that coral cover in this sector ranged from about 16% to 20%, or approximately one half that found in the Nohili sector. The dominant coral species in the Mana sector (*Porites lobata*) was the same as in the Nohili. Other species that occurred on the tops of the knolls were also the same as observed off Nohili.

As with corals, fish were correspondingly less abundant on the flat platforms of the Mana sector. Where small depressions and undercutting were encountered in the hard bottom, a number of fishes were seen. Species commonly encountered include the puhi laumilo or moray eel (*Gymnothorax undulatus*), ala'ihi or squirrelfish (*Sargocentron punctatissimum*), blacktail snapper or to'au (*Lutjanus fulvus*), weke or yellowstripe goatfish (*Mulloides flavolineatus*), sidespot goatfish or malu (*Parupeneus pleurostigma*), manybar goatfish or moano (*Parupeneus multifasciatus*), damselfishes (*Plectroglyphidodon imparipennis* and *Chromis vanderbilti*), sergeant major or mamo (*Abudefuf abdominalis*), damselfish or alo'ilo'i (*Dascyllus albisella*), tableboss or a'awa (*Bodianus bilunulatus*), wrasse or hinalea (*Coris venusta*), cigar wrasse or kupoupou (*Cheilio inermis*), saddleback wrasse or hinalea lauwili (*Thalassoma duperrey*), stareye parrotfish or ponuhunuhu (*Calatomus carolinus*), orangebar surgeonfish or na'ena'e (*Acanthurus olivaceus*), ringtail surgeonfish or pualo (*Acanthurus blochii*), eye-stripe surgeonfish or palani (*Acanthurus dussumieri*), brown surgeonfish or ma'i'i'i (*Acanthurus nigrofuscus*), triggerfish or humuhumu nukunuku apua'a (*Rhinecanthus rectangulus*), boxfish or moa (*Ostrcion meleagris*) and toby (*Canthigaster jactator*). Also seen under the shelter of ledges are spiny lobsters or 'ula (*Panulirus marginatus*) and on the nearby hard bottom are occasionally seen the octopus or he'e (*Octopus cyanea*).

In this central part of the PMRF shore fishermen target a number of commercially important species including Pacific threadfin or moi (*Polydactylus sexfilis*), a number of jack or papio species (family Carangidae such as omilu - *Caranx melampygus*, yellow papio or pa'opa'o - *Gnathanodon speciosus*, lemon spot papio - *Carangoides ferdau* and the silver papio or pa'u'u - *Caranx ignobilis*) as well as the bonefish or 'oio (*Albula vulpes*). Commercial fishermen sometimes find schools of the bigeye scad or akule (*Selar crumenophthalmus*) in the water offshore of the PMRF which are captured using nets. The estimated standing crop or biomass in the Mana sector is not high because of the relative scarcity of shelter. The biomass is estimated to range between 2 to 30 g/m ^{2} and the mean is about 10 g/m^2 in this biotope.

Major's Bay Sector

The southernmost sector of the PMRF consists of a slight indentation in the coastline that is commonly called Major's Bay or Waiokapua Bay. The Bay terminates to the south at Kokole Point, and to the north by Mana Point. The nearshore region of Majors Bay differs substantially from the two northern sectors in that there is little solid reef structure within the nearshore area within the 20 m depth contours. Rather, nearly the entire bottom consists of shifting sands. Results of quantitative transects conducted at selected areas within this region where that at least some hard bottom was encountered, and revealed coral cover of less than 2% of bottom cover.

Offshore Sector

This zone, or biotope, is essentially continuous along the northern region of PMRF seaward of the Nohili and Mana sectors described above. The predominant physical structure of the area is a flat, pitted limestone surface (Figures 6 and 7). The seaward extent of this biotope is defined by the limestone shelf break encountered at 20 to 25 m in depth. This shelf break ranges from a vertical face to a 20 degree slope dropping away into sand at about 25 to 30 m of water (Figure 8). There are occasional potholes in the limestone flat that range from 1 to 5 m in diameter and up to 3 m in depth. These potholes are spaced from 20 to 80 m apart and thus are not a common feature.

The predominant corals found in this zone and occur as single large branching colonies are *Pocillopora eydouxi* (Figure 6). Because of the lack of wave forces at depth, these fragile branching forms may grow to heights up to 1 m. Other corals found on the platform are primarily smaller species that have a collective coverage of about 5% of bottom cover. Coral species seen include *Pocillopora meandrina*, *P. eydouxi, Porites lobata, Pavona varians, P. duerdeni, Montipora flabellata, M. patula, M. verrilli, M. verrucosa, Leptastrea purpurea* and *Fungia scutaria*. Also present along the shelf break is the black coral (*Antipathes dichotoma*) and wire coral (*Cirrhipathes anguina*) (Figure 8).

The general lack of cover and shelter sites for organisms is a prominent feature of this deep, low coral coverage biotope. Thus, where it occurs, many fishes and macroinvertebrates are aggregated about the available shelter. The exposed nature of the substratum enables a better delineation of many otherwise cryptic species. Macroinvertebrates seen in this biotope other than corals include the sea urchins (*Echinometra mathaei, Tripneustes gratilla, Echinostrephus aciculatum, Echinothrix diadema, E. calamaris,* and *Eucardis metularia*), cone shells (*Conus lividus, C. miles, C. leopardus, C. miliaris, C. distans, C. imperialis*), rock oyster (*Spondylus*

tenebrosus), polychaete worm (*Loimia medusa*), cushion star (*Culcita novaeguineae*), starfish (*Linckia diplax*), and octopus or he'e (*Octopus cyanea*).

Fishes seen in the deep biotope of open limestone include the puhi paka (*Gymnothorax flavimarginatus*), anthias (*Anthias thompsoni*), po'opa'a (*Cirrhites pinnulatus*), hilu piliko'a (*Paracirrhites forsteri*), piliko'a (*P. arcatus* and *Cirrhitops fasciatus*), to'au (*Lutjanus fulvus*), mu (*Monotaxis grandoculis*), weke'ula (*Mulloides vanicolensis*), moano kea (*Parupeneus cyclostomus*), moano (*P. multifasciatus*), kikakapu (*Chaetodon auriga, C.kleinii, C. multicinctus, C. quadrimaculatus*), lau wiliwili (*C. milaris*), butterflyfishes (*Hemitaurichthys polylepis, Heniochus diphreutes*), lau wiliwili nukunuku'io'io (*Forcipiger flavissimus*), angelfishes (*Holocanthus arcuatus, Centropyge potteri, C. fisheri*), damselfishes (*Plectroglypidodon johnstonianus, Chromis hanui, C. agilis, C. vanderbilti, C. verator*), alo'ilo'i (*Dascyllus albisella*), po'ou (*Cheilinus unifasciatus*), wrasses (*Laborides phthirophagus, Pseudocheilinus tetrataenia, Pseudojuloides cerasinus*), a'awa (*Bodianus bilunulatus*), hinalea lauwili (*Thalassoma duperry*), 'ohua (*Halichoeres ornatissimus*), spectacled parrotfish or uhu uliuli (*Scarus perspicillatus*), palukaluka (*Scarus rubroviolaceus*), kihikihi (*Zanclus cornutus*), na'ena'e (*Acanthurus olivaecus*), palani (*Acanthusu dussumieri*), pualo (*Acanthurus xanthopterus*), ma'i'i'i (*Acanthurus nigrofuscus*), maiko (*Acanthurus nigroris*), kole (*Ctenochaetus strigosus*), umaumalei (*Naso lituratus*), sleek unicornfish or kala holo (*Naso hexacanthus*), spotted unicornfish or kala lolo (*Naso brevirostris*), blenny (*Plagiotremus ewaensis*), triggerfish (*Xanthichthys auromarginatus*), humuhumu mimi (*Sufflamen fraenatus*), humuhumu lei (*Sufflamen bursa*), humuhumu'ele'ele (*Melichthys niger*), humuhumu hi'ukole (*Melichthys vidua*), and tobies (*Canthigaster jactator* and *C. coronata*).

Several wandering predatory species were also seen during the survey of the biotope of open limestone; these include the grey snapper or uku (*Aprion virescens*), a small school of opelu (*Decapterus macarellus*), leatherback or la'i (*Scombroides laysan*) and papio (*Caranx melampygus, Caranx ignobilis* and *C. cheilio*). The standing crop of fishes in this biotope is estimated to be 50 g/m^2. (reference?)

THREATENED AND ENDANGERED SPECIES

Marine Mammals

There are frequent sightings of the endangered Hawaiian monk seal (*Monachus schauinslandi*) both in nearshore waters and hauled out on beaches all around Kauai, including the vicinity of PMRF. In addition, it has been documented that at least four monk seal pups have been born at PMRF since 1989. Unfortunately, three of these pups have been found dead.

During the winter breeding season from December through May endangered humpback whales (*Megaptera novaeangliae*) are present in coastal waters, primarily within water depths of 300 m of the main Hawaiian Islands, including the areas off PMRF. Non-listed protected (Marine Mammal Protection Act) marine mammals that may be found in the coastal waters of Kauai include spinner dolphins *(Stenella longirostris*), spotted dolphins (*S. artenuata*), bottlenose dolphins (*Tursiops truncatus gilli*), false killer whales (*Psuedorca crassidens*), pilot whales (*Globicephala macrorhynchus*), melon headed whales (*Peponocephala electra*) and pygmy killer whales (*Feresa attenuata*). There are other species of small cetaceans that may be present in coastal waters but are generally cryptic and not often observed.

During the course of the fieldwork notes were taken on all threatened and endangered species seen offshore of the PMRF. Two small pods of spinner dolphins (*Stenella longirostris*) were seen in the southern part of the site, and have also been observed numerous times in the area during other fieldwork. One pod was estimated to be comprised of 12 individuals while the second had about 25 individuals. Both of these pods were moving in a northwest direction along the ~25 m isobath. Spinner dolphins are known to rest by day in bays and other protected waters around the Hawaiian Islands and there are several schools known to occur around Kauai. Shallenberger (1981) notes that the largest groups occurred between Nawiliwili and Waimea during that study. It was his opinion that rather than a number of small distinct schools, there are only two or three schools that are distinct, and each of these is made up of smaller discrete groups. The smaller groups are sometimes found by themselves and at other times they are aggregated into larger schools. Thus the two small pods seen in this survey probably are part of a larger group. Shallenberger (1981) notes that the small groups are believed to be tightly knit, cohesive social units that do not usually break up.

Hawaiian spinner dolphins appear to have a well-defined home range and can be found with a high degree of regularity in the same area. They are the most "inshore" of the Hawaiian cetaceans, spending considerable time close to shore in waters 15 m or less in depth (Shallenberger 1981). Shallenberger (1981) notes that the typical diurnal activity pattern or cycle for spinner dolphins is an early morning period of school movement and high activity (sexual, spins, head slaps, etc.), followed by a calm period lasting most of the day. In the late afternoon high activity recommences during which time the smaller groups may join together and head seaward presumably to feed during the night. Prey consumed by Hawaiian spinner dolphins are primarily mesopelagic fish and epipelagic squid suggesting the use of offshore feeding areas.

Hawaiian Green Sea Turtles

Because of declining populations the green sea turtle (*Chelonia mydas*) was granted protected status under the federally mandates Endangered Species Act in 1977-78. The endangered hawksbill turtle (*Eretmochelys imbricata*) also occurs, but in considered rare compared to the green turtle. Green turtles as adults are know to forage and rest in the shallow waters around the main Hawaiian Islands. Reproduction in the Hawaiian population occurs primarily in the Northwest Hawaiian Islands (NWHI). Adults migrate to the isolated NWHI in the summer, when reproduction takes place, and return to the main Hawaiian Islands in late summer or early fall. Nesting occurs on sandy beaches above the high tide mark; upon hatching, juvenile green turtles enter the sea where they presumably take up a pelagic existence until attaining a carapace length of about 30 cm. At this size, young turtles take up residence in the nearshore habitats around the main Hawaiian Islands.

In the nearshore habitat, green turtles will rest during the day along ledges or in caves in coastal waters at depths usually from 12 to 25 m. Under the cover of darkness, turtles will travel inshore to shallow subtidal and intertidal habitats to forage on selected species of marine algae (limu) (Balazs et al., 1987). The normal range of these daily movements between resting and foraging areas is believed not to exceed 1 km (Balazs 1980, Balazs et al., 1987). Thus, the ideal green turtle habitat in Hawaiian waters would have the presence of suitable resting areas (caves, depressions, ledges and undercuts), located within a kilometer of abundant algal pastures situated in shallow water.

Visual reconnaissance of the nearshore area off Nohili Point noted numerous turtles on the surface, particularly off the mouth of Nohili Ditch. Underwater observations identified an elongated depression approximately 20 m x 60 m in dimension within an area of numerous caves and undercuts directly offshore of Nohili Ditch. Four turtles, all at less than 75 cm in carapace length were observed underwater in resting behaviors within the depression. Ten years ago, fifteen turtles were counted in this area ranging in size (carapace length) 40 to 80 cm (Brock 1990).

The emergent limestone bench fronting Nohili Point has a diverse assemblage of macrothalloid algal species, many of which are forage species for green turtles. Preferred algal species by green turtles (per Balazs et al., 1987) on the bench fronting Nohili Point include limu lipuupuu (*Dictyospheria versluysii*), limu pahalahala (*Ulva fasciatus*), limu kala-lau-nunui *(Sargassum echinocarpum*), limu kala (*S. obtusifolium*), *Acanthophora specifera*, limu pepe-iao *(Amansia glomerata*), limu manauea (*Gracilaria coronopifolia*), limu huna (*Hypnea spp.*), limu huluilio (*Jania sp.*) Limu mane'one'o (*Laurencia nidifica*), limu plaewawae (*Laurencia sp.*) Spyridia filamentosa, and limu loloa (*Pterocladia capillacea*). In addition, large pastures of limu kohu (*Asparagopsis taxiformis*) were noted on the offshore reef bench throughout the Nohili Point area.

Observations of the intertidal area off Nohili ditch in 1989 conducted at dusk during high tide revealed a concentration of green turtles foraging on the seaward edge of the shoreline bench (Brock 1990). During a fifteen minute interval nine turtles were observed foraging within 50 m of either side of the ditch discharge directly inshore of the offshore resting habitat. Only one turtle was observed 50 m from the discharge up to a distance of approximately 200 m from either side of Nohili Ditch.

The apparent lack of turtles foraging on the bench at distances more than 50 m may be related to the distribution of limu loloa (*Pterocladia capillacea*) that was abundant on the shoreline bench in the vicinity of Nohili Ditch in 1989. On rocky intertidal coasts, *P. capillacea* occurs as a well-developed band in the lower intertidal from about mean low tide (zero) to about -30 cm. These algal bands are best developed in areas receiving some freshwater input. On the beach fronting the study site, *P. capillacea* is found from a point commencing about 80 m north of the ditch discharge to the southern terminus of the limestone bench (about 450 m to the south of the ditch). *Pterocladia* is of the preferred forage genera of green turtles (Balazs 1980); the foraging turtles encountered in this survey appeared to be feeding primarily on the band of *Pterocladia.*

Department of Land and Natural Resources personnel on Kauai (D. Heacock) report one documented case of nesting by a green turtle about 2 km north of Kokole Point in 1989. There have been two documented green turtle nests (producing 38 hatchlings) in the past year (1999) alone, and four indications of further nesting activity such as digs and pits in the Nohili Ditch area (Heacock, personal communication).

While Nohili Ditch discharges turbid fresh water at the shoreline within the boundary of the PMRF, observations and past studies from other locales suggest that this is not a detrimental factor affecting turtle behavior, and may actually be a favorable condition for turtles compared to areas without such discharge. During the dredging of swimming lagoon entrance channels at West Beach, Oahu, green sea turtles apparently vacated offshore resting habitat (about 1 km offshore) in favor of resting habitat about 250 m directly fronting the construction work. The

reason(s) for this shift are unknown, but at face value, it appears that the turbidity generated by the dredging was at least not a detriment to turtles inhabiting the area, and may have even provided a more suitable resting habitat as a result of the increased protection from predation offered by the lowered visibility of the turbid water (Brock, personal observations).

Within Pearl Harbor, Oahu, a well-utilized green turtle resting habitat is the crevice between the channel floor and the discharge pipe from the Fort Kamehameha Sewage Outfall. The crevice provides a narrow space that numerous small turtles squeeze into during the daylight hours, even though the turbidity of the water is generally so high that visibility is less than one foot. As with the Nohili area, the resting habitat under the sewage pipe lies adjacent to a foraging area on the Fort Kamehameha reef flat that contains high standing crops of preferred algal forage species (Dollar, personal observation).

The combination of a desirable nesting beaches, foraging habitat, and resting habitat all situated within a small geographical area combine to provide an ideal "complete habitat" for green sea turtle at Nohili Ditch at PMRF. The suitability of the forage area is enhanced by the combination of ideal intertidal physiography (limestone bench) and the abundance of preferred forage species of algae that are a response to nutrient subsidies provided by the freshwater discharge from the Ditch.

It appears that any impacts associated with the operation of PMRF and threatened and endangered species would occur on the sand beaches. As noted, green sea turtles have been noted to use the beach for nesting (oviposition of eggs). Should nesting continue, foot and vehicular traffic could result in compaction of sand that could either destroy the nests or preclude the successful emergence of hatchlings (Mann 1977). Similarly, the use of lights directed at the beach could be a deterrent to hatchlings (Carr and Ogren 1960, Mortimer 1981) and to turtles emerging to nest or successfully complete a nesting attempt. It might also be argued that light impinging on the foreshore could deter turtles from foraging in this area at night. However, Brock (1987) noted that green turtles foraged on the intertidal bench at Paradise Cove, West Beach, Oahu, during the evening under floodlights with a "Hawaiian luau" going on nearby for several hundred people. These observations suggest that green turtles may habituate to nearby human activities. Similar evidence of such habituation has been noted by the authors at the Hawaii Kai Marina in East Oahu (Brock 1989), and within Kailua Bay in Kailua-Kona, on the Island of Hawaii (Dollar, personal observation).

The controlled access of the public to the beach resources at PMRF has probably served to conserve and protect the green turtles in the Nohili Point area. The controlled access which has been in place for years may serve to reduce possible poaching and/or disturbance to resident turtles or seals. The results of the present survey, as well as past work, have shown that green turtles reside primarily in the waters just off the Nohili Ditch and forage on algal resources present on the intertidal bench within the influence of the ditch discharge. These data suggest that the operation of the facility to date has not served to deter turtles from utilizing the marine habitats at PMRF.

RECOMMENDATIONS

The potential for impacts to threatened and endangered species by the actual activities at PMRF within the nearshore ocean are considered minimal. As none of the primary activities (e.g.,

launching of missiles) takes place on the beaches or within the nearshore ocean, there is essentially no means for direct impacts to occur. Rather, indirect activities associated with increased access to beaches and the nearshore ocean afforded by the facility appear to be the most important factor with respect to management of natural resources.

As discussed above, the beaches of PMRF are desirable haul-out areas for both Hawaiian green sea turtles and monk seals. In addition, these beaches have been utilized as pupping grounds for seals, and nesting sites for turtles. As these breeding activities are relatively rare for beaches in the main Hawaiian Islands, management actions should strive to limit human disturbances, particularly vehicular activities, to the greatest extent possible. Increased public awareness, through appropriate signage, legal protection enforcement, and educational materials should also be implemented as management measures.

With respect to aquatic and marine resources, statements have been made that Nohili and Kawaiele ditches are polluting coastal waters through organic loading and increased turbidity. Nutrient discharges from ditch discharge has been assumed responsible for fish kills, and for promoting conditions that could lead to toxic algal blooms. A solution offered to amend these perceived conditions is to restore the wetlands at the terminus of the ditches to serve as natural biofilters.

While restoration of wetlands may be a worthwhile effort, it must be stated by the authors that a valid justification for such an action does not include "pollution" of coastal waters by ditch discharge. Extended study of the reefs off of the ditch discharge area indicates that the open coastal nature of the receiving waters results in very rapid dilution and dispersal of the freshwater plumes. In addition, most of the particulate material that reaches the ocean is contained in a surface plume of lower density water, resulting in little contact with the ocean bottom. In fact, coral communities were most abundant in the vicinity of the Nohili discharge, and no terrigenous materials were noted to accumulate on the reef surface. Should the ditches drain to enclosed basins or embayments, the effects to receiving waters might be considerably different than what is observed in the high energy open coastal shoreline system found at PMRF.

Rather than causing "toxic algal blooms" the freshwater discharge at Nohili appears to be at least partially responsible for the preferred turtle foraging habitat by stimulating filamentous algae growth on the nearshore reef bench. Similarly, several documented cases indicate that turtles utilize turbid water for resting habitat, and may even prefer such conditions to clear water. As a result, altering the flow of freshwater to the nearshore zone could result in lessening the high desirability of the area for green sea turtles in terms of both foraging and resting habitats. Discharge of turbid waters from the drainage ditches does not represent a unique situation on Kauai, as numerous rivers throughout the Island drain to the ocean.

With respect to the offshore resources, the results of this study indicate several possible actions. Boat traffic in the area is substantial in terms of fishing boats and commercial vessels carrying people from Port Allen and Kikiaola Harbors to the Na Pali coast. The combination of relatively high populations of turtles and seals in the region, and appreciable boat traffic could raise the potential for boat impact with these animals. Limitation of speed, or development of a distance envelope from the shoreline in which boats cannot travel could mitigate such problems.

Inspection of the reefs indicated that there are no apparent problems with anchor damage or debris accumulation (including fishing gear) that could be corrected with increased management. Local fisherman operating from boats generally work fishing grounds that are relatively far from shore that are beyond the range of PMRF management. Access to the beach for shore fishing should be considered a positive public relations action between PMRF and the Kauai populace. However, such access presently results in vehicular traffic on the beach that can be detrimental to protected and endangered species. Therefore, vehicular traffic on the beaches of PMRF, especially in areas frequented by protected species should be more closely managed in terms of vehicular access and use while continuing to provide pedestrian access in appropriate areas.

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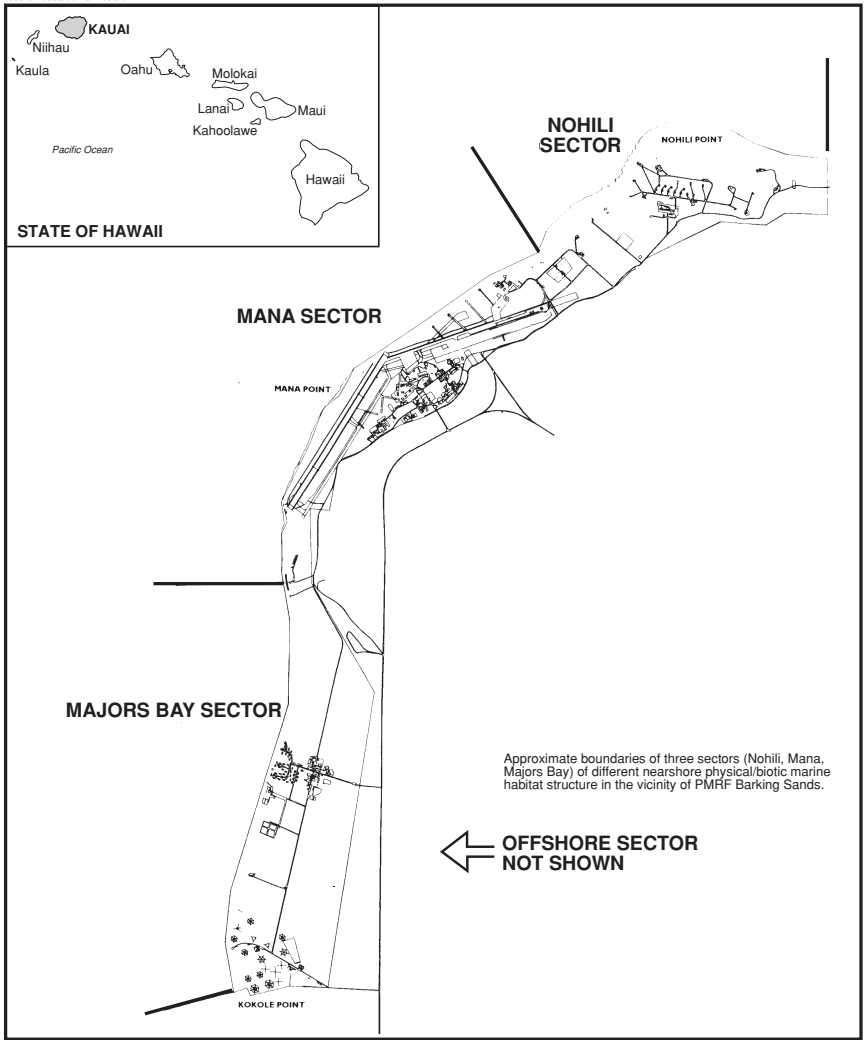
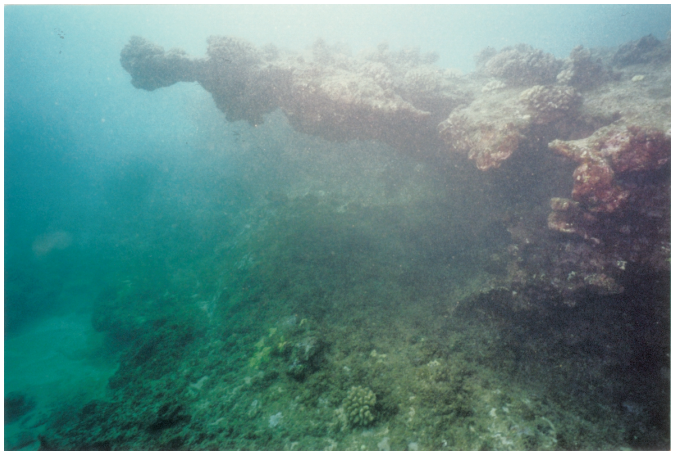


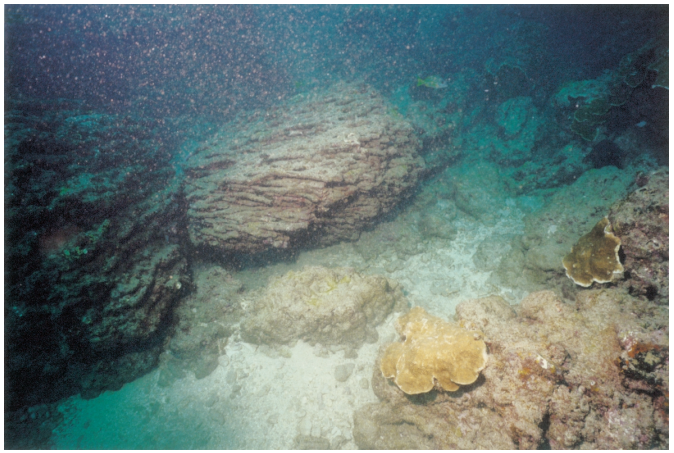
Figure 1
MARINE SECTORS, BARKING SANDS, KAUAI
APPENDIX C: MARINE AND FISHERIES RESOURCES

Integrated Natural Resource Management Plan
Pacific Missile Range Facility

1999.82.0603/002-9 k1/30/01



2. Undercut limestone ledge off Nohili Point at PMRF Kauai. Water depth is approximately 10 m. Ledges and caves serve as green sea turtle resting habitat.

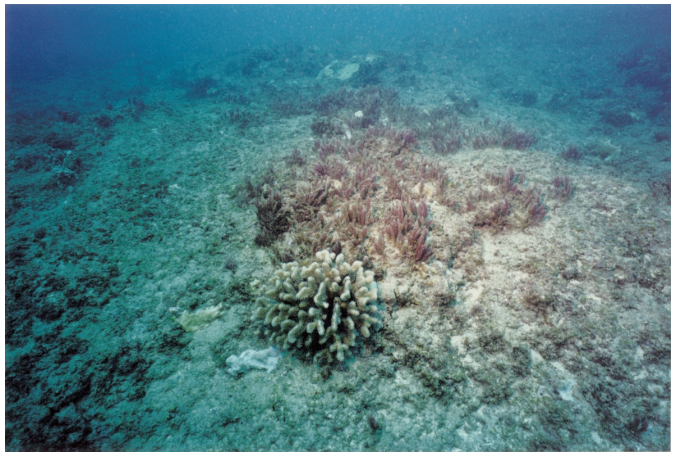


3. Large blocks of broken fossil *Porites compressa* reef off Nohili Point, PMRF Kauai. Very little living *P. compressa* is presently found on the reef, indicating substantially different physical conditions in past decades. Water depth is approximately 12 m.

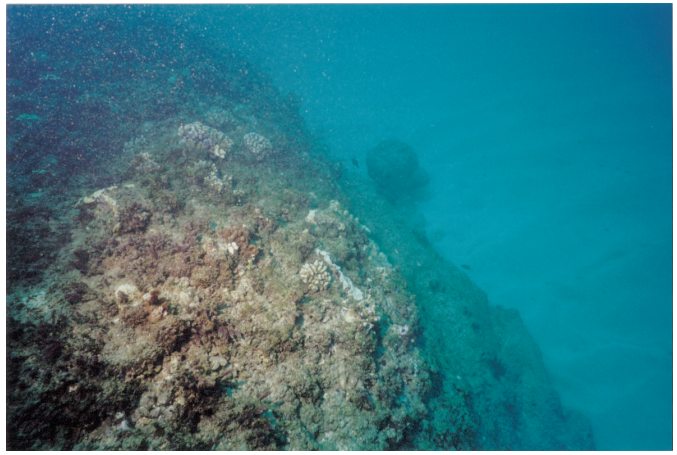
Source: Marine Research Consultants. May 2000.

Figures 2 & 3
MARINE LEDGES AND CAVES, NOHILI SECTOR, BARKING SANDS, KAUAI
APPENDIX C: MARINE & FISHERIES RESOURCES

Integrated Natural Resource Management Plan
Pacific Missile Range Facility



4. Top surface of coral knoll within the Mana sector of the PMRF. Branching coral in foreground is *Pocillopora meandrina*. The abundant filamentous red algae is *Asparagopsis taxiformis*, which is seasonally abundant throughout the reef tops. Water depth is approximately 8 m.

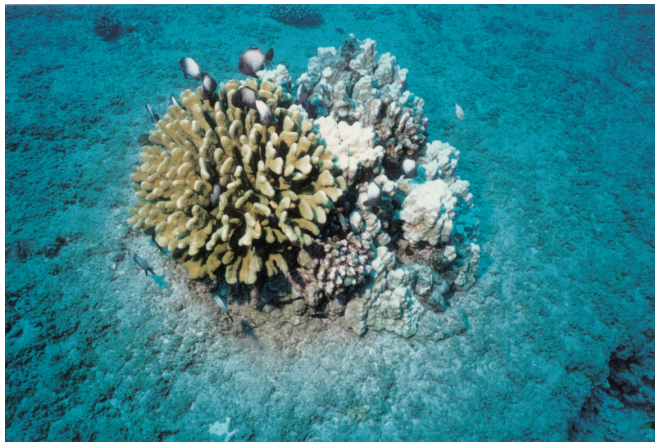


5. Sloping edge of reef knoll which terminates in channel of white sand off the Mana sector of PMRF, Kauai. Water depth is approximately 10 m.

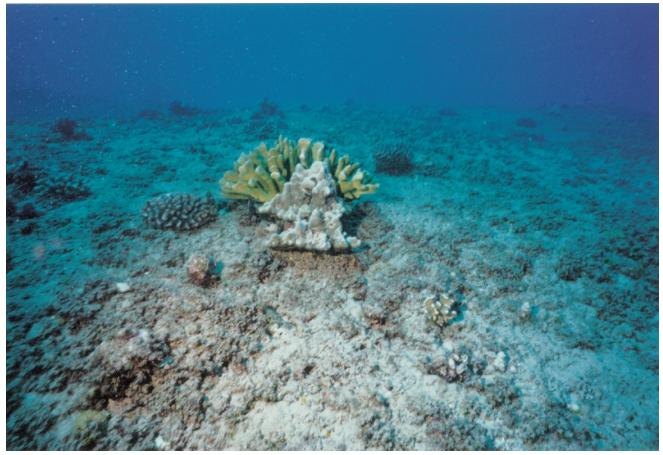
Source: Marine Research Consultants. May 2000.

Figures 4 & 5
MARINE LEDGES AND CAVES, NOHILI SECTOR, BARKING SANDS, KAUAI
APPENDIX C: MARINE & FISHERIES RESOURCES

Integrated Natural Resource Management Plan
Pacific Missile Range Facility



6. Large colony of *Pocillopora eydouxi* on outer reef flat off of PMRF. Isloted colonies of this coral are found sporadically on the pitted reef surface inhabited by the black and white damselfish *Dascyllus albisella*. Water depth is approximately 20 m.



7. Low angle view of flat surface of offshore reef fronting PMRF. Water depth is approximately 20 m.

Source: Marine Research Consultants. May 2000.

Figures 6 & 7
MARINE LEDGES AND CAVES, NOHILI SECTOR, BARKING SANDS, KAUAI
APPENDIX C: MARINE & FISHERIES RESOURCES

Integrated Natural Resource Management Plan
Pacific Missile Range Facility

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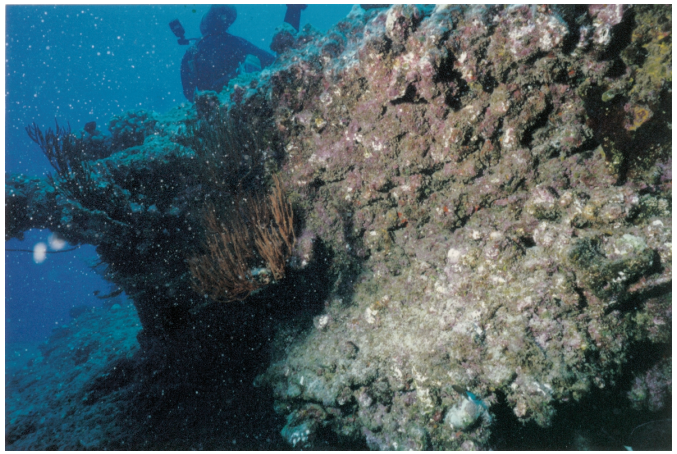

8. Undercut fossil shoreline at a depth of 24 m off PMRF. Branching red colony in left center of photo is black coral (*Antipathes dichotoma*).

Source: Marine Research Consultants. May 2000.

Figure 8
MARINE LEDGES AND CAVES, NOHILI SECTOR, BARKING SANDS, KAUAI
APPENDIX C: MARINE & FISHERIES RESOURCES

Integrated Natural Resource Management Plan
Pacific Missile Range Facility

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C3 - SUMMARY OF MARINE SPECIES OBSERVED OFF OF BARKING SANDS

1

Table 1: Marines Species Observed Off of Barking Sands

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Fish Species										
Family Myliobatidae										
		Aetobatis narninari	No	No	No	No	No	Yes	No	*No*
Family Albulidae										
		Albula glossodonta	No	No	No	No	No	Yes	No	*No*
Family Muraenidae										
	puhi laumilo	*Gymnothorax undulatas*	Yes	No	No	No	Yes	No	No	*Yes*
		G. flavimarginatus	Yes	No	No	No	No	No	Yes	*No*
		G. meleagris	Yes	No	No	No	No	No	No	*No*
		Gymnothorax steindachneri	No	No	No	No	No	Yes	No	*No*
		Conger cinerus	Yes	No	No	No	No	No	No	*No*
Family Synodontidae										
		Synodus gracilis	No	No	No	No	No	Yes	No	*No*
Reef Lizardfish	ʻulae	*Synodus varegatus*	Yes	No	No	No	No	No	No	*Yes*
Family Holocentridae										
menpachi*		*Myriprises amaena*	C	A	No	No	No	No	No	*No*
Crown squirrelfish	alaihi	*Sargocentron diadema*	C	C	No	No	No	No	No	*No*
Hawaiian squirrelfish	ʻalaiʻihi	*Sargocentron xantherythrum*	C	C	No	No	No	No	No	*No*

Source: Dollar et al 2006 and 2000; C= common; A= Abundant, Yes= noted but not common

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Peppered squirrelfish	ʻalaiʻihi	*Sargocentron punctatissimum*	Yes	C	No	No	Yes	No	No	*No*
Brick soldierfish	ʻuʻu	*Myripristis amanea*	No	No	C	A	No	No	No	*No*
Family Aulostomidae										
Trumpetfish	nunu	*Aulostomus chinensis*	Yes	Yes	No	Yes	Yes	Yes	No	*No*
Family Scorpaenidae										
Devil scorpionfish*	nohu ʻo mākaha	*Scorpaenopsis dibolus*	Yes	No	No	Yes	No	No	No	*No*
Jenkin's scorpionfish*	nohu	*Scorpaenopsis cacopsis*	No	Yes	No	No	No	No	No	*No*
Family Serranidae										
Peacock grouper	roi	*Cephalopholis argus* ***(A)***	C	Yes	No	Yes	No	No	No	*No*
		Pseudanthis thompsoni	No	No	No	No	No	No	Yes	*Yes*
Family Priacanthidae										
Glasseye	aweoweo	*Heteropriacanthus cruentatus*	No	C	No	No	No	No	No	*No*
Family Cirrhitidae										
Stocky hawkfish	poʻopaʻa	*Cirrhitus pinnulatus*	Yes	Yes	No	No	No	No	Yes	*No*
Arc-eye hawkfish	pilikoa	*Paracirrhites arcatus*	C	C	No	C	No	Yes	C	*C*
Blackside hawkfish	hilu pilikoa	*Paracirrhites forsteri*	Yes	Yes	No	Yes	No	No	Yes	*Yes*
Red-barred hawkfish		*Cirrhitops fasciatus*	No	Yes	No	Yes	No	Yes	Yes	*Yes*
Family Apogonidae										
Iridescent cardinalfish	ʻupapalu	*Apogon kallopterus*	Yes	C	No	Yes	No	C	C	*C*

Source: Dollar et al 2006 and 2000; C= common; A= Abundant

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Family Malacanthidae										
Flagtail tilefish	makaʻa	*Malacanthus brevirostris*	No	No	No	No	No	Yes	No	*Yes*
Family Carangidae										
Island trevally	papio	*Carangoides orthogrammus*	Yes	Yes	No	No	No	No	No	*No*
Bluefin trevally	ʻomilu	*Caranx melampygus*	Yes	Yes	No	Yes	No	No	Yes	*Yes*
		Caranx cheilio	No	No	No	No	No	No	Yes	*No*
Mackerel scad	ʻopelu	*Decapterus macarellus*	C	No	No	No	No	No	Yes	*C*
Yellow jack or golden travally	ulua paʻopaʻo	*Gnathanodon speciosus*	No	No	No	Yes	No	No	Yes	*Yes*
Family Lutjanidae										
Gray snapper or green jobfish*	uku	*Aprion virescens*	No	Yes	No	No	No	Yes	Yes	*Yes*
Blacktail snapper*	toʻau	*Lutjanus fulvus* ***(A)***	Yes	C	No	C	Yes	No	Yes	*Yes*
Bluestripe snapper	taʻape	*Lutjanus kasmira* ***(A)***	C	A	C	C	C	A	No	*C*
Family Lethrinidae										
Bigeye emperor*	mu	*Monotaxis grandoculis*	Yes	C	No	C	No	No	Yes	*Yes*
Family Mullidae										
Yellowstripe goatfish*	wekeʻa	*Mulloidichthys flavolineatus*	C	A	No	No	C	C	No	*C*
Yellowfin goatfish*	wekeʻula	*Mulloidichthys vanicolensis*	C	A	C	No	No	No	Yes	*C*
Manybar goatfish *	moano	*Parupeneus multifasciatus*	C	C	Yes	C	Yes	Yes	C	*Yes*
Sidespot goatfish*	malu	*Parupeneus pleurostigma*	Yes	Yes	No	C	Yes	Yes	No	*Yes*

Source: Dollar et al 2006 and 2000; C= common; A= Abundant, Yes= noted but not common

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Doublebar goatfish*	munu	*Parupeneus bifasciatus*	Yes	Yes	Yes	Yes	No	No	No	Yes
Blue goatfish	moano kea	*Parupeneus cyclostomus*	Yes	No	No	No	No	No	Yes	Yes
Whitesaddle goatfish	kumu	*Parupeneus porphyreus*	No	No	No	No	No	Yes	No	No
Family Kyphosidae										
Gray chub, rudderfish*	nenue	*Kyphosus bigibbus*	C	C	No	A	No	No	No	No
Family Chaetodontidae										
Raccoon butterflyfish	kikakapu	*Chaetodon lunula*	No	No	No	No	No	Yes	No	No
Threadfin butterflyfish	kikakapu	*Chaetodon auriga*	No	Yes	No	No	No	No	Yes	No
Butterflyfish	kikakapu	*Chaetodon kleini*	No	No	No	No	No	No	C	C
Bluestripe butterflyfish	kikakapu	*Chaetodon fremblii*	Yes	No	No	No	No	No	No	No
Teardrop butterflyfish	lauhau	*Chaetodon unimaculatus*	Yes	Yes	No	No	No	No	No	No
Raccoon butterflyfish	kikakapu	*Chaetodon lunula*	Yes	No	No	Yes	No	No	No	No
Milletseed butterflyfish	lau wiliwili	*Chaetodon miliaris*	Yes	Yes	No	Yes	No	No	Yes	C
Multiband butterflyfish	kikakapu	*Chaetodon multicinctus*	C	No	No	No	No	No	C	No
Ornate butterflyfish	kikakapu	*Chaetodon ornatissimus*	Yes	Yes	No	Yes	No	No	No	No
Fourspot butterflyfish	lauhau	*Chaetodon quadrimaculatus*	Yes	Yes	Yes	Yes	No	No	Yes	No
Longnose butterflyfish	lau wiliwili nukunuku ʻoiʻoi	*Forcipiger flavissimus*	Yes	Yes	No	No	No	No	Yes	Yes
Pennantfish	--	*Heniochus diphreutes*	No	No	No	No	No	No	C	Yes
Pyramid butterflyfish	--	*Hemitaurichthys polylepis*	No	No	No	No	No	No	Yes	Yes

Source: Dollar et al 2006 and 2000; C= common; A= Abundant, Yes= noted but not common

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Family Oplegnathidae										
Spotted knifejaw*	--	*Oplegnathus punctatus*	No	Yes	No	No	No	Yes	No	*No*
Family Pomacentridae										
Agile chromis	--	*Chromis agilis*	No	No	No	No	No	No	C	*C*
Hawaiian sergeant major	mamo	*Abudefduf abdominalis*	A	C	C	C	Yes	No	No	*No*
Oval chromis	--	*Chromis ovalis*	C	No	No	No	C	No	No	*No*
Blackfin chromis	--	*Chromis vanderbiliti*	A	A	A	A	A	A	A	*A*
Hawaiian bicolor chromis	--	*Chromis hanui*	No	C	No	No	No	No	Yes	*C*
Threespot chromis	--	*Chromis verator*	No	No	No	No	No	No	C	*C*
Hawaiian damsel	ʻaloʻiloi	*Dascyllus albisella*	C	No	No	No	Yes	No	C	*C*
Blue-eye damselfish	--	*Plectroglyphidodon johnstonianus*	No	No	No	Yes	No	No	Yes	*Yes*
Damselfish		*Plectroglyphidodon imparipennis*	No	No	Yes	Yes	Yes	No	No	*No*
Pacific gregory		*Stegastes fasciolatus*	Yes	Yes	No	No	No	No	No	*No*
Family Pomacanthidae										
Bandit angelfish	--	*Holocanthus arcuatus*	No	No	No	No	No	No	Yes	*Yes*
Potter's angelfish	--	*Centropyge potteri*	No	No	No	No	No	No	Yes	*Yes*
--	--	*Centropyge fisheri*	No	No	No	No	No	No	Yes	*No*
Family Labridae										
Hawaiian dogfish	ʻaʻawa	*Bodianus bilunulatus*	Yes	Yes	No	Yes	Yes	No	Yes	*Yes*
Wrasse	hinalea	*Coris venusta*	Yes	Yes	Yes	No	Yes	C	No	*No*
Yellowstripe coris	hilu	*Coris flavovittata*	Yes	No	No	No	No	No	No	*Yes*

Source: Dollar et al 2006 and 2000; C= common; A= Abundant, Yes= noted but not common

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Yellowtail coris	hinalea ʻakilolo	*Coris gaimard*	Yes	No	Yes	No	No	No	No	*Yes*
Pearl wrasse	opule	*Anampses cuvier*	Yes	No	Yes	No	No	No	No	*No*
Ornate Wrasse	ʻohua	*Halichoeres ornatissimus*	No	Yes	No	C	No	No	Yes	*Yes*
Bird wrasse	hinalea ʻiʻiwi	*Gomphosus varius*	Yes	C	No	C	No	No	No	*No*
Hawaiian cleaner wrasse	--	*Labroides phthirophagus*	Yes	Yes	No	Yes	No	Yes	Yes	*No*
Belted wrasse	omaka	*Stethojulis balteata*	C	No	No	No	No	No	No	No
Saddleback wrasse	hinalea lauwili	*Thalassoma duperrey*	C	C	C	C	C	C	C	C
Blacktail wrasse	hinalea luahine	*Thalassoma ballieui*	Yes	No	No	No	Yes	No	No	No
Christmas wrasse	awela	*Thalassoma trilobatum*	Yes	No	Yes	No	No	No	No	No
Rainbow or surge wrasse	hou	*Thalassoma purpureum*	No	Yes	No	No	No	No	No	No
Eightstripe wrasse	--	*Pseudocheilinus octotaenia*	No	Yes	No	No	No	No	No	No
Peacock razorfish	laenihi	*Xyrichtys pavo*	No	No	No	No	No	Yes	No	No
Cigar wrasse	kupoupou	*Cheilio ineris*	No	No	No	No	No	Yes	No	No
--	--	*Cheilinus rhodochrous*	No	No	No	No	No	No	Yes	No
--	--	*Pseudocheilinus tetrataenia*	No	No	No	No	No	No	Yes	No
Smalltail wrasse	--	*Pseudojuloides cerasinus*	No	No	No	No	No	No	Yes	Yes

Source: Dollar et al 2006 and 2000; C= common; A= Abundant; Yes= noted but not common

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Family Scaridae										
Stareye parrotfish	ponuhunuhu	*Calotomus carolinus*	No	Yes	No	No	Yes	No	No	No
Spectacled parrotfish*	uhu uli uli, ulu ʻahuʻula	*Scarus perspicillatus*	No	C	No	No	No	No	Yes	Yes
Bullethead parrotfish	uhu	*Scarus sordidus*	Yes	Yes	No	No	No	Yes	No	No
Palenose parrotfish	uhu	*Scarus psittacus*	Yes	C	No	C	No	No	No	No
Redlip parrotfish*	palukaluka	*Scarus rubroviolaceus*	No	C	No	Yes	No	No	Yes	Yes
Family Blenniidae										
Shortbodied blenny	paoʻo kauila	*Exallus brevis*	No	No	No	Yes	No	No	No	No
Biting blenny		*Plagiotremus goslinei*	Yes	Yes	No	Yes	No	No	No	Yes
		Plagiotremus ewaensis	No	No	No	No	No	No	Yes	No
Family Zanclidae										
Moorish idol	kihikihi	*Zanclus cornutus*	Yes	Yes	No	Yes	No	No	Yes	Yes
Family Acanthuridae										
Achilles tang	pakuʻikuʻi	*Acanthurus achilles*	Yes	No	No	No	No	No	No	No
Eyestripe surgeonfish*	palani	*Acanthurus dussumieri*	C	C	C	C	Yes	Yes	Yes	Yes
Ringtail surgeonfish*	pualu	*Acanthurus blochii*	C	C	Yes	C	Yes	C	No	Yes
Whitebar surgeonfish	maikoiko	*Acanthurus leucoparieus*	C	A	C	C	No	No	No	No
Brown surgeonfish*	maʻiʻiʻ	*Acanthurus nigrofuscus*	C	A	C	A	C	C	C	C
Blue-hued surgeonfish	maiko	*Acanthurus nigroris*	Yes	No	No	Yes	No	No	Yes	No
Orangeband surgeonfish*	naenae	*Acanthurus olivaceus*	Yes	C	Yes	A	Yes	C	C	C
Convict tang*	manini	*Acanthurus triostegus*	C	A	C	A	No	No	No	No

Source: Dollar et al 2006 and 2000; C= common; A= Abundant; Yes= noted but not common

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Yellowfin surgeonfish	pualu	*Acanthurus xanthopterus*	Yes	A	Yes	A	No	No	Yes	Yes
Gold-rim tang	--	*Acanthurus glaucopareius*	No	Yes	No	No	No	No		
Goldring surgeon*	kole	*Ctenochaetus strigosus*	C	C	No	C	No	No	C	Yes
Chevron tang	--	*Ctenochaetus hawaiiensis*	N	C	No	No	No	No	No	No
Sleek unicornfish	kala holo	*Naso hexacanthus*	No	No	No	No	No	No	Yes	C
Orangespine unicornfish	umaumalei	*Naso lituratus*	C	C	Yes	C	No	No	Yes	Yes
Bluespine unicornfish*	kala	*Naso unicornis*	Yes	C	Yes	C	No	No	Yes	C
Yellow tang	lauʻipala	*Zebrasoma flavescens*	Yes	C	No	C	No	No	No	No
Family Balistidae										
Black durgon	humuhumu ʻeleʻele	*Melichthys niger*	C	C	No	No	No	No	C	C
Pinktail durgon	humuhumu hiʻukole	*Melichthys vidua*	No	No	Yes	Yes	No	No	Yes	Yes
Reef triggerfish	humuhumu nukunuku ʻapuaʻa	*Rhinecanthus rectangulus*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Lei triggerfish	humuhumu lei	*Sufflamen bursa*	Yes	Yes	No	Yes	No	No	Yes	Yes
Bridled triggerfish	humuhumu mimi	*Sufflamen fraenatus*	Yes	Yes	No	No	No	Yes	Yes	Yes
Gilded triggerfish	--	*Xanthichthys auromarginatus*	No	No	No	No	No	No	Yes	Yes
Crosshatch triggerfish	--	*Xanthichthys mento*	No	No	No	No	No	No	No	Yes

Source: Dollar et al 2006 and 2000; C= common; A= Abundant; Yes= noted but not common

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Family Monacanthidae										
Barred filefish	Oʻili	*Cantherhines dumerili*	No	Yes	No	No	No	Yes	No	No
Squaretail filefish	Oʻili lepa	*Cantherhines sandwichiensis*	Yes	Yes	Yes	Yes	No	No	No	No
Family Ostraciidae										
Spotted boxfish	moa	*Ostracion meleagris*	Yes	Yes	No	No	Yes	No	No	Yes
Family Tetraodontidae										
Hawaiian whitespotted toby	--	*Canthigaster jactator*	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Crown toby	--	*Canthigaster cornata*	Yes	Yes	No	No	No	Yes	Yes	No
Macroinvertebrates										
Group Algae										
--	--	*Amansia glomerata*	Yes	Yes	No	Yes	No	No	No	No
--	limu kohu	*Asparagopsis taxiformis*	Yes	Yes	Yes	Yes	No	No	No	No
--	--	*Cladymenia pacifica*	No	No	No	No	No	Yes	No	No
--	--	*Corallina sp.*	No	No	No	No	No	No	No	Yes
--	--	*Desmia hornemannii*	Yes	Yes	No	No	Yes	Yes	No	Yes
--	--	*Halimeda opuntia*	No	No	No	Yes	No	Yes	No	No
--	--	*Jania sp.*	No	Yes	No	No	No	Yes	No	No
--	--	*Peyssonellia rubra*	No	Yes	No	No	No	No	No	No
		Porolithon onkodes	No	Yes	No	Yes	No	No	No	No
--	--	*Tolypiocladia sp.*	No	No	No	No	No	Yes	No	No
Group Mollusca										
Cone shells		*Conus lividus*	Yes	No	No	Yes	No	No	Yes	No

Source: Dollar et al 2006 and 2000; C= common; A= Abundant; Yes= noted but not common

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Cone shells	--	*Conus sistans*	No	No	No	No	No	No	Yes	Yes
Cone shells	--	*Conus imperaialis*	No	No	No	No	No	No	Yes	No
Cone shells	--	*Conus ebreus*	Yes	Yes	No	No	No	No	No	No
Cone shells	--	*Conus leopardus*	Yes	Yes	No	No	No	No	Yes	No
Cone shells	--	*Conus miles*	No	No	No	No	No	No	Yes	Yes
Cone shells	--	*Conus miliaris*	No	No	No	No	No	No	Yes	No
Tiger cowry snail	leho-kiko	*Cypraea tigris*	No	Yes	No	No	No	No	No	No
Black-lipped oyster*	pa	*Pinctada margaritifera*	No	Yes	No	No	No	No	No	No
Rock oyster	--	*Spondylus tenebrosus*	Yes	Yes	No	No	No	No	Yes	Yes
Octopus*	heʻe	*Octopus cyanea*	Yes	Yes	Yes	No	No	No	Yes	Yes
Phylum Porifera										
--	--	*Chondrosia chucalla*	No	No	No	No	No	Yes	No	No
--	--	*Dactylospongia sp.*	No	No	No	No	No	Yes	No	No
Phylum Annelida										
		Loimia medusa	No	No	No	No	No	No	Yes	No
Christmas tree hydroid		*Halocordyle disticha*	No	No	No	No	No	Yes	No	No
Christmas tree worm	--	*Spirobranchus giganteus*	No	Yes	No	No	No	Yes	No	Yes
Phyllum Arthropoda										
Slipper lobster*	ʻulaʻpapa	*Paribaccus antarcticus*	Yes	No	No	No	No	No	No	Yes
Spiny lobster*	ula	*Panulirus marginatus*	No	Yes	No	No	No	No	No	No
Spiny lobster	ula	*Paribaccus penicillatus*	No	No	No	Yes	No	No	No	No
Spiny lobster	ula	*Panulirus marginatus*	No	No	No	No	No	Yes	No	No

Source: Dollar et al 2006 and 2000; C= common; A= Abundant; Yes= noted but not common

Table 1: Marine Species Observed Off of Barking Sands (Continued)

			Nohili Sector		Mānā Point Sector		Majors Bay Sector		Offshore Sector	
Common Name	**Hawaiian Name**	**Latin Binomial**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**	**2000**	**2006**
Phyllum Echinodermata										
Sea urchin	--	*Echinothrix calamaris*	No	No	No	Yes	No	Yes	Yes	Yes
Sea urchin	--	*Echinothrix diadema*	No	Yes	No	No	No	No	Yes	No
--		*Echinometra matheai*	No	No	No	No	No	No	Yes	No
--		*Eucardus metularia*	No	No	No	No	No	No	Yes	No
Sea urchin	--	*Echinostrephus aciculatum*	No	Yes	No	Yes	No	No	Yes	Yes
Sea urchin		*Tripneustes gratilla*	No	No	No	Yes	No	No	Yes	Yes
Sea cucumber		*Holothuria atra*	Yes	No	No	Yes	No	Yes	No	Yes
Sea Cucumber	--	*Holothuria whitmaei*	No	No	No	No	No	Yes	No	No
Sea cucumbers	--	*Actionpyge mauritana*	Yes	Yes	No	No	No	No	No	No
Sea star	--	*Linckia multiflora*	Yes	No	No	No	No	No	No	Yes
--	--	*Linckia diplax*	No	No	No	No	No	No	Yes	No
--	--	*Culcita novaeguineae*	No	No	No	No	No	No	Yes	Yes
Crown-of-thorns starfish		*Acanthaster planci*	No	Yes	No	No	No	No	No	No

Source: Dollar et al 2006 and 2000; C= common; A= Abundant; Yes= noted but not common

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C4 - SUMMARY OF FISH SPECIES OBSERVED OFF OF KA‘ULA ISLAND

Table 1: Fish Species Observed in the Waters of Ka‘ula Island (1996)

Common Name	Hawaiian Name	Latin Binomial	Key	Notes	Status
Galapagos shark	*mano*	*Carcharhinus galapagensis*	R	One seen	Culturally significant
Sandbar shark	*mano*	*C. plumbeus*	R	One seen	Culturally significant
Coral croucher	—	*Caracanthus sp.*	C	—	—
Goatfish	*wekea*	*Mulloidichthys flavolineatus*	S	—	—
Threadfin butterfly	—	*Chaetodon auriga*	C	—	—
Flame angelfish	—	*Centropyge loriculus*	R	One large individual seen	—
Hawaiian sergeant	*mamo*	*Abudefduf abdominalis*	C	—	Endemic
Pacific Gregory	—	*Stegastes fasciolatus*	C	—	Endemic
Oval chromis	—	*Chromis ovalis*	C	—	Endemic
Eightline wrasse	—	*Pseudocheilinus octotaenia*	C	—	—
Psychedelic srasse	*hi nalea*	*Anampses chrysocephalus*	C	—	Endemic
Old Woman wrasse	*hi nalea luahine*	*Thalassoma ballieui*	C	Very large individuals seen	Endemic
Fivestripe wrasse	*hi nalea*	*T. quinquevittatum*	R	One at 20-foot depth	—
Shortnose wrasse	*hi nalea*	*Macropharyngodon geoffroy*	S	—	Endemic
Belted wrasse	*o maka*	*Stethojulis balteata*	S	—	Endemic
Convict tang	*manini*	*Acanthurus triostegus sanvicensis*	C	—	—
Ringtail surgeonfish	*pualu*	*A.. blochii*	C	—	—
Whitebar surgeonfish	*maikoiko*	*A.. leucopareius*	C	—	—

Table 8-4: Fish Species Observed in the Waters of Ka‘ula Island (1996) (Continued)

Common Name	Hawaiian Name	Latin Binomial	Key	Notes	Status
Picasso triggerfish	*humuhumunuku nuku a pua a*	*Rhinecanthus rectangulus*	S	—	State Fish of Hawai‘i
Crowned toby	*puu olai*	*Canthigaster coronata*	R	—	—
Spotted boxfish	*moa*	*Ostracion meleagris*	C	—	—
Spotted puffer	*oopu hue*	*Arothron meleagris*	S	—	—
Porcupine fish	*kokala*	*Diodon hystrix*	S	—	—

A = abundant, C= common, S= scarce, R= rare, one specimen observed – source Navy 2001

Table 2: Commercial Fisheries Catch Statistics for Years 1991-1995, Ka'ula Rock Mean Annual Catch (lbs.) of Benthic and Inshore Marine Resources

Common Name	Hawaiian Name	Latin Binomial	Weight in pounds (kg)
Deep Bottomfish			5,244 (2,379)
grouper	*hapu'upu'u*	*Epinephelus quernus*	380 (172)
amberjack	*kāhala*	*Seriola dumerili*	99 (45)
snapper	*ta'ape*	*Lutjanus kasmira*	41 (19)
gray snapper or green jobfish	*uku*	*Aprion virescens*	2,381 (1,080)
Jacks			1,636 (742)
thicklipped jack	*buta ulua*	*Pseudocaranx dentex*	110 (50)
white ulua or giant trevally	*ulua aukea*	*Caranx ignobilis*	17 (8)
Other			1,509 (685)
In-shore Fish	—	—	148 (67)
Crabs	—	—	12 (5)

Note: Mean Annual Catch (lbs) of Benthic and In-shore Marine Resources

Commercial fisheries landing data have been gathered by the State DLNR, Division of Aquatic Resources, based on monthly trip reports that all commercial fishers are required to complete. Significant underreporting and non-reporting are believed to occur in these data. A large number of unlicensed commercial fishers, as well as recreational fishers, also impact fisheries resources (DLNR in Navy 2001)

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C5 - CORAL INSERT

CORAL INSERT

I. Definition of coral and coral reef

Corals from one or more taxa are present from the North Pole to the South Pole and from the intertidal zone to the abyss. Corals addressed in this document are exclusively tropical species occurring (primarily) at depths of less than 325 feet (ft) [100 meters (m)].

The Coral Reef Conservation Act of 2000 defines several related terms: coral, coral reef, and coral reef ecosystem as follows.

"CORAL- The term "coral" means species of the phylum Cnidaria, including --

(A) all species of the orders Antipatharia (black corals), Scleractinia (stony corals), Gorgonacea (horny corals), Stolonifera (organpipe corals and others), Alcyonacea [misspelled](soft corals), and Coenothecalia (blue coral), of the class Anthozoa; and

(B) all species of the order Hydrocorallina (fire corals and hydrocorals) of the class Hydrozoa.

CORAL REEF- The term "coral reef" means any reefs or shoals composed primarily of corals.

CORAL REEF ECOSYSTEM- The term "coral reef ecosystem" means coral and other species of reef organisms (including reef plants) associated with coral reefs, and the nonliving environmental factors that directly affect coral reefs, that together function as an ecological unit in nature."

Section III C. of this Deliverable discusses coral taxonomy and points out that there are significant differences of opinion, even among experts. To further clarify the definition of coral and coral reef the following definition is provided. It is not intended to alter the legal definition provided in the Act, but facilitate taxonomic comparisons.

CORAL- The term "coral" means species of the phylum Cnidaria, including --

- Class Hydrozoa Order Milleporina (fire corals also known as Hydrocorallina)
- Class Hydrozoa Order Stylasterina (lace corals also known as Hydrocorallina)
- Class Anthozoa, Subclass Hexacorallia, Order Scleractinia (stony corals)
- Class Anthozoa, Subclass Ceriantipatharia, Order Antipatharia (black corals and wire corals)
- Class Anthozoa, Subclass Octocorallia, Order Alcyonacea (soft corals and Tubipora corals)
- Class Anthozoa, Subclass Octocorallia, Order Gorgonacea (horny corals/sea fans)
- Class Anthozoa, Subclass Octocorallia, Order Helioporacea (blue corals)

II. Coral taxonomy and biogeographic regions

Taxonomy is the branch of biology which includes the theory, principals, and process of classifying organisms into established categories. Coral taxonomy is more controversial than taxonomy relating to many other groups of organisms due to the plastic nature of coral skeletons in response to environmental factors. Taxonomic differences of opinion have significant relevance to species-specific management. The taxonomy of many coral species, including members of the following genera (*Acropora, Agaricia, Montastraea, Montipora,* and *Porites*) is contested (Wallace & Willis 1994, Pennisi 2002, Shearer & Coffroth 2006, Willis et al. 2006). This can potentially alter the true number of listed/proposed species.

The Hawaiian Archipelago falls within the Hawaii ecoregion, Hawaiian province and the Eastern Indo-Pacific biogeographic realm (Spalding 2007). Jokiel (2008) lists about 40 scleractinian species and Randall (2007) lists 612 fish species. The Hawaiian ecoregion has suffered a significant decline in the distribution, diversity and abundance of coral reef organisms during the last 40 years (NOAA & HI Coral Reef State of the Reefs).

III. General navy practices which benefit corals and near shore marine natural resources

There are scores of environmental protection and natural resource standard practices, guidance documents and policies (hereafter referred to as practices) which the Navy routinely implements. While some of these practices were not originally designed specifically to benefit corals and coral reefs the net result has been extremely beneficial to corals, coral reefs and a myriad of associated organisms including shell fish, fin fish and sea turtles. These practices can be broadly divided into six major categories: (1) INRMPs; (2) terrestrial pollution control and land management practices; (3) vessel pollution control practices; (4) construction management practices; (5) bio-security practices; and (6) installation- specific practices. It should be noted that many installation specific practices have been adopted and are funded based upon a legally operative and approved INRMP. Below is a brief example of how these practices have benefitted corals; the example is followed by abbreviated summaries of standard practices which benefit corals, coral reefs and associated marine natural resources.

Pearl Harbor provides an example of 'indirect' benefits these practices provide. Until the 1960s Navy vessels discharged waste water into Pearl Harbor and shore waste water received little or no treatment. No corals were present or recorded from Pearl Harbor at that time (Evans et al. 1974). With the adoption of stringent practices to control terrestrial and vessel pollution as well as the implementation of strict land management and construction management techniques water quality improved and marine resources thrived. Today there are 13 different species of coral found in Pearl Harbor, fishery target species are abundant and numerous invertebrates like the pearl oyster are returning (Smith et al. 2006; Smith personal communication 2010).

Daszak et al. (2000), Worm et al. (2006) and many other investigators have noted that coastal development and associated activities are having increasingly adverse impacts upon coastal ecosystems around the world. These impacts have resulted in the severe degradation of many coral reefs and their associated flora and fauna. During the last decade, ecologists have discovered that while many publicly accessible coastal areas are declining, marine natural resources in areas under DoD control, with little or no public access, are thriving and/or in significantly better condition than adjacent areas. Stein et al. (2008) demonstrated that DoD properties support three times the densities of ESA status species and imperiled species as are found on public lands. Marine resources within these DoD controlled areas are generally healthier, more abundant, and larger than those outside.

Many anthropogenic stressors that have highly deleterious impacts upon coral reefs and the associated flora and fauna are either completely absent in DoD controlled areas or experienced at much lower levels of intensity than in public coastal zones. Anthropogenic stressors include, but are not limited to those presented in Table 1.

Table 1 - Common Coral Reef Stressors Which Are Absent or Reduced at DoD Sites

Stressors	**Stressors**
Reef walking	Grounding of personal watercraft
Skin /Scuba Diving	Untreated sewage discharge personal watercraft
Spear fishing	Improper/inadequate waste water disposal
Trap & net fishing	Improper/inadequate storm water runoff disposal
Hook & line fishing	Illegal dumping of hazardous materials/waste
Jet skiing	Improper/inadequate erosion control
Motorized personal watercraft	Harassment of marine life by beachgoers
Collection of corals & invertebrates for the aquarium trade	Reduced H2O quality from large volumes of Sun block
Anchor damage from commercial recreational & private boaters	Improper disposal of refuse, particularly plastics, diapers, pull tabs, bottle caps and cans

Non-consumptive recreational activities, like reef walking and skin/scuba diving can have a profound negative long-term adverse impacts to corals, coral reefs and associated marine resources; this fact has been well established by numerous investigators world wide (e.g. Sudara and Nateekarnchanalap, 1988; Harriott, Davies and Banks, 1997; and Van Treech and Schumacher 1998). These types of activities are banned or greatly restricted at DoD properties, thus reducing or eliminating the associated adverse impacts.

Consumptive recreational and commercial activities, primarily fishing and the collection of aquarium specimens adversely impact corals/coral reefs as well as the species actually captured. Raymundo *et al*. (2009) clearly demonstrated that functionally diverse and healthy reef-fish communities reduce the incidence of coral disease. Raymundo *et al.*

(2009), Smith *et al.* (2006) and other investigators have shown that MPAs and DOD restricted marine areas support significantly higher fish diversity and biomass than adjacent public areas. These healthier, more natural fish populations play a key role in maintaining healthier corals and coral reefs on DOD properties.

The elimination and/or reduction many of the other stressors listed in Table 1 are discussed in Section V of this document. A review of the management and enforcement activities of MPAs world wide will show that few, if any, actually have the level of protection, management and enforcement that is present at DoD facilities. Cook et al. (2010) stated "Comprehensive review of available evidence shows major, rapid benefits of no-take areas for targeted fish and sharks, in both reef and non-reef habitats, with potential benefits for fisheries as well as biodiversity conservation…reserves also appear to benefit overall ecosystem health and resilience…".

DoD ecosystem-based management

While DOD-controlled marine areas have the positive benefits of restricted commercial and recreational activities on nearshore tropical resources, including no commercial fishing, limited recreational marine resource extraction, no commercial water-based recreational activity, and no industrial/wastewater discharges on ranges, DOD base commanders and resource managers also actively implement ecosystem-based management to magnify effects on coral reef systems. This ecosystem-based management includes the following actions:

- Sustainably managing the degree of access, use and exploitation of marine natural resources;
- Effectively managing the terrestrial portion (watershed) of the military installation bordering the maritime area; and
- Influencing the management of coastal land-based ecosystems, terrestrial runoff, and coastal and upland human development outside of the DoD facility.

The above DoD environmental-stewardship actions appear to have greatly enhanced the condition of the resource above what it would likely be if not managed. This ecosystem-based management also generates a spill-over effect into non-DoD surrounding areas, and in sum creates a net conservation benefit to the resource

DOD ecosystem-based management of coral reef systems and adjacent watersheds not only yields important science-based natural resources information important for the effective regulation and management of endangered and threatened species, but it also fosters compliance with international treaties (e.g. Convention on International Trade in Endangered Species [CITES]) and national and international initiatives (e.g., the US Coral Reef Initiative and the International Coral Reef Initiative). These efforts also help conserve and restore critical habitat for these species and minimize the need for listing of additional species.

Integrated Natural Resource Management Plans

All Navy installations with significant natural resources are required to prepare INRMPs, in compliance with the Sikes Act Improvement Act (SAIA) of 1997 (P.L. 105-85). INRMPs must provide for:

- Conservation and rehabilitation of natural resources
- Sustainable multi-purpose uses of resources; and
- Public access for use of natural resources, subject to the Navy's mission, operational and security requirements.

Federal agencies are required by the Endangered Species Act (ESA) to manage federally listed threatened and endangered (T&E) species and their habitats in a manner that promotes their conservation and is consistent with recovery plans for such species. INRMPs serve as the key vehicle through which Navy installations meet this requirement for T&E species located on Navy facilities. Section 7 of the ESA and the SAIA require that the Navy enter into consultation with the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) Fisheries whenever actions are proposed that may affect listed and proposed T&E species.

Rigorous surveys and/or investigations of corals and/or the two T&E listed coral species have been conducted at NAS Key West, SFOMF, Naval Station Pearl Harbor, PMRF, Naval Base Guam and the Farallon De Medinilla and Tinian Military Lease Areas. At many of these sites, long term coral assessment and monitoring coral programs have been in effect for more than five years. For those sites at which long term studies are underway, it has been shown that corals, coral reefs and associated organisms are, in fact more robust and healthy than in adjacent areas which are not under Navy control.

The Navy's legal and actual ability to control navigation, anchoring, mooring, construction, diving, fishing and other activities, combined with Navy INRMPs and the myriad of additional standard environmental and natural resource practices ensure that corals, coral reefs and associated organisms at Navy facilities will benefit in many ways, including, but not limited to the following:

- The cumulative benefits of the management activities will ensure the maintenance or increase of the species population and enhance and/or restore habitat, baring uncontrollable natural disasters or events such as global sea surface temperature increases. Through implementation of the INRMPs and adherence to requirements of other practices (e.g. Clean Water Act) the Navy can ensure that all proposed actions that could potentially affect corals and coral reefs are in compliance with Section 7 of the ESA and other relevant guidance documents.
- The Navy's INRMP plans and other practices will be implemented. Personnel charged with implementing plans and practices are capable of accomplishing the objectives and have the funding and authority to do so.
- The management effectiveness of these plans and practices has been demonstrated and documented in previous sections of this document and will be further documented in following sections.

OPNAV Instruction 5090.1C is the Environmental Readiness Program Manual from the Chief of Naval Operations dated 30 October 2007. This document discusses requirements, delineates responsibilities, and issues policy for the management of the environmental, natural and cultural resources for all Navy ships and shore activities. The Navy is committed to operating successfully in a manner compatible with the environment. The mission of the Navy's Environmental Readiness Program is to ensure the ability of the United States Navy forces to effectively operate world-wide in an environmentally responsible manner, both ashore and afloat. Navy, joint and combined operations and training must be planned and executed to fully meet operational readiness requirements and Navy environmental objectives. In order to ensure that the Navy can prepare, train and operate as required, personnel must be aware of the environmental requirements established by federal, state and local laws and regulations; Executive Orders (EO); and Department of Defense (DoD) and Navy policy. National defense and environmental protection are, and must continue to be, compatible goals. Achievement of these goals requires the leadership and personal commitment of military and civilian personnel throughout the Navy chain of command. Sections within multiple chapters of OPNAVINST 5090.1C have direct and indirect relevance to preserving water quality in the marine environment. Maintaining and improving water quality is essential to protecting and enhancing corals and coral reefs as well as the associated invertebrates, fishes and sea turtles.

V. Coral Resource Description and Management at PMRF

Distribution of corals

Spalding (2007) places the Hawaiian Archipelago within the Hawaii ecoregion, Hawaiian province and the Eastern Indo-pacific biogeographic realm. Jokiel (2008) lists about 40 scleractinian species and Fenner (2005) lists 66. Coral diversity in the Hawaiian Islands is comparable to that found in the Western Atlantic and Caribbean; both have less than $1/10^{th}$ the number of coral species found in Guam and CNMI. However, diversity is only one measure of the biological importance of a coral reef and the Hawaiian reefs are significant from ecological, commercial, recreational and cultural perspectives.

Figure 1 indicates classification of percent coral cover by a towed optical assessment device at several locations around Kaua‘i. The data is from NOAA's Pacific Island Benthic Habitat Mapping Center (PIBHMC). Although optical assessment coverage is sparse, indications are that the greatest concentration of coral around Kaua‘i lies on the northwest side of the island, north of Barking Sands and shoreward of the Shallow Water Training Range.

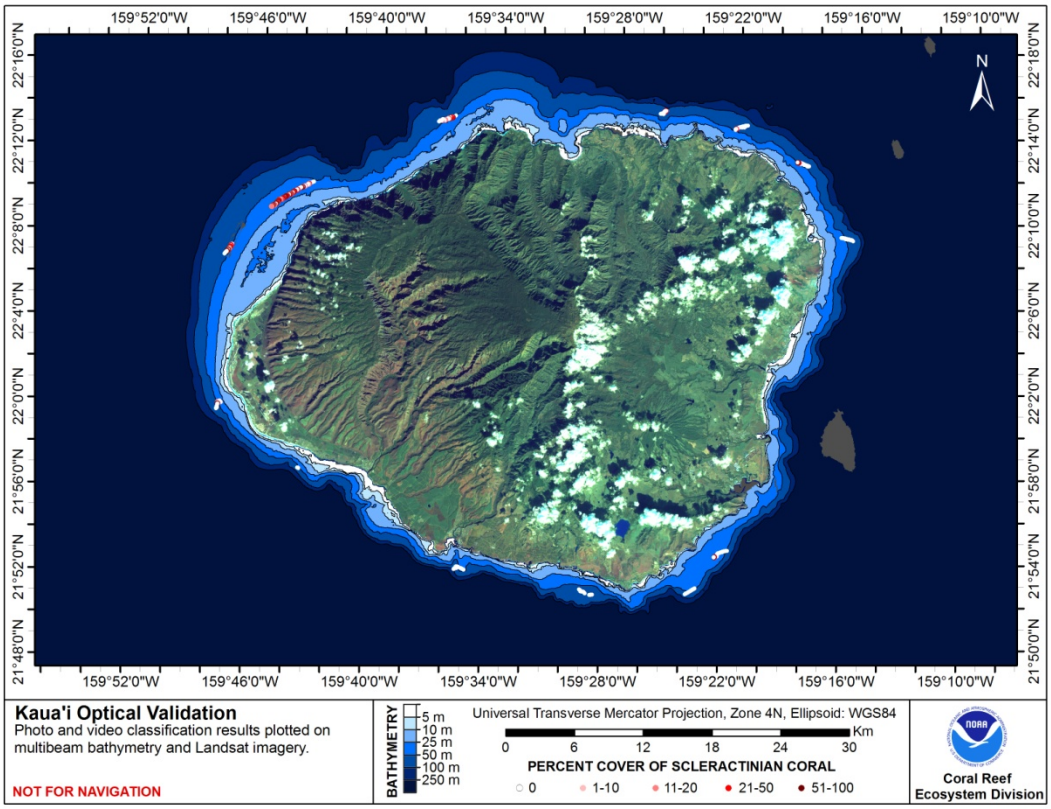

Figure 1**.** NOAA Map of Scleractinian coral distribution around Kaua'i. From ftp://ftp.soest.hawaii.edu/pibhmc/website/data/mhi/optical/kauai/kau_toad.jpg

The coastline of PMRF main base is broken into three sectors (Figure 3-11 of the draft PMRF INRMP): Nohili is the northernmost sector, Mānā Point is the central sector, and Majors Bay is the southernmost sector. These sectors extend from the shoreline to a depth of 50 ft (15 m). Coral cover in the Major's Bay Sector is very sparse – less than 2 percent of the bottom area (DoN 2001).

Transect data from the Nohili Sector reveal that total coral cover ranged from 32 percent to 39 percent of the total bottom cover (Dollar and Brock 2006). Ringed rice coral (*Montipora patula*), one of the 83 species proposed for listing, cauliflower coral (*Pocillopora meandrina)*, and *Porites lobata* are the most abundant coral species found off the coast of Nohili Point. Other less abundant species in the area include *Porites compressa*, *Montipora capitata* (formerly *Montipora verrucosa*), and *Pavona varians*. Several additional corals were noted in the Nohili Sector, including *Porites evermanni*, *Pavona varians*, *P. duerdeni*, *Leptastrea purpurea*, *Montipora flabellata*, and *M. verrilli* (Dollar and Brock 2006). Macroinvertebrates in this area include the rock oyster (*Spondylus tenebrosus*), cone shells (*Conus* spp.), sea urchins (*Echinometra mathaei*), and sea cucumbers (*Holothuria atra*). North of Nohili Point, the uncolonized pavement ends and the colonized pavement continues along a northward heading; it turns gradually to the east to join the coastline north of Keawanui (DoN 2008).

Coral is less abundant along the Mānā Point sector than in the northern Nohili area. Solitary colonies of *Porites lobata* and *Pocillopora spp*. are the most abundant corals occurring along the central portion of PMRF (Dollar and Brock 2006), and the distribution of corals is half of that found along the northern part of Barking Sands. North of Mānā Point, a narrow fringing reef follows the coastline up to Nohili Point and Barking Sands. This crosses from the Mānā Point sector to the Nohili sector. The fringing reef has low coral density and is dominated by lobe coral (*Porites lobata*) and small stands of arborescent (branched or tree shaped) corals. Broad uncolonized pavement (1,772 ft wide) and colonized pavement (2,297 ft wide) stretch along the coastline seaward of the fringing reef. This area is characterized by solid carbonate rock underneath a thin layer of sand. Macroalgae, hard coral, and sessile invertebrates are commonly found on the pavement, which continues northward along the coastline past Barking Sands (DoN 2008).

Offshore of the Nohili and Mānā Point sectors [extending from the edge of the shoreline sectors to a depth of 65 ft (20 m)], the predominant physical structure of the area is a flat, pitted limestone surface. The seaward extent of this biotope is defined by the limestone shelf break encountered at 65 to 82 ft (20 to 25 m) in depth (Dollar and Brock 2006). The predominant coral found in this zone is *Pocillopora eydouxi*, which occurs as single large branching colonies up to approximately 3 ft (1 m). Other corals found on the platform are primarily smaller species that have a collective coverage of approximately 5 percent of bottom cover. Coral species recorded in the area include *Pocillopora meandrina*, *Porites lobata, Pavona varians, P. duerdeni, Montipora flabellata* (one of the 83 species proposed for listing), *M. patula* (another of the 83 species proposed for listing), *M. verrilli, M. verrucosa, Leptastrea purpurea*, and *Fungia scutaria*. Also present along the shelf break are black coral (*Antipathes dichotoma*) and wire coral (*Cirrhipathes anguina*) (Dollar and Brock 2006).

Land and jurisdictional issues

The Navy does not own submerged lands around PMRF main base (Barking Sands) or Kaʻula Islet, but the Navy installation controls primary land access to water assets off of Barking Sands, and controls entry into a 3-mile radius danger zone in waters around Kaʻula Islet (DoN 2009). The installation on the seaward boundary generally ends at the high water mark. There is a no anchorage zone off of PMRF, but this is due to the presence of underwater cables and not for security or conservation reasons. The offshore sector is considered territorial waters.

The underwater ranges, Barking Sands Tactical Underwater Range (BARSTUR), Barking Sands Underwater Range Expansion (BSURE), the Kingfisher Range, and the Shallow Water Training Range, cover approximately 1,100 square nautical miles. This property is not owned, leased, or controlled by the Navy. The underwater ranges are within open ocean areas and extend into territorial waters. The Navy does not have exclusive use over these areas. Navy follows strict Standard Operating Procedures (SOP) and mitigation measures developed in consultation with resource agencies when operating in these areas. These are followed to ensure that the Navy can maintain

mission essential operations by using prudent measures to protect sensitive resources while operating in the underwater ranges. However, because the Navy does not exercise management authority over the underwater areas, they are not included in the INRMP.

Security zones

The harbor of Port Allen is approximately 17 miles southeast of PMRF main base on the southern coast of Kaua'i. The Port Allen security zone is all waters extending 100 yards in all directions from each large passenger vessel (LPV) in Port Allen or within 3 nautical miles seaward of the Port Allen COLREGS DEMARCATION (See 33 CFR 80.1440). This is a moving security zone when the LPV is in transit and becomes a fixed zone when the LPV is anchored, position-keeping, or moored. This security zone does not directly affect coral resources located near PMRF; however, some coral reef could fall within the moving security zone around an LPV transiting the in-water ranges relatively close to the shore.

Economic zones/port authorities/port ops

Port Allen is a State of Hawai'i harbor facility. The Navy leases office, storage, and berthing space at the Port Allen pier for range vessels and surface target support. Port Allen hosts PMRF's Range Support Boats and Seaborne Powered Target Boat operations and maintenance facilities, and provides pier space, protected anchorage, and small boat launch facilities.

There is virtually no commercial shipping within the range areas. The ranges are included in air and sea navigational warning and restricted zones. The training operations are considered to have little or no significant impact on the sea environment.

Key factors influencing corals

Zones of influence from streams/rivers

According to Coral Reef Assessment and Monitoring Program (CRAMP, cramp.wcc.hawaii.edu), there are four watersheds with three perennial streams that flow through PMRF. The northernmost watershed and stream is called Nahomalu. It contains a perennial stream that collects water from about 11,627 acres. The outflow to the ocean is known as Nohili Ditch and is approximately 0.5 miles south of Nohili Point. This particular wetland occurs in close proximity to the area of richest coral growth close to PMRF.

The second most northern watershed and stream is Ka'awaloa, and it is a perennial stream that collects water from about 4,231 acres. The outflow is near the middle of the PMRF coastline. The Niu watershed, south of the Ka'awaloa watershed is small, approximately 1,768 acres, and does not have a perennial stream associated with it.

The southernmost watershed is called Hoea. The perennial stream in that watershed is Kinikini (or Kinekine) Ditch. Little information is available on this stream which appears to flow above ground for a very short distance – the terminal channel is only about 3 km long (Parnham 2002). The stream collects water from about 10,212 acres. The outflow is south of Mana Point.

Primary threats to corals at and adjacent to subject installation

The primary limiting factor/threat to corals along the coastline of PMRF is physical damage from heavy wave activity. The north shore is especially exposed to breakage, abrasion and scour from the large waves, and in most cases corals are unable to rebuild themselves as quickly as they are eroded (Dollar and Brock 2006).

There are a variety of potential anthropogenic stressors that could influence coral in the area near PMRF. They include the following local and global elements:

Local Stressors

- Coastal development has been limited because of slow population growth on Kaua'i and little development on base; this could change.
- Pollution from the agricultural zone inland from PMRF could impact corals. The Navy leases 200 acres of land on a floodplain inland from the base (DoN 2009).
- Beach and in-water recreation and fishing are allowed along two miles (3.2 km) of coastline along the Major Bay Sector are available to PMRF employees, active duty, reserve and retired military, and their dependents. As stated before, this area has very low coral concentration (2% bottom cover). Any U.S. citizen can also acquire a pass to use this area. Recreational surfing, fishing, and boating can occur in this area. There is a special use area that extends along the beach north approximately a mile into the Mānā Point Sector. It is also available for recreational activities during times that do not conflict with runway use. If there are no military maneuvers scheduled, the coast of PMRF is available for recreational boating, diving, and fishing.
- Marine debris originating from both distant locations and local activities represents a challenge to coral reefs in the area. PMRF has participated in a National Marine Debris Monitoring Program. During past coral surveys, scientists have noted significant debris offshore of PMRF. Dollar and Brock (2006) noted that "a multitude of man-made materials were observed on the reef structure including fouled fishing nets and metal objects (possible ordnance or test materials remnants)."

Global Stressors

- Regional and global coral disease is a potential threat that is beyond the scope of this document or the Navy's control.
- Global temperature change is a potential threat that is beyond the scope of this document or the Navy's control.
- Ocean acidification is a potential threat that is beyond the scope of this document or the Navy's control.

Operational and training requirements

Barking Sands has multiple underwater ranges extending over 1,100 square nautical miles off the coast of PMRF. The underwater ranges include: BARSTUR, BSURE, the Hawaiian Area Tracking System (HATS), the Shallow Water Training Range (SWTR), and a simulated underwater minefield. Marine activity focuses on maneuvering large

naval vessels such as frigates, destroyers and submarines on the deep water range for anti-sub warfare (ASW). This includes torpedo firing and recovery (by either helicopter or small boats), sonar use, sonobuoy use, and occasional sinking exercises far out on the range. The vast majority of marine activities at PMRF and the associated ranges go on in very deep water where there is little to no coral. Some missiles release rocket stages into the nearshore environment. These are rare events and are probably the only direct threat to coral.

The only beach activities that have occurred in the past have been at Majors Bay. Majors Bay is an ideal place for these types of exercises with respect to coral because coral cover is very low and the coral occurs at depths below which the exercise vehicles come in contact with the sea floor. Every two years, an exercise involving Landing Craft Air Cushion (LCAC) hovercraft occurs in conjunction with RIMPAC exercise. The landing of amphibious tracked vehicles by the Marines at Majors Bay has occurred, but is not routinely done. These are rare events and protocol for monitoring and clearing the beach are followed when the exercises occur.

Installation Specific Recommendations for Protection of Corals and Coral Reefs

With a minimum of near shore military activity and close regulation of use of the recreational beaches, PMRF is ideally positioned to maintain coral reef resources at the current high level of health. The intense wave activity in the area helps to maintain an environment that, while challenging for delicate species, facilitates high oxygen and nutrient transport and quickly dilutes any effects from runoff or freshwater outflow. The State of Hawai‘i Department of Agriculture owns and operates the ditches running through Barking Sands. Coordination and careful monitoring and management of runoff are recommended as a way to guarantee continued coral health, particularly in the Nohili and Mānā Point sectors. Assessment of runoff quality and quantity patterns will provide give a greater understanding of local input into the area from land sources.

A program of regular marine debris removal, similar to the program in the Northwest Hawaiian Islands (Dameron et al. 2007), would help remove the existing debris in the reef areas referred to by Dollar and Brock (2006). The existing waste management practices utilized by the Department of the Navy are very beneficial and should continue to be implemented.

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APPENDIX D
LEGAL REQUIREMENTS

D1 - LEGAL REQUIREMENTS

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Acronyms and Abbreviations

ARPA	Archaeological Resources Protection Act of 1979
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNO	Chief of Naval Operations
CWA	Clean Water Act
DOD	Department of Defense
DOH	Department of Health
DON	Department of the Navy
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EO	Executive Order
ESA	Endangered Species Act
FMPs	fishery management plans
ft	foot (feet)
HAPC	Habitat Area of Particular Concern
INRMP	Integrated Natural Resources Management Plan
km	kilometer(s)
m	meter(s)
MBTA	Migratory Bird Treaty Act of 1918
mi	mile(s)
MMPA	Marine Mammal Protection Act of 1972
MPA	Marine Protected Areas
MSA	Magnuson-Stevens Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act of 1976
NAGPRA	Native American Graves Protection and Repatriation Act
NANPCA	Non-indigenous Aquatic Nuisance Prevention Control Act of 1990
NAVFAC	Naval Facilities Engineering Command
NAVFACINST	NAVFAC Instruction
NAWMP	North American Waterfowl Management Plan
NCP	National Oil and Hazardous Substances Contingency Plan
NHPA	National Historic Preservation Act
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration

1	NOAA Fisheries	NOAA National Marine Fisheries Service
2	NPDES	National Pollutant Discharge Elimination System
3	PL	Public Law
4	SAIA	Sikes Act Improvement Amendments
5	SOH	State of Hawai'i
6	U.S.	United States
7	U.S.C.	United States Code
8	USFWS	U.S. Fish and Wildlife Service
9	WPRFMC	Western Pacific Regional Fishery Management Council

1 **Table 1: Summary of Sikes Act Improvement Amendments and Related Guidance**

Title	Description
Sikes Act Improvement Amendments (SAIA)	
SAIA of 1997 (16 United States Code (U.S.C.) 670a-670o [Public Law {PL} 86-797]	Requires military installations to prepare and implement a plan for the management, conservation, and rehabilitation of their natural resources, while still supporting the military mission, operational and security requirements. Requires all military installations that occupy land and water property suitable for the conservation and management of natural resources to prepare and implement comprehensive Integrated Natural Resources Management Plan (INRMP) by November 2001. INRMP must be continually monitored, reviewed annually, updated if necessary, and reapproved at least every 5 years.
Sikes Act of 1960 (Conservation Programs on Military Reservations)16 U.S.C. 670a-670o (PL 86-797)	Provides framework for management of natural resources on military lands.
Department of Defense (DOD) and Navy Guidance on Natural Resources Management	
Draft Guidelines for Preparing INRMPs for Navy Installations (Naval Facilities Engineering Command [NAVFAC] 2005)	Provides interpretation of the processes necessary to prepare INRMPs so that they comply with federal laws and regulations and provides appropriate stewardship of the natural resources entrusted to the Navy's care and use.
Environmental Conservation Program dated 3 May 1996 DOD Directive 4715.3 (replaces 4700.4)	Outlines procedures for the integrated management of natural and cultural resources on DOD-controlled property. The instruction is consistent with the provisions of SAIA. It states that natural resources under DOD control are to be managed to support and be consistent with military mission, while protecting and enhancing those resources for multiple use, sustainable yield, and biological integrity. It also notes that DOD lands and water shall be made available to the public for educational or recreational use, when access is compatible with military mission activities, ecosystem sustainability and other considerations such as security, safety, and fiscal soundness. This instruction implements policy, assigns responsibilities, and prescribes procedures for integrated management of natural and cultural resources on property under DOD control. Instruction also establishes the DOD Conservation Committee and designates "DOD Executive Agents" to lead DOD implementation of key conservation issues.

Table 1: Summary of Sikes Act Improvement Amendments and Related Guidance (continued)

Title	Description
Real Estate Operations & Natural Resources Management Procedural Manual Volume II, Naval NAVFAC P-73	Provides a comprehensive document addressing all Chief of Naval Operations (CNO) natural resources program requirements, guidelines, and standards. The Land Management chapter specifies that the land management section provide guidance covering soil and water conservation, lake or pond management, surface and subsurface water protection and use, agricultural outleasing, erosion control, landscaping, grounds maintenance, and range management, where applicable. The plan must also provide direction to improve real estate values, reduce maintenance, protect wildlife habitats, protect and improve the natural landscapes, and enhance the appearance of the installation, and it shall identify natural areas for agricultural outleasing.
Economy Act, 31 U.S.C. 1535	Provides for the utilization of non-DOD government agencies and non-profit organizations to perform natural resources work when said work would be less expensive than outsourcing and in-house personnel resources are sufficient.
Land Management Guidance	
NAVFAC Instruction (NAVFACINST) **MO-110.1**	Provides guidance on water and wind erosion. Preventing and correcting erosion problems protects landforms, conserves soil resources, and reduces the negative effects of water and airborne soil particulates.
Outdoor Recreation Management, NAVFACINST **MO-100.4**	Management of natural resources to provide recreation opportunities that are sustainable, within the military mission, within established carrying capacities, and consistent with the natural resources upon which they are based.
Soil Conservation and Domestic Allotment Act of 1963, 16 U.S.C. 590A	Provides for application of soil conservation practices on federal lands.
Watershed and Floodplain Protection, 16 U.S.C. 1001 et seq.	Directs federal government to cooperate with States and their political subdivisions, soil or water conservation districts, flood prevention or control districts, and other local public agencies for the purpose of preventing damages associated with flooding, of further conservation, development, utilization, and disposal of water, and the conservation and utilization of land and thereby of preserving, protecting, and improving the Nation's land and water resources and the quality of the environment.
Wild and Scenic Rivers Act of 1968, 16 U.S.C. 1271-1287 (PL 90-542)	Requires identification and protection of any river or stream that qualifies under the Act.
Fish and Wildlife Guidance	
Fish and Wildlife Management, NAVFACINST **MO-100.3**	A coordinated program of actions designed to preserve, enhance, and regulate indigenous wildlife and it habitats, including conservation of protected species and non-game species, management and harvest of game species, bird aircraft strike hazard reduction, and animal damage control.

Table 1: Summary of Sikes Act Improvement Amendments and Related Guidance (continued)

Title	Description
Animal Damage Control Act of 1931, 7 U.S.C. 426 (PL 102-237)	Act gives Animal and Plant Health Inspection Services the authority to control wildlife damage on federal, State, or private land. PL 102-237 adds Brown treesnakes to list of animals to watch.
Department of Defense Appropriations Act of 1991 (Legacy Program) (PL 10-2-396)	Establishes the Legacy Resources Management Program, a program for the stewardship of biological, geophysical, cultural, and historic resources on DOD lands.
Fish and Wildlife Conservation Act of 1980 (Nongame Act), 16 U.S.C. 2901-2911 (PL 96-366)	Encourages management of non-game species.
Outdoor Recreation Guidance	
Disabled Sportsman's Bill, 1999	Amends the Sikes Act to require military installations to ensure disabled have access to the same recreation facilities as the general public.
Recreational Coordination and Outdoor Recreation –Federal/State Programs Act of 1963 (Organic Act), 16 U.S.C. 4601 (PL 88-29)	Defines a program for managing of lands for outdoor recreation.
Military Construction Authorization Act of 1956– Military Reservations and Facilities and – Hunting, Fishing, and Trapping, 10 U.S.C. 2671 (PL 85-337)	Provides that hunting, fishing, and trapping on military lands will be in accordance with State laws.
Agricultural Outlease Guidance	
Farm Land Protection Policy Act, 7 Code of Federal Regulations (CFR) 658	Requires federal agencies to (a) use the criteria to identify and take into account the adverse effects of their programs on the preservation of farmland, (b) consider alternative actions, as appropriate, that could lessen adverse effects, and (c) ensure that their programs, to the extent practicable, are compatible with State and units of local government and private programs and policies to protect farmland.

Table 2: Summary of Applicable Cultural Resources Laws, Regulations, and Requirements

Title	Description
National Historic Preservation Act (NHPA), 16 U.S.C. 470 (f), PL 89-665	Recognizes the nation's historic heritage and establishes management practices encouraging preservation of historic properties. Sections 106 and 110 of the NHPA convey compliance obligations for federal agencies.
Archaeological Resources Protection Act of 1979 (ARPA), 16 U.S.C. 470aa-470ll (43 CFR Part 7)	ARPA specifies that no person may excavate, remove, damage, or otherwise alter or deface any archaeological resources located on public lands, unless such activity is undertaken pursuant to a permit issued by an appropriate federal land manager. As prerequisite to the approval of such work, it must be demonstrated that any archaeological resources excavated or removed from public lands will be curated in accordance with the Department of the Interior Final Rule 36 CFR Part 79, Curation of Federally-Owned and Administered Archaeological Collections. It further specifies that it is illegal to sell, purchase, exchange, transport, or receive any archaeological resources that were obtained in violation of the Act.
Native American Graves Protection and Repatriation Act (NAGPRA), 43 CFR Part 10	NAGPRA acknowledges the ownership of certain Native American and Native Hawaiian human remains and cultural items (funerary objects, sacred objects, and objects of cultural patrimony) by Native American or Native Hawaiian organizations, and treats these remains and objects in a way that is agreeable to these organizations. This Act applies to Native Hawaiian human remains and cultural items discovered, either inadvertently or intentionally excavated, during future undertakings. The implementing regulations, 43 CFR Part 10, provide guidance and procedures for notifying and consulting Native Hawaiian organizations; determining affiliation to the remains or objects; and ensuring proper treatment of the remains and objects in accordance with the affiliated organization's wishes.

Table 3: Summary of Applicable Wetlands and Water Quality Laws, Regulations, and Requirements

Title	Description
Clean Water Act (CWA) 33 U.S.C. 1251-1376 (PL 92-500 [1977])	**Section 319** requires federal agency consistency with State non-point source pollution abatement plans. **Section 401** requires a water quality certification from the State of Hawai'i (SOH) Department of Health (DOH) for activities that may result in the discharge of pollutants into waters of the United States (U.S.). **Section 402** is the basis for the National Pollutant Discharge Elimination System (NPDES) program administered by SOH DOH to control discharges of pollutants into surface waters of the U.S. NPDES General Permit coverage for discharges of storm water associated with construction activity is required for construction projects that result in the disturbance of 1 acre (0.4 hectare) or more. Additionally, NPDES General Permit coverage is required for discharges associated with construction activity dewatering regardless of the size of the construction project. NPDES General Permit coverage is also required for discharge of hydrotesting waters from facilities or activities, which involve a release, or discharge of hydrotesting waters to SOH waters regardless of construction size. **Section 404** prohibits the discharge of dredged or filled materials into U.S. waters, including wetlands, without a Department of the Army permit from the U.S. Army Corps of Engineers.
Executive Order (EO) 11990, Protection of Wetlands	This EO was issued to avoid long- and short-term adverse impacts associated with the destruction or modification of wetlands. A national policy directive that requires that federal agency actions avoid resulting in a net loss of wetlands supports this EO.
Federal Water Pollution Control Act of 1948 (amended by the CWA of 1977), 33 U.S.C. 1251-1376 (PL 845)	See CWA
North American Wetlands Conservation Act of 1989, 16 U.S.C. Section 4401-4414	Funds the North American Waterfowl Management Plan (NAWMP) and the Tripartite agreement on wetlands between Canada, Mexico, and the U.S. The Act directs the Secretary of the Interior to develop and implement a wetlands conservation strategy, and report to Congress on NAWMP project implementation.

Table 4: Summary of Applicable Environmental Contamination Laws, Regulations, and Requirements

Title	Description
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 26 U.S.C. 4611-4682 (PL 96-510)	As amended by the Superfund Amendments Reauthorization Act, CERCLA establishes a series of programs for cleanup of hazardous waste disposal and programs for the cleanup of hazardous waste disposal and spill sites nationwide. Requires protection of human health and the environment. Work under this legislation is conducted under the Navy Installation Restoration Program.
Federal Insecticide, Fungicide, and Rodenticide Act , 7 U.S.C. 136 et seq. (PL 92-516)	Governs the use and application of pesticides in natural and resource management program.
Clean Air Act of 1990 (42 U.S.C. 7401-7671)	Advises federal government agencies to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population.
Oil Pollution Act of 1990, 33 U.S.C. 2701 et seq. (PL 101-380)	Redefines the requirements of the National Oil and Hazardous Substances Contingency Plan (NCP) to include planning for rescue of, minimization of injury to, and assessment of damages to fish and wildlife resources.
NCP, Designation of Federal Trustees, 40 CFR 300.600	Designates federal officials to act on behalf of the public as trustees in natural resources damage assessments pursuant to the Oil Pollution Act, CERCLA, and CWA.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements

Title	Description
Endangered Species Act (ESA) 16 U.S.C. 1531-1544 (PL 93-205)	Provides for the identification of threatened and endangered species of animals and plants and their critical habitats. Requires federal agencies to insure that any action authorized, funded or carried out is not likely to jeopardize the continued existence of any endangered or threatened species or result in destruction or adverse modification of habitat. Requires biological assessments of any agency action when a listed species may be present in the area(s) affected by the action. Requires federal agencies to carry out programs to protect and conserve federally-listed endangered and threatened plants and wildlife in consultation with and assistance from the U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries), which jointly administer the act. Makes the USFWS and NOAA Fisheries responsible for designating and listing species and habitats critical to their survival, issuing expert biological opinions regarding Navy actions which may affect listed species, and for enforcing statutory and regulatory provisions. The INRMP addresses maintenance and improvement of habitat and provides for the long-term conservation of threatened and endangered species. Because of this cooperative approach, it is unlikely that a Section 7 consultation would be necessary. Nevertheless, Section 7 discussions and, if necessary, consultations will be initiated as appropriate.
Fish and Wildlife Service List of Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 &17.12	List of threatened and endangered wildlife and plants protected under the ESA.
Migratory Bird Treaty Act of 1918 (MBTA), 16 U.S.C. 703-712 (PL 65-186)	This domestic law implements the U.S.' commitment to four international conventions for the protection of shared migratory bird resources, which includes most bird species in the U.S. The Act protects migratory birds recognized by international treaties with Great Britain, Mexico, Japan, and Russia, and establishes a permitting process for legal taking of a migratory bird, its eggs, nest or young. Under the Act, it is unlawful to take, import, export, possesses, buy, sell, purchase or barter any migratory bird. Feathers or other parts, nests, eggs, and products made from migratory birds are also covered by the Act. MBTA requires federal agencies to have regulatory authorization from the USFWS before taking migratory birds. federal courts have affirmed that federal agencies are subject to MBTA prohibitions on "take" of migratory birds. Navy installations are required to strive to reduce adverse impacts on migratory birds in their activities.
Application of Migratory Bird Treaty Act, date 08 February 2007, CNO Memorandum	Provides Navy guidance for incidental and intentional taking of birds protected under the Migratory Bird Treaty Act.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements (continued)

List of Migratory Birds, 50 CFR 10.13	List of migratory birds protected under the MBTA.
Fish and Wildlife Coordination Act of 1958, 16 U.S.C. 661-667e (PL 85-624)	Provides mechanism for wildlife conservation to receive equal consideration and be coordinated with water-resource development programs. The Fish and Wildlife Coordination Act of 1958, 16 U.S.C. §662 expanded the instances in which diversions or modifications to water bodies would require consultation with the USFWS. These amendments permitted lands valuable to the Migratory Bird Management Program to be made available to the State agency exercising control over wildlife resources.
Marine Mammal Protection Act of 1972 (MMPA), 16 U.S.C. 1361-1407 (PL 92-522)	Protects taking or harming of marine mammals without the appropriate permit and establishes a marine mammal commission. The Act establishes a federal responsibility to conserve marine mammals in U.S. waters and designates management of cetaceans and pinnipeds to NOAA Fisheries.
Regulations Concerning Marine Mammals, 50 CFR 10, 18 216, 228	Provides direction for marine mammal protection and management.
National Defense Exemption to MMPA, 23 January 2007	A two-year national defense exemptions from requirements of the MMPA for naval activity involving mid-frequency active sonar use, and a new sensor that uses small explosive charges, during major training exercises and on established ranges and operating areas. Authority for the exemption was included by Congress in the National Defense Authorization Act of Fiscal Year 2004.
Magnuson-Stevens Fishery Conservation and Management Act of 1976 16 U.S.C. 1802 et seq. (PL 94-265)	The Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSFCMA) is the governing authority for all fishery management activities that occur in federal waters within the U.S. 200 nautical mile (nm) and 370 kilometer (km) limit, or Exclusive Economic Zone (EEZ). The MSFCMA was amended in 1986 and 1996. Under the 1996 amendments, the MSFCMA was renamed Magnuson-Stevens Act (MSA) (16 U.S.C. §1855 et seq.) and calls for direct action to stop or reverse the loss of species that are managed under the Act. On 12 January 2007, the President signed the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006. The new law sets a deadline to end over-fishing; uses market-based incentives to replenish the national fish stocks; strengthens enforcement of fishing laws; creates programs to improve the quality of information for fishery managers; and promotes cooperation between federal, state and local organizations. The NOAA Fisheries is the lead agency for administering the MSA. To provide a forum for state, industry and public participation, the MSA set up a system of regional fishery management councils. One of the purposes of the 1996 amendments is to promote the protection of Essential Fish Habitat (EFH), which is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding and growth to maturity." An area within the designated EFH that is particularly important and/or sensitive is a Habitat Area of Particular Concern (HAPC). Regional Fishery Management Councils, established under the Act, are responsible for preparing and amending fishery management plans (FMPs) for each fishery under their authority that requires conservation and management.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements (continued)

Magnuson-Stevens Fishery Conservation and Management Act of 1976 (Continued)	Hawaii's EEZ fisheries are under the jurisdiction of the Western Pacific Regional Fishery Management Council (WPRFMC), which writes FMPs for each fishery under its jurisdiction. FMPs set the levels of total allowable catch in the fishery and identify habitats that are considered essential for the sustainment of managed fisheries. The FMPs are either approved or rejected by the Secretary of Commerce. Once approved, NOAA Fisheries implements the FMPs and the U.S. Coast Guard provides enforcement. WPRFMC has or is in the process of finalizing FMPs for the following fisheries: bottomfish, coral reefs, crustaceans, pelagics, and precious corals. All FMPs are subject to NEPA requirements and require an EIS. The MSA requires that NOAA Fisheries be consulted when a proposed federal action may adversely affect an EFH. EFH designations have been quite broad, encompassing virtually all of the waters of SOH. Slopes and escarpments at a depth of 131 to 918 feet (ft) (40 to 280 meters [m]) are designated as HAPC for bottomfish. All seamounts and banks around islands to a depth of 6,562 ft (2,000 m) are HAPC for pelagic fishes.
Sustainable Fisheries Act of 1996 (amends Magnuson-Stevens Fishery Conservation & Management Act), 16 U.S.C. 1801 (PL 104-297)	Amends the Magnuson-Stevens Act to require Fishery Management Councils to establish guidelines to identify and describe EFH and requires federal agencies to consult on any activity authorized, funded, or undertaken or proposed to be that may adversely affect EFH.
Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, PL 101-646, as amended.	The Act is aimed at preventing the unintentional introduction of nonindigenous species into the waters of the U.S. and controlling the spread of species already introduced. The Act calls for international cooperation in the prevention of unintentional introductions of aquatic species, prevention and control of aquatic nuisance species, zebra mussel demonstration programs, and state aquatic nuisance species management plans.
EO 13089, Coral Reef Protection dated 11 June 1998	Requires federal agencies to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment. Establishes a multi-agency Coral Reef Task Force. Under this EO, all federal agencies are required to (1) identify any of their actions that may affect U.S. coral reef ecosystems; (2) utilize their programs to protect and enhance the conditions of such ecosystems; and (3) to the extent permitted by law, ensure that any actions authorized, funded, or carried out do not degrade such ecosystems. The DOD issued its Coral Reef Protection Implementation Plan (October 2000) outlining its responsibilities under the EO.
EO 13112, Invasive Species	Under this EO, all federal agencies whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, (1) identify such actions; (2) subject to the availability of appropriation, and within Administration budgetary limits, use relevant programs and authorities to address invasive species; and (3) not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the U.S. or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize the risk of harm will be taken in conjunction with the actions.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements (continued)

EO 13148, Greening the Government Through Leadership in Environmental Management. Part 6, Section 601 of EO 13148, dated 21 April 2000.	This EO requires federal agencies to incorporate the Guidance for Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds (60 Federal Register 40837) into their landscaping programs, policies, and practices. The Guidance focuses on (1) the use of regionally native plants for landscaping, (2) construction practices that minimize adverse effects on natural habitat, (3) pollution prevention, (4) water and energy efficient practices, and (5) the creation of outdoor demonstration practices. The INRMP update is consistent with the purpose of the Guidance, which is intended to promote principles of "sustainable landscape design and management."
EO 13158, Marine Protected Areas (MPA), dated 26 May 2000	Directs federal agencies to strengthen the management, protection, and conservation of MPAs and establish new or expanded MPAs. MPAs are defined as areas of the marine environment that have been reserved by federal, state, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein. Directs federal agencies to "enhance and expand protection of existing MPAs and to establish or recommend new MPAs as appropriate." The Secretary of Commerce and the Secretary of the Interior are directed publish and maintain a list of MPAs. There are no MPAs in the vicinity of the PMRF INRMP study area. Also on June 15, 2006, President George W. Bush issued a public proclamation creating Northwestern Hawaiian Islands Papahānaumokuākea National Monument under the Antiquities Act of 1906. The Monument encompasses the islands and surrounding waters, forming the largest marine wildlife reserve in the world (139,793 square miles [367,061 square kilometers] of ocean). It extends 1,200 mile (mi) (1,931 km) from Nihoa Island located 155 mi (249 km) northwest of Kauai to Kure Atoll located 1,355 mi (2,181 km) northwest of Kauai. Previous steps have been taken to protect the same area, including a designation as an 'ecosystem reserve' by President Bill Clinton in 2000.
EO 13186, Responsibility of Federal Agencies to Protect Migratory Birds	This EO is designed to assist federal agencies in their efforts to comply with the MBTA, and does not constitute any legal authorization to take migratory birds or otherwise supersede MBTA requirements. The EO directs each federal agency taking actions that have, or are likely to have, a measurable negative impact on migratory bird populations to develop and implement a Memorandum of Understanding with the USFWS for the conservation of migratory bird populations.
EO 13443, Facilitation of Hunting Heritage and Wildlife Conservation, August 16, 2007	This order directs federal agencies that have activities that have a measurable effect on outdoor recreation and wildlife management, to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat. It directs federal agencies to cooperate to conserve hunting opportunities.
Lacey Act Amendments of 1981 (replaces most of the original Lacey Act), 16 U.S.C. 3371-3378	Makes it unlawful to import, export, transport, buy or sell fish, wildlife, or plants taken in violation of federal, state, or tribal laws.
Federal Noxious Weed Act of 1974, 7 U.S.C. 2801 et seq. (PL 93-6290	Establishes control and eradication of noxious weeds and regulates them in interstate and foreign commerce.

Table 5: Summary of Applicable Protected Species and Habitat Laws, Regulations, and Requirements (continued)

Fishery Conservation and Management, 16 U.S.C. 1801 et seq.	Advises federal agencies to conserve and manage the fishery resources found off the coasts of the U.S., and the anadromous species (species that migrate from the sea upstream) and Continental Shelf fishery resources of the U.S.
Marine Protection, Research, and Sanctuaries Act of 1972, 33 U.S.C. 1401-1445 (Title I, II); 16 U.S.C. 1431-1445 (Title III) (PL 92-532)	Establishes regulations relating to dumping specific material into open waters. Title III establishes a program for designation and regulation of national marine sanctuaries.
National Invasive Species Act of 1996 (amends Non-indigenous Aquatic Nuisance Prevention Control Act of 1990 [NANPCA]) 16 U.S.C. 4701 et seq. (PL 104-332)	Reauthorizes and amends the NANPCA to prevent and control infestations of the coastal inland waters of the U.S. by zebra mussel and other non-indigenous aquatic nuisance species, to reauthorize the National Sea Grant College Program, and for other purposes. Establishes an Aquatic Nuisance Species Task Force, a National Ballast Water Clearinghouse, and establishes ballasts water programs (see EO 13112).

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_____. Title 43 Part 10, Native American Graves Protection and Repatriation.

_____Title 50 Parts 17.11 &17.12, Fish and Wildlife Service List of Endangered and Threatened Wildlife and Plants.

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_____ Instruction MO-100.3. *Fish and Wildlife Management*

_____. Instruction MO-100.4: *Special Interest Areas*

_____. Instruction MO-110.1.

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_____. 10-2-396, Department of Defense Appropriations Act of 1991 (Legacy Program).

United States Code (USC) Title 7 Section 136 et seq. (PL 92-516), *Federal Insecticide, Fungicide, and Rodenticide Act of 1947*.

_____.Title 7 Section 426 (PL 102-237), *Animal Damage Control Act of 1931*

_____. Title 7 Sections 2801 et seq. (PL 93-6290), *Federal Noxious Weed Act of 1974.*

_____. Title 10 Part 2671 (PL 85-337), Military Construction Authorization Act of 1956.

_____. Title 16 Part 470(f), as amended (PL 89-665), *National Historic Preservation Act*

_____. Title 16 Part 470aa-470ll (43 CFR Part 7), *Archaeological Resources Protection Act of 1979*

TABLE 2-1: KEY LEGAL REQUIREMENTS, PUBLIC LAWS, EXECUTIVE ORDERS, AND INSTRUCTIONS (CONTINUED)

_____Title 16 Part 590A, Soil Conservation and Domestic Allotment Act of 1963

_____. Title 16 Parts 661-667e (PL 85-624), *Fish and Wildlife Coordination Act of 1958.*

_____Title 16 Part 670, Sikes Act Improvement Amendments

_____. Title 16 Parts 703-712 (PL 65-186), *Migratory Bird Treaty Act of 1918.*

_____Title 16 Part 1001 et seq., *Watershed and Floodplain Protection*

_____Title 16 Part 1271-1287 (PL 90-542), *Wild and Scenic Rivers Act of 1968*

_____. Title 16 Parts 1361-1407 (PL 92-522), *Marine Mammal Protection Act of 1972.*

_____. Title 16 Sections 1401-1445 (Title III) (PL 92-532), *Marine Protection, Research, and Sanctuaries Act of 1972.*

_____. Title 16 Part Part1531-1544 (PL 93-205), *Endangered Species Act.*

_____. Title 16 Sections 1801 et seq. *Fishery Conservation and Management.*

_____. Title 16 Section 1801 (PL 104-297), *Sustainable Fisheries Act of 1996* (amends Magnuson-Stevens Fishery Conservation & Management Act).

_____. Title 16 Parts 1802 et seq. (PL 94-265), Magnuson-Stevens Fishery Conservation and Management Act of 1976.

_____. Title 16 Part 2901-2911 (PL 96-366), Fish and Wildlife Conservation Act of 1980 (Nongame Act).

_____. Title 16 Sections 3371-3378, *Lacey Act Amendments of 1981.*

_____. Title 16 Sections 4401-4414, *North American Wetlands Cons*ervation Act of 1989.

_____. Title 16 Part 4601 (PL 88-29), Recreational Coordination and Outdoor Recreation – Federal/State Programs Act of 1963.

_____. Title 16 Sections 4701 et seq. (PL 104-332), *National Invasive Species Act of 1996.*

_____. Title 26 Sections 4611-4682 (PL 96-510) Comprehensive Environmental Response Compensation, and Liability Act of 1980.

_____ Title 31 Part 1535, *Economy Act.*

_____. Title 33 Sections 1251-1376 (PL 92-500), *Clean Water Act of 1977*

_____. Title 33 Sections 1251-1376 (PL 845), *Federal Water Pollution Control Act of 1948*

_____. Title 33 Sections 1401-1445 (Title I, II); (PL 92-532) *Marine Protection, Research, and Sanctuaries Act of 1972.*

_____. Title 33 Sections 2701 et seq. (PL 101-380), *Oil Pollution Act of 1990*.

_____. Title 42 Section 7401-7671, *Clean Air Act of 1990*.

APPENDIX E
IMPLEMENTATION STATUS OF 2001 INRMP RECOMMENDATIONS

E1 - IMPLEMENTATION STATUS OF 2001 INRMP RECOMMENDATIONS

Table 1: Status of 2001 Integrated Natural Resources Management Plan (INRMP) Recommended Actions

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
1. Threatened & Endangered Species Protection				
FW/LM	Sea Turtle Protection/Beach and Nohili Ditch Restrictions (Barking Sands)	2004, 2006, 2008, 2010	2 – MA/NOC	The INRMP proposed restricting vehicular and pedestrian access to Nohili Ditch by the use of additional and permanent vehicular barriers to keep off-road vehicles out of areas used by nesting turtles. Pedestrian traffic would be addressed by signage and periodic patrols during peak sea turtle nesting season. The implementation of these restrictions required cooperation among the Navy, State of Hawai'i (SOH), and county officials as the beach is SOH property which may be accessed via State, Navy, and county property. **Estimated cost in 2001**: $27,000
Implementation Status: Implemented. Changes in security were made at Pacific Missile Range Facility (PMRF) after 11 September 2001 terrorist attacks in the United States (U.S.) including restricted vehicular access to Nohili Ditch. The recommended vehicle barriers are no longer required. Pedestrian traffic is restricted at Nohili Ditch and a sign was installed to alert pedestrians of the presence of the protected species and to stay out of the area. The area is patrolled by U.S. Department of Agriculture-Wildlife Services (USDA-WS) on a daily basis and by PMRF security personnel several times a day at no added cost for a cost savings of $27,000.				
FW	Sea Turtle Population Monitoring (Barking Sands)	Not specified.	2 – MA/NOC	The INRMP proposed that the PMRF Environmental Coordinator work with National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries), U.S. Fish and Wildlife Services (USFWS), and SOH Department of Land and Natural Resources (DLNR) to monitor sea turtle nests and maintain data records on all nesting activities at Barking Sands, including false nesting, attempted nesting, and successful hatching. In addition, the INRMP proposed that base security staff patrol reports include presence and locations of turtles/turtle nesting sites and be submitted to the PMRF Environmental Coordinator for formal recording. The INRMP proposed that the population monitoring data would be evaluated for any necessary changes or improvements in threatened and endangered species protection planning. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented. USDA-WS patrols the beach on a daily basis and makes note of sea turtles and their activities, which are recorded in a log book at the Environmental Coordinator's office. In addition, PMRF security personnel also report the presence of sea turtles and any nesting activity to the Environmental Coordinator.				

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
FW/LM	Hawaiian Monk Seal Protection/Beach Restrictions (Barking Sands)	Not specified.	2 – MA/NOC	The INRMP proposed that Base Security staff note the presence of monk seals during routine security rounds and report the time and location of any sighting to the PMRF Environmental Coordinator for the permanent record. Furthermore, the PMRF Environmental Coordinator would cooperate with NOAA Fisheries in maintaining data records on haul-out frequency and locations for monk seals in order to aid in evaluating the need for future changes to the protection plan. Training constraints would be published to ensure that operational activities did not cause significant impacts to natural resources. The PMRF Training and Operations staff would adhere to Navy policy regarding inspections of training areas for the presence of protected marine mammals a minimum of six hours before commencing any military exercise, landing, or air to surface delivery of inert ordnance. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented. USDA-WS patrols the beach on a daily basis and makes note of monk seals and their activities which are recorded in a log book at the Environmental Coordinator's office. In addition, PMRF security personnel also report the presence of monk seals and any pupping activity to the Environmental Coordinator. PMRF reports all monk seal activity to Dr. Mimi Ory, Doctor of Veterinarian Medicine, Kaua'i Marine Conservation Coordinator for the DLNR. PMRF Training and Operations staff adhere to Navy policy regarding inspections of training areas for the presence of protected marine mammals a minimum of six hours before commencing any military exercise, landing, or air to surface delivery of inert ordnance.				
FW	Humpback Whale Protection/Training Area Surveillance (Barking Sands, Ni'ihau, Ka'ula Island)	Not specified.	2 – MA/NOC	The 2001 INRMP proposed that the PMRF Training and Operations staff adhere to Navy policy requiring reconnaissance of offshore training ranges for the presence of protected marine mammals before commencing any military exercises. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented. The Navy provides training for ship board personnel involved in military exercises in the vicinity of humpback whale populations, including those off shore of Barking Sands, Ni'ihau, and Ka'ula island.				
FW/LM	Short-tailed Albatross Protection (Barking Sands)	Not specified.	2 – MA/NOC	The 2001 INRMP noted that the existing USDA-WS permit for handling albatross does not include handling for the short-tailed albatross. The 2001 INRMP recommended that if and when a short-tailed albatross appeared at PMRF, it would be left alone and its presence was immediately reported to the USFWS on O'ahu. The bird would not be hazed or disturbed in anyway unless it presented a hazard to human health and safety. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented. USDA-WS patrols Barking Sands on a daily basis for birds and other species. There have been no sightings of short-tailed albatross at the installation during the period from 2001 to 2006. However, should a short-tailed albatross be sighted at the installation, the USDA-WS would be notified and the bird would not be hazed or disturbed in anyway unless it presented a hazard to human health and safety.				

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
FW/LM	Predator Control at Waterbird Nesting Sites (Barking Sands)	2004-2011	2- Class 2	The 2001 INRMP proposed that predator control in waterbird habitat areas and seabird nesting areas be continued in coordination with USDA-WS. **Estimated cost in 2001:** $21,000
Implementation Status: Implemented. USDA-WS patrols the waterbird nesting sites on a daily basis and provides predator control to these areas (the two wedge-tailed shear water colonies, oxidation ponds).				
FW/LM	Nēnē Protective Measures/Predator Trapping (Mākaha Ridge)	2004-2011	2- Class 2	The PMRF Environmental Coordinator would increase predator trapping activities at the Mākaha Ridge Tracking Station during nesting season and while goslings were present on site. The data would be evaluated for any necessary changes or improvements in management actions. The PMRF Environmental Coordinator would implement policies to strongly discourage Navy personnel from feeding nēnē. **Estimated cost in 2001:** $21,000
Implementation Status: Between 2001 and 2006 there have been no nēnē nesting activities at Mākaha Ridge and no goslings present on site; therefore, the recommendation could not be implemented as there has been no need for predator trapping. Natural resources personnel report that the main problem identified at Mākaha Ridge with regard to nēnē is the need to exclude goats so that nēnē can nest. The Navy is working with DLNR DOFAW for goat removal and intends to erect exclosure fencing to keep goats out of the installation.				
FW/LM	Physical Protection of Dwarf Iliau (Mākaha Ridge)	2004, 2009	2- Class 2	The 2001 INRMP recommended that the PMRF Environmental Coordinator coordinate with USFWS and DLNR Division of Fish and Wildlife (DOFAW) to evaluate the feasibility of using protective fencing around the existing plants, and explore other recovery possibilities. The efforts would include ensuring that actions would be consistent with guidelines in the Recovery Plan for Kaua‘i. In conjunction with USFWS and DLNR DOFAW, a plan to prevent off-road vehicles, removal of alien plant species, outplant common native species appropriate for this area, fire control, control of rats and mice, and control of invasive insects would be developed and implemented. Data would be used to measure the effectiveness of the management practices. **Estimated cost in 2001:** $11,000
Implementation Status: Implemented. The Navy recognizes that the population of goats is the most significant and serious issue for PMRF in terms of INRMP funding. The presence of goats at the Mākaha Ridge Tracking Station has contributed to soil erosion (health/safety concerns for personnel and structures), nēne nesting, and native plant recovery including federally-listed endangered dwarf iliau and *Spermolepis hawaiiensis*. The Navy has estimated that the cost for installing the necessary exclusionary fencing will be $502,000 and is included as cost under the implementation plan (Chapter 9).				

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
FW	Waterbird Counts and Surveys (Barking Sands)	2004-2011	3 – Class 3	The 2001 INRMP recommended that the Environmental Coordinator coordinate with DLNR DOFAW and the National Audubon Society regarding the Annual Christmas Bird Count to include a waterbird census on all PMRF lands and maintained such records, including maps of concentrated nesting and foraging area. Data from these surveys would be shared with USFWS. **Estimated cost in 2001:** $9,500
Implementation Status: Implemented. The Navy has conducted bird surveys at all of the Kaua'i PMRF installations. However, these were not part of the National Audubon Society's Annual Christmas Bird Count. Data from the Navy's surveys are included as in this INRMP update.				
FW	Nēnē Population Monitoring (Mākaha Ridge)	2004-2011	3 – Class 3	The 2001 INRMP recommended that the PMRF Environmental Coordinator coordinate with DLNR DOFAW and USFWS to collect nēnē population-monitoring data and would maintain banding schedules. **Estimated cost in 2001:** $2,000
Implementation Status: Not implemented.				
FW	Hoary Bat Population Monitoring Surveys (Barking Sands, Mākaha Ridge, Koke'e sites)	2004-2011	3 – Class 3	The 2001 INRMP recommended that the Environmental Coordinator continue to assist DLNR DOFAW in surveys of feeding behaviors and population estimates for hoary bats at Barking Sands, Mākaha Ridge, and Kōke'e sites. Population monitoring data would be evaluated for any necessary changes or improvements to management actions. **Estimated cost in 2001:** $2,000
Implementation Status: Not implemented.				
FW	Monk Seal Population Monitoring/Surveys (Kaula Island)	2002-2011	3 – Class 3	The 2001 INRMP recommended that the Environmental Coordinator coordinate with NOAA Fisheries to maintain data and maps indicating locations and frequencies of monk seal haul-out behavior on Kaula Island. Population monitoring data would be evaluated for necessary changes or improvements in management actions. When monk seal monitoring involved the use of helicopters, special consideration would be given to addressing the risks of bird aircraft strike hazard (BASH) and helicopter operations near Ka'ula Island. **Estimated cost in 2001:** $30,000
Implementation Status: Naval Facilities Engineering Command Pacific (NAVFAC PAC) biologists are planning to survey Ka'ula Island; however, access to the island has not been approved.				

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
FW	Humpback Whale Monitoring (Barking Sands, Niʻihau, Kaula Island)	2002-2011	3 – Class 3	The 2001 INRMP recommended that the Environmental Coordinator coordinate with NOAA Fisheries to maintain data and maps indicating locations and frequencies of humpback whale sightings in the waters off of Barking Sands, Niʻihau, and Kaula Island. Population monitoring data would be evaluated for any necessary changes or improvements in management actions. **Estimated cost in 2001:** $27,500
Implementation Status: Partially implemented. PMRF participates in the NOAA Ocean Count on the last Saturday of December, January, and February of each year in order to provide locations and frequencies of humpback whale sighting in the waters off of Barking Sands. The Navy does not do this for the waters off of Niʻihau or Kaʻula Island due to access issues.				
FW/LM	Tire Island Construction at Oxidation Ponds (Barking Sands)	2002, 2007, 2011	3 – Class 3	The 2001 INRMP recommended that tire islands for nesting be constructed within the ponds' fence line. **Estimated cost in 2001:** $9,000.00
Implementation Status: Not implemented due to lack of funds. However, enhancements to waterbird habitat at three of the four oxidation pond chambers are in the planning stages.				
2. Natural Resources Education Campaign				
LM	Standard Operating Procedure (SOP) Checklist (Barking Sands)	2002, 2007	2 – MA/NOC	The 2001 INRMP recommended that SOPs for troop training at and personnel relocating to PMRF include information on the effects of alien plant and animal species to native ecosystems, and threatened and endangered species. Preventive measures to avoid introduction of alien species and inadvertent destruction of the environment would be developed and implemented. A Natural Resources Incident Checklist would be developed and distributed for the Officer of the Day and the Base Operating Support (BOS) contractor security staff. The checklist would identify the correct response and actions to be taken in the event of endangered species incidents or other wildlife interactions on base, especially after regular duty hours and on weekends. The checklist would provide telephone contact information for the Environmental Coordinator as primary contact, and contact numbers for associated federal and State agencies such as USFWS, DLNR, and USDA-WS. Since the airstrip is a potential port of entry for invasive plant and animal species that may adversely natural resources, management efforts would explicitly address prevention measures, such as inspection of cargo and aircraft bound for PMRF before departure and upon arrival. **Estimated cost in 2001:** $30,000

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
Implementation Status: Implemented. Welcome Aboard packages for incoming Navy personnel currently include information regarding the sensitive habitats at Barking Sands and other PMRF installations and the necessity for cooperation from troops, personnel, and residents on preventing the introduction of invasive species. PMRF includes information on the effects of alien plant and animal species to native ecosystems, and threatened and endangered species. The airstrip is a potential port of entry for invasive plant and animal species that may adversely natural resources. PMRF requires that all equipment on board incoming flights be cleaned and inspected prior to boarding. Most incoming flights to Barking Sands stop in Honolulu prior to flying to the installation. While in Honolulu, these aircraft are for inspected by SOH Department of Agriculture DOA Quarantine Officer of any planes arriving directly from the U.S. mainland or Alaska. PMRF coordinates with DOA for the inspection of the flight's cargo and the procession of the agriculture declaration.				
LM/OR	Natural Resources Information Center (Barking Sands)	2002-2011	3-Class 3	The 2001 INRMP recommended that the Environmental Coordinator establish and maintain a central location for display of natural resources educational material. Brochures and other materials would be made available for self-guided nature walks and bird watching opportunities both on base and in the surrounding areas. The information center would be located at the Visitors Center at the main gate of Barking Sands. Information on threats to native Hawaiian ecosystems and threatened and endangered species would be included with particular emphasis on the introduction and spread of alien plant species and the negative effects of off-road vehicles in sensitive environments and measures that can be taken to avoid such impacts. Copies of natural resources brochures, flyers, and education materials from partner agencies and organizations such as USFWS, NOAA Fisheries, Hawaii Audubon Society, and local nature conservation groups would also provided in this location. **Estimated cost in 2001:** $16,000
Implementation Status: Partially implemented. Natural resources education material is available at the Pass and Identification office at the main gate to Barking Sands. The information is provided in the form of posters depicting the protected species at the installation. Brochures, flyers, and educational materials from partner agencies are available; however, due to staffing issues, restocking of these materials occurs when time and materials are available.				
LM/OR	Natural Resources Signage (Barking Sands)	2002, 2003, 2007	3-Class 3	The 2001 INRMP recommended the installation of signs indicating appropriate behavior to protect and preserve threatened and endangered species and fragile habitats such as coastal dunes and wetlands. The signs would explain legal and regulatory implications of interacting with threatened or endangered species. The signs would be placed where such interactions are most likely, such as threatened green sea turtle habitat at Nohili Ditch and areas of frequent monk seal activity. The content of the sign concerning threatened and endangered species would be coordinated with USFWS and NOAA Fisheries. **Estimated cost in 2001:** $93,500

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
Implementation Status: Implemented. As discussed in Section 2.9.2, the PMRF Environmental Coordinator and NAVFAC PAC Natural Resources staff have prepared signs indicating appropriate behavior to protect and preserve threatened and endangered species and other protected species at Barking Sands. In addition, PMRF has the capability to print vinyl signs and is initiating educational and cautionary signage at various locations including Migratory Bird Treaty Act (MBTA) bird nesting areas, and fragile habitats such as coastal dunes and wetlands would be placed in appropriate locations.				
LM	Information Integration (Barking Sands)	2002-2011	3-Class 3	The 2001 INRMP recommended that PMRF continue to distribute natural resources information to reporting personnel and base visitors through a variety of printed materials and venues. Materials would be placed for distribution at strategic locations such as the Visitor's Center, the main gates security office, in the snack bar, and at community activity centers and would be restocked as needed. Natural resources information brochures would be provided to the Personnel Support Center for inclusion in the "Welcome Aboard" packages given to Navy personnel and family members, Navy civilian workers, and base personnel. The packet would include information on PMRF's natural resources, and a brief summary of all PMRF policies and applicable federal and State regulations. This information identifies volunteer and recreational opportunities sponsored by the base and the community such as habitat restoration projects, wildlife monitoring projects, bird watching, and nature walks. **Estimated cost in 2001:** $4,500
Implementation Status: Implemented. Welcome Aboard packages for incoming Navy personnel currently include information regarding the sensitive habitats at Barking Sands and other PMRF installations and the necessity for cooperation from troops, personnel, and residents on preventing the introduction of invasive species. PMRF includes information on the effects of alien plant and animal species to native ecosystems, and threatened and endangered species. As discussed in Section 2.9.2, the PMRF Environmental Coordinator has implemented an environmental education campaign directed at installation personnel, residents, visitors, and the general public. The continuation of PMRF's natural resources education campaign includes: (1) educating the community by widely distributing posters, brochures, and signs about the installation's natural resources; (2) providing maps identifying restricted or sensitive areas to installation personnel, residents, and visitors; and (3) including references to the cultural significance of the resource as well as Hawaiian names of plants, animals, and ecosystems in all natural resources information.				
3. Integration of Facilities Planning and Natural Resources Constraints				

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
LM	Future Base Expansion Planning (Barking Sands)	2002-2011	2 – MA/NOC	The 2001 INRMP recommended that the Environmental Coordinator support other PMRF staff representative assigned to evaluate options in the PMRF Activity Overview Plan. The Activity Overview Plan proposes expansion of operations and airfield facilities by procuring approximately 5,000 acres (ac) (2,223 hectares [ha]) of former agricultural lands adjacent to the installation's current northeastern boundary. A routine procedure would be implemented to assure coordination among facilities planners, resource managers, State and county officials. The Environmental Coordinator would be the point of contact to provide relevant information on issues with potential to affect waterbirds, such as flight frequencies, sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of the birds to disturbance. Wetland and waterbird surveys would be required and mitigation measures were developed, as necessary, to assure protection of endangered species and their habitats. **Estimated cost in 2001:** Costs are included in day-to-day functions.
Implementation Status: Not implemented as the expansion never occurred.				
FW	Regulatory Agency Coordination (All PMRF facilities)	2002-2011	2 – MA/NOC	The 2001 INRMP recommended that annual meetings among Navy, federal, State and county natural resources agencies would be hosted by the Environmental Coordinator for mutual review of program status and development enhancements. The Sikes Act Improvement Amendments directs close cooperation and coordination in development and implementation of the INRMP. **Estimated cost in 2001:** Costs are included in day-to-day functions.
Implementation Status: Implemented. The PMRF Environmental Coordinator, NAVFAC PAC Natural Resources staff, and the CNRH Natural and Cultural Resource Program Manager coordinate with the Sikes Act partner agencies on natural resources issues pertaining to threatened and endangered species, critical habitat, and species of concern. PMRF works with USDA-WS including predator control for waterbirds and seabirds; DLNR DAR for monk seal reporting and rescue; DLNR DOFAW for Laysan albatross removals and egg incubation and alien plant removal (LTK); and NOAA Fisheries for humpback whale census.. In addition, the Navy coordinated with the Sikes Act partner agencies in the preparation of the 2001 INRMP and is coordinating with them for this INRMP update.				

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
4. Migratory Seabird Protection				
FW/OR	Beach Restrictions (Barking Sands)	Not specified.	2-MA/NOC	The 2001 INRMP noted that shearwaters feed at sea and are inclined to fish for hooked bait at the end of a fishing line. This behavior leads to entanglement, injury, and death. Restrictions on shoreline fishing in the vicinity of the shearwater nests are difficult to implement and enforce. The 2001 INRMP recommended that the PMRF Environmental Coordinator propose to State and county officials the implementation of an education program and would encourage restriction of evening or nighttime line fishing during the nesting season in the vicinity of the wedge-tailed shearwater burrowing colonies. The colonies are located near the beach recreation cabins and Nohili Dunes. **Estimated cost in 2001:** Not specified.
Implementation Status: Implemented. Currently, there is no line fishing allowed at night. The beach area access is restricted one hour after sunset each day.				
FW	Laysan Albatross Relocation (Barking Sands)	Not specified.	2-MA/NOC	The 2001 INRMP noted that Laysan albatross attempt to nest at Barking Sands and recommended that the Navy continue to work with USFWS and USDA-WS to develop an appropriate strategy to minimize the BASH hazards and to protect the Laysan albatross. **Estimated cost in 2001:** Not specified.
Implementation Status: Implemented. The Navy has continued to work with USDA-WS and USFWS for the protection of Laysan albatross and the removal of these birds and their eggs from Barking Sands. The Environmental Coordinator has provided incubators to assist in the successful hatching of the removed eggs and the placement of the fledglings at Kilauea Point Wildlife Refuge.				
FW	Shearwater Colony Protection (Barking Sands)	Not specified.	2 – Class 2	The 2001 INRMP recommended increased protections for the shearwater colonies at Barking Sands including the placement of signage at the shearwater colony adjacent to beach cabins. Other means for protection of the Nohili Dunes colony would be considered. **Estimated cost in 2001:** Not specified.
Implementation Status: Implemented. Signage has been placed at the southern shearwater colony. An exclusionary fence is located around the southern shearwater colony to keep pedestrians from walking through the colony. The USDA-WS provides predator control in the shearwater colonies. NAVFAC PAC natural resources personnel control weeds and help propagate native plants in the colonies and help reinforce shearwater burrows to prevent accidental collapsing. Additional Navy land has been cleared behind the fenced southern shearwater colony and is being populated by the shearwaters in increasing numbers during the past two nesting seasons.				
FW	Predator Control (Barking Sands)	Not specified.	2 – Class 2	The 2001 INRMP recommended trapping of feral dogs, cats, and rats be continued at the two shearwater-nesting areas at Barking Sands during nesting season when ground-nesting birds and chicks are most vulnerable to predation. **Estimated cost in 2001:** Costs included in 1 (Threatened & Endangered Species Protection/Predator Control)

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
Implementation Status: Implemented. The USDA-WS provides predator control to the two shearwater colonies at Barking Sands.				
FW	Ka'ula Rock MBTA Compliance (Ka'ula Rock)	Not specified.	2 – Class 2	The 2001 INRMP recommended that the Navy work with USFWS and DLNR to maintain compliance with the MBTA. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.				
FW	Shearwater Surveys (Barking Sands)	2002-2011	3 – Class 3	The 2001 INRMP recommended that the PMRF Environmental Coordinator coordinate with USFWS and DLNR DOFAW to band birds in the Barking Sands shearwater colonies and would conduct population monitoring. Population monitoring data would be evaluated for any necessary changes and/or improvements in management actions. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented.				
5. Native Habitat Improvement				
LM/FW	Long-thorn kiawe (LTK) Eradication (Barking Sands).	Not specified	2-MA/NOC	The 2001 INRMP recommended that PMRF work with the University of Hawai'i Agricultural Extension Service to eradicate and control the LTK growing in the southern part of the main base. **Estimated cost in 2001:** Not specified.
Implementation Status: Implemented. Approximately 15 ac (6 ha) of LTK were removed by a Navy contractor beginning in 2005. Removal took place in two areas along the dunes at the southern boundary of Barking Sands and will continue northward in 2007. In addition, the Environmental Coordinator is evaluating the cost and viability of kiawe and haole koa removal from other parts of Barking Sands.				
FW	Nursery Development (Barking Sands)	Not specified	2-MA/NOC	The 2001 INRMP recommended that the Environmental Coordinator evaluate the possibility of establishing a nursery to propagate native plants for landscaping and habitat restoration. This includes consultation with DLNR (regarding its nursery output and operations) and the National Tropical Botanical Garden would be completed. The Environmental Coordinator would evaluate the possibility of requesting seeds from rare or endangered plants on Ni'ihau for propagation in the native plant nursery. Stringent criteria for the cleanliness of the plants and soil used for restoration and landscaping would be required to prevent introduction of harmful alien fungi, nematodes, and other invertebrates into sensitive ecosystems. **Estimated cost in 2001:** Not specified.
Implementation Status: Implemented. The propagation and planting of native plant species has been on-going at Barking Sands (dunes, shearwater colonies, and long-thorn kiawe removal areas). The Navy is in the planning stages for a native plant nursery at Barking Sands if and when funds become available. The PMRF Environmental Department views the development of a nursery as an ideal opportunity for cooperative conservation with the National Tropical Botanical Garden				

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
LM/FW	Landscape Design (Kaua'i and Oahu PMRF Facilities)	Not specified	2-MA/NOC	The 2001 INRMP recommended that the Environmental Coordinator evaluate all on-going landscape design and installation projects for habitat restoration and the use of native plants whenever possible. The preference for plant materials from immediately adjacent areas, as well as the importance of using sterile soil to prevent the introduction of pests such as nematodes, would be emphasized. **Estimated cost in 2001:** Not specified.
Implementation Status: Between 2001 and 2006 there have been no new landscapes designed for PMRF. Native vegetation has naturally been restored in the long-thorn kiawe removal areas and native vegetation has been planted in the shearwater colonies.				
LM/FW	Alien Plants Control (Barking Sands)	2004-2011	2- Class 2	The 2001 INRMP recommended that the Environmental Coordinator initiate a two-phase plan by first evaluating and prioritizing additional invasive noxious plants to be controlled, with emphasis on newly emerging weeds or those species or populations encroaching on healthy native plant populations and habitats, such as coastal dunes and native montane and mesic forests. The prevention and control of weed populations would be incorporated into this plan. These efforts would be coordinated with grounds maintenance personnel to apply limited herbicide in selected areas. In the Koke'e region, alien plant control priorities would be coordinated with the DLNR State Parks Division. Wildlife needs would be evaluated in the context of alien plant control measures. For example, the wedge-tailed shearwater burrowing areas would be excluded from any weeding or planting activities during nesting season to avoid impacts to burrows. Similarly, wetland areas would not completely cleared of vegetation, as dense growth provides important habitat for endangered, endemic waterbirds. **Estimated cost in 2001:** $90,000.
Implementation Status: Implemented. Long-thorn kiawe removal began in fiscal year 2005 and continued into 2007. The 2006 botanical survey of Nohili Dunes identified additional invasive noxious plants to be controlled which will be addressed by PMRF Environmental and NAVFAC PAC Natural Resources staff in their ongoing efforts to restore native dune vegetation. In addition, all grounds equipment (mowers, equipment, tools) is washed down and blown dry by the grounds keepers prior to movement from each installation in order to prevent invasive species introductions. The Navy intends to continue the long-thorn kiawe removal along the beach dunes and targeting the removal of invasive species in Nohili Dunes. The Environmental Coordinator is currently evaluating the feasibility of regular kiawe removal in other portions of the installation.				
LM/FW	Plant Native Species (Kaua'i PMRF facilities)	2004-2011	2- Class 2	The 2001 INRMP recommended that, when practicable, native species from Kaua'i (preferably from PMRF sites) would be used in landscaping, replanting, recovery, and other conservation efforts. The Environmental Coordinator would promote participation with interested parties. **Estimated cost in 2001:** $22,000.

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
Implementation Status: Implemented. Native seed collection and seeding of native plants occurred along the dunes. Native plants are naturally recovering at kiawe removal sites.				
6. Coastal Dune Ecosystem Protection				
LM	Dune Access Restrictions (Barking Sands)	2002-2011	2-MA/NOC	The 2001 INRMP noted that the most important step in successful habitat restoration of coastal dune ecosystems is restriction of vehicle access points to eliminate physical impacts to dune structure and vegetation. The 2001 INRMP recommended that through partnering efforts with DLNR State Parks Division, vehicular access restrictions would apply to Polihale State Park visitors, recreational users at Barking Sands beach, and PMRF personnel, including security patrols. The following steps would be taken to reduce impacts on coastal dunes: (1) vehicle and pedestrian traffic would be restricted to the existing traffic route/berm road and (2) when practical, security personnel would conduct patrols from the paved road above the dunes. Restricted areas would be clearly delineated and mapped in all natural resources educational materials. Signs indicating a restricted access area would be posted at the boundaries of sensitive coastal dune ecosystem. Because the dune ecosystem is located on both PMRF and State land, these restrictions would require joint Navy/DLNR action. **Estimated cost in 2001:** $0.
Implementation Status: Implemented. Only base security is allowed to drive on the dunes and the drivers of those vehicles utilize established paths. As discussed in Section 2.9.2, the PMRF Environmental Coordinator and NAVFAC PAC Natural Resources staff have prepared signs indicating appropriate behavior to protect and preserve threatened and endangered species and other protected species at Barking Sands. In addition, PMRF has the capability to print vinyl signs and is initiating educational and cautionary signage at various locations including MBTA bird nesting areas, and fragile habitats such as coastal dunes and wetlands would be placed in appropriate locations.				
LM	Habitation Improvement (Barking Sands)	2002-2011	2- Class 2	The 2001 INRMP recommended that habitat improvements be initiated and implemented after impacts from off-road vehicles are eliminated. This plan would include identifying priority alien, invasive plant species/populations for removal, planting native coastal dune species, and coordinating with similar efforts at Polihale State Park. Whenever possible, native plants would be derived from Polihale Dune populations. **Estimated cost in 2001:** Costs included in 5. Native Habitat Improvement.
Implementation Status: Implemented. Long-thorn kiawe removal began in fiscal year 2005 and continues into fiscal year 2006. Dune restoration was allocated $30,000 in fiscal year 2006. Some native seed collection and seeding of native plants has been completed. Native plants naturally recover once the kiawe is removed.				

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
7. Soil Erosion Prevention				
LM	Project Development. (Mākaha Ridge Tracking Station)	2002-2003	2-MA/NOC	The 2001 INRMP recommended that the Environmental Coordinator evaluate, map, and prioritize areas of extensive erosion such as the developed areas and the helicopter-landing zone (HLZ) at Mākaha Ridge. These evaluations and resulting maps would be based on collected baseline data examining the extent of erosion by comparing photos over time and slope analysis. **Estimated cost in 2001:** Not specified
Implementation Status: Implemented. The evaluation process was begun in fiscal year 2002. The areas were mapped in fiscal year 2004. Goats are present at the Mākāha Ridge Tracking Station. They contribute to soil erosion, interfere with nesting of nēne at the station, and threaten the native vegetation including the federally-listed plants, dwarf iliau and *Spermolepis hawaiiensis*. The Navy is currently evaluating the feasibility of installing exclusion fencing to exclude the goats from the station, including the cliffs where the native plants are located. DLNR DOFAW has agreed to catch and remove the goats at no cost to the Navy. They would build a fenced area to herd the goats into, then remove them for relocation into hunting areas. This could be done prior to the installation of exclosure fencing by the Navy.				
LM	Replanting (Mākaha Ridge Tracking Station)	Not specified.	2- Class 2	The 2001 INRMP recommended that the areas of worst erosion be replanted to stabilize slopes and reduce erosion. Drought-resistant plantings would be planted in the HLZ to withstand high winds, exposure, rotor wash within a site where water is a limited resource. Erosion control cloth such as Geojute, which has been an erosion control tool used in conjunction with outplanting native species, would be used as appropriate. **Estimated cost in 2001:** $15,000
Implementation Status: Not implemented. Goats need to be removed from the ridge before this can take place. The SOH intends to remove the goats by non-lethal means (netting) from the ridge. After that takes place, if funds are available, the Navy would replant and stabilize the eroded slopes.				
LM	Fencing (Mākaha Ridge Tracking Station)	Not specified.	2- Class 2	The 2001 INRMP recommended herbivore exclusion fences be placed around threatened and endangered plants and replanted areas. The Environmental Coordinator would work with DLNR to reduce grazing pressures and associated threats to rare plants. Vehicle access would be restricted to paved roads and designated paved parking areas. Parking in grassy or bare earth areas would be discouraged. Restrictions on pedestrian traffic in replanted areas would be implemented. **Estimated cost in 2001:** Not specified
Implementation Status: On-going. The Navy is currently evaluating the feasibility of installing exclusion fencing to exclude the goats from the station, including the cliffs where the native plants are located. DLNR DOFAW has agreed to catch and remove the goats at no cost to the Navy. They would build a fenced area to herd the goats into, then remove them for relocation into hunting areas. This could be done prior to the installation of exclosure fencing by the Navy.				

Table 1: Status of 2001 NRMP Recommended Actions (continued)

Code[1]	2001 INRMP Recommended Action	Fiscal Year Funding	Priority[2]	Description
8. Coral Reef Ecosystem Protection				
FW	Agency Coordination (Barking Sands, Niʻihau Sites, and Kaula Island)	2002	2-MA/NOC	The 2001 INRMP recommended that the PMRF Environmental Coordinator work with NOAA Fisheries, USFWS, DLNR, and HCRI staffs to determine the level of Navy participation and support required to conduct marine resources surveys and assessments. **Estimated cost in 2001:** $0.
Implementation Status: Partially implemented. The Navy does not have natural resources management jurisdiction over the marine environment at Barking Sands, Niʻihau, or Kaʻula Islands;however, the Navy has completed an update to their previous marine resources survey off of Barking Sands.				
FW	**Niʻihau and Kaʻula Island Surveys** (Niʻihau Sites and Kaʻula Island)	2002	3 – Class 3	The 2001 INRMP recommended that the PMRF Environmental Coordinator cooperate with the NOAA Fisheries, USFWS, DLNR, and HCRI to assist in conducting marine resources surveys and assessments in the waters around Niʻihau and Kaʻula Islands. Data on coral reefs and associated species would be collected and evaluated for any necessary changes and/or improvements in the management actions. **Estimated cost in 2001:** $5,000.
Implementation Status: Not implemented. The Navy does not have natural resources management jurisdiction over the marine environment at Niʻihau and Kaʻula Islands. Currently, there is no access to Kaʻula Rock due to safety and BASH concerns. There have not been marine resources surveys and/or assessments.				

Note: Code refers to the category of natural resource action proposed:

LM = Land Management
FW = Fish and Wildlife Management
OR = Outdoor Recreation.

Priority Abbreviations:

2- MA/NOC = Priority 2 Management Action/Normal Operating Costs (Projects required to remain in compliance with legal requirements or to meet established deadlines)

2-Class 2 = Priority 2 Project/Class 2 Funding (Projects required to remain in compliance with legal requirements or to meet established deadlines)

3-Class 3 = Priority 3 Project/Class 3 Funding (Projects are feasible actions that would enhance natural resources, but are not required to comply with laws or regulations. Funding for Class 3 projects is not always readily available. When funds are provided, the Priority 3 projects are initiated in the order proposed by the PMRF Environmental Coordinator and approved by appropriate command structure.)

Source: Department of the Navy 2001

Acronyms and Abbreviations

ac	acres
BASH	bird aircraft strike hazard
BOS	Base Operating Support
DLNR	Department of Land and Natural Resources (SOH)
DOA	Department of Agriculture
DOFAW	Division of Fish and Wildlife (SOH DLNR)
FW	fish and wildlife
ha	hectares
HLZ	helicopter-landing zone
INRMP	Integrated Natural Resources Management Plan
LM	land management
LTK	long-thorn kiawe
MA/NOC	Management Action/Normal Operating Costs
MBTA	Migratory Bird Treaty Act
NAVFAC PAC	Naval Facilities Engineering Command Pacific
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Oceanic and Atmospheric Administration National Marine Fisheries Service
OR	outdoor recreation
PMRF	Pacific Missile Range Facility
SOH	State of Hawai‘i
SOP	Standard Operating Procedure
U.S.	United States
USDA-WS	U.S. Department of Agriculture-Wildlife Services
USFWS	U.S. Fish and Wildlife Services

APPENDIX F
CORRESPONDANCE

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 NE. 11th Avenue
Portland, Oregon 97232-4181

IN REPLY REFER TO
AFR

OCT 30 2001

Melvin N. Kaku
Director, Environmental Planning Division
Department of the Navy
Pacific Division, Naval Facilities Engineering Command
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

Dear Mr. Kaku:

The Fish and Wildlife Service (Service) has reviewed the Final Draft Integrated Natural Resources Management Plan (INRMP) for the Pacific Missile Range Facility on several Hawaiian islands (PMRF INRMP). The purpose of this letter is to communicate the Service's agreement that the management measures contained in the PMRF INRMP are consistent with PL 105-85, also known as the Sikes Act Improvement Act of 1997 (SAIA), and should benefit fish and wildlife resources.

In compliance with the SAIA, military installations must prepare INRMPs that provide for conservation and rehabilitation of natural resources, sustainable multipurpose uses of the resources, and public access for use of natural resources, subject to safety requirements and military security. INRMPs are to be prepared in cooperation with the Service and relevant State resource agencies so that each approved INRMP reflects the mutual agreement of the parties concerning conservation, protection, and management of fish and wildlife resources.

The PMRF INRMP is a programmatic document intended to identify management objectives for natural resources over a ten-year planning horizon. The INRMP may be updated as often as necessary, but at least one update must occur no more than five years from initial approval. Consistent with the SAIA, the PMRF INRMP is intended to be a guide for future activities that involve the protection, conservation, and management of natural resources occurring within certain areas of the main base at PMRF Barking Sands on Kauai; support facilities at Makaha Ridge, Kokee, and Kamokala Magazines on Kauai; a parcel on Niihau; Kaula Island; and a parcel at Mauna Kapu on Oahu.

The Service's Pacific Islands Fish and Wildlife Office has reviewed multiple versions of the draft PMRF INRMP and has shared numerous related concerns with your staff over the course of many meetings. We appreciate the comprehensive manner in which the Navy has responded to our INRMP concerns. Of particular note, discussions with Steve Smith, Marine Ecologist, Naval Facilities Engineering Service Center, and Randy Miyashiro, Environmental Protection Specialist, Navy Region Hawaii, have been very constructive. As a result of this open dialogue, the Service has been able to contribute to the INRMP planning process and most of our concerns have been resolved, as reflected in the Final Revised Draft.

With regard to the protection of species listed under the Endangered Species Act, the Service and Navy completed informal section 7 consultation on May 24, 2001. The Service concurred with the Navy's determination that the PMRF INRMP is not likely to adversely affect listed species, with the understanding that this concurrence will not preclude the need for further consultations as specific actions associated with projects proposed in the plan become identified.

As you know, the Service is drafting a critical habitat proposal for endangered plants reported from the island of Kauai. We have identified areas covered by the PMRF INRMP that may be important for the conservation of one or more listed plant species. We have noted that it is the Navy's position that the PMRF INRMP meets the Service's requirements, as published in the *Federal Register* on February 7, 2001, for obviating the designation of critical habitat on PMRF lands. The Service is concerned that this INRMP does not adequately address the threats to the habitat essential to the conservation of *Panicum niihauense* and *Wilkesia hobdyi*. In addition, the Service believes that the INRMP may not ensure that appropriate conservation management strategies will be adequately funded or effectively implemented. We intend to coordinate very closely with you in the development of conservation planning efforts for these, and other, endangered plants.

The Service would like to initiate a dialogue with you and the heads of the Navy Environmental Compliance and Environmental Restoration divisions at Pearl Harbor concerning the role of environmental contaminant assessment and remediation in relation to natural resource and/or ecosystem management at this installation. Contaminants adversely affect the quality of habitats and the viability of plant and animal populations. We recommend that yearly reviews and future revisions to this INRMP include a section summarizing known or suspected contaminant-related issues and management actions taken, or identify additional information needed to protect fish and wildlife resources and rehabilitate contaminant-affected habitats. The Service has extensive expertise in assessing environmental contaminant impacts to fish and wildlife and recommending actions to restore habitats adversely affected by contamination. It is our desire to work with the Navy to identify opportunities, consistent with the SAIA, to rehabilitate wildlife habitat in conjunction with contaminated site remediation during implementation of the INRMP.

The Department of Defense and the Service are currently developing a MOU to implement Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*. While the MOU is being developed, the Service encourages continued dialogue between our agencies on cooperative efforts to protect and conserve migratory birds and their habitats, with special emphasis on the species identified in Service's list of birds of conservation concern. During the implementation phase of this INRMP, we would like to work with you to incorporate migratory bird conservation actions on military lands. Programs and recommendations contained in comprehensive migratory bird plans such as the U.S. National Shorebird Plan, North American Waterfowl Management Plan, Partners-in-Flight, and North American Waterbird Conservation Plan should be integrated into management actions on military lands.

We also would like to clarify that any action that is undertaken specifically to take, kill or capture migratory birds requires the appropriate migratory bird permit from our Regional Office in Portland, Oregon.

As we move into the implementation phase of the PMRF INRMP, our agencies should work as closely as possible within the scope of the 1999 Memorandum of Understanding Between the Department of Defense and the Fish and Wildlife Service for the Ecosystem-based Management of Fish, Wildlife, and Plant Resources on Military Lands (MOU). The type of resource management mandated by the SAIA is a shared, long-term responsibility that may be facilitated through implementation of the MOU and execution of subagreements made pursuant to the MOU. Through this instrument, the Service would be able to ensure that adequate staff time is allocated to working with your staff in areas such as the ongoing development of proposed INRMP project details, project implementation, annual INRMP reviews/updates, and in an INRMP revision at least once every five years.

The SAIA and MOU provide clear funding opportunities to support Service and military capabilities in carrying out our SAIA obligations. It is our view that this support may be highly appropriate in the Pacific where such a large number of military installations occur and play crucial roles in the recovery of endangered species. Please feel free to contact my Pacific Islands Fish and Wildlife Office Supervisor, Paul Henson, at (808) 541-3441, to discuss our mutual interests in INRMP monitoring and implementation.

Sincerely,

Regional Director

cc:
Gil Coloma-Agaran, Hawaii Department of Land & Natural Resources
Charles Karnella, National Marine Fisheries Service
Paul Henson, Field Supervisor, Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii
Rich Johnson, Region 1 Sikes Act Coordinator, Fish and Wildlife Service, Portland, Oregon
Jeanette Gallihugh, Branch of Federal Activities, Sikes Act Coordinator, Fish and Wildlife Service, Arlington, Virginia

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
Pacific Island Area Office
1601 Kapiolani Boulevard, Suite 1110
Honolulu, Hawaii 96814-0047

August 8, 2001

Rear Admiral R.T. Conway
Commander
Navy Region Hawaii
517 Russell Avenue
Pearl Harbor, HI 96860-4884

Dear Admiral Conway:

The National Marine Fisheries Service (NMFS) has reviewed the *Final Draft Pacific Missile Range Integrated Natural Resources Management Plan (INRMP)*. NMFS has worked with the Navy over the past year to develop programmatic recommendations for the protection and enhancement of natural resources located at the Pacific Missile Range Facility. Our comments on the INRMP were sent to the Navel Facilities Engineering Command on May 31, 2001. NMFS concurs that the programmatic objectives and recommendations as presented in the draft plan are compatible with the objectives of the Sikes Act Improvement Act of 1997. In addition, NMFS concurs that the implementation of these recommendations should serve to protect and enhance marine resources under our jurisdiction and look forward to working with the Navy to better define the programmatic recommendations as stated in the plan.

Sincerely,

for Rebecca Lent, Ph.D.
Regional Administrator

Copies Furnished:

Ms. Leona Stevenson, Southwest Region, NMFS, 501 West Ocean Blvd.,Suite 4200, Long Beach, CA 90802-4213

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P.O. BOX 621
HONOLULU, HAWAII 96809

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND DIVISION
STATE PARKS
WATER RESOURCE MANAGEMENT

September 14, 2001

LD/NAV
PACIFICMISSILERANGEINRMP.RCM

Department of the Navy, Pacific Division
Naval Facilities Engineering Command
Melvin N. Kaku, Director
Environmental Planning
258 Makalapa Dr., Ste 100
Pearl Harbor, Hawaii 96860-3134

Attn: Steve Smith

Dear Mr. Kaku:

SUBJECT: Department of Land and Natural Resources (DLNR) Concurrence with Programmatic Objectives and Recommendations of Pacific Missile Range Facility Hawaii Integrated Natural Resource Management Plan

Naval installations are required to prepare integrated natural resources management plans that are in compliance with the Sikes Act Improvement Act (SAIA) of 1997.

The integrated natural resource management plan (INRMP) must provide for the following:

- Conservation and rehabilitation of natural resources
- Sustainable multi-purpose uses of resources, and
- Public access for use of natural resources, subject to the Navy's mission, operational and security requirements

DLNR understands that the INRMP planning horizon is ten (10) years and will be used by installation personnel to guide and prioritize short (0-2 years), mid (3-5 years) and longer-term (6-10 years) conservation planning actions and projects. The INRMP will be reviewed annually and updated every five (5) years. The review and updating schedule allows partnering agencies regular opportunities to contribute to the planning process.

DLNR has worked with the Navy for over two (2) years to develop programmatic recommendations for the protection and enhancement of natural resources within the Pacific Missile Range Facility. At this time, the DLNR concurs that the programmatic objectives and recommendations as presented in the Draft Pacific Missile Range Facility Integrated Natural Resources Management Plan are compatible with the objectives of the SAIA. Furthermore, the DLNR agrees that implementation of present recommendations and subsequent recommendations should protect and enhance those living resources and habitats for which the DLNR has jurisdiction. The DLNR Divisions of Forestry & Wildlife, Aquatic Resources, Historic Preservation, State Parks and Land look forward to continuing to work with the Navy in defining the programmatic recommendations contained in the INRMP.

Page 2
PACIFICMISSLERANGEINRRMP.RCM

We further recommend the following:

- The United States Navy consider committing resources, i. e. funding and organizational infrastructure, needed to accomplish the management strategies and environmental tasks called for in the Pacific Missile Range Facility Hawaii INRMP, including increasing public recreational opportunities.

- The United States Navy consider expanding public recreational opportunities on bases whenever possible.

- The United States Navy consult with the DLNR when the military schedules implementation of recommendations contained in the Pacific Missile Range Facility Hawaii INRMP.

Attached herewith is a copy of the Division of Forestry and Wildlife comments.

Thank you for the opportunity to comment on the Draft Pacific Missile Range Facility Hawaii Integrated Natural Resources Management Plan.

Should you have any questions regarding specific natural resources within the Pacific Missile Range Facility that you would like to address with DLNR, please feel free to contact any of the following: David Smith of the Division of Forestry and Wildlife (DOFAW) at 973-9786, Patrick Costales the DOFAW Oahu Branch Manager at 973-9787, Francis Oishi of the Division of Aquatic Resources at 587-0094, Elaine Jourdane of the Historic Preservation Division at 692-8027. To coordinate DLNR review of future INRMP documents, please contact Nicholas A. Vaccaro of the Land Division Support Services Branch at 587-0438.

Sincerely Yours,

GILBERT S. COLOMA-AGARAN
Chairperson

c: District Land Office
Division of Forestry and Wildlife
Division of Aquatic Resources
Historic Preservation Division

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

August 24, 2001

Mr. Nick Vaccaro
Land Agent
DLNR, Land Division
1151 Punchbowl St. Rm. 220
Honolulu, Hawaii 96813

Dear ~~Mr. Vaccaro~~ Nick:

Subject: Concurrence with Programmatic Objectives and Recommendations of Integrated Natural Resources Management Plan (INRMP) for Pacific Missile Range Facility Hawaii.

We appreciate the coordinated efforts of Mr. Steve Smith bringing the various Federal, State and County agency representatives to review the draft INRMP for Pacific Missile Range Facility Hawaii. The draft is a good start to integrate the mission of the Pacific Missile Range Facility Hawaii with the natural resource management issues that many agencies were asked to review. Mr. Smith held at least two meetings to bring resource managers together to work out differences among agency mandates. The final draft represents the diligent work and coordination of Mr. Smith's efforts.

At this time DLNR, Division of Forestry and Wildlife concurs with the results and the recommendations for the protection and enhancement of the Natural resources within the PMRF INRMP project area as described in the final draft INRMP for the Pacific Missile Range Facility Hawaii. We believe that the implementation of the recommendations will help protect and improve the plants and wildlife along with their habitats. Realizing that this is not a finite document, we will continue to work and assist the Navy with improving the recommendations contained in this plan. Thank you for the opportunity to comment on this important document covering the INRMP for the Pacific Missile Range Facility Hawaii.

Sincerely yours,

for Michael G. Buck
Administrator

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

EV2 MLL 9/2
EV22 TS
VP

In Reply Refer To:
1-2-2005-I-326

AUG 31 2005

Ms. Connie M. Chang
Acting Director, Environmental Planning Division
Naval Facilities Engineering Command, Pacific
Department of the Navy
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860-3134

Dear Ms. Chang:

Thank your for your July 12, 2005, letter requesting our concurrence under Section 7 of the Endangered Species Act (Act) that the *Prosopis juliflora* (long-thorn kiawe) removal project at Barking Sands, Pacific Missile Range Facility (PMRF) is not likely to adversely affect federally endangered or threatened species, or designated critical habitat. We received your letter on July 15, 2005. Your letter identifies critical habitat for the federally endangered *Panicum niihauense* (lauehu) in the proposed project area. On August 2, 2005, Gregory Koob from my office contacted Vanessa Pepi of your office to request additional information on the Navy's proposed measures to avoid adverse impacts to the native plant species that are primary constituent elements of *P. niihauense* critical habitat. On August 10, 2005, we received the information in an email from Ms. Pepi.

The Navy proposes to remove *Prosopis juliflora* from PMRF for at least the next ten years. Branches of this non-native, invasive species will be removed using chain saws and a mobile wood chipper. The remaining stumps will be cut close to the ground and treated with the systemic herbicide Garlon IV. Cleared areas will be systematically surveyed for new *Prosopis juliflora* seedlings and any seedlings observed will be removed until no new seedlings are observed.

The project area does not contain any endangered or threatened plants but is critical habitat for *Panicum niihauense*. The primary constituent elements for *P. niihauense* are elevations between 0 and 29 meters (0 and 95 feet) and sand dunes in coastal shrubland containing one or more of the following plant species: *Cassytha filiformis* (kaunaoa pehu), *Chamaesyce celastroides* (akoko), *Dodonaea viscosa* (aalii), *Nama sandwicensis* (hinahina kahakai), *Ophioglossum pendulum* ssp. *falcatum* (puapua moa), *Scaevola taccada* (naupaka), *Sida fallax* (ilima), *Sporobolus virginicus* (akiaki), and *Vitex rotundifolia* (pohinahina).

The proposed project area may contain some of the native plant species listed above. According to Ms. Pepi's email, the Navy will avoid damaging any native plant species in the area while removing *Prosopis juliflora*. Individual plants or areas where native plant species are located will be marked with survey flagging tape and personnel working in the area will be advised to avoid those areas and plants. One person will be on site, monitoring the project to ensure native species are not damaged in the *P. juliflora* removal process.

The wood chipping machinery may disturb approximately the top 15 centimeters (6 inches) of the loose sand. The impacts of this disturbance will be short term and will not permanently affect any of the primary constituent elements of *Panicum niihauense* critical habitat.

Based on our review of the proposed project, we concur with your determination that the proposed *Prosopis juliflora* removal at PMRF is not likely to adversely affect federally listed species or designated critical habitat. Our concurrence is based on the absence of federally listed species in the project area, the beneficial effects of removing the invasive plant species *P. juliflora*, your incorporation of measures to avoid damaging existing native plants species, and the short-term nature of sand disturbance.

We appreciate your efforts to minimize impacts to listed species and critical habitat. If you have any questions regarding this letter, please contact Dr. Gregory A. Koob, Botanist, of my office by telephone at (808) 792-9400 or by facsimile at (808) 792-9581.

Sincerely,

for Patrick Leonard
Field Supervisor

Pepi, Vanessa E CIV NAVFAC PAC

From: Pepi, Vanessa E CIV NAVFAC PAC
Sent: Wednesday, August 10, 2005 2:30 PM
To: 'greg_koob@fws.gov'
Cc: Kaku, Melvin N CIV NAVFAC PAC ; Sutterfield, Timothy W CIV NAVFAC PAC ; Burger, John CIV PMRF
Subject: Informal Consultation on the Removal of Long Thorn Kiawe from Lau'ehu CH at PMRF, Kauai

Dear Mr. Koob,

Following up on the Navy's letter 11015.11, Ser EV32/932 of July 12, 2005, INFORMAL CONSULTATION ON THE REMOVAL FOR LONG THORN KIAWE FROM CRITICAL HABITAT FOR *PANICUM NIIHAUENSE*, PACIFIC MISSILE RANGE FACILITY (PACMISRANFAC), KAUAI, the Navy is providing additional clarifying information for your consideration.

The Navy is preparing to undertake a long thorn kiawe removal project at Barking Sands, PACMISRANFAC, Kauai. Portions of the project action area are located within habitat designated under the Endangered Species Act (ESA) as critical for *Panicum niihauense*. In order to ensure that critical habitat will not be adversely affected, the Navy will avoid damaging any native species in the area while conducting the removal of long thorn kiawe.

The following actions are proposed for the project: (1) We will flag with survey flagging tape, individual plants or areas where native species are located within critical habitat; (2) prior to beginning work on a management section, we will inform all personnel (i.e., KISC and the Navy's contractor) of the flagging procedures and individual plants or areas flagged to ensure the avoidance and protection of native species; and (3) we shall have at least one individual monitoring the project while long thorn kiawe removal activities are ongoing.

Based on these management practices, the Navy has determined that the project to remove long thorn kiawe from the critical habitat for *Panicum niihauense* will have not have an adverse effect on critical habitat.

Sincerely,

Vanessa E. Pepi
Fish and Wildlife Biologist
EV2 Environmental Planning
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

☎ Tel: (808) 472-1406 Fax: (808) 474-5419
✉ E-mail: vanessa.pepi@navy.mil

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND, PACIFIC
258 MAKALAPA DR., STE. 100
PEARL HARBOR, HAWAII 96860-3134

11015.11
Ser EV32/ 932
12 JUL 2005

Mr. Patrick Leonard
Pacific Islands Administrator
U.S. Fish and Wildlife Service
P.O. Box 50167
Honolulu, HI 96850

Dear Mr. Leonard:

Subj: INFORMAL CONSULTATION ON THE REMOVAL OF LONG THORN KIAWE FROM CRITICAL HABITAT FOR PANICUM NIIHAUENSE, PACIFIC MISSILE RANGE FACILITY (PACMISRANFAC), KAUA'I

The Navy is preparing to undertake a long thorn kiawe (*Prosopis juliflora*) removal project at Barking Sands, PACMISRANFAC, Kaua'i, Hawai'i (Figs. 1-4). Portions of the project action area along the beach are located within habitat designated under the Endangered Species Act (ESA) as critical for lau'ehu (*Panicum niihauense*). While the removal action may affect those areas, the Navy has determined that no constituent elements of critical habitat will be adversely affected. Therefore, there will be no destruction or adverse modification of critical habitat that would require formal section 7 ESA consultation. Further, no listed species of plants or animals are present at any of the proposed project sites, and none will be affected by the project. The Navy seeks the U.S. Fish and Wildlife Service's concurrence with this determination.

Project Description:

It is anticipated that the removal of long thorn kiawe from Barking Sands will occur over at least ten years. The proposed project will begin at the southwest corner of the base (Fig. 4) as an initial test to refine the methodology and confirm this initial phase of the long term long thorn kiawe project timeline. Long thorn kiawe branches will be mechanically removed using a mobile wood-chipper and chain saws. Stumps will be cut as close to the ground as possible and treated with the systemic herbicide, Garlon IV. Areas will then be systematically surveyed for new long thorn kiawe seedlings and any seedlings observed will be removed until no new seedlings are found.

Effect On Critical Habitat:

Long thorn kiawe is a non-native, invasive species. Its thorns have killed native species of seabirds and its control and eradication are recommended in the PMRF Integrated Natural Resources Management Plan and by the Kauai Invasive Species Committee

(KISC). The plant is not, nor is it associated with, a constituent element of critical habitat for lau'ehu.

While the wood-chipping machinery that will be used to remove the long thorn kiawe trees and woody debris may disturb approximately the top 15 cm of loose sand, impacts would be short term and would not affect any constituent elements of critical habitat.

The Navy is requesting your written concurrence with our determination that the action will not adversely affect any listed species or designated critical habitat. Thank you for your consideration of this conservation action and our request. Should you have any questions, please contact Ms. Vanessa E. Pepi at (808) 472-1406 or by E-Mail at vanessa.pepi@navy.mil.

Sincerely,

Connie M. Chang

CONNIE M. CHANG
Director
Environmental Planning Division
Acting

Encl:
(1) Maps of the Location of the Project Area (Figs. 1-4)

Copy to:
COMNAVREG Hawaii
(N456, Mr. Randy Miyashiro)
PACMISRANFAC
(Mr. John Burger)

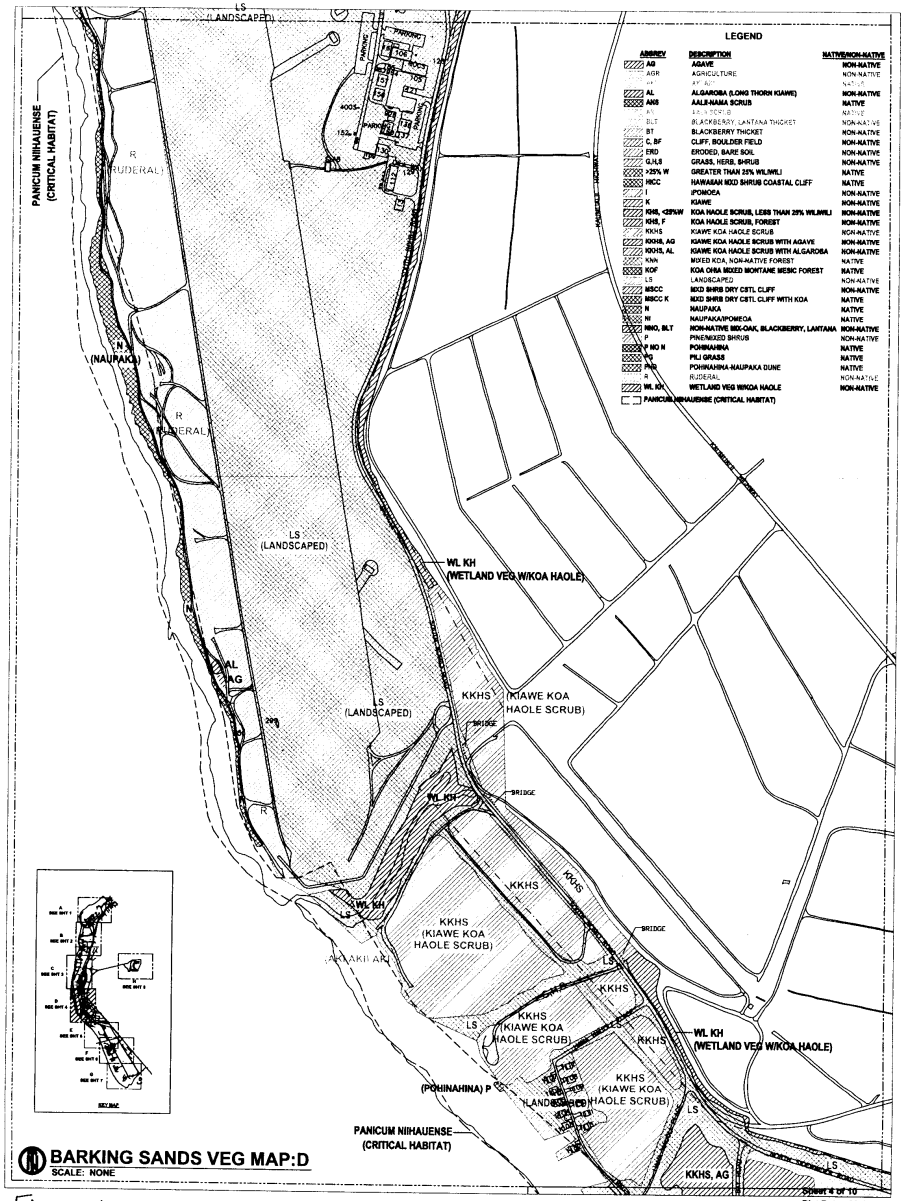

Figure 1.

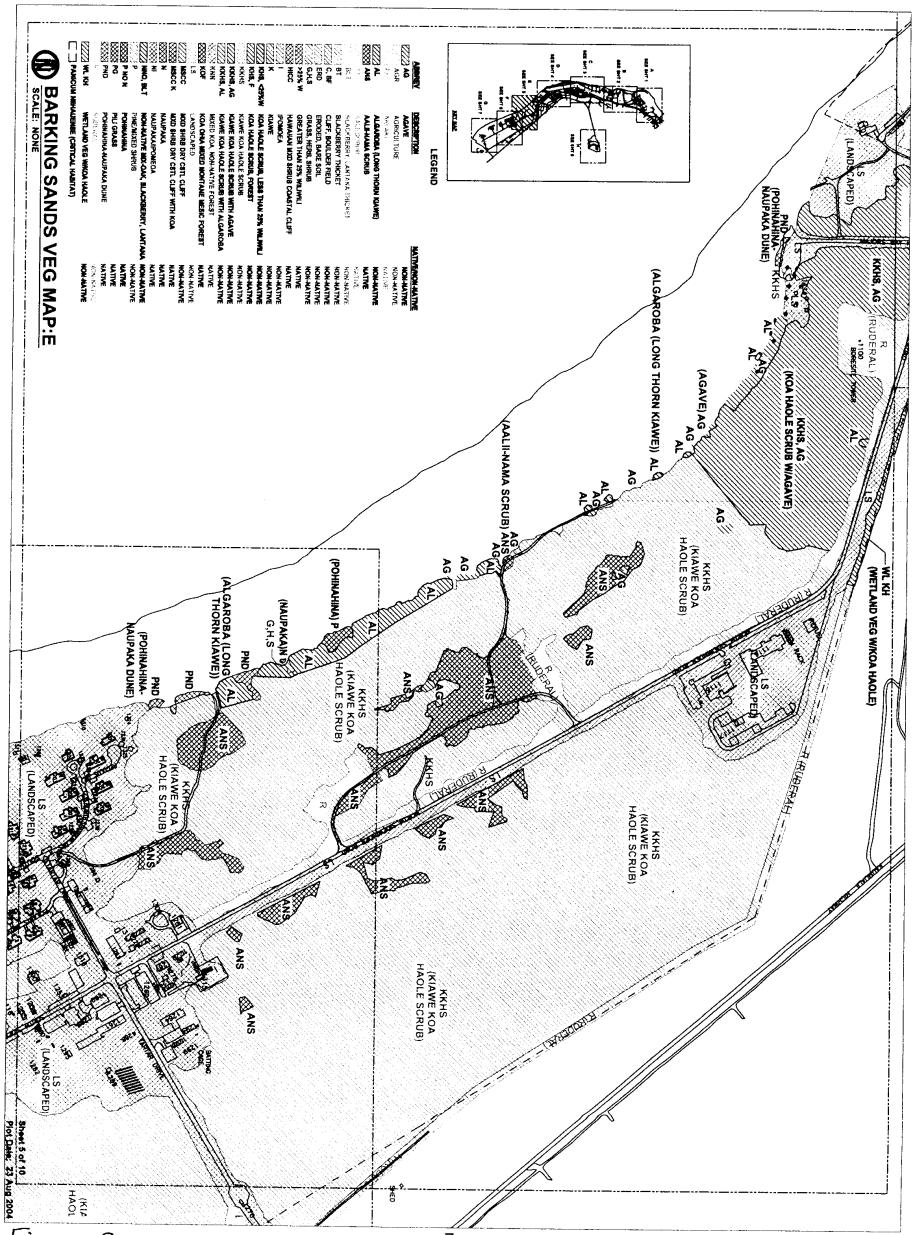

Figure 2.

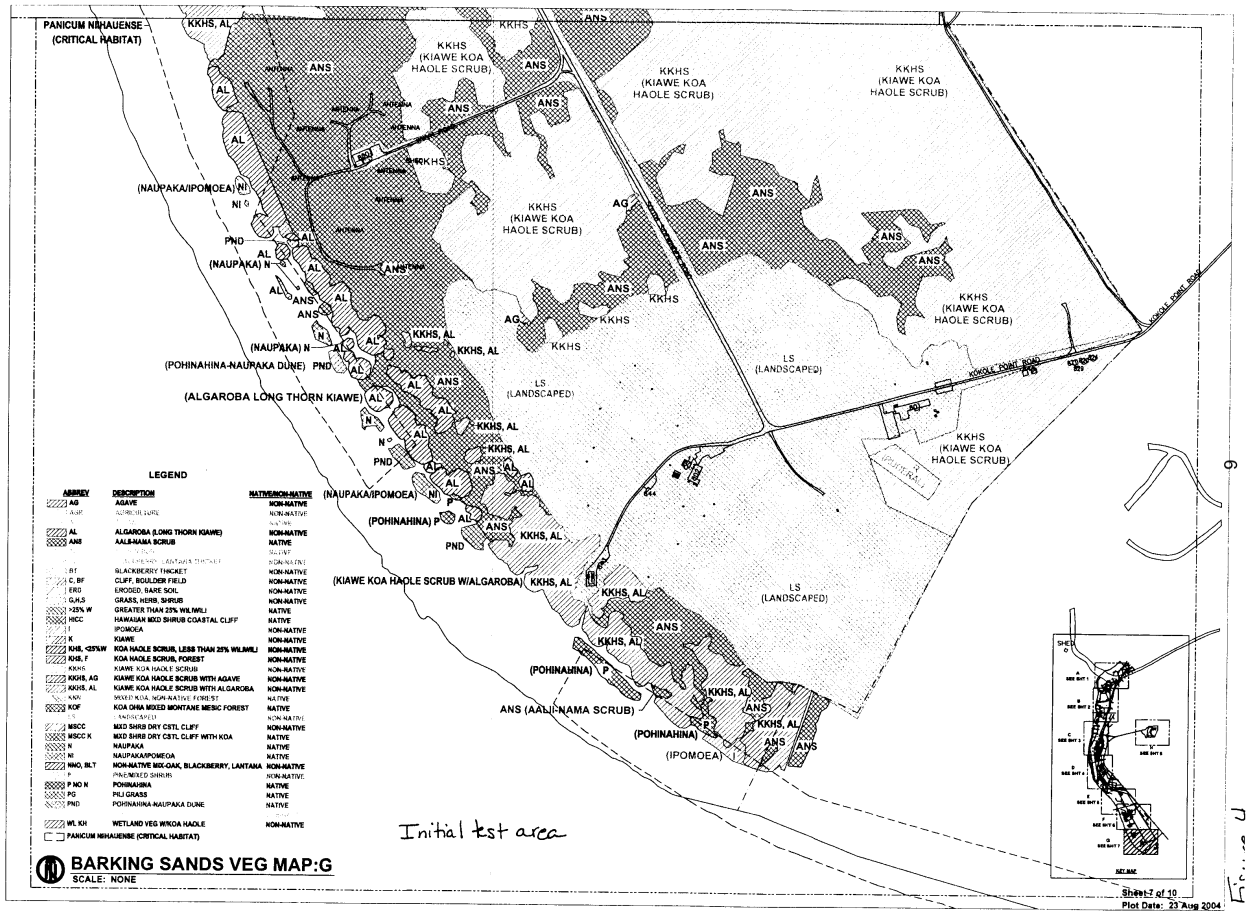

Figure 9

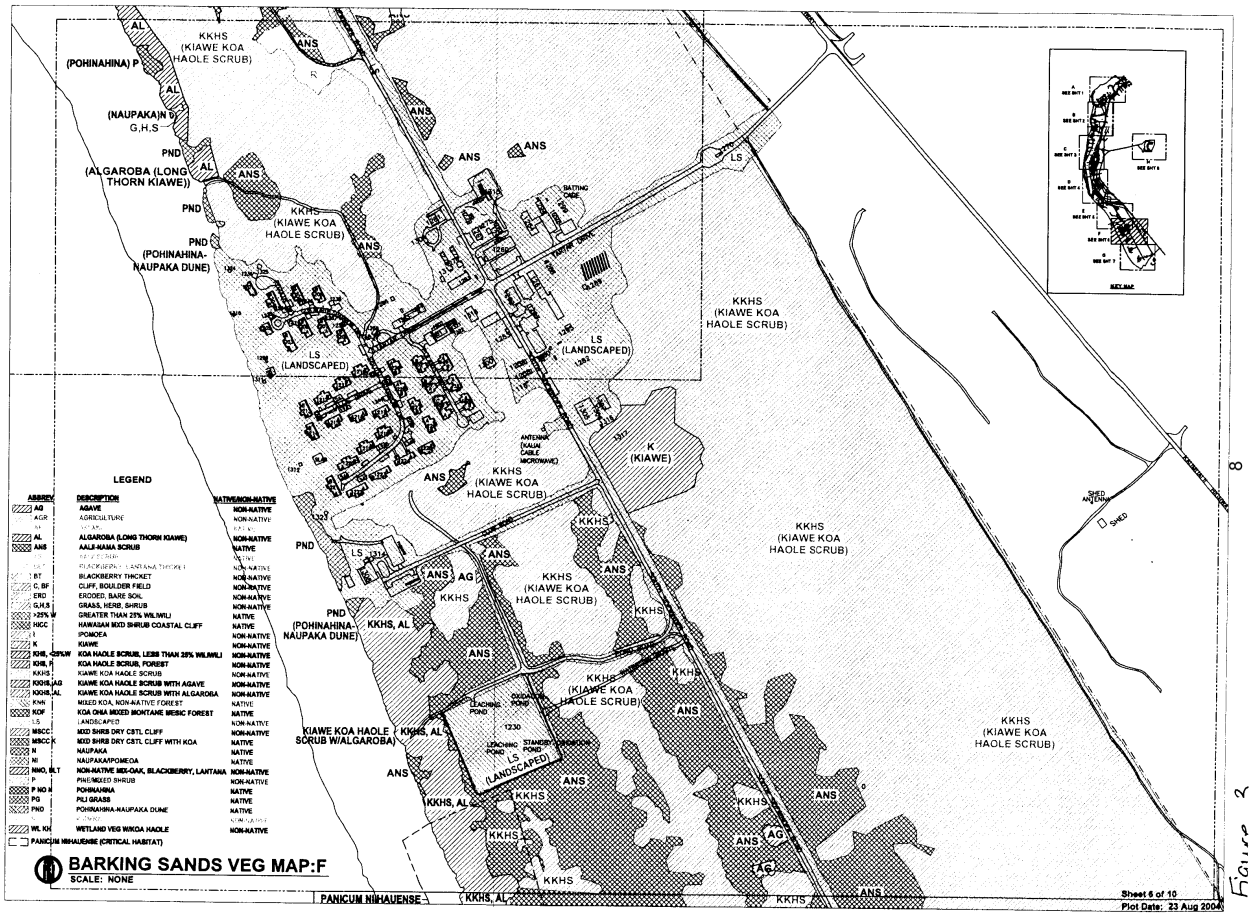

Figure 8

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG

ROBERT K. MASUDA

JEAN NAKANO, Acting

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

June 29, 2006

Mr. Leighton G.M. Wong
Business Line Manager, Environmental
Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive STE. 100
Peal Harbor, Hawaii 96860-3134

Dear Mr. Wong:

Subject: Request for Comments: Commander Navy Region Hawaii INRMP Updates – Oahu Complex and Kauai Pacific Missile Range, State of Hawaii.

We appreciate the opportunity to comment on your subject request. DLNR, Division of Forestry and Wildlife's August 29, 2001 comments (see attachment) 5-years ago remain relevant to this request with the following added recommendations.

General Comments:

- Encourage the Department of Navy to integrate its natural resource management programs with DLNR, Division of Forestry and Wildlife Comprehensive Wildlife Strategic Plan.
- Strongly encourage the integration of statewide response between DLNR and Department of Navy for invasive species, oil spills, stranded wildlife, and avian disease monitoring.
- Maintain and restore cultural resources on Department of Navy lands.
- Provide recreational opportunities and uses on Department of Navy lands.
- Increase fauna and flora T&E populations currently present on Navy lands. In addition, DLNR, Division of Forestry and Wildlife on Kauai are developing a management plan for the Mana Waterbird Sanctuary that may benefit PMRF to protect native resources in the area. Also, DLNR, Division of Forestry and Wildlife encourage Department of Navy to fence portions of Makaha ridge facility on Kauai to maintain the vegetation required for nene habitat and their nesting areas.
- Encourage Department of Navy to acquire lands to buffer impacts to existing resource management programs and areas.
- Encourage the Department of Navy to develop watershed (i.e. develop Waianae watershed partnership alliances) and wetland partnership programs in areas beneficial to all interested cooperating entities.

F4 - USFWS SPECIES LIST AND TECHNICAL ASSISTANCE REGARDING INFORMAL SECTION 7 CONSULTATION FOR HAWAIʻI RANGE COMPLEX 8 NOVEMBER 2007

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2008-TA-0021

NOV 0 8 2007

Mr. Larry M. Foster
United States Pacific Fleet
250 Makalapa Drive
Pearl Harbor, Hawaii 96860-3131

Subject: Species List and Technical Assistance regarding Informal Section 7 Consultation for the Hawaii Range Complex

Dear Mr. Foster:

This letter is in response to your letter dated October 12, 2007, requesting concurrence with your species and critical habitat lists and requesting initiation of informal section 7 consultation. The *Hawaii Range Complex Biological Assessment – Terrestrial* (Terrestrial BA), and the *Hawaii Range Complex Biological Assessment – Marine* (both dated September 2007) were also transmitted with your letter to support your request for informal consultation. We received your request on October 16, 2007. The Hawaii Range Complex, as a proposed action by the U.S. Navy, is the ongoing and future construction, modification, operation, and maintenance of support facilities and the ongoing and future instrumentation, launch, flight and other training activities associated with the U.S. Navy's use of Department of Defense (DOD) facilities within and around the Hawaiian Islands. This response is in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

We have reviewed the species and critical habitat lists that you have provided and determined that several of the lists are incomplete; therefore, we have enclosed updated species and critical habitat lists for all areas identified in your October 12, 2007, letter.

The U.S. Fish and Wildlife Service (Service) has begun a review of candidate species and/or potential critical habitat to propose for listing under the Endangered Species Act. Under section 7(a)(4) of the Act, Federal action agencies may request a conference on a proposed action that may affect proposed species or proposed critical habitat. The Service recommends the U.S. Navy conference on the proposed species and critical habitat, in lieu of re-initiating consultation after the listing process. If you wish to do so, we can provide a candidate species list.

We have also begun reviewing the Terrestrial BA to determine if the continued implementation and initiation of new activities, by the U.S. Navy within the Hawaii Range Complex, will affect federally endangered or threatened species or their designated critical habitat. The Hawaii Range Complex covers many DOD facilities and many U.S. Navy actions. Due to the size and complexity of the proposed action, additional time and site visits will be needed to provide adequate review. Once we have completed our preliminary review of the Terrestrial BA, we propose to coordinate with you via telephone to set up a series of informal meetings or conference calls. These informal meetings would be specific to each DOD facility in order to address any outstanding information needs. When necessary, these meetings should be scheduled at the facility in question so that a site visit can be completed.

If you have any additional questions regarding this letter or the development of appropriate conservation measures, please contact Megan Laut, Fish and Wildlife Biologist, Consultation and Technical Assistance Program, at 808-792-9400.

Sincerely,

Patrick Leonard
Field Supervisor

Enclosure

Enclosure 1. List of Endangered, Threatened and Candidate Species and their Critical Habitat on Facilities Listed in the Hawaii Range Complex Terrestrial Biological Assessment

NIHOA AND NECKER ISLANDS		
Common Name	**Scientific Name**	**Status**
Plants		
No common name	*Amaranthus brownii*	Endangered
Lo ulu	*Pritchardia remota*	Endangered
No common name	*Schiedea verticillata*	Endangered
Ohai	*Sesbania tomentosa*	Endangered
Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Birds		
Nihoa millerbird	*Acrocephalus familiaris kingi*	Endangered
Nihoa finch	*Telespyza ultima*	Endangered
Mammals		
Hawaiian monk seal	*Monachus schauinslandi*	Endangered
KAUAI		
Pacific Missile Range Facility/Main Base		
Plants		
Lau chu	*Panicum nihauense*	Endangered
Ohai	*Sesbania tomentosa*	Endangered
Reptiles		
Loggerhead sea turtle	*Caretta caretta*	Threatened
Green sea turtle	*Chelonia mydas*	Threatened
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Olive ridley sea turtle	*Lepidochelys olivacea*	Threatened
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian goose	*Branta sandvicensis*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Short-tailed albatross	*Phoebastria albatrus*	Endangered

Hawaiian petrel	*Pterodroma phaeopygia sandwichensis*	Endangered
Newell's shearwater	*Puffinus auricularis newellii*	Threatened
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus semotus*	Endangered
Hawaiian monk seal	*Monachus schauinslandi*	Endangered
Critical Habitat		
Lau ehu	*Panicum niihauense*	Endangered
Ohai	*Sesbanai tomentosa*	Endangered

*observed in May 2000

Pacific Missile Range Facility – Kahili

Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian goose	*Branta sandvicensis*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Hawaiian petrel	*Pterodroma phaeopygia sandwichensis*	Endangered
Newell's shearwater	*Puffinus auricularis newellii*	Threatened
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus semotus*	Endangered

Pacific Missile Range Facility – Kokee

Plants		
Akoko	*Chamaesyce halemanui*	Endangered
No common name	*Diellia pallida*	Endangered
Na ena e	*Dubautia latifolia*	Endangered
No common name	*Lipochaeta waimeaensis*	Endangered
Aiea	*Nothocestrum peltatum*	Endangered
No common name	*Phyllostegia waimeae*	Endangered
Kopiko	*Psychotria grandiflora*	Candidate
No common name	*Schiedea spergulina spergulina*	Endangered
Popolo aiakeakua	*Solanum sandwicense*	Endangered
No common name	*Spermolepsis hawaiiensis*	Endangered
Invertebrates		
Hawaiian picture-wing fly	*Drosophila musaphila*	Endangered
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian goose	*Branta sandvicensis*	Endangered
Hawaiian coot	*Fulica alai*	Endangered

Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Hawaiian petrel	*Pterodroma phaeopygia sandwichensis*	Endangered
Newell's shearwater	*Puffinus auricularis newellii*	Threatened
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus semotus*	Endangered
Critical Habitat		
Akoko	*Chamaesyce halemanui*	
Na ena e	*Dubautia latifolia*	
No common name	*Mariscus pennatiformis*	
Aiea	*Nothocestrum peltatum*	
No common name	*Poa mannii*	
No common name	*Poa siphonoglossa*	
Popolo aiakeakua	*Solanum sandvicense*	

Pacific Missile Range Facility – Makaha Ridge

Plants		
No common name	*Spermolepis hawaiiensis*	Endangered
Dwarf iliau	*Wilkesia hobdyi*	Endangered
Birds		
Hawaiian goose	*Branta sandvicensis*	Endangered
Hawaiian petrel	*Pterodroma phaeopygia sandwichensis*	Endangered
Newell's shearwater	*Puffinus auricularis newellii*	Threatened
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus semotus*	Endangered

Pacific Missile Range Facility – Niihau

Plants		
Olulu	*Brighamia insignis*	Endangered
Pu uka a	*Cyperus trachysanthos*	Endangered
No common name	*Lobelia niihauensis*	Endangered
Lau ehu	*Panicum niihauense*	Endangered
Lo ulu	*Pritchardia aylmer-robinsonii*	Endangered
Ohai	*Sesbania tomentosa*	Endangered
Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian goose	*Branta sandvicensis*	Endangered

Hawaiian coot	*Fulica alai*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus semotus*	Endangered
Hawaiian monk seal	*Monachus schauinslandi*	Endangered
Critical Habitat		
Olulu	*Brighamia insignis*	

Pacific Missile Range Facility – Kaula

Plants		
No common name	*Amaranthus brownii*	Endangered
Lo ulu	*Pritchardia remota*	Endangered
No common name	*Schiedea verticellata*	Endangered
Ohai	*Sesbania tomentosa*	Endangered
Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Mammals		
Hawaiian monk seal	*Monachus schauinslandi*	

OAHU

Coast Guard Air Station Barbers Point

Plants		
Ewa Hinahina	*Achyranthes splendens* var. *rotundata*	Endangered
Akoko	*Chamaesysce skottsbergii* var. *skottsbergii*	Endangered
Reptiles		
Loggerhead sea turtle	*Caretta caretta*	Threatened
Green sea turtle	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Birds		
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Mammals		
Hawaiian monk seal	*Monachus schauinslandi*	Endangered

Dillingham Military Reservation (DMR), exclusive of Military Vehicle Trail

Plants		
Pu uka a	*Cyperus trachysanthos*	Endangered
No common name	*Dicllia falcata*	Endangered
Ma o hau hele	*Hibiscus brackenridgei*	Endangered
Kulu i	*Nototrichium humile*	Endangered
Mo oli oli	*Schiedea kealiae*	Endangered
Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus semotus*	Endangered
Hawaiian monk seal	*Monachus schauinslandi*	Endangered
Critical Habitat		
Ma o hau hele	*Hibiscus brackenridgei*	
Mo oli oli	*Schiedea kealiae*	
No common name	*Vigna owahuensis*	

Ford Island

Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Mammals		
Hawaiian monk seal	*Monachus schauinslandi*	Endangered

Hickam Air Force Base

Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered

Mammals		
Hawaiian hoary bat	*Lasiurus cinereus semotus*	Endangered
Hawaiian monk seal	*Monachus schauinslandi*	Endangered

Kahuku Training Area

Plants		
No common name	*Adenophorus periens*	Endangered
Akoko	*Chamaesyce rockii*	Endangered
Haha	*Cyanea grimesiana* ssp. *grimesiana*	Endangered
Haha	*Cyanea koolauensis*	Endangered
Haha	*Cyanea longiflora*	Endangered
Nioi	*Eugenia koolauensis*	Endangered
Nanu	*Gardenia mannii*	Endangered
No common name	*Hesperomannia arborescens*	Endangered
Haha	*Phyllostegia hirsuta*	Endangered
Ohe ohe	*Tetraplasandra gymnocarpa*	Endangered
Invertebrates		
Oahu tree snail	*Achatinella bulimoides*	Endangered
Oahu tree snail	*Achatinella curta*	Endangered
Oahu tree snail	*Achatinella dimorpha*	Endangered
Oahu tree snail	*Achatinella elegans*	Endangered
Oahu tree snail	*Achatinella sowerbyana*	Endangered
Oahu tree snail	*Achatinella valida*	Endangered
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Oahu elepaio	*Chasiempis sandwichensis ibidis*	Endangered
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus semotus*	Endangered
Critical Habitat		
Nioi	*Eugenia koolauensis*	
Haha	*Cyanea longiflora*	
Haha	*Cyanea koolauensis*	
Haha	*Cyanea crispa*	
Nanu	*Gardenia mannii*	
No Common Name	*Viola oahuensis*	

Kechi Lagoon

Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Mammals		
Hawaiian monk seal	*Monachus schauinslandi*	Endangered

Lima Landing

Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Mammals		
Hawaiian monk seal	*Monachus schauinslandi*	Endangered

Makua Military Reservation

Plants		
No common name	*Abutilon sandwicense*	Endangered
Mahoe	*Alectryon macrococcus* var. *micrococcus*	Endangered
No common name	*Bonamia menziesii*	Endangered
Kamanomano	*Cenchrus agrimonioides* var. agrimonioides	Endangered
Akoko	*Chamaesyce celastroides* var. *kaenana*	Endangered
Akoko	*Chamaesyce herbstii*	Endangered
Pauoa	*Ctenitis squamigera*	Endangered
Haha	*Cyanea grimesiana* ssp. *obatae*	Endangered
Haha	*Cyanea longiflora*	Endangered
Haha	*Cyanea superba* ssp. *superba*	Endangered
Ha iwale	*Cyrtandra dentata*	Endangered
No common name	*Delissea subcordata*	Endangered
No common name	*Diellia falcata*	Endangered
Na ena e	*Dubautia herbstobatae*	Endangered
No common name	*Euphorbia haeleeleana*	Endangered
Mehamehame	*Flueggea neowawraea*	Endangered
No common name	*Gouania vitifolia*	Endangered
No common name	*Hedyotis degeneri var. degeneri*	Endangered

No common name	*Hedyotis parvula*	Endangered
No common name	*Hesperomannia arbuscula*	Endangered
Ma o hau hele	*Hibiscus brackenridgei* ssp. *mokuleianus*	Endangered
No common name	*Lobelia niihauensis*	Endangered
Nehe	*Melanthera tenuifolia* (= *Lipochaeta tenuifolia*)	Endangered
No common name	*Neraudia angulata*	Endangered
Kulu i	*Nototrichium humile*	Endangered
Makou	*Peucedanum sandwicense*	Threatened
No common name	*Phyllostegia kaalaensis*	Endangered
Laukahi kuahiwi	*Plantago princeps var. princeps*	Endangered
Loulu	*Pritchardia kaalae*	Endangered
No common name	*Sanicula mariversa*	Endangered
No common name	*Schiedea hookeri*	Endangered
No common name	*Schiedea kaalae**	Endangered
No common name	*Schiedea nuttallii*	Endangered
No common name	*Schiedea obovata* (= *Alsinidendron obovatum*)	Endangered
No common name	*Silene lanceolata*	Endangered
No common name	*Spermolepis hawaiiensis*	Endangered
No common name	*Tetramolopium filiforme*	Endangered
olopu; pamakani	*Viola chamissoniana* ssp. *chamissoniana*	Endangered
Invertebrates		
Oahu tree snail	*Achatinella mustelina*	Endangered
Hawaiian picture-wing fly	*Drosophila obatai*	Endangered
Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Birds		
Oahu elepaio	*Chasiempis sandwichensis ibidis*	Endangered
Oahu creeper	*Paroreomyza maculata*	Endangered
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus spp. semotus*	Endangered
Hawaiian monk seal	*Monachus schauinslandi*	Endangered
Plant Critical Habitat		
No common name	*Bonamia menziesii*	
Kamanomano	*Cenchrus agrimonioides* var. *agrimonioides*	
Akoko	*Chamaesyce celastroides* var. *kaenana*	
Akoko	*Chamaesyce herbstii*	
Kauila	*Colubrina oppositifolia*	
Haha	*Cyanea grimesiana* ssp. *obatae*	

Haha	*Cyanea longiflora*
Haha	*Cyanea superba* ssp. *superba*
No common name	*Cyperus pennatiformis*
Ha iwale	*Cyrtandra dentata*
No common name	*Delissea subcordata*
No common name	*Diellia falcata*
Na ena e	*Dubautia herbstobatae*
No common name	*Euphorbia haeleeleana*
Mehamehame	*Flueggea neowawraea*
No common name	*Gouania vitifolia*
No common name	*Hedyotis degeneri* var. *degeneri*
No common name	*Hedyotis parvula*
No common name	*Hesperomannia arbuscula*
Ma o hau hele	*Hibiscus brackenridgei* ssp. *mokuleianus*
Aupaka	*Isodendrion laurifolium*
Aupaka	*Isodendrion longifolium*
Wahine noho kula	*Isodendrion pyrifolium*
Nehe	*Melanthera tenuifolia*
Alani	*Melicope pallida*
No common name	*Neraudia angulata*
Kulu i	*Nototrichium humile*
No common name	*Phyllostegia kaalaensis*
Laukahi kuahiwi	*Plantago princeps* var. *princeps*
No common name	*Sanicula mariversa*
No common name	*Schiedea hookeri*
No common name	*Schiedea kaalae*
No common name	*Schiedea nuttallii*
No common name	*Schiedea obovata*
Popolo aiakeakua	*Solanum sandwicense*
No common name	*Spermolepis hawaiiensis*
Bird Critical Habitat	
Oahu elepaio	*Chasiempis sandwichensis ibidis*

**Schiedea kealiae*, a different species, occurs at DMR

Marine Corps Base Hawaii

Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Hawaiian petrel	*Pterodroma phaeopygia sandwichensis*	Endangered

Newell's shearwater	*Puffinus auricularis newellii*	Threatened
Mammals		
Hawaiian hoary bat	*Lasiurus cinerueus semotus*	Endangered
Hawaiian monk seal	*Monachus schauinslandi*	Endangered

Marine Corps Training Area Bellows

Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Hawaiian petrel	*Pterodroma phaeopygia sandwichensis*	Endangered
Newell's shearwater	*Puffinus auricularis newellii*	Threatened
Mammals		
Hawaiian hoary bat	*Lasiurus cinerueus semotus*	Endangered
Hawaiian monk seal	*Monachus schauinslandi*	Endangered

Pearl Harbor Naval Station

Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered
Mammals		
Hawaiian monk seal	*Monachus schauinslandi*	Endangered

West Loch Pearl Harbor – Explosive Ordnance Disposal

Reptiles		
Green sea turtle	*Chelonia mydas*	Threatened
Birds		
Hawaiian duck	*Anas wyvilliana*	Endangered
Hawaiian coot	*Fulica alai*	Endangered
Hawaiian moorhen	*Gallinula chloropus sandvicensis*	Endangered
Hawaiian stilt	*Himantopus mexicanus knudseni*	Endangered

Mammals		
Hawaiian monk seal	*Monachus schauinslandi*	Endangered

Wheeler Air Field

Invertebrates		
Hawaii picture-wing fly	*Drosophila tarphytrichia*	Endangered
Mammals		
Hawaiian hoary bat	*Lasiurus cinerueus semotus*	Endangered

HAWAII ISLAND

Pohakuloa Training Area and Bradshaw Army Airfield

Plants		
Fragile fern	*Asplenium fragile* var. *insulare*	Endangered
Honohono	*Haplostachys haplostachya*	Endangered
Kiocle	*Kadua coriacea*(previously *Hedyotis coriacea*)	Endangered
Aupaka	*Isodendrion hosakae*	Endangered
Nehe	*Lipochaeta venosa*	Endangered
Spotted nettlebrush	*Neraudia ovata*	Endangered
Poe	*Portulaca sclerocarpa*	Endangered
Hawaiian catchfly	*Silene hawaiiensis*	Threatened
Lance-leaf catchfly	*Silene lanceolata*	Endangered
Popolo ku mai	*Solanum incompletum*	Endangered
Hawaiian parsley	*Spermolepis hawaiiensis*	Endangered
No common name	*Stenogyne angustifolia*	Endangered
No common name	*Tetramolopium arenarium* ssp. *arenarium*	Endangered
Oahu vigna	*Vigna o-wahuensis*	Endangered
Ae	*Zanthoxylum hawaiiense*	Endangered
Birds		
Hawaiian goose	*Branta sandvicensis*	Endangered
Hawaiian hawk	*Buteo solitarius*	Endangered
Palila	*Loxioides bailleui* (Critical Habitat only)	Endangered
Hawaiian dark-rumped petrel	*Pterodroma phaeopygia* spp. *sandwichensis*	Endangered
Newell's Shearwater	*Puffinus auricularis newelli*	Endangered
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus* spp. *semotus*	Endangered

F5 - USFWS LETTER PERTAINING TO THE REVIEW OF THE PRELIMINARY FINAL ENVIRONMENTAL IMPACT STATEMENT FOR HAWAIʻI RANGE COMPLEX 28 DECEMBER 2007

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2008-FA-0035

DEC 2 8 2007

Public Affairs Officer
Pacific Missile Range Facility
P.O. Box 128
Kekaha, Hawaii 96752-0128

Dear Sir or Madam:

The U.S. Fish and Wildlife Service (Service) has reviewed the Preliminary Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) for the Hawaii Range Complex (HRC) provided by your office on November 26, 2007. These comments are provided in accordance with the National Environmental Policy Act of 1969 [42 U.S.C. 4321 *et seq.*; 83 Stat. 852] and other authorities mandating Federal oversight of environmental resources, including the Fish and Wildlife Coordination Act of 1934 [16 U.S.C. 661 *et seq.*; 48 Stat. 401], as amended; the Federal Clean Water Act [33 U.S.C. 1251 *et seq.*; 62 Stat. 1155], as amended; the Endangered Species Act of 1973 [16 U.S.C. 1531 *et seq.*; 87 Stat. 884], as amended; the Migratory Bird Treaty Act of 1918 [16 U.S.C. 703 *et seq.*; 40 Stat. 755] as amended; and the Sikes Act of 1960 [16 USC *et seq.*;74 stat. 1052], as amended.

The proposed action would upgrade and modernize the capabilities of the HRC, which encompasses land, air and sea training ranges in and around the Hawaiian Islands. The HRC supports local military units and multi-national exercises and facilitates the rapid deployment of U.S. defense forces, as necessary. This proposed action is intended to fulfill and improve U.S. government national security and alliance requirements in the Pacific Region and increase the strategic defense role of the Hawaiian Islands.

In a previous letter (dated September 24, 2007), we raised concerns about the adequacy of the Draft EIS/OEIS to serve as a decision-making document for the proposed HRC action. Based upon our subsequent discussions and our review of the Preliminary Final EIS/OEIS our concerns have been adequately addressed and we support proceeding to a final document.

As we continue to coordinate on the HRC activities, we recommend incorporating improvements to the Laysan albatross relocation program enacted to reduce bird air strike hazards (BASH) at the Pacific Missile Range Facility. Attached is a summary of our recommendations.

We appreciate the opportunity to comment on this Preliminary Final EIS/OEIS and the willingness of the Navy to collaborate closely with us on the review. If you have questions regarding these comments please contact Fish and Wildlife Biologist Dwayne Minton or Megan Laut at 808-792-9400.

Sincerely,

for Patrick Leonard
Field Supervisor

Attachment

cc:
Mr. Vajai N. Rai, OEPC, Washington D.C.
Ms. Patricia Port, OEPC, Oakland
Mr. Don Steffeck, USFWS, Region 1, Portland
EPA Region 9, Honolulu
NMFS – PIRO, Honolulu
Hawaii DAR
Hawaii DOFAW

ATTACHMENT

Currently, the Navy contracts the U.S. Department of Agriculture's Animal Plant and Health Inspection Service - Wildlife Services (WS) to capture, band, and translocate breeding and non-breeding adult Laysan albatross from Pacific Missile Range Facility (PMRF) to the north shore of Kauai, where they are released. This practice has been in place for many years, and is applied to non-breeding birds and breeding birds once their eggs have been taken. The purpose of the translocation is to reduce the risk of aircraft strike by encouraging birds to nest at a site other than PMRF. Partnership with the Kilauea Point National Wildlife Refuge (KPNWR) allows Laysan albatross eggs laid at PMRF to be fostered by birds at KPNWR and in other nearby breeding colonies. In the case of many other bird species, these actions would successfully reduce nesting activity, however, the biology and behavior of the Laysan albatross was not adequately considered when this program was developed for PMRF.

Habitat Modifications to Deter Nesting

Laysan albatross nest on the ground and prefer to locate their nests in open areas. To the best of our knowledge, the WS albatross management plan does not include methods to deter nesting in high-risk areas, e.g., near launch pads or runways, through modification of vegetation or other means. Discouraging the albatross from nesting in high risk areas would benefit both the Navy and the birds. Therefore, we would like to work with you to deter albatross nesting through various methods such as planting dense woody vegetation and/or the installation of ground cloth to make specific areas inhospitable to nesting.

Laysan Albatross Relocation

When nests fail under natural circumstances, breeding albatross will return to their nest sites intermittently before abandoning the site and returning to sea. Therefore, breeders that are captured and relocated from PMRF return to the base. Band resighting data indicate that many breeders are relocated multiple times in a single season. For example, during the 2006-07 breeding season, 166 breeding Laysan albatross were relocated from PMRF a total of 587 times; of these, nearly half of the individuals were captured four or more times each and transported to the north shore for release (one individual was relocated 15 times during the past season). Therefore, rather than reducing potential air strikes with albatross, this practice increases the amount of bird traffic flying into the airspace at PMRF, which is contrary to the intended purpose of the BASH Program.

In addition, no albatross nesting on the north shore of Kauai were banded as breeders at PMRF, nor have breeders banded at PMRF been observed breeding at colonies on other islands. Moreover, the repeated intervention in the birds' natural process of abandoning empty nests likely prolongs rather than curtails their presence at PMRF. Allowing breeding albatross at PMRF to abandon the colony on their own once their eggs have been removed likely will hasten their departure from the colony for the season. In summary, no data exist to demonstrate that capturing and moving breeding albatross is an effective means of discouraging these birds from returning to PMRF. We, therefore, strongly recommend that this practice be discontinued.

Egg Removal and Cross-Fostering

Until 2005, WS destroyed albatross eggs on PMRF as soon as they were laid. In 2005, a lapse in funding resulted in PMRF albatross incubating their eggs nearly to hatching. The Service biologist at KPNWR was able to locate albatross pairs on the Refuge and in other north shore colonies to foster the eggs from PMRF. All of the viable eggs transferred from PMRF nests to these surrogate pairs hatched, and most of the chicks fledged successfully. These excellent results of the partnership between the Navy, WS, and the Service led to similar efforts in the two subsequent breeding seasons to develop an alternative to destroying the albatross eggs laid at PMRF. The goal of these efforts was to remove eggs from PMRF nests and foster them to failed north shore nests as early as possible in the season.

Now we have learned that the removal of most albatross eggs to an incubator directly after laying has resulted in the loss of 50 percent or more of all the eggs produced in the last two seasons. Either the eggs didn't hatch or chicks died at hatching, a rate far higher than the natural rate of egg loss in a Laysan albatross colony. Data from the past two years of egg removal and artificial incubation prior to placement in foster nests indicate that successful hatching of eggs removed from albatross nests is inversely related to the amount of time they spend in the incubator. Egg viability can be determined as soon as seven days after laying. We recommend eggs should be left in the nest until their viability can be assessed and then transferred directly to foster nests on the north shore, or placed in the incubator until a foster nest can be identified. Minimizing time in the incubator decreases the potential of damage to the eggs.

Continued Partnership

The efforts of the BASH Program at PMRF to address concerns about albatross on the base with a minimum of egg and adult mortality are laudable and should continue. The voluntary partnership of the Navy, WS, and the Service has been instrumental in assessing the effectiveness and efficiency of the program. Working closely with Navy and WS staff, Service biologists have contributed significant time and expertise to analyze the BASH Program and other data and provide recommendations for improving methods to reduce potential bird strike risks at PMRF, reduce handling of and risk to adult birds, increase survival of fostered eggs, and minimize staff time and resources necessary for these activities. Analysis of data collected by WS, including timing of egg removal, banding information, and when birds are moved off the base provides new insights into the life history and behavior of the Laysan albatross, and this knowledge affords better management of the species, especially at PMRF. For the management on the base to continue to improve, this partnership should continue. We recommend that complete data exchange between the three partner agencies continue unimpeded, if necessary through formalized, regularly scheduled meetings to plan for the upcoming season, exchange information, and discuss necessary modifications to the existing program.

In summary, we recommend the following in regard to the PMRF BASH Program and the Laysan albatross:

1. Make areas near runway and missile launch areas inhospitable to nesting albatross (ground cloth, vegetation changes, etc.) to encourage nesting pairs to find other places to nest.
2. To reduce the number of birds flying through PMRF airspace and the staff time and resources expended on the BASH program, leave incubating adults at nest site when eggs are removed from nests. Discontinue all capture and transport of breeding albatross, because this activity does not reduce bird air strike risk.
3. Until further modifications are made to the BASH program, coordinate the release of all captured non-breeding adult birds with KPNWR staff to improve knowledge of post-release status and behavior.
4. To reduce egg mortality, improve hatch success, and minimize the resources and staff time expended on the BASH program, allow albatross to incubate their eggs until viability can be determined.
5. To reduce egg mortality, draft and circulate for review a protocol for moving albatross eggs that minimizes vibration and jarring and minimizes their time in transport between nests or between nest and incubator.
6. In partnership with the Service, determine viability of albatross eggs at PMRF and in foster colonies as soon as possible (seven days) after laying and move PMRF eggs off base; eliminate or minimize artificial incubation.
7. Provide KPNWR with complete data sheets to improve knowledge of life history and behavior of the Laysan albatross.

F6 - INFORMAL SECTION 7 CONSULTATION REGARDING THE U.S. DEPARTMENT OF THE NAVY PROPOSED ACTION IN THE HAWAIʻI RANGE COMPLEX, HAWAIʻI

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2008-I-0232

JUN 13 2008

Captain Jorge P. Rios
U.S. Department of Navy
258 Makalapa Drive, Suite 100
Pearl Harbor, Hawaii 96860

Subject: Informal Section 7 Consultation Regarding the U.S. Department of the Navy Proposed Action in the Hawaii Range Complex, Hawaii

Dear Captain Rios:

This letter is in response to an electronic mail (email) letter sent by Captain Dean Leech, of your office on June 6, 2008, requesting concurrence that the proposed action for the Hawaii Range Complex (HRC) may affect, but is not likely to adversely affect federally listed species. We received your final signed letter via electronic mail on June 6 and hard copy on June 10, 2008, and you have requested a response letter by June 13, 2008. Your letter did not include the list of species that you are requesting be reviewed in this consultation, however, your letter did state (page 5) that you will only be consulting for species that occur on Navy lands including Kaula. Therefore, we used the species lists (Enclosure 1) for Pacific Missile Range Facility – Main Base, Kauai; and Naval Station Pearl Harbor (including Ford Island, Naval Inactive Ship Maintenance Facility, Pearl Harbor EOD Land Range, Naval Magazine Pearl Harbor West Loch, and Lima Landing), Oahu; and Kaula provided in our November 8, 2007 letter, and the final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) received on May 19, 2008. We reviewed these species lists and upon further investigation we decided to remove the listed plant species from Kaula since they are not known to occur on the island.

Additionally, your letter did not provide sufficient information regarding potential effects to federally listed species. Therefore, we coordinated with Vanessa Pepi and William Kramer (Navy) and they provided additional information on June 10 and 11, 2008. We reviewed your biological assessment, the draft HRC EIS/OEIS; revisions to these documents, Pacific Missile Range Facility (PMRF) site visit notes, and numerous meeting notes, conference calls, emails,

letters, and other information available to us, to develop the findings and recommendations in this consultation. We also provide additional clarification and recommendations in reference to your June 6, 2008, letter. A complete administrative record is on file in our office. This response is in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*).

Potential Affects to Listed Species

Plants

Lau ehu (*Panicum niihauense*) and ohai (*Sesbania tomentosa*) are both flowering plants and their biology and ecology are described in their recovery plan (Service 1999). PMRF was surveyed for the presence of both plants by Navy biologists in 2004 and none were found. Both species are known to have small populations in the sandy dune habitats near the northern boundary of the PMRF Main Base on State of Hawaii lands at Polihale State Park. PMRF and State lands are separated along that boundary by a fence; the border is guarded 24 hours per day. Though not currently known from PMRF Main Base, their habitat does extend onto the base. There will be no movement of personnel or equipment associated with the described actions over this boundary.

Even though these plants have not been observed at PMRF, the Navy recognizes that there is the possibility that a few plants may exist that have yet to be detected. To further decrease the possibility of damage to these plants and their habitats at PMRF, routes to move personnel, vehicles, and equipment across the beach and into upland areas during Expeditionary Assault and SPECWAROPS have been limited. Troops are directed to avoid areas that provide suitable habitat for these species during swimmer insertion/extraction and HAO/NEO events (including installation of temporary structures, *i.e.,* tents). Additionally, the Navy incorporates policies to limit the introduction of invasive weed species and washes amphibious vehicles after each activity.

These species are not known from the Strategic Target System launch pad and the area is maintained with landscaped vegetation. Additionally, the Navy will further minimize any potential affects from fire by installing a portable blast deflector on the launch pad, by clearing dry vegetation around the launch pad, or by spraying the vegetation with water prior to use. Quick-response fire control equipment is maintained on site. Emergency fire crews would be on site during launches to quickly extinguish a fire and will use an open spray nozzle to reduce erosion.

Therefore, we concur that the lau ehu and ohai may be affected, but are not likely to be adversely affected from: 1) trampling by personnel, vehicles, or equipment; 2) invasive species introductions from training; 3) heat or fire generated at the Strategic Target System launch pad; or 4) emissions from use of the launch pad. We considered the potential affects from the proposed project discountable because these species are not known to be present and if there are some individuals present implementation of the avoidance and minimization measures described above (and see HRC Final EIS/OEIS 2008) address potential impacts.

Critical Habitat

Approximately 183 acres of coastal dune habitat was designated as critical habitat for *Panicum niihauense* on PMRF – Main Base. The EIS/OEIS states that Navy training operations and

major exercises do not occur in designated *Panicum niihauense* critical habitat areas at PMRF. There is small risk of impacting critical habitat if there is a mishap associated with a missile launch due to fire or falling debris. To minimize the risk of impacts from fire all vegetation is sprayed with water prior to the launch and a fire crew is on site to immediately suppress any fire that may ignite. In addition, if a mishap occurs, the Navy will cleanup the resultant debris and restore the impacted area to its original condition (pers. comm., Randy Gallien). Due to the established best management practices for missile launches including wetting the vegetation near the launch site, having a fire crew on site, and restoring damaged critical habitat, we concur the proposed actions are not likely to adversely affect critical habitat for *Panicum niihauense.*

Reptiles

The biology and ecology of the green sea turtle (*Chelonia mydas*) are summarized in its recovery plan (NMFS and USFWS 1998a). The National Marine Fisheries Service (NMFS) has jurisdiction over sea turtles in estuarine and marine environments; therefore, we only reviewed the proposed projects for potential affects to the species in the terrestrial environment. It is our understanding that NMFS has prepared a draft biological opinion regarding the potential impacts from implementation of the proposed action in the marine environments (L. Smith pers. comm. 2008). The green sea turtle is known to use terrestrial habitat at PMRF – Main Base for basking; however, no nesting is known to occur in these areas. Educational signs have been erected near Nohili Point (PMRF) ordering personnel to not enter beach areas when turtles are present. No sea turtles are known to come ashore at Kaula and the terrestrial habitats are currently considered unsuitable for nesting and basking.

To avoid impacts to the green sea turtle while using beach habitat, the Navy will survey the landing routes and beach area one hour prior to landing activities. If sea turtles are detected, the training will be delayed until the animals voluntarily leave the area. We concur that the green sea turtle may be affected, but is not likely to be adversely affected from beach landings and beach use by the Navy at Pearl Harbor and PMRF – Main Base. We consider the potential affects from the proposed project discountable because they are extremely unlikely to occur due to implementation of the avoidance measures described above.

The biology and ecology of the Hawksbill sea turtle (*Eretmochelys imbricata*) are summarized in its recovery plan (NMFS and USFWS 1998b). This species is not known to use terrestrial or offshore habitats within Pearl Harbor or at PMRF – Main Base. The species has been documented in offshore habitats around Kaula but has not been documented using terrestrial habitats at Kaula which are considered unsuitable for nesting and basking. Actions at Kaula consist of approaching the area via aircraft and or dropping non-explosive munitions on the island. We concur that the hawksbill sea turtle may be affected, but is not likely to be adversely affected by proposed actions affecting terrestrial habitats at Pearl Harbor, PMRF – Main Base, or Kaula. We consider the potential affects from the proposed project discountable because they are extremely unlikely to occur because the hawksbill sea turtle is unlikely to be present within these areas.

Birds

The biology and ecology of the short-tailed albatross (*Phoebastria albatrus*) is summarized in its draft recovery plan (Service 2005a). The short-tailed albatross has been detected at PMRF – Main Base only on one occasion in 2000. All of the current and ongoing activities at PMRF –

Main Base may affect this species (lighting, missile launches, training, use of antennas and communications towers, etc.); however, we concur with your determination that these actions are not likely to adversely affect this species. We believe the potential affects are discountable because this species is extremely unlikely to be in the action area.

The biology and ecology of the Hawaiian duck (*Anas wyviliana*), Hawaiian coot (*Fulica alai*), Hawaiian moorhen (*Gallinula chloropus sandvicensis*), and Hawaiian stilt (*Himantopus mexicanus knudseni*) are summarized in the Draft Revised Hawaiian Waterbirds Recovery Plan (Service 2005b). All four endangered waterbirds are known to use wetland areas of PMRF Main Base, including drainage canals. At Nohili Ditch, near the launch facilities in the northern portion of the Main Base, the species may be affected by the noise of the launches. However, the launches are intermittent and there is some level of habituation to the noise and disturbance. In addition, the ditches are low and narrow, and the water level is at least six feet lower in elevation than surrounding lands, further protecting any birds from the noise of launches. No new construction will be conducted in wetland areas used by these species.

On Oahu, the four waterbirds may be found flying in almost any area of Pearl Harbor, although their nesting is largely confined to units of the Pearl Harbor National Wildlife Refuge. Activities proposed are similar to the normal actions that occur within Navy-controlled waters and lands within Pearl Harbor and their effect on the birds would be expected to be similar. We concur with your determination that the proposed actions at PMRF – Main Base and Pearl Harbor, may affect but are not likely to adversely affect the four endangered waterbirds. We believe that potential impacts are discountable as the actions are not expected to occur or affect the wetland habitats used by these species.

The biology and ecology of the Hawaiian goose (*Branta sandvicensis*) is summarized in its recovery plan (Service 2004). This species is known to occur at PMRF and is a Bird Aircraft Strike Hazard (BASH) concern there. We have issued a permit to U.S. Department of Agriculture, Wildlife Services unit, to haze geese at PMRF for aircraft safety. We concur that disturbance related to the proposed training and continued use of facilities and housing, may affect but is not likely to adversely affect Hawaiian goose.

Mammals

The biology and ecology of the Hawaiian hoary bat (*Lasiurus cinereus semotus*) is summarized in its recovery plan (Service 1998). The Hawaiian hoary bat is known from the vicinity of the PMRF, but has not been documented from PMRF – Main Base. Specific use of the PMRF – Main Base by the Hawaiian hoary bat is unknown, however, the species may be using the area for foraging and roosting. No habitat will be removed from the continued use of housing, facilities, and ongoing training activities at PMRF – Main Base. Additionally, if Hawaiian hoary bats are using their echolocation while flying, they will able to detect and avoid collision with potential obstacles. Therefore, we concur with your determination that the proposed action may affect, but is not likely to adversely affect the Hawaiian hoary bat.

Federally Listed Seabirds

You have made a no effect determination regarding impact from the new and existing communications antennas and towers, lighting associated existing housing, and night time field carrier landing practices (FCLP), all located at PMRF – Main Base to two federally listed

seabirds (Hawaiian petrel, *Pterodroma phaeopygia sandwichensis* and Newell's shearwater, *Puffinus auricularis newelli*). While we recognize you are not requesting our concurrence on your determination, we do have the following concerns: 1) listed seabirds fly at night and are attracted to artificially-lighted areas which can result in disorientation and subsequent fallout from exhaustion; 2) these species are known to collide with objects such as utility lines, guy wires, and towers that protrude above the vegetation layer; 3) night time lighting and structures within the flight paths occur at PMRF – Main Base; 4) the proximity to the ocean and flyways for these species; 5) Newell's shearwater and Hawaiian petrel have been documented from PMRF – Main Base, from the Save Our Shearwaters database; and 6) letters from the Navy (November 22, 2002, and the June 6, 2008 letter) indicating that downed listed seabirds have been found in the housing area at PMRF – Main Base.

You have indicated that in the housing area you will review safety and security requirements and whether shielding of lights and limiting use of lights during the high fall-out period is possible. Shielding of lights minimizes affects to listed seabirds; however, shielding of lighting typically reduces fallout by only 40 percent (Reed et al. 1985). Therefore, shielding of lights would minimize the take of listed seabirds, but will likely not eliminate it. You have also indicated that the Navy will be implementing a monitoring program to determine the presence and extent of listed seabird issues at PMRF, including the antennas, towers, housing, and FCLP areas. It is our understanding that this program will be coordinated and agreed upon with our office, and initiated this year.

Other Clarifications

In your June 6, 2008 letter, you provide summary information regarding agreements that were made during the National Environmental Policy Act (NEPA) process and during informal consultation. Below we provide additional clarification in support of your information.

Future consultations

At this time, the Navy has not determined if it will string fiber optic lines from utility poles or underground the lines between PMRF – Main Base to Kokee and Makaha Ridge. We believe stringing the fiber optic lines on utility poles will adversely affect listed seabirds. In your letter, you indicate that you will consult with our office if fiber optic lines are strung from utility poles. If the decision is to underground the lines, we recommend you conduct surveys for listed plants and evaluate potential impacts to critical habitat within the proposed alignment. Per a June 9, 2008, email, consultation will be requested once the Navy determines which method they will use to install the lines. Therefore, this consultation does not consider the potential impacts to listed species from the action of installing fiber optic lines, or the continued operation, use, and maintenance of these facilities.

Also on page 6 you indicated that we recommended that you conference with the Service on proposed species and critical habitats. In a June 9 email, we requested clarification regarding conferencing on proposed and candidate species and you have elected not to conference on these species.

Navy Actions on Non-Navy Lands and Facilities

On page 3 you indicate that the coordination procedures for Pohakuloa Training area and Makua Military Reservation are provided as examples to demonstrate the planning process for the use of

these facilities. You included language indicating that prior to HRC implementation on other Department of Defense (DoD) installations, the Navy will work with other DoD landowners to ensure that their actions are in compliance with existing biological opinions. The Navy indicated for their actions on non-Navy lands they would follow existing biological opinions and all applicable DoD policies and procedures. Therefore, the Service is not consulting on Navy training actions on other DoD installations. We request that we be informed of all compliance measures associated with training activities on other DoD facilities.

Based on information provided (Page 3) it is our understanding you will conduct studies at Port Allen to address concerns regarding potential light attraction to listed seabirds raised during our NEPA discussions. Port Allen is a State of Hawaii harbor facility on Kauai and we appreciate that you will be conducting these analyses at Port Allen. You have made a no effect determination regarding potential impacts from the proposed project to listed species at Port Allen. We recommend upon completion of your analysis, that you contact our office regarding the findings.

On page 4 and 5 of your letter, you discuss the potential impacts associated with missile debris and training related fires on Nihoa and Necker. Per your letter, you have provided information that supports the probable debris temperature would be below the ignition temperature of dry vegetation and would be unlikely to start a fire. We concur with your determination that the THAAD missile launches are not likely to adversely affect listed species on Nihoa and Necker.

Summary

You restricted the action area to Navy lands at Naval Station Pearl Harbor, PMRF – Main Base, Kaula, and Nihoa and Necker. We have reviewed the actions described for the Hawaii Range Complex at these locations and their potential impacts to listed species. You made a no effect determination regarding Newell's shearwater and Hawaiian petrel at PMRF – Main Base, and therefore, we did not provide concurrence for these two species. We have concurred that the other listed species at these locations may be affected, but are not likely to be adversely affected. We concur that no critical habitat will be adversely affected or destroyed. If the project description changes, or new information reveals that the effects of the proposed action may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, reinitiation of this consultation will be necessary. We look forward to working with you to develop a monitoring program for listed seabirds for PMRF – Main Base and to address your future consultation needs for Kokee and Makaha. If you have questions regarding this consultation, please contact Megan Laut or Patrice Ashfield, Section 7 and Technical Assistance Program Coordinator, at 808-792-9400.

Sincerely,

for Patrick Leonard
Field Supervisor

Enclosure: Species List

cc:
Julie Rivers, Department of Navy
Tom Craven, U.S. Army Space and Missile Defense
Randy Gallien, U.S. Army Space and Missile Defense

Literature Cited

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998a. Recovery plan for U.S. Pacific populations of the green turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998b. Recovery plan for U.S. Pacific populations of the hawksbill turtle (*Eretmochelys imbricata*). National Marine Fisheries Service, Silver Spring, MD.

U.S. Fish and Wildlife Service. 1998. Recovery Plan for the Hawaiian Hoary Bat. U.S. Fish and Wildlife Service, Portland, OR. 50 pp.

U.S. Fish and Wildlife Service. 1999. Recovery Plan for Multi- Island Plants. U.S. Fish and Wildlife Service, Portland, OR. 206 pages + appendices.

U.S. Fish and Wildlife Service. 2004. Draft Revised Recovery Plan for the Nene or Hawaiian Goose (*Branta sandvicensis*). U.S. Fish and Wildlife Service, Portland, OR. 148 + xi pp.

U.S. Fish and Wildlife Service. 2005a. Short-tailed Albatross Draft Recovery Plan. Anchorage, AK, 62 pp.

U.S. Fish and Wildlife Service. 2005b. Draft Revised Recovery Plan for Hawaiian Waterbirds, Second Draft of Second Revision. U.S. Fish and Wildlife Service, Portland, Oregon. 155 pp.

Personal Communications

Smith, Lance. 2008. Email correspondence regarding the National Marine Fisheries Service consultation for the Hawaii Range Complex.

Species List and Affects Determination for U.S. Department of Navy Lands as of May 2008.

Scientific Name	Common Name	Federal Status*	Navy Determination	Service Concurrence
PMRF – Main Base				
Panicum niihauense	Lau ehu	E/CH	NLAA**	Yes
Sesbania tomentosa	Ohai	E	NLAA	Yes
Chelonia mydas	Green sea turtle	T	NLAA	Yes
Anas wyviliana	Hawaiian duck	E	NLAA	Yes
Branta sandvicensis	Hawaiian goose	E	NLAA	Yes
Fulica alai	Hawaiian coot	E	NLAA	Yes
Gallinula chloropus sandvicensis	Hawaiian moorhen	E	NLAA	Yes
Himantopus mexicanus knudseni	Hawaiian stilt	E	NLAA	Yes
Phoebastria albatrus	Short-tailed albatross	E	NLAA	Yes
Pterodroma phaeopygia sandwichensis	Hawaiian petrel	E	No Effect	---
Puffinus auricularis newelli	Newell's shearwater	T	No Effect	---
Lasiurus cinereus semotus	Hawaiian hoary bat	E	NLAA	Yes
Naval Station Pearl Harbor, Ford Island, Naval Inactive Ship Yard, Pearl Harbor EOD Land Range, Naval Magazine Pearl Harbor West Loch, and Lima Landing				
Chelonia mydas	Green sea turtle	T	NLAA	Yes
Anas wyviliana	Hawaiian duck	E	NLAA	Yes
Fulica alai	Hawaiian coot	E	NLAA	Yes
Gallinula chloropus sandvicensis	Hawaiian moorhen	E	NLAA	Yes
Himantopus mexicanus knudseni	Hawaiian stilt	E	NLAA	Yes
Kaula				
Chelonia mydas	Green sea turtle	T	NLAA	Yes
Eretmochelys imbricata	Hawksbill sea turtle	E	NLAA	Yes
Nihoa and Necker				
Amaranthus brownii	No common name	E	NLAA	Yes
Pritchardia remota	Loulu	E	NLAA	Yes
Schiedea verticillata	No common name	E	NLAA	Yes
Sesbania tomentosa	Ohai	E	NLAA	Yes
Acrocephalus familiaris kingi	Nihoa millerbird	E	NLAA	Yes
Telespyza ultima	Nihoa finch	E	NLAA	Yes

***E=Endangered, T=Threatened, CH=Critical Habitat**

****May affect, not likely to adversely affect**

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F7 - NOAA FISHERIES LETTER OF AUTHORIZATION
14 JANUARY 2010

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

Letter of Authorization

The Commander, U.S. Pacific Fleet (CPF), 250 Makalapa Drive, Pearl Harbor, HI 96860-7000, and persons operating under his authority (i.e., Navy), are authorized to take marine mammals incidental to Navy exercises conducted in the Hawaii Range Complex (HRC) in accordance with 50 CFR Part 216, Subpart P--Taking Marine Mammals Incidental to U.S. Navy Training in the Hawaii Range Complex (HRC) subject to the provisions of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*; MMPA) and the following conditions:

1. This Authorization is valid for the period January 15, 2010, through January 14, 2011.

2. This Authorization is valid only for the unintentional taking of the species of marine mammals and methods of take identified in 50 CFR § 216.172(c) and Condition (5) of this Authorization incidental to the activities specified in 50 CFR § 216.170(c) and Condition (4)(a) of this Authorization and occurring within the Hawaii Operational Area, which extends from 16 to 43° N. lat. and from 150 to 179° degrees W. long.

3. This Authorization is valid only if the Holder of the Authorization or any person(s) operating under his authority implements the mitigation, monitoring, and reporting required pursuant to 50 CFR §§ 216.174 & 216.175 and implements the Terms and Conditions of this Authorization.

4. (a) This Authorization is valid for the activities and designated amounts of use listed below:

(1) The use of the following mid-frequency active sonar (MFAS) and high frequency active sonar (HFAS) sources for U.S. Navy anti-submarine warfare (ASW) training, maintenance, and research, development, testing and evaluation (RDT&E) in the amounts indicated below (+/- 10 percent):

(i) AN/SQS-53 (hull-mounted sonar) – 1284 hours
(ii) AN/SQS-56 (hull-mounted sonar) – 383 hours
(iii) AN/AQS-22 or AN/AQS-13 (helicopter dipping sonar) – 1010 dips
(iv) SSQ-62 (sonobuoys) – 2423 sonobuoys
(v) MK-48, MK-46, or MK-54 (torpedoes) – 313 torpedoes
(vi) AN/BQQ-10 or AN/BQQ-5 (submarine mounted sonar) – 200 hours
(vii)AN/SSQ-110A (IEER)/SSQ-125 (AEER) – up to four events (960 buoys) per year combined of either AEER or EER/IEER

(2) The detonation of the underwater explosives indicated in (2)(i) conducted as part of the training exercises indicated in (2)(ii):

(i) Underwater Explosives:
(A) 5" Naval Gunfire (9.5 lbs)
(B) 76 mm rounds (1.6 lbs)
(C) Maverick (78.5 lbs)
(D) Harpoon (448 lbs)
(E) MK-82 (238 lbs)
(F) MK-83 (574 lbs)
(G) MK-84 (945 lbs)
(H) MK-48 (851 lbs)
(I) Demolition Charges (20 lbs)
(J) EER/IEER (5 lbs)

(ii) Training Events:
(A) Mine Neutralization – 68 exercises
(B) Air-to-Surface MISSILEX – 50 exercises
(C) Surface-to-Surface MISSILEX – 12 exercises
(D) BOMBEX – 38 exercises
(E) SINKEX – 6 exercises
(F) Surface-to-Surface GUNEX – 91 exercises
(G) Naval Surface Fire Support – 28 exercises
(H) EER/IEER – up to four events (960 buoys) per year combined of either AEER or EER/IEER

(b) If the number of sonar hours, dips, and sonobuoys, and exercises indicated in Condition 4(a)(1) are exceeded by more than 10 percent, subsequent LOAs issued under the HRC final rule will ensure that the total activities over five years do not result in exceeding the amount of authorized marine mammal takes indicated in 50 CFR 216.172(c).

(c) The sonar hours conducted as described in Condition (4)(a)(1) will be seasonally and spatially distributed such that no additional exposures of humpback whales to MFAS/HFAS would occur beyond those used to estimate take in the years with a RIMPAC.

5. This authorization is valid only for the incidental take of the following marine mammal species, and only by the indicated method and amount of take:

(a) Level B Harassment:
(i) Mysticetes:

(A) Humpback whale (Megaptera novaeangliae) - 1496
(B) Minke whale (Balaenoptera acutorostrata) – 70
(C) Sei whale (Balaenoptera borealis) – 1

(D) Fin whale (Balaenoptera physalus) – 22
(E) Bryde's whale (Balaenoptera edeni) – 670

(ii) Odontocetes:

(A) Sperm whales (Physeter macrocephalus) – 800
(B) Pygmy sperm whales (Kogia breviceps) – 952
(C) Dwarf sperm whale (Kogia sima) – 2334
(D) Cuvier's beaked whale (Ziphius cavirostris) – 1265
(E) Blainville's beaked whale (Mesoplodon densirostris) – 393
(F) Longman's beaked whale (Indopacetus pacificus) – 116
(G) Rough-toothed dolphin (Steno bredanensis) – 1185
(H) Bottlenose dolphin (Tursiops truncatus) – 807
(I) Pan-tropical dolphins (Stenella attenuata) – 2419
(J) Spinner dolphins (Stenella longirostris) – 463
(K) Striped dolphins (Stenella coeruleoalba) - 3530
(L) Risso's dolphin (Grampus griseus) – 547
(M) Melon-headed whale (Peponocephala electra) – 657
(N) Fraser's dolphin (Lagenodelphis hosei) – 1372
(O) Pygmy killer whale (Feresa attenuata) – 216
(P) False killer whale (Pseudorca crassidens) – 51
(Q) Killer whale (Orcinus orca) – 51
(R) Short-finned pilot whale (Globicephala macrorynchus) –1978

(ii) Pinnipeds: Hawaiian monk seal (Monachus schauinslandi) – 121

(b) Level A Harassment and/or mortality of 10 individuals of each of the species listed below over the course of the 5-year regulations: Bottlenose dolphin (Tursiops truncatus), Pygmy and Dwarf sperm whales (Kogia breviceps and sima), Melon-headed whale (Peponocephala electra), Pantropical spotted dolphin (Stenella attenuata), Pygmy killer whale (Feresa attenuata), Short-finned pilot whale (Globicephala macrorynchus), Striped dolphin (Stenella coeruleoalba), Cuvier's beaked whale (Ziphius cavirostris), Blainville's beaked whale (Mesoplodon densirostris), and Longman's beaked whale (Indopacetus pacificus).

(c) If any of the take in Condition (5)(b) occurs, it will be deducted from the take to be authorized in subsequent LOAs under 50 CFR Subpart P so as to ensure that the total taking over 5 years does not exceed the amounts indicated in Condition 5(b) and 50 CFR § 216.172(c).

6. Mitigation - The Holder of this Authorization, and any individuals operating under his authority, must implement the following mitigation measures when conducting activities identified in 50 CFR § 216.170(c) and Condition 4(a) of this Authorization:

(1) Mitigation Measures for ASW training:

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

(ii) All Commanding Officers, Executive Officers, and officers standing watch on the Bridge shall have reviewed the MSAT material prior to a training event employing the use of mid-frequency active sonar.

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

(iv) Lookout training shall include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, Lookouts shall complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects).

(v) Lookouts shall be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

(vi) On the bridge of surface ships, there shall be at least three people on watch whose duties include observing the water surface around the vessel.

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

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

(ix) On surface vessels equipped with mid-frequency active sonar, pedestal mounted "Big Eye" (20x110) binoculars shall be present and in good working order.

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

(xi) After sunset and prior to sunrise, lookouts shall employ Night Lookouts Techniques in accordance with the Lookout Training Handbook.

(xii) Personnel on lookout shall be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck.

(xiii) CPF shall distribute the final mitigation measures contained in this Authorization and NMFS' Biological Opinion to the Fleet.

(xiv) Commanding Officers shall make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

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

(xvi) During mid-frequency active sonar training activities, personnel shall utilize all available sensor and optical systems (such as Night Vision Goggles) to aid in the detection of marine mammals.

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

(xviii) Aircraft with deployed sonobuoys shall use only the passive capability of sonobuoys when marine mammals are detected within 200 yards (182 m) of the sonobuoy.

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

(xx) Safety Zones - When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) the Navy shall ensure that MFAS transmission levels are limited to at least 6 dB below normal operating levels if any detected marine mammals are within 1000 yards (914 m) of the sonar dome (the bow).

(A) Ships and submarines shall continue to limit maximum MFAS transmission levels by this 6-dB factor until the marine mammal has been seen to leave the 1000-yard safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards (1828 m) beyond the location of the last detection.

(B) The Navy shall ensure that MFAS transmissions will be limited to at least 10 dB below the equipment's normal operating level if any detected animals are within 500 yards (457 m) of the sonar dome. Ships and submarines shall continue to limit maximum ping levels by this 10-dB factor until the marine mammal has been seen to leave the 500-yard safety zone, has not been detected for 30 minutes, or the vessel has transited more than 2000 yards (1828 m) beyond the location of the last detection.

(C) The Navy shall ensure that MFAS transmissions are ceased if any detected marine mammals are within 200 yards of the sonar dome. MFAS transmissions will not resume until the marine mammal has been seen to leave the 200-yard safety zone, has not been detected

for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

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

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

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

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

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

(xxiv) Helicopters shall not dip their sonar within 200 yards (183 m) of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards (183 m) after pinging has begun.

(xxv) Submarine sonar operators shall review detection indicators of close-aboard marine mammals prior to the commencement of ASW training activities involving active mid-frequency sonar.

(xxvi) Night vision goggles shall be available to all ships and air crews, for use as appropriate.

(xxvii) Humpback Whale Cautionary Area – this area is defined as the area extending 5km (2.7 nm) from a line drawn from Kaunakakai on the island of Molokai to Kaena Point on the Island of Lanai; and an area extending 5 km (2.7 nm) from a line drawn from Kaunolu on the Island of Lanai to the most Northeastern point on the Island of Kahoolawe; and within a line drawn from Kanapou Bay on the Island of Kahoolawe to Kanahena Point on the Island of Maui and a line drawn from Cape Halawa on the Island of Molokai to Lipoa Point on the Island of Maui, excluding the existing submarine operating area. Following are the required measures related to this area:

(A) Should national security needs require MFAS training and testing in the cautionary area between 15 December and 15 April, it must be personally authorized by

the CPF based on his determination that training and testing in that specific area is required for national security purposes. This authorization shall be documented by the CPF in advance of transiting and training in the cautionary area, and the determination shall be based on the unique characteristics of the area from a military readiness perspective, taking into account the importance of the area for humpback whales and the need to minimize adverse impacts on humpback whales from MFAS whenever practicable. Further, the CPF will provide specific direction on required mitigation measures prior to operational units transiting to and training in the cautionary area.

(B) The Navy shall provide advance notification to NMFS of any such activities (listed in xxvii(A), above).

(C) The Navy shall include in its periodic reports for compliance with the MMPA whether or not activities occurred in the Humpback Whale Cautionary Area described above and any observed effects on humpback whales due to the conduct of these activities.

(xxviii) The Navy shall abide by the letter of the final "Stranding Response Plan for Major Navy Training Exercises in the HRC" (Attachment A) to include the following measures:

(A) Shutdown Procedures– When an Uncommon Stranding Event (USE – as defined in 50 C.F.R. § 216.171(b) and Attachment A) occurs during a Major Training Exercise (MTE, including RIMPAC, USWEX, or Multi-Strike Group Exercise) in the HRC, the Navy shall implement the procedures described below.

(1) The Navy shall implement a Shutdown (as defined in 50 C.F.R. § 216.171(b) and Attachment A) when advised by a NMFS Office of Protected Resources Headquarters Senior Official designated in the HRC Stranding Communication Protocol that a USE involving live animals has been identified and that at least one live animal is located in the water. NMFS and Navy will maintain a dialogue, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures.

(2) Any shutdown in a given area shall remain in effect in that area until NMFS advises the Navy that the subject(s) of the USE at that area die or are euthanized, or that all live animals involved in the USE at that area have left the area (either of their own volition or herded).

(3) If the Navy finds an injured or dead animal floating at sea during an MTE, the Navy shall notify NMFS immediately or as soon as operational security considerations allow. The Navy shall provide NMFS with species or description of the animal(s), the condition of the animal(s) including carcass condition if the animal(s) is/are dead), location, time of first discovery, observed behavior (if alive), and photo or video (if available). Based on the information provided,

NMFS will determine if, and advise the Navy whether a modified shutdown is appropriate on a case-by-case basis.

(4) In the event, following a USE, that: a) qualified individuals are attempting to herd animals back out to the open ocean and animals are not willing to leave, or b) animals are seen repeatedly heading for the open ocean but turning back to shore, NMFS and the Navy shall coordinate (including an investigation of other potential anthropogenic stressors in the area) to determine if the proximity of MFAS training activities or explosive detonations, though farther than 14 nm from the distressed animal(s), is likely contributing to the animals' refusal to return to the open water. If so, NMFS and the Navy will further coordinate to determine what measures are necessary to improve the probability that the animals will return to open water and implement those measures as appropriate.

(B) Within 72 hours of the notification of the USE the Navy will inform NMFS where and when they were conducting training (within 80 nm and 72 hours of the event) and whether or not they were operating sonar or detonating explosives. Within 7 days of the completion of any exercises that were being conducted within 80 nm or 72 hours prior to the event, the Navy will further provide information to NMFS (per the HRC Stranding Communication Protocol), as available, regarding the number and types of acoustic/explosive sources, direction and speed of units using MFAS, and marine mammal sightings information associated with those training activities. Information not initially available regarding the 80 nm, 72 hours, period prior to the event will be provided as soon as it becomes available. The Navy will provide NMFS investigative teams with additional relevant unclassified information as requested (or classified information to qualified NMFS staff), if available.

(xxix) While in transit, Naval vessels shall be alert at all times, use extreme caution, and proceed at a "safe speed" so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

(xxx) When marine mammals have been sighted in the area, Navy vessels shall increase vigilance and take reasonable and practicable actions to avoid collisions and activities that might result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).

(2) Mitigation for IEER and AEER

(i) Crews shall conduct aerial visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 500 yards (457 m) at a slow speed, if operationally feasible and weather conditions permit. In dual aircraft training activities, crews are allowed to conduct coordinated area clearances.

(ii) Crews shall conduct a minimum of 30 minutes of visual and acoustic monitoring of the search area prior to commanding the first post detonation. This 30-minute observation period may include pattern deployment time.

(iii) For any part of the intended sonobuoy pattern where a post (source/receiver sonobuoy pair) will be deployed within 1,000 yards (914 m) of observed marine mammal activity, the Navy shall deploy the receiver ONLY (i.e., not the source) and monitor while conducting a visual search. When marine mammals are no longer detected within 1,000 yards (914 m) of the intended post position, the source sonobuoy (AN/SSQ-110A/SSQ-125) will be co-located with the receiver.

(iv) When able, crews will conduct continuous visual and aural monitoring of marine mammal activity. This shall include monitoring of aircraft sensors from the time of the first sensor placement until the aircraft have left the area and are out of RF range of these sensors.

(v) Aural Detection: If the presence of marine mammals is detected aurally, the aircrew will increase the diligence of their visual surveillance. Subsequently, if no marine mammals are visually detected, then the crew may continue multi-static active search.

(vi) Visual Detection:

(A) If marine mammals are visually detected within 1,000 yards (914 m) of the source sonobuoy (AN/SSQ-110A/SSQ-125) intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 30 minutes, or are observed to have moved outside the 1,000 yards (914 m) safety buffer.

(B) Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 1,000 yards (914 m) safety buffer.

(vii) Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the "Payload 1 Release" command followed by the "Payload 2 Release" command. Aircrews shall refrain from using the "Scuttle" command when two payloads remain at a given post. Aircrews will ensure that a 1,000 yard (914 m) safety buffer, visually clear of marine mammals, is maintained around each post as is done during active search operations.

(viii) Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary or tertiary method.

(ix) The Navy shall ensure all payloads are accounted for. Explosive source sonobuoys (AN/SSQ-110A) that cannot be scuttled shall be reported as unexploded ordnance via voice communications while airborne, then upon landing via naval message.

(x) Marine mammal monitoring shall continue until out of own-aircraft sensor range.

(3) Mitigation for Demolitions (DEMOs) and Mine Countermeasure (MCM) Training (Up to 20 lb).

(i) Exclusion Zones – Explosive charges shall not be detonated if a marine mammal is detected within 700 yards (640 m) of the detonation site.

(ii) Pre-Exercise Surveys - For MCM training activities, the Navy shall conduct a pre-exercise survey within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air. If a marine mammal is detected within the survey area, the exercise shall be suspended until the animal voluntarily leaves the area.

(iii) Post-Exercise Surveys - Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event.

(iv) Reporting - Any evidence of a marine mammal that may have been injured or killed by the action shall be reported immediately to NMFS.

(v) Mine Laying Training – Though mine laying training operations involve aerial drops of inert training shapes on floating targets, measures 1, 2, and 3 for Demolitions and Mine countermeasures (above) will apply to mine laying training. To the maximum extent feasible, the Navy shall retrieve inert mine shapes dropped during Mine Laying Training.

(4) Mitigation for SINKEX, GUNEX, MISSILEX, and BOMBEX.

(i) All weapons firing shall be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.

(ii) Extensive range clearance operations shall be conducted in the hours prior to commencement of the exercise.

(iii) An exclusion zone with a radius of 1.0 nm (1.85 km) shall be established around each target. An additional buffer of 0.5 nm (0.93 km) shall be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which extends out an additional 0.5 nm (0.93 km), shall be surveyed. Together, the zones extend out 2 nm (3.7 km) from the target.

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

(A) Overflights within the exclusion zone shall be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue (SAR) Tactical Aid (TACAID).

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

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

(D) On each day of the exercise, aerial surveillance of the exclusion and safety zones shall commence two hours prior to the first firing.

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

(F) If a marine mammal observed within the exclusion zone is diving, firing shall be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes has elapsed.

(G) During breaks in the exercise of 30 minutes or more, the exclusion zone shall again be surveyed for any marine mammals. If marine mammals are sighted within the exclusion zone, the OCE would be notified, and the procedure described above would be followed.

(H) Upon sinking of the vessel, a final surveillance of the exclusion zone shall be monitored for two hours, or until sunset, to verify that no marine mammals were harmed.

(v) Aerial surveillance would be conducted using helicopters or other aircraft based on necessity and availability. These aircraft shall be capable of (and shall, to the extent practicable) flying at the slow safe speeds necessary to enable viewing of marine mammals with unobstructed, or minimally obstructed, downward and outward visibility. The Navy may cancel the exclusion and safety zone surveys in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise.

(vi) Where practicable, the Navy shall conduct the exercise in sea states that are ideal for marine mammal sighting, i.e., Beaufort Sea State 3 or less. In the event of a Beaufort Sea State

of 4 or above, the Navy shall utilize additional aircraft (conducting tight search patterns), if available, to increase survey efforts within the zones.

(vii) The exercise shall not be conducted unless the exclusion zone can be adequately monitored visually.

(viii) In the unlikely event that any marine mammals are harmed during the exercise, a detailed description of the animal shall be documented, the location noted, and if possible, photos taken. This information shall be provided to NMFS as soon as practicable.

7. Monitoring and Reporting – When conducting operations identified in 50 CFR § 216.170(c) and Condition 4(a), the Holder of the Authorization and any person(s) operating under his authority must implement the following monitoring and reporting measures. All reports should be submitted to the Director, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring MD 20910 and a copy provided to the Assistant Regional Administrator for Protected Resources, Pacific Islands Regional Office, National Marine Fisheries Service, 1601 Kapiolani Boulevard, Suite 1110, Honolulu, HI 96814.

(a) The Navy must notify NMFS immediately (or as soon as clearance procedures allow) if the specified activity identified in Condition (4)(a) is thought to have resulted in the mortality or injury of any marine mammals, or in any take of marine mammals not identified in 50 C.F.R. § 216.172(c) and Condition 5.

(b) The Navy shall implement the 2010 Update to the HRC Monitoring Plan (Attachment B).

(c) The Navy shall comply with the 2009 Integrated Comprehensive Monitoring Program Plan and continue to improve the program, as appropriate, in consultation with NMFS. Any changes and improvements to the program made during 2010 will be described in an updated 2010 ICMP and shall be submitted to NMFS by October 31, 2010 for review. The Navy shall submit a final 2010 ICMP to NMFS by December 31, 2010.

(d) General Notification of Injured or Dead Marine Mammals - Navy personnel shall ensure that NMFS (regional stranding coordinator) is notified immediately (or as soon as clearance procedures allow) if an injured or dead marine mammal is found during or shortly after, and in the vicinity of, any Navy training exercise utilizing MFAS, HFAS, or underwater explosive detonations. The Navy shall provide NMFS with species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). The Navy shall consult the final HRC Stranding Response Plan (attachment A) to obtain more specific reporting requirements for specific circumstances.

(e) Annual HRC Monitoring Plan Report - The Navy shall submit a report on October 1, 2010 describing the implementation and results (through August 1, 2010) of the HRC Monitoring Plan, described above. The report will also include any analysis conducted or

conclusions reached based on the previous years data that were not completed in time for the previous years monitoring report. Data collection methods will be standardized across range complexes to allow for comparison in different geographic locations. Although additional information will be gathered, the marine mammal observers (MMOs) collecting marine mammal data pursuant to the HRC Monitoring Plan shall, at a minimum, provide the same marine mammal observation data required in condition (7)(F). The HRC Monitoring Plan Report may be provided to NMFS within a larger report that includes the required Monitoring Plan Reports from multiple Range Complexes.

(f) Annual HRC Exercise Report - The Navy shall submit an Annual HRC Exercise Report on October 1, 2010 (covering data gathered through August 1, 2010)). This report shall contain the information identified below.

(1) MFAS/HFAS Major Training Exercises - This section shall contain the following information for Major Training Exercises (MTEs, which include RIMPAC, USWEX, and Multi Strike Group) conducted in the HRC:

(i) Exercise Information (for each MTE):

(A) Exercise designator
(B) Date that exercise began and ended
(C) Location
(D) Number and types of active sources used in the exercise
(E) Number and types of passive acoustic sources used in exercise
(F) Number and types of vessels, aircraft, etc., participating in exercise
(G) Total hours of observation by watchstanders
(H) Total hours of all active sonar source operation
(I) Total hours of each active sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)).
(J) Wave height (high, low, and average during exercise)

(ii) Individual marine mammal sighting info (for each sighting in each MTE):

(A) Location of sighting
(B) Species (if not possible – indication of whale/dolphin/pinniped)
(C) Number of individuals
(D) Calves observed (y/n)
(E) Initial Detection Sensor
(F) Indication of specific type of platform observation made from (including, for example, what type of surface vessel, i.e., FFG, DDG, or CG)
(G) Length of time observers maintained visual contact with marine mammal
(H) Wave height (in feet)
(I) Visibility
(J) Sonar source in use (y/n).

(K) Indication of whether animal is <200yd, 200-500yd, 500-1000yd, 1000-2000yd, or >2000yd from sonar source in (J) above.

(L) Mitigation Implementation – Whether operation of sonar sensor was delayed, or sonar was powered or shut down, and how long the delay was.

(M) If source in use (J) is hullmounted, true bearing of animal from ship, true direction of ship's travel, and estimation of animal's motion relative to ship (opening, closing, parallel).

(N) Observed behavior – Watchstanders shall report, in plain language and without trying to categorize in any way, the observed behavior of the animals (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming, etc.).

(iii) An evaluation (based on data gathered during all of the MTEs) of the effectiveness of mitigation measures. This evaluation shall identify the specific observations that support any conclusions the Navy reaches about the effectiveness of the mitigation.

(2) ASW Summary - This section shall include the following information as summarized from both MTEs and non-major training exercises (i.e., unit-level exercises, such as TRACKEXs):

(i) Total annual hours of each type of sonar source (along with explanation of how hours are calculated for sources typically quantified in alternate way (buoys, torpedoes, etc.)).

(ii) Total hours (from December 15, 2009 through April 15, 2010) of hull-mounted active sonar operation occurring in the dense humpback areas generally shown on the Mobley map (73 FR 35510, 35520) plus a 5-km buffer, but not including the Pacific Missile Range Facility. The Navy shall work with NMFS to develop the exact boundaries of this area.

(iii) Total estimated annual hours of hull-mounted active sonar operation conducted in Humpback Whale Cautionary area between December 15, 2009 and April 15, 2010.

(iv) Cumulative Impact Report - To the extent practicable, the Navy, in coordination with NMFS, shall develop and implement a method of annually reporting non-major (i.e., other than RIMPAC, USWEX, or Multi-Strike Group Exercises) training exercises utilizing hull-mounted sonar. The report shall present an annual (and seasonal, where practicable) depiction of non-major training exercises geographically across the HRC. The Navy shall either include (in the HRC annual report) the Cumulative Impact Report, as described above, or provide a brief annual progress update on the status of development of the Cumulative Report.

(3) SINKEXs - This section shall include the following information for each SINKEX completed that year:

(i) Exercise information (gathered for each SINKEX):

(A) Location
(B) Date and time exercise began and ended
(C) Total hours of observation by watchstanders before, during, and after exercise
(D) Total number and types of rounds expended / explosives detonated
(E) Number and types of passive acoustic sources used in exercise
(F) Total hours of passive acoustic search time
(G) Number and types of vessels, aircraft, etc., participating in exercise
(H) Wave height in feet (high, low and average during exercise)
(I) Narrative description of sensors and platforms utilized for marine mammal detection and timeline illustrating how marine mammal detection was conducted

(ii) Individual marine mammal observation (by Navy lookouts) information (gathered for each marine mammal sighting)

(A) Location of sighting
(B) Species (if not possible, indicate whale, dolphin or pinniped)
(C) Number of individuals
(D) Whether calves were observed
(E) Initial detection sensor
(F) Length of time observers maintained visual contact with marine mammal
(G) Wave height
(H) Visibility
(I) Whether sighting was before, during, or after detonations/exercise, and how many minutes before or after
(J) Distance of marine mammal from actual detonations (or target spot if not yet detonated) – use four categories to define distance: 1) the modeled injury threshold radius for the largest explosive used in that exercise type in that OPAREA (91 m for SINKEX in HRC); 2) the required exclusion zone (1 nm for SINKEX in HRC); (3) the required observation distance (if different than the exclusion zone (2 nm for SINKEX in HRC); and, (4) greater than the required observed distance. For example, in this case, the observer would indicate if < 91 m, from 91 m – 1 nm, from 1 nm – 2 nm, and > 2 nm.
(K) Observed behavior – Watchstanders will report, in plain language and without trying to categorize in any way, the observed behavior of the animal(s) (such as animal closing to bow ride, paralleling course/speed, floating on surface and not swimming etc.), including speed and direction.
(L) Resulting mitigation implementation – Indicate whether explosive detonations were delayed, ceased, modified, or not modified due to marine mammal presence and for how long.
(M) If observation occurs while explosives are detonating in the water, indicate munition type in use at time of marine mammal detection.

(4) IEER/AEER Summary - This section shall include an annual summary of the following IEER information:

(i) Total number of IEER/AEER events conducted in the HRC
(ii) Total expended/detonated rounds (buoys)
(iii) Total number of self-scuttled IEER rounds

(5) Explosives Summary - To the extent practicable, the Navy will provide the information described below for all of their explosive exercises. Until the Navy is able to report in full the information below, they will provide an annual update on the Navy's explosive tracking methods, including improvements from the previous year.

(i) Total annual number of each type of explosive exercises identified in 50 C.F.R. § 216.170 and in Condition 4(a)(2) that are conducted in the HRC
(ii) Total annual expended/detonated rounds (missiles, bombs, etc.) for each explosive type

(g) Sonar Exercise Notification - The Navy shall submit to the NMFS Office of Protected Resources (list of email addresses and phone numbers attached) either an electronic (preferably) or verbal report within fifteen calendar days after the completion of any major exercise (RIMPAC, USWEX, or Multi Strike Group) indicating:

(1) Location of the exercise
(2) Beginning and end dates of the exercise
(3) Type of exercise (e.g., RIMPAC, USWEX, or Multi Strike Group)

(h) HRC 5-yr Comprehensive Report - The Navy shall submit to NMFS a draft report that analyzes and summarizes all of the multi-year marine mammal information gathered during ASW and explosive exercises for which annual reports are required (Annual HRC Exercise Reports and HRC Monitoring Plan Reports). This report will be submitted at the end of the fourth year of the rule (November 2012), covering activities that have occurred through June 1, 2012.

(i) Comprehensive National ASW Report - By June 2014, the Navy shall submit a draft Comprehensive National Report that analyzes, compares, and summarizes the active sonar data gathered (through January 1, 2014) from the watchstanders in accordance with the Monitoring Plans for the HRC, the Atlantic Fleet Active Sonar Training, the Southern California (SOCAL) Range Complex, the Mariana Islands Range Complex, the Northwest Training Range, the Gulf of Alaska, and the East Coast Undersea Warfare Training Range.

(j) The Navy shall respond to NMFS comments and requests for additional information or clarification on the HRC Comprehensive Report, the draft National ASW report, the Annual HRC Exercise Report, or the Annual HRC Monitoring Plan Report (or the multi-Range Complex Annual Monitoring Plan Report, if that is how the Navy chooses to submit the information) if

submitted within 3 months of receipt. These reports will be considered final after the Navy has addressed NMFS' comments or provided the requested information, or three months after the submittal of the draft if NMFS does not comment by then.

(k) In 2011, the Navy shall convene a Monitoring Workshop in which the Monitoring Workshop participants will be asked to review the Navy's Monitoring Plans and monitoring results and make individual recommendations (to the Navy and NMFS) of ways of improving the Monitoring Plans. The recommendations shall be reviewed by the Navy, in consultation with NMFS, and modifications to the Monitoring Plan shall be made, as appropriate.

8. This Authorization may be modified, suspended or withdrawn (pursuant to 50 CFR § 216.106(e)(1 or 2) if the Holder or any person operating under his authority fails to abide by the conditions prescribed herein or if the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

9. A copy of this Authorization (including Attachment A) and the attached Subpart P of the regulations, or a document containing the equivalent requirements specified in this Authorization and 50 CFR Subpart P, must be in the possession of the on-site Commanding Officer in order to take marine mammals under the authority of this Letter of Authorization while conducting the specified activity(ies).

10. The Holder of this Authorization and any person operating under his authority is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS' Biological Opinion as they pertain to listed marine mammals.

JAN 14 2010

James H. Lecky, Director
Office of Protected Resources
National Marine Fisheries Service

Date

Stranding Response Plan for Major Navy Training Exercises in the Hawaii Range Complex
January 2009

Strandings

Strandings, as defined by the Marine Mammal Protection Act (MMPA), have occurred throughout recorded history, although U.S. stranding programs have only been keeping consistent records in some cases as long as the last three decades but more commonly the last decade. Strandings may result from many different causes, including, for example, infectious agents, biotoxicosis, starvation, fishery interaction, ship strike, unusual oceanographic or weather events, sound exposure, or combinations of these stressors sustained concurrently or in series. In many cases, a cause of stranding or death cannot be unequivocally determined for a number of reasons. Several marine mammal strandings have been associated with mid-frequency active sonar (MFAS), however, scientific uncertainty remains regarding the exact combination of behavioral and physiological responses that link MFAS exposure to strandings (though several mechanisms have been theorized). Available evidence suggests that in some cases it may be the presence of additional specific environmental or physical conditions working in confluence with the exposure of marine mammals to MFAS that can potentially result in a stranding. The National Marine Mammal Stranding Network (created under the Marine Mammal Health and Stranding Response Program Act (MMHSRPA)) consists of over 100 organizations partnered with the National Marine Fisheries Service (NMFS) to investigate marine mammal strandings in U.S. waters. NMFS is currently developing (with help anticipated from the Navy, the petroleum industry, and other agencies and entities) a series of studies to correlate long-term stranding patterns and pathologies with all known anthropogenic stressors, such as sound and including seismic surveys and active military sonar. Among other things, the plan discussed below is intended to contribute to the better understanding of why strandings occur.

Introduction to the Stranding Plan

Pursuant to 50 CFR Section 216.105, the plan outlined below will be included by reference and summarized in the regulations and included fully as part of (attached to) the Navy's MMPA Letter of Authorization (LOA), which indicates the conditions under which the Navy is authorized to take marine mammals pursuant to training activities involving MFAS or explosives in the Hawaii Range Complex (HRC). This Stranding Response plan is specifically intended to outline the applicable requirements the authorization is conditioned upon in the event that a marine mammal stranding is reported in the Hawaii Range Complex (HRC) during a *major training exercise* (MTE) (see glossary below). As mentioned above, NMFS considers all plausible causes within the course of a stranding investigation and this plan in no way presumes that any strandings in the HRC are related to, or caused by, Navy training activities, absent a determination made in a Phase 2 Investigation as outlined in Paragraph 7 of this plan, indicating that MFAS or explosive detonation in the HRC were a cause and/or contributed to the stranding. This plan is designed to address the following three issues:

- Mitigation – When marine mammals are in a situation that can be defined as a *stranding* (see glossary below), they are experiencing physiological stress. When animals are

stranded, and alive, NMFS believes that exposing these compromised animals to additional known stressors would likely exacerbate the animal's distress and could potentially cause its death. Regardless of the factor(s) that may have initially contributed to the stranding, it is NMFS' goal to avoid exposing these animals to further stressors. Therefore, when live stranded cetaceans are in the water and engaged in what is classified as an *Uncommon Stranding Event* (USE) (see glossary below), the shutdown component of this plan is intended to minimize the exposure of those animals to mid-frequency active sonar (MFAS) and explosive detonations, regardless of whether or not these activities may have initially played a role in the event.

- Monitoring – This plan will enhance the understanding of how MFAS or explosive detonations (as well as other environmental conditions) may, or may not, be associated with marine mammal injury or strandings. Additionally, information gained from the investigations associated with this plan may be used in the adaptive management of mitigation or monitoring measures in subsequent LOAs, if appropriate.

- Compliance – The information gathered pursuant to this protocol will inform NMFS' decisions regarding compliance with Sections 101(a) (5) (B and C) of the MMPA.

In addition to outlining the necessary procedural steps for the Navy to undertake in the event of a USE during an MTE (as required by the LOA), this document describes NMFS' planned participation in stranding responses in the HRC, as NMFS' response relates specifically to the Navy requirements described here. The NMFS MMHSRP and the participating Pacific Island regional Stranding Networks have specific responsibilities regarding unusual marine mammal mortality events (UMEs) pursuant to Title IV of the MMPA. This document does not serve to replace or preclude any of the procedures currently in place for NMFS' response to UMEs. NMFS will pursue any activities to fulfill obligations relative to UMEs any time that a trigger is reached as determined by the Working Group on Marine Mammal Unusual Mortality Events. This document highlights (or adds to) applicable existing (and developing) protocols and procedures to be used with the specific circumstances and specific subset of strandings addressed here, namely a USE within the HRC during the MTE. This document has been reviewed and approved by the NMFS staff responsible for conducting and overseeing the referenced activities in Hawaii and this plan will be implemented by NMFS to the degree that resources are available and logistics are feasible.

General Notification Provision

If, at any time or place within the HRC, Navy personnel find a *stranded* marine mammal (see glossary below) either on the shore, near shore, or floating at sea, NMFS requests the Navy contact NMFS immediately (or as soon as clearance procedures allow) as described in the HRC Stranding Communication Protocol (currently under development, but subject to incorporation into this plan upon mutual agency approval). NMFS requests the Navy provide NMFS with species or description of animal (s), the condition of the animal (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available).

Operational Response Plan

This section describes the specific actions the Navy must take in order to comply with the LOA if a USE is reported to the Navy in the HRC coincident to, or within 72 hours of, an MTE. This Stranding Response Plan will include an associated HRC Stranding Communication Protocol (currently under development, but subject to incorporation into this plan upon mutual agency approval), which will indicate, among other things, the specific individuals (NMFS Office of Protected Resources - HQ senior administrators) authorized to advise the Navy that certain actions are prescribed by the Stranding Response Plan. A glossary is included at the end of this document. Words included in the glossary are italicized in this section the first time they are used.

1. Initial Stranding Response - The NMFS regional stranding network will respond to all reports of stranded marine mammals, when feasible. All marine mammals will receive examination appropriate to the condition code of the animal and the feasibility of the logistics. If a *qualified* individual determines that the stranding is a *USE*, NMFS staff (or qualified individual) will initiate a *Phase 1 Investigation*. NMFS will contact appropriate NMFS and Navy personnel (pursuant to the HRC Stranding Communication Protocol). NMFS and Navy will maintain a dialogue, as needed, regarding the identification of the USE and the potential need to implement shutdown procedures.

2. *Shutdown* Procedures – Shutdown procedures are not related to the investigation of the cause of the stranding and their implementation is in no way intended to imply that MFAS is the cause of the stranding. Rather, as noted above, shutdown procedures are intended to protect cetaceans *exhibiting indicators of distress* and involved in a USE (see glossary) by minimizing their exposure to possible stressors (MFAS or explosive detonations), regardless of the factors that initially contributed to the USE. Only individuals specifically identified in the HRC Stranding Communication Protocol (NMFS Protected Resources – HQ senior administrators) will be authorized to advise the Navy of the need to implement shutdown procedures (pursuant to the Stranding Response Plan/LOA).

a) If no live or freshly dead cetaceans are involved in the USE, NMFS will advise the Navy that shutdown procedures need not be implemented. Aerial surveys will be conducted if feasible (see second bullet under b, below).

b) If live or freshly dead cetaceans are involved in the USE, the Navy will implement the following procedures:

- If live cetaceans involved in the USE are in the water (i.e., could be exposed to sonar), NMFS will advise the Navy of the need to implement shutdown procedures defined in the glossary (pursuant to the Stranding Response Plan/LOA).

- NMFS will coordinate internally, with the Navy, and with other agencies and entities with the intent of obtaining aerial survey arrangements. If an aircraft is

available, a survey will be conducted within 14 nm (on the shore and in the water) to look for additional animals that meet the USE criteria. NMFS will request that the Navy assist with aerial surveys, as resources are available.

- If no additional animals that meet the USE criteria are found (including if no aircraft were available to conduct a survey), and the originally detected animals are not in the water, and will not be put back in the water for rehabilitation or release purposes, or are dead, NMFS will advise the Navy that shutdown procedures need not be implemented at any additional locations.

- If additional cetacean(s) meeting the USE criteria are detected by surveys, the shutdown procedures will be followed for the newly detected animal(s) beginning at 2(a) above.

o If a qualified individual determines that it is appropriate to put live animals that were initially on the beach back in the water for rehabilitation or release purposes, NMFS will advise the Navy of the need to implement shutdown procedures pursuant to the Stranding Response Plan/LOA.

c) If the Navy finds an injured or dead animal floating at sea during an MTE, the Navy shall notify NMFS (pursuant to HRC Stranding Communication Protocol) immediately or as soon as operational security considerations allow. The Navy should provide NMFS with the information outlined in the general notification provision above, as available. Based on the information provided, NMFS will determine if a modified shutdown is appropriate on a case-by-case basis.

d) In the event, following a USE, that: a) qualified individuals are attempting to herd animals back out to the open ocean and animals are not willing to leave, or b) animals are seen repeatedly heading for the open ocean but turning back to shore, NMFS and the Navy will coordinate (including an investigation of other potential anthropogenic stressors in the area) to determine if the proximity of MFAS operations or explosive detonations, though farther than 14 nm from the distressed animal(s), is likely decreasing the likelihood that the animals return to the open water. If so, NMFS and the Navy will further coordinate to determine what measures are necessary to further minimize that likelihood and implement those measures as appropriate. Navy and NMFS will maintain a dialogue regarding the plan to return the animal(s) to the water.

3. Restart Procedures

- If at any time, the subject(s) of the USE at one location die or are euthanized, NMFS will immediately advise the Navy that the shutdown around that location is no longer needed,

- Shutdown procedures will remain in effect until NMFS determines that, and advises the Navy that, all live animals involved in the USE have left the area (either of their own

volition or herded). Leading up to restart, NMFS will coordinate internally, with the Navy, and with other federal and state agencies with the intent of securing arrangements to track the movement of the animals following the dispersal of the USE (aircraft, vessel, or tags). If the Navy has restarted operations in the vicinity of the animals, NMFS and the Navy will further coordinate to determine (based on location and behavior of tracked animals and location/nature of Navy activities) if the proximity of MFAS operations or explosive detonations is likely increasing the likelihood that the animals re-strand. If so, NMFS and the Navy will further coordinate to determine what measures are necessary to minimize that likelihood and implement those measures as appropriate.

4. Information - Within 72 hours of the notification of the USE the Navy will inform NMFS where and when they were operating MFAS or conducting explosive detonations (within 80 nm and 72 hours of the event). Within 7 days of the completion of any exercises that were being conducted within 80 nm or 72 hours prior to the event, the Navy will further provide information to NMFS (per the HRC Stranding Communication Protocol), *as available*, regarding the number and types of acoustic/explosive sources, direction and speed of units using MFAS, and marine mammal sightings information associated with those training activities. Information not initially available regarding the 80 nm, 72 hours, period prior to the event will be provided as soon as it becomes available. The Navy will provide NMFS investigative teams with additional relevant unclassified information as requested (or classified information to qualified NMFS staff), if available.

5. Phase 1 Investigation – Within 4 weeks of a USE (when feasible), NMFS will conduct and complete the Phase 1 Investigation (list of procedures typically included in Phase 1 investigation are included in the Glossary of this document, description of actual procedures are contained in the Biomonitoring Protocols) for all USEs that occur in the HRC coincident with MTEs. Results from the Phase 1 Investigation will be categorized in one of the two ways discussed below and trigger the indicated action:

- If the results of the Phase 1 Investigation indicate that the USE was likely caused by something (such as entanglement or ship strike) other than MFAS or explosive detonations authorized by the Navy's LOA, the USE investigation will be considered complete as related to the MMPA authorization.

- If NMFS cannot conclude that the stranding was likely caused by something other than MFAS or explosive detonations authorized by the Navy LOA, rather, the results of the Phase 1 Investigation range from completely inconclusive to including potential early indicators that acoustic exposure could have played a role, a Phase 2 Investigation will be conducted by qualified individuals, under the direction of NMFS staff, and an individual case report will be prepared for each animal (list of procedures typically included in Phase 2 investigation are included in the Glossary of this document, description of actual procedures are contained in the Biomonitoring Protocols).

6. Memorandum of Agreement (MOA) - The Navy and NMFS will develop an MOA, or other mechanism consistent with federal fiscal law requirements (and all other applicable laws), that

allows the Navy to assist NMFS with the Phase 1 and 2 Investigations of USEs through the provision of in-kind services, such as (but not limited to) the use of plane/boat/truck for transport of stranding responders or animals, use of Navy property for necropsies or burial, or assistance with aerial surveys to discern the extent of a USE. The Navy may assist NMFS with the Investigations by providing one or more of the in-kind services outlined in the MOA, when available and logistically feasible and which do not negatively affect Fleet operational commitments.

7. Phase 2 Investigation - Results from the Phase 2 Investigation (procedures outlined in the Biomonitoring Protocols) will be categorized in one of the three ways discussed below and trigger the indicated action:

- If the results indicate that the USE was likely caused by something (such as entanglement or blunt force trauma) other than MFAS or explosive detonations authorized by the Navy's LOA, the *USE* investigation will be considered complete as related to the MMPA authorization.

- If the results are inconclusive which is, historically, the most likely result, i.e. NMFS can neither conclude that the USE was likely caused by something other than acoustic trauma nor conclude that there is a high likelihood that exposure to MFAS or explosive detonations were a cause of the USE, the USE investigation will be considered complete as related to the MMPA authorization.

- If the results of a comprehensive and detailed scientific investigation into all possible causes of the stranding event indicate that there is a high likelihood that MFAS or explosive detonation were a cause of the USE, one of the following will occur:

    - If the total mortalities determined to be caused by MFAS or explosive detonation do not exceed the number analyzed for the 5-yr period in the regulations (10 and 0, respectively), they will be recorded (to add on to if there is another stranding) and NMFS will take no further action beyond that indicated in 8, below.

    - If the total mortalities determined to be caused by MFAS exceed the number analyzed for the 5-yr period in the regulations, NMFS will begin the process of determining whether or not suspension or withdrawal of the authorization is appropriate.

The Navy will be provided at least ten working days to review and provide comments on NMFS' summary and characterization of the factors involved in the USE. NMFS will consider the Navy's comments prior to finalizing any conclusions and/or deciding to take any action involving any take authorization.

8. USE Response Debrief and Evaluation – Within 2 months after a USE, NMFS and Navy staff will meet to discuss the implementation of the USE response and recommend modifications or

clarifications to improve the Stranding Response Plan. These recommendations will feed into the adaptive management strategy discussed below.

9. Adaptive Management - The regulations under which the Navy's LOA (and this Stranding Response Plan) are issued will contain an adaptive management component. This gives NMFS the ability to consider the results of the previous years' monitoring and/or the results of stranding investigations when prescribing mitigation or monitoring requirements in subsequent years. In the event that NMFS concludes that there is a high likelihood that MFAS or explosive detonations were a cause of a USE, NMFS will review the analysis of the environmental and operational circumstances surrounding the USE. In subsequent LOAs, based on this review and through the adaptive management component of the regulations, NMFS may require the mitigation measures or Stranding Response Plan be modified or supplemented if the new data suggest that modifications would either have a reasonable likelihood of reducing the chance of future USEs resulting from a similar confluence of events or would increase the effectiveness of the stranding investigations. Further based on this review and the adaptive management component of the regulations, NMFS may modify or add to the existing monitoring requirements if the data suggest that the addition of a particular measure would likely fill in a specifically important data gap. Additionally, the USE Debrief and Evaluation discussed above (in combination with adaptive management) will allow NMFS and the Navy to further refine the Stranding Response Plan for maximum effectiveness.

Communication

Effective communication is critical to the successful implementation of this Stranding Response Plan. Very specific protocols for communication, including identification of the Navy personnel authorized to implement a shutdown and the NMFS personnel authorized to advise the Navy of the need to implement shutdown procedures (NMFS Protected Resources HQ – senior administrators) and the associated phone trees, etc. (to be included in the document entitled "HRC Stranding Communication Protocols") are currently in usable draft form and will be finalized for the HRC by March 2009 and updated yearly (or more frequently, as appropriate).

The Stranding Response Plan is dependent upon advance notice to NMFS of the planned upcoming MTE. NMFS and the Navy will develop a mechanism (that conforms with operational security requirements) wherein the Navy can provide NMFS with necessary advance notification of MTEs.

NMFS will keep information about planned MTE's in a confidential manner and will transmit information to NMFS personnel responding to USE's to the minimum necessary to accomplish the NMFS mission under this plan.

Glossary:

Freshly dead – Code 2 carcass condition (2a-as if just died, no bloating; or 2b-slight decomposition, slight bloating, blood imbibitions visible).

Major training exercise (MTE) – An MTE, within the context of this document, means RIMPAC, USWEX, and Multi Strike Group exercises involving MFAS or explosives. These exercises are expected to encompass approximately 40 to 60 days per year.

Exhibiting Indicators of Distress – Animals exhibiting an uncommon combination of behavioral and physiological indicators typically associated with distressed or stranded animals. This situation would be identified by a qualified individual and typically includes some combination of the following characteristics:

- Marine mammals continually circling or moving haphazardly in a tightly packed group – with a member occasionally breaking away and swimming towards the beach.
- Abnormal respirations including increased or decreased rate or volume of breathing, abnormal content or odor
- Presence of an individual of a species that has not historically been seen in a particular habitat, for example a pelagic species in a shallow bay when historic records indicate that it is a rare event.
- Abnormal behavior for that species, such as abnormal surfacing or swimming pattern, listing, and abnormal appearance

Phase 1 Investigation – A Phase 1 Investigation, for the purposes of this document, will typically include the following tests and procedures (which are described in NMFS' Biomonitoring Protocols):

- Demographics of the stranding
- Environmental parameters
- Behavioral assessment of group
- Live animal
    - physical examination
    - blood work
    - diagnostics such as AEP or ultrasound
    - assessment or treatment
- Dead animal
    - External examination and external human interaction evaluation
    - Morphometrics
    - Photographs
    - Diagnostic imaging including CT/MRI scans or ultrasound as appropriate and feasible
    - Necropsy with internal examination, descriptions, photographs and sample collection

Note that several factors will dictate whether all or a subset of these procedures are conducted, including:

- The condition of a carcass
- For live cetaceans - the time it would take necessary personnel and equipment to arrive at the site
- Availability (both in time and space) of resources and feasibility of implementation

Phase 2 Investigation – A Phase 2 Investigation, for the purposes of this document, will typically include the following tests and procedures (which are described in NMFS' Biomonitoring Protocols):

- Analyses and review of diagnostic imaging obtained in Phase I
- Histopathology
- Special stains
- Ancillary diagnostics (e.g., PCR for infections, gas emboli)
- CT of ears
- Additional diagnostic imaging as needed
- Histology of ears
- Case summaries
- Review

Note that several factors will dictate whether all or a subset of these procedures are conducted, including:

- The condition of a carcass
- Logistics for transport
- Available resources
- Validated diagnostic techniques

Qualified – NMFS has a rigorous set of standards and training in place to qualify stranding responders. For the purposes of this document, NMFS will identify (in the Biomonitoring Protocol) the specific qualifications necessary for individuals to be considered qualified for the following activities: 1) identifying a USE; 2) determining if an animal is freshly dead (Code 2); 3) conducting a Phase 1 or Phase 2 Investigation; and, 4) making determinations as to cause of death. These qualifications are currently in development and will be refined and finalized in the Biomonitoring Protocols. Not all qualified individuals (veterinarians, technicians, etc.) will be NMFS employees. However, only specific individuals (NMFS Protected Resources, HQ – senior administrators) indicated in the HRC Stranding Communication Protocol will be empowered to advise the Navy of the need to implement shutdown procedures.

Stranding – an event in the wild in which:

(a) a marine mammal is dead and is –

(i) on the beach o r shore of the United States; or

(ii) in waters under the jurisdiction of the United States (including any navigable waters); or

(b) a marine mammal is alive and is –

(i) on a beach or shore of the United States and unable to return to the water;

(ii) on a beach or shore of the United States and, although able to return to the water, is in apparent need of medical attention; or

(iii) in the waters under the jurisdiction of the United States (including navigable waters), but is unable to return to its natural habitat under its own power or without assistance.

Shutdown Procedures – The act of the Navy ceasing operation of sonar or explosive detonations within a designated area for a designated time. The time is designated by the Restart Procedures (# 3, above). The designated area, for the purposes of this document, is an area within 14 nm of any live, in-water animal involved in the USE. This distance (14 nm) is the distance at which sound from the sonar source is anticipated to attenuate to approximately 140-145 dB (SPL). The risk function predicts that less than 1% of the animals exposed to sonar at this level (mysticete or odontocete) would respond in a manner that NMFS considers Level B Harassment. As indicated above in 2(d), if this distance appears too short (i.e, the proximity of sonar use may likely be deterring the animals from returning to the open water), NMFS and the Navy will further coordinate to determine what measures are necessary to further minimize that likelihood and implement those measures as appropriate.

Uncommon Stranding Event (USE) – A stranding event that takes place during an MTE and involves any one of the following:

- Two or more individuals of any cetacean species (not including mother/calf pairs, unless of species of concern listed in next bullet) found dead or live on shore within a two day period and occurring on same shore lines or facing shorelines of different islands.
- A single individual or mother/calf pair of any of the following marine mammals of concern: beaked whale of any species, kogia sp., risso's dolphin, melon-headed whale, pilot whales, humpback whales, sperm whales, blue whales, fin whales, sei whales, or monk seal.
- A group of 2 or more cetaceans of any species exhibiting indicators of distress.

Supplemental Documents in Development

HRC Stranding Communication Protocol – This document, which is currently in development, will include all of the communication protocols (phone trees, etc.) and associated contact information required for NMFS and the Navy to carry out the actions outlined in this Stranding Response Plan. This document is currently in usable draft form and will be finalized by March 2009 and updated yearly (or more frequently, as appropriate).

Biomonitoring Protocols for the HRC – This document (which is currently in a usable draft form, but will be finalized in 2009) will contain protocols for the procedures that are necessary for NMFS staff to implement this Stranding Plan including:

- Qualifications necessary for individuals to implement certain parts of the Stranding Plan, such as: identifying a USE, identifying a Code 2 animal, or conducting a Phase 1 or 2 Investigation
- A protocol for the stranding responders that outlines the actions to take in the event of a stranding during MTEs
- Protocols for the investigators that describe in detail the procedures implemented for Phase 1 and Phase 2 Investigations

Memorandum of Agreement – This document (or other mechanism consistent with federal fiscal law requirements and all other applicable laws), which will be finalized in 2009, will establish a framework whereby the Navy can assist with stranding investigations when feasible. This

document will include a comprehensive list of the specific ways the Navy could provide this assistance.

LOA Stranding Plans in Other Geographic Regions

The frequency and nature of strandings (naturally occurring or otherwise), the nature of military operations, and the NMFS resources and qualified staff available for stranding response, can be very different in different geographic regions. Measures and procedures developed for and implemented in this Stranding Response Plan may not be appropriate, or even possible, in other geographic regions. As the need arises, NMFS and the Navy will work together to develop appropriate Stranding Response Plans for other geographic regions based on available information and resources. This Stranding Response Plan is not intended to serve as a template for other geographic regions, and, in fact, Stranding Plans for other areas may be significantly different.

APPENDIX G
INSTRUCTIONS, PROTOCOL, GUIDANCE, AND AGREEMENTS FOR THE PROTECTION OF NATURAL RESOURCES

G1 - MEMORANDUM OF UNDERSTANDING AMONG U.S. DEPARTMENT OF DEFENSE, U.S. FISH AND WILDLIFE SERVICE, AND THE INTERNATIONAL ASSOCIATION OF FISH AND WILDLIFE AGENCIES FOR A COOPERATIVE INTEGRATED NATURAL RESOURCES MANAGEMENT PROGRAM ON MILITARY INSTALLATIONS

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MEMORANDUM OF UNDERSTANDING
AMONG
THE U.S. DEPARTMENT OF DEFENSE
AND
THE U.S. FISH AND WILDLIFE SERVICE
AND
THE INTERNATIONAL ASSOCIATION OF FISH AND WILDLIFE AGENCIES
FOR A
COOPERATIVE INTEGRATED NATURAL RESOURCE MANAGEMENT PROGRAM
ON MILITARY INSTALLATIONS

A. PURPOSE

The purpose of this Memorandum of Understanding (MOU) is to establish a cooperative relationship between the U.S. Department of Defense (DoD), the U.S. Department of the Interior, Fish and Wildlife Service (FWS), and the State fish and wildlife agencies as represented by the International Association of Fish and Wildlife Agencies (IAFWA) in preparing, reviewing, and implementing integrated natural resource management plans (INRMPs) on military installations.

B. BACKGROUND

In recognition that military lands have significant natural resources, Congress enacted the Sikes Act in 1960 to address wildlife conservation and public access on military installations. The 1997 amendments to the Sikes Act require the DoD to develop and implement an INRMP for each military installation with significant natural resources. The INRMP must be prepared in cooperation with the FWS and the State fish and wildlife agency (States) and reflect the mutual agreement of the parties concerning conservation, protection, and management of fish and wildlife resources on military lands.

INRMPs provide for the management of natural resources, including fish, wildlife, and plants. They incorporate, to the maximum extent practicable, ecosystem management principles and provide the landscape necessary for the sustainment of military land uses. INRMPs allow for multipurpose uses of resources, including public access necessary and appropriate for those uses, provided such access does not conflict with military land use requirements. Effective partnering among the DoD, the FWS, and the States, initiated early in the planning process at national, regional, and the military installation levels, is essential to the development and implementation of comprehensive INRMPs. When such partnering involves the participation of all parties and synchronization of INRMPs with existing FWS and State natural resource management plans, the mutual agreement of all parties is achieved more easily. Consistent with the use of military installations to ensure the readiness of the Armed Forces, the purpose of INRMPs is to provide for the conservation and rehabilitation of natural resources on military lands. Thus, a clear understanding of land use objectives for military lands should enable DoD, the FWS, and the States to share a common understanding of land management requirements while preparing and reviewing INRMPs.

This MOU addresses the responsibilities of the Parties to facilitate optimum management of natural resources on military installations. It replaces a DoD-FWS MOU on "Ecosystem-based Management of Fish, Wildlife and Plant Resources on Military Lands" which expired May 17, 2004.

C. AUTHORITIES

This MOU is established under the authority of the Sikes Act, as amended, 16 U.S.C. 670a-670f, which requires the Secretary of Defense to carry out a program to provide for the conservation and rehabilitation of natural resources on military installations in cooperation with the FWS and the State fish and wildlife agencies. The DoD's primary mission is national defense. DoD manages approximately 30 million acres of land and waters under the Sikes Act to conserve and protect biological resources while supporting sustained military land use.

The FWS manages approximately 96 million acres of the National Wildlife Refuge System, and administers numerous fish and wildlife conservation and management statutes and authorities, including: the Fish and Wildlife Coordination Act, the Migratory Bird Treaty Act of 1918, the Endangered Species Act, the Marine Mammal Protection Act, the Bald and Golden Eagle Protection Act, the Anadromous Fish Conservation Act, the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, the Federal Noxious Weed Act, the Alien Species Prevention Enforcement Act of 1992, the North American Wetland Conservation Act, and the Coastal Barrier Resources Act.

The States in general possess broad trustee and police powers over fish and wildlife within their borders, including – absent a clear expression of Congress' intent to the contrary – fish and wildlife on Federal lands within their borders. Where Congress has given Federal agencies certain conservation responsibilities, such as for migratory birds or species listed as threatened or endangered under the Endangered Species Act, the States, in most cases, have cooperative management jurisdiction.

The Sikes Act (16 U.S.C. 670c-1) allows the Secretary of a military department to enter into cooperative agreements with States, local governments, nongovernmental organizations, and individuals to provide for the maintenance and improvement of natural resources, or to benefit natural and cultural resources research, on DoD installations.

The Sikes Act (16 U.S.C. 670f(b)) also encourages the Secretary of Defense, to the greatest extent practicable, to enter into agreements to use the services, personnel, equipment, and facilities, with or without reimbursement, of the Secretary of the Interior in carrying out the provisions of this section.

The Economy Act (31 U.S.C. 1535 and 1536) allows a Federal agency to enter into an agreement with another Federal agency for services, when those services can be rendered in a more convenient and cost effective manner by another Federal agency.

The Intergovernmental Cooperation Act of 1968 (P.L. 90-577 (82 Stat. 1098)) allows the "improvement of the administration of grants-in-aid to the States, to permit provision of reimbursable technical services to State and local government.

D. RESPONSIBILITIES

The Parties to this agreement hereby enter into a cooperative program of INRMP development and implementation with mutually agreed-upon fish and wildlife conservation objectives to satisfy the goals of the Sikes Act.

1. **The DoD, the FWS and IAFWA (the Parties) mutually agree, in accordance with all applicable Federal, State and local laws and regulations:**

   a. To meet at least annually to discuss implementation of this MOU. The DoD will coordinate the annual meeting and any other meetings related to this MOU. Proposed amendments to the MOU should be presented in writing to the parties at least 15 days prior to the annual meeting. The terms of this MOU and any proposed amendments may be reviewed at the annual meeting. The meeting may also review mutual Sikes Act accomplishments, research and technology needs, and other emerging issues.

   b. To establish a Sikes Act Tripartite Working Group consisting of representatives from the Parties. This Working Group will meet at least quarterly to discuss and develop projects and documents to assist in the preparation and implementation of INRMPs and to discuss Sikes Act issues of national importance.

   c. The Sikes Act Tripartite Working Group will encourage the establishment of INRMP Development and Implementation Teams to facilitate early communication during preparation, review, revision or implementation of an INRMP and to ensure that such INRMPs are comprehensive and implemented as mutually agreed.

   d. Supplemental Sikes Act MOUs or other agreements may be developed at the regional and/or State level.

   e. To recognize the current DoD and FWS Sikes Act Guidelines on http://www.fws.gov and http://www.denix.osd.mil as the guidance for communication and cooperation of the Parties represented by this MOU.

   f. That none of the Parties to the MOU is relinquishing any authority, responsibility, or duty as required by law, regulation, policy, or directive.

g. To engage in sound management practices for natural resource protection and management pursuant to this MOU with due regard for military readiness, the welfare of the public, native fish and wildlife, threatened and endangered species, and the environment.

h. Consistent with DoD's primary military mission and to the extent reasonably practicable, to promote the sustainable multipurpose use of natural resources on military installations, to include hunting, fishing, trapping, and nonconsumptive uses such as wildlife viewing, boating, and camping.

i. To designate the individuals listed below as the national representative from each signatory to participate in the activities pursuant to this MOU. Representatives may also be designated at the regional and local levels to participate in similar Sikes Act planning or coordination activities.

   i. DoD: Conservation Team Leader, ODUSD (I&E) EM, 1225 Clark Street Suite 1500, Arlington, VA 22202-4336

   ii. FWS: National Sikes Act Coordinator, U.S. Fish and Wildlife Service, 4401 North Fairfax Drive, Room 400, Arlington, VA 22203.

   iii. IAFWA: Executive Vice-President, IAFWA, 444 North Capitol Street, NW, Suite 544, Washington, DC 20001.

2. DoD agrees to:

a. Communicate the establishment of this MOU to all DoD Components.

b. Take the lead in the development of policies related to INRMP development and implementation and seek the cooperation of the FWS and the State fish and wildlife agencies during development, review, and implementation.

c. Ensure distribution of the DoD and revised FWS Sikes Act Guidelines to all appropriate DoD offices at every level of command.

d. Encourage military installations to invite appropriate FWS and State fish and wildlife agency offices to participate in developing and updating the INRMPs. All such invitations should be extended well in advance of the needed date for the product or work in order to facilitate meaningful participation by all three Parties.

e. Encourage military installations to take advantage of FWS and State fish and wildlife agency natural resources expertise through the use of Economy Act transfers and cooperative agreements. Priority should be given to projects that:

   i. Sustain the military mission;

   ii. Consider the strategic planning priorities of the FWS and the State fish and wildlife agency; and

   iii. Effectively apply the principles of ecosystem management.

f. Encourage military installation to identify INRMP project requirements and give priority to those that:

   i. Ensure conservation of natural resources while sustaining military mission activities;

   ii. Achieve compliance with Federal, State, and local laws; and

   iii. Provide adequate staffing for the development and implementation of the INRMP.

g. Discuss with the FWS and the State fish and wildlife agencies all issues of mutual interest related to the protection, conservation, and management of fish and wildlife resources on DoD installations, and obtain the mutual agreement of the FWS and the States regarding all INRMP provisions related to activities within their legal jurisdiction.

h. Subject to mission, safety and security requirements, provide public access to military installations to facilitate the sustainable multipurpose use of its natural resources.

i. Identify DoD natural resource research needs, and develop research proposals with input from FWS and/or the IAFWA.

j. Encourage the Military Services to establish natural resources management liaisons to facilitate:

   i. Coordination and mutual agreement of INRMPs;

   ii. Development and implementation of cooperative regional and local natural resource conservation partnerships and conservation initiatives with FWS and State fish and wildlife agency offices; and

   iii. Natural resources conservation technology transfer and training initiatives between the Military Services, Federal land management agencies, and State fish and wildlife agencies.

3. FWS agrees to:

a. Communicate the establishment of this MOU to each FWS Regional Office and appropriate field stations in close proximity to military installations.

b. Distribute the DoD and revised FWS Sikes Act Guidelines to each FWS Regional Office and appropriate field station in close proximity to military installations.

c. Designate regional and field station FWS liaisons to develop partnerships and assist the DoD in implementing joint management of ecosystem-based natural resource management programs.

d. Identify FWS personnel needs for the development, review, updating, and implementation of INRMPs and expedite the fulfillment of those needs, as appropriate, based on funding and FWS priorities.

e. Provide technical assistance to the DoD in managing Federal trust resources such as endangered species, migratory birds, interjurisdictional fisheries, invasive species, contaminants, wetlands, coastal resources, law enforcement, or other natural resource issues within the scope of FWS responsibilities, funding constraints and expertise.

f. Work with the DoD to coordinate military natural resource research efforts and the creation of a consolidated source of information, with a particular emphasis on research on listed species and species at-risk.

g. Disseminate upcoming proposed listing and critical habitat designations to DoD Headquarters offices and potentially affected installations as part of outreach efforts before the Federal Register publication of such proposed designations.

h. Provide law enforcement support to protect fish, wildlife and plant resources on military installations within the jurisdiction of the FWS.

4. IAFWA agrees to:

a. Communicate the establishment of this MOU to each State fish and wildlife agency director and appropriate field offices.

b. Distribute the DoD and revised FWS Sikes Act Guidelines to each State fish and wildlife agency director and appropriate field offices.

c. Facilitate and coordinate with the States to encourage them to:

i. Participate in the development, review, updating and implementation of INRMPs upon request of military installations.

ii. Designate State liaisons to assist in developing partnerships and to assist the DoD in implementing natural resource conservation and management programs.

iii. Identify State wildlife management areas in close proximity to military installations and, where appropriate, participate in the joint management of ecosystem-based natural resource management projects.

iv. Provide technical assistance to the DoD in managing natural resource issues such as endangered species, migratory birds, interjurisdictional fisheries, invasive species, contaminants, wetlands, coastal resources, law enforcement, outdoor recreation, or other natural resource issues within the scope of State responsibility and expertise.

v. Identify State personnel needs for the development, review and implementation of INRMPs and expedite the fulfillment of these needs as appropriate based on available funding and State priorities.

vi. Coordinate current and proposed State natural resource research efforts with those that may relate to DoD installations.

vii. Coordinate with DoD installations in development of comprehensive state wildlife conservation plans.

E. STATEMENT OF NO FINANCIAL OBLIGATION

This MOU does not impose any financial obligation on the part of any signatory.

F. ESTABLISHMENT OF COOPERATIVE AGREEMENTS

The Parties are encouraged to enter into cooperative agreements to coordinate and implement natural resource management on military installations. If fiscal resources are to be transferred in support of this MOU, the Parties must develop a separately funded cooperative agreement. Such cooperative agreements may be entered into under the authorities of the Sikes Act (16 U.S.C. 670a-670f, as amended) and the Economy Act (31 U.S.C. 1535 and 1536). Each funded cooperative agreement shall include a work plan and a financial plan that identify goals, objectives, and a budget and payment schedule. A cooperative agreement to accomplish a study or research also will include a study design and methodology in the work plan. It is understood and agreed that any monies allocated via these cooperative agreements shall be expended in accordance with its terms and in the manner prescribed by the fiscal regulations and/or administrative policies of the party making the funds available.

G. AMENDMENTS

This MOU may be amended at any time by mutual agreement of the parties in writing.

H. TERMINATION

Any party to this agreement may remove itself from this MOU upon sixty (60) days written notice to the other parties.

I. EFFECTIVE DATE AND DURATION

This MOU will be in effect upon date of final signature and will continue for five years from date of final signature. The parties will meet 6 months prior to the expiration of this MOU to discuss potential modifications and renewal terms.

1/31/06
Date

Alex A. Beehler
Assistant Deputy Under Secretary of Defense
(Environment, Safety and Occupational Health)
U.S. Department of Defense

1/31/06
Date

H. Dale Hall
Director
Fish and Wildlife Service
U.S. Department of Interior

1/31/06
Date

Executive Vice-President
International Association of Fish and Wildlife Agencies

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G2 - PMRF INSTRUCTION 5090.7
BIRD-AIRCRAFT STRIKE HAZARD (BASH) PLAN
MARCH 2008

(DON 2008)

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

IN REPLY REFER TO:

PMRFINST 5090.7A
N3A/RG:dkk
07 MAR 2008

PACIFIC MISSILE RANGE FACILITY (PACMISRANFAC) INSTRUCTION 5090.7A

Subj: BIRD AIRCRAFT STRIKE HAZARD (BASH) PLAN

Ref: (a) OPNAVINST 5090.1C CH-13
(b) NAVFAC P-73, Vol II CH-4
(c) OPNAVINST 3750.6R
(d) FAA Handbook 7110.65
(e) Integrated Natural Resources Management Plan for the Pacific Missile Range Facility, HI, dtd October 2001
(f) PMRFINST 3710.1M

Encl: (1) Pacific Missile Range Facility BASH Plan
(2) Wetland Map
(3) Bird Sighting Information Map

1. Purpose. Per references (a) and (b), enclosure (1) is issued as a program to reduce the potential for collisions between aircraft and birds or other animals.

2. Cancellation. PMRFINST 5090.7

3. Background. No single solution exists to the Bird Aircraft Strike Hazard (BASH) problem. A variety of techniques and organizations must be involved to ensure success of this program. A comprehensive BASH program encompasses all actions which may identify, reduce, or eliminate bird or other animal hazards to aviation, specifically, bird avoidance and bird control (including harassment, grounds maintenance, habitat modification, and depredation).

4. Objectives. BASH does exist at this installation and within the immediate vicinity due to resident and migratory bird species. Daily and seasonal bird movements create various hazardous conditions to aviation. This plan is designed to:

a. Establish a Bird Hazard Working Group (BHWG) to monitor and provide recommendations to the BASH program manager.

b. Establish procedures for identifying and reporting local hazardous bird activity.

c. Identify high hazard situations and establish BASH Conditions.

d. Provide procedures for dissemination of information to all local and transient aircrew on bird hazards and procedures for bird avoidance.

e. Establish aircraft and airfield operating procedures to avoid high hazard situations.

f. Establish guidelines to decrease airfield attractiveness to birds (or other wildlife that may be an aviation hazard).

g. Provide procedures for dispersing/hazing birds when they are present on the airfield.

h. Establish procedures to modify flying operations during hazardous conditions.

i. Establish procedures for collecting bird strike remains and reporting damaging and non-damaging bird strikes.

5. Administration. This plan shall be reviewed and updated annually. Recommended changes should be submitted to the Base Operations Officer.

A. L. CUDNOHUFSKY

Distribution:
List 1, 2, 4, 5, 6

PACIFIC MISSILE RANGE FACILITY BASH PLAN

TABLE OF CONTENTS

CHAPTER 1
GENERAL

1.1 SITUATION

1.1.1 General. Pacific Missile Range Facility (PMRF), Barking Sands, Hawaii has substantial and potentially dangerous bird populations around the airfield facility and the sea test ranges due to shear numbers and sizes of particular species of birds. Daily and seasonal bird movements in the vicinity of the airport and the sea test ranges create various hazards to aircraft. Accordingly, the Bird Aircraft Strike Hazard (BASH) Program is designed to control birds and to provide increased levels of safety during the critical phases of flight. This plan establishes specific procedures to reduce known and future bird hazards. There is no single solution or agency that can solve the bird strike problem. Therefore, a variety of techniques and organizations must be involved in the overall program. This plan is designed to:

a. Establish a Bird Hazard Working Group (BHWG) and designate responsibilities to its members.

b. Establish training for all base members involved in airport operations and aviation activities concerning responsibilities, awareness programs, and actions.

c. Establish procedures to identify high hazard situations and to aid supervisors and aircrews in alerting and or discontinuing flying operations when required.

d. Establish aircraft and airfield operating procedures to avoid high hazard situations.

e. Provide a method for disseminating information to all tenant and transient aircrews on bird hazards and procedures for bird avoidance.

f. Establish passive and active techniques to decrease airfield attractiveness to birds and mammals.

g. Establish local procedures for reporting of damaging/non-damaging wildlife strikes and near-miss events to the Navy Safety Center and provide this information to other installation offices.

h. Establish procedures for collecting and submitting bird strike remains for identification.

1.1.2 Background

1. Wildlife strikes have plagued naval aviation since its early beginnings. The Navy's first loss of life due to a bird strike occurred in 1914, coincidentally the same year it obtained its first

aircraft. From March 1980 to October 2002, Naval Aviators reported more than 20,000 wildlife strikes which have resulted in 345 aircraft mishaps, 247 foreign object damage to engines resulting in over 308 million dollars in damages. During this same time period there were 16 aircraft destroyed resulting in 2 aircrew fatalities. Also during that same period, the USAF had two major BASH related mishaps with two aircraft totally destroyed resulting in 24 fatalities. These incidents have heightened the Navy/Department of Defense's (DOD) interest in BASH prevention programs. The Naval Safety Center's review of recent USN bird-aircraft mishaps found that the lack of a facility BASH Plan/Program was a consistent deficiency.

2. Naval Safety Center data shows that 65 percent of all bird strikes occur within the airfield environment. The Naval Safety Center also estimates that only 1 of 5 bird strike events are reported, suggesting that an even larger hazard exists.

3. A bird-aircraft strike can cause major damage and loss of life. Because of aircraft design, mission, and airport environment, PMRF and transient aircraft are vulnerable to bird strikes. While severe aircraft mishaps by definition are rare events, it is difficult to estimate the absolute risk of a bird strike causing a crash. Instead, in aviation, it is customary to examine leading indicators that are correlated with mishap risk but occur much more often, i.e., bird populations, near-misses, engine damage and reported strikes. Increases in these factors are considered to show deterioration in the margin of safety, even if no mishaps take place. Historically, rises in leading indicators were a prelude to major mishaps. An effective BASH program can reduce the relative risk.

1.1.3 Airfield Installation Description

1. PMRF, Barking Sands has an active military airfield. The primary missions supported are range surveillance, weapon recovery and training with logistic and search and rescue operations in a secondary role. The primary aircraft types assigned to PMRF include three C-26 Metroliners and two S-61 Sikorsky helicopters. Extensive transient aircraft from various Navy and other military commands also utilize the airfield for mission and training related activities.

1.1.4 Local Area

1. PMRF, Barking Sands is the world's largest instrumented, multi-environment military test range. It supports training, tactics development, and evaluations of air, surface, and subsurface weapons systems for the Navy, other DOD agencies, foreign military forces, and private industries.

2. PMRF consists of multiple land and sea operating areas and facilities throughout the State of Hawaii that are either owned or leased by the Navy. The principal operating area for PMRF consists of 1925 acres of Navy owned land and 209 acres of State leased land located on the Mana Plain of Kauai's western coast.

3. The airport facility at PMRF is comprised of a 6,000 ft runway adjacent to the coastline on the western shore of Kauai.

1.1.5 General Topography. PMRF is located on the west, or leeward, side of Kauai on a low-lying coastal terrace. The site is approximately 120 nautical miles northwest of Pearl Harbor, Oahu, and occupies a land area of approximately 2,060 acres, lying just south of Polihale State Park on the Mana Plain. The Mana Plain bounds the western flank of the island, forming gentle westerly slopes near the volcanic upland and relatively flat land at the coastal margin. PMRF has a generally flat topography with a nominal elevation of 15 feet above mean sea level. Low beach barrier dunes, mildly undulating blanket sands, and the more prominent Nohili Dunes located at the northern end of the base form local relief.

1.1.6 Developed Area. The airfield (includes runway and taxiway) and base support facilities account for approximately 23 percent of the total installation area.

1.1.7 Vegetation Cover Types. The Mana Plain is historically associated with extensive wetlands separated from the extensive coastal beach by high sand dunes. The four significant habitats in the immediate area of PMRF are (1) altered and natural wetlands, (2) coastal beach, (3) high dune, and (4) maritime, near shore. Six vegetation types are recognized on the undeveloped portions of the facility.

1.1.8 Landfills. There are no active landfills on the facility; however, the Kekaha Landfill is located on the installation's southern border.

1.1.9 Sewage Ponds. A 1-acre sewage pond is located on the southern end of the station. This pond system is an attractant to many species of waterbirds including stilts, egrets, and herons. Due to its location away from the approach of the runway, it does not appear to be a problem.

1.1.10 Habitats. According to the birds survey lists for PMRF, a total of 91 different bird species occur within the four major habitat types found on the facility. Standing water, perch sites, tall brush and short grass are all present on station and attract large numbers of individual and flocking birds. The combination of all these environments and attractors increase the potential for a serious bird strike incident.

1.2 SPECIES. Chapter 5 contains a general listing of birds/mammals which may be observed in the airfield area. There may be occasional sightings of other species during migration, but this list is considered thorough for BASH purposes.

1.3 GLOSSARY OF TERMS

1.3.1 Wildlife Services (WS). An office of the U.S. Department of Agriculture, Animal and Plant Health Inspection Service which may be under contract at installations to provide BASH assistance.

1.3.2 Active Bird Dispersal. Harassment techniques employed to disperse birds from airfield and surrounding areas.

1.3.3 BASH. Bird Aircraft Strike Hazard. General term to describe bird and wildlife hazards and bird hazard programs.

1.3.4 BHWG. Bird Hazard Working Group. Local committee of base and unit offices concerned with bird hazards. Executes and makes recommendations to the BASH Program.

1.3.5 BASH condition. Bird/Animal Strike Hazard (BASH) Condition. A bird or animal activity alert condition used to warn aircrew.

1.3.6 BASH condition Red. A severe BASH condition indicating heavy concentrations of birds on or immediately adjacent to the runway, which presents an immediate hazard to flight operations; or any concentration of birds in and around the flight path that presents a danger to aircraft

1.3.7 BASH condition Yellow. A condition which indicates that moderate concentrations of birds are in a location that represent a probable hazard to flight operations.

1.3.8 BASH condition Green. A condition which indicates sparse bird activity on the airfield and a low probability of hazard.

1.3.9 BASH Window. Known periods of severe bird activity where restrictions to flight operations may be automatically imposed.

1.3.10 BASH Advisory. A radio transmission from ATC or aircrew reporting specific bird hazard information. May be real time or disseminated in ATIS broadcasts.

1.3.11 Depredation. Technique used to remove problem wildlife permanently from the airfield and hangars when other scare tactics are ineffective. Permits for some species are required.
1.3.12 Bird Strike. Any contact between a bird or other animal and an aircraft, whether or not damage occurred.

1.3.13 Bird Exclusion Zone. The designated area surrounding the airfield where wildlife habitation is discouraged.

CHAPTER 2
ORGANIZATIONAL TASKS and RESPONSIBILITIES

2.1 BIRD HAZARD WORKING GROUP (BHWG)

2.1.1 General. The Bird Hazard Working Group is organized to implement and monitor the BASH Plan. The BHWG allows facilities personnel involved with wildlife issues, the opportunity to meet on a regular basis to discuss those issues and possible solutions. The BHWG shall meet regularly as scheduled by the Aviation Safety Officer with representatives from each organization listed below in Section 2.1.2.

2.1.2 Composition. As a minimum, the BHWG shall have a representative assigned from the following departments:

a. Aviation Safety Officer (ASO) (Chairman)

b. Air Operations Officer (AOO) (Co-chairman)

c. Public Works Environmental Officer (PWEO)

d. Air Traffic Control Department

e. Public Works Department

f. Airfield Manager

g. Security Department

2.1.3 Authority. The Commanding Officer (CO) is responsible for the BASH Program and is the approval authority for all BHWG recommendations. The BASH Program is a part of the Aviation Safety Program, and as such, the ASO shall serve as the Chairman and monitor the effectiveness of the program. BHWG Co-chairperson shall be appointed, normally the AOO since the majority of BASH actions are coordinated through this department.

2.1.4 BHWG Meeting Schedule. The BHWG should meet semi-annually. Additionally, the BHWG may meet as often as necessary to stay current on bird/wildlife hazards and to discuss solutions, results, and effectiveness of the program. An important concept is that the BHWG address problems as they develop, before they create a serious safety hazard.

2.1.5. BHWG Function

1. Execute and update the facility BASH Plan.

2. Collect, compile, and review data on all bird strikes.

3. Identify and recommend actions to reduce bird or animal hazards.

4. Recommend changes in operational procedures.

5. Prepare informational programs and safety briefings for aircrews.

2.2 AVIATION SAFETY OFFICER (ASO) (Chairman)

1. Serve and Chairman of the BHWG and designate the AOO as co-chair.

2. Serves as the single point of contact for reporting bird strikes to the Naval Safety Center through the Web Enabled Safety System (WESS) to track all bird strikes occurring at PMRF and associated ranges.

3. Serve as the liaison with all aviation activities at PMRF concerning BASH issues.

4. Develop passive, active, and static procedures to reduce the BASH hazard.

5. Monitor grass height, drainage ditches, etc., and report problems to Public Works Department.

6. Ensure that visiting squadrons are briefed on bird strike reporting procedures.

7. Develop a continuing information and education program to disseminate bird hazard information and reporting procedures.

8. Copy all bird strike reports submitted to the Naval Safety Center to Public Works Environmental.

9. In conjunction with the PMRF AOO, conduct periodic exercises and review of the BASH program.

10. Provide animal remains to Public Works Environmental and the USDA Wildlife Services for identification.

11. Establish a BASH awareness-training program for all personnel that work on or near the airfield.

12. Ensure that the PMRF BASH program is a part of safety reviews conducted by the Naval Safety Center.

2.3 AIR OPERATIONS OFFICER (AOO) (Co-chairman)

1. Publish operating instructions as appropriate to support the facilities BASH Plan.

2. Provide BASH program briefings prior to training evolutions for PMRF aircrews, visiting squadrons, and range operations groups.

3. Ensure a bird hazard awareness program is briefed prior to training events and that briefings include reporting requirements, videos, posters, and information on seasonal bird hazards.

4. Ensure aircrew briefings are conducted on BHC's and attendance documented. This briefing is mandatory for all aircrew and shall cover in-flight avoidance procedures and go/no-go criteria.

5. During nesting periods make BASH a special interest item.

6. Issue specific guidance to PMRF and visiting personnel on reporting observed hazardous bird activity to the Tower or Air Operations Officer.

7. Issue specific guidance to all personnel for reporting of all discovered bird remains on aircraft and birds found on or near the runways to the ASO.

8. Issue procedures for the preservation of bird remains if discovered on an aircraft and runway environment. Even the smallest fragment of a feather should be preserved for identification.

2.4 PUBLIC WORKS ENVIRONMENTAL OFFICER (PWEO)

1. Recommend changes to environmental conditions and management practices to reduce bird strike potential. These changes will be presented to the BHWG for consideration.

2. Initiate necessary environmental documentation for airfield modifications as required by law.

3. Conduct periodic avian/airfield surveys.

4. Provide Natural Resources/USDA-Wildlife Services support as outlined below:

a. Obtain and maintain Federal and State permits required for depredation, salvage, collection, and possession of all protected avian species.

b. Alert airfield management of migration/nesting seasons and unusual bird activity.

c. Coordinate wildlife studies as necessary to improve wildlife hazard control, assess the potential impacts of control activities on wildlife populations and distribution, and evaluate the potential effects of wildlife displacement.

2.5 AIR TRAFFIC CONTROL TOWER

1. At the discretion of the Tower Supervisor, declare BASH condition's based on reported sightings or BASH condition criteria in Paragraphs 3.2. and 3.3.

2. Pass BASH condition information to Air Operations.

3. Advise the Air Operations Office anytime BASH condition RED (Severe) condition is declared.

4. Allow priority movement on the airfield to disperse birds on or near active runways.

5. Include BASH condition and bird advisory information when communicating with aircrews. Update frequently.

6. Issue bird advisory information to aircraft over air traffic control frequencies per FAA Orders 7110.65 and 7210.3.

7. Establish a training program covering this instruction for all ATC personnel. This training will be documented in training jackets and reviewed annually.

2.6 PUBLIC WORKS DEPARTMENT

1. Provide representation to BHWG.

2. Based upon the direction of the BHWG, maintain runway lateral and approach zones in a manner that is least attractive to birds.

3. Ensure training is conducted for all PW/BOS Contract personnel (sweepers, etc) covering responsibilities, actions, and techniques applied under this instruction.

4. Ensure all trash receptacles have covers that prevent bird access and are emptied on a timely basis to prevent overflowing. Trash is a bird attractor.

5. Incorporate practices described in Chapter 3 into the base land management plan.

2.7 AIRFIELD MANAGER

1. Attend BHWG meetings as scheduled by ASO.

2. Coordinate with PWEO and Public Works to keep vicinity adjacent to the runway clear of habitat attractive to wildlife.

2.8 SECURITY DEPARTMENT

1. Provide representation to BHWG.

2. Ensure that all patrol units report bird activity near the runways to the tower.

CHAPTER 3
CONCEPT OF OPERATIONS

3.1 GENERAL. The BASH program is an ongoing process, which includes both information dissemination and active/passive bird control techniques. Of these processes, the most critical is the aircrew notification and warning system of wildlife conditions on the airfield. This system establishes procedures for the immediate exchange of information between ground agencies and aircrews concerning the existence and location of birds that pose a hazard to flight safety. Additionally, a precautionary advisory is published in the DOD Flight Information Publication AP/1 under Supplementary Airdrome Remarks.

3.2 BIRD HAZARD WARNING SYSTEM. The following standardized BASH conditions will be used at PMRF to warn aircrew and support personnel of the current bird threat to operations. These codes are identical to the USAF codes in section B of the DOD FLIP Flight Information Handbook. Bird locations should be given with the condition code.

3.2.1 BASH condition Red (Severe)

1. Generally defined as heavy concentrations of birds (**more than 15 large or 30 small**) on or immediately adjacent to the active runway or other specific locations that present an immediate hazard to flight operations. Tower/Base Operations will direct USDA active dispersal during this condition and apply applicable Go/No-Go restrictions based on safety-to-flight considerations.

WARNING
Landing or departing in condition RED may result in aircraft damage from a bird strike.

Note
RED may also be declared when birds of any size or quantity present an immediate hazard.

3.2.2 BASH condition Yellow (Moderate). Generally defined as moderate (**concentrations of 15-30 small or 5-15 large**) birds observable in locations that represent a probable hazard to flying operations. Positive actions should be taken to disperse the concentrations of birds that are causing the hazard.

3.2.3 BASH condition Green (Low). Sparse bird activity on and above the airfield (**less than described in Yellow**) with a low probability of hazard.

Note
Personnel making BHC reports may not necessarily follow the numerical numbers in Table 1. This is a guide only. If, in the judgment of the observer, the number of birds is less than

those indicated for a specific BHC, but a hazard is believed to exist, a higher BHC may be declared. Example: Condition Red may be declared if one albatross is on or immediately adjacent to the active runway.

PMRF BIRD HAZARD CONDITIONS

TABLE 1.

BASH condition	MODIFIER	BIRD ACTIVITY
RED	SEVERE	15+ large birds, or 30+ small birds.
YELLOW	MODERATE	5-15 large, or 15-30 Small birds
GREEN	LOW	Sparse bird activity

Note

The Tower may determine if bird activity away from the primary runway constitutes a threat to flying operations. If it does not, the Tower may lower the BASH condition for the primary runway while keeping the higher BASH condition for the other area.

Note

BASH condition descriptions will be reported using the colors (Red) vice modifiers (Severe). Until DOD standardizes this system, either of these terms may be encountered at other military airfields. While each base may have a slightly different definition for its hazard conditions, an associated level of danger can reasonably be ascertained from either reporting standard. Requests for clarification from ATC or airport management are recommended when confusion or doubt exists.

3.2.4 Bird Watch Alert. A general warning that indicates when weather, time of day, and seasonal conditions make an influx of birds onto the airfield likely. Upon receipt of special conditions, airfield management will set the alert and the Tower will include a general statement to aircrews.

3.2.5 BASH Window. BASH windows are based on historical bird survey data that show specific times when a hazard is known to exist, i.e., dawn seagull movements, etc. When BASH windows are set, aircraft operations during these time frames are not recommended. The Air Operations Officer will post BASH windows in the aircrew brief room. Aircrew schedulers should avoid scheduling operations during BASH windows. Guidance for aircraft operations are contained in Chapter 4.

3.3 BIRD HAZARD CONDITION REPORTS

3.3.1 Bird Hazard Reporting. The PMRF Air Operations Officer (AOO) or designated representative ensures hazardous conditions are reported. Declaration of a BASH condition will be based on the following:

a. Visual observation of bird activity on or near the airfield by any airfield personnel, Tower, or USDA personnel.

b. Information relayed by airborne and taxiing aircraft.

c. Observations relayed to the Tower by any of the following personnel: airfield facilities, weather observers, ground electronics maintenance, airfield lighting technicians, crash crews, arresting gear maintenance, sweepers, mowers, security police, transient line personnel, and any other personnel driving on the airfield.

d. All reports will be made to the PMRF ASO or Base OPS personnel immediately via phone or in person.

3.3.2 BHC Declarations by Maintenance Personnel, Sweepers, Grass Mowers, and Others

1. If a bird hazard exists, other personnel may notify the Tower as applicable. This notification can be made on a radio net or by telephone. Telephone reports can also be passed to the Base Operations at extension 4310/4311. Reports should include:

a. Identity of caller:

(1) Location.

(2) Altitude.

(3) Time of sighting.

(4) Approximate number of birds.

(5) Type of birds (if known).

(6) Behavior of birds (soaring, flying to or from a location, etc.)

3.3.3 Aircrew Reports. Aircrews should report significant activity as follows:

a. Notify Tower

b. On a range area, notify ATC and PMRF Schedules after landing of any large flocks of birds noticed during flight. Make sure to include direction of flight and behavior of the birds and whether or not they are a threat to aviation safety.

3.4 DOWNGRADING BASH conditions. Once a condition has been declared, it shall be downgraded as the bird hazard dissipates. The Control Tower will make the final BASH condition determination.

3.5 BIRD HAZARD NOTIFICATION.
Disseminating BASH Conditions is critical to BASH effectiveness. The Tower will disseminate the conditions by the following means:

1. Include BASH conditions when communicating to aircrews.

2. Alert inbound/departing aircraft of change in BASH condition if aircraft has received previous report and there is a difference.

3. Provide additional bird advisories per reference (d).

4. Pass BASH conditions to Base Operations.

3.6 CRASH CREW PROCEDURES. If firefighting crews detect the presence of birds on the airfield they will pass the information to the Tower. Crash vehicles may be used to disperse birds as required.

3.7 PUBLIC WORKS LAND MANAGEMENT PROCEDURES. One of the most effective and permanent methods of discouraging birds from using the airfield is the removal of attractive habitat features. Passive control methods include:

3.7.1 Managing Grass Height. Mow to maintain a uniform grass height to best deter bird activity on the airfield. Grass/vegetation length shall be maintained between 4-10 inches in height by mowing every other month, or as needed to accomplish this task. This length will provide best protection against nesting and foraging of the various species that inhabit the Barking Sands area.

3.7.2 Planting Bare Areas. Eliminate bare areas on the airfield. Plant grass as necessary and appropriate to maintain ground cover.

3.7.3 Fertilizing. Selectively stimulate grass growth to promote a uniform cover.

3.7.4 Removing Edge Effect. Maintain the airfield as uniformly as possible to reduce the transition zone between two distinct habitat types (e.g., runway to brush / grassland).

3.7.5 Leveling of Airfield. Level or fill high or low spots to reduce attractiveness to birds and prevent standing water.

3.7.6 Removing Dead Vegetation. As soon as possible, remove dead vegetation such as brush piles, grass clippings, etc., and the cover it affords.

3.7.7 Maintaining Drainage Ditches. Regularly inspect ditches to keep them clear. Maintain ditch sides as steeply as possible (minimum slope ratio of 5 to 1) to discourage wading birds and emergent vegetation. Improve drainage as necessary to inhibit even temporary ponds or puddles.

3.7.8 Employing Erosion Control Vegetation. Use vegetation that is appropriate for the region and does not produce seeds at heights below 14 to 18 inches.

3.7.9 Eliminate Roosting Sites. Control roosts by vegetation management of roost sites where possible. Remove or prune trees to reduce the number of perches if necessary

3.7.10 Controlling Waste Disposal. Landfills are the most significant attractant to hazardous bird species. FAA Order 5200.5 should be consulted for disposal site operation.

3.7.11 Bird Proof Buildings and Hangars. Often, bird proofing of buildings and hangars is required to exclude pigeons and common mynas. Excluding birds from a structure they currently utilize will often displace them to an adjacent structure. Existing birds should be destroyed (in accordance with the facilities depredation permit if required for the species) prior to the exclusion effort whenever possible. Denying access by screening windows, closing doors, and blocking entry holes is most effective. When necessary consider:

a. Toxic perches. Install where maximum numbers of birds will contact them. Ensure perches are maintained with avicides to remain effective.

b. Netting. Install under superstructure to exclude birds from roosting areas.

c. Avitrol. Pest Management should place in or near hangar to remove birds or create a distressed response that scares other birds.

d. Trapping and Removal. Use a large cage with food and water to trap birds. Release birds away from buildings or depredate if permitted by law. Permits will be coordinated through Environmental Office.

e. Door coverings. Use netting or plastic strips suspended over the doors to exclude birds. Ensure no tears or holes are present that allow birds access to the hangar.

f. Sharp Projections. Use in limited areas such as ledges and overhangs, or small places where birds cannot be allowed.

3.8 UNITED STATES DEPARTMENT OF AGRICULTURE SUPERVISOR ROLE

3.8.1 Bird and animal hazard prevention. Specie population should be controlled by the appropriate means to provide a safe operating environment for aircraft. Attend the BHWG as scheduled by the ASO to advise the group on current population issues and recommendations. Implement an active dispersal program for bird activity during BASH condition Red. Routinely patrol areas of the base and manage the bird and animal populations.

3.8.2 Removing bird and animal carcasses from the airfield. This is to avoid attracting scavengers that feed on them. Forward remains, which may have been caused by collision with aircraft, to the Environmental Office for identification and inform the ASO of conditions and apparent cause of death.

3.8.3 Pest Control. Invertebrates and rodents are key food sources for many birds. Periodically survey and reduce these pests when required. Pesticides and traps can reduce pest populations. Only EPA approved pesticides are authorized, and they must be used strictly according to label instructions. Inspection and control should begin early in the spring after coordination is made with the animal control section of reference (e).

3.9 MANAGEMENT OF OFF-BASE LAND USE. The Navy cannot control off-base land use, however, when a proposed land use may increase or alter bird populations and habits (i.e., landfills, new crops, etc.), the Navy's concerns should be addressed at public hearings, zoning meetings, and in writing. The Environmental Office, AICUZ and Public Works shall monitor off-base land use and report findings to the BHWG.

3.10 AGRICULTURAL OUTLEASES. Public Works and the Environmental Office shall consider BASH requirements if considering agricultural out-lease contracts.

CHAPTER 4
AIRCREW PROCEDURES

4.1 PLANNING THE FLIGHT

1. Check FLIP AP/1 (Supplementary Aerodrome Remarks) and NOTAMS for information about permanent and seasonal bird problems at both departure and destination airports and on route of flight.

2. Check local NOTAMS and flight planning displays for BASH Conditions and BASH Windows in effect.

3. Consult with the base ASO for additional BASH information.

4. Brief all crewmembers on potential bird problems and a strong lookout doctrine.

5. Discuss emergency procedures before departure, including aborts following a strike and engine failures.

6. Discuss procedures for cockpit lost communications, including change of aircraft control.

7. Consider using combination sunglasses and visor during daylight hours and the clear visor at night during all low-level phases of flight.

4.2 AT THE AERODROME

1. Prior to taxi, listen to tower for current BASH conditions. Ask tower for specific bird locations or additional information as needed.

2. When taxiing, watch for birds on the airport. The most frequently struck birds (pheasants) have a brown or green coloring on their back making them hard to see on the tarmac or adjacent grasses. Flocking birds may be partially hidden in grass areas. Look for seabirds circling overhead. Report bird sightings to the Tower.

3. Birds on the ground face into the wind and may not see or hear you coming. They may take flight just prior to you reaching them.

4. If birds are observed, notify the Tower and request that USDA BASH personnel disperse them before takeoff, if they are in a location that presents a likely danger to any aircraft.

5. Increase interval on section departures to 20 seconds during condition Yellow. The lead aircraft in flight can cause birds to lift and circle behind causing a strike to the wingman.

6. Use landing lights during takeoff, climb, descent, approach and landing. Although there is no conclusive evidence that birds see and avoid aircraft lights, they will make the aircraft more visible.

7. Travel as much as possible above the bird layer. More than 50% of all strikes occur below 100'AGL and 88% of all strikes occur below 2000'AGL. In practice, this means to climb to 100' AGL as rapidly and safely as possible and continue to climb without delay to 2000'.

8. If you see birds ahead, attempt to pass above them, as birds usually dive downward when threatened.

9. If dense bird concentrations are expected, avoid high-speed descent and approach. Reducing speed can significantly reduce impact energy. The force of impact is roughly proportional to the square of the aircraft's speed.

10. If flocks are encountered during approach, go around for a second attempt, the approach area may then be clear. If not, request a BASH active dispersal from tower.

11. When able, descend and climb-out in a straight line. This makes it easier for the birds to anticipate your flight path and thus get out of your way.

12. Avoid flying one hour before and after dawn and dusk **to the maximum extent practical**.

4.3 RANGE OPERATIONS AND LOW LEVEL ROUTES. Guidance for aircrew actions on ranges/routes with severe bird activity should avoid those segments that are under Bird Hazard Condition RED (Severe) based on migration patterns and aircrew reports. The following are some general operational changes to reduce threats from bird strikes, mission permitting:

a. When practical, reduce low-level flight time.

b. Reduce formation flying. The first aircraft can redirect birds into trailing aircraft.

c. Reduced airspeeds will allow birds to be seen sooner and lessen damage in event of a strike.

d. Avoid areas with known seabird concentrations during migration and nesting seasons.

4.4 ACTIONS FOLLOWING A BIRD STRIKE

1. If airborne, complete the damaged aircraft checklist IAW specific NATOPS procedures.

2. During a takeoff or planned touch and go, the aircraft commander should assess the option of aborting if a bird strike occurs, and if enough runway remains to stop. Bird strike damage cannot be accurately assessed in flight and may result in a complex airborne emergency. Only maintenance personnel on the ground can make damage assessments. Several bird strikes that appeared to cause minor damage have proven to be much more substantial and, had aircrews continued the mission, a serious emergency could have resulted. Structural damage, such as a dent in the wing, has led to fuel and hydraulic system failures. Birds lodged in landing gear have prevented proper gear operation.

3. Aircrew experiencing en route bird strikes should abort the mission when possible.

4. After landing, if you suspect or have had a strike, check the aircraft for damage and any bird remains.

4.5 BIRD STRIKE REPORTING

1. Post flight follow-up and reporting of bird strikes are an essential and important part of the BASH program. After a strike:

a. If airborne, inform control tower and complete emergency landing, if required.

b. After post-flight inspection, preserve any remains (however slight) and notify the ASO immediately. Turn in ALL remains, no matter how small, to the ASO or the USDA Supervisor for remains identification.

c. Report strikes even if no bird remains are found on the aircraft. Airfield facilities personnel may be able to retrieve the bird on the airfield. Remember birds left on the runways are FOD for follow-on aircraft.

d. Both damaging and non-damaging strikes are <u>required</u> to be reported. The Web Enabled Safety System (WESS) from the Naval Safety Center tracks bird hazards around the globe for the Navy. The ASO will submit bird strike reports into WESS when received from aircrews.

2. The Naval Safety Center also encourages aircrews to report near misses that involve evasive action or whenever the proximity of the miss is too close for comfort.

4.6 BIRD IDENTIFICATION

1. All bird strike data is required to be entered into WESS to help track and identify bird hazards. Therefore, it is necessary to know which species are causing bird strike problems so appropriate measures can be taken. Identification of bird remains is essential. If bird remains are found on the aircraft, the following preservation procedures shall be followed:

a. Remove all feathery remains from aircraft, and place in zip lock plastic bag. It does not take much (remains) to identify the bird species. Even if just a small part, feather or bloody smear, the species can be identified through microscopic techniques.

b. Turn in all remains to the Aviation Safety Officer or the USDA Supervisor for identification.

4.7 OPERATIONAL LIMITS AND GO/NO-GO CRITERIA

1. BASH condition RED

a. Bird/wildlife active dispersal efforts will be initiated immediately after BASH condition Red is set. Normally, the hazard can be removed within 5 minutes. However, if initial dispersal efforts have failed, the Control Tower will update delay information in 10-minute intervals to allow aircrew ample time to calculate fuel/divert/mission planning.

b. Guidance for aircrew actions during BASH condition RED:

(1) Fuel and weather permitting, inbound aircraft will hold until USDA action or natural movements have lowered the hazard condition, otherwise proceed to alternate.

(2) Departing aircraft will hold on deck until USDA action or natural movements have lowered the hazard condition.

WARNING

Landing or departing in condition RED may result in aircraft damage from a bird strike.

Note

If the bird/animal hazard is fouling the runway, the control tower will close the runway IAW FAA directives. Tower clearance will not be issued. Accordingly, all operations will be at the discretion and risk of the pilot in command.

2. BASH condition YELLOW. Guidance for aircrew actions during BASH condition YELLOW:

a. Delay or terminate practice approaches.

b. Modify altitude above the hazard (restricted low approach to 500' AGL, etc.)

c. Initial takeoffs and full stop landings are at the aircraft commander's discretion.

d. Increase interval on section departures to 20 seconds minimum.

e. Increase spacing to a minimum 1 nautical mile between landing aircraft.

CHAPTER 5
LOCAL WILDLIFE SPECIES

5.1 GENERAL. The following is a summary of birds within the airfield environment. Associated with each is a brief description of how they can be controlled or avoided. Each control measure will require action by one or more tasked organizations as described in Chapter 2. It is very important to know which avian species or airfield attractants are present before control techniques can be effectively applied.

5.2 PMRF WILDLIFE HAZARDS

5.2.1 Laysan Albatross (LAAL). These birds represent the most significant hazard to aircraft at airports worldwide. Due to their omnivorous feeding habits and preference for flat, open areas to rest, they are commonly found on this airfield. LAAL are most active just after sunrise and before sunset as they move to and from feeding areas. These birds may inhabit the airfield, particularly during inclement weather. Continued capture and relocation efforts by the USDA/WS are necessary to discourage these birds. The LAAL arrive at PMRF around November each year and leave in late spring.

5.2.2 Waterfowl (ducks & geese). A distinction must be made between resident and migrating populations. Resident waterfowl are attracted to an area to breed or feed. Ponds, lake, drainage ditches, etc., may attract these birds, particularly if these areas contain emergent or submerged vegetation for feeding, nesting, or shelter. Resident birds are most active at dawn and dusk, moving at low altitudes to and from feeding areas. Avoid flying near wildlife refuges, or any pond with known waterfowl concentrations during these times. Migrating waterfowl are particularly dangerous to flight safety due to the large numbers and generally higher altitude of the birds. Migrating birds are most active from sunset through midnight, with numbers decreasing in the early morning hours. September through February is the most hazardous. Avoidance of flying during the evening hours is generally safest. Wintering concentration areas should be avoided.

5.2.3 Long-legged Waders (Herons and stilts). Most of these species are attracted to water where they feed on fish, amphibians, insects, and arthropods. Control is best accomplished by eliminating the food sources.

5.2.4 Francolin and Pheasants. These game birds are most effectively controlled through proper grass-height management. Do not allow grass to exceed 10 inches and eliminate all weeds and brush patches on the field, particularly if the plants are seed producing. The destroying of these birds outside the normal hunting season requires special permits from the U.S. Fish and Wildlife Service and the state wildlife agency.

5.2.5 Shorebirds (Sandpipers, plovers, etc.). The most significant hazard from these birds occurs when large numbers flock in tight groups, particularly during migration and along coastlines. Many of these species such as Sanderlings may rest on airfields in the fall and winter. To control these birds, proper grass height management must be observed.

5.2.6 Owls. Most owls are nocturnal and attracted to rodents as a food source. Rodent control may be necessary on the airfield. Limit the number of perch sites by removing perch sites such as unnecessary fence posts and dead trees. Avoid flying over landfills at night to reduce hazards from owls.

5.2.7 Sky Larks. These birds are very difficult to control. They are attracted by bare spots such as along runway sides, where they eat weed seeds and insects. The best defense against these birds is a thick, uniform grass with no bare spots. Consider coating bare spots, particularly along runways, with oil-base or asphalt cover. Persistence is the key to success.

5.2.8 Cattle Egrets. These omnivorous birds are common in open areas and around landfills and solid waste transfer stations. These birds may occur in large flocks particularly at sunset as they return to roost sites. Proper grass height management will reduce population numbers. Remove any known roost sites or thin individual roost trees. Landfills and transfer stations must be operated in a manner to discourage these birds.

5.2.9 Mynas. These birds can be particularly hazardous because they frequently occur in large huge flocks. Mynas are attracted to flat, open areas to feed, rest, or stage/pre-roost. Maintenance of grass height between 5 and 10 inches is the best method of reducing airfield myna numbers. Poisoning or trapping may also be considered with U.S. Fish and Wildlife Service and USDA Wildlife Service assistance. If these birds occur in hangars, toxic bird perches are recommended to eliminate the problem.

5.2.10 Meadowlarks. These birds occur on nearly every airfield and are attracted to grasslands and low weeds. Eliminate broad-leafed weeds and maintain grass height at 4-10 inches. Elimination of suitable perching sites, such as fence posts and brush, will also aid in reduction.

5.3 MAMMALIAN SPECIES. While concern is mostly centered on birds, several mammalian species also pose threats to flight operations and must be considered. Close coordination with the station's Integrated Natural Resources Management Plan is necessary to reduce this type of hazard.

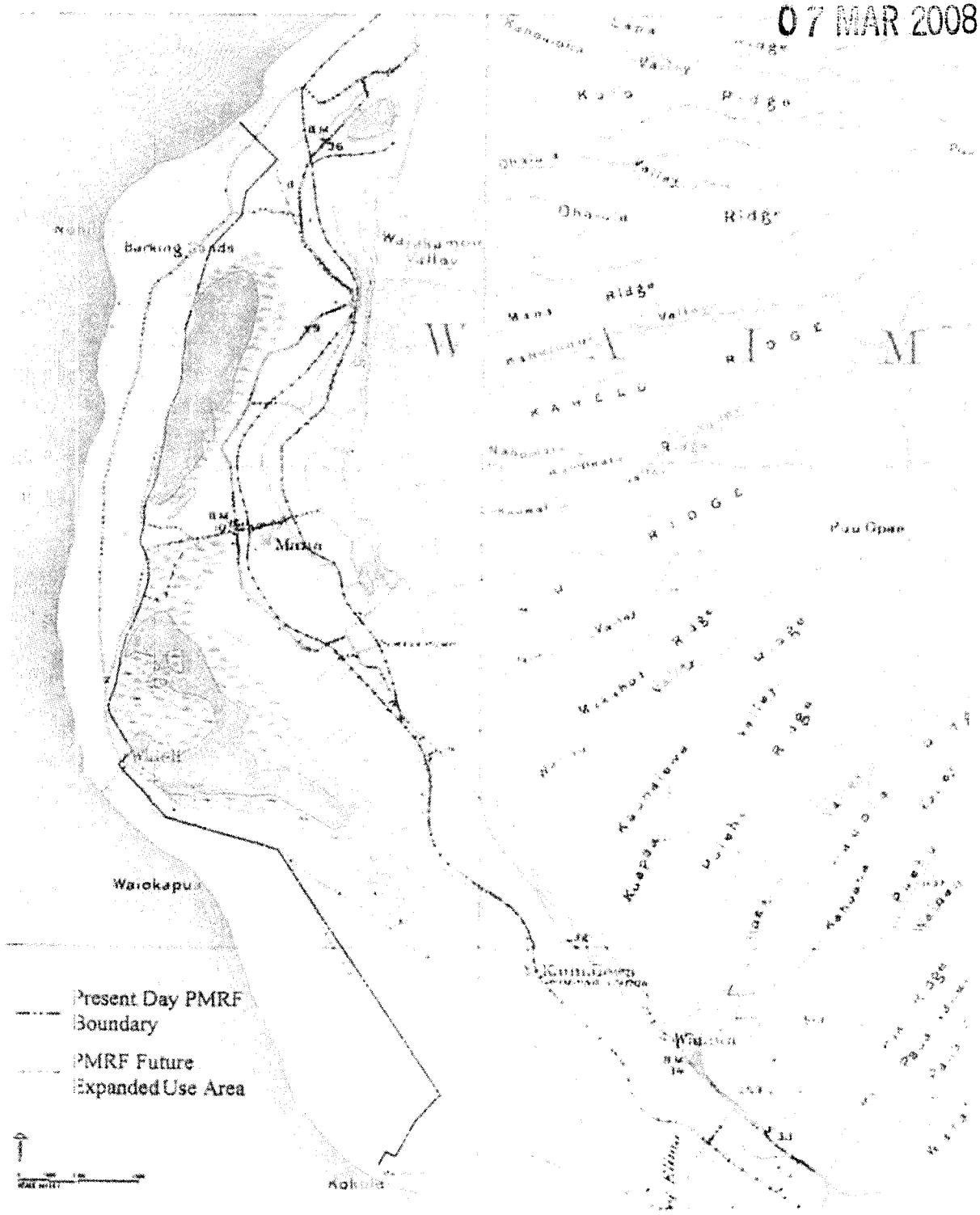
5.3.1 Rodents. These animals attract owls, herons, and egrets. Control by maintaining a uniform turf at the proper heights. Rodenticides may be used in some cases.

5.3.2 Deer. Several sets of deer tracks have been observed in the northern portion of the facility by USDA personnel. This mammalian species poses the greatest threat to aircraft due to its size

and preferred nocturnal activities. Control techniques include installing or modifying perimeter fences to become deer proof and selected shooting of problem individuals.

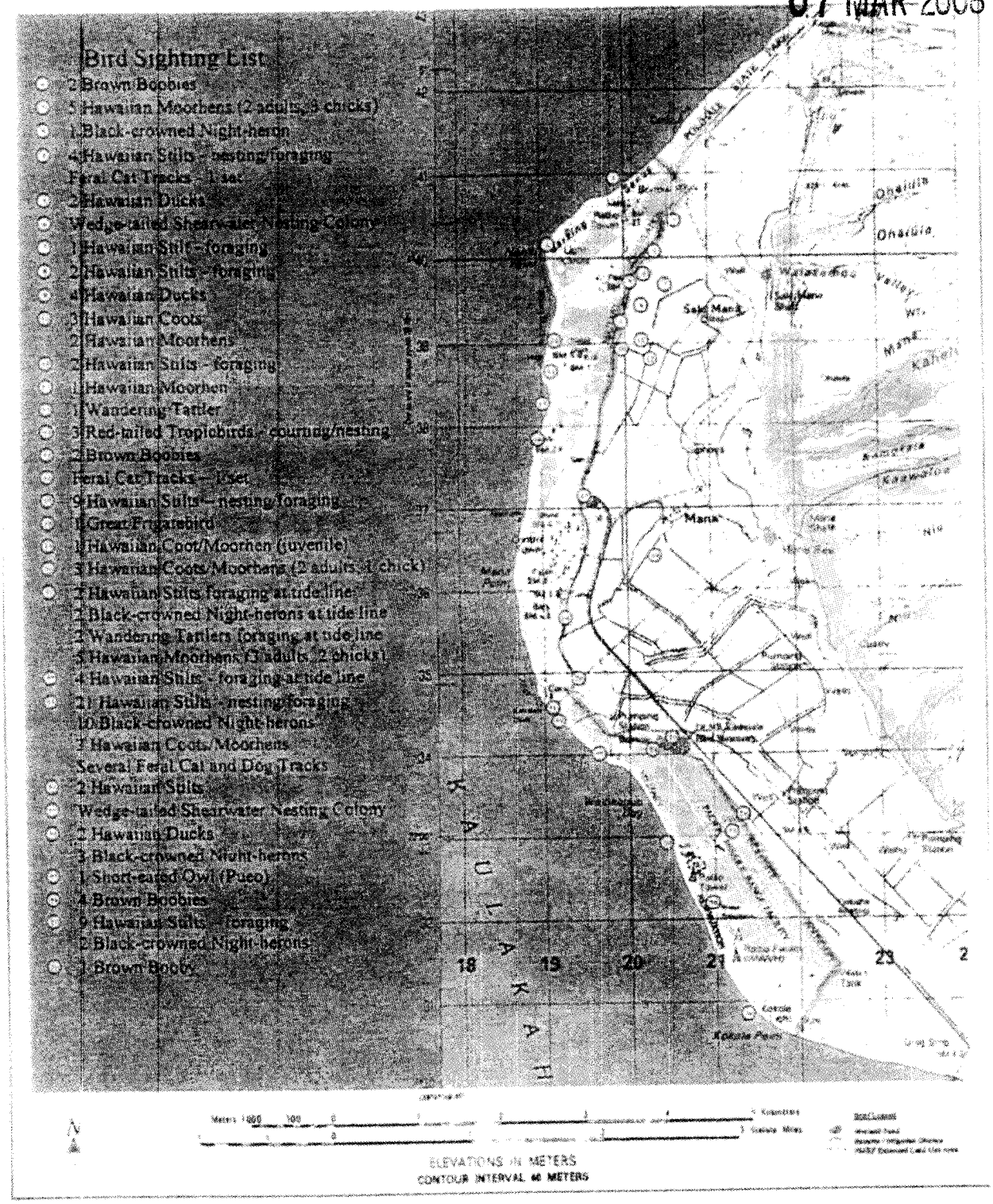
5.3.3 Feral Pigs. According to USDA personnel several individual pigs have been observed in the dense brush areas of the northern portion of the facility. All pigs should be removed as they pose a high risk to aviation safety. Pigs should be removed through an established shooting program.

5.3.4 Bats. All bat strikes should be treated as a wildlife strike event and reported to the Aviation Safety Officer. Since the only bat species known to occur at the Facility is the endangered Hawaiian Hoary Bat, all bat strikes should be reported and the U.S. Fish and Wildlife Service notified.



Appendix C-1: 1912 USGS Topographical Map of Historic Wetland Area Surrounding Present-Day PMRF Location, Mana Plain, Kauai

Enclosure (2)



Wetland Map and Bird Sighting Information from June 22 – June 26, 2000,
Pacific Missile Range Facility, Kauai

Enclosure (3)

G3 - KA‘ULA ISLAND DRAFT SEABIRD MONITORING PLAN

DRAFT

KAULA ISLAND DRAFT SEABIRD MONITORING PLAN

July 2008

Developed by NAVFAC Pacific and CPF
[11015.4A11]

PART I

INTRODUCTION

In the Pacific Missile Range Facility Enhanced Capability Final Environmental Impact Statement (PMRF FEIS) Record of Decision (ROD) executed on April 14, 1999, the Deputy Assistant Secretary of the Navy (Installations and Facilities) stated that Navy would continue periodic monitoring of bird populations on Kaula. Navy ceased the monitoring program due to the Bird Air Strike Hazard (BASH) associated with landing aircraft on Kaula. Navy has not placed personnel on the ground (including Explosive Ordnance Disposal Personnel) since 1998. This proposed monitoring plan does not involve placing personnel on the ground by aircraft due to the associated risks. Boat landings are also risky due to the lack of safe beach access and the steep topography of Kaula. Navy considered conducting low altitude aerial surveys by helicopter, such as is done at Farallon de Medinilla (CNMI), but after discussions with military and commercial pilots, deemed the BASH risk to be too high. Therefore, the proposed monitoring plan does not include helicopter flights. Navy also notes that the main reason for the original commitment to monitor birds at Kaula was the Navy's anticipated plan to continue to use live ordnance at Kaula, but Navy no longer uses live ordnance at Kaula.

Purpose

Develop an index baseline population estimate and implement monitoring for seabird populations nesting on Kaula Island. Should safety conditions permit, Navy Region Hawaii intends to conduct more detailed management of Kaula Island through the PMRF Hawaii Integrated Natural Resource Management Plan (INRMP), which is currently in draft form. The INRMP will be coordinated with National Marine Fisheries Service and U.S. Fish and Wildlife Service as required by the Sikes Act.

Owner Information

Kaula Island is owned by the federal government and controlled by the Navy.

Property Description

Kaula is a small, uninhabited islet near the islands of Niihau and Kauai. It is located 20 nautical miles west-southwest of Niihau and approximately 60 miles southwest of PMRF, Kauai. It has an area of approximately 136 acres, with a summit elevation of 540 feet (Palmer 1936). The island is crescent-shaped with steep slopes and very little level terrain. (Elmer & Swedburg 1971). The southern end of the island is currently used as a range for inert ordnance and aircraft gunnery; the impact area represents approximately 8% of the island.

Species of Interest/Survey History

Terrestrial

Flora

The literature mainly cites the description provided by Palmer and Caum from their August 1932 trip to Kaula Islet (Caum 1939).

Fauna

During various surveys to determine the status of nesting seabirds on Kaula Island, 27 species of birds have been recorded on the island, with 18 species of seabirds recorded as breeding on the island (Telfer 1998; Walker 1993; Walker 1984; Walker 1982; Walker 1979; Elmer & Swedburg 1971; Caum 1939); (see Table 1). The largest number of species have been observed nesting during the April-May timeframe but there are a few species that begin nesting in November. Rats (assumed to be Polynesian rats [*Rattus exulans*]) and barn owls (*Tyto alba*) have been recorded during every survey. Introductions of various rodents to the earth's islands during centuries of exploration and colonization have been recognized worldwide as a major conservation problem (Atkinson 1985).

PART II

MONITORING PLAN DETAILS

Surveys conducted on Kaula Island from 1932 to 1998 have shown that a diversity of bird species frequent the island throughout the year, ranging from native seabirds to non-native urban species. The surveys of Kaula Island that occurred from 1971 – 1998 indicate that the populations of seabirds remained relatively stable, with no dramatic declines in the number of birds. Seasonally, nesting seabirds were found distributed throughout the non-impact zones, including right along the perimeter of the impact zone.

Method

Obtain high altitude high-resolution imagery from a fixed-wing aircraft to gather a static count of the number of birds that nest above ground. With the appropriate resolution (< 0.5 meter), the species of the birds flying and/or sitting on nests may be identified. Post-survey imagery will be analyzed by Navy or Navy-contracted biologists with experience in identifying Hawaiian birds. Analysis will provide species identification, distribution and relative densities of birds.

Prior survey data indicated that in order to capture adult breeding birds, two surveys per year are ideal. During April/May, the largest number of birds and highest species diversity exists, whereas during late November, the nesting Albatross can be observed. Therefore, obtaining high-resolution imagery of Kaula during the months of April/May and late November from 2008 – 2011 is recommended.

PART III

FINAL RECOMMENDATIONS

The Navy proposes to conduct high altitude aerial imagery surveys from fixed-wing aircraft in April/May and in late November. Previous surveys have shown no apparent Navy-caused impacts to birds that utilize the habitat provided by Kaula Island. Therefore, the Navy proposes to conduct surveys for three years (November 2008 to May 2011) and if data continues to show a lack of impact to coastal resources from navy activities, the Navy will reduce or eliminate survey frequency, unless surveys will be incorporated into land management under the INRMP. Implementation of all federal survey efforts is always contingent on the availability of funds and subject to all provisions of the Department of Defense Appropriation Act and Anti-Deficiency Act.

1. Surveys

Contract high-resolution aerial imagery to document major bird species and the overall condition of the island. Such photographs will provide for crude population estimates of the birds that (1) can be identified from the photos, (2) that are visible in the photos, and (3) that are present at the moment the photograph is taken. Such photographs will not document the occurrence of smaller species of birds that may not be visible or included in the photos and burrow-nesting species or the impact of rodent or owl predation and herbivory, but they will provide for "snap shot" species lists and estimates that can be compared with similar photographs taken in the past and future in order to develop trend analysis.

Timeframe: During apparent peak diversity. First survey is proposed for April/May 2009 with a subsequent survey in April/May 2010.

2. Management

Under the Sikes Act, the Navy prepares INRMPs, which are coordinated with the USFWS, NMFS and DLNR. An updated INRMP for Pacific Missile Range Facility (PMRF) is currently under development by the Navy, and management actions may be considered in this document after initial inventory and assessment. There are potential actions that can be undertaken that will not conflict with the Navy's use of the island for training, such as bird predator control. Based on results involving other, similar islands, elimination of rats (and, possibly mice and/or owls) may result in a significant increase in bird numbers on Kaula and improvements in sea bird habitat related to regrowth of vegetation damaged by rat and mouse herbivory. Newer registered rodenticides that can be applied from the air have proven effective elsewhere, and recent developments in delivery technology have greatly improved results. USFWS and the DLNR are currently spearheading a Joint Programmatic EIS to expand rodent control efforts in Hawaii, including the offshore islets. Navy Region Hawaii is a participating member of the Agency Coordination Team for this EIS. Developing and implementing a plan for the elimination of rats (and possibly mice and owls) on Kaula Island may be recommended

as a component of the PMRF INRMP depending on cost, effectiveness, safety (BASH hazard issues) and associated ancillary environmental impacts caused by rodenticide dispersion.

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Table 1. Bird species observed on Kaula Island.

Common Name	Species Name	Aug-32	Aug-71	Jan-76	Sep-76	Mar-78	Aug-78	Mar-79	Jun-80	Apr-84	Jun-93	Nov-98
Black-footed albatross	*Diomedea nigripes*	est egg	-	x	-	x	-	x	-	x	x	x
Laysan Albatross	*Diomedea immutabilis*	-	-	x	-	x	-	x	x	x	x	x
Wedge-tailed shearwater	*Puffinus pacificus*	x	x	-	x	-	x	-	x	x	x	x
Christmas shearwater	*Puffinus nativatis*	-	x	-	x	-	x	x	x	x	x	-
Bonin petrel	*Pterodroma hypoleuca*	est egg	-	-	-	-	-	-	-	-	-	-
Bulwer's petrel	*Bulweria bulwerii*	x	x	-	x	-	x	-	x	x	x	-
Red-tailed tropicbird	*Phaethon rubricauda*	x	x	-	x	x	x	x	x	x	x	x
White-tailed tropicbird	*Phaethon lepturus*	-	x	x	x	-	x	x	-	-	-	x
Masked booby	*Sula dactylatra*	x	x	x	x	x	x	x	x	x	x	x
Brown booby	*Sula leucogaster*	x	x	x	x	x	x	x	x	x	x	x
Red-footed booby	*Sula sula*	x	x	x	x	x	x	x	x	x	x	x
Great frigatebird	*Fregata minor*	x	x	x	x	x	x	x	x	x	x	x
Pacific golden plover	*Pluvialis fulva*	x	-	x	x	-	x	x	-	x	-	x
Ruddy turnstone	*Arenaria interpres*	-	x	x	x	-	x	x	x	x	x	x
Wandering tattler	*Heteroscelus incanus*	-	-	x	x	-	x	x	-	-	-	-
Grey-backed tern	*Sterna lunata*	x	x	-	x	x	x	x	x	x	x	-
Sooty tern	*Sterna fuscata*	x	x	x	x	x	x	x	x	x	x	x
Blue-grey noddy	*Procelsterna cerulea*	x	-	-	x	-	-	-	-	-	-	x
Brown noddy	*Anous stolidus*	x	x	x	x	x	x	x	x	x	x	-
Black noddy	*Anous minutus*	-	x	x	x	x	x	-	-	x	x	-
White tern	*Gygis alba*	x	x	x	x	x	x	-	x	x	x	-
Barn owl	*Tyto alba*	-	x	x	x	-	x	x	x	x	x	x
Japanese white eye	*Zosterops japonicus*	-	-	x	x	-	-	-	-	-	x	-
House finch	*Carpodacus mexicanus*	-	x	x	x	-	x	x	-	x	x	x
Northern cardinal	*Cardinalus cardinalus*	-	x	-	x	-	-	-	-	-	-	-
Mockingbird	*Mimus polyglottos*	-	-	-	x	-	-	-	-	-	-	-
Ricebird/Nutmeg mannikin	*Lonchura punctulata*	-	-	-	x	-	-	-	-	-	-	-

G4 - MEMORANDUM OF RECORD PMRF BEACH AND KINIKINI FISHING AREA ACCESS AND USE POLICY 29 JAN 2008

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

IN REPLY REFER TO:
11000
01/00-1
29JAN08

MEMORANDUM FOR THE RECORD

Subj: PMRF BEACH AND KINIKINI FISHING AREA ACCESS AND USE POLICY

Encl: (1) Map of authorized PMRF Beach and Fishing Use Areas

1. **Purpose**. The following policy is set forth in order to establish clear guidance on authorized locations, times, activities, and personnel for the use of PMRF beaches and the Kinikini fishing access, and to establish authorized access points to those areas by different categories of users. This policy will remain in effect until this Memorandum is canceled or modified at some point in the future.

2. **Authorized Personnel**. The following personnel are authorized to use the beach areas and Kinikini Fishing Area as delineated in this memorandum:

a. Active Duty, Retired, Reserve Military personnel, any PMRF Housing residents, and their sponsored guests.

b. Government Civilians and their sponsored guests.

c. Government contractors who work on PMRF and their immediate family members (defined as Spouse, Father, Mother, Brother, Sister, Son, Daughter), must be accompanied by sponsor at all times (unless residents of base housing).

d. MWR Guest Pass holders. Pass must be current, no guests authorized.

e. In all cases, children less than 16 years old must be closely accompanied & supervised by a parent/parents or other responsible adult (18 years and older) designated by the child's parent at all times when in the water because of the strong currents and rips that exist off the beach at PMRF and the fact that there are no lifeguards posted.

3. **Authorized Activities**. Running, walking, surfing, swimming, diving (spear guns authorized for use by adults only and un-cocked until water entry), snorkeling, fishing, sports, picnicking, shell collecting, sunbathing, and other appropriate activities for beach use. Bonfires are authorized with an approved request signed by the PMRF Fire Chief and the Executive Officer. Only residents of PMRF housing may have dogs on the beach, and shall have a leash and bag or other container present and shall remove any feces left by their pet, as well as use the leash to restrain their pet if it is uncontrollable and creating a hazard or nuisance for other beach users.

4. **Unauthorized Activities**. Motor vehicle use of any kind except for Security/Emergency vehicles. Discharging of firearms or use of bow and arrows.

Camping or overnight use except in designated MWR camping sites with a valid reservation. Any activity outside of the authorized boundaries. Other areas and recreation facilities (skate park, basketball courts, ball fields, swimming pool, etc.) are off limits to MWR Rec Pass holders and will result in immediate loss of Pass and privileges.

5. **Access Points**. All authorized users may access the beach at Shenanigans, Majors Bay Recreation Area, and the Kinikini Fishing Area (fishing use only). Only Beach Cabin residents and their guests may park and access the beach at the Beach Cabin area. Only Family Housing residents and their guests may park and access the beach through the Family Housing area (also known as the Berm area). Beach use in front of the Family Housing area by anyone who is not a resident or guest of a housing resident is restricted to the sand portion of the beach only, and ends at the vegetation along the edge of the Berm area. The Berm area picnic pavilions, seating platforms and showers are ONLY for use by housing residents and their guests. One clearly marked Public shower and rest room is located near Shenanigans, and another one is located at Majors Bay. These are the only two shower/restroom facilities available for all beach users. Violation of access rules will result in removal of an individual by PMRF security and punitive action (loss of beach privilege, MWR Guest Pass, etc) by the Commanding Officer.

6. **Beach and Fishing Hours**. Beach use is authorized from 0500 until 2200 daily unless otherwise posted. Kinikini fishing hours are also from 0500 to 2200 on all days the Kinikini Fishing Area is open for fishing (Weekends and Holidays when no flight operations are being conducted or as promulgated on a short-notice basis, see enclosure (1) for physical boundaries).

7. **Cleanliness**. No garbage shall be left on the beach. Everything that you carry on the beach must be removed off the beach and properly disposed of in trash receptacles. If you see rubbish/trash that has washed up on the beach, please be responsible and help keep our Hawaii beaches clean by picking up all trash and properly disposing of it.

8. **General**. It is important to remember that **all use of PMRF beaches and fishing areas are use At Your Own Risk!! Lifeguards and beach safety patrols are not provided.** Beach use at night adds some additional risk and one should take that into account prior to entering the water or going near the surf at night. The surf and currents are often extremely hazardous and unpredictable along PMRF beaches. **Use extreme caution at all times**. The beach and fishing areas are wonderful assets for the PMRF community to be able to enjoy, and continued use is dependent on all users heeding and obeying these regulations. **If you need to report a violation or have an emergency and need help call 911 or (808) 335-4532 for security**.

9. Those who violate these rules are subject to immediate termination of their beach privileges by the Commanding Officer.

Subj: PMRF BEACH AND KINIKINI FISHING AREA ACCESS AND USE POLICY

A. L. CUDNOHUFSKY
Captain, U. S. Navy
Commanding Officer

Copy to: List 1-6

Enclosure (1)

G5 - MARINE MAMMAL RESPONSE PROTOCOL FOR PACIFIC MISSILE RANGE FACILITY

MARINE MAMMAL RESPONSE PROTOCOL FOR PACIFIC MISSILE RANGE FACILITY

Events occurring within PMRF that require a response include strandings, sightings of injured or dead marine mammals, harassment of marine mammals, and any other display of abnormal behavior by a marine mammal in the range.

Contact PMRF Security Dispatch

335-4523

PMRF Security will notify Environmental

John Burger……..335-4632

Environmental will notify and coordinate with CNRH N00L, ARE1, and NAVFAC Pacific; CNRH N00L will contact NOAA Fisheries Service and COMPACFLT N01CE

CNRH N00L……473-4731

ARE1…….473-4137 x224

NAVFAC Pacific……..472-1406

NOAA Fisheries Service
24-hour
Marine Mammal Hotline……1-888-256-9840

COMPACFLT N01CE……471-4235

If there is a law enforcement issue, then CHRH N00L will contact NOAA Law Enforcement and/or State of Hawaii DOCARE and COMPACFLT N01CE

NOAA Law Enforcement…….541-2727

DOCARE……..274-3521

COMPACFLT N01CE……471-4235

General Instructions:

- Do not approach the marine mammal
- Gather and relay as much information about the marine mammal as possible without approaching it (e.g. tagged, injured, dead, location, etc.)

G6 - INJURED BIRD RESPONSE PROTOCOL FOR PACIFIC MISSILE RANGE FACILITY

INJURED BIRD RESPONSE PROTOCOL FOR PMRF

Injured birds requiring response include seabirds, endangered waterfowl (stilts, moorhens, coots, Hawaiian duck, and Nene), and owls. Dead birds do not require response but may be reported for West Nile virus surveillance by dialing 211.

For injured birds sighted in and around the Pacific Missile Range Facility (PMRF):

Contact PMRF Security Dispatch……...**335-4523**

PMRF Security Dispatch will then notify Environmental:

John Burger……**335-4632**

Environmental will notify ARE1, NAVFAC Pacific and USFWS for the bird:

ARE1..……...**473-4137 x224**
NAVFAC Pacific……**472-1406**
Injured endangered waterfowl – USFWS……..**828-1413**

If the bird injury is a law enforcement issue, then Environmental will contact State of Hawaii DOCARE

DOCARE……**274-3521**

General Instructions:

- Gather and relay as much information about the bird as possible (e.g. tagged, nature of injury, location, etc.)
- Collect the bird as gently as possible and contain with a cardboard box or small animal carrier
- Try to minimize stress on the bird as it awaits/undergoes transportation

G7 - SNAKE SIGHTING RESPONSE PROTOCOL FOR PACIFIC MISSILE RANGE FACILITY

SNAKE SIGHTING RESPONSE PROTOCOL FOR PACIFIC MISSILE RANGE FACILITY

For injured snakes sighted in and around PMRF:

PMRF Security Dispatch……..**335-4523**

The area security officers will provide the first response to the snake sighting. The first response shall consist of:

- Informing PMRF dispatch (335-4523) of the situation
- Notifying the Hawaii Department of Agriculture (274-3069)
- Containing (kill or capture) the snake if it is visibly present
- Gathering information on the sighting (description, location, time, etc.)
- Acting as the point of contact for other responders arriving on the scene

PMRF Security will notify Environmental of the snake sighting:

John Burger……**335-4632**

Environmental will notify the ARE1 office and the NAVFAC Pacific Natural Resources Branch:

ARE1……..**473-4137 x224**

NAVFAC Pacific……**472-1406**

General Information:

- Security police shall be trained in snake response and snake handling equipment and techniques
- Brown tree snake awareness snake reporting procedures should be including in military and DOD civilian newcomer briefs
- Brown tree snake information posters should be displayed in buildings and common areas
- For more information contact Jennifer Sakai, NAVFAC Environmental, at 471-1171 ext 345 or Patricia Colemon, NAVFAC Environmental, at 473-4137 ext 224.

G8 - MONK SEAL HAUL-OUT PROTOCOL FOR PACIFIC MISSILE RANGE FACILITY

MONK SEAL HAUL-OUT PROTOCOL FOR PACIFIC MISSILE RANGE FACILITY

Hauling out is normal behavior for monk seals. They spend time on land to either rest, molt, nurse their pups, or recover from giving birth. The duration of their haul-outs is highly variable. Monk seals are intolerant of human presence and are very sensitive to disturbance. If provoked, they may display aggressive behavior.

Contact PMRF Security Dispatch
335-4523

PMRF Security will notify Environmental

John Burger…….....335-4632

Environmental will notify and coordinate with the NOAA Marine Mammal Research Program and NAVFAC Pacific

Marine Mammal Research Program…..651-7668

ARE1……473-4137 x224

NAVFAC Pacific……..472-1406

If there is a law enforcement issue, then Environmental will contact NOAA Law Enforcement and/or State of Hawaii DOCARE

NOAA Law Enforcement……..541-2727

DOCARE……...274-3521

General Instructions:

- Do not disturb the monk seal
- Gather and relay as much information about the monk seal without disturbing it (e.g. Date and time of sighting, descriptive location of sighting, estimated size of seal (length), any identifying characteristics [hind flipper tags, applied bleach mark on shoulder, significant scars or other markings])

G9 - STRANDED SEA TURTLE RESPONSE PROTOCOL FOR PACIFIC MISSILE RANGE FACILITY

STRANDED SEA TURTLE RESPONSE PROTOCOL FOR PACIFIC MISSILE RANGE FACILITY

A stranded sea turtle is defined as any ocean turtle found dead, injured, sick, tumored, or otherwise abnormal and sometimes even “normal” in appearance, and out of the water, usually along the shoreline.

PMRF Security Dispatch

335-4523

PMRF Security Dispatch will notify Environmental

John Burger……..335-4523

Environmental will notify and coordinate with the DLNR Division of Aquatic Resources, NMFS Marine Turtle Research and Stranding Program, ARE1, and NAVFAC Pacific

Regular Hours (0700-1600)…….645-0532

After hours
(Incl. Weekends and Holidays) ….645-0532

ARE1……..473-4137 x224

NAVFAC Pacific…….472-1408

If the turtle stranding is a law enforcement issue, then Environmental will contact NOAA Law Enforcement and/or State of Hawaii DOCARE

NOAA Law Enforcement…….541-2727

DOCARE……..274-3521

General Instructions:

- Do not approach the turtle
- Gather and relay as much information about the turtle (e.g. tagged, injured, dead, location, etc.)
- If the turtle is dead and floating in the water, if safe to do so, bring the carcass to the shoreline

G10 - HAWAIIAN MONK SEAL DESCRIPTION FOR MWR USERS

(CNRH 2004)

Enjoy watching but DO NOT DISTURB the monk seals

Monk Seals

During your time on the beach, you may be lucky enough to see the endangered Hawaiian monk seal. Like most large wild animals, monk seals (*monachus schauinslandi*) were once hunted nearly to the point of extinction. Because seals compete with fishermen in some parts of the world, seals continue to be killed or attacked by humans. In the U.S., the Hawaiian monk seal rarely suffers direct harm from people. But the number of monk seals continues to decline.

These solitary (monk-like) agile swimmers live primarily in the remote Northwest Hawaiian Islands. Within the past 20 years, a number of monk seals have made their way south to the main Hawaiian Islands apparently in search of food and perhaps space.

Monk seals seem to seek out quiet beaches to rest, nap, and relax and as places for the adult females to deliver and nurse pups. A monk seal pup was born at PMRF in 1999 and a seal is frequently seen in the winter months at Barbers Point. The seal's Hawaiian name, ***ilio-holo-i-ka-uaua***, seems to be a description of what they look like - dog that lives in rough water.

Should you have the rare opportunity to see a monk seal lying on a beach or swimming offshore, it's best to just leave the seal alone, giving it the right of way. It doesn't need human help unless you can see that it's entangled in fishing gear or marine debris or if a dog or another human are disturbing the seal. Do not get between a mother and a pup. Seals have been known to bite humans. Please note the date, time and location of the seal and pass that information along by *telephone to PMRF Security @ 4523. Also report if the animal is entangled in gear or has any other visible sign of injury/distress. PMRF Security will perform the necessary follow-up* including any *calls to the proper authorities."*

Both the Marine Mammal Protection Act (16 USC 1362,1372, 1375) and the Endangered Species Act (16 USC 1538, 1540) make it illegal to harass these animals. While boats and planes are required to stay a specified distance from our visiting humpback whales (50 CFR 244.103(A)), no equivalent required stay-back distance has been created for monk seals. Biologists suggest that the best idea is to stay far enough away so the animal doesn't notice you. Please make sure dogs do not go near the seal as seals may snarl and bite and dogs can carry diseases that would destroy the remaining seal population.

Thanks for helping to keep monk seals wild and well in Hawaii. For more information on Hawaiian monk seals, check out your favorite search engine and web site.

Written by Becky Hommon, Environmental Counsel, Navy Region Hawaii, Pearl Harbor, HI 96860, for use at the beach cottages at Pacific Missile Range, Barking Sands, Kauai' and Barbers Point, Oahu (Aug 04).

G11 - UNIFIED FACILITIES CRITERIA LANDSCAPE ARCHITECTURE

(DOD 2009)

UFC 3-201-02
23 February 2009
Including Change 1, November 2009

UNIFIED FACILITIES CRITERIA (UFC)

LANDSCAPE ARCHITECTURE

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UNIFIED FACILITIES CRITERIA (UFC)

LANDSCAPE ARCHITECTURE

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by **1**\ ... /**1**/)

Change No.	Date	Location
1	November 5, 2009	Corrected UFC and UFGS designations throughout

This UFC supersedes UFC 3-210-05FA, dated 16 January 2004; NAVFAC P-904/Army TM 5-830-1; and NAVFAC P-905/Army TM 5-830-4/AFM 88-17, Chapter 4

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD(AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

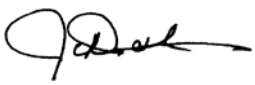
UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Center for Engineering and the Environment (AFCEE) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: Criteria Change Request (CCR). The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

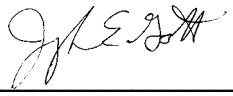
- Whole Building Design Guide web site http://dod.wbdg.org/.

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

AUTHORIZED BY:



JAMES C. DALTON, P.E.
Chief, Engineering and Construction
U.S. Army Corps of Engineers



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Chief Engineer
Naval Facilities Engineering Command

DENNIS FIRMAN P.E.
Director of the Air Force Center for Engineering and the Environment
Department of the Air Force

MICHAEL McANDREW
Director, Facility Investment and Management
Office of the Deputy Under Secretary of Defense (Installations and Environment)

UNIFIED FACILITIES CRITERIA (UFC)
NEW DOCUMENT SUMMARY SHEET

Document: UFC 3-201-02, *Landscape Architecture*
Superseding: Various DoD manuals

Description:

This UFC – through succinct reference to industry and government standards, codes and reference works – makes possible the replacement and/or consolidation of numerous criteria documents. To date, this UFC supersedes the following criteria documents on the subject matter.

- NAVFAC P-904/Army TM 5-830-1 *Planting Design*
- NAVFAC P-905/Army TM 5-830-4/AFM 88-17, Chap. 4, *Planting and Establishment of Trees, Shrubs, Ground Covers and Vines*
- UFC 3-210-05FA, *Design: Landscape Design and Planting Criteria*

Reason for Document: To comply with defense standardization laws and unification requirements of MILSTD 3007. This unification effort will result in the more effective use of DoD funds, in two ways: first, by significantly improving DoD projects and facilities, through a more efficient **application** of facilities criteria; and second, through more efficient **maintenance** of facilities criteria.

Impact: This UFC will have a pronounced positive impact on the functionality, sustainability, maintenance, appearance, and life cycle cost of DoD projects. Overall impact to design and construction costs will be minimal.

Non Unified Issues: none

CONTENTS

CHAPTER 1 INTRODUCTION

1-1 PURPOSE AND SCOPE

The purpose of this UFC is to provide technical requirements and design guidance in the discipline field of landscape architecture associated with site improvements and site design for Department of Defense (DoD) projects.

1-2 APPLICABILITY

This UFC is applicable to all DoD projects with ***site improvements*** regardless of the method of execution or the funding source. This includes *sustainment, restoration and modernization* as well as new construction. The term ***site improvements*** refers to all site modification that will result in permanent, on or above-ground, paving, features, or landforms. Representative types of site modification are indicated in the section on *Pre-Design and Design Services*. The term ***site improvements*** does not refer to either: enclosed buildings, in themselves; or, airfield pavements. For a more comprehensive presentation of potential site improvement issues and treatments see Appendix B *Best Practices in Landscape Architecture*.

1-3 GENERAL REQUIREMENTS

Design of all site improvement features shall be accomplished by an experienced registered professional. As a minimum, all construction projects with site improvement costs over $250,000 shall have a landscaping plan and supporting details signed by a registered professional in the state of the project location. For states without licensure requirements, the designer shall be licensed in an adjacent state or jurisdiction. This requirement is consistent with that of the Federal Acquisition Regulations (FAR) and the majority of state departments of professional regulation, which require signature by a licensed professional in their field of study and expertise. In most cases this will be a registered Landscape Architect. More stringent professional requirements and certifications may be required in the individual design and construction contracts.

1-3.1 Experience

The designer shall have a minimum of three years experience in the design and management of projects similar in scope and complexity to the current project. In addition, the designer shall have experience in sustainable development and low impact design as it relates to site improvements and features.

1-3.2 Design Services

The designer shall facilitate the integration of the current project with the existing context, focusing on such specifics as safety, security, sustainability,

accessibility, circulation, function, cost effectiveness, aesthetics, and compatibility with surrounding land use.

1-3.2.1 Pre-Design and Design Services

The following key components of planning and design shall be addressed (examples are provided below, in parenthesis):

- Programming (development and clarification of project scope based on customer needs and expectations)
- Site Analysis (visual and functional analysis, natural landscape analysis, historical and cultural landscape elements, landscape development zoning, existing site plan, project limits)
- Site Planning (preliminary development of spatial-functional relationships based on programming and site analysis)
- Preservation and Maintenance of Existing Resources (plant material, historical, cultural, and natural resources)
- Grading and Drainage (erosion and sedimentation control, low impact development)
- Circulation Systems (roads, streetscapes, parking areas, recreational trails, bikeways and walkways)
- Common Areas (plazas and courtyards, parade grounds, recreational areas, pedestrian and vehicular gates/entrances, playgrounds and tot lots, monuments, memorials, static displays)
- Planting Design (plant selection and location, low maintenance, regionally native species, xeriscape, remediation and reclamation, green roofs, interior planting)
- Forestry (trees, brush and fire management, urban forestry management)
- Irrigation Design (minimizing water requirements, plant establishment and survival, water budgeting and hydrozoning, water sources)
- Site Furnishings (exterior lighting, seating, shelters, trash and ash receptacles, fences and walls, bicycle racks, grates, bollards, planters, water features)

- Signage Systems (interpretive, informational, identification, wayfinding)
- Site Security (comprehensive planning, facility site design, site security details)
- Construction Documents (plans, details, specifications, cost estimating)

1-3.2.2 **Post-Design Services**

As contracted, the designer shall address the following key components of post-design (examples are provided below, in parenthesis):

- Field Consultation During Construction (inspection, quality control, shop drawing and submittal review)
- Landscape Establishment, Maintenance and Management (comprehensive landscape maintenance, landscape maintenance tasks and methods, landscape management plan development)

1-4 CRITICAL DESIGN REQUIREMENTS

The designer shall address the following critical design issues: (Requirements for the following critical issues can be found in the documents listed in paragraph 1-5.)

- Security (Antiterrorism/Force Protection)
- Accessibility
- Sustainable Development (Economical, Environmental, Low-Impact Development)
- Planting and Irrigation Establishment Period
  - Typical time period: 1 year warranty and maintenance
  - Periodic inspections: Establishment start, completion, and once per quarter (minimum)

1-4.1 Sustainable Development

Projects must comply with Executive Order 13423, Strengthening Federal Environment, Energy, and Transportation Management, dated 24 January 2007. EO 13423 requires compliance with the Memorandum of Understanding (MOU) on Federal Leadership in High Performance and Sustainable Buildings. The

Guiding Principles of the MOU align with the US Green Building Council Leadership in Energy and Environmental Design (LEED) green building rating system. The following LEED-New Construction credits that landscape architecture could impact should be included in the design to comply EO 13423: SS 6.1, SS 6.2, WE 1.1, WE 3.1, EA 1, MR 2.1,MR 4.1, MR 6, MR 7 and EQ 4.

Projects must comply with P.L. 110-140 (H.R.6) Energy Independence and Security Act 2007 (EISA 2007). Section 438 provides storm water runoff requirements for federal projects.

Navy and Marine Corps projects must consider Low Impact Development strategies to comply with the storm water management requirements in the Assistant Secretary of the Navy (Installations & Environment) Memorandum: Department of the Navy Low Impact Development (LID) Policy for Storm water Management dated 16 November 2007.

1-5 STANDARDS & CODES

The following standards and codes contain additional site and Landscape Architectural requirements. Under each category, additional project-specific requirements may be applicable and will be provided as appropriate.

1-5.1 Industry

- AASHTO (American Association of State Highway Transportation Officials*, Guide for the Development of Bicycle Facilities*) (http://www.transportation.org/.)
- *USPC* (U.S. Consumer Product Safety Commission) *Handbook for Public Playground Safety* (http://www.cpsc.gov/cpscpub/pubs/325.pdf.)
- ANSI Z60.1, *American Standard for Nursery Stock*, (http://www.anla.org/applications/Documents/Docs/ANLAStandard2004.pdf.)

1-5.2 Government

- ADAAG (*Americans with Disabilities Act Accessibility Guidelines*) (http://www.access-board.gov/adaag/html/adaag.htm)
- ADA and ABA Accessibility Guidelines (http://www.access-board.gov/ada%2Daba/)
- *Endangered Species Act of 1973*, U.S. Fish and Wildlife Service, (http://www.fws.gov/endangered/esa.html)

- *Energy Policy Act of 2005* (http://www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id=2969&destination=ShowI)

- Executive Order 13112, *Invasive Species* (http://www.archives.gov/federal-register/executive-orders/1999.html)

- Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management (http://www.wbdg.org/ccb/FED/FMEO/eo13423.pdf)

- *Energy Independence and Security Act of 2007* – P.L. 110-140 (H.R.6)

- *Federal Clean Water Act of 1977*, Environmental Protection Agency (EPA), (http://www.epa.gov/region5/water/cwa.htm)

- *Uniform Federal Accessibility Standards* (UFAS) (http://www.access-board.gov/ufas/ufas-html/ufas.htm)

- *Federal Leadership in High Performance and Sustainable Buildings* Memorandum of Understanding (http://www.eh.doe.gov/oepa/guidance/p2/hpsb_mou.pdf)

1-5.3 **Department of Defense**

- UFC 1-200-01, *General Building Requirements* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)

- UFC 1-300-09N, *Design Procedures* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)

- UFC 3-120-01, *Air Force Sign Standard* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)

- UFC 3-210-02, *POV Site Circulation and Parking* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)

- UFC 3-210-10, *Low Impact Development* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)

- UFC 3-250-03, *Standard Practice Manual for Flexible Pavements* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)

- UFC 3-250-04, *Standard Practice for Concrete Pavements* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)
- UFC 3-260-01, *Airfield and Heliport Planning and Design* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)
- UFC 3-420-01, *Plumbing Systems* (http://www.wbdg.org/ccb/browse_inactive.php?o=29&c=4)
- UFC 3-440-02N, *Water Conservation Operation and Maintenance* (http://www.wbdg.org/ccb/browse_inactive.php?o=29&c=4)
- UFC 3-701-XX (series), *DoD Facilities Pricing Guide*, (where XX indicates the fiscal year), (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)
- UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)
- UFC 4-020-01, *DoD Security Engineering Facilities Planning Manual* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)
- UFC 4-022-01, Security Engineering: *Entry Control Facilities/Access Control Points* (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)
- UFC 4-022-02 Selection and Application of Vehicle Barriers (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)
- UFC 4-022-03 Security Engineering: Fences, Gates, and Guard Facilities (under development at time of publication)
- UFC 4-030-01, Sustainable Development (http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)

1-5.3.1 Service-Specific

1-5.3.1.1 Army

- *Access Control Points Standard Definitive Design* (https://pdc.usace.army.mil/library/.).
- EM 1110-2-301, *Guidelines for Landscape Planting and Vegetation Management at Floodwalls, Levees, and Embankment Dams.* (http://www.usace.army.mil/usace-docs/eng-manuals/em1110-2-301/toc.htm.)

1-5.3.1.2 Air Force

- Facility and Landscape Design Guides (http://www.afcee.brooks.af.mil/dc/products/dcproducts.asp.)
- AFI 32-7062, *Air Force Comprehensive Planning,* (http://www.e-publishing.af.mil.)
- AFI 32-7064, *Integrated Natural Resources Management*, (http://www.e-publishing.af.mil.)
- *Model Pesticide Reduction Plan*, (http://www.afcesa.af.mil/ces/cesm/pest/cesm_pestmgt.asp.)

1-5.3.1.3 Navy/Marines

- OPNAVINST 5530.14D, *Navy Physical Security and Law Enforcement Manual,* (http://doni.daps.dla.mil/default.aspx)

1-5.3.2 Local and Installation-Specific

Contact the appropriate entity for access to the following standards.

- State Historic Preservation Office (SHPO) - check with the SHPO, or similar entity, for local policies and guidelines, if aspects of the project may have historical significance.
- Natural Resources Management Plan - check for installation policy or guidelines for natural resource management.
- Cultural Resources Management Plan - check for installation policy or guidelines for cultural resource management.
- Installation Appearance Plans (IAP) – check for installation policy or guidelines for Landscape Architecture.
- Base Exterior Architecture Plans (BEAP) - check for installation policy or guidelines for Landscape Architecture.
- Installation Design Guide - check for installation policy or guidelines for installation design.

APPENDIX A REFERENCES

A-1 **NOT USED**.

Due to the nature of this UFC, Appendix A is not used.

APPENDIX B BEST PRACTICES

B-1 LANDSCAPE ARCHITECTURE

This Appendix is a supplemental reference, and is not required policy.

B-1.1 Role of the Landscape Architect

The landscape architect coordinates and oversees the design and stewardship of natural and built environments on DoD sites. The landscape architect takes a leadership role in the following aspects of the site design process:

- Analysis: Coordinate site assessment and documentation.
- Site Design: Establish use areas and locate building footprints, as well as address the remaining listed items in order to establish a physical plan for the entire site area.
- Design of Circulation Systems: Coordinate interdisciplinary collaboration for the planning and design of vehicular, bicycle, service vehicle, and pedestrian circulation systems.
- Common Area Design: Work with user groups to establish the best and safest possible use of recreational land, ceremonial areas, and other open space systems such as greenways, corridors, and neighborhood linkages.
- Planting Design: Conceptualize planting patterns, forms, types, and heights within clear zones and throughout entire installations at various scales.
- Forestry: Work with a forester to determine preservation areas and future tree planting requirements.
- Site Furnishings: Design site furnishings that respond to users and are appropriate to the architectural and natural surroundings.
- Security: Develop creative solutions to address security requirements within a landscape while meeting or exceeding user expectations.
- Implementation, Maintenance, and Management: Document and oversee the implementation process. Establish a one-year review period to ensure planting quality and to review maintenance contracts.

B-1.2 Documentation

This UFC is a guide for the preparation of documents to promote consistent quality of landscape architectural design and implementation on DoD installations. For organizational purposes, this documentation is grouped into three main categories.

For more information on design procedures and the necessary documentation for **Navy** projects, refer to \1\UFC 1-300-09N, *Design Procedures*./1/

B-1.2.1 Planning Documentation

Planning documents describe actions that affect the entire installation and ensure a consistent approach to all site designs throughout the installation. Typical planning documentation includes the following:

- Base Map of the project;
- Land Use Plan (including natural constraints and program elements;
- Base Comprehensive Plan;
- Land Development Plan;
- Capital Improvements Plan;
- Visual Analysis and Theme Development;
- Approved Plant List;
- Approved Materials List;
- Approved Site Furnishings List;
- Specifications (see Unified Facilities Guide Specifications;) and
- Details.

B-1.2.2 Site Design Documentation

Each site design project requires a combination of documents to communicate the landscape architect's design intent to the construction and maintenance contractors. Typical site design documentation includes:

- Site Analysis Documents (including natural, visual, cultural, and historical elements)
- Concept Design
- Site Plan

- Implementation/Installation Documents (including Demolition Plan, Grading Plan, Drainage Plan, Planting Plan, Irrigation Plan, Details, and Specifications according to the UFGS)

Figure B-1.1 Example Diagram to Illustrate Land Use Relationships

B-1.2.3 Land Management Plan

A land management plan describes long-term or continued actions to ensure proper maintenance and management of the installation. Without proper maintenance and management, landscape elements will have a shorter lifespan. A land management plan is tailored to the specific requirements of the installation, and may include the following documents:

- Grounds Maintenance Plan
- Maintenance schedules (includes plant, hardscape, site furnishing, and water feature requirements)
- Urban Forestry Management Plan
- Brush Management Plan

- Erosion Management Plan

B-1.3 Planning Process

The planning process may include land use plans, area development plans, and erosion control plans, and existing conditions survey.

B-1.3.1 Land Use Plan

A land use plan highlights the type of activities that occur in different parts of an installation. Land use impacts site development in the following ways:

- Functional relationship to existing facilities;
- Proximity to user and customer;
- Scope of requirement and expansion potential;
- Noise, environmental impact, safety, and security needs;
- Existing infrastructure capacity; and
- Required site preparation.

B-1.3.2 Area Development Plan

Area development planning blends existing conditions and future facility requirements. Some of the factors that the landscape architect will evaluate in this phase include:

- Architectural theme of surrounding buildings;
- Pedestrian and vehicular needs, volumes, destinations, and access;
- Future facility requirements;
- Conceptual parking configuration; and
- Street realignments and closures.

B-1.3.3 Erosion Control Plan

The potential for erosion on the site should be addressed early in the planning and design process to correct existing problems and prevent further erosion from occurring. The results of the plan are often shown on the grading and drainage plans for proposed construction projects.

B-1.3.4 Existing Conditions Survey

Evaluate topography, drainage patterns and structures, soil types, the extent and type of vegetative cover, impermeable surfaces, vehicular and pedestrian circulation patterns, and above- and below-grade drainage structures. Record climatic information, including norms and extremes in temperature, precipitation and wind, to help define both expected and unusual conditions that may affect design decisions.

In developing the existing conditions survey, consider governmental regulations that may affect design actions. These include the *Federal Clean Water Act*, which regulates the discharge of material into waters of the United States, and the *Endangered Species Act*, which regulates actions that may have an impact on rare plants and animals. Projects or actions that may require permits or approvals under these and other acts entail coordination with various Federal agencies, including the U.S. Army Corps of Engineers, the Environmental Protection Agency, and the U.S. Fish and Wildlife Service. The State Historic Preservation Office regulates cultural resources including historic buildings, districts, and archeological sites. Also consider state or local laws that may affect planning and design.

B-1.4 Site Design Process

Synthesize planning and analysis with project requirements during the design process. The result will be a solution that improves the functionality, image, and quality of life for the users. The main components of the design process are:

- Project Programming: During this first stage of the process, summarize requirements, priorities, and user needs.

- Site Analysis: Evaluation factors at this stage include views, existing conditions, vehicular and pedestrian circulation, plant types, noise, and security requirements.

- Concept Design: The concept design illustrates the overall design intent to be discussed with and approved by the client prior to moving forward with more detailed designs.

- Site Plan: Site planning factors include topography, existing vegetation, existing nearby structures, existing natural features, entrances/service areas, orientation, walkways, parking details, lighting, drainage, pedestrian and vehicular circulation, building setback from street, and security elements.

- Theory: Design theory, along with comprehensive site analysis, is key to successful landscape design. Apply the following design principles: proportion, scale, unity, harmony, line, emphasis, contrast, variety, repetition, form, texture and color. The choice of materials also contributes to the quality of landscape design. Landscape materials typically include: plants, inert materials, landforms, site amenities, and water features.

Figure B-1.2 Example Concept Drawing

B-1.4.1 Design Guidelines

Basic principles of quality landscape architecture apply to all projects. The following general guidelines are typically employed:

- Use hardy, regionally native and drought-tolerant plant materials when possible.
- Create design solutions that minimize adverse impacts on the natural habitat.
- Prevent pollution by reducing fertilizer and pesticide requirements and by using integrated pest management techniques, recycle green waste, and minimize runoff.
- Preserve and enhance existing natural landforms and vegetation.
- Maximize low-maintenance landscapes.
- Maximize the use of water-efficient plant material.
- Install water-efficient irrigation systems.
- Ensure site and planting plans promote energy conservation.
- Screen undesirable views and land uses.

- Use mass plantings, berms, groups of trees, and architecturally compatible fencing as screens and buffers.
- Create attractive entries.
- Reduce building mass by creative, security-sensitive foundation plantings.
- Use thornless and non-toxic plant material near children's play areas.
- Use site amenities that are durable, well constructed, and resistant to vandalism.
- Design irrigation systems to minimize damage to key components, including sprinkler heads, controllers, and backflow preventers.

Figure B-1.3 Example Site Plan of a Common Area and Pedestrian Circulation

Figure B-1.4 Example Grading Plan

B-1.5 Implementation and Installation Process

Communicate design intent to the contractors responsible for installing and maintaining the designed landscape. Typical construction documents include:

- Demolition Plan;
- Grading Plan;
- Planting Plan;
- Irrigation Plan;
- Landscape Details;
- Specifications - refer to UFGS Specifications;
- Cost Estimate;
- Planting Plan;

- Establishment Period Contract;
- Construction Management Plan; and
- Maintenance Plan

B-2 SITE DESIGN

B-2.1 Role of the Landscape Architect

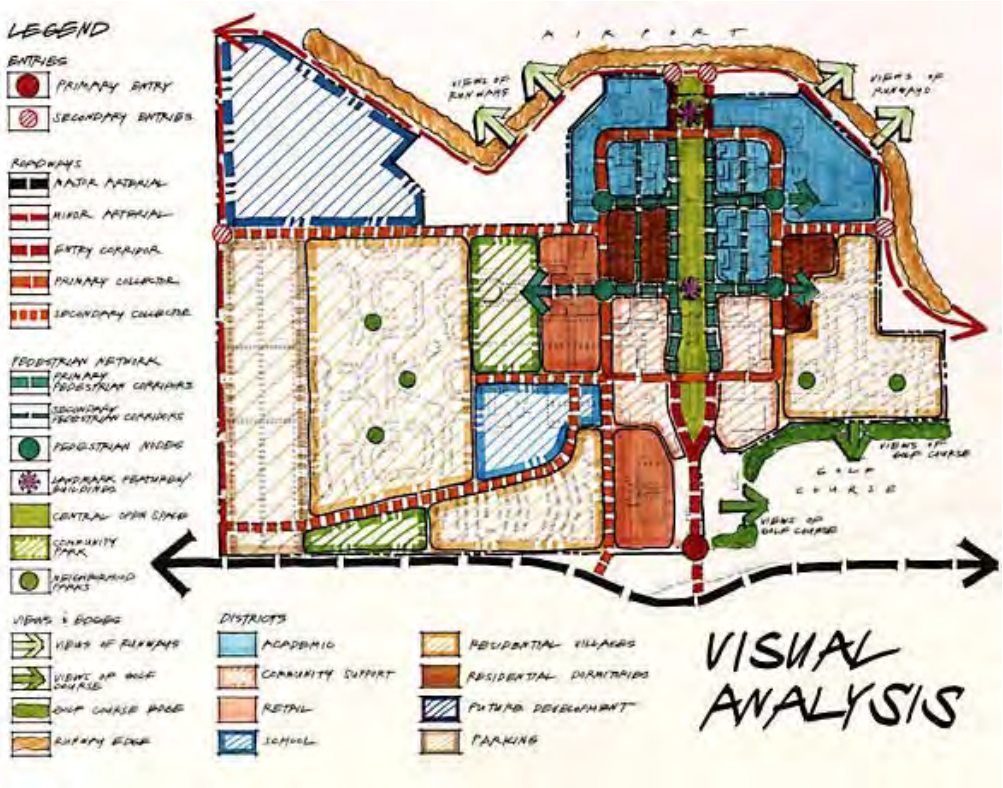
Coordinate, oversee, and conduct the site design process, which includes the following responsibilities:

- Provide a detailed site analysis that includes a thorough assessment of visual, natural, cultural, and historical resources.
- Study design opportunities and constraints that will contribute to the resulting form of the site plan.
- Respond to functional and user requirements with maximum efficiency by the placement and relationship of buildings and circulation networks.
- Conserve natural resources.
- Establish a safe and secure site through creative landscape architectural design solutions.
- Enhance the quality of life by designing a pedestrian-friendly environment.
- Allow for future expansion of surrounding facilities.
- Incorporate sustainable design solutions that are economically and environmentally beneficial for the long-term.
- Use natural amenities in designating recreational areas.
- Provide guidance on identifying and reinforcing an appropriate image through visual design, including enhancement of visual structure, hierarchy, and quality.

B-2.2 Visual Analysis

A site's visual environment consists of visible land, water, vegetation, facilities, architectural compatibility, landscape development, and treatment of natural areas. In addition to expressing mission and function, the character, quality, and relationships of physical features contribute to the comprehension and perception of the visual environment.

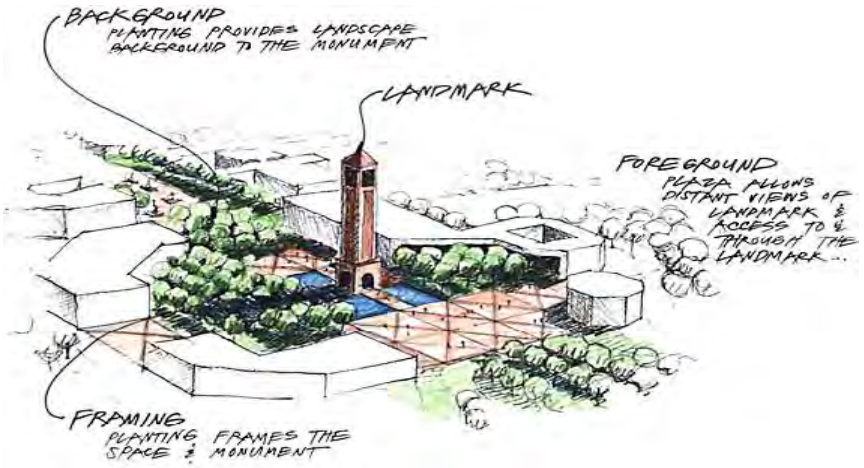
Figure B-2.1 Example of a Comprehensive Summary of the Results of a Visual Analysis



B-2.2.1 Visual Quality

Achieving, enhancing, and maintaining a high level of visual quality strengthens DoD institutions. The visual and physical environments where people work and live have significant effects on their attitudes and quality of life. Provide a framework for accomplishing improvements and enhancements to the visual environment.

Figure B-2.2 Example of How Landmarks Orient Users in the Landscape



B-2.2.2 Factors Affecting the Visual Environment

Land, water, vegetation, buildings, and other physical features shape installations. Our perception of the visual environment is influenced by the following elements:

- Natural Influences: Natural factors that may affect the character of an installation include landform, the presence and characteristics of vegetation, water, and climate.
- Land Use and Facility Siting: The way that land is used, and the relationship of those uses affects overall form, visual and spatial character of a site.
- Circulation Characteristics: The arrangement of vehicular, pedestrian, and bicycle movement corridors plays a significant role in how people perceive an area.
- Urban Design and Development Form: Density, the expression of building form, height, massing, and scale, gives character and form to the space.
- Architectural Style, Building Materials, and Colors: The consistent application and use of building style, materials, and colors, in combination with the principles of building form, mass, and scale.
- Open Space Development: Definition of spaces, buffers uses, softens large expanses of paving, reinforces vehicular and/or pedestrian corridors and enhances the settings of buildings.
- Site Furnishings: Provides an opportunity to create visual design continuity and compatibility.
- Hardscape and Paving Materials: Provides an opportunity to create consistency and continuity on the ground plane and denotes areas of special function.
- Historical and Cultural Features: Can form the basis of a visual theme or image for the installation.
- Dominant Features and Views: Provides opportunities for the formulation of a theme or image.

B-2.2.3 Visual Analysis Summary

Prepare a graphical summary analysis with annotations. Use photographs and/or sketches that illustrate the nature of the findings to support the summary analysis. Develop supporting narratives to document the characteristics, quality and condition of the analyzed components.

B-2.2.3.1 Visual Analysis Requirements

A visual analysis summary includes the following:

- Priority Problem Areas and Opportunities;
- Visual Improvement Recommendations;
- Image and Theme; and
- Priority Projects Development.

B-2.2.3.2 Analysis Elements

Include the following elements in a visual analysis summary:

- Entrances;
- Corridors;
- Vehicular Hierarchy;
- Pedestrian and Bikeway Corridors;
- Edges;
- Visual Districts;
- Activity Nodes;
- Vehicular Nodes;
- Pedestrian Plazas and Open Spaces; and
- Landmarks.

B-2.3 Natural Landscape Analysis

The natural landscape consists of elements and processes inherent in a site. The natural landscape can provide constraints and opportunities for the design process. Manipulate the natural landscape to create places; however, first analyze the site's natural landscape in order to design a sustainable site that maximizes environmental benefits.

B-2.3.1 Natural Landscape Elements

Analyze the potential impacts of the following natural elements prior to design:

- Topography: The natural terrain is a major determinant of the layout and form of the installation and specific site. Maintaining the natural topography of the

installation helps to prevent erosion. Existing landforms on a site can be natural or constructed landforms. Use both natural and constructed in conjunction with each other, including berms, swales, and terraces.

- Wetlands: Wetlands provide a resource for storing stormwater, recharging groundwater, and wildlife. All wetlands on federal lands must be identified and protected throughout the site design and construction processes.

- Vegetation: Existing vegetation on an installation, especially trees, is an asset, and analyzing the type, amount, and condition of the vegetation is an important step to understanding the site. Design the installation or site to protect and preserve existing native vegetation to reduce maintenance and enhance sustainability. Examine sites to determine both individual species and plant associations.

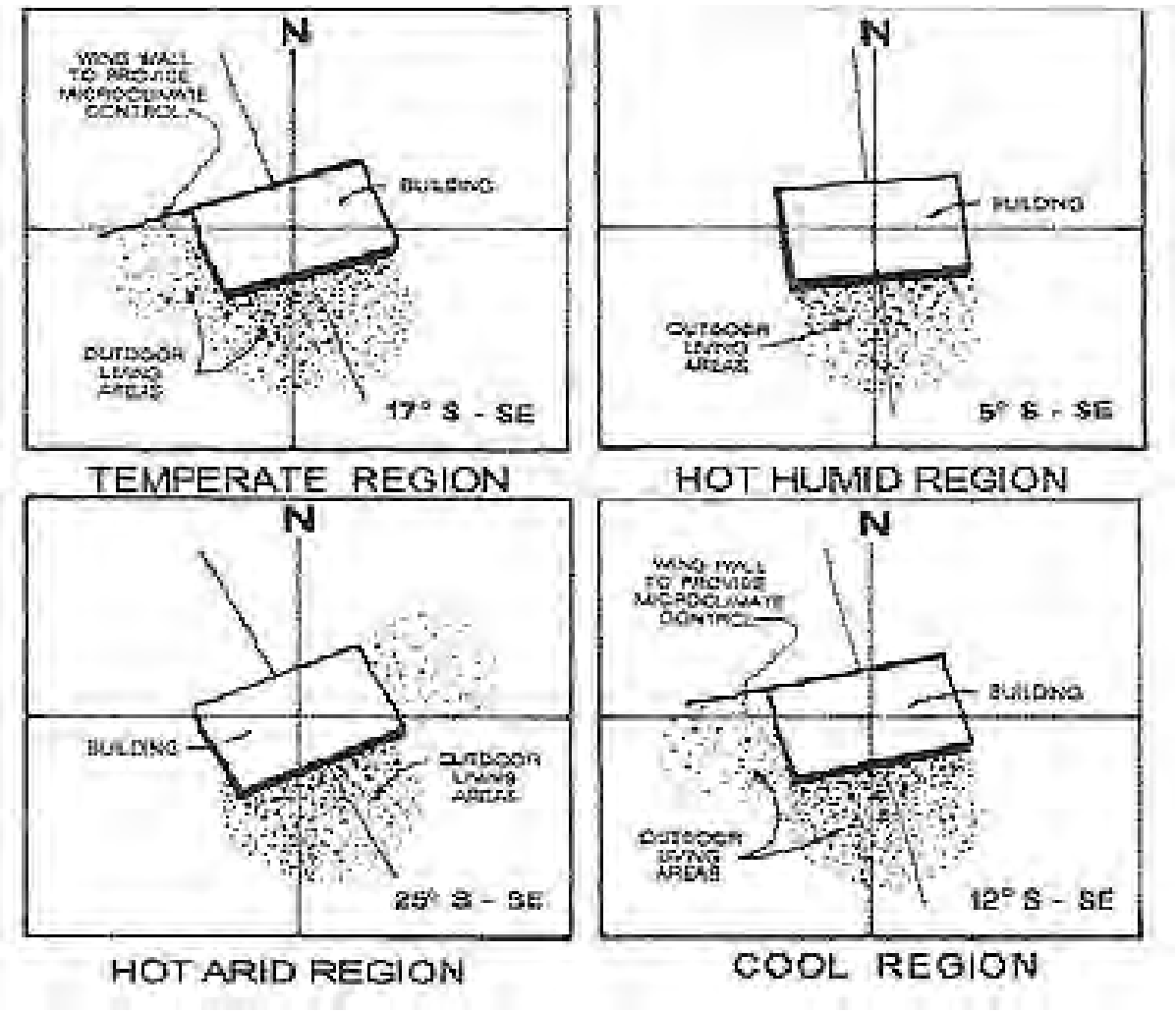
Figure B-2.3 Shrubs, Trees, and Berms Used to Screen a Parking Area

- Prevailing Winds: Whether to encourage winds to cool outdoor spaces in a hot, humid climate or to decrease winds to prevent erosion, understanding the prevailing winds is an important aspect of natural conditions. Interaction of winds with other natural elements will impact design decisions. Because they are most effective when placed perpendicular to the direction of the wind, use windbreaks only where the direction of erosive-force winds is predictable.

- Climate: Climatic considerations are important to human comfort and energy efficiency. Individual installations should maintain design guidelines that respond to local climatic conditions. Evaluate the site-specific microclimates by

determining how the general weather conditions are influenced by such site elements as topography, vegetation, water bodies, and built elements, including buildings, airfields, and parking lots. The principal climatic variables are radiant energy, temperature, air movement, and humidity.

Figure B-2.4 Building Orientation



B-2.3.2 Natural Landscape Processes

Erosion and drainage are both natural processes that occur on a site. Developing a site can increase the rate of these processes; however, there are design choices that can mitigate the impact.

B-2.3.2.1 Erosion

Erosion is influenced by a number of factors, such as soil type, vegetation, and topography; it can be accelerated by various activities that occur on an installation. While there are many

aspects of erosion that can be controlled during initial site design and planning, a long-term management plan is best.

Conduct and maintain an existing conditions survey for the entire installation, but prepare a similar and more detailed survey for proposed construction projects, identifying site-specific factors that may affect erosion and influence project design. The existing conditions survey provides the physical data upon which to base an analysis of erosion potential. Such conditions include topography, drainage patterns, soil types, the extent and kind of vegetative cover, impermeable surfaces, and above- and below-grade drainage structures.

B-2.3.2.1.1 Erosion Process

The soil erosion process involves the dislodging, transport, and deposition of soil particles. These forces are at work whether erosion occurs on a large flat surface, a slope, or in a drainage way or other waterway. Factors that influence soil erosion include soil characteristics, vegetative cover, slope, water, and wind.

B-2.3.2.1.2 Erosion Control Planning Process

In order to achieve effective erosion control, follow a logical and comprehensive planning process. This process should include an analysis of potential existing conditions survey, an erosion survey, and an erosion control plan. While the results of this process are shown on grading and drainage plans for proposed construction projects, it should also be applied to an analysis of erosion potential throughout the installation to determine *corrective* actions for existing problems and *preventive* measures for potentially erosive conditions.

B-2.3.2.1.2 Vegetative Soil Stabilization Measures

Vegetative stabilization measures employ plant material to protect soil exposed to the erosive forces of water and wind. Vegetation above the surface reduces the impact of precipitation, provides direct protection of the soil from wind, intercepts and slows runoff, and removes water from the soil through evapotranspiration. Below the surface, vegetation helps to bind the soil and increase the infiltration of runoff. Areas that will benefit from vegetative soil stabilization include:

- Slopes;
- Channels;
- Large flat areas;
- Areas susceptible to wind erosion;
- Seeding areas; and
- Planting pre-grown stock planting areas.

B-2.3.2.1.3 Structural Soil Stabilization Measures

Structural soil stabilization measures involve the physical control of a potentially unstable condition. This includes the modification of site grades and the use of structural elements to retain or provide structure for soil. Structural soil stabilization measures include:

- Slope reduction and compaction;
- Retaining walls; and
- Soil covering.

B-2.3.2.2 Drainage

Drainage incorporates all the natural drainage corridors, floodplains and waterways located on the site. Included in these waterways are wetlands, which require special protection under the Federal Clean Water Act. Increasing or decreasing the amount of water flowing into the waterways can dramatically affect natural ecosystems. Initial goals for site development should, at minimum:

- Preserve and maintain natural drainage areas and floodplains.
- Limit development in floodplains to open spaces and recreation uses.
- Preserve wetlands, rivers, lakes, streams, or other waterways, and incorporate them into the design layout.
- Maintain stormwater infiltration to recharge the groundwater system.

Figure B-2.5 Example of Environmentally Sensitive Site Design

B-2.3.2.2.1 **Stormwater Systems Design**

Stormwater systems move runoff from circulation areas, and can help clean contaminants picked up from parking areas, roofs, and the air. Stormwater systems are most efficient when considered early in the site design process. Create a sensitive stormwater system with the following benefits:

- Water conservation;
- Groundwater recharge;
- Erosion control;
- Sedimentation control;
- Contaminant control; and
- Wildlife habitat preservation.

Design surface and subsurface drainage systems to control the amount of sediment leaving the site. Use these systems in combination to slow water and divert it from exposed soils or other vulnerable areas.

B-2.3.2.2.2 **Runoff from Impermeable Surfaces**

Streets, paved parking lots, roofs, and other impermeable surfaces allow no infiltration of runoff and provide little resistance to flow. Runoff draining from these surfaces can be highly concentrated and move at a velocity greater than runoff flowing over an unpaved surface. Soils must be protected from this erosive force, particularly at the edges of impermeable surfaces and soils. Figure B-2.6 shows a bioswale for runoff from a parking lot.

At airfields, the accumulation of runoff from runway, apron, and taxiway pavements can be considerable, see \1\UFC 3-260-01, *Airfield and Heliport Planning and Design*./1/

Figure B-2.6 Bioswale with Native Planting

B-2.3.2.2.3 **Detention**

On-site detention of runoff protects adjacent property from erosion, and prevents sediment from discharging off site. Detaining runoff allows suspended soil particles to be filtered or settle out before the runoff is released. After sediment has been trapped, runoff can be released from the basin at controlled rates to reduce the erosion potential. Figure B-2.7 shows a detention pond incorporated as a design element.

Airfield planning guidance permits water bodies, including retention and detention ponds, within runway clear zones and accident potential zones. See \1\UFC 3-260-01/1/ for more information.

Figure B-2.7 Example of a Retention Basin Functioning as a Design Element

B-2.3.2.2.4 **Sustainable Stormwater Management**

Several techniques and technologies allow for a wide variety of stormwater management systems. The techniques described below can be integrated in a comprehensive system to make a site more sustainable. Many of the techniques listed have accepted quantifiable results and are gaining popularity and acceptance with local regulators.

- Permeable paving;
- Paving;
- Rain gardens;
- Gardens;
- Bioswales;
- Wet ponds;
- Ponds;
- Constructed wetlands;
- Wetlands;
- Bioretention; and
- Green Roofs (see figure B-2.8 for example.)

Figure B-2.8 Beginnings of a Green Roof

Refer to the most recent LEED point system for specific goals to help towards certification. A minimum site design should aim to achieve the following:

- Limit runoff rate and quantity;
- Control erosion during construction and for the life of the site;
- Select sites away from sensitive areas, including wetlands;
- Reduce site disturbance during construction;

- Protect or increase open space on existing heavily -developed sites;
- Treat stormwater to eliminate contaminants, such as suspended solids and phosphorous; and
- Grade the site to increase water efficiency for planting areas.

B-2.4 Historical and Cultural Landscape Elements

Historic sites and structures can be community and cultural focal points. Historic resources include buildings, sites, objects, structures, and districts. A site may be in an area significant for its historic or archaeological importance or for its cultural importance. Structures or sites listed on, or eligible for, the National Register of Historic Places may pose development constraints.

B-2.5 Site Plan

After a thorough analysis, a site plan refines the preferred spatial relationships and accommodates the program into a hardline plan for the site. It provides accurate location, dimensions and elevations for facilities and site improvements. This concept plan can identify potential conflicts and problems, preventing costly changes later in the process. The site plan provides sufficient detail to serve as the basis for construction documents for the project. The concept site plan does not resolve all the site problems, but indicates, at a minimum, how they will be addressed and their costs.

B-2.5.1 Landscape Development Zoning Plan

Landscape development zoning defines the level of landscape treatment a particular area or facility should receive. It is the basis for budgeting for future landscape development. The landscape development zoning plan graphically depicts these zones to assist installation landscape programming, design, construction, and maintenance.

There are three zones of landscape development: primary, secondary, and tertiary. Landscape development zones are created through analysis of facilities and surrounding areas. Determine the intensity of landscape development by looking at the areas in terms of visual and historical significance, visitor frequency, proximity to major circulation routes, and other criteria specific to the installation.

B-2.5.1.1 Primary Zone

The primary zone is an area that is highly significant to the perceived visual quality and image of the installation. Facilities listed below commonly occur in the primary development zone. These facilities warrant additional funds for landscape design, construction, and maintenance.

- Main gate(s);

- Command and Headquarters buildings;
- Primary administration offices;
- Community Center;
- Main roadways;
- Visitor Center;
- Significant static displays and parade grounds;
- Billeting office;
- Distinguished Visitor quarters;
- Hospital;
- Airfield entrance to Base Operations;
- Clubs;
- Base Operations facility;
- Military Family Housing areas (MFH); and
- Golf clubhouse and course.

B-2.5.1.2 **Secondary Zone**

The secondary zone contains most of the remaining developed areas of an installation. Many facilities in this area are important in the daily lives of the installation's community, but extensive landscape development is not essential due to lower visibility and maintenance budget requirements.

This zone is a transition between what is generally a highly developed primary zone and the functionally and simply developed tertiary zone. Consistent and proper project programming and design become paramount as the secondary zone can be significant in creating a positive visual image for the installation.

- Base Civil Engineering facility;
- Fitness Center;
- Family Support Center;
- Squadron Operations facilities;

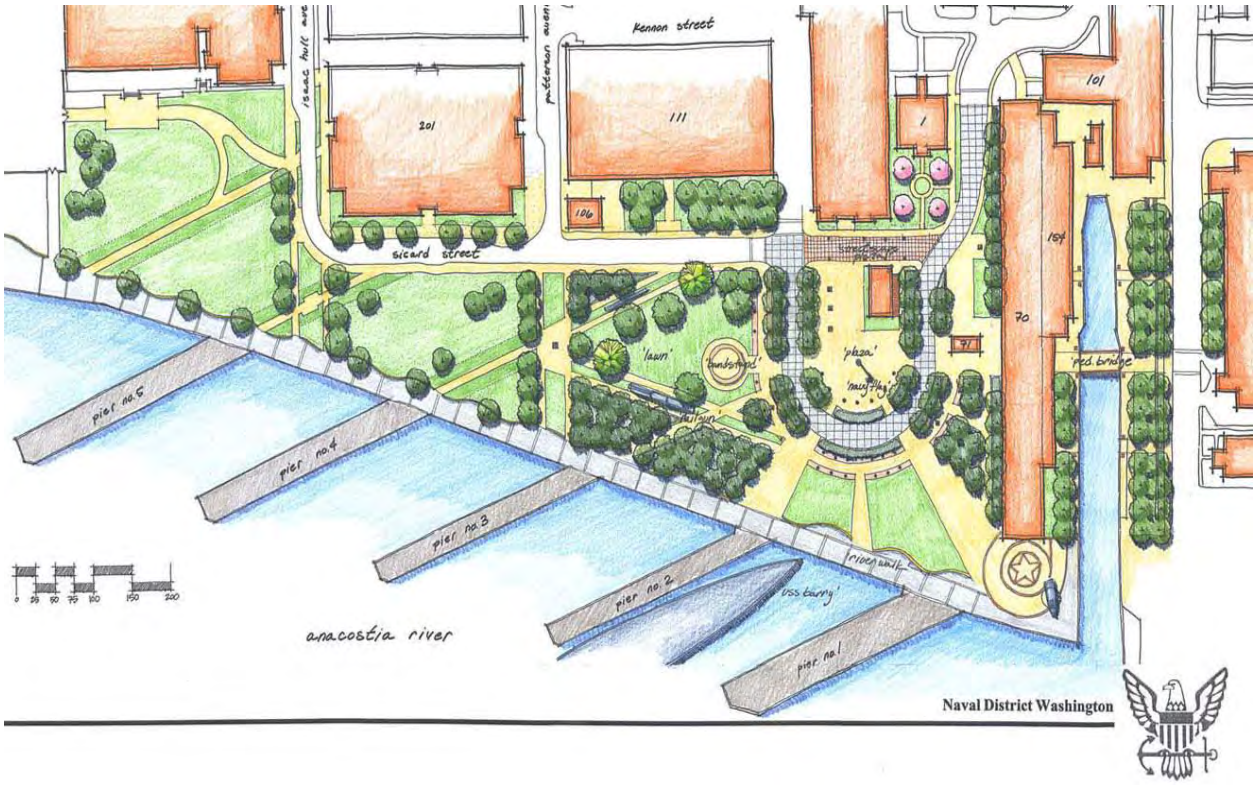
- Credit Unions and banks;
- Bowling Center;
- Fam Camp;
- Convenience stores;
- Undeveloped areas or open space in MFH; and
- Moderate public visibility areas of perimeter fence.

B-2.5.1.3 **Tertiary Zone**

The tertiary zone encompasses those areas that will require little to no long-term landscape development. Many of these areas are adjacent to the flightline, in or near clear zones, or serve as buffer areas around the installation. Most of the areas should be left natural. Maintenance requirements in the tertiary zone are minimal, typically consisting of rough mowing or managing of grassy areas. Wooded areas require even less maintenance.

- POL tank farm;
- Munitions storage facilities;
- Operations side of runway facilities;
- Civil engineer storage and shop areas;
- Forested areas outside of cantonment area;
- Service roads;
- Water treatment facilities;
- Test cells;
- Limited public visibility areas of perimeter fence; and
- Security areas.

Figure B-2.9 Example of Site Plan for a Park



B-2.5.2 Site Plan Elements

Figure B-2.1811 shows an example of a site plan. The level of detail may vary with the size of the site; however, the site plan should address the following principle considerations. Many of these topics are discussed in greater detail in other sections of this UFC.

B-2.5.2.1 Construction Lines

This plan locates critical construction lines (e.g. setbacks, easements, or building spacing). Many of these regulations are dictated by security or force protection standards; review the most current standards, and keep abreast of changes.

B-2.5.2.2 Buildings

This plan precisely defines the location of the building footprints, identifies all entrances, including fire exits, and refines the outdoor space between facilities.

B-2.5.2.3 Vehicular Circulation and Parking

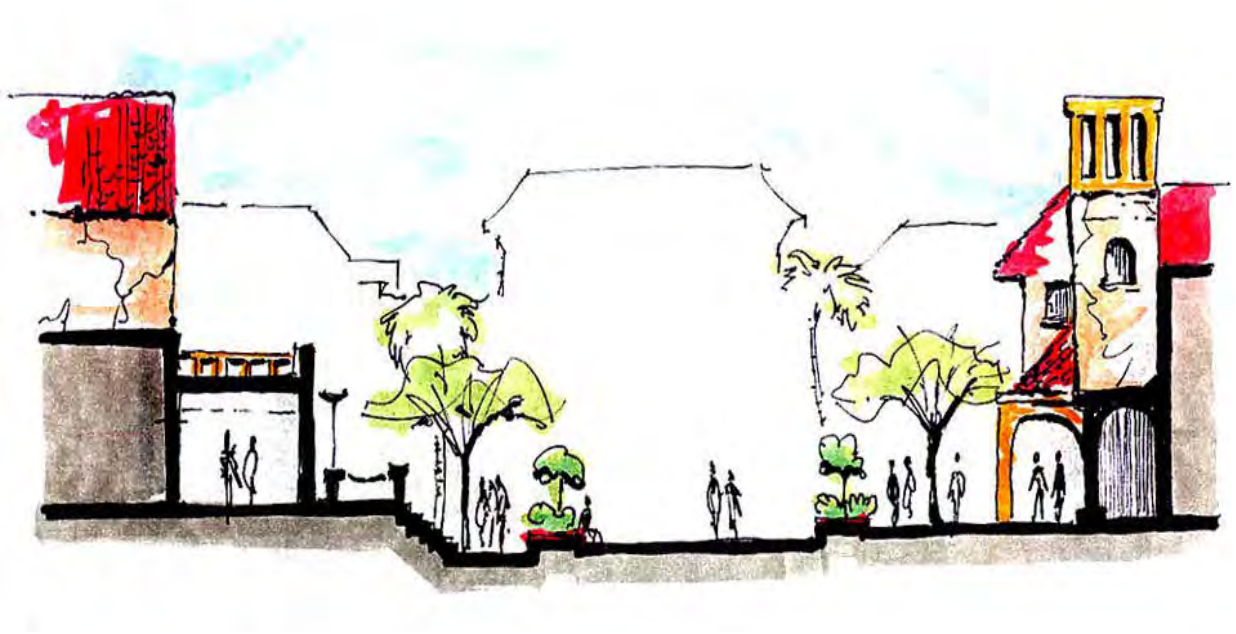
This plan defines access, service, and emergency drives. It defines parking areas, including delineated parking spaces, barrier-free spaces, proper count, and islands and medians. Indicate turning radii throughout the site, including sufficient turnaround room for service and

emergency vehicles. Locate and properly delineate elements such as gates, drop-off areas, and dumpster pads.

B-2.5.2.4 Pedestrian Circulation

This plan refines pedestrian circulation to assure clear, convenient, and safe flow of pedestrian movement both within the site and connecting to adjacent sites. Assure barrier-free accessibility between buildings and from barrier-free parking spaces to at least one building entrance, including the location of any necessary ramps. Identify means of using topography and plant material to help direct pedestrian flow.

Figure B-2.10 Example of Spatial Relationships of a Site Design



B-2.5.2.5 Grading and Drainage

This plan establishes an overall grading concept for the site, showing proposed contours and critical elevations. Locate and provide critical elevations for structures, including retaining walls and steps, needed to facilitate grading conditions. Define and locate proposed stormwater management areas on site. Determine the need for and location of retention or detention ponds. Indicate methods of controlling erosion or sediment.

B-2.5.2.6 Energy Conservation

This plan responds to climatic conditions.

B-2.5.2.7 Utilities

This plan defines the locations of utility lines, and identifies access points from the supply lines and entry points into buildings. Ensure that utility lines are not located under proposed paved areas to facilitate line maintenance and repair.

B-2.5.2.8 Lighting

The site plan develops a preliminary lighting coverage scheme and identifies areas requiring higher lighting levels or special lighting. See \1\UFC 3-520-01/1/ for more information on lighting.

B-2.5.2.9 Physical Security

This plan indicates proposed security measures to comply with force protection standards.

B-2.5.2.10 Landscape Plantings

This plan refines the planting scheme by broadly describing the types of vegetative massing and lawn areas.

B-2.5.2.11 Outdoor Spaces and Site Amenities

This plan refines the design for outdoor areas and gives preliminary consideration to the location of site features.

B-3 CIRCULATION SYSTEMS

This chapter provides information regarding vehicular circulation, parking, bikeways, and walkways. While each of these systems has distinct guidelines for design, coordinate the location and interaction of these systems. Streets and sidewalks are important landscape elements because they connect centers of activities.

B-3.1 Role of the Landscape Architect

The circulation plan for each project should incorporate the following:

- Encourage circulation patterns that reduce the need for automobile use.
- Design a pedestrian system that is logically connected from start to finish, meets Americans with Disabilities Act Accessibility Guidelines (ADAAG) and other width regulations, and is separated from vehicular traffic.
- Design principals and elements, including scale, street trees, material selections, and site furnishings, to delineate and clarify wayfinding.
- Sustainable design solutions for parking areas, such as bioswales and permeable surfaces.

B-3.2 Streetscapes

The roadway system on DoD installations not only provides the primary means of circulation, but is also the major vantage point from which the installation is viewed and comprehended. The streetscape environment consists of the roadways and the visual corridors through which they pass. Elements within these visual corridors include landscape planting, signs, light fixtures, site furnishings, walkways and bikeways, utilities, and the roads themselves. A well-planned streetscape system reinforces the vehicular circulation system hierarchy, reduces potential safety conflicts, and enhances the visual image of the installation.

According to \1\UFC 3-210-02/1/, *POV Site Circulation and Parking*, a multi-disciplinary team of design professionals is responsible for developing a streetscape system. This team must include, and is often led by, a landscape architect. See \1\UFC 3-210-02/1/ for detailed requirements of turning radii, street widths, sight lines, parking layout and geometry, and special areas including drop-off zones. Once a system is designed, a streetscape may be implemented as a standalone project or as part of various projects throughout the installation.

Figure B-3.1 Example of a Streetscape with Pedestrian Elements

B-3.2.1 Streetscape System Design Process

In order to successfully integrate the diverse elements of the streetscape, the streetscape design process should be logical and comprehensive, and should include an existing conditions survey, a corridor identification analysis, and a streetscape corridor plan.

Use a streetscape hierarchy to effectively clarify circulation, and apply it consistently throughout an installation. Elements to be included in each corridor type include vegetation, lighting, site furnishings, and crosswalks.

B-3.2.2 Streetscape Elements

Address the following elements in the streetscape design process:

- Medians;
- Pedestrian buffer;
- Force protection;

- Entrances;
- Streetscape image;
- Streetscape planting;
- Furnishings;
- Signs and signals; and
- Paving materials.

B-3.3 Parking Areas

Parking areas that are concurrently designed and developed with facilities are more efficient and less costly than stand-alone parking projects. Determine parking requirements and assess opportunities to reduce the size of parking area lots and other means.

Figure B-3.2 Example of Incorporating Pedestrian Circulation into Planting Design

B-3.3.1 Design Considerations

Refer to \1\UFC 3-210-02/1/ for details relating to required geometry and sizes of parking areas. Parking lots should be easy to use and safe for both vehicles and pedestrians, while mitigating adverse stormwater impacts stemming from the increase of impervious surfaces. Other considerations for parking lot design include:

- Siting;
- Orientation;
- Geometry;
- User walking distance;
- Islands;
- Maintenance;
- Stormwater runoff; and
- Lighting and safety.

Figure B-3.3 Example of Adequate Walkways in Parking Lots

B-3.3.2 Reducing Heat Island Effects

Heat islands are created when heat from the sun is absorbed by dark, non-reflective surfaces, particularly roofs and parking lots, and radiated back into surrounding areas. The resulting ambient temperatures in areas with significant impervious surfaces are artificially elevated by

10 degrees or more, increasing cooling equipment and operational costs in surrounding buildings. Good landscape design can mitigate heat island effects by providing trees, which cool the environment through shade and transpiration, and by using light-colored materials that reflect heat.

Figure B-3.4 Example of Sustainable Parking Lot

The U.S. Green Building Council's (USGB) Leadership in Energy and Environmental Design (LEED) suggests that providing shade and using appropriate materials significantly reduces heat island effects in parking lots. To effectively reduce such effects and increase energy savings, materials used in parking lots should be highly reflective over the life of the product. Specify highly reflective materials for non-vehicular areas including walkways and plazas.

There are new coating and integral colorants that can be used in parking surfaces to improve solar reflectivity. If such products cannot be used, consider an open paving system that increases perviousness by at least 50%, reducing the amount of low reflective material and increasing infiltration of stormwater. Open grid paving systems cannot withstand high-traffic areas; however, they are ideal for overflow parking areas. Shade trees can significantly decrease heat island effects by lowering the ambient temperature. Design strategies and landscaping schemes should reduce solar heat absorption of exterior materials.

Figure B-3.5 Example of Parking Lot with a Permeable Parking Surface and Bioswales

B-3.3.3 Controlling Runoff

Parking areas typically create large amounts of runoff, taxing stormwater management systems. Techniques that help mitigate the runoff include bioretention, bioswales and strategically placed detention areas.

Figure B-3.6 Example of Drainage Solution in Parking Lot

Reducing the size of parking lots is ultimately the best way to minimize negative effects of impervious surfaces. Scrutinize the parking requirements; parking lots may not need to be

designed for peak use. Overflow parking areas constructed of pervious materials may meet the occasional peak demand, reducing stormwater runoff and increasing on-site infiltration.

B-3.3.4 Horticultural Requirements

Parking areas are not normally conducive to healthy plant growth. Reflected sunlight, heat, and exhaust fumes pose challenges to plants. Non-porous pavement eliminates essential water exchange between plant roots and the atmosphere. For healthy plant growth, it is important to protect vital plant components (- roots, trunks, and leaves) - by providing adequate space for root growth and protecting the roots from cars.

Figure B-3.7 Examples of Adequate Planting Areas in Parking Island

B-3.3.5 Tree Selection Criteria

Trees are the most effective means of improving the aesthetics of parking areas. Some species are more appropriate than others for parking lots. Select trees with the following characteristics:

- Provide medium-to-dense shade in summer;
- Have normal lifespans over 60 years;
- Thrive in a typical urban environment;
- Demonstrate tolerance to salt and de-icing compounds where applicable - examples of tolerant trees are red oak, white oak, and red cedar;
- Require little pruning and are structurally sound; and
- Resist insects and diseases.

B-3.4 Bikeway and Walkway Planning Process

The automobile has become the primary means of transportation between the home, workplace, and community and commercial areas. Alternative circulation systems, including walkways for pedestrians and bikeways for bicyclists, can help reduce problems related to automobile travel, including traffic congestion, the consumption of resources, air pollution, parking area requirements, and potential safety conflicts. Adequate pedestrian and bicycle networks provide convenient, efficient, and aesthetically pleasing pathways and create opportunities for healthy activity. The objectives for walkway and bikeway networks include:

- Connect continuous pathways to community path systems where possible;
- Provide accessible pathways to all users, including challenged persons;
- Reduce safety conflicts between pedestrians, bicyclists, and automobiles;
- Provide amenities for the pedestrians and bicyclists; and
- Provide design consistency throughout the pedestrian and bicycle networks.

B-3.4.1 Planning Process

In order to create successful pedestrian and bicycle networks, develop an existing conditions survey, an origin-destination study, an adequacy analysis, and a network plan.

B-3.4.2 LEED Credits

LEED gives credits for encouraging alternative transportation, including public transit, bicycles, and alternative-fuel vehicles. In order to receive credit for alternative transportation using bicycles, the project must include adequate, secure bicycle storage and changing/shower facilities.

B-3.4.3 Fitness Trails

Military personnel must maintain a good level of physical fitness. Outdoor trails provide an alternative to indoor fitness centers. Lighting can extend the use of the trail into evening or early morning hours. Furnishings provide additional amenities along the trail. Coordinate fitness trails with other circulation systems for safety and usability.

B-3.4.4 Bikeways

Plan and design bikeways according to classifications that define the level of separation from roadways and walkways. Ideally, bikeways should be separate from both walkways and roads. When designing a bike path, key considerations include:

- Pavement widths;

- Bikeway clearances;
- Paving materials;
- Gradients and curvature;
- Stopping distances;
- Street crossings; and
- Signage.

B-3.4.5 Walkway Network Hierarchy

Based upon projected levels and types of use, design a hierarchical pedestrian circulation system that organizes walkways into a logical network according to each segment's function and reinforces the function through the width, treatment, amenities, and location of each segment.

Figure B-3.8 Example of Pathway Hierarchy

B-3.4.6 Troop Movement Walkways

Troop movement walkways are specific to military installations. Include special design considerations if the installation will have troops that regularly move from one location to another. Troops move four abreast, and a minimum of 10 ft (3 m) of unobstructed width should be provided.

Figure B-3.9 Troop Movement Walkway

B-3.4.7 Walkway Location

Locate walkways in response to the levels and patterns of user demand. Walkways should provide direct routes between destinations; however, walkways may instead provide physical and visual continuity where the pedestrian network may be otherwise discontinuous.

B-3.4.8 Crosswalks

Locate and clearly designate crosswalks to encourage pedestrians to use safe street crossings. Include crosswalks in all street intersections where there is pedestrian traffic. The design of crosswalks should follow these guidelines:

- Mark crosswalks with clearly visible painted stripes or by street paving that is consistent with the walkway paving material.
- Crosswalks should be the width of the adjacent walkway, but a minimum of 6 ft (1.8 m) wide.
- Provide curb-cut ramps for wheelchair access at each crossing. Apply a textured finish or raised devices to the ramp to indicate the vehicle roadway.
- Maintain sight lines to give both pedestrians and drivers an unobstructed view.

- Where a walkway and bikeway intersect, provide pavement markings to warn both pedestrians and bicyclists of the others' presence.

B-3.4.9 Steps and Ramps

Minimize the use of steps and ramps along walkways because they are more difficult to negotiate or, for some users, impassable. Gradients of 3 percent or less are preferred along walkways, and any walkway that exceeds a 4.2 percent gradient should be designated as a ramp. Follow the requirements of the Americans with Disabilities Act Accessibility Guidelines (ADAAG), and Uniform Federal Accessibility Standards (UFAS).

B-4 COMMON AREAS

Common areas include plazas, courtyards, parade grounds, recreational areas, landscape architecture at main gates, building entrances, playgrounds, and monuments. Design of common areas is similar to site design and the planning of circulation systems.

B-4.1 Role of the Landscape Architect

Coordinate and oversee the common area design process, which includes the following responsibilities:

- Provide a detailed analysis that includes a thorough assessment of visual, natural, cultural, and historical resources.
- Study design opportunities and constraints that will contribute to the resulting form of the common area.
- Design common areas to incorporate the overall circulation system and contextual surroundings.
- Select permeable surface materials for common areas unless an impermeable surface is a user requirement.

B-4.2 Plazas and Courtyards

The design process of a plaza or courtyard follows the same principles established in the site design and circulation systems described in the previous chapters.

B-4.2.1 Analysis

Conduct a visual analysis of the site and adjacent areas. Identify any buildings or structures that frame the space, and understand the scale relationships between these structures and the proposed open space. Other important analyses include context, views into and out of the site, destination points, circulation, topography, color, line, mass, and void.

Plazas and courtyards are typically proposed in urban environments, but natural resources play a significant role in the design process. Hydrologic systems and vegetative cover can affect a courtyard's resulting form. Both the locations of existing vegetation and the drainage requirements of a plaza or courtyard site may result in constraints on proposed utility locations and other structures that affect the proposed form and organization of the courtyard or plaza. Other natural variables include climate and topography.

The public benefits from interpretive elements of cultural and historic resources. Many DoD installation landscapes provide this opportunity, and all future plaza and courtyard installations should be assessed for such value.

Figure B-4.1 Illustration of a Courtyard

B-4.2.2 Programmatic Considerations

Most plazas and courtyards need space for group gathering and events. In these instances, it is appropriate to allow approximately 4 ft^2 (0.36 m^2) to approximately 12 ft^2 (1.1 m^2) per person. Different size requirements result in different spaces, including an intimate space or a larger, more open space that allows fluid circulation.

B-4.2.3 Materials

Types of impermeable surface materials that can be used in plazas and courtyards include, but are not limited to, unit pavers, concrete, and special paving. Asphalt is typical for vehicular applications and ball courts. Communicate with local paving suppliers and vendors for the availability of paving options.

B-4.3 Parade Grounds

Parade grounds are traditionally manicured lawns. Parade grounds provide sober, formal spaces for military ceremonies, formation drills, parade and review functions, and honor ceremonies. Like plazas and courtyards, the size and shape of a parade ground is determined by its use. Perform a needs assessment of programmatic uses during the planning or renovation process.

The size of a parade field is typically one acre per 125 persons. Surfaces are turf where feasible, and must be stabilized where climate and other conditions dictate. A reviewing stand may be planned with a capacity based on 5 -percent of the total officer strength.

Figure B-4.2 Example of Parade Ground

B-4.4 Recreational Areas

Recreational areas discussed in this chapter refer to fitness trails, sports fields, picnic areas, and golf courses. Dependent upon region and programmatic use, surfaces can range from compacted dirt to wild flowers. Other possible surfaces are mulched trails, planting zones of trees and shrubs, and even recycled rubber tires. Design recreational areas according to the predominant use intent.

B-4.5 Entrances

Entrances, as discussed in this chapter, refer to both main gates and building entrances. As key indicators of image and importance, design entrances in collaboration with a multi-disciplinary team. Involve security personnel in entrance design to ensure that security requirements are met.

B-4.6 Playgrounds

The design of playgrounds involves understanding the needs of the users, assessing the constraints and opportunities of the site, and addressing security issues with an interdisciplinary team approach. Landscape architects have traditionally designed playgrounds and are able to incorporate environmental education, sports, recreation, and low-maintenance surface and planting materials into designs. \1\UFC 3-210-04/1/*, Children's Outdoor Play Area*, details the required elements for playground design. UFC 4-740-14, *Design, Child Development Centers* provides information regarding outdoor landscaping for child development centers.

Figure B-4.3 Playground with Safe Low-Maintenance Surfaces

B-4.7 Monuments

Monuments identify places, memorialize individuals, and commemorate events and missions that are significant to the history of a DoD installation. Monuments can be as simple as a memorial plaque attached to a building, or they can be statues or sculptures, historic military equipment, or other freestanding commemorative displays. With proper planning and design, monuments will fulfill their intended function as aesthetic and cultural objects, and contribute to the visual quality and identity of a DoD installation.

Monuments increase awareness of an installation's history and strengthen its image and identity by:

- Preserving historically or culturally significant objects or features;
- Commemorating places, events, individuals, and missions that are significant to the history and identity of the installation or the region; and
- Contributing to the visual quality of the installation.

Figure B-4.4 Static Display Included as Part of the Overall Site Design

B-4.8 Surface Materials

The benefits of impermeable surfaces are discussed below. When applicable, specify local materials for quality, timeliness in delivery, and local access for repairs. In addition, LEED encourages the use of local materials.

B-4.8.1 Impermeable Surfaces

Specify impermeable surfaces for common areas that must accommodate vehicular traffic and equipment such as bicycles, wheelchairs, strollers, roller blades, skate boards, and maintenance vehicles. A few of the many other common area uses that require an impermeable surface are ball courts, outdoor cafes, and swimming areas. Impermeable surfaces should only be used program requirements since they often increase stormwater runoff, increase light reflection, and can be more labor-intensive to construct and maintain than many permeable surfaces.

B-4.8.2 Permeable Surfaces

From an environmental, construction, and maintenance standpoint, permeable surfaces are preferred for common areas where possible. Permeable surfaces allow water to infiltrate through the ground's surface and recharge underground aquifers. They also result in less retention of heat than large masses of impermeable or hard surface paving.

Some permeable surfaces are more environmentally responsible and cost-effective than others. For example, turf grass typically requires irrigation, chemical treatments, and high levels of maintenance. Conversely, areas planted with low-maintenance local vegetation, including groundcovers, varieties of grasses, as well as combinations of trees and understory plantings, may not. Refer to the installation plant list for low-maintenance, drought-resistant planting options in the project's region.

B-5 PLANTING DESIGN

This chapter provides guidelines for the planting design process to produce functional, attractive, and sustainable landscapes.

B-5.1 Role of the Landscape Architect

The planting design process includes the following:

- A detailed analysis that includes a thorough assessment of existing vegetation, wildlife, sun-shade studies, soil types, climate, and user needs.
- Use of planting design, material, and maintenance procedures that are sustainable, manageable, and affordable.
- Planting plans that define space through mass, form, scale, line, pattern, texture, color, framework and variety.
- The selection of plants to ensure that they are indigenous or otherwise appropriate to the site.

B-5.2 Planting Design Goals

Planting plans should promote energy conservation, direct circulation, and minimize maintenance and irrigation requirements. The following sections highlight key goals for planting design on a DoD installation.

B-5.2.1 Sustainability

A sustainable planting design may initially cost more to install, but it can ultimately result in a more viable and attractive landscape. Strive to design using the latest sustainable techniques. Some of the benefits of sustainable designs include:

Requires less maintenance;

Maximizes installation operational efficiency;

Contributes to the overall visual quality of the installation;

Increases the quality of life on the installation; and

Increases erosion control.

B-5.2.2 Compatibility

The installation should promote a simple, low- maintenance planting style. To ensure consistency in planting design solutions, all landscape architects, design agents, and tenants should comply with the installation landscape development plan.

B-5.2.3 Maintenance

Landscape maintenance becomes the key issue considering dwindling budgets and personnel. Strategically select and locate plant material to minimize maintenance requirements.

Figure B-5.1 Dry Stream Bed Adjacent to an Outdoor Storage Lot

Figure B-5.2 Example of Planting Design Reducing Effects of Solar Glare and Reflection

B-5.2.4 Grading and Drainage

Consider the effects of heavy rainfall, drainage patterns, downspouts or roof drains, and potential ponding areas in the final planting design. Choose and locate plants and inert material to make drainage and grading elements more functional and attractive. In drier climates, grading and drainage should direct runoff to landscaped areas to minimize irrigation requirements.

Many projects may require retention or detention facilities to impound or delay storm water runoff, potentially creating special planting design situations. Opportunities for creative planting that alleviate extensive use of stormwater infrastructure include:

- Rain gardens;
- Bioswales;
- Wet ponds;
- Constructed wetlands;
- Bioretention areas; and
- Green Roofs.

B-5.2.5 Site Security

Planting design plays an integral role in the site security design. Choose plants to either open lines of sight or block views or movement of people. In sensitive areas, planting design must closely coordinate with security. See \1\UFC 4-010-01/1/*, DoD Minimum Antiterrorism Standards for Buildings*, for specific guidance. Installation should determine a list of low-growing plants that require minimum maintenance.

B-5.2.6 Functional Uses of Plants

Besides adding seasonal variety and beauty, use planting design to achieve the following functions.

- Energy conservation/temperature modification;
- Wind control;
- Noise abatement;
- Security;
- Glare control;

- Surface erosion control;
- Wildlife habitat; and
- Wetlands.

Figure B-5.3 Example of Low-Growing, Native Plants

Figure B-5.4 Example of Planting to Diffract and Break-Up Sound Waves

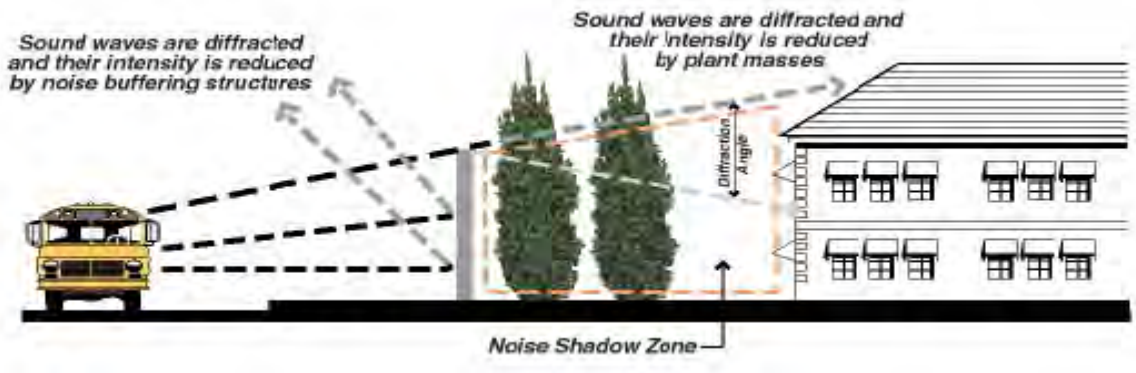
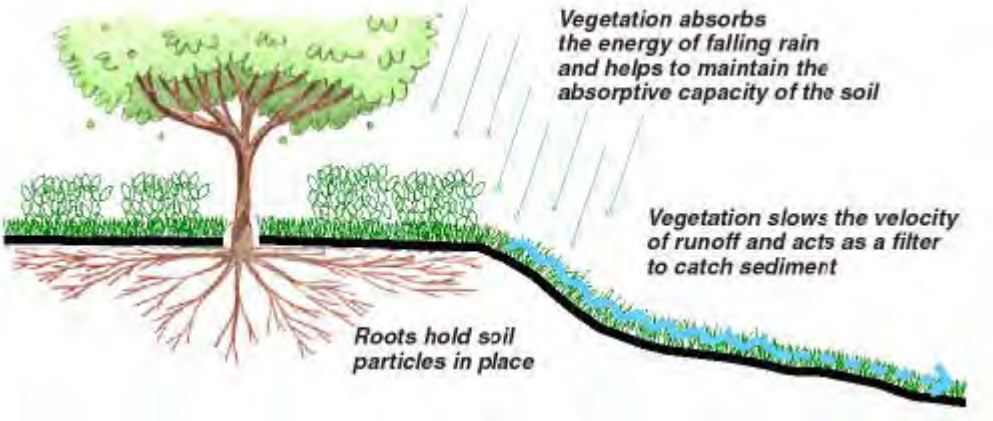


Figure B-5.5 Example of Planting to Prevent Erosion



B-5.2.7 Visual Effect

Use planting design to create the following visual effects through planting design:

- Streetscape wayfinding;
- Architectural softening;
- Visual barriers to physical movement;
- Screen undesirable elements;
- Accent key places or elements; and
- Parking area buffers.

Figure B-5.6 Example of Consistent Identity of Streets

(Formal [Left] and Informal [Right])

Figure B-5.7 Example of Trees Used as Architectural Elements to Frame Building Entry

Figure B-5.8 Example of Visual Barrier with Plants

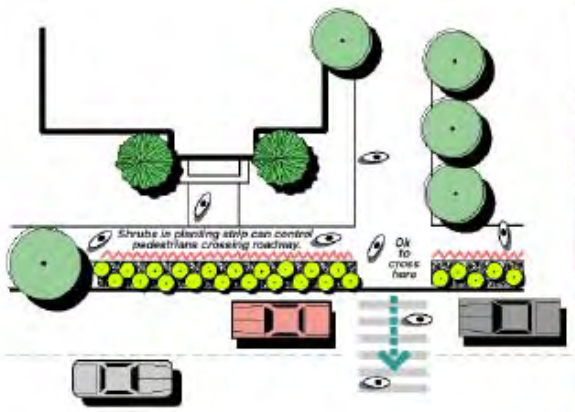


Figure B-5.9 Shrubs and Trees Buffer Pedestrian Walkways and Vehicular Traffic

Figure B-5.10 Trees Screen a Parking Structure

Figure B-5.11 Example of Parking Lot Screened by Native Planting Design

B-5.3 Design Process

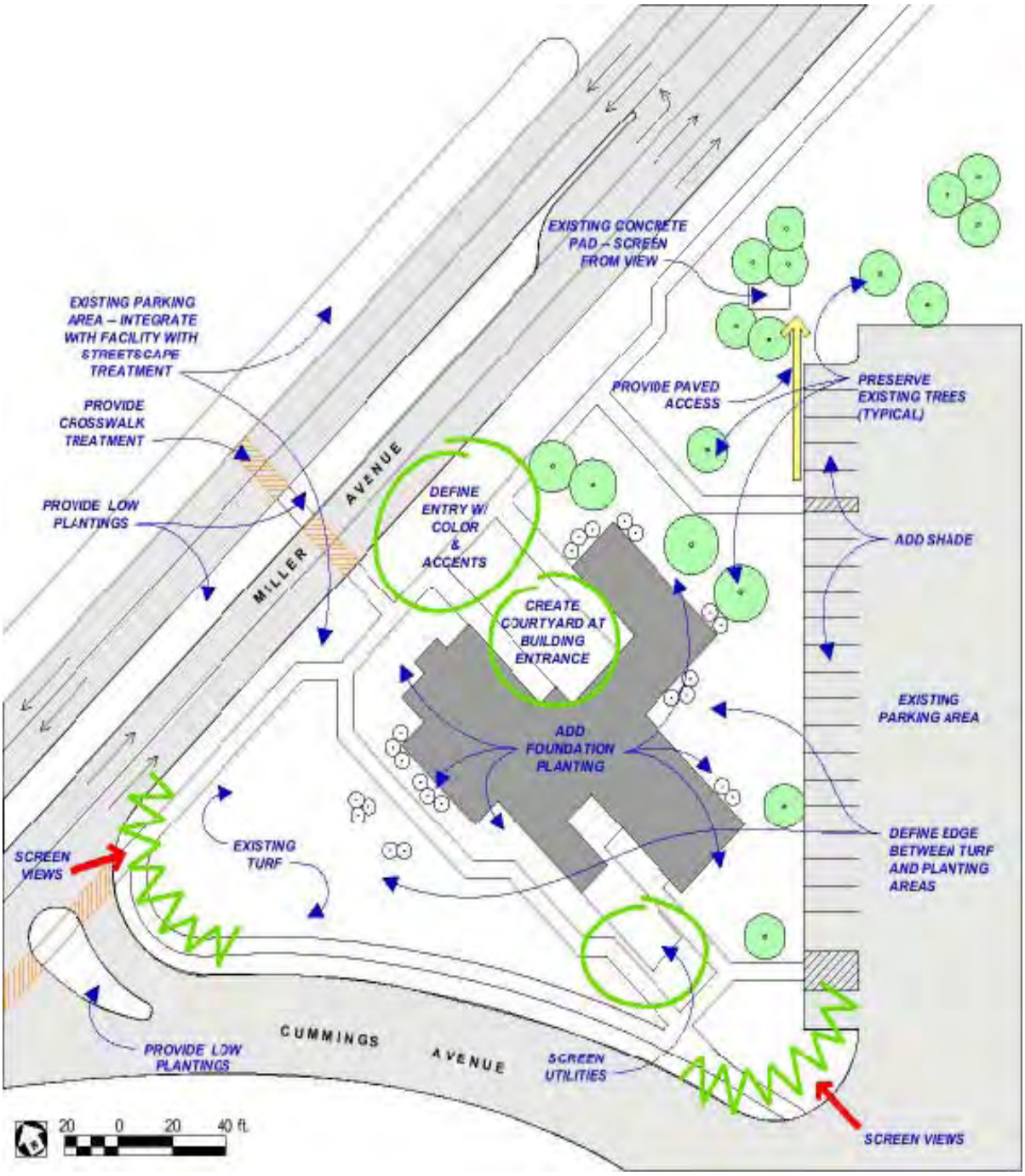
The planting design process closely parallels all successful problem-solving methods, and consists of three basic steps: analysis, concept, and implementation. Each of these steps has a graphic component. Before beginning a planting design, finish the site plan, including major site elements such as parking areas, screen walls, and sidewalks, and complete the following tasks:

- Determine existing vegetation to be saved;
- Determine major grading requirements; and
- Locate both proposed and existing utilities.

B-5.3.1 Analysis

Identify the functional areas, which will greatly assist in plant material location and selection later in the planting design process. See Figure B-5.12 for an example planting design analysis.

Figure B-5.12 Example of Planting Design Analysis

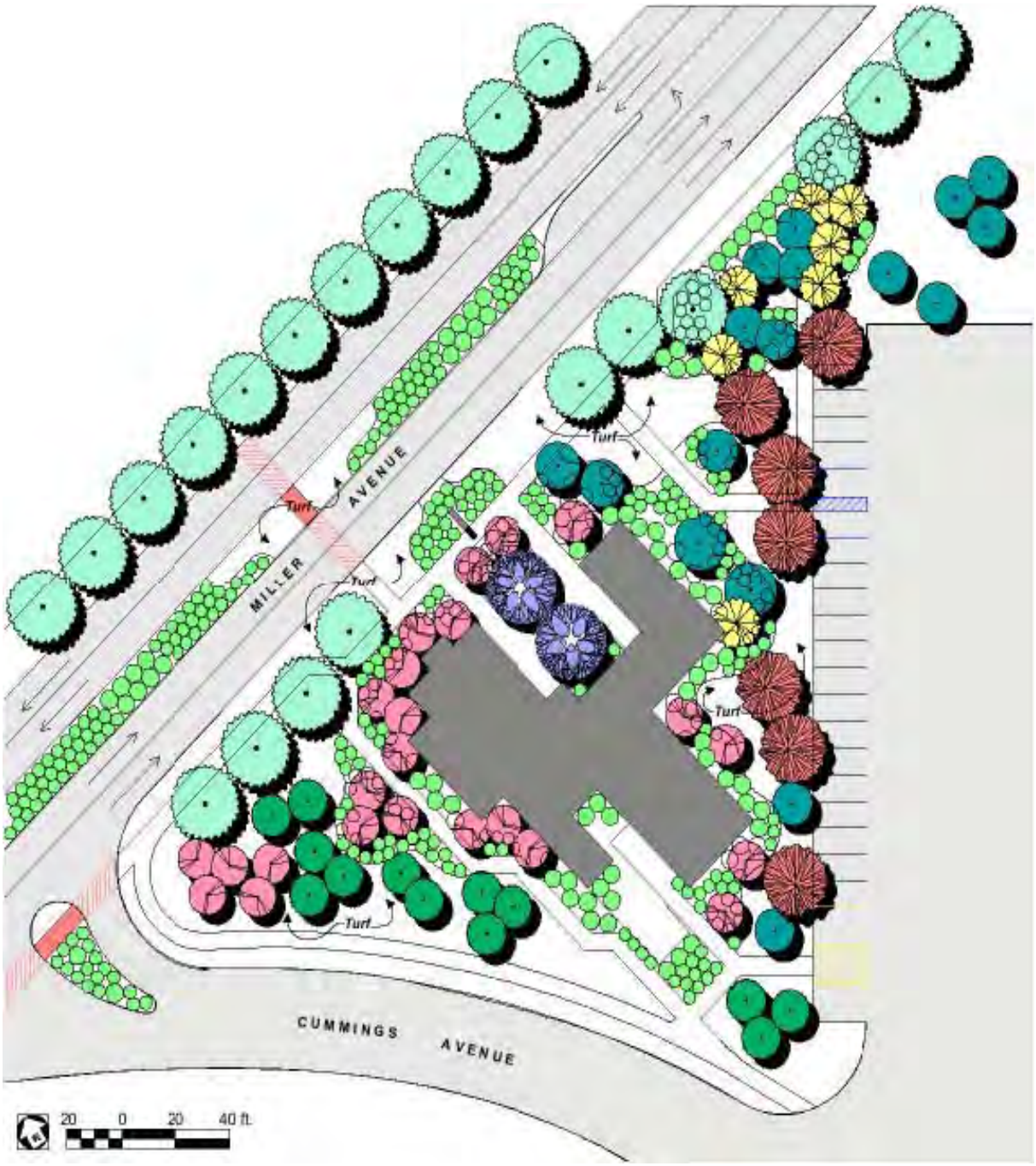


B-5.3.2 **Concept**

Rather than making specific plant choices, think in terms of general plant size and character. Use concept plans to discuss design concepts and plant choices with commanders, nursery

personnel, customers, facility users, or other landscape professionals. See figure B-5.13 for an example of a concept planting plan.

Figure B-5.13 Example of a Concept Planting Plan

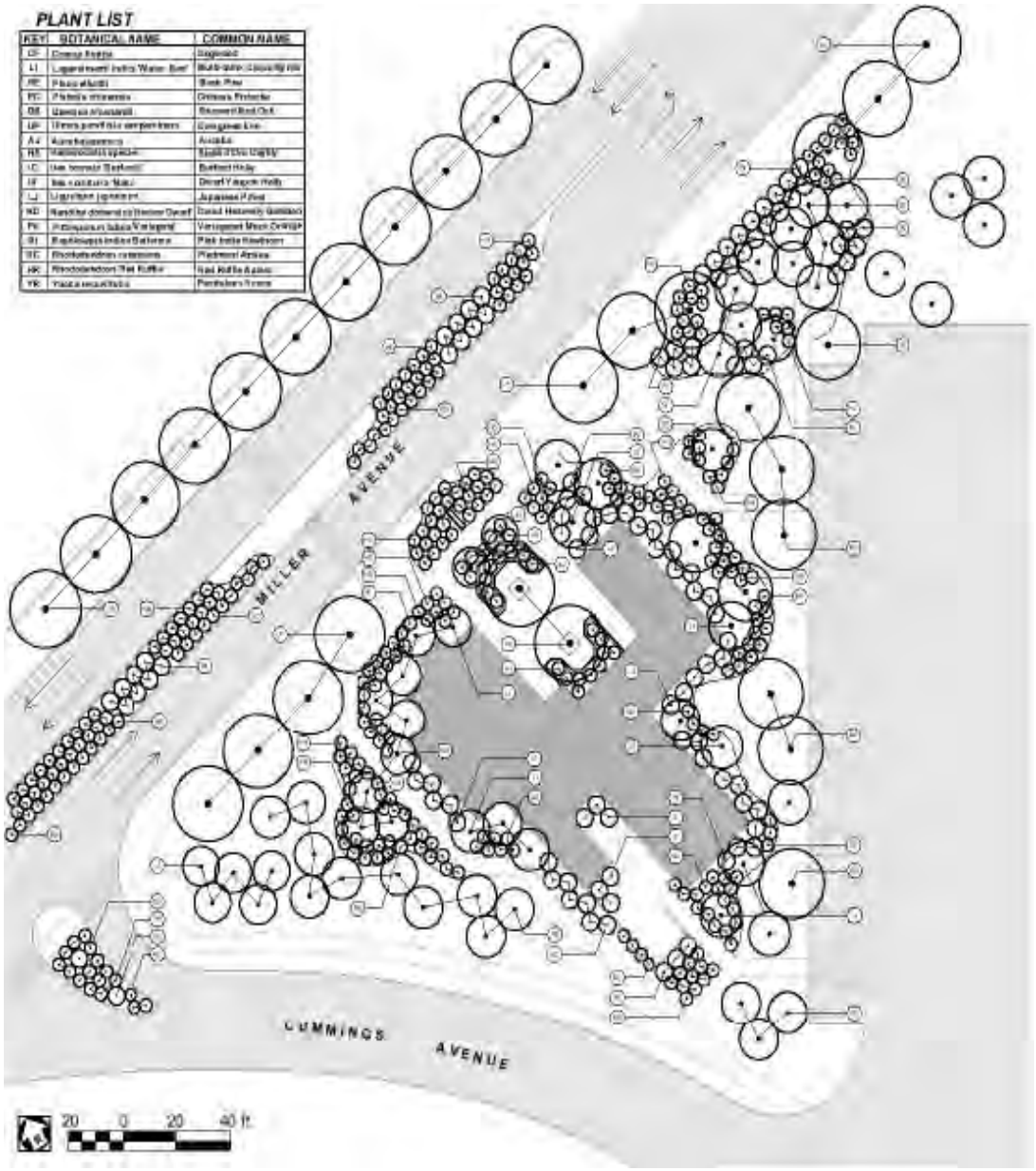


B-5.3.3 **Implementation**

Communicate construction elements of the final design on the planting plan. Consider the following elements during the implementation phase of the planting design process:

- Location;
- Identification;
- Quantity; and
- Clarification.

Figure B-5.14 Example of Planting Plan Specifying Number and Location of Plants in a Design



B-5.4 Selecting and Locating Plants

In order to create low-maintenance and attractive landscapes, select and use plants that grow together in native plant communities in the region.

B-5.4.1 Plant Types

A good planting design includes plants at several different scales. Combining plants of several types - including trees, shrubs, groundcovers, grasses, vines, perennials, and annuals - adds richness to the site. In an exemplary and sustainable planting design, each plant contributes to the intended overall effect.

Figure B-5.15 Example of Groundcover in Area Difficult to Mow

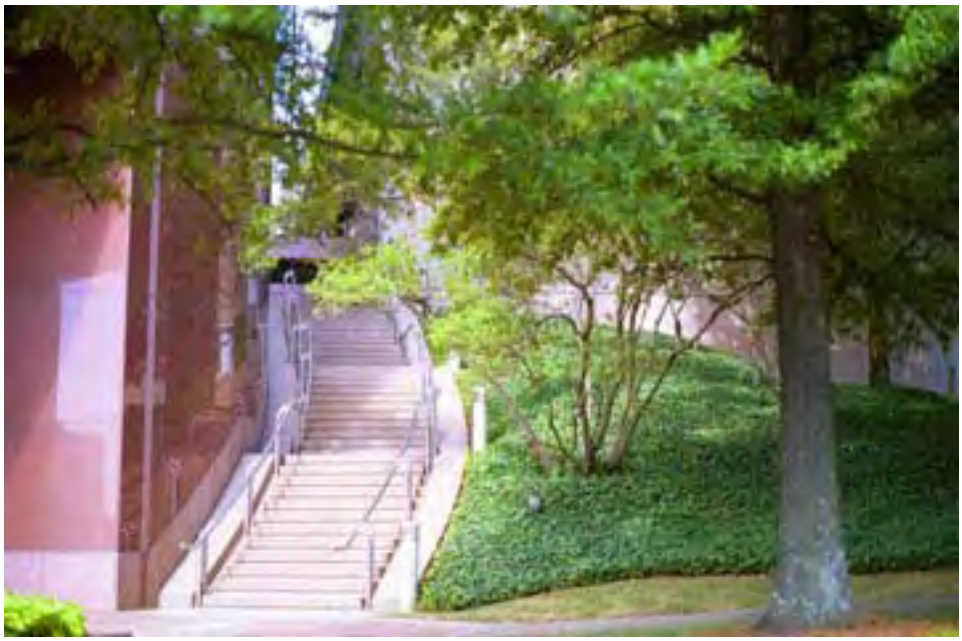


Figure B-5.16 Example of Perennials and Annuals used to Accent a Pedestrian Path.

Figure B-5.17 Example of Ornamental Grass Used as an Accent

B-5.4.2 Plant Communities

Selecting plants from the same natural community reinforces the regional landscape character while offering the following benefits:

- Naturally compatible soil and nutrient needs reduce significant requirements for planting pit preparation and amendments.
- Complementary visual image provides cohesiveness and unity to eventual planting design composition.
- Comparable water needs reduce requirements for expensive irrigation systems.

An experienced, conscientious landscape architect is knowledgeable about species composition, plant distribution patterns, natural order, and diversity of the commonly occurring plant communities. Identify plants native to the installation's region in the installation plant list.

B-5.4.3 Installation Plant List

The installation plant list documents trees, shrubs, annuals, perennials, turfgrasses, and groundcovers to be used in landscape design projects. The installation plant list should be part of the installation design guidelines. The plant list is the backbone of installation planting design and helps to unify the image of the installation. The installation plant list provides a palette of desirable plant material that possesses the following characteristics:

- Hardy and relatively pest-free;
- Regionally native or indigenous;
- Minimal maintenance and irrigation; and

- Readily available.

B-5.4.3.1 Plant List Information

The installation plant list should include the following information for each plant:

- Genus, species, and cultivar (if necessary);
- Common name;
- Evergreen/deciduous;
- Mature height and width;
- Planting size;
- Exposure (sun/shade tolerance); and
- Irrigation requirements.

B-5.4.3.2 Use Categories

Plant material selected for the installation plant list should be categorized according to the following uses:

- Foundation;
- Barrier;
- Screen;
- Accent;
- Wetlands; and
- Wildlife.

B-5.4.3.3 Invasive Plants

The installation plant list should also contain a section for plants that **must not** be specified. Invasive plants are non-native species that spread quickly. These non-native species are difficult to control and can infest both designed and natural areas.

B-5.5 Xeriscape

Xeriscape is the theory and practice of planting that conserves water and energy through creative and adaptive landscape design. Xeriscape landscapes are attractive solutions that

save money, water, and maintenance. Xeriscape uses native, naturally-occurring plant material in the landscape design to convey a sense of regional context while embracing sustainable landscape design and preservation of native and endangered species.

B-5.5.1 Xeriscape Design Techniques and Maintenance

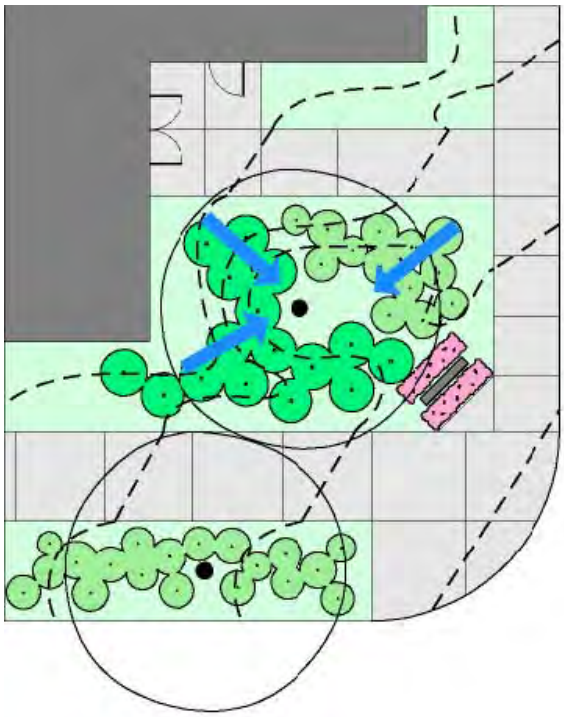
Reduce the amount of outdoor water use through appropriate techniques and proper maintenance specification.

- Select turf varieties that require minimal additional irrigation, or alternate with plant materials that require less water.
- Design larger turf areas in shallow depressions to passively collect rainwater.
- Use innovative rainwater harvesting techniques including berming and sensitive site grading for collecting, concentrating, and storing water for use by plants.
- Select water-efficient plants. Installations should populate their plant lists with native plants that have demonstrated long-term landscape value through hardiness, availability, and minimal maintenance and water requirements.
- Use pine needles, bark, or other inert organic mulches to reduce water needs and weed growth while providing surface erosion control and soil improvement through slow decomposition.
- Practice proper maintenance, including raising the mower height and pruning appropriately to reduce evapotranspiration.
- Irrigate efficiently by watering slowly, deeply, and infrequently.

Figure B-5.18 Example Xeriscape Planting Design

Figure B-5.19 Example of Combination Mulch and Groundcovers

Figure B-5.20 Example of Water Harvesting Plan



B-5.5.2 Xeriscape Guidelines

Follow these principles to ensure functional and attractive xeriscape plants.

- Contact local landscape architects, nursery personnel, and county extension agents to obtain specific xeriscape information.
- Regularly update the installation plant list to include newly available water-efficient material.
- Replace missing or broken sprinkler heads or emitters immediately.
- Adjust irrigation controller programs according to temperature and seasonal changes.
- Regularly inspect emitter flow and flush distribution tubing, and clean filters on drip systems.
- Consider replacing turf areas with groundcovers or inert materials.
- Mulch plants wherever possible.

- Integrate well-timed applications of fertilizers, pesticides, and herbicides to the maintenance program of xeriscape plantings.

- Conduct regular xeriscape seminars to increase the understanding and appreciation of water-conserving practices among military family housing residents and facility managers and custodians.

B-5.6 Remediation and Reclamation

Several sites across the country are the by-products of DoD operations activities which have had long-term, harmful impacts on the land. Various types of personnel training, munitions and ordnance production and testing, and other types of research and development, produce toxic wastes that have resulted in significant contamination of soil, groundwater, and air. The contamination threatens ecosystems and poses potential health risks to adjacent human communities. Remediation is a possible solution to the negative effects of contamination, and multiple organizations within DoD are actively engaged in studying and using remediation technologies to address these issues.

For sites that require consideration of bioremediation and phytoremediation techniques, engage an interdisciplinary team that is actively engaged in studying and using remediation technologies.

B-5.6.1 Sites

Many types of sites, including the following, are potential candidates for remediation.

- Former defense sites;

- Training ranges;

- Small arms ranges;

- Bombing and aerial gunnery ranges; and

- Underground test area project and offsites.

B-5.6.2 Contamination

Remediation is a solution to the following types of contamination and disruption:

- Deforestation;

- Unexploded ordnance;

- Lead;

- Explosive compounds;

- Heavy metals;
- Polyaromatic hydrocarbons; and
- Petroleum and oil lubricants.

B-5.6.3 Technologies

Consider the following remediation technologies:

- Revegetation;
- Terrestrial phytoremediation;
- Wetland phytoremediation;
- Removal and off-site decontamination of soil;
- Incineration;
- Air sparging and bioventing;
- Soil washing;
- Acid leaching; and
- Slurry reactor.

B-5.6.4 Case Studies

To learn more about the use of remediation on DoD installations, look at the following demonstration projects:

- Milan Army Ammunition Plant (MAAP) in Tennessee;
- Small Arms Range Remediation at Fort Polk, Louisiana; and
- Iowa Army Ammunition Plant in Middleton, Iowa.

B-5.7 Interior Planting

Indoor plants were once considered to play only an aesthetic role as a "nice-looking green mass." Plants can control traffic flow, screen views, and reduce glare. They can enliven any indoor setting and be environmentally beneficial by filtering and purifying the air.

B-5.7.1 Design

Base interior designs upon sound design principles and an understanding of the unique indoor environment. The design should consider all of the following:

- Benefits (aesthetic, engineering uses, environmental);
- Light (intensity, plant response, sources);
- Temperature;
- Atmosphere (air movement, relative humidity, air pollutants); and
- Maintenance level.

Figure B-5.21 Examples of Indoor Plants Defining a Large Space

B-5.7.2 **Planters**

Planters can be either permanent fixtures or moveable containers. The selection and design requires careful consideration and planning. It is important to consider the practical and aesthetic qualities of the choices when selecting planters for interior use. These qualities include:

- Plant needs;
- Aesthetics;
- Cost and availability;
- Strength and durability;
- Weight;
- Drainage; and

- Material.

Figure B-5.22 Examples of Permanent and Moveable Containers

B-5.7.3 **Maintenance**

Maintenance is the key to successful interior planting design. Poor maintenance makes even the best design and installation a failed interior landscape. To ensure long-term success of the interior landscape, the landscape architect should be involved when writing the maintenance contract.

B-5.7.4 **Interior Planting Principles**

Sound interior planting design principles and appropriate maintenance techniques minimize environmental impacts while maximizing long-term value and efficiency. The following are principles for efficient and attractive interior planting designs.

- Consult local extension agents and nurseries on the suitability and availability of interior plant material.

- Comply with installation interior landscape development and design policies.

- Always factor all facility, site, user, and environmental considerations into the final design.

- To ensure interior plant beauty and viability, establish a watering and fertilizing schedule and keep plants free of dust, pests, and disease.

- Ensure trimming and maintenance tools are routinely disinfected with alcohol or bleach.

- Ensure indoor environmental conditions are maintained appropriately to maintain plant viability.

- Remove any standing water from planter saucers.

B-6 FORESTRY

Trees, whether naturally occurring or planted, are a valuable asset on every DoD installation. This chapter outlines the importance of an urban forestry program. Forested areas improve air quality, reduce energy costs, preserve wildlife habitat, and contribute to water and soil conservation in a built environment.

B-6.1 Role of the Landscape Architect

Coordination and oversight of the urban forestry design process includes:

- Promotion of urban forestry practices as a required aspect of site planning, design, and construction.
- Conservation of existing and native trees in built areas through environmentally sensitive and creative site planning and design.
- Oversight of the establishment of a tree inventory.
- Oversight of the writing of a maintenance plan and the development of management tools for urban forestry.

B-6.2 Trees

Trees are an important resource that not only provide texture, color, and beauty to an installation's surroundings, but also modify the local environment and give an installation a specific character and identity. Trees should be properly managed, including selection, planting, and maintenance.

Figure B-6.1 Example of Trees Used to Soften Architecture

B-6.2.1 Energy Conservation

Place trees strategically to maximize energy savings. The shade and canopy cover from trees alter surrounding micro-environments and reduce energy costs by reducing cooling demand. During winter months, trees alter wind flow and drifting snow by blocking or redirecting winds, passively reducing winter heating costs.

B-6.2.2 Natural Resources

A forestry program is useful to locate, improve, and preserve the habitat of wildlife species.

B-6.2.3 Environmental Influence

Trees reduce air pollution by serving as natural air cleaners, removing carbon dioxide from the air and releasing oxygen. Trees intercept rainfall to help control erosion. The root systems of trees help stabilize the soil and slow rainfall runoff by absorbing water before it enters a storm drainage system. Trees return overall benefits and value to the installation beyond the time and money invested in them for planting, protection, and maintenance.

Figure B-6.2 Examples of Trees Used to Shade Roadways and Parking Areas

B-6.3 Urban Forestry Management Plan

Identifying, quantifying, and understanding an installation's tree population is crucial to determining a comprehensive, long-term approach to its well being. Trees will generally live longer and gradually require less intensive care with scheduled maintenance.

B-6.3.1 Management Categories

Trees on an installation fall into four management categories. Each of these categories will have different management or maintenance requirements.

B-6.3.1.1 Native Forests

Native forests found in undeveloped areas should be managed as part of the commercial forestry program.

B-6.3.1.2 Native Trees in Developed Areas

Native trees located in and around developed areas should be inventoried and become part of the urban forest database, which should receive regularly scheduled maintenance and care.

B-6.3.1.3 Installed

Every tree planted as seedlings, transplants, or nursery stock should be included in the urban forestry inventory and receive scheduled maintenance and care.

B-6.3.1.4 **Airfield**

See \1\UFC 3-260-01/1/, *Airfield and Heliport Planning and Design*. Proper planning and management should ensure safe aircraft operations while eliminating the need to remove maturing trees.

B-6.3.2 **Tree Inventory**

A tree inventory can yield valuable information for the landscape architect, community planner, natural resources planner, and grounds maintenance manager. Below are a few of the uses for the tree inventory:

- Indicate locations of tree resources that should be protected and integrated into the building siting process.
- Provide location, species, and size of existing trees to inform of existing conditions for site analysis and planting design.
- Provide an information database for the installation's urban forestry management plan.

Information about protecting and managing trees should be incorporated into a computer aided drafting program (CAD) database or geographical information system (GIS) which can be customized to create an integrated management strategy to effectively maintain the installation's valuable tree resources. The following information is typically gathered during a tree inventory:

- Botanical and common names;
- Size (height, canopy spread, trunk diameter at breast-height);
- Approximate age and life expectancy;
- Condition;
- Replacement value;
- Maintenance needs;
- Tree location reference points;
- Hazard potential; and
- Tree box or planting strip condition.

B-6.3.3 Analysis

Use tree condition data to develop cost-effective pruning and removal schedules, personnel or labor needs, and material requirements. The following areas contribute to a viable maintenance program:

- Species diversification;
- Approximate age and life expectancy; and
- Removal and pruning requirements.

Table B-6.1 Sample Table of Species Population Distribution

(No genus and species should account for more than 10 percent of the total tree population.)

Genus Species	Common Name	#	%
Acer ginnala	Amur Maple	686	17.3
Acer rubrum	Red Maple	208	5.2
Betula nigra	River Birch	534	13.4
Cedrus deodara	Deodar Cedar	294	7.4
All others	Miscellaneous	-	56.7

Table B-6.2 Sample Table Shows Annotation of Age Data

(The ideal age distribution of a species in the urban forest is 20 percent young, 60 percent mature, and 20 percent over-mature.)

DBH Range	Number of Trees	Percentage of Trees
Young (<15 cm)	2,260	56.8
Mature (>15 to 61 cm)	1,499	37.7
Overmature (>61 cm)	215	5.5

B-6.3.4 Implementation

Properly collected and analyzed data provides the urban forest manager or landscape architect with information to formulate replacement schedules, maintenance policies, and budgets. A comprehensive tree inventory facilitates the following urban forestry tasks:

- Maintenance scheduling;
- Planting recommendations; and
- Database management.

B-6.4 Planning Actions

Healthy trees increase in value with age while providing both tangible and intangible benefits. Urban forest resources should be protected and preserved. New trees should be added to the inventory as a legacy of DoD stewardship and concern. Installation leadership can make a contribution to the future by implementing a comprehensive and progressive Urban Forestry Management Plan.

Below are recommended actions to initiate and execute a comprehensive Installation Urban Forestry Management Plan:

- Develop an installation tree inventory to identify and assess the extent, condition, and needs of the urban forest.
- Use a computer to effectively and efficiently manage and update tree database information.
- Integrate the tree inventory with installation planning and design functions.
- Enlist the education and experience of a certified arborist.
- Follow tree care specifications.
- Consult with landscape architects in developing tree planting designs.

B-7 IRRIGATION DESIGN

Limited water and energy resources place great importance on the need for irrigation efficiency and sustainable design practices. Irrigation design is closely tied to the entire site design, especially planting design. Consider the impacts of irrigation at the beginning of the design process.

B-7.1 Role of the Landscape Architect

Coordination and oversight of the irrigation system design process includes:

- Consideration of the unique characteristics of the soil, climate, topography, quantity and quality of water and specific plant material when determining a preliminary irrigation strategy.
- Providing irrigation system designers and vendors with the information necessary to understand the irrigation resources, requirements, and sustainable design opportunities of a project.
- Promotion of water conservation efficiency to irrigation designers.
- Guidance of the overall planning and design concept of irrigation systems.

B-7.2 Irrigation Importance

Irrigation systems are an important part of establishing and maintaining a landscape. Planting on a DoD installation is a large investment, and without proper maintenance it will not survive. If the irrigation system is not properly designed, however, it can be a large financial and water drain on an installation. Design an irrigation system to efficiently conserve water while delivering required resources to the landscape.

B-7.2.1 Water-Efficient Landscapes

The LEED program gives credit for water-efficient landscapes. The intent is to limit or eliminate the use of potable water for landscape irrigation. Obtaining this goal creates economic and water efficiencies for installations. This chapter outlines techniques to create planting designs that require less irrigation.

B-7.2.2 Efficient Systems

High-efficiency irrigation systems deliver up to 95 percent of the water supplied versus conventional irrigation systems that are as little as 60 percent efficient. Research into the latest technology should save water and money.

B-7.2.3 Technical Guides

For technical information related to irrigation, see \1\UFC 3-420-01/1/*, Plumbing Systems,* Unified Facilities Guide Specifications (UFGS) \1\32 84 23/1/, *Underground Sprinkler Systems*, and UFGS 32 84 24, *Irrigation Sprinkler Systems*. The information in this chapter discusses broad concepts relating to site design to efficiently use irrigation systems.

B-7.3 Minimizing Water Requirements

Design a comprehensive landscape plan to minimize water requirements. The following techniques should be used in coordination or alone, depending on the site.

B-7.3.1 Plant Material Selection

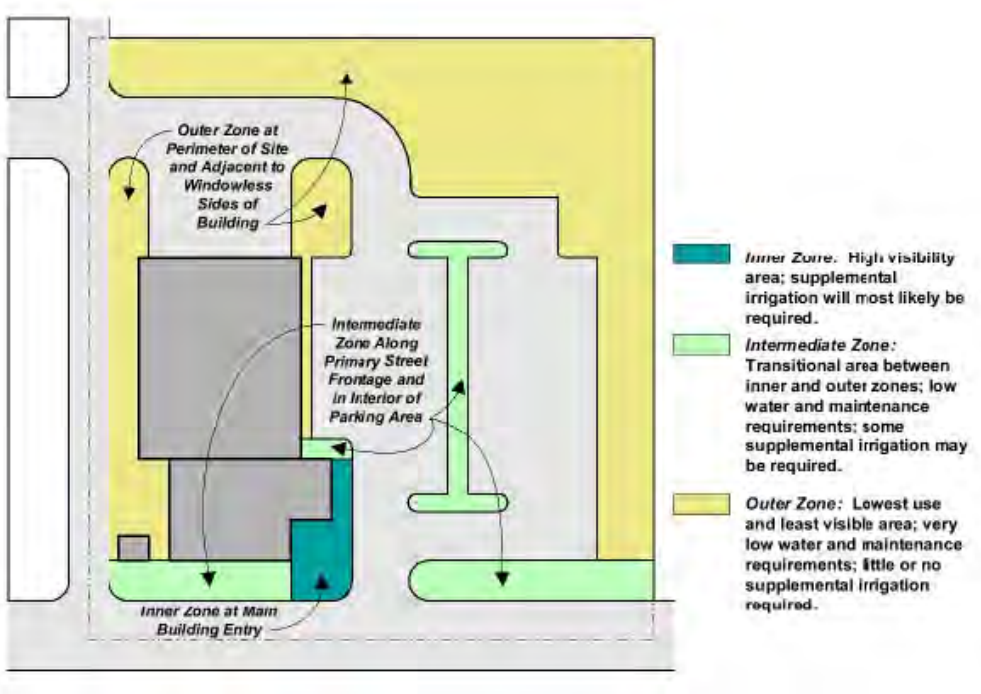
Consider water requirements when choosing plant material in order to reduce water consumption. The following planting practices reduce water requirements:

- Limiting the amount of turf grass will reduce a large amount of water required.
- Grouping plants with similar water requirements allows for greater efficiency in the irrigation system.
- Native plants are more acclimated to the climate and require less irrigation. Choosing plants that grow together in nature, called plant associations, is one way to assure that they will have similar requirements.

B-7.3.2 Water Budgeting

Concentrating plants with similar water-use requirements, or creating hydrozones, simplifies and economizes irrigation system design and maintenance requirements. Hydrozoning a landscape development based on site use patterns, plant material densities, supplemental water requirements, and microclimates is fully embodied in the concept of water budgeting. Three hydrozones are discussed below:

Figure B-7.1 Example of Hydrozoning Concept Plan



- **Inner Zone:** The inner zone of a planting plan is the area which will have high visibility and be significantly important to the facility in terms of appearance, image, and use. Even though the inner zone has a higher water demand than other zones, it can still require less irrigation than a traditional landscape if it is planned appropriately.

- **Intermediate Zone:** Plants in the intermediate zone may require more water than available from natural precipitation. Plant densities are less than in the Inner Zone. Overall, maintenance and water use should be minimal. By taking advantage of runoff from paved areas or roof drains, supplemental irrigation can be reduced.

- **Outer Zone:** The Outer Zone is generally characterized by plants having the lowest water requirements and lowest intensity of human use. Once established, plants in the Outer Zone typically require very little to no irrigation or maintenance, with the exception of weed control and occasional pruning. Choose plant materials especially for their hardiness and extremely low water requirements.

B-7.3.3 Water Schedule

Water requirements will change throughout the year. Update the schedule with each season. Some scheduling systems allow for daily updates based on information gathered at the nearest weather station.

B-7.3.4 Irrigate Efficiently

The methods of daily application of water can greatly influence growth patterns and hardiness of plants. The following three irrigation practices should reduce the overall amount of water used:

- Water Slowly: Never apply water faster than the infiltration rate of the soil. Slow and even irrigation allows for proper soil moisture to be maintained in the root zone, providing for the best growing conditions for plant material while eliminating or minimizing runoff and potential erosion.

- Water Deeply: Irrigate each plant variety long enough for water to reach the root zone.

- Water Infrequently: Deep watering promotes deeper roots, further reducing irrigation requirements.

B-7.3.5 Grading

When applicable, use the slope of the land to direct water to planting areas, reducing the amount of irrigation needed and controlling excessive stormwater runoff.

B-7.4 Water Sources

Irrigation typically uses potable water, although lower quality water is equally effective for irrigating landscapes. Sources of non-potable water include the following:

- Captured rainwater from roof and parking lot runoff;

- Graywater from building systems; and

- Municipal recycled water supply systems.

Figure B-7.2 Example of a Rainwater Collection System

B-7.5 Establishment

After a planting design has been installed, there is a required establishment period. New plantings are in a stressful situation and require additional care, observation, and water to promote growth and vigor. A one-year establishment period is typical; however, some plants, particularly trees, may need longer. After the plants are established, evaluate the irrigation control system and adjust if necessary.

Personnel responsible for maintaining the project after installation should be aware of the watering needs of the plants on-site, as well as the operation of the total irrigation system from the controller to the individual sprinkler heads. Adjustments to the irrigation system should be made in a timely and correct manner. Proper establishment significantly increases the chances that the landscape will provide years of function and beauty.

B-7.6 Maintenance

Immediately following installation of the irrigation system, establish a comprehensive and aggressive maintenance program to ensure lasting results of the irrigation system and landscape. Include the following in an irrigation system maintenance program:

- Adjust the controller program according to seasonal changes;
- Establish a schedule to clean all filters and strainers on the entire system;
- Ensure that controllers are operating correctly by checking them at least weekly;
- Regularly check the connections and fuses and test the rechargeable program back-up battery;

- Verify that spray and rotary head spray patterns are not spraying undesired areas such as driveways or parking lots;

- Test backflow prevention devices at least two times a year to confirm correct operation;

- Educate grounds maintenance personnel to ensure they minimize lawnmower and string trimmer damage to risers and delivery devices;

- During inspection tours of the project site, look carefully for dry or overly wet spots; and adjust components as necessary;

- Establish a schedule to clean all delivery device orifices annually;

- In cold winter areas, establish dates to purge and drain the irrigation system and ensure the components are protected from the effects of freezing; and

- On drip systems, ensure the narrow "spaghetti" tubes with the emitters on the end are protected and those installed in the ground remain covered.

B-7.7 Conclusion

Efficient irrigations systems begin with sustainable landscape design. Educate the client and the contractors about the water-efficient intent of the design. When the design requires extensive irrigation, especially when it must be sustained indefinitely, educate the client regarding the consequences of intense irrigation.

B-8 SITE FURNISHINGS

Landscape architectural involvement in specifying and designing site furnishings will ensure that the intended and agreed-upon design concept and functional requirements of a project site will be met.

B-8.1 Role of the Landscape Architect

Coordination and oversight of the site furnishing design and specification process includes:

- Understanding the project user needs and requirements for site furnishings and the maintenance availabilities of a site.
- Coordinating site furnishings with all aspects of the site plan and installation requirements, including security design requirements.
- Providing recommendations for site furnishings that fit within the local context of a site and are available through accessible vendors.
- Considering the use of sustainable materials in the selection of site furnishings.
- Providing adequate lighting for the safety and security of drivers and pedestrians.

Site furnishing design specifics will be addressed on a per-installation basis through the base installation design guide.

B-8.2 Exterior Lighting

Choose fixtures that are energy-efficient and have low maintenance requirements. A qualified lighting professional should be involved in the selection of equipment and the development of a lighting system design. For **Army** and **Navy** projects, refer to \1\UFC 3-530-01/1/, *Design: Interior and Exterior Lighting and Controls*.

In order to establish nighttime security, orientation, and illumination of features, the planning process for the lighting system should be logical, comprehensive, and include the following documents:

- Existing conditions survey;
- Adequacy analysis; and
- Lighting plan.

B-8.2.1 Exterior Lighting Equipment

Choose light fixtures based on existing architectural standards of the installation and that reflect the installation's architectural character and visually unify the streetscape and other areas. Use of standardized parts and procedures should simplify maintenance and repair of equipment.

B-8.2.1.1 Lamps

The type of lamp used in the light fixture determines brightness, color, energy efficiency, life span, and suitability for a specific application.

B-8.2.1.2 Luminaires

Based on the use of the area, decide on the distribution pattern of light on a surface. The pattern will be controlled by placing the lamp in a luminaire with the use of an enclosure, reflector, refracting lens, or a combination of these.

B-8.2.1.3 Poles

Select light poles according to length, material, finish, and shape based on existing architectural standards and the installation's proposed architectural character. The variety of light poles used on an installation will be limited. Common materials for poles include:

- Concrete poles;
- Aluminum poles;
- Decorative wood poles;
- Painted steel poles; and
- Weathered steel poles.

Table B-8.1 Characteristics and Uses of Different Lamp Types

Lamp Type	Color Rendition	Energy Efficiency (lumens / watt)	Life (hours)	Recommended Uses
Incandescent	renders colors well with emphasis on warmer tones	10–20	750–2,000	pedestrian areas, where natural color rendition is important
Mercury Vapor	green to blue-green; cannot render reds and yellows well	30–65	24,000	residential street lighting and accent lighting for planting material

Metal Halide	white light; renders colors well	75–125	15,000	general area lighting in public areas
High-Pressure Sodium	golden cast	75–130	20,000	primary and secondary roadway and parking lot lighting

B-8.2.1.4 Design Considerations

Consider the design, material, and scale of lighting equipment during the development of a lighting system. Other design considerations include:

- Light fixtures should reflect similar design, materials, and finishes throughout the lighting system to promote continuity and consistency;
- Fixtures should be appropriate in scale and character with the setting;
- Coordinate light fixtures with other site furnishings;
- Light fixture materials, such as poles and luminaire enclosures, should have a matte or dulled finish to prevent glare;
- To reduce negative visual impacts, clutter, and potential conflicts with trees and other elements, locate lines supplying power to light fixtures underground; bury existing overhead lines during new construction or renovation projects when possible; and
- To minimize streetscape clutter, integrate light fixtures with traffic signs, street signs, and traffic control signals.

B-8.2.2 Economy of Operation, Maintenance, and Repair

The type, design, and location of lighting equipment can increase energy efficiency and help minimize the long-term operation, maintenance, and repair associated with the lighting system.

- Minimize the variety of light fixtures used in the lighting system to facilitate maintenance, repair, and ordering and storage of parts.
- Use the highest-efficiency, longest-lived lamp appropriate to a particular application. Limit incandescent lamps to pedestrian areas to improve color and facilitate replacement.
- Coordinate the placement of light fixtures with tree locations to prevent tree canopies from interfering with the proper distribution and level of lighting.

- Choose light fixtures and luminaires that are durable and resistant to vandalism and damage from accidents.

- The placement, height, and design of light fixtures should allow for easy access for replacement of lamps and luminaires.

B-8.2.3 Roadway Lighting Hierarchy

Use street lighting to reinforce the vehicular circulation hierarchy on the installation. To properly reinforce the hierarchy, apply a consistent street lighting concept throughout the installation roadway network. Various types of streets should be illuminated by the level of lighting and by the appearance of the light fixtures.

B-8.2.4 Parking Lots

Provide adequate lighting in all parking lots that will be used at night. Set light fixtures back a minimum of 2 ft (0.6 m) from circulation aisle and parking stalls.

B-8.2.5 Pedestrian Lighting

Design pedestrian lighting to reinforce the hierarchy of the installation walkway network and to extend the use of the nighttime environment by providing lighting to increase safety and security.

B-8.2.6 Safety and Security

Lighting levels allow pedestrians to clearly distinguish the edges of the walkway, changes in direction, intersecting walkways, and any potential obstacles or hazards. Illuminate street crossings, changes in grade, and other potentially hazardous locations at a higher level than other sections of the walkway. Locate light fixtures so they do not impede pedestrian traffic.

B-8.2.7 Illumination of Features

The use of direct or indirect lighting can accentuate features or create a special effect. Installation entry areas, monuments, static displays, architectural landmarks, and other special features may be lighted with floodlights or spotlights, to create the intended effect.

Figure B-8.1 Example of Dramatic Effect of Landscape Lighting

B-8.3 Signs

The signage system is integral to the continuity of the installation. Design a signage system to ensure order and separation of vehicular and pedestrian traffic, while providing clear, concise directions and information. For **Air Force** and **Navy** projects, refer to \1\UFC 3-120-01/1/, *Air Force Sign Standard*.

Figure B-8.2 Sign Types Follow a Logical Order and Sequence from the Roadway Entrances to the Final Building Destinations

Guidelines developed for each installation will promote an integrated, coordinated signage system. The design principles and major sign types recommended for a signage guide are listed below.

- Programming messages (including color, number of messages, message order);
- Materials;
- Typefaces;
- Hierarchy of sign types;
- Site entry identification;
- Vehicular directionals;
- Pedestrian wayfinding;
- Directories;
- Regulatory signs (including traffic control signage); and
- Building identity signs.

B-8.4 Seating

Provide seating at all primary building entrances, drop-off zones, congregation points, and high-activity areas. Place seating at least 3 to 6 ft (1 to 2 m) away from sign post, trash receptacle, or any stationary obstacle, to avoid blocking pedestrian flow. Select benches and seat walls that create a unified system of seating.

B-8.5 Shelters

Locate bus shelters near public areas or gathering spaces to encourage the use of public transit. Locate shelters adjacent to pathways so they will not impede pedestrian circulation. Pave the inside of shelters for wheelchair access and easy access to buses. Provide outdoor seating at the bus shelters.

Locate smoking shelters near buildings with a large employee population. They should be located near secondary entrances in areas which are protected from winter winds and summer sun. They should have low seat walls or benches appropriate for seating. Scale the size of the shelter proportionately with the buildings immediately adjacent to it, as well as the number of users expected.

B-8.6 Trash Receptacles

Strategically place trash receptacles along major walkways, intersections of paths, near building entrances, picnic areas, food services, and congregation points. Since many trash receptacles can conceal packages that may threaten security, consult with security personnel on the selection and placement of receptacles. Refer to \1\UFC 4-010-01/1/.

B-8.7 Fences and Walls

Use walls, fences, and gates to define the interface between the general public and the security perimeter of the base. The perimeter walls or fences will provide adequate security while complementing surrounding architecture, materials and styles of the region. Inside perimeter fence, additional fencing walls will define open spaces, provide privacy or protection, and screen unsightly uses. They should relate in scale and material to surrounding structural features.

B-8.8 Bicycle Racks

Convenient bicycle racks encourage bicycle use as an alternative method of transportation. Integrate bicycle racks into the site plan; they should be readily accessible to high-activity areas, yet not impede vehicular or pedestrian circulation. In addition, site racks in visible locations to decrease the opportunity for theft. Size bike racks according to the number of bikes expected at a single location.

B-8.9 Grates

Specify tree grates to be used when trees are installed in a formal paved area, such as on a primary avenue, an entry area, a plaza, or a courtyard. Grates allow air and water to pass to the root system without impeding foot traffic.

Drainage grates are necessary in courtyards or plaza areas and other non-impermeable paved surfaces. Narrow trench drains should be black cast iron or heavy steel, and should be incorporated into the paving design to create a high-quality environment.

B-8.10 Bollards

Use bollards to control or separate vehicle and pedestrian traffic. In certain circumstances, a removable bollard is recommended for pedestrian areas while also allowing emergency vehicle access.

B-8.11 Planters

Planters should be used in highly visible pedestrian areas, building entries, plazas or courtyards. Planters provide both aesthetic and security functions.

Figure B-8.3 Example of Tree Grate

B-9 SITE SECURITY

Security design must be approached by a multi-disciplinary team. The landscape architect must understand force protection issues in order to offer creative site and planting design solutions that incorporate security requirements. This chapter outlines key issues and discusses basic guidelines that allow a landscape architect to incorporate security features as an integral part of a site plan. Specific requirements and standards are delineated in \1\UFC 4-010-01/1/, *DoD Minimum Antiterrorism Standards for Buildings*. Check the most current version of \1\UFC 4-010-01/1/ as well as any service-specific documentation for authoritative decisions.

Other UFCs applicable to site security are \1\UFC 4-020-01/1/, *DoD Security Engineering Facilities Planning Manual*, \1\UFC 4-022-01/1/, *Security Engineering Entry Control Facilities/Access Control Points*, \1\UFC 4-022-02/1/, *Selection and Application of Vehicle Barriers* and \1\UFC 4-022-03, *Fences, Gates and Guard Facilities* (under development)/1/.

B-9.1 Role of the Landscape Architect

The following responsibilities are included in the coordination and oversight of the security design and force protection process as related to landscape architecture:

- Coordinate with decision-makers and security specialists to determine project force protection requirements;
- Explore creative landscape architectural solutions to meet force protection and site security requirements through the use of strategic site planning, circulation design, and planting plans; and
- Use design solutions that incorporate structural elements into the force protection landscape such as walls, bollards, fencing, hardened street furniture, natural features, and plantings.

B-9.2 Comprehensive Planning

Implementing appropriate force protection measures at the planning stage can preclude the need for costly security enhancements later on. Incorporate force protection measures into the following comprehensive planning areas.

B-9.2.1 Land Use Planning

When preparing land use plans, locate high-risk land uses in the interior of the installation. High-risk land uses contain high concentrations of personnel located in administrative, community, and housing areas. Consolidate high-risk land uses to increase security efficiency and minimize control points. Also assess off-base adjacent land use and zoning plans for potential development that would impact security within the installation.

In most cases, integrating force protection measures at the comprehensive planning level will increase the land area needed for individual facilities due to security stand-off requirements. Accordingly, when preparing future land use plans, take into account the land areas associated with proposed force protection measures in the calculation of land area requirements.

B-9.2.2 Site Selection

When selecting a site for a facility, consider its location relative to the base perimeter, interior roads, and parking lots. In addition, consider that elevated sites generally enhance surveillance of the surrounding area. Adjacent high terrain or structures outside the base boundary, however, allow observation of on-base areas by outsiders. Dense vegetation in proximity to a facility can screen covert activity and must be avoided.

B-9.2.3 Area Development Planning

Facility site design includes the arrangement of the facility footprint, relationship of a building to a specific site, internal circulation, access, parking, landscaping, lighting, and signage. By comparison, area development plans focus on broader site planning, facility siting, and circulation variables.

Provide a separation distance between facilities to minimize collateral damage of a potential attack. Facilities will, however, be sited within view of other occupied facilities. Clustering facilities that are functionally compatible and have similar threat levels reduces the perimeter area to be protected, limits access points, and provides compact security areas. The practical benefits of clustering facilities must be balanced with the survivability benefits of resource dispersal in the event of an attack.

The arrangement of buildings into complexes with strongly delineated boundaries and buildings oriented to enhance surveillance opportunities results in the creation of “defensible space” that can be protected more efficiently than scattered buildings. Eliminate vehicle parking between clusters of high-risk buildings.

B-9.2.4 Vehicular Access and Circulation

A landscape architect will often become involved in the design of vehicular access and circulation. In these instances, refer to \1\UFC 4-022-01/1/. One key element of vehicular design is to avoid straight-line access to high-risk facilities.

B-9.3 Facility Site Design

See \1\UFC 4-020-01/1/. Force protection issues for consideration at the facility site design stage include orientation of buildings and integration of circulations systems, control points, physical barriers, landscape planting, and parking. Conflicts sometimes arise between security site design and conventional site design. For example, open circulation and common spaces, which are desirable for conventional design, are often undesirable for security design. To resolve these and other issues, coordination between design disciplines (e.g., landscape

architecture, planning, architecture, and engineering) is critical in the force protection design process. Designers will balance force protection priorities with the requirements of the Americans with Disabilities Act Accessibility Guidelines (ADAAG), Uniform Federal Accessibility Standards (UFAS), National Fire Protection Codes (NFPA), and all applicable local building codes.

As a site planner, the landscape architect will be involved in locating building footprints and designing comprehensive site designs to include security features. Key security elements are discussed below.

B-9.3.1 Standoff Zones

\1\UFC 4-010-01/1/ sets out the requirements for "standoff zones" that ensure a minimum guaranteed distance between a potential explosion and target structure. Locate facilities as far as possible from points on the site perimeter that are accessible to vehicles. "Standoff zones" can be defined by site elements that function as perimeter barriers to vehicles. Facilities should be located away from other buildings that are not potential targets to minimize damage to them in the event of an explosion.

Figure B-9.1 Example of Clear Zone Planting Design

The ideal stand-off distance is determined by the type and level of threat, the type of construction, and desired level of protection, per \1\UFC 4-010-01/1/. The minimum standoff distances identified in \1\UFC 4-010-01/1/ were developed to provide survivable structures for a wide range of conventionally constructed buildings and expeditionary/temporary structures, ranging from tents and wood-framed buildings to reinforced concrete buildings. For a more detailed discussion of this issue, refer to \1\UFC 4-010-01/1/ and \1\UFC 4-020-01/1/.

B-9.3.2 Orientation of Buildings on a Site

Orient buildings to deny aggressors a clear "line of sight" to the facility from on or off base and to protect the facility from visual surveillance.

B-9.3.3 Relationship of Roads

If possible, choose a site away from main thoroughfares. Locating the facility away from uncontrolled vehicle access and minimizing the number of access roads and entrances into a facility will help to increase safety during times of threat.

B-9.3.4 Landforms and Natural Resources

Avoid siting the facility adjacent to higher surrounding terrain, non-DoD facilities that are unsecured; and vegetation masses, drainage channels, or ditches, ridges or culverts, which can provide concealment. However, carefully designed berms used in conjunction with other physical barriers can be a successful security design. Discuss facility site alternatives with the anti-terrorism/force protection (AT/FP) specialists assigned to the project.

B-9.3.5 Physical Barriers

Barriers are selected and designed based on threat levels per \1\UFC 4-010-01/1/. Some barriers are fixed and obvious (fences and gates), while others are simply visual (e.g., sidewalks far away from buildings, curbs with lawn). Where physical barriers are required, consider using landscape elements and materials to create barriers that are soft and naturalistic rather than obviously engineered. Carefully designed high curbs, low berms, shallow ditches, trees, shrubs and other physical separations can be effective and attractive. Consider bollards for keeping vehicles out of restricted areas.

B-9.3.6 Landscape Planting

Specify landscape planting appropriately to screen and protect the facility without providing hiding places. Proper selection, placement, and maintenance of landscape planting can both screen and provide a greater field of vision. Design landscape planting to permit building occupants to see out but prevents outside monitoring of functions or people inside the building. \1\UFC 4-010-01/1/ provides guidance on size restrictions on masses of groundcover in a clear zone. Carefully choose and place tall deciduous plantings. Potential hiding places can be minimized through strategic placement of landscape materials. Dense, thorn-bearing plant materials can create natural barriers to deter aggressors.

B-9.3.7 Parking

\1\UFC 4-010-01/1/ provides the requirements for parking within the clear zone and the standoff zone of inhabited buildings or portions of buildings. Ensure that parking plans comply with \1\UFC 4-010-01/1/.

B-9.4 Site Security Details

The following are discussions and images of barriers, bollards, planters, and landforms designed and used as security features.

B-9.4.1 Site Furnishings

People need to be protected inside a building without disrupting movement and accessibility of the surrounding streets and sidewalks. Good urban design and effective security at DoD installations requires a well-coordinated, multi-disciplinary effort between landscape architects, architects, engineers, and security experts. Effective security design should meet the following goals:

- Provide a balance between perimeter security and the vitality of streetscapes and common areas with site furnishing design by incorporating long-range planning and exceeds temporary measures, such as the placement of basic concrete barriers;
- Provide security in the context of streetscape enhancement;
- Explore site furnishing design options that do not evoke an uneasy sense of defensiveness and visual monotony; instead provide superior protection as well as the function and beautification of a site;
- Provide structural and visual continuity along streets by creating a coherent strategy for designing a family of site security furnishings that reflect the architecture of an area; and
- Provide perimeter security that does not impede commerce, operational use, pedestrian and vehicular mobility, nor impact the health of existing vegetation.

Figure B-9.2 Example of Low Fencing

If site furnishings are hardened to provide crash resistance and are placed with approved spacing, they can be incorporated as part of the perimeter design. \1\UFC 4-010-01/1/ provides guidance on the types of site furnishings that are prohibited and what types are allowed if properly hardened. Specific types of site furnishings to consider for the purpose of security design are:

- Benches;
- Tree enclosures;
- Trash receptacles;
- Light posts;
- News stands;
- Café carts;
- Café enclosures;
- Vendor carts; and
- Bollards.

B-9.4.2 **Barriers**

Barriers include fences, walls, gates, ditches, berms, and bollards. They typically provide controlled perimeters and limited access to a site. Depending on their specific function, barriers may have a variety of design characteristics. Whenever possible, it is preferable that barriers have similar design characteristics to surrounding architecture to reduce any negative visual impacts. The requirements for various barrier types will be contained in \1\UFC 4-022-02/1/, *Selection and Application of Vehicle Barriers*, and \1\UFC 4-022-03/1/, *Fences, Gates and Guard Facilities (under development)* The landscape architect must be familiar with the requirements set out in these two UFC when involved in site security planning and design.

B-9.4.2.1 **Fencing**

Security fences must meet DoD standards based on facility priority. Prior to beginning the design of any projects that involves fences, check for the availability of \1\UFC 4-022-03/1/.

Limit the use of chain link fence to temporary and secondary uses. Fences serve the purposes listed below:

- Platform for the Intrusion Detection System;
- Pre-detonation screen for some standoff weapons;
- Stop moving vehicles, if they are reinforced to do so;
- Define boundaries and to deter penetration of a secure area; and
- Assist in controlling and screening authorized access to a secure area.

B-9.4.2.2 **Walls**

Walls are an alternative to fencing and provide similar protection. Some types of walls recently used for security are plinth walls, ha-ha walls, and retaining walls. Prior to beginning the design of any projects that involves walls, check for the availability of \1\UFC 4-022-02/1/.

Figure B-9.3 Example of Security Fencing

Figure B-9.4 Example of Proper Plant Selection Softening the appearance of a Wall without Compromising Security

B-9.4.2.3 **Gates**

Gates are also employed in security design, adding not only to the safety of a site but also to the general appearance and landscape quality. Prior to beginning the design of any project that involves gates, check for the availability of UFC 4-022-03.

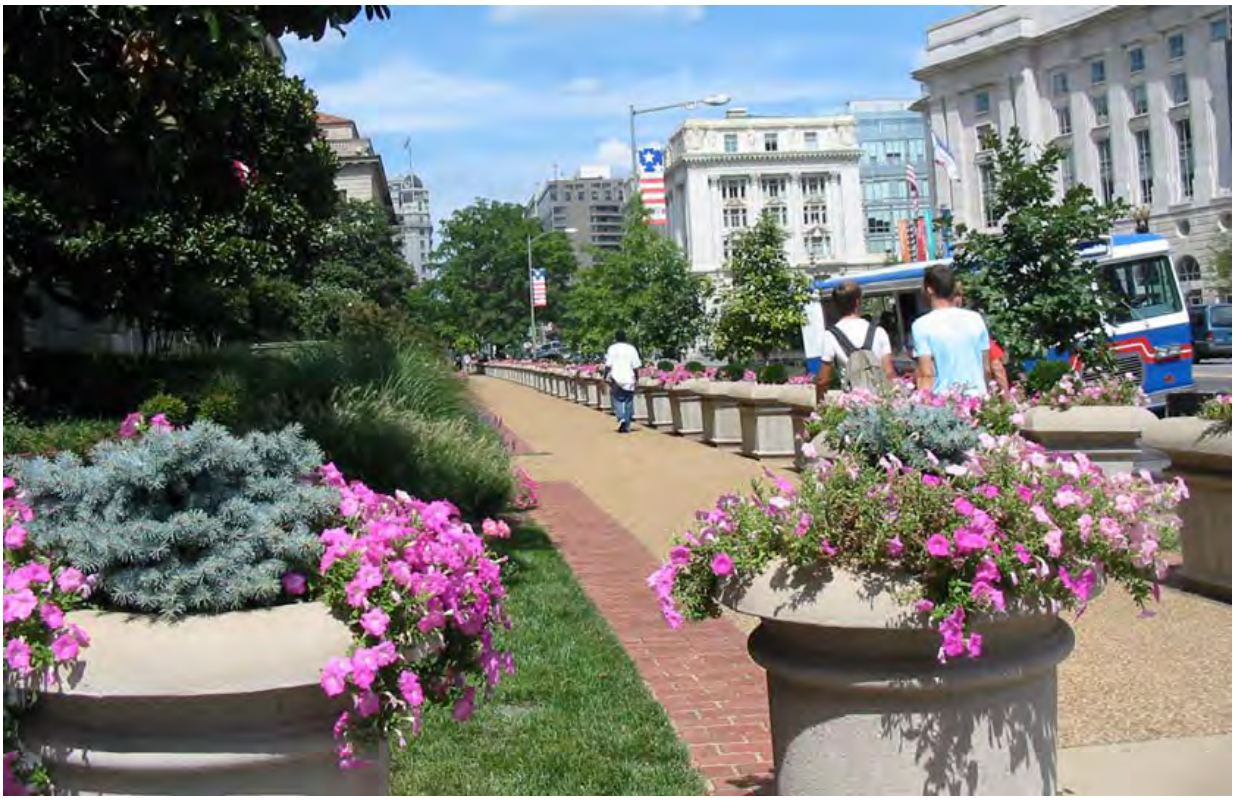
Figure B-9.5 Example of Double Security Gate

Figure B-9.6 Example of Bollards Matching the Existing Architectural Character

B-9.4.2.4 **Planters**

Reinforce moveable planters to secure certain areas. A good planter will have a watering and drainage system. Planters can also be built in place. The addition of plant material, particularly in plazas, will soften the look of a security element while maintaining an adequate level of protection. Prior to beginning the design of any project that involves planters to be used for site security, check for the availability of \1\UFC 4-022-02/1/.

Figure B-9.7 Planters Containing a Mix of Evergreen and Seasonal Plants



B-9.4.2.5 **Natural Features**

Use topography, including berms, ditches, forests, wetlands, and bodies of water, effectively in the landscape to provide protection against vehicular threats. Prior to incorporating natural features into the design of any project for the purpose of vehicular barriers, check for the availability of \1\UFC 4-022-03/1/.

B-9.4.2.5.1 **Berms**

For detailed guidance regarding use of berms as a security feature, refer to \1\UFC 4-020-01/1/.

Figure B-9.8 Berms and Vegetation for Perimeter Control

B-9.4.2.5.2 **Ditches**

Integrate ditches into the landscape and architectural context of a site. Ditches can serve as a design feature and once all requirements are met, can be approached from an environmental and visual standpoint. Prior to incorporating ditches in the design of any project as a security feature, refer to \1\UFC 4-020-01/1/.

B-10 IMPLEMENTATION

Ensure project construction documents convey the necessary information to successfully implement the design. While landscape architects are responsible for designing the project, the landscape contractor is responsible for the actual implementation, installation, and establishment of the design. Following installation, maintenance personnel are responsible for the various landscape elements of the project to maturity. Between the design, implementation, and establishment phases is a need for clear communication. Plan drawings, construction details, and specifications are the tools used to communicate the intent of the design to the contractors.

B-10.1 Role of the Landscape Architect

The following responsibilities are included in the coordination and oversight of the design implementation process:

- Conduct interdisciplinary and user coordination meetings throughout the implementation process.
- Prepare construction documents for use by a landscape contractor. These documents are required to be stamped by a registered landscape architect.
- Design and determine all proposed site structures and materials.
- Design and determine all proposed plant materials and exact locations.

B-10.1.2 Construction Documents Package

In communicating the design intent to the contractors, submit the following documents to contractors:

- Demolition plan;
- Grading plan;
- Planting plan;
- Irrigation plan;
- Details;
- Specifications; and
- Cost estimate.

B-10.2 Construction Details

Details, along with specifications and plans, are the tools used to communicate design intent to the project contractor.

Details should eliminate doubt and confusion on how to bid or construct the project. Metric measurements are now the DoD standard. Installation personnel should compile a landscape architecture detail library based on installation and regional standards, policies, and practices. Use the Tri-Service CADD/GIS Technology Center (https://tsc.wes.army.mil/) as a resource for DoD-approved details. Details can be created for any of the following:

- Site-work;
- Irrigation;
- Site amenities;
- Planting; and
- Inert materials.

B-10.3 Implementation Specifications

Landscape implementation specifications define the type and quality of materials and equipment and specify the required construction standards and methods. In contracted work, specifications are the final word if there are contradictions between the various implementation documents, including drawings and details.

B-10.4 Cost Estimating

Landscape architects, planners, and programmers require accurate cost estimates to ensure scarce project dollars are factored into overall project costs. See \1\UFC 3-701-XX/1/ (where XX indicates the fiscal year) for specific guidance on cost-estimating a site design project.

Approach landscape cost estimating by compiling project costs according to the expected order of construction. The following landscape components occur in the following order:

- Site-work;
- Irrigation;
- Site amenities;
- Planting;
- Inert materials; and
- Establishment.

B-10.5 Conclusion

To ensure the designs are built correctly, convey the user's design needs to the contractors. In the absence of being on-site, conduct coordination meetings, prepare construction documents, communicate design intent for all proposed site structures and materials, and convey location and types of plant materials.

B-11 LANDSCAPE MAINTENANCE AND MANAGEMENT

The regular care of plant material, site furnishings, and other outdoor elements ensure that a site will function and appear as it was designed. Collaboration between maintenance supervisors and landscape architects is the key to establishing and maintaining a site with sustainable goals for the long-term.

B-11.1 Role of the Landscape Architect

The following responsibilities are included in the coordination and oversight of the maintenance and management of a site.

- Collaborate early with the maintenance team to understand and communicate maintenance requirements and limitations.
- Apply planting design decisions to typical maintenance and management practices.
- Enforce a required one-year minimum establishment period on all landscape installation contracts.
- Write or oversee the writing of a landscape management plan for each project.

B-11.2 Comprehensive Landscape Maintenance

Develop a comprehensive plan to direct and control the quality of work. Base this plan on field practices, compliance with DoD directives, and satisfaction of mission requirements.

B-11.2.1 Grounds Maintenance Plan

Develop plans to direct the type and frequency of landscape maintenance tasks needed for specific areas. Maps will delineate the grounds maintenance into levels and a statement of work will describe each task based on an area's maintenance level. When designing specific sites, remember the level of maintenance it will receive. The three levels are designated as follows:

- Improved grounds consist of turf grass areas and planting material which will require intensive maintenance.
- Semi-improved grounds are areas where landscape maintenance is performed primarily for functional or operational purposes. The semi-improved category contains airfield safety zones, rifle ranges, and open spaces in developed areas.
- The unimproved grounds category includes all other grounds on the installation and is made up of undeveloped areas. This level is comprised of forests, wildlife areas, crop, and grazing lands, lakes, ponds, and airfield areas outside the clear

zone. Minimal maintenance will be required. Annual mowing or pruning will be part of the installation's grounds maintenance or management plans. Responsible design and management practices will allow larger proportions of the base to be maintained at the unimproved level.

B-11.2.2 Establishment Period

Every landscape project will have a required establishment period, typically one year, in which the site will require more intensive maintenance. Specific tasks during this time may include irrigation, pruning, and plant replacement. After this period, many landscapes can be designed to require minimal maintenance.

B-11.2.3 Erosion Control Maintenance Procedures

Specify proper maintenance of the following elements to prevent the development of potential erosion problems. Complete specific maintenance projects to prevent problems and correct existing problems, such as:

- Drainage structures;
- Unstable soils;
- Runoff;
- Plant materials; and
- Irrigation systems.

B-11.2.4 Land Management Plan

According to DoD policy, this document must be updated at least every five years. Landscape architects must be consulted in the development of the land management plan to ensure consistent implementation while meeting long-term landscape design, planning, and maintenance objectives.

The land management plan is used as a reference in design and landscape maintenance contracts. It will contain specific information, including the plant and inert material lists, standard landscape construction specifications and details, and soils maps.

B-11.3 Landscape Maintenance Tasks And Methods

Well-defined maintenance guidelines are key to an efficient and effective program. Include the following tasks—common to installation landscape maintenance—in every task list:

- Aeration;
- Fertilization;

- Mowing;
- Mulching;
- Pest and plant disease control;
- Pruning (trees and shrubs);
- Soil amendments;
- Trimming; and
- Weed control.

B-11.4 Landscape Management

Some landscapes on DoD installations require long-term management to protect them from potential problems. Areas such as forests and ranges need to be understood from operational, wildlife, and natural resources perspectives. Federal lands must comply with Federal legislation actions, including the Endangered Species Act. Large areas of forest or agricultural land may provide additional income to the installation. A wide array of land management plans may be compiled for different installations. These plans are most effective when developed by an inter-disciplinary team that includes a landscape architect. Landscape architects have the knowledge and skills needed to understand how different land uses and practices affect the surrounding land and resources.

B-11.5 Plan Development

The emphasis on increasing the quality of life on DoD installations while decreasing funding for maintenance continues to gain momentum. It is important that funding for landscape maintenance is spent constructively and wisely.

As described above, the following are some of the actions necessary to implement an efficient and logical landscape maintenance program:

- Ensure grounds maintenance plan, land management plan, and installation landscape development objectives are coordinated for consistency and long-term compatibility.
- Require project-specific landscape maintenance guidance be provided for all new landscape projects on the installation.
- Request landscape establishment specifications be provided for all new landscape projects on the installation.

- Provide and require landscape maintenance training for all installation grounds personnel.

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G12 - BARKING SANDS PACIFIC MISSILE RANGE FACILITY, PROPOSED LAYSAN ALBATROSS MANAGEMENT PLAN TO REDUCE BIRD-AIRCRAFT STRIKE HAZARD POTENTIAL

(NAVFAC 2009b)

BARKING SANDS,
PACIFIC MISSILE RANGE FACILITY,
PROPOSED LAYSAN ALBATROSS MANAGEMENT PLAN TO REDUCE BIRD-AIRCRAFT STRIKE HAZARD POTENTIAL

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BACKGROUND

Purpose

To reduce the bird-aircraft strike hazard (BASH) risk posed by Laysan albatrosses *(Phoebastria immutabilis)* at Barking Sands, Pacific Missile Range Facility.

Property Description

PMRF Main Base, Barking Sands, is located along the coastline on the west side of Kauai and encompasses approximately 834 ha (2,060 ac) (Figure 1). The terrain is generally flat, with a nominal elevation of 4.6 m (15 ft) above mean sea level. The ocean side of the installation consists of low barrier dunes and the more prominent Nohili Dunes, which rise approximately 30 m (100 ft) above mean sea level. The installation currently has operations, including an active runway; administration and housing facilities; quality of life features; and antenna arrays.

Figure 1. Location and base map of Barking Sands, Pacific Missile Range Facility.

Prior Use

The land now occupied by Barking Sands, PMRF, was first used as an airstrip in 1932, when residents of Kauai created a grass runway for a pilot flying from Australia to Hawaii. In 1940, the U.S. Army acquired just over 500 acres of land in the area, including the runway. The Army paved the runway, naming the airfield Mana Airport, and in 1941 acquired an additional 1500 acres. In 1954, Bonham Air Force Base was established on this land, and in 1956 the base became a joint Navy base. The base was transferred to the Department of the Navy in 1964, and the Navy's Pacific Missile Range Facility was established at Barking Sands in July 1968 (https://www.cnic.navy.mil/Hawaii).

Species of Interest

Laysan albatross (Phoebastria immutabilis)

Laysan albatrosses are a protected species under the U.S. Migratory Bird Treaty Act. Ninety-nine percent of the global population of Laysan albatrosses breeds in the Northwestern Hawaiian Islands, which are protected as a Marine National Monument, two National Wildlife Refuges, a State Marine Refuge, and a State Wildlife Sanctuary (Arata et al. 2009) (Figure 2). Total Laysan albatross population size is estimated at 2.5 million birds, of which 800,000 are breeding adults and 1.7 million are non-breeding sub-adults (Awkerman et al. 2009). Smaller subpopulations of this species (from a few to several dozen breeding pairs) currently nest on the main Hawaiian Islands, including Kaula, Niihau, Lehua, Kauai, Oahu, and Moku Manu (Harrison 1990, Young et al. 2009).

Albatrosses are the largest seabirds in the Pacific region. In the Hawaiian Archipelago, Laysan albatrosses are second in size only to black-footed albatrosses (*Phoebastria nigripes*). Males are slightly larger than females, but in general adult Laysans have a mean body mass of approximately 3 kg (6.6 lbs) (Fisher 1967) and a wingspan of 2 m (6.5 ft) (Harrison et al. 1983). Albatrosses use dynamic soaring in flight, a process that takes advantage of differences in wind speed at varying elevations. Take-offs and landings are arduous, requiring either strong wind speeds or large, open areas for running and flapping until the bird is airborne (Awkerman et al. 2009).

Laysan albatrosses are extremely consistent in the timing of their breeding from year to year, and nesting is very synchronous among individuals within colonies (Awkerman et al. 2009). On Kauai, adults arrive at the breeding colonies beginning approximately 7 November, and eggs are laid between approximately 22 November and 15 December (U.S. Fish and Wildlife Service, unpublished data). A single egg is laid at the nest, and re-nesting will not occur if the nest fails (Awkerman et al. 2009). Eggs are incubated for 64 days, with hatching occurring from late January through mid-February, and chicks fledge from late June through July (Awkerman et al. 2009). Both adults within a pair provide parental care, alternating shifts during incubation and brooding, and later making foraging trips to sea to provision the chick (Awkerman et al. 2009). The first incubation

shift by the female immediately after laying averages 2 days, and the second shift by the other pair member averages 24 days. Subsequent incubation shifts average 12 days for both members of the pair, with a total incubation period of 64 days (Awkerman et al. 2009).

After fledging, juveniles remain at sea for two to three years, then begin returning to the breeding colonies each year between late December and April to begin forming a pair bond with a future mate (Rice and Kenyon 1962). Individuals generally begin breeding at 7 or 8 years of age and nest every 1 to 2 years throughout their lifetimes (Awkerman et al. 2009). Breeding site fidelity is very high, with males and females returning to the same nesting site each year. Laysan albatrosses are socially monogamous and form long-term pair bonds that last until one member of the pair dies (Rice and Kenyon 1962). Mean lifespan is approximately 20 years, with a maximum known lifespan of 55 years (Naughton et al. 2007).

Figure 2. Laysan albatross in flight at French Frigate Shoals, Northwestern Hawaiian Islands. Photo: U.S. Fish and Wildlife Service.

PMRF Bird-Aircraft Strike Hazard (BASH) Program for Laysan albatrosses

Following severe population declines in the early 1900s due to feather and egg collectors, introduced predators, and World War II activities (Awkerman et al. 2009), in the 1970s Laysan albatross population sizes began to increase, and birds began recolonizing islands on which the species had previously been extirpated (Young et al. 2009). During this expansion, the first known nesting attempt on Kauai was observed in February 1977, on the east side of Kilauea Point (Zeillemaker and Ralph 1977).

Over the next decade, the colony at Kilauea Point increased in size, and birds also began attempting to nest at a location on the west side of the island, at Barking Sands (Figure 3). This choice of location by nesting albatrosses was likely not coincidental, as the conditions that made Barking Sands an attractive site for an airstrip in 1932 would also provide high-quality conditions for a large seabird species that benefits from strong winds and open space during take-offs and landings (Awkerman et al. 2009).

As part of its operations at Barking Sands, the Navy operates an 1800 m (6000 ft) runway, with regular take-offs and landings and daily touch and go practice of cargo planes, fighter jets, and other aircraft. Laysan albatrosses have continued to attempt to nest at Barking Sands since the late 1980s. With the species' large body size and flight characteristics, these birds pose a high bird-aircraft strike hazard (BASH) risk near the Barking Sands runway. In response to this hazard, in 1988 the U.S. Department of Agriculture Animal and Plant Health Inspection Service (USDA APHIS) Wildlife Services implemented a BASH Program to relocate Laysan albatrosses away from the PMRF runway.

From 1988 through the spring of 2008, Wildlife Services attempted to capture all albatrosses at Barking Sands as soon as an individual bird was observed. Breeding pairs were not intentionally allowed to lay an egg, although some birds were discovered after egg-laying, in which case the incubating bird was captured and relocated and the egg destroyed. In the late 1980s, albatrosses were captured and relocated to an area away from the runway within Barking Sands. In later years, birds were captured and transported to other parts of Kauai, including Kilauea Point National Wildlife Refuge (KPNWR) on the north side of the island.

Figure 3. Laysan albatrosses near the runway at Barking Sands, PMRF.

OBJECTIVES

The objectives of this proposed Laysan albatross management plan for Barking Sands, PMRF, include the following:

1. Assess capture data for non-breeding albatrosses to determine effectiveness of BASH Program relocations at decreasing numbers of sub-adult albatrosses in the air at Barking Sands.

2. Assess multiple years of capture data for individual adult albatrosses attempting to nest at Barking Sands to determine effectiveness of BASH Program relocations at decreasing numbers of adult albatrosses in the air.

3. Based on the results of Objectives 1 and 2, the species' biology, and the needs of the PMRF BASH Program, provide management recommendations on Laysan albatrosses at Barking Sands for the 2009-10 breeding season and future years to decrease the bird-aircraft strike hazard risk posed by this species.

METHODS

Data Sets Used

USDA APHIS Wildlife Services bands all Laysan albatrosses captured at Barking Sands with uniquely-numbered leg bands, including a U.S. Fish and Wildlife Service (USFWS) metal band and field-readable plastic band. Captures of all individual birds are thus recorded throughout the breeding season, including band number, date, time, location (recorded as Section 1 – 8 of the base and latitude/longitude coordinates), behavior (breeding, sitting, standing, flying), presence of egg, observer action (observed, chased, captured), and location to which the bird was relocated. Capture/relocation data for non-breeding and breeding albatrosses from the 2006-07, 2007-08, and 2008-09 breeding seasons are used in this report.

RESULTS

Objective 1: Assessment of capture data on non-breeding albatrosses

The non-breeding Laysan albatrosses at Barking Sands consist almost entirely of sub-adult individuals between 2 and 8 years of age that visit the breeding colony between December and April each year to attempt to establish and solidify a long-term pair bond with a future mate. Information on the number of captures and relocations of these non-breeding albatrosses during the 2006-07 and 2007-08 breeding seasons is presented in Figure 4.

For non-breeding birds, almost all individuals are captured and relocated just one time within a year, after which these individuals do not return to Barking Sands within that

year. During 2006-07, 107 of 145 non-breeding birds (74%) were captured and relocated a single time. In 2007-08, a similar percentage (59/83, or 71%) had to be relocated from the base just one time. In 2006-07, the greatest number of times that an individual non-breeding bird was removed from the base was 8, and in 2007-08, non-breeders had to be captured and relocated at most a total of 4 times. A single capture and relocation of the majority of these non-breeding sub-adult individuals thus accomplishes the goal of removing the birds from Barking Sands in order to reduce BASH risk.

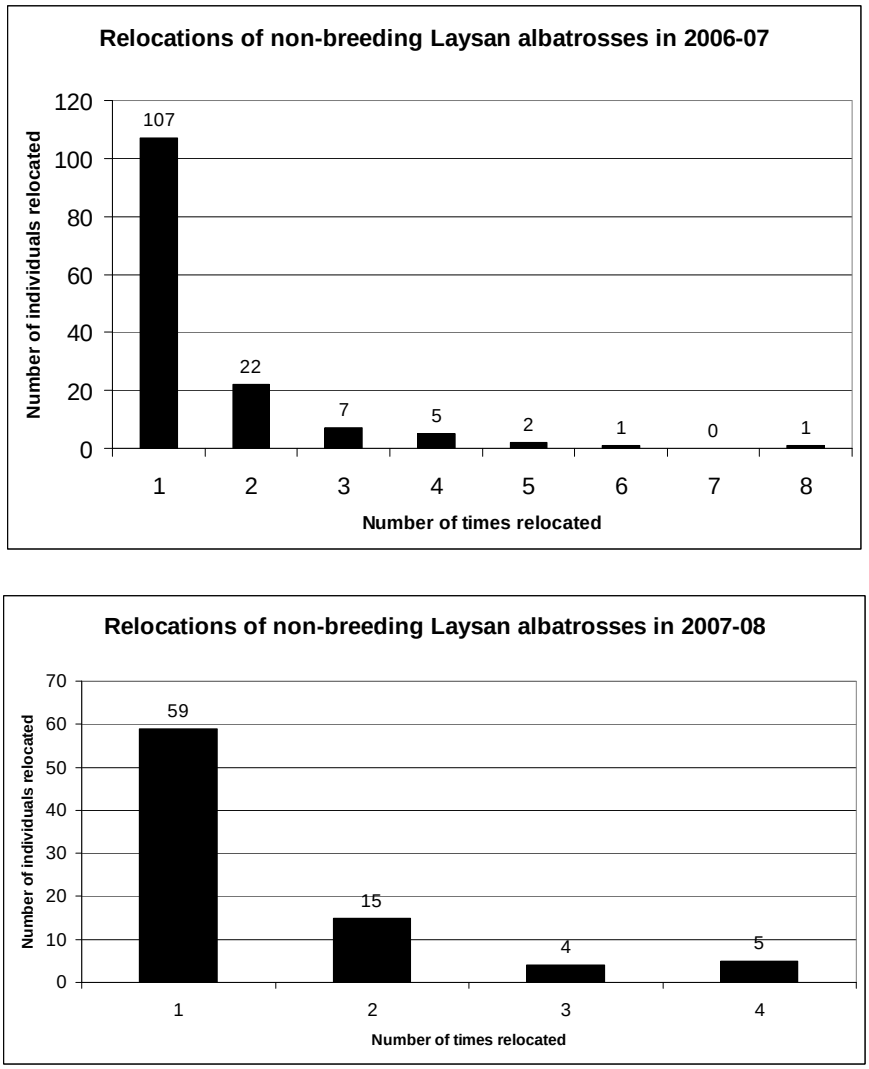


Figure 4. Numbers of times sub-adult non-breeding albatrosses were captured and relocated off of Barking Sands during 2006-07 and 2007-08.

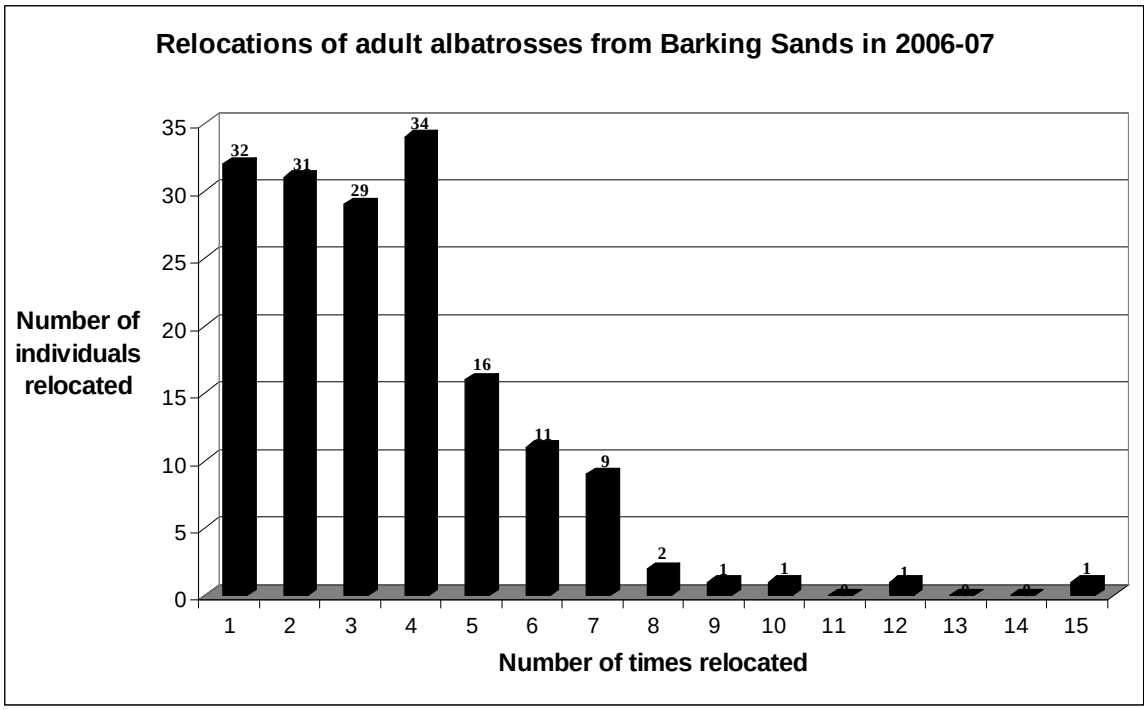
Objective 2: Assessment of capture data for adult albatrosses attempting to nest at Barking Sands

BASH Program protocol through the 2007-08 breeding season

Unlike sub-adult non-breeding birds, adult albatrosses that return to the breeding colony at Barking Sands in November of each year are displaying strong site fidelity to a breeding location that was established when the birds were sub-adults. Nest site fidelity is stronger in albatrosses than in almost all other bird species, with breeding pairs returning to an area within centimeters of the location of previous nests or nesting attempts (Fisher 1971). Even after multiple years of failed nesting attempts, Laysan albatrosses will return to the same nest site to attempt to breed until one member of the pair dies, at which time the other pair member will re-mate with an unpaired individual (Awkerman et al. 2009).

Data on numbers of captures and relocations of adult Laysan albatrosses at Barking Sands in 2006-07 and 2007-08 are presented in Figure 5. In contrast to the low numbers of relocations necessary to minimize BASH risk from sub-adult non-breeding albatrosses, individual adult albatrosses had to be captured and relocated from Barking Sands a total of up to 18 times within a single breeding season. In both 2006-07 and 2007-08, more than 70% of adult albatrosses were captured and relocated from Barking Sands more than once within the breeding period. For both years combined, 21% of all individual adult albatrosses had to be relocated more than 4 times within a breeding season.

The numbers of captures and relocations of individual adult Laysan albatrosses from Barking Sands within each year are an indication of the extreme nest site fidelity of this species. For all albatross species, the incubation of an egg and care of a chick require the efforts of both parents, and the long-term pair bonds established in these species is maintained in part by indication from both nesting adults of their fidelity to this process. For the Laysan albatrosses at Barking Sands, then, removal of a member of a breeding pair from the base, particularly prior to egg-laying, will almost always result in that bird returning to the base to re-pair with its mate and attempt to carry out the nesting process. For this reason, the capture and relocation of adult birds attempting to nest will result in an increase in the number of albatrosses in the air at Barking Sands, as these birds return to the base after each capture and relocation attempt. Multiple captures and relocations of adult Laysan albatrosses, then, act to increase the BASH risk posed by this species at PMRF.



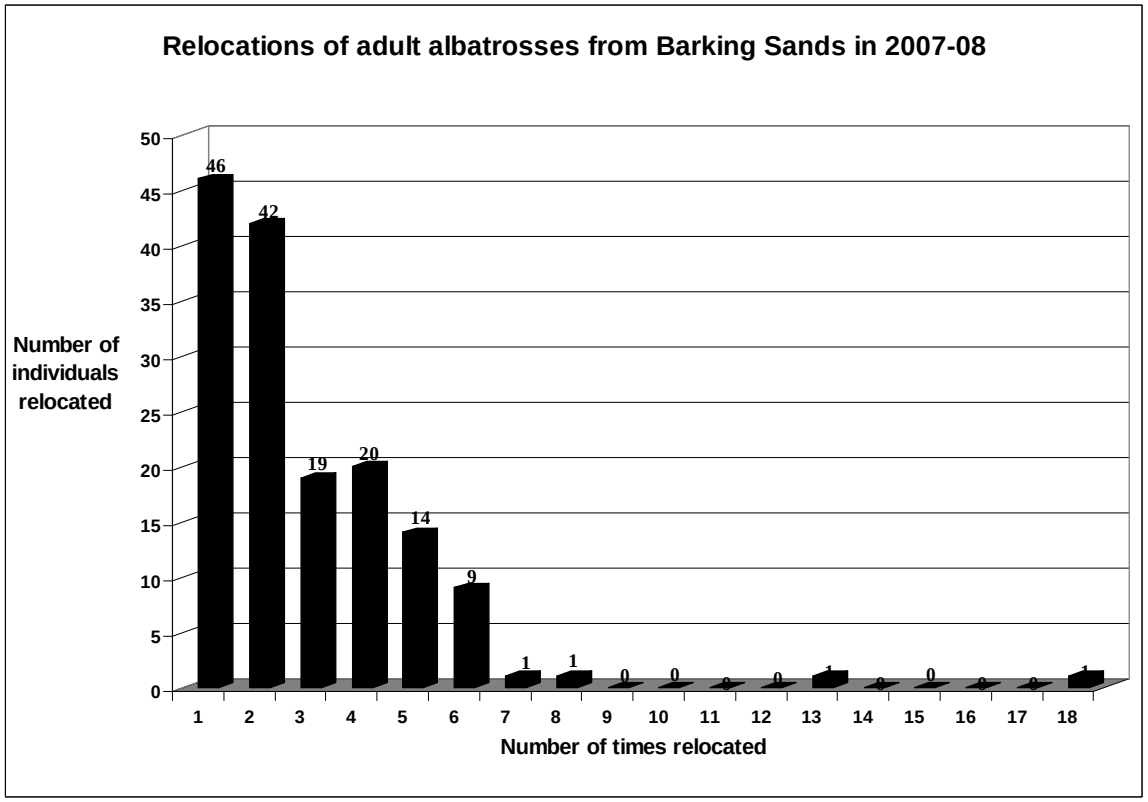


Figure 5. Numbers of times adult albatrosses were captured and relocated off of Barking Sands during 2006-07 and 2007-08.

BASH Program protocol at Kauai Training Facility (KTF) in 2008-09

Although the Laysan albatross portion of the BASH Program at Barking Sands has been carried out almost continuously since 1988, during the 2004-05 albatross breeding season, funding was not allocated to Wildlife Services to remove albatrosses or destroy albatross eggs at Barking Sands. As a consequence, that year the Navy and USFWS began a collaborative project to translocate albatross eggs and chicks from Barking Sands to foster nest sites at KPNWR and other locations on the north shore of Kauai at which nesting pairs' eggs were determined to be inviable. This program proved successful in 2004-05, and although adult albatrosses were removed from Barking Sands in subsequent years, any eggs that were found to have been laid on base during the 2005-06 through 2007-08 breeding seasons were placed in incubators and translocated to foster nests at other sites off base.

As part of this program to translocate Laysan albatross eggs from Barking Sands to other sites on Kauai, in 2008-09, adult albatrosses attempting to nest within the Kauai Training Facility (KTF) section of PMRF were allowed to incubate their eggs naturally after laying. That is, rather than capturing and relocating adult birds and placing their eggs in incubators, breeding birds were left at KTF to incubate their eggs through mid-December. After a foster nest site was located at KPNWR or another area to which a Barking Sands albatross egg could be translocated, the egg was removed from KTF, and the incubating adult albatross was captured and relocated off base.

Although this protocol at KTF was followed in conjunction with the albatross egg translocation project, the lack of removal of adult albatrosses that were attempting to nest at KTF likely also served the purpose of decreasing the numbers of albatrosses in the air at Barking Sands. To examine this possibility, capture data from individuals that nested at KTF in 2008-09 can be compared to the capture data for those same individual birds in previous years, when these individuals also attempted to nest but were immediately captured and relocated.

Table 1 provides information on the number of times that individual adult Laysan albatrosses returned to Barking Sands after being allowed to lay and incubate an egg at KTF in 2008-09, versus the number of times that these same individuals returned to Barking Sands after being immediately captured and relocated in 2006-07 and 2007-08. During the 2008-09 breeding season, these birds were not captured and relocated at the beginning of the season; instead, they were allowed to lay and incubate an egg through mid-December. When the egg could be translocated to a site off base, the egg was removed, and the adult albatross that had been incubating was captured and relocated. Examining each row in Table 1, 20 of 29 individual albatrosses returned to Barking Sands fewer times following laying, incubation, and egg removal in 2008-09 than they had in both 2006-07 and 2007-08. In examining the total numbers of times these birds returned to Barking Sands (that is, the total number of times that birds were in the air posing a BASH risk), in 2006-07 and 2007-08 a total of 88 and 97 returns occurred, respectively. In 2008-09, these same individuals returned a total of just 44 times. These data indicate that leaving Laysan albatrosses to lay and incubate eggs through mid-

December may result in birds returning to the base fewer times throughout the breeding season, decreasing the overall BASH risk posed by this species at Barking Sands.

Table 1. For individual albatrosses that nested at KTF in 2008-09, the number of times those individuals returned to Barking Sands following removal of the egg and capture/relocation in 2008-09, in comparison to the numbers of times those individuals returned to Barking Sands following capture and relocation in 2006-07 and 2007-08. For 20 of 29 albatrosses (denoted in red font), the birds returned to Barking Sands fewer times after being allowed to lay and incubate eggs than they had in previous years, in which they had not been allowed to nest.

Band number of individual nesting albatross	2006-07 Number of times returned to PMRF after captures/relocations	2007-08 Number of times returned to PMRF after captures/relocations	2008-09 Number of times returned to PMRF following egg removal and capture/relocation
A033	1	6	1
A136	4	4	2
A038	3	4	2
A062	2	1	0
A025	4	2	0
A168	2	2	1
A160	2	1	1
A032	3	2	1
A057	7	2	1
A058	3	4	0
A137	5	4	2
A162	1	2	0
A063	4	5	2
A129	2	3	3
A263	0	2	3
A265	0	2	3
A034	0	5	0
A035	4	6	3
A156	4	3	3
A018	2	2	3
A060	5	5	2
A013	3	4	0
A118	4	5	1
A037	4	4	2
A014	5	5	0
A030	4	4	0
A147	2	0	2
A040	4	2	3
A035	4	6	3
Total number of times birds returned to PMRF	**88**	**97**	**44**

Number of returns of the adult albatrosses that were allowed to incubate eggs at KTF can also be compared to the number of returns of adult albatrosses on other areas of the base in 2008-09. As shown in Figure 6, individual adult albatrosses outside of KTF (indicated by yellow sections of bars), that were captured and relocated immediately - i.e. not allowed to incubate their eggs - were relocated up to 9 times throughout the breeding season. In contrast, albatrosses that were allowed to incubate eggs through mid-December in the KTF area (indicated by red sections of bars) were relocated only up 4 times throughout the breeding season.

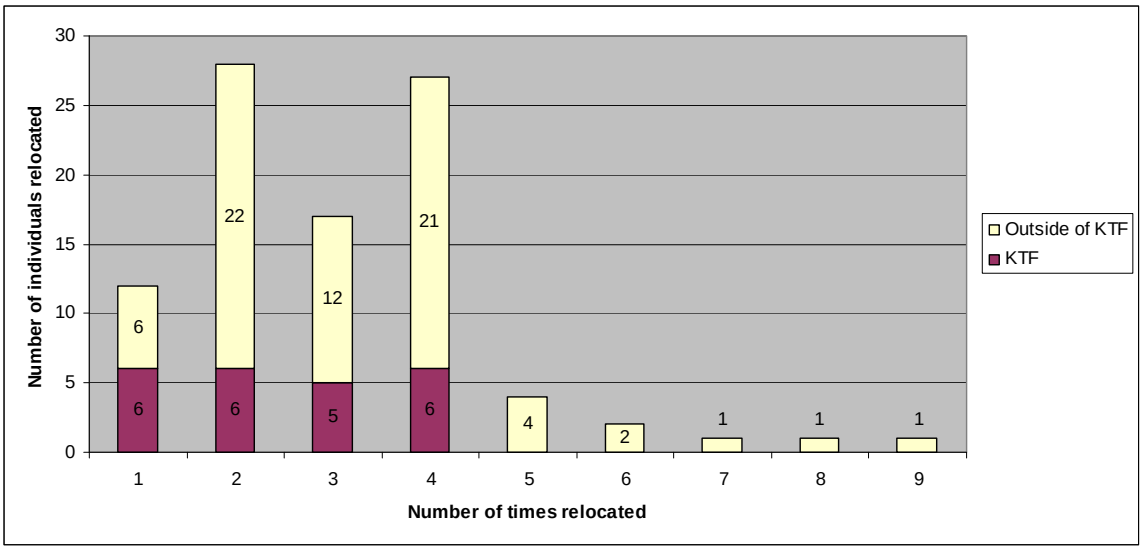


Figure 6. Number of times adult albatrosses outside of KTF (those not allowed to incubate their eggs) were captured and relocated in 2008-09 (yellow section of bars) relative to the number of times albatrosses inside KTF, which were allowed to incubate their eggs through mid-December, were captured and relocated (red section of bars).

Potential for attracting additional nesting albatrosses

Although nesting colonies of some seabird species act to attract additional breeding adults to an area, this is not the case for albatrosses. As described in the "Species of Interest" section of this report, nesting of Laysan albatrosses is extremely synchronous, with all breeding pairs laying within an approximate 3-week window in late November and early December (Awkerman et al. 2009). Adult birds arriving at a colony to nest in November and early December consist only of: 1) pairs that have attempted to breed together in that same location for several years, and 2) young pairs that will attempt to nest together for the first time. In this second case, young pairs (consisting of 7- to 8-year old birds) attempting to nest for the first time would have visited that location within the colony to establish and strengthen their pair bond over multiple breeding seasons in previous years, such that they would have nested in that location that year regardless of the presence or absence of other nesting albatrosses (Rice and Kenyon 1962, Fisher 1971,

Awkerman 2009). Sub-adult (non-breeding) albatrosses may be attracted to an area already containing nesting adults; however, sub-adults do not begin arriving at Laysan albatross breeding colonies until late December (Whittow 1993). If nesting albatrosses are allowed to lay and incubate eggs only through mid-December, there should be no attraction of additional sub-adult birds to the breeding colony.

To examine whether allowing albatrosses to lay and incubate eggs through mid-December in the KTF area attracted additional albatrosses to this area, capture data for KTF for 2006-07, 2007-08, and 2008-09 can again be examined. Table 1, above, shows capture data for all adult albatrosses that nested at KTF in 2008-09. All 29 of these nesting individuals were captured at KTF in 2006-07 and/or 2007-08, such that none of them were new birds that had been attracted by the presence of other nesting albatrosses at KTF in 2008-09. Table 2, below, lists all non-nesting albatrosses that were captured at KTF in November or December 2008 (the period of time that nesting birds were allowed to incubate their eggs). Of the 8 non-breeding birds captured during this time period, only one individual (A337) had not been captured at KTF during the previous two years, such that this individual may have been attracted to KTF in 2008 due to the presence of incubating adults. Albatross A337 was captured and relocated once from KTF and did not subsequently return to Barking Sands in 2008-09. The fact that no new adult albatrosses, and just one of eight non-breeders, were new to KTF during November-December 2008 indicates that the presence of incubating adults during the November-December time period likely does not attract additional Laysan albatrosses to the area.

Table 2. Non-breeding albatrosses captured in the Kauai Training Facility section of Barking Sands in November-December 2008 (the time period during which adult albatrosses were allowed to lay and incubate eggs at KTF). Of these eight individuals, just one (A337) had not been captured at KTF in 2006-07 or 2007-08, such that it may have been attracted to KTF by the presence of nesting albatrosses in 2008-09.

Band number of non-breeding albatross	2006-07 Captured in KTF	2007-08 Captured in KTF	2008-09 Captured in KTF	KTF Nov-Dec 2008 capture date
A019	Yes	No	Yes	11/17/2008
A064	Yes	No	Yes	11/17/2008
A337	**No**	**No**	**Yes**	**11/17/2008**
A226	Yes	No	Yes	11/21/2008
A134	Yes	Yes	Yes	12/24/2008
A135	Yes	Yes	Yes	12/24/2008
A115	Yes	Yes	Yes	12/24/2008
A036	Yes	Yes	Yes	12/30/2008

Objective 3: Management recommendations on Laysan albatrosses at Barking Sands to decrease the BASH risk posed by this species

Sub-adult non-breeding albatrosses

Based upon the information in Objective 1, above, we recommend that USDA APHIS Wildlife Services continue the protocol used in past years for sub-adult non-breeding albatrosses, including the capture and relocation of these individuals when and where they are encountered at Barking Sands. Data from previous years indicate that approximately 70-75% of these individuals do not return to Barking Sands within a given year after just a single capture/relocation event. The removal of sub-adults in this way thus decreases BASH risk within each year and also serves to decrease the opportunity for sub-adults at Barking Sands to form and maintain pair bonds (which would have the potential to lead to future breeding attempts by these individuals at Barking Sands).

Adult albatrosses

For individual adult albatrosses that are known to have attempted to nest (e.g. those that have laid eggs) at Barking Sands in previous years:

At KTF: Based upon the information in Objective 2, above, and on the distance of KTF from the active 6000-ft runway at Barking Sands, we recommend that in the KTF section Wildlife Services allow adult albatrosses to lay eggs and incubate them through mid-December, prior to the arrival of sub-adult non-breeding birds. The eggs can then be transferred directly to available foster nest sites that have been identified by USFWS personnel at KPNWR or other areas on Kauai; transferred to an incubator for later translocation if foster nest sites are not immediately identified by USFWS; or destroyed via freezing if foster nest sites at KPNWR or other areas are not available.

Following removal of the egg at nests at KTF, we recommend that the incubating adult albatross be left at KTF rather than captured and relocated. Although incubating birds did return to Barking Sands fewer times following capture and relocation than did birds that were not allowed to incubate, Table 1 indicates that incubating albatrosses still returned to the base up to 3 times following egg removal and capture/relocation. We recommend allowing these adult albatrosses to leave Barking Sands on their own beginning in the 2009-10 breeding season, and collecting observational data each day after removal of the egg to determine presence/absence and return rates of these individual birds. The breeding partner at each nest site should similarly not be captured and relocated, but instead be allowed to leave the colony on its own after discovery of nest “failure” (i.e. removal of the egg). Observational data should also be collected on the presence/absence of the breeding partner following egg removal. Based upon albatross behavior following natural nest failure during the incubation period, these albatrosses will very likely remain at KTF for one to a few days following egg removal or discovery of nest failure, and will then leave Barking Sands on their own and not return that year. This process would

decrease the number of times albatrosses fly back to Barking Sands within each year, decreasing the overall BASH risk posed by this species.

The above recommendations apply to adult albatrosses attempting to nest within the KTF area at Barking Sands based upon the distance of KTF from the 6000-ft active runway, and upon results of the methods used at KTF in 2008-09. If the PMRF Safety Officer, Air Operations personnel, USDA Wildlife Services, and other experts at Barking Sands determine that additional albatross nesting areas are a great enough distance from the runway to implement these recommendations outside of KTF (e.g. in the entire area north of Nohili ditch), these methods could be implemented in other areas. If this is done, we recommend – as with recommendations for the KTF area – that data be collected daily on the presence/absence (i.e. natural departures and returns) of individual adult birds in those areas so that this information can be formally analyzed and compared to numbers of returns of these individual birds following their capture and relocation in previous years.

Near runway: Based upon the large body size, extremely high nest site fidelity, and lifespan of Laysan albatrosses, and on the Navy's uses of the 6000-ft active runway at PMRF, for adult albatrosses attempting to nest within 2.4 km (1.5 miles) of the active runway at Barking Sands, we recommend permanent removal of these individuals from the population. Repeated captures and relocations of these adult albatrosses would result only in the individuals returning to their prospective nest site at Barking Sands, and allowing these birds to lay and incubate eggs near the runway, while likely decreasing the numbers of birds in the air at Barking Sands, would still allow for some number of flights by these individuals into and out of Barking Sands in very close proximity to the runway. Unlike the sub-adult non-breeding albatrosses that are captured and relocated from Barking Sands, these birds will not likely eventually settle and nest in a breeding colony in another location, but will return to Barking Sands each year throughout their lifetimes, continuing to repeatedly pose a BASH risk for military pilots and aircraft at PMRF. Permanent removal of these individuals could potentially involve placing the individuals in a captive care facility or culling of the birds from the population.

If such permanent removal of adults attempting to nest near the runway is not possible due to permitting or logistics reasons, we recommend continued investigation into mechanical methods of deterring albatrosses from landing on the ground near the runway. Black ground fabric has been successful in decreasing numbers of nesting attempts in construction areas and at the ends of runways on the National Wildlife Refuges in the Northwestern Hawaiian Islands (A.D. Anders, personal observation), but this method does not deter albatrosses from landing on the ground, as they do land on the fabric, so it would likely not help in reducing BASH risk at Barking Sands. Investigation of other mechanical methods that may prevent birds from landing near the runway would be useful.

Overall, implementation of any of the above management recommendations for Laysan albatrosses should be effective in significantly decreasing the number of flights into Barking Sands by this species, thus reducing the BASH risk posed to pilots and aircraft at PMRF.

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APPENDIX H
HUMPBACK WHALE, HAWAIIAN MONK SEAL, AND SEA TURTLE SIGHTINGS

H1 - HUMPBACK WHALE SIGHTINGS

		SIGHTINGS AND OBSERVATIONS
		Logged by RMKH, N00L, based on reports made to her by Harbor Patrol or Tower
DATE	TIME	SIGHTINGS AND OBSERVATIONS
3/21/1998		Whale and calf enters harbor
		PH1 William Goodwin photographs whale in Pearl Harbor
same season, later		USS LOUISVILLE (sub) departing channel glanced whale
		Tower reported procedure put in place
1999 June		Coral collision Kaneohe, LCU from USS PELELIU, June JTFX,
1/18/2000		Six whales sighted aprx 2 miles out from Papa Hotel
		Four reported by TWR 7, two reported by CLINGER
5/26/2000		Cynthia Pang advises OSOT team has observed at various times:
		Hammer heads, turtles, one sea pup, dolphins at Intrepid Bay/Point West Loch
2/20/2001	8:28 a.m.	USS CHICAGO - Whale seen, entrance Papa Hotel
2/21/2001		USS CHARLOTTE - Saw whales 2-3 miles away - channel btwn Molokai & Oahu
2/27/2001		NMFS called by Signal Tower of whale in Pearl Harbor
1/6/2004	6:00 p.m.	USS COLUMBIA - Departing Pearl Harbor, whales either side, 200 yds Buoys 1 & 2
1/21 or 1/22/2004	5:45 p.m.	KISKA - btwn Buoys 1 & 2
2/5/2004	5:00 p.m.	HOPPER (inbound) whales headed east (DH) btwn 1&2
2/12/2004	5:15 p.m.	Whale observed in vicinity of PH entrance Buoy 1
2/26/2004	11:00 a.m.	Security boats - whales btwn Buoys 1 & 2
3/18/2004	9:30 a.m.	Pod of dolphins seen by vessel inbound Buoy 7 security boat
4/12/2004	9:09 a.m.	Monk seal 100' off Hickam O'Club. Spotted by Danny aboard Tug Lanai transiting from
		Victor Pier to Alpha Docks
2004 December		Port Ops advises whale sighting PH (Papa Hotel)
1/16/2005	4:00 p.m.	Monk seal basing at Iroquois Point harbor
1/19/2005	10:48 a.m.	Ctrl Tower reports two whales spotted headed east at Buoys 1 & 2
1/20/2005	10:00 a.m.	Whales seen 1MSW Buoys 1 & 2
1/24/2005	1:00 p.m.	Channel marker 7 at IP - Buoy 7, "injured" presumed, no fishing line
		Monk seal - hauled out on beach

2/1/2005	5:40 p.m.	Outbound sub reports two whales headed west 500 yds off Buoys 1 & 2
2/11/2005		Monk seal - White Sands Beach
2/16/2005		Monk seal - White Sands Beach
3/4/2005	10:30 a.m.	Monk seal basking, White Plains
3/10/2005	2:47 p.m.	Seal at White Plains
3/11/2005	9:02 a.m.	Monk seal - White Plains
4/30/2005	9:45 a.m.	Monk seal - White Plains
2005 May		USS RUSSELL firing - 50 cal - VIP saw spout - firing stopped
2006 February	3:20 p.m.	NOAA calls - advises charter boat saw HMS entangled S of Niihau. Advised PMRF
	4:10 p.m.	Whale sighted 1,000 yds west of Buoy 1
3/27/2006	10:00 a.m.	Whale headed E 2 NM S of reef runway
	1:30 p.m.	Whale 300 yds Buoys 1 & 2 headed east
	1:45 p.m.	Two whales west of Buoys 1 & 2, 300 NM
4/3/2006		Flt departing PMRF saw adult whale & calf
5/1/2006		Tower reports two whales, Buoys 3 & 4, headed east
5/19/2006	7:20 a.m.	White Plains Beach cottage HMS
12/5/2006	2:15 p.m.	Iroquois Point/Hammer Point HMS hauled out
1/22/2007	9:14 a.m.	Whale headed SW at Papa Hotel - report from ship to tower
6/4/2007	9:00 a.m.	HMS White Plains Beach
8/1/2007		Dead turtle (papilomas) at Iroquois Point EOD dock
8/16/2007		Dead turle (papilomas) at Laulaunui in West Loch

H2 - HAWAIIAN MONK SEAL SIGHTINGS

		MONK SEAL SIGHTINGS AND OBSERVATIONS
Note: all sightings and observations are during day time hours. Where notation reads, No sightings, this means beaches were patrolled by USDA but no seals seen.		
DATE	TIME	SIGHTINGS AND OBSERVATIONS
5/25/2006	9:30	USDA reports one monk seal resting on beach across runway in line with hangar - no tag - tan in color
5/30/2006	8:00	Security reported a large monk seal below housing berm, by pavilion. No tag.
6/2/2006	10:06	USDA observed large monk seal across runway in line with hangar. No tag.
6/5/2006	9:45	USDA reported monk seal, opposite hangar, large, black in color, no tag.
6/6/2006	9:46	USDA observed large monk seal across runway in line with hangar. No tag.
6/7/2006	8:49	USDA reported monk seal, across runway. No tag.
6/8/2006	8:49	USDA reported what look like same seal across runway.
6/8/2006	9:47	USDA reported seal on beach across fuel farm by crash fire marker.
6/9/2006	9:02	USDA reported what looks like same seal by crash fire marker.
6/12/2006		Beach patrolled by USDA. No activity.
6/14/2006	9:15	USDA reports a female monk seal ocean side of reef runway, close to
6/19/2007	9:07	USDA reports small tan seal, at 3000 foot marker, resting on beach.
6/20/2006	10:10	USDA reports small tan seal, at 3000 foot marker, resting on beach.
	10:26	USDA reports female tan monk seal resting on beach at TACAN site.
6/21/2006	10:16	USDA reports monk seal, ocean side of runway, across hangar resting on beach.
	11:20	Observation for mission. No seals or turtles observed within 10,000 ft GHA.
6/22/2006	8:44	USDA reports one small monk seal resting on sand at 3000 foot marker.
	9:11	USDA reports one large monk seal with red tag between red label area and fuel farm resting on sand.
	9:58	USDA reports monk seal by red label observed entering water and swimming south.
	12:28	USDA reports monk seal sighted at 8:44 this morning still in same place.
6/23/2006	11:32	USDA reports one monk seal observed resting on beach across from main hanger, outside GHA.
	1:00	USDA reports monk seal in same as 11:32. Launch was at 12:30. Seal 10,000 feet from launch.
6/27/2006	9:00	USDA reports seal at 3000 foot marker resting on beach. Believes same seal spotted on 6/22/06 at 8:44 and 12:28
6/29/2006	9:05	USDA reports small tan seal oceanside of runway 34, marker 2, resting on sand, no tag.
6/30/2006	9:15	USDA reports small tan seal oceanside of runway opposite hangar resting on reef.
7/3/2006	12:02	USDA reports small tan monk seal, oceanside opposite hangar resting on reef.
7/6/2006	9:22	USDA reports small, tan monk seal resting on reef opposite hangar.
7/10/2006	8:47	USDA reports small, tan monk seal resting on reef opposite hangar. No tag.

	8:48	Large female monk seal spotted close to seal listed above.
7/11/2006	9:25	USDA reports large female monk seal resting on red across runway
		from hangar. No tag.
	10:45	USDA reports monk seal by majors bay swimming in water.
7/12/2006	9:09	USDA reports small tan monk seal, resting on reef, runway opposite
		hangar. No tag.
7/13/2006	9:10	USDA reports small tan monk seal resting on reef runway opposite
		runway. No tag
7/17/2006	9:45	USDA reports large female monk seal resting on red across runway
		by hangar.
7/19/2006	9:15	Same sighting as above.
7/20/2006	9:31	USDA reports one large monk seal opposite runway by main hangar,
		resting on reef. No tag.
7/31/2006	10:00	USDA reports one small monk seal ocean side of runway across main
		hangar. No tag.
8/1 & 2/06		No sightings.
8/3/2006	10:26	Same as 31 July
8/14/2006	9:08	USDA reports one small monk seal ocean side of runway, resting on
		reef. No tag.
8/23/2006	9:33	USDA reports one small monk seal oceanside of runway across main
		hangar, resting on reef. No tag.
8/30/2006	8:16	USDA reports one large monk seal, ocean side of runway, across
		main hangar resting on reef.
9/12/2006	8:43	USDA reports one small monk seal on ocean side of runway, across
		main hangar resting on reef. No tag.
10/5/2006	AM	PMRF security reported one monk seal at rocket reef resting on sand.
10/6/2006	8:59	USDA reports one small monk seal on ocean side of runway, across
		main hangar, resting on reef. No tag.
10/12/2006		No sightings.
10/13/2006	9:29	Security reported a monk seal on beach across fuel farm.
10/17/2006	10:56	Security reported one large monk seal resting on beach between Kini
		Kini and North Beach cottage.
10/18 & 19/06		No sightings.
10/31/2006	9:39	Security reported a monk seal at base housing/surfing beach. No tags.
11/6-9/06		No sightings.
11/16/2006	9:04	USDA reported 2 monk seals on ocean side of runway, across main
		hangar, resting on reef.
11/27/2006		Security reports a monk seal resting on beach between Shenanigans
		and base housing.
11/28-30/06		No sightings.
12/7-14/06		No sightings.
12/20-25/06		No sightings.
1/9/2007	9:11	USDA reports one monk seal at Majors Bay.
	5:00	Same sighting as above.
1/10-12/07		No sightings.
1/18/2007	9:16	USDA reports a monk seal at red label area. Two tags on fin.
1/19/2007	10:00	Same as above.
1/22/2007	9:35	USDA reports two monk seals at red label area. Tags on fin.
2/9/2007	10:08	Security reported one large monk seal at rocket reef. No tag.
2/12/2007		No sightings.
2/13/2007	8:37	USDA reports monk seal at runway 34 by 5000 marker. No tag.
2/21/2007	8:45	USDA reports a large monk seal at rocket reef. No tag.

		1:18	USDA reports two large female monk seals at rocket reef.
	2/23/2007	10:44	USDA reports what looks like same seal at rocket reef. No tag.
	2/26/2007	8:30	USDA reports two monk seals at rocket reef. No tags.
	3/6/2007		No sightings.
	3/12/2007		No sightings.
	3/14/2007	12:32	USDA reports seal just left of pine trees at rocket reef resting on sand.
			Seal is pregnant.
	3/15/2007	9:05	USDA reports seal spotted yesterday in same area to left of trees.
	3/16/2007		USDA reports seal at rocket reef has moved off.
	4/2-4/07		No sightings.
	4/9/2007		No sightings.
	4/19/2007	9:45	Security reported a monk seal at rocket reef area. No tag.
	4/23/2007	9:36	USDA reports one large, one medium monk seal resting on sand at
			rocket reef. No tag.
	4/24/2007	9:15	USDA reports one monk seal resting on sand at Rocket Reef.
	4/25/2007	9:15	USDA reports one monk seal oceanside of runway across hangar
			on beach. No tag.
	4/26/2007	9:30	Security reported two monk seals, one male, one female resting
			left of pine trees 100 yards off rocket reef.
	4/30/2007	8:46	USDA reports one medium monk seal across hangar on beach, male.
			No tag.
	5/3/2007	8:45	USDA reports one medium monk seal across hangar on beach, male.
			No tag.
	5/4/2007	8:27	USDA reports same sighting and area as above.
	5/7/2007	9:05	USDA reports one monk seal ocean side of runway, male. No tag.
	5/11/2007		No sightings.

H3 - SEA TURTLE SIGHTINGS

		GREEN SEA TURTLE SIGHTINGS AND OBSERVATIONS
Note: all sightings and observations are during day time hours. Where notation reads, No sightings, this means beaches were patrolled by USDA but no seals seen.		
DATE	TIME	SIGHTINGS AND OBSERVATIONS
5/24/2006		No sightings.
5/31/2006	800	USDA reports turtle activity at Nohili, drag marks on sand.
6/1/2006		No sightings.
6/5/2006	10:46	USDA reports four turtles feeding at Nohili on reef.
6/6/2006	10:45	USDA reports one small turtle on sand at Nohili, no tag.
		USDA reports one turtle feeding in water on reef.
6/8/2006	12:32	USDA reports three turtles feeding on reef at Nohili.
6/9/2006	1:30	USDA reports turtle on reef across from main hangar.
	10:21	USDA reports turtle feeding in water by Nohili.
6/12/2006		No sightings.
6/13/2006	8:01	USDA reports turtle activity in sand opposite fuel farm. Holes in sand.
	8:11	USDA reports a large turtle reting on beach at Nohili.
	8:14	USDA reports two small turtle in water at Nohili
6/14/2006	9:40	USDA reports turtle tracks on sand at Nohili, six?
	1:00	USDA reports one turtle feeding in water on reef at Nohili
6/15/2006	1:00	USDA reports turtle activity on beach at Nohili, tracks on sand.
6/16/2006	8:19	USDA reports turtle activity on beach at Nohili, tracks on sand. (new).
	9:15	USDA reports turtle activity on beach at Red Label area, tracks on sand.
6/21/2006	9:07	USDA reports turtle activity on beach at Nohili, tracks on sand (new).
	11:20	Patrol of beaches due to mission at 12:01. Mission scrapped at 12:45.
		No sightings within 10,000 feet GHA.
6/22/2006	9:12	USDA reports turtle tracks on sand at Nohili (new).
6/23/2006	8:20	USDA reports three turtle tracks on sand at Nohili.
6/27/2006	9:51	USDA reports one turtle track on sand at Nohili.
6/28/2006	10:47	USDA reports three turtle tracks on sand at Nohili.
6/29/2006	9:39	USDA reports three turtle tracks on sand at Nohili (new).
6/30/2006	9:37	USDA reports three turtle tracks on sand at Nohili.
7/3/2006	12:30	USDA reports two large, one small turtle feeding off reef at Nohili (new).
7/5/2006	12:24	USDA reports four turtles feeding at Nohili on reef.
7/6/2006	1:25	USDA reports four turtles feeding at Nohili on reef.
7/7/2006	10:00	USDA reports one turtle feeding at Nohili on reef.
7/12/2006	9:33	USDA reports three turtle tracks on sand at Nohili.
7/13/2006	9:35	USDA reports three turtle tracks on sand at Nohili (new).
7/14/2006	10:00	USDA reports one turtle track on sand at Nohili (new).
7/20/2006	10:40	USDA reports two turtle tracks on sand at Nohili.
7/25/2006	9:43	USDA reports one turtle track on sand at Nohili.
7/28/2006	10:00	USDA reports sighting one large green sea turtle in water off runway.
8/4/2006	10:15	USDA reports one large turtle resting on sand at Nohili + tracks of one additional turtle.
8/9/2006	11:11	USDA reports turtle tracks at Nohili.
8/10/2006	10:52	USDA reports two large turtles resting/feeding on reef at Nohili + one set of turtle tracks on sand.
8/11/2006	10:41	USDA reports one small turtle swimming along reef at Nohili.
8/17/2006	9:29	USDA reports three turtles feeding on reef at Nohili.
8/23/2006	10:02	USDA reports one turtle track on sand at Nohili.

8/28/2006	9:50	USDA reports one turtle track on sand at Nohili.
8/30/2006	9:38	USDA reports one medium turtle on sand at Nohili.
9/5/2006	9:45	USDA reports one turtle track on sand at Nohili.
9/6/2006	10:20	USDA reports one turtle track on sand at Nohili (new).
9/7/2006	10:56	USDA reports one large turtle resting on sand at Nohili.
9/15/2006	9:13	USDA reports one large and one small turtle resting/feeding on reef
		at Nohili.
9/19/2006	9:22	USDA reports one large turtle on sand at Nohili.
9/22/2006	9:30	USDA reports one large turtle on sand at Nohili.
9/26/2006	9:30	USDA reports one large turtle in water at Nohili.
10/2/2006	9:30	USDA reports one turtle track on sand at Nohili.
	1:01	USDA reports one large turtle on sand at Nohili.
10/3/2006	10:28	USDA reports two turtle tracks on sand at Nohili.
	13:12	USDA reports one large turtle on sand at Nohili. Four large, two small
		turtles feed on reef.
10/5/2006	1:01	USDA reports one large turtle on reef at Nohili
10/6/2006	8:53	USDA reports one large turtle swimming in ocean at end of RW 16.
10/13/2006	10:31	USDA reports one large turtle in water at Nohili.
10/16/2006	10:12	USDA reports one large, one small turtle in water at Nohili.
10/20/2006	10:21	USDA reports one turtle track on sand at Nohili.
10/25/2006	9:55	USDA reports one turtle track on sand at Nohili.
10/26/2006	10:26	USDA reports one turtle track on sand at Nohili (new).
10/27/2006		No sightings.
11/1/2006	10:54	USDA reports one turtle track on sand at Nohili.
11/2/2006	11:20	USDA reports one medium turtle on sand at Nohili.
	11:29	USDA reports one large turtle on sand at Nohili.
11/6-0/2006		No sightings.
11/3/2006	9:15	USDA reports two turtles on sand at Nohili.
11/14-15/2006		No sightings.
11/16/2006	8:44	USDA reports two turtle tracks on sand at Nohili.
11/17/2006	10:07	USDA reports one medium turtle on sand at Nohili.
11/28-30/6		No sightings.
12/6/2006	8:41	USDA reports two turtles at Nohili.
12/1-5/2006		No sightings.
12/6/2006	8:41	USDA reports two turtles on sand at Nohili.
12/7-14/2006		No sightings.
12/18/2006	9:51	USDA reports two turtles on sand at Nohili.
12/19/2006	10:10	USDA reports one large turtle on sand at Nohili.
12/20-24/6		No sightings.
12/26/2006	9:45	USDA reports one large turtle on sand at Nohili + one track.
12/27-30/2006		No sightings.
1/2-3/2007		No sightings.
1/4/2007	9:36	USDA reports two turtles on sand at Nohili.
1/16/2007	10:00	USDA reports one turtle on sand at Nohili.
1/19/2007	10:10	USDA reports one turtle on sand at Nohili.
1/22/2007	9:40	USDA reports one small turtle on sand at Nohili.
1/23-24/2007		No sightings
1/25/2007	9:42	USDA reports one turtle track on sand at Nohili.
1/26/2007	3:17	USDA reports one large turtle resting on sand and one on reef at Nohili.
1/29 - 2/6 2007		No sightings.
2/7/2007	9:47	USDA reports two turtle tracks on sand at Nohili.
2/8/2007		No sightings.

2/9/2007	11:06	USDA reports one turtle track on sand at Nohili.
2/12/2007		No sightings.
2/13/2007	9:29	USDA reports three turtles on sand at Nohili + one extra track.
	13:30	USDA reports four turtles on sand at Nohili.
2/14/2007	9:23	USDA reports one turtle on sand at Nohili + one new track.
2/15/2007	8:57	USDA reports one turtle on sand at Nohili.
	14:01	USDA reports two large turtles on sand at Nohili.
2/20/2007	10:01	USDA reports two turtles on sand at Nohili.
2/22/2007	9:37	USDA reports two turtle tracks on sand at Nohili.
2/23/2007	9:55	USDA reports three turtle tracks on sand at Nohili.
2/26/2007	9:24	USDA reports one turtle on sand at Nohili
2/27/2007	9:18	USDA reports three turtle tracks on sand at Nohili.
2/28/2007	9:05	USDA reports two new turtle tracks on sand at Nohili.
3/1/2007	9:42	USDA reports one new track on sand at Nohili.
3/2/2007	10:21	USDA reports two turtles on sand at Nohili.
3/5/2007	10:51	USDA reports one turtle on sand at Nohili
3/6/2007		No sightings.
3/7/2007	7:58	USDA reports one turtle on sand at Nohili.
3/8/2007	9:57	USDA reports three turtle tracks on sand at Nohili
3/9/2007	9:35	USDA reports two new turtle tracks on sand at Nohili.
3/12/2007		No sightings.
3/13/2007	8:33	USDA reports two large, one medium turtle on sand at Nohili.
3/14/2007		No sightings.
3/16/2007		No sightings.
3/19/2007	9:23	USDA reports one turtle track at Nohili.
3/20/2007	8:41	USDA reports two turtles on sand at Nohil + three tracks.
3/21/2007	9:10	USDA reports three turtles on sand at Nohili.
3/22/2007	8:35	USDA reports three turtles on sand at Nohili + four new turtle tracks.
3/23/2007	11:05	USDA reports one small turtle on sand at Nohili + three new tracks.
3/26/2007	9:13	USDA reports four new turtle tracks at Nohili + one large turtle hole.
3/27/2007	9:14	USDA reports two new turtle tracks on sand at Nohili.
3/28/2007	9:13	USDA reports one small turtle on reef at Nohili + one new track.
3/29/2007	9:41	USDA reports one large turtle on sand at Nohili.
3/30/2007	1:09	USDA reports one medium turtle on sand at Nohili.
4/2, 3 & 4/2007		No sightings.
4/5/2007	9:43	USDA reports one medium turtle on sand at Nohili + two tracks.
4/6/2007	9:05	USDA reports three new turtle tracks on sand at Nohili.
4/9/2007		No sightings.
4/10/2007	8:04	USDA reports three turtle tracks at Nohili.
4/11/2007	9:00	USDA reports one large, one medium turtle at Nohili + one track.
4/12/2007	9:00	USDA reports four new turtle tracks at Nohili.
	11:15	USDA reports one large turtle on sand at Nohili.
4/13/2007	8:48	USDA reports two large, one medium turtle on sand at Nohili + two tracks.
	12:54	USDA reports two small, four medium, two large turtles on sand at Nohili
		plus one large turtle in water at Nohili entrance.
4/16/2007	9:04	USDA reports one large turtle in sand at Nohili + two tracks.
4/17/2007	9:07	USDA reports one medium turtle on sand at Nohili + one track.
4/18/2007	8:35	USDA reports one new turtle track on sand at Nohili.
4/19/2007	11:40	USDA reports four new turtle tracks on sand at Nohili.
4/20/2007	8:30	USDA reports four new turtle tracks on sand at Nohili.
	12:56	USDA reports two small turtles on sand at Nohili.
4/24/2007	8:34	USDA reports three turtle tracks at Nohili.

	4/26/2007	1:00	USDA reports one large turtle on sand at Nohili.
	4/27/2007	9:00	USDA reports two turtles on sand at Nohili.
		11:40	USDA reports one medium, four small turtles on sand at Nohili.
	4/30/2007	9:12	USDA reports two turtle tracks on sand at Nohili.
	5/1/2007	9:20	USDA reports five turtle tracks on sand at Nohili.
	5/2/2007	9:07	USDA reports one new turtle track on sand at Nohili.
		3:30	USDA reports one small turtle feed on reef at Nohili.
	5/4/2007	8:47	USDA reports three turtles on sand at Nohili.
	5/8/2007	8:55	USDA reports two medium, one small turtle on sand at Nohili.
	5/9/2007	8:56	USDA reports one large turtle on sand at Nohili + one track.
	5/10/2007	11:55	USDA reports one large turtle on sand at Nohili.
	5/11/2007		No sightings.
	5/15/2007	9:20	USDA reports one turtle track at Nohili.
	5/16/2007	9:10	USDA repords one turtle on sand at Nohili + three tracks.
	5/17/2007	9:31	USDA reports two turtles on sand at Nohili.
	5/18/2007	9:06	USDA reports six turtle tracks on sand at Nohili.
	5/21/2007	10:06	USDA reports two new turtle tracks on sand at Nohili.
	5/22/2007	9:54	No sightings.
	5/23/2007	9:10	USDA reports one new turtle track on sand at Nohili.
	5/24/2007	11:27	USDA reports one large, two medium turtles on sand at Nohili.
	5/25/2007	9:25	USDA reports one large, one medium turtle at Nohili.
	5/29/2007	9:05	USDA reports three turtle tracks on sand at Nohili.
	5/30/2007	9:56	USDA reports two new turtle tracks on sand at Nohili.
	5/31/2007	9:40	USDA reports four new turtle tracks on sand at Nohili.
	6/4/2007	9:15	USDA reports four new turtle tracks on sand at Nohili.
	6/5/2007	9:01	USDA reports one medium turtle on sand at Nohili.

APPENDIX I
COMMENTS/RESPONSE TO COMMENTS ON INRMP UPDATE

I1 - USFWS COMMENTS ON AGENCY REVIEW DRAFT OF PRMF INRMP

Item Number	Line, Table, Fig Number	Comments	Response to Comment
USFWS.1	Section 3.3	The endangered species lists for the sites are inconsistent within and between chapters and/or appendices. For example, the Hawaiian goose and short-tailed albatross are listed in 3.3.1, but are not discussed in 3.3.4.1. The most recent bird survey of PMRF, Appendix B2, indicates Newell's shearwater and Hawaiian petrels commute through PMRF during the breeding season, but they are not listed in Chapter 3. **Suggested Action by USFWS:** Describe the Hawaiian goose, Hawaiian petrel, Newell's shearwater, and short-tailed albatross in section 3.3.4.1	The following text was added after the first paragraph of Section 3.3.1.1: "In addition, two federally-listed seabirds, Newell's shearwater (*Puffinus auricularis newelli*) or ʻaʻo and Hawaiian petrel (*Pterodroma sandwichensis*) or ʻuaʻu commute through Barking Sands during breeding season." Text regarding Newell's shearwater and Hawaiian petrel from DOFAW 2005 was added to the end of the bird species discussion in Section 3.3.1.1:
USFWS.2	Section 3.4.1.2. Line 7, 9.9.1.1 (Priority 2 Normal operating costs)	Short-tailed albatross protection. The document states that if a short-tailed albatross is sighted at the installation, USDA Wildlife Services would be notified, and the bird would not be hazed or disturbed in any way unless it presented a hazard to human health and safety. **Suggested Action by USFWS:** The Service recommends revising line 7 of section 3.4.1.2 revised to further define situations that might present a hazard to human health and safety. If a short-tailed albatross is observed at the installation, training activities that may harm or harass the albatross should cease and the Service should be notified immediately.	The following text was added to the end of the paragraph: "However, should a short-tailed albatross be sighted at the installation, the USDA-WS would be notified and the bird would not be hazed or disturbed in anyway unless it presented a hazard to human health and safety (e.g., threat to aviation or itself). If the bird is observed at Barking Sands, training activities that may harm or harass the albatross would cease and the USFWS would be notified immediately."
USFWS.3	Section 3.4.2	The irrigation ditches, which are utilized by endangered waterbirds, are maintained by the State of Hawaii. **Suggested Action by USFWS:** The Service recommends better coordination, and description of the coordination, regarding vegetation maintenance of the ditches. Mowing, dredging, or other activities should be initiated only after surveys for waterbird nests are conducted.	The following text was added to the end of Section 3.4.2: "The Navy coordinates with SOH prior to conducting maintenance activities at the ditches (mowing, dredging, or other activities) to ensure that waterbird nests are not present."
USFWS.4	3.4.3.1 and 9.3.3.1(Priority 2 Normal operating costs)	Laysan albatross relocation and surrogate parenting (Priority 2 Normal operating costs) **Suggested Action by USFWS:** The Service is concerned about the efficacy of the BASH program, detailed in our December 28, 2007 letter (2008-FA-0035, attached). The Navy should work with the Service, USFWS Refuges, and Wildlife Services to optimize results of the BASH program.	The following text was added to the end of Section 3.4.3.1: "In December 2007, USFWS made seven recommendations to improve the efficacy of the BASH program (Appendix F). The Navy coordinated with USFWS over the 2008 breeding season to implement these recommendations, which include the following. 1. To reduce the number of birds flying through Barking Sands airspace and staff time and resources expended on the BASH program, the Navy will leave incubating adults at nest sites

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			when eggs are removed from nests and discontinue all capture and transport of breeding albatrosses as these birds will return to the base. 2. The Navy coordinates the release of all captured non-breeding adult birds with KPNWR staff to improve knowledge of post-release status and behavior. 3. To reduce egg mortality, improve hatch success, and minimize the resources and staff time expended on the BASH program, the Navy will allow albatrosses to incubate their eggs until viability can be determined. 4. To reduce egg mortality, the Navy will draft and circulate for review a protocol for moving albatross eggs that minimizes vibration and jarring and minimizes their time in transport between nests or between nest and incubator. 5. In partnership with USFWS, the Navy will determine the viability of albatross eggs at PMRF and in foster colonies as soon as possible (seven days) after laying and move Barking Sands eggs off base and eliminate or minimize artificial incubation. 6. The Navy will provide KPNWR with complete data sheets to improve knowledge of life history and behavior of Laysan albatross. 7. The Navy will make the areas near the runway and missile launch sites inhospitable to nesting albatross (ground cloth, vegetation changes, etc.) to encourage nesting pairs to find other places to nest."

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USFWS.5	3.4.3.4 and 9.3.1.2 (Priority 2 Class 2 Funding)	The Service commends the Navy on the Wedge-tailed shearwater protection and colony enhancement project. **Suggested Action by USFWS:** This should be identified as a priority project for funding.	The following text was added to the end of Section 3.4.3.4: "In addition, the USFWS has commended the Navy on the wedge-tailed shearwater colony protection and enhancement project and recommends that this program be continued as a high priority for project funding." The following text was added at the end of Section 9.3.3.2 Priority 2/Class 2 Funding Shearwater Protection and Colony Enhancement: "USFWS has commended the Navy on the wedge-tailed shearwater colony protection and enhancement project and has recommended that this program be continued as a high priority for project funding."
USFWS.6	3.4.5.3, 3.4.5.4	The Service commends the Navy on the long-thorned kiawe control and native plant habitat improvement. **Suggested Action by USFWS:** Continue to fund and implement this program	The following text was added to the end of Section 3.4.5.3: "In addition, USFWS has commended the Navy on the LTK control at Barking Sands and recommended continued funding and implementation of the program." The following text was added to the end of Section 3.4.5.4: "In addition, USFWS has commended the Navy on native habitat improvement at Barking Sands and recommended continued funding and implementation of the program."
USFWS.7	3.4.7 and 9.3.7	Invasive species **Suggested Action by USFWS:** The Service recommends further description of the actions taken to reduce invasive species introductions from aircraft, ships, or personnel.	The following text was added to Section 3.4.7.1: "…All inbound flights carrying cargo from areas outside of Hawai'i and landing at Barking Sands are advised to inspect and secure cargo in accordance with OPNAVINST 6210.2, Quarantine Regulations of the Navy prior to shipment to ensure that it is free of invasive species. These regulations are intended to prevent the introduction and dissemination, domestically or internationally originated, of diseases affecting humans, plants, and animals; prohibited or illegally taken wildlife; arthropod vectors; and pests of health and agricultural importance. Furthermore, all Navy and contractor vehicles are washed down prior to mobilization to Barking Sands and other PMRF facilities and are washed down again after completion of activities in order to minimize the potential for introducing alien and/or invasive species…"
USFWS.8	4.4.1.2	Encouragement of Hawaiian goose nesting **Suggested Action by USFWS:** The Service encourages fencing at Makaha Ridge to exclude feral goats, and the implementation of predator control when nesting occurs.	The following text was added at the end of Section 4.4.1.2: "The USFWS and DLNR encourages fencing at Mākaha Ridge Tracking Station to exclude feral goats, and the implementation of predator control when nesting occurs."

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USFWS.9	4.4.1.3	Protection of dwarf iliau and Spermolepis hawaiiensis **Suggested Action by USFWS:** The Service encourages fencing at Makaha Ridge to exclude feral goats.	The following text was added at the end of Section 4.4.1.3: "The Navy is evaluating the feasibility of installing exclosure fencing at the station to protect these plants from feral goats, which is encouraged by the USFWS and DLNR."
USFWS.10	5.4.17 and 9.3.1.2	Surveys for Hawaiian picture-wing flies (Priority 2 Class 2 funding) **Suggested Action by USFWS:** The Service encourages the Navy to fund and conduct surveys for these species.	The following text was added at the end of Section 5.4.17 and Section 9.3.1.2 (item 4): "USFWS has encouraged the Navy to fund and conduct surveys for these species."
USFWS.11	7.3.3.7	Kaula Island **Suggested Action by USFWS:** The Service recommends the Navy prioritize surveys for natural resources on Kaula, as the most recent survey is 10 years old. Surveys for nesting seabirds, vegetation composition, and non-native mammalian species, i.e., rats, should be conducted. Several trips throughout the year should be conducted as the various species of seabirds do not nest synchronously, weather conditions can affect plant germination, and, if present, the density of rat and mouse populations is cyclic. We recommend you work with us to facilitate rodent eradication.	Comment noted. It is the PMRF Commanding Officer's opinion that it is not safe to land a helicopter on the island due to the physiography of the island (undercut cliff faces) as well as BASH and UXO concerns on the island. The PMRF CO is responsible for the safety of anyone who goes to the island with his permission and he is not willing to take the risk. The Navy recommends the use of remote sensing surveys of the island (when feasible) and an aerial rat eradication program for the island. Section 7.4.3 Fish and Wildlife was revised as follows: "NAVFAC PAC Natural Resources staff are planning to conduct natural resources surveys, including bird surveys, at Ka'ula Island as soon as access to the island is permitted or as remote-sensing technology permits. Appendix G provides NAVFAC PAC's Kaula Island Draft Seabird Monitoring Plan. In addition, the Navy, in conjunction, with USFWS is recommending an aerial rat eradication program (Section 9.3.1.2)."
USFWS.12		Implementaiton of Seabird Fallout Monitoring **Suggested Action by USFWS:** As stated in our June 13, 2008, informal consultation letter for the Hawaii Range Complex (2008-I-0232, attached), the Navy will develop in coordination with the Service, a monitoring program to look for federally listed seabirds that have fallen out near antennas, towers, housing and Field Carrier Landing Practice (runway) areas. This program will be implemented beginning in late September 2008. Therefore a monitoring program must be developed by August 30, 2008. We are available to coordinate with you to help prepare this plan.	Comment noted. The Navy has begun monitoring program for federally listed seabirds that have fallen out near antennas, towers, housing, and runway areas. Because Newell's shearwaters commute across Barking Sands during breeding season, the Navy works with the group Save Our Shearwaters (SOS) to recover shearwaters that fallout on Navy lands. In addition, the Navy, in conjunction with USFWS, began monitoring for shearwaters and other birds at Barking Sands in 2008.

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USFWS.13	3.3.4.4	The conclusion drawn regarding increases in fishery stock sizes (mean per species), abundance and diversity are not supported by the data presented in Appendix C. **Suggested Action by USFWS:** We recommend that supporting data is either provided or that conclusion about increases in fishery stock sizes, abundance and diversity are removed from the report. (See comments on Appendix C for additional details)	Commented noted. The Navy believes that there is sufficient basis to retain the conclusions reached by Drs. Brock and Dollar in the Survey of Marine and Fishery Resources (Dollar et al. 2006) (Appendix C1).
USFWS.14	3.4.6.1 and 3.4.6.2	The data presented does not support the conclusion of increases in size, diversity, and quanitity of fishery species. **Suggested Action by USFWS:** See recommendations for Appendix C1.	Commented noted. The Navy believes that there is sufficient basis to retain the conclusions reached by Drs. Brock and Dollar in the Survey of Marine and Fishery Resources (Dollar et al. 2006) (Appendix C1).
USFWS.15	Appendix C1. Section 3.0	Insufficient information on the methodology and survey design have been provided to assess the quality of the data and the conclusions. **Suggested Action by USFWS:** We recommend that the following information be provided: 1) number of sites surveyed, their location (perferrably on a figure), depth, approximate water clarity, the method used to select them, and 2) Additional detail on the survey methodology including length of swim, time spent surveying, orientation of the swim (e.g., along isocline, parallel to shore, perpendicular to shore, etc.), number, frequency and timing of visual estimates at each survey site, number of individuals conducting each type of visual estimate, and approximate search effort (e.g. looked in crevices, stayed above the bottom). Additionally, we recommend that a justification for surveying sites that had the greatest relative abundance be provided and discussion of how this affects fishery stock estimates be provided.	Commented noted. The Navy believes that there is sufficient basis to retain the conclusions reached by Drs. Brock and Dollar in the Survey of Marine and Fishery Resources (Dollar et al. 2006) (Appendix C1).

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USFWS.16	Appendix C1. Section 6.0	While Appendix C argues that water quality is not adversely affected by the presence of Nohili Ditch and Kawaaiele Ditch Outfalls, no data is presented to support this finding. Photographs included in Appendix C (Figures 5-8, 10) clearly show a reef environment heavily impacted by sediment. **Suggested Action by USFWS:** Measures taken on land to reduce this sediment load will have beneficial impacts on the coral reef community. We recommend that the PMRF consider implementing landbased activities and projects that will improve water quality in the Nohili Ditch and Kawaaiele Ditch Outfalls. Without additional information, specific recomendations cannot be made, but standard BMPs and construction designs would improve non-point source pollution run-off into ditches, restriciting off road vehicle access and improving/expanding wetlands typically decrease particulate and pollutant loads in run-off.	Commented noted. The Navy believes that there is sufficient basis to retain the conclusions reached by Drs. Brock and Dollar in the Survey of Marine and Fishery Resources (Dollar et al. 2006) (Appendix C1). The Navy continues to employ BMPs during construction activities at all PMRF facilities that are designed to address the reduction of non-point source and point source pollution. As discussed in the INRMP the Navy restricts off-road vehicle access at Barking Sands and other PMRF facilities. As discussed in the meeting with USFWS representatives on 2 October 2008, the Navy does not control the land areas upgradient from Barking Sands that contribute to the sediment load entering the Nohili and Kawaaiele Ditch systems. Ideally, these land areas which are primarily in agricultural use would also employ BMPs to reduce non-point source pollution.
USFWS.17	Appendix C1. Section 7.0	Quantitative fishery data is provided in the recommendations but the source or methodology used to collect this data has not been provided. Without more information, it is not possible to assess the conclusions of stock increases **Suggested Action by USFWS:** We recommend that mean values be stated with estimates of variability and where appropriate statistical tests be used to assess differences.	Commented noted. The Navy believes that there is sufficient basis to retain the conclusions reached by Drs. Brock and Dollar in the Survey of Marine and Fishery Resources (Dollar et al. 2006) (Appendix C1).

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USFWS.18	Appendix C1. Section 7.0	The conclusion that "increases in abundance and mean sizes of fish suggest a decrease in fishing pressure" is not supported by the data. No data on fishing pressure has been provided to support this conclusion. Additionally, the survey design as described is not sufficient to test this relationship. **Suggested Action by USFWS:** We recommend the following: 1) wording is changed to acknowlege that fishing is a likely explanation for the observed data (as opposed to the data demostrating an change in fishing pressure); 2) data on fishing pressure (e.g., CPUE, number of fishermen [permits] issued, etc.) be provide to support the observation of decreased fishing pressure; 3) the survey/sampling design is described with greater detail in order to assess the validity of the conclusion. If this information cannot be provided, we recommend that this conclusion be removed from the INRMP.	Commented noted. The Navy believes that there is sufficient basis to retain the conclusions reached by Drs. Brock and Dollar in the Survey of Marine and Fishery Resources (Dollar et al. 2006) (Appendix C1).
USFWS.19	Appendix C1. Section 7.0	The report notes that numerous pieces of marine debris "…that appeared to be remnants of ordnance or test material related to operations, possibly eminating from PMRF…" were observed on the reef. The authors then conclude that impacts from "PMRF within the nearshore ocean are considered minimal." Additionally, pieces of marine debris and other man-made structures are visible in several photos (Figures 4, 7, & 10). No supporting data is provided. **Suggested Action by USFWS:** We recommend that data assessing the amount and type of debris on the bottom be provided to support the conclusion of minimal impact, otherwise we recommend this concluson be removed from the report or qualified.	Commented noted. The Navy believes that there is sufficient basis to retain the conclusions reached by Drs. Brock and Dollar in the Survey of Marine and Fishery Resources (Dollar et al. 2006) (Appendix C1).
USFWS.20	Appendix C1. Section 7.0	No data on fishing from shore is provided to support the conclusion that shore fishing has decreased from 2000 to 2006 **Suggested Action by USFWS:** We recommend that data on fishing effort or number of fishermen be provided provided to support this conclusion. If data cannot be provided, we recommend that this conclusion be removed from the report.	Commented noted. The Navy believes that there is sufficient basis to retain the conclusions reached by Drs. Brock and Dollar in the Survey of Marine and Fishery Resources (Dollar et al. 2006) (Appendix C1).

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USFWS.21	Appendix C1. Section 7.0	No data on fishing from boats is provided ot support the conclusion that boat fishing has decreased from 2000 to 2006 **Suggested Action by USFWS:** We recommend that data on fishing effort or number of fishermen fishing from boats or counts of fishing boats be provided to support this conclusion. If data cannot be provided, we recommend that this conclusion be removed from the report.	Commented noted. The Navy believes that there is sufficient basis to retain the conclusions reached by Drs. Brock and Dollar in the Survey of Marine and Fishery Resources (Dollar et al. 2006) (Appendix C1).
USFWS.22	Appendix C4	No source is provided for the data in the table. **Suggested Action by USFWS:** We recommend that the source of the data be provide.	The source of the data (Navy 2001) was added to the tables per comment.

I2 - NOAA COMMENTS ON AGENCY REVIEW DRAFT OF PRMF INRMP

Item Number	Line, Table, Fig Number	Comments	Response to Comment
NOAA.1	Section 3.3.4.4	Finally had a chance to finish going through the document. Overall I don't expect any adverse impacts to EFH or coral reef habitat resulting from activities covered by the INRMP. However, it would be good to have a separate section discussing potential impacts to essential fish habitat. We also would like to be notified of any projects relating to coral reef issues that our Habitat Division can collaborate on. Sorry for the delay in our response and thanks for the opportunity to comment.	The Navy does not have natural resources management authority over the marine environment at Barking Sands or elsewhere. Any potential impacts to essential fish habitat resulting from any future Navy actions would be addressed in the appropriate NEPA document (e.g., EA or EIS). This is also true of any potential impacts to coral reefs. Currently, the Navy is not aware of any on-going activities on Navy controlled lands associated with PMRF that have the potential to impact coral reefs or essential fish habitat.

I3 - DBEDT CZM PROGRAM COMMENTS ON AGENCY REVIEW DRAFT OF PMRF INRMP

Item Number	Line, Table, Fig Number	Comments	Response to Comment
DBEDTOP.1	general	*Navy requests that DBEDT identify existing or planned natural resources plans or proposals that are directly or indirectly affected by Navy activities with the Oahu Complex or PMRF:* The Hawaii Coastal Zone Management (CZM) Program, in conjunction with the Hawaii Department of Health, Clean Water Branch published Hawaii Implementation Plan for Polluted Runoff Control in July 2000. The implementation plan is available in either hard copy or on CD from our office. This plan addresses key elements required by the Environmental Protection Agency for the State of Hawaii to be recognized as a Tier I Nonpoint Source State. The plan also establishes long- and short-term goals and activities to control nonpoint source pollution as required for the implementation of Hawaii's Coastal Nonpoint Pollution Control Program, based on the Coastal Zone Act Reauthorization Amendments of 1990. Pearl Harbor is identified in the plan as a Water Quality Limited Segment pursuant to the Federal Clean Water Act. Implementation strategies identified in the plan are scheduled to be updated in 2007. The CZM Program is also currently updating the Hawaii Ocean Resources Management Plan (ORMP) which is scheduled to be finalized by December 2006. Elements of the ORMP are likely to be pertinent to the INRMPs. In addition to the plans above, the INRMPs are likely to require CZM federal consistency review by the Hawaii CZM Program, pursuant to Federal Coastal Zone Management Act (CZMA). Our designee for the INRMP Working Group, John Nakagawa, can provide guidance on the CZMA compliance requirement. The Hawaii CZM Program's areas of interest relative to the INRMPs are based on the ten objectives and supporting policies of Hawaii CZM law, Hawaii Revised Statutes, Chapter 205A. These are: (1) recreational resources, (2) historic resources, (3) scenic and open spaces, (4) coastal ecosystems, (5) economic uses, (7) managing development, (8) public participation, (9) beach protection, and (10) marine resources. Recreational resources at Navy installations should be included as natural resources subject to	Comments noted.

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		management under the INRMPs. The CZM Program considers it a priority that the provision of public access to recreational resources be continued, particularly at Kalaeloa, Oahu and at PMRF where limited public access to the beach and near shore areas are currently allowed. In addition, PMRF operations affect public access to and use of Polihale state park. Other CZM priority areas relative to the INRMPs are historic and cultural resources and practices, coastal ecosystems, beach protection, and marine resources. These CZM areas of interest will be factored into the CZM federal consistency review.	
DBEDTOP.2	general	*Navy requested that DBEDT share recent baseline resource information relevant to the Oahu Complex and PMRF.* Our Hawaii Statewide Geographic Information System Program web site provides a variety of resource information. If other information is needed, please contact our INRMP member, John Nakagawa.	Comment noted.
DBEDTOP.3	general	*Navy requests that DBEDT comment on the quality of historic interagency coordination relevant to Oahu Complex and PMRF and suggest ways to improve the coordination.* Interagency coordination between Commander Navy Region Hawaii and the Hawaii CZM Program has been very good. Early coordination, such as provided through the INRMP Working Group meetings, is the best way to facilitate the CZM federal consistency process.	Comment noted.
DBEDTOP.4	general	*Navy requests DBEDT review the list of agencies and, if appropriate, suggest others.* In addition to the list of agencies listed in your May 19, 2006 letter, the following agencies should be consulted: Mr. Henry Eng, Director, Department of Planning and Permitting, City and County of Honolulu; Mr. Stanton Enomoto, Kalaeloa Planning and Development Director, Kalaeloa Community Development District, Hawaii Community Development Authority (Administers and regulates activities within the State of Hawaii Kalaeloa Community Development District); Division of State Parks, State of Hawaii Department of Land and Natural Resources (PMRF has direct	Comment noted. Navy has forwarded a copy of the agency review draft DLNR DOFAW offices on Oahu and Kauai. In addition, the Navy will transmit a copy of the public review draft to DLNR for distribution to all of its division as well as the agencies suggested by DBEDT.

Item Number	Line, Table, Fig Number	Comments	Response to Comment
		influence on Polihale State Park, Kauai); Mr. Sam Lemmo, Administrator, Office of Conservation and Coastal Lands, State of Hawaii Department of Land and Natural Resources (Lands adjacent to Pearl Harbor and PMRF are within the State Conservation District); Mr. Dennis Lau, Chief, Clean Water Branch, State of Hawaii Department of Health (Administers the State of Hawaii water quality standards, Section 401 Water Quality Certifications, and National Pollutant Discharge Elimination System permits).	
SOH DBEDT CZM.1	Page 7-5, lines 20-29 and 30-32	Re: Bird Species and Mammal Species. There is a possible rat infestation problem on Kaula Island which could adversely affect Hawaii CZM Program resources, such as the 21 species of MBTA protected bird species and one State of Hawaii listed threatened seabird (black-footed albatross). To address this we suggest coordinating with U.S. Fish and Wildlife Service which conducts rat eradication on offshore islets.	The following text was added to Section 7.3.3.1, item 1 (Bird Species): "Ka‘ula Island may have a rat infestation problem that could adversely affect the protected bird species on the island (SOH DBEDT CZM 2008) and the Navy, in conjunction, with USFWS is considering the feasibility of an aerial rat eradication program (Section 9.3.1.2)." The following text was added to Section 9.3.1.2: "7. Rat Eradication at Ka‘ula Island The Navy would coordinate with USFWS on rat eradication at Ka‘ula Island in an effort to protect MBTA-protected bird species and SOH-listed threatened bird species (black-footed albatross) on island."
SOH DBEDT CZM.2	Page 9-3, lines 11-18	Re: Hawaiian Monk Sealt protection. It is not clear whether the Navy policy regarding inspections of training areas for the presence of protected marine mammals a minimum of six hours before commencing military exercise, landing, or air to surface delivery of inert ordnance applies to both Barking Sands and Kaula Island. This should be clearly identified for INRMP purposes. If the policy does not apply to Kaula Island, we recommend that Kaula be included to ensure protection of the resident population of Hawaiian monk seals identified by the INRMP, section 7.3.1.1, page 7-5, lines 3-7.	The following text was added to Section 7.4.1: "PMRF Training and Operations staff adhere to Navy policy regarding inspections of training areas, including Ka‘ula Island, for the presence of protected marine mammals a minimum of six hours before commencing any military exercise, including air to surface delivery of inert ordnance." A reference to Section 7.4.1 was added to Section 9.3.1.1, item 4.

I4 - DLNR DOFAW COMMENTS ON AGENCY REVIEW DRAFT OF PMRF INRMP

Item Number	Line, Table, Fig Number	Comments	Response to Comment
DOFAW.1	general	Encourage the Department of Navy to integrate its natural resource management programs with DLNR, Division of Forestry and Wildlife Comprehensive Wildlife Strategic Plan	Comment noted. Program elements for Barking Sands, Mākaha Ridge Tracking Station, Kōkeʻe Sites, Kamokala Ridge Magazines, Kaʻula Island, and Mauna Kapu facilities are presented in Sections 3.4, 4.4, 5.4, 6.4, 7.4, and 8.4, respectively. These program elements are consistent with DOFAW's Comprehensive Wildlife Strategic Plan (DOFAW 2005).
DOFAW.2	general	Strongly encourage integration of statewide response between DLNR and Department of Navy for invasive species, oil spills, stranded wildlife, and avian disease monitoring.	Comment noted. Sections 3.4.7, 4.4.7, 5.4.7, 6.4.7, 7.4.7, and 8.4.7 discuss program elements for invasive species for PMRF facilities. Sections 3.4.3, 4.4.3, 5.4.3, 6.4.3, 7.4.3, and 8.4.3 discuss program elements for bird monitoring. Appendix G provides SOPs for the Navy's oil spill response and stranded wildlife response.
DOFAW.3	general	Maintain and restore cultural resources on Department of Navy lands.	Comment noted. The Navy has completed a draft Integrated Cultural Resources Management Plan (November 2008) which addresses the maintenance and restoration of cultural resources. The PMRF INRMP discusses cultural resources and their relationship to natural resource management in Sections 3.1.1.5, 4.1.1.5, 5.1.1.5, 6.1.1.5, 7.1.15, and 8.1.1.5.
DOFAW.4	general	Provide recreational opportunities and uses on Department of Navy lands.	Comment noted. Outdoor recreational opportunities are discussed in Section 2.9.1 and Sections 3.4.11, 4.4.11, 5.4.11, 6.4.11, 7.4.11, and 8.4.11.
DOFAW.5	general	Increase fauna and flora T&E populations currently present on Navy lands. In addition, DLNR, Division of Forestry and Wildlife on Kauai are developing a management plan for the Mana Waterbird Sanctuary that may benefit PMRF to protect native resources in the area. Also, DLNR, Division of Forestry and Wildlife encourage Department of Navy to fence portions of Makaha Ridge facility on Kauai to maintain the vegetation required to for nene habitat and their nesting areas.	Comment noted. Protected fauna and flora species are discussed in Sections 3.3.1 to 8.3.1. Program elements for these same species are discussed in Sections 3.4.1, 4.4.1, 5.4.1, 6.4.1, 7.4.1, and 8.4.1. The Mana Waterbird Sanctuary is discussed in Section 9.3.2.3 (item 2). Section 9.3.1.2 (items 3 and 5) discuss the recommendation for the installation of fencing at Mākaha Ridge Tracking Station to protect nēne and federally-listed endangered plant species.
DOFAW.6	general	Encourage Department of Navy to acquire lands to buffer impacts to existing resource management programs and areas.	Section 2.10 discusses encroachment partnering agreements that that the Navy has with the State of Hawaiʻi and the County of Kauaʻi.

Item Number	Line, Table, Fig Number	Comments	Response to Comment
DOFAW.7	general	Encourage Department of Navy to develop watershed (i.e., develop Waianae watershed partnership alliances) and wetland partnership programs in areas beneficial to all interested cooperating entities.	Comment noted.
DOFAW.8	general	Continue to seek new funding and support from DOD for Legacy and other resource management programs.	Comment noted.
DOFAW.9	general	Encourage Department of Navy to work with Federal Fire Department, and DLNR, Division of Forestry and Wildlife to develop a wildland fire management plan to areas of common interest.	Comment noted. Sections 3.4.8, 4.4.8, 5.4.8, 6.4.8, 7.4.8, and 8.4.8 discuss wildland fire program elements for PMRF facilities.
DOFAW.10	general	Request that the Department of Navy work with other DLNR agencies (i.e., Division of Conservation and Resources Enforcement, State Parks, Division of Aquatic Resources, State Historic Preservation Division) as part of DLNR review of subject request.	Comment noted. Navy has forwarded a copy of the agency review draft DLNR DOFAW offices on Oahu and Kaui and will provide a copy of the public review draft to DLNR for distribution to each of its divisions.

I5 - KAUA‘I INVASIVE SPECIES COMMITTEE COMMENTS ON AGENCY REVIEW DRAFT OF PMRF INRMP

Item Number	Line, Table, Fig Number	Comments	Response to Comment
KISC.1	Figure 3-7, 3-8	In Legend: Algaroba is more commonly known as Long Thorn Kiawe, or Mesquite	The text in the legend was revised to reflect both long thorn kiawe and mesquite
KISC.2	Page 3-46, line 34	Spines on LTK are from 1 to 4 inches long	The text was revised per comment.
KISC.3	Page 3-53, line 5	Switch algarroba to mesquite	The text was revised to reflect both long thorn algarroba and mesquite.
KISC.4	Appendix A-1, page 7	Long spined mesquite. The Kauai Invasive Species Committee should be contacted for information on eradicating the plants; KISC has mapped the distribution and numbers of P.juliflora.	Comment noted.
KISC.5	Appendix A-1, page 14	Prosopis juliflora Common name: Long thorn Kiawe, mesquite Prosopis pallida Common name: Kiawe, mesquite	Comment noted.

I6 - USDA COMMENT ON AGENCY REVIEW DRAFT OF PRMF INRMP

Item Number	Line, Table, Fig Number	Comments	Response to Comment
USDA.1	p.3-33, table 3-1, row 3, column 4	4th sentence under Comments states that "but is not protected in Hawaii." This statement is not correct. MBTA applies to the cattle egret even in Hawaii. Cross reference with Table 1: p 1 in appendix B5, row 9 and on, where cattle egret is correctly listed as MBTA-protected.	The text was deleted per comment.
USDA.2	p. 3-36, table 3-1, row 1, column 4	1st sentence under Comments states "This is a non-native," can be deleted since this bird is not a resident. This is not a rule, just an adherence to convention. The Laughing Gull is an occasional visitor to Hawaii, with many records of observations according to Pratt et. al (1987). **Suggested Action by USFWS:** 1st sentence under Comments states "This is a non-native," can be deleted since this bird is not a resident. This is not a rule, just an adherence to convention. The Laughing Gull is an occasional visitor to Hawaii, with many records of observations according to Pratt et. al (1987).	The text was revised as follows: "This is a smallish gull with a black head and is an occasional visitor to Hawai'i." The term "non-native" was deleted per comment.
USDA.3	p. 3-48, 3.4.1.1. line 40	Where it states that "PMRF contracts with USDA-WS" it should state instead that "PMRF and USDA-WS have an interagency service agreement to control predation to protect seabird nesting colonies and endangered waterbirds. The agreement also includes the implementation of the PMRF BASH plan where the objective is to eliminate the Laysan albatross nesting colony adjacent to the runway, through dispersal, translocation and removal of eggs.	The text was revised per comment.
USDA.4	B5, p. 2, Table 1, row 9	"Regulatory Status: not protected" is incorrect. All birds in Hawaii are protected. See Hawaii Revised Statutes §183D-62 Taking, injuring, or destroying wild birds prohibited. Also the following species are protected as in the above but are listed as game birds listed in Hawaii Administrative Rules §13-122-6 with hunting of these species governed by Title 13 DLNR Subtitle 5, Forestry and Wildlife , Part 2 – Wildlife - Chapter 122. Black Francolin, Erckel's Francolin, Ring-necked pheasant, Wild Turkey, Spotted dove, and Zebra dove.	The text was revised to reflect "Regulatory Status: HRS § 183D-62" and reference to HAR § 13-122-6 as well as DLNR Subtitle 5, Forestry and Wildlife, Part 2 – Wildlife – Chapter 122, as appropriate.
USDA.5	B5, p. 5, Table 2, row 8 and on	Same comments as item 4. All birds are protected. Chukar is also a game bird according to HAR §13-122-6.	The text was revised to reflect "Regulatory Status: HRS § 183D-62" and reference to HAR § 13-122-6 as well as DLNR Subtitle 5, Forestry and Wildlife, Part 2 – Wildlife – Chapter 122, as appropriate.

Item Number	Line, Table, Fig Number	Comments	Response to Comment
USDA.6	B5, p.7, Table 3, row 6 and on	Same comments as item 4. All birds are protected by HRS §183D-62	The text was revised to reflect "Regulatory Status: HRS § 183D-62" and reference to HAR § 13-122-6 as well as DLNR Subtitle 5, Forestry and Wildlife, Part 2 – Wildlife – Chapter 122, as appropriate.
USDA.7	D3, p 12, Table 5	Need to add Executive Order (EO) 13443 dated August 16, 2007. Facilitation of Hunting Heritage and Wildlife Conservation. This order directs Federal agencies that have activities that have a measurable effect on outdoor recreation and wildlife management, to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat. It directs federal agencies to cooperate with states to conserve hunting opportunities. The PMRF INRMP does not address this EO which may constitute a significant omission of the document and plan.	EO 13443 was added to Table 5 of Appendix D3.
USDA.8	Appendix F, PMRF BASH plan, section 3	The BASH plan incorrectly states that there are 39 "birds". It should be "species". Also the federal agency U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA-WS) is misidentified as Department of Agriculture (DOA) which is the name and acronym commonly used for the Hawaii State Department of Agriculture. DOA has never been involved in the PMRF BASH plan. It has always been USDA. More importantly the BASH Plan mis-states that shearwater nests are relocated. This is not correct. USDA recommends a revision of the BASH Plan, PMRF Instruction 5090.5 to correct these errors.	The BASH plan has been revised to reflect 39 species, USDA-WS, and remove references to relocation of shearwater nests per comment.

APPENDIX J
COMMENTS/RESPONSE TO COMMENTS ON PUBLIC REVIEW DRAFT

J1 - USFWS COMMENTS ON PUBLIC REVIEW DRAFT OF PMRF INRMP

USFWS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
USFWS.1	General	1	The INRMP very briefly describes the measures undertaken by the Navy to reduce Bird Airstrike Hazards from the Laysan albatross (Phoebastria immutabilis) nesting near the runway at Barking Sands. Currently, the Navy contracts with the U.S. Department of Agriculture's Animal Plant and Health Inspection Service – Wildlife Services (WS) to capture, band, and translocate breeding and non-breeding adult Laysan albatross from PMRF to the north shore of Kaua'i, where they are released. This practice has been in place for a number of years, and is applied to non-breeding birds and breeding birds, once their eggs have been taken. Because this is an important program, we recommend the INRMP describe the program in greater detail. The INRMP should include a table to show the number of eggs removed, incubated, fostered, and successfully hatched under each of these treatments for all years, the number of individual adult birds captured and moved, and the number of times each was translocated from PMRF each year. On December 28, 2007, our office sent a letter (Service File 2008-FA-0035) that outlined concerns about the Laysan albatross fostering and translocation program, and suggested methods to improve hatching success while reducing the frequency of adult birds returning to PMRF. The INRMP should indicate the extent that these recommendations were implemented, and whether or not they will be employed in future years. We would be able to assist you in these endeavors.	
Response to Comment (RTC) USFWS.1: Section 3.4.1.1 Bird Air Strike Hazard describes the current management actions for Laysan albatross. Appendix G12 includes the Barking Sands Pacific Missile Range Facility, Proposed Laysan Albatross Management Plan to Reduce Bird-Aircraft Strike Hazard Potential (NAVFAC PAC 2009b). Section 9.4 (Table 9-2, item 1) provides the Navy's recommendation for continued BASH control described in Chapter 3.				

USFWS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
USFWS.2	General	2	During informal Section 7 consultation for the Hawai'i Range Complex (Service File 2008-I-0323), the Navy made a "no effect" determination regarding impacts from the new and existing communications antennas and towers, lighting associated existing housing, and night-time field carrier landing practices (FCLP), all located at PMRF – Main Base to the federally endangered Hawaiian petrel (*Pterodroma sandwichensis*) and the federally threatened Newell's shearwater (*Puffinus aruricularis newelli*). These two species are attracted to lights and are known to collide with buildings, light poles, wires, and other tall objects. These injured or downed birds are then vulnerable to predation by dogs and cats. In an effort to evaluate impacts from the aforementioned activities at PMRF, the Navy committed to review safety and security requirements and determine whether shielding of lights and limiting use of lights during the high fall-out period is possible. The Navy also agreed to develop a seabird monitoring program to determine the presence and extent of listed seabird issues at PMRF, including the antennas, towers, housing, and FCLP areas. The monitoring plan was to be developed in cooperation with our office and implemented in the fall of 2008. We did not receive the monitoring plan with sufficient time to provide comments and revisions prior to the onset of the 2008 seabird fallout season. We recommend the Navy prioritize funding for additional staff to revise and implement the monitoring plan for future years.	Section 3.4.1.3 (item 1) describes current monitoring and management for Hawaiian petrel and Newell's shearwater. Section 9.4 (Table 9-2, item 4), Section 9.5 (Table 9-3, item 2), and Section 9.6 (Table 9-4, item 1) describe recommended Nocturnal Seabird Fallout Monitoring and Management.

USFWS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
USFWS.3	General	3	The INRMP is programmatic in nature and will be a planning document. For this reason, we anticipate that consultation under Section 7 of the Endangered Species Act of 1973 (16. U.S.C. 1531 et seq.; 87 Stat. 884), as amended, will be undertaken on a project-specific basis prior to implementation of proposed projects. It is our understanding the U.S. Navy will consult on their ongoing actions that may have adverse effects on listed species.	Section 1.5.3 was revised to reflect this comment.
USFWS.4	ES-5	4	Protected animals section should include Newell's shearwater (*Puffinus auricularis newelli*) and Hawaiian petrel (*Pterodroma sandwichenis*). Recommended action: Discuss the Newell's shearwater and Hawaiian petrel in the Executive Summary since they are discussed in subsequent sections.	The text was revised to reflect Newell's shearwater and Hawaiian petrel.
USFWS.5	1-14, 1.5.2 Authority	5	This section states that the Navy requested informal consultation under Section 7 of the ESA. Recommended action: No request has been received by this office.	The text was revised per RTC USFWS.3.
USFWS.6	2-4, Section 2.7 Planning for National Environmental Policy Action Compliance	6	This comment is intended to be a general comment to assist with Invasive Species Prevention and Control through out the document. The activities discussed in this document have the potential to introduce terrestrial and aquatic non-native invasive species through multiple pathways including, but not limited to, construction equipment, delivery services, foot traffic, recreational vehicles, and other sources that provide conditions for non-native invasive species associated with harborage and sanitation. It is recommended that consideration be given to Integrated Pest Management approaches and implementation of Hazard Analysis and Critical Control Point Planning (HACCP) planning for routine maintenance practices. Recommended action: Incorporate IPM into the document and implement IPM in maintenance and construction practices. Develop HACCP plans with USFWS for routine operations such as restoration activities (LTK) and grounds-keeping. Please visit http://www.haccp-nrm.org. you may also contact Jeffrey Herod with USFWS at Jeffrey_herod@fws.gov or 808.792.9462 for HACCP training, plan development, and plan revisions.	

USFWS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
RTC USFWS.6: Section 9.4, Table 9-2, item 14 describes the Navy's recommendation to develop a biosecurity program including HACCP.				
USFWS.7	Page 3-18, 3.3.1.1 Threatened and Endangered Species and Species of Concern – Animals, 1. Bird Species	7	The Hawaiian stilt (*Himatopus mexicanus knudseni*) is improperly referred to as the black-necked stilt, and the Hawaiian moorhen (*Gallinula chloropus sandwichensis*) is improperly referred to as the common moorhen. Recommended action: Correct the usage of the common names and spelling of the scientific names throughout the document.	The text was revised per comment.
USFWS.8	Page 3-23, line 34 to page 3-25, line 18 3.3.1.1 Threatened and Endangered Species and Species of Concern – Animals	8	Newells's shearwater species description and Hawaiian petrel species description – inaccurate information about breeding locations. Recommended action: consult publications such as the Birds of North America accounts to revise the species description.	
RTC USFWS.8: The descriptions of the breeding locations for both species were obtained from the DLNR DOFAW publication *Hawaii's Comprehensive Wildlife Conservation Strategy* (October 2005). That publication cited information from *The Birds of North America.* The breeding location descriptions are believed to be accurate. No change was made to the text.				
USFWS.9	Page 3-23, line 34 to page 3-25, line 18 3.3.1.1 Threatened and Endangered Species and Species of Concern – Animals	9	Newell's shearwater and Hawaiian petrel descriptions mention that birds fall out at PMRF and are recovered and given to the Save Our Shearwaters program, which is considered take. The Navy did not consult under Section 7 of the Endangered Species Act for impacts to the Newell's shearwater and Hawaiian petrel. Recommended action: Initiate consultation with the Service for impacts from Navy activities on the Newell's shearwater and Hawaiian petrel.	
RTC USFWS.9: Section 3.4.1.3 (item 1) describes current monitoring and management for Hawaiian petrel and Newell's shearwater. The Navy has initiated consultation with USFWS with regard to Newell's shearwater and Hawaiian petrel.				

USFWS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
USFWS.10	p.3-25 3.3.1.1 Threatened and Endangered Species and Species of Concern – Animals	10	Newell's shearwater and Hawawiian petrel descriptions mention that the Navy has begun monitoring for listed seabirds that have fallen out near antennas, towers, housing, and runway areas. Recommended Action: The Navy has not coordinated sufficiently with the Service regarding the development of a statistically sound monitoring plan. The Navy should request funding so that the plan can be adequately developed, and funded for implementation.	See RTC USFWS.2.
USFWS.11	p.3-31 3.3.2 Wetlands	11	The INRMP mentions ditches and oxidation ponds that occur at Barking Sands facility, but does not mention that a significant wetland, Kawaiele Wildlife Sanctuary is directly adjacent to the property. Recommended Action: Mention the proximity of Kawaiele wetland and include considerations regarding any indirect affects from activities on PMRF to this wetland.	
RTC USFWS.11: Section 9.4, Table 9-2, item 20 indicates that PMRF will continue to be involved with DLNR in the planning process for the restoration of the Kawaiele wetland which is part of the Kawaiele Wildlife Sanctuary located immediately east of Barking Sands. In addition, the Navy should enlist volunteers to help support wetland restoration.				
USFWS.12	p.3-34, 3.3.4.1 Fish and Wildlife Bird Species, 2. Seabirds	12	The INRMP describes the coordination between the Navy, USDA Wildlife Services, and USFWS Refuges for fostering Laysan albatross chicks and moving adult birds for the 2006 season that occurred during the 2006 season. Recommended Action: The description should include data from each of the years this program has been implemented and should provide data tables showing that individual adult birds were "translocated" multiple times. Please refer to our letter dated December 28, 2007 (Service File 2008-FA-0035) for further recommendations to improve the program.	See RTC USFWS.1

USFWS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
USFWS.13	Page 3-51, 3.4.1 Threatened and Endangered Species, Critical Habitat, and Species of Concern, 1. Regulatory Agency Coordination	13	This section fails to mention the need for further coordination with the Service regarding the development and implementation of a monitoring plan for assessing impacts of PMRF facilities to listed seabirds, specifically light attraction and collision with existing communication antennas. Recommended Action: Include that the Navy will coordinate with the Service in the development of the monitoring plan, and that the plan will be finalized one month prior to the beginning of the fledgling seabird fallout season (October through December).	
RTC USFWS.13: See RTC USFWS.2.				
USFWS.14	3-52, Threatened and Endangered Species, Critical Habitat, and Species of Concern, 3. Hawaiian Monk Seal and Sea Turtle Population Monitoring	14	This section states that USDA Wildlife Services patrols the beach and notes monk seal and green turtles activities. Other sections mention that nesting of green sea turtles has not been confirmed in a number of years. Recommended actions: Develop and implement standardized surveys for sea turtle nesting, which includes specific time periods to look for tracks and burrows on the beach. If a nest is observed, implement predator control to protect the nest.	
RTC USFWS.14: Section 3.4.13 item 8 describes the procedures in place that use a systematic methodology for surveying for turtle nests as well as trapped turtles. In addition, PMRF has procedures in place for predator control, restricted access, and other protections for nests found.				
USFWS.15	Page 3-53, 3.4.3 Fish and Wildlife, 3.4.3.1 Laysan Albatross Relocation and Surrogate Parenting	15	This section outlines recommendations made by the Service in a December 2007, letter. The INRMP does not evaluate the extent to which these recommendations were implemented, nor does it provide data comparing results (number of eggs fostered, birds translocated). The Navy does not indicate that these recommendations will be implemented in full in future years.	See RTC USFWS.1.

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
USFWS.16	Page 3-58, 3.4.7 Invasive Species, 3.4.7.1 Invasive Species Prevention Control	16	The activities discussed in this section and in previous sections have the potential to introduce terrestrial non-native invasive species through multiple pathways including but not limited to, construction equipment, delivery services, and vehicles. Hazard Analysis and Critical Condition Point (HACCP) planning is a pathway risk assessment tool that meets the spirit and intent of Executive Order 13112. The Service develop a 5-Step HACCP (hhtp://www.haccp-nrm.org/). HACCP uses a transparent decision making process that includes conceptual risk assessment and management. HACCP incorporates monitoring and evaluation of corrective actions. The 5-Step HACCP Planning has recently been accepted as an international standard (ASTM E2590-08) for reducing or eliminating the spread of unwanted species during specific processes or practices or in materials or products. Recommended Action: Develop HACCP plans with the Service for routine operations such as restoration activities (LTK) and grounds-keeping. Please visit http://www.haccp-nrm.org. You may also contact Jeffrey Herod with USFWS at Jeffrey_herod@fws.gov or 808.792.9462 for HACCP training, plan development, and plan revisions.	
RTC USFWS.16: See RTC to USFWS.6.				
USFWS.17	Page 3-59, 3.4.9 Land Management, 3.4.9.1 Base Planning	17	There is no mention of invasive species as a subject specifically discussed in Base planning. Invasive species should be considered early in the planning process and Integrated Pest Management (IPM) practices should be provided to the extent possible. IPM is adaptive management. Recommended Action: Provide IPM practices and review with partners as a component to enhance the Base planning section. Information related to sanitation, rodent control, insect pest control, landscaping (e.g., native plants), and grounds-keeping operations should be provided.	
RTC USFWS.17: Day to day operations are covered under the installation Integrated Pest Management Plan. Section 9.4, Table 9-2, item 14 describes the Navy's recommendation to develop a biosecurity plan for PMRF.				
USFWS.18	Page 3-59, 3.4.11 Outdoor Recreation	18	There appears to be an opportunity to provide outreach and education to users of the Navy Region Recreation Pass Program about invasive species and aquatic hitchhikers (http://www.protectyourwaters.net/). Recommended Action: You may also contact Jeffrey Herrod with USFWS at Jeffrey_herrod@fws.gov or 808.792.9462 for free material on the Stop Aquatic Hitchhikers Campaign http://www.protectyourwaters.net/ as well as contact KISC for general invasive species information.	

USFWS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
RTC USFWS.18: Section 9.4, Table 9-2, item 34 includes a recommendation for the Dissemination of Pertinent Natural Resources Information to Recreation Pass Program Applicants. Under this recommendation the Navy would provide PMRF Recreation Pass Program applicants with information on invasive species, aquatic hitchhikers, and other pertinent natural resources information as part of the application process.				
USFWS.19	Page 4-9, 4.3.4 Fish and Wildlife, 4.3.4.2 Mammalian Species	19	Only goats and cats are mentioned in this section. Are rats, mice, or other non-native species present. Recommended Action: Work with partners to provide information and incorporate this data into GIS for the distribution of additional harmful, invasive species such as rats, mice, and insects.	
RTC USFWS.19: A lot of insects and the house mouse are ubiquitous on Kauai. If USFWS is proposing a broad insect survey and survey for mice, some of the data may be gleaned from pest management records. Navy is proposing to develop a Biosecurity Plan which includes HACCP (Table 9-2 item 15).				
USFWS.20	Page 4-15, 4.4.7 Invasive Species	20	The goats will be addressed by removing animals and building fences. There needs to be management of cats and other non-native species. Recommended Action: Work with partners to develop management actions to prevent the introduction, control large populations, and eradicate incipient populations of non-native birds, rats, mice, cats, reptiles, and insects.	
RTC USFWS.20: The Navy is aware that non native birds, rodents, and other species are present in the Makaha Ridge Area. The Navy is proposing to develop a Biosecurity Plan which includes HACCP. Management of these non native species would be addressed after the preparation of the Biosecurity Plan and HACCP.				
USFWS.21	Page 5-3, 5.1.1 Current Conditions and Use, 5.1.1.2 Land Use Constraints	21	This section mentions proposed critical habitat for *Drosophila musaphilia*. Recommended Action: Critical habitat has been designated so this section should be updated. In addition, in an email from John Muroaka to us, dated Sept. 15, 2008, regarding the designation of critical habitat for *Drosophila musaphilia*, it was stated that presence/absence surveys for the endangered fly would be done to determine if the fly was present at the Kokee Sites and if present, then measures to benefit the fly will be included in the INRMP.	
RTC USFWS.21: Section 5.4.1.1, item 3 includes the following text: NAVFAC PAC conducted an initial field survey at the Kōkeʻe Sites for one species of Hawaiian Picture-Wing Fly, *Drosophila musaphilia* (photo 5-2), from 23-26 March 2010 to determine the presence or absence of this federally-listed species.				

USFWS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
USFWS.22	P. 5-13, Section 5.4.7 Invasive Species	22	This section focuses on the Asian melatome. There should be additional information on rats and the skink that arepresent. Are there other non native species? Recommended Action: Work with partners to develop management plans for non-native species. Include distributional data in GIS. Develop and implement HACCP plan for field work related to non-native species control. Please visit http://www.haccp-nrm.org. You may also contact Jeffrey Hrod with USFWS at Jeffrey_herod@fws.gov or 808.792.9462 for HACCP training, plan development, and plan revisions.	
RTC USFWS.22: See RTC USFWS.6.				
USFWS.23	P.6-11, Section 6.4.7 Invasive Species	23	In the previous section it states that black-tailed deer, pigs, cows, and feral cats have all been observed at Kamokala Ridge Magazine, but this section states that invasive species are not present. Recommended Action: Develop management actions to control widely distributed vertebrate pests and eradicate incipient populations of ecologically harmful invasive species (insects, reptiles, etc.).	
RTC USFWS.23: See RTC USFWS.6.				

USFWS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
USFWS.24	P. 7-14, Section 7.4.3 Fish and Wildlife	24	Over 20 MBTA-protected bird species have been observed on the island, but surveys have not occurred recently, and a population of rats may impact breeding success. Recommended Action: The Navy should provide natural resources staff with access to the island to survey for birds and to assess the presence and abundance of rat species. Remote sensing technology is encouraged as a supplemental method to evaluate bird use of the island. If rats are confirmed to occur on the island, then an eradication should be confirmed.	Past use included military bombing and strafing training with live ordnance. As a result of those activities, there are UXO hazards that remain in the area. Therefore, public access to the island is not permitted. Avian surveys at Ka‘ula Island were conducted by NAVFAC PAC for COMPACFLT in 2009 and 2010 via a research vessel (Appendix G11). Additional ship-based surveys will be conducted annually or twice per year over the next three years. It is acknowledged that a rat eradication can have significant conservation benefits to nesting seabirds, especially to the smaller, burrow nesting seabirds breeding on Ka`ula. However, due to the recent failure of eradicating rats at Lehua and the regulatory restriction imposed by the State Of Hawaii Department of Health for aerial broadcasting of rodenticide on offshore islets, a rat eradication for Ka`ula will not be considered at this time. We may include an eradication project in future INRMP versions if the above regulatory atmosphere improves.

J2 - NOAA COMMENTS ON PUBLIC REVIEW DRAFT OF PMRF INRMP

NOAA Fisheries Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO., TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
NOAA.1	General	1	While NOAA Fisheries appreciates the opportunity to be involved in developing the INRMP, while completing an ESA Section 7 consultation with the Navy on the implementation of the INRMP is challenging, because it does not constitute a discrete Federal action with definable effects on ESA-listed species. That is, the INRMP is a planning document, so the manner in which specific projects resulting from the INRMP will be implemented has yet to be determined. Thus NOAA Fisheries cannot concur that implementation of the INRMP is not likely to adversely affect ESA-listed species. When PMRF proposes specific projects for the implementation of the INRMP, and determines that projects may affect ESA-listed marine species, please contact ESA Team Leader Lance Smith of my staff (808-944-2258, lance.smith@noaa.gov) regarding ESA Section 7 consulttion. Instructions for making ESA effects determinations, and templates for the appropriate record-keeping and correspondence, are on the NOAA Fisheries' Pacific Islands Regional Office website http://www.fpir.noaa.gov/PRD/prd_esa_consultation.html. NOAA Fisheries may determine that a proposed Federal action benefits ESA-listed species through the ESA Section 7 process, as explained in the material on the above website. However, NOAA Fisheries cannot determine at this time if the INRMP provides a net benefit to ESA-listed species.	Comment noted.

NOAA Fisheries Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO., TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
NOAA.2	ES-1		ESA Section 7 Consultation: We suggest replacing the language in the Executive Summary, Section 1.5.2.2, and elsewhere if relevant, regarding ESA Section 7 consultation with the following language: "Section 7 of the ESA requires federal agencies to consult with USFWS and/or NOAA Fisheries if an action may affect ESA-listed species. If a federal action may adversely affect ESA-listed species, formal consultation with USFWS and/or NOAA Fisheries is required. In formal consultation, USFWS and/or NOAA Fisheries write a biological opinion which determines if the federal action is likely to jeopardize the continued existence of the ESA-listed species, or adversely modify or destroy its designated critical habitat."	Section 1.5.3 was revised as follows: "Office of the Chief of Naval Operations instruction (OPNAVINST) 5090.1C (DON 2007) reiterates Section 7 of the ESA by requiring Navy to review its proposed and ongoing activities and identify those that may affect federally-listed species or designated critical habitats and those that may jeopardize the continued existence of proposed species or destroy or adversely modify proposed critical habitat. Further, where Navy determines that such an action may affect a listed species or a designated critical habitat, formal consultation with USFWS and/or NOAA Fisheries is required. Where Navy determines that the action may jeopardize the continued existence of a proposed species or destroy or adversely modify proposed critical habitat, the Navy must confer with USFWS and/or NOAA Fisheries. The required processes are detailed in 50 Code of Federal Regulations (CFR) Part 402."

NOAA Fisheries Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO., TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
NOAA.3	Page 3-26, Hawaiian monk seal	3	Hawaiian Monk Seal: In general, the draft INRMP understates the importance of Kaula Rock to the monk seal. As described in the recent Hawaiian monk seal recovery plan (NMFS 2007), monk seals appear to be re-colonizing the main Hawaiian Islands (MHI) from the Northwestern Hawaiian Islands (NWHI). Significant numbers of monk seals now occur on or around Kaula Rock, Niihau, and certain parts of Kauai. For example, counts of 15 or more seals have been documented during recent surveys in the Kaula Rock area. The description of the Hawaiian monk seal in Section 3.3.1.1, and the descriptions of animals in the Kaula Rock area in Section 7.3.1.1 should be revised accordingly.	
RTC NOAA.3: Hawaiian monk seals at Barking Sands and Kaula Rock are discussed in Sections 3.3.1.1 and 7.3.1.1, respectively. Section 3.4.3.1 (item 6) and Section 7.4.1.1 (item 2) describe current management actions to protect Hawaiian monk seals per comment. Section 9.4, Table 9-2 item 10 and Section 9.8, Table 9-6, item 1 describe recommended actions for Hawaiian monk seal protection at Barking Sands and Kaula Island, respectively.				
NOAA.4	Page 3-26, Hawaiian monk seal	4	Also with regard to monk seals and the PMRF, NOAA Fisheries is in the process of responding to a petition to revise critical habitat for this species. On July 9, 2008, we received the petition (Center for Biological Diversity et al., 2008), and on October 3, 2008, we announced we were initiating a review to determine if the revision is warranted (73 FR 57583). Currently designated critical habitat for the Hawaiian monk seal is limited to the NWHI. The petition seeks to revise monk seal critical habitat to include haul-out areas and foraging areas in the MHI. Information about critical habitat is provided on NOAA Fisheries' Pacific Islands Regional Office website http://www.fpir.noaa.gov/PRD/prd_critical_habitat.html. If you have any questions about monk seal critical habitat, please contact Lance Smith of my staff (see above).	
RTC NOAA.4: Comment noted. See RTC NOAA.3				
NOAA.5	Page 3-26		Other Protected Species: Thank you for the detailed information on green sea turtles and other protected species in Section 3.3.1.1. We do not have any revisions or additions.	Comment noted.
NOAA.6	Page 3-40, line 11-12	6	It is unclear what Dollar et al. 2006 refers to …Dollar and Brock 2007 (revised 2006 document) in the reference provided in Appendix C, but Dollar and Brock are cited in the reference section. The 2007 revision states that surveys of the environment occurred in April 2000 and August 2006, not June 2000 (as suggested in the reference to Dollar et. al 2001) or April 2006. If correct, information within the more recent document should be considered for use and cited appropriately.	The text was revised to Dollar 2007. The dates of the surveys were revised to reflect April 2000 and August 2006.

NOAA Fisheries Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO., TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
NOAA.7	Page 3-57, line 31-33	7	Appendix C Methods indicate that, for the most part, qualitative approaches (observation point to point swims) were used to assess resources in the area in 2000 and 2006, even though the apparent survey intent was for "comparative purposes". The surveys were conducted in different seasons of different years and may have involved slightly different areas, which may have confounded reported findings. Replicate swims covering all point to point areas in both 2000 and 2006 (and/or multiple in-between years to evaluate trend trajectory and variability) would have allowed for a very gross characterization of resource and observer variability, but did not occur. No statistical basis was employed for evaluating the probability that change occurred. It is our opinion that the state of "documented increases in the size, diversity and quantity of both commercial and recreational fisheries and marine resources" lacks appropriate justification absent a more quantitatively based approach, and should be removed or changed. Overall, it appears there is intent to suggest that a reduction in fishing pressure has resulted in established gains for fish and other resources in the area. However, in addition to questions regarding the qualitative approach and findings, little clarity is provided as to whether stated implementation of security restrictions has actually resulted in declines in fishery pressure. Consideration should be given to a formal study of such. If truly suspected to be the case, perhaps the following statement may be more appropriately used: "Theoretically, a decline in fishing activities should result in increased sizes and abundance of fish, and/or a potential sift in their behavior (fish in such areas may be less inclined to swim away from divers entering and swimming in the water, which confounds fish census data). The 2000 and 2006 surveys suggest such change may be occurring for certain fish species in certain areas; however, further and more thorough investigation is required." We recommend suggestion of change in other marine resources be abandoned until an appropriate experimental design is employed in a manner that can adequately justify such. Planning and implementation of a quantitatively rigorous marine resource inventory and assessment should occur as a basis for developing appropriate methodologies for determining community baselines and effective monitoring. We recommend such be incorporated into the INRMP as a designated "research need" (page 3-61, lines 14-16; see also and apply to page 9-11 lines 23-25). Although natural marine resources seaward of the high water mark are stated as "no managed by the Navy" (page 1-6, lines 15-16), information from appropriately designed and conducted quantitative resource assessments and monitoring is suggested as fundamentally necessary for achieving meaningful stewardship actions consistent with SAIA INRMP objectives listed on page 1-8, lines 7, 9, 11-12; page 1-9 Table 1-2 objectives 1, 3, 4, 7 and page 1-19, lines 12-39.	

NOAA Fisheries Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO., TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
RTC NOAA.7: The following text was added to of Section 3.4.2.2: "PMRF Environmental Department funded a follow-on marine resources and fisheries survey of the coastal/marine environment at Barking Sands in 2006 (Appendix C1). This survey documented what appears to be an increase in the size, diversity, and quantity of both commercial and recreational fisheries and marine resources (Dollar and Brock 2007). Theoretically, a decline in fishing activities should result in increased sizes and abundance of fish, and/or a potential shift in their behavior. The 2000 and 2006 surveys suggest such change may be occurring for certain fish species in certain areas; however, further and more thorough investigation is required." Section 9.4, Table 9-2, item 25 provides a recommendation for a fisher survey and item 24 provides a recommendation for follow-up marine resource surveys.				
NOAA.8	Page 3-58, lines 14-43	8	If "outside" marine vessels are utilized and or operate at Barking Sands, clarification should be provide on mechanisms (or lack of) used to avoid/minimize the potential introduction of alien and/or invasive marine species. Has an adequate inventory and assessment of marine invasive organisms occurred at this site? If not, perhaps such should be considered in the plan, along with a reasonable level of monitoring. If relevant, we recommend this be incorporated as a "research need" (page 3-61, lines 14-16; see also and apply to page 9-11, under line 15). This INRMP would benefit from clarity regarding marine consistency with page 1-9, objectives 4 and 7.	
RTC NOAA.8: Amphibious vessels are utilized and operated at Barking Sands as part of RIMPAC exercises which occur every other year on even numbered years. Section 9.4, Table 9-2, items 13 and14 address the Navy's recommendations invasive species prevention and control and the development of a biosecurity plan. As part of both recommendations, the Navy would continue to comply with HRC EIS/OEIS Sections mitigation measures for the introduction of invasive species (Section 6.10.2 and Appendix C, C3).				

NOAA Fisheries Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO., TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
NOAA.9	Page 4-5, lines 10-36	9	The document appears to lack needed clarity regarding the causal factors of the severe erosion that is indicated at the Makaha Ridge Tracking Station. In addition, although marine environments reportedly do not to fall directly within the station boundaries, potential impacts to reef sources resulting from erosion on Naval occupied property should be thoroughly investigated and adequately addressed. The suggestion on page 4-14 lines 2-3 that erosion issues at the station do not affect the marine environment appears to contrast page 4-5 lines 10-13 which state, "Areas of the station experience severe erosion, causing silt-laden runoff to apparently flow down the cliff-face and into the coastal waters directly below". This marine issue appears very relevant and should be described under Coastal/Marine (page 4-15, line 9) and considered a priority action item in this INRMP (as an identified "research need", see page 4-16, line 16, in concert with proposed actions listed under 9-14, line 21). Clarification on compliance/noncompliance with natural resource laws and regulations (see page 1-8, line 20 and page 4-15, line 29 which suggests "developed areas and the helicopter-landing zone" as areas of extensive erosion, and page 9-14 line 21 which state priority 2 class 2 funding) should also be provided directly in the text as appropriate context. The suggestion of goat control (page 4-14, lines 30-31, page 9-15 lines 1-2) as potential erosion control management activity seems sensible. We also support prioritization of active re-vegetation/forestry and vehicle/pedestrian traffic restrictions (pages 9-14 lines 21-22, page 9-15 lines 4-6) as a means to begin achieving goals/objectives listed on page 1-8, lines 7,9, 11-12, 25-34; page 1-9 Table 1-2 objectives 1, 3,4, 7, and page 1-19, lines 12-39). However, page 4-15, lines 26-31 indicate a land management prioritization process began in FY2002 and that eroded areas were mapped in FY2004, but that the Environmental Coordinator is, at this time (May 2009, roughly five years later), "waiting for the results of the investigation." Clarification is need as the timeline provided suggests a failure in the INRMP process may be occurring.	
RTC NOAA.9: The first sentence of Section 4.2.5 was revised as follows: "Areas of the station experience severe erosion; this is part of a much broader erosion problem of the Mākaha Ridge and the Na Pali Coast which are comprised of soil types with severe erosion hazards. Further exacerbating these soil conditions is the presence of feral goats which eat erosion-inhibiting vegetation. These regional conditions result in silt-laden runoff to flow down the cliff-face and into the coastal waters directly below." As described in Section 4.2.5, several soil types at the facility (rRO, BL, NcD, NcE2) have severe erosion hazards as determined by USDA. In addition, feral goats located on SOH lands, of which Makaha Ridge Tracking Station is a small part, exacerbate soil erosion by eating erosion-inhibiting vegetation. For those reasons and the fact that the station is not a coastal site, PMRF does not specifically address marine water quality at the station. The erosion study/survey was done in-house and was limited to the built environment in order to find ways to protect structures and human health and provide for employee safety. In response to the findings of the study, the Navy installed textiles to prevent erosion in walkways and in the vicinity of the built environment. However, soil erosion over the largely undeveloped environment at Makaha Ridge, including portions of the Makaha Ridge Tracking Station, is the result of naturally occurring soil conditions and the presence of feral goats. While there is nothing the Navy can do to address the natural soil types at the station, it plans to install fencing and eradicate goats from within the property (Table 9-3 item 6) which will likely improve the coastal water quality.				

NOAA Fisheries Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO., TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
NOAA.10	Page 7-5		Hawaiian Monk Seal: In general, the draft INRMP understates the importance of Kaula Rock to the monk seal. As described in the recent Hawaiian monk seal recovery plan (NMFS 2007), monk seals appear to be re-colonizing the main Hawaiian Islands (MHI) from the Northwestern Hawaiian Islands (NWHI). Significant numbers of monk seals now occur on or around Kaula Rock, Niihau, and certain parts of Kauai. For example, counts of 15 or more seals have been documented during recent surveys in the Kaula Rock area. The description of the Hawaiian monk seal in Section 3.3.1.1, and the descriptions of animals in the Kaula Rock area in Section 7.3.1.1 should be revised accordingly.	Section 3.3.1.1 was revised per comment. Section 7.3.1.1 was revised per comment.

J3 - DBEDT CZM PROGRAM COMMENTS ON PUBLIC REVIEW DRAFT OF PMRF INRMP

DBEDT CZM Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
CZM.1	Entire Document	1	No additional comments to those provided for Agency Draft Review.	Comment noted.

J4 - DLNR DOFAW COMMENTS ON PUBLIC REVIEW DRAFT OF PMRF INRMP

DLNR DOFAW Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
DOFAW.1	Page 4-14, 4.4.1.2 Encouragement of Nene nesting	1	New, recent information: The Makaha area was recently approved for a trial archery goat hunting program with the Barking Sands Archery club in coordination with DLNR-DOFAW. Please add the following: In addition to fencing, PMRF will institute a trial archery goat hunting program with the Barking Sands Archery Club in coordination with the DLNR DOFAW.	Section 9.5, Table 9-3, item 8 provides a recommendation for trial goat hunting. PMRF would institute a trial goat hunting program with the Barking Sand Archery Club or other organization in coordination with the DLNR DOFAW to reduce the presence of goats at the Mākaha Ridge Tracking Station.
DOFAW.2	Page 4-14, Section 4.4.3 Fish and Wildlife	2	New, recent information; please add: The Barking Sand Archery Club will assist in the removal of goats through an archery hunting program in coordination with the U.S. Navy and DOFAW.	See RTC DOFAW.1.
DOFAW.3	Page 4-15, Section 4.4.7 Invasive Species	3	New information, please add: <u>Please delete sentences on line 17, 18, and 19:</u> DLNR has agreed to catch and remove the goats at no cost to the Navy. It proposes to build a fenced area to herd the goats into, and then remove them for relocation in the hunting areas. <u>Please remove the above sentences wherever found in this draft.</u> <u>Please add the following to the paragraph:</u> DLNR is currently evaluating the feasibility of installing a herding wing fence to remove goats in the area. PMRF will institute a trial archery goat hunting program with the Barking Sands Archery Club in coordination with the DLNR DOFAW.	Section 9.5, Table 9-3, item 6 provides a recommendation for Feral Goat Control. PMRF would install exclusion fencing to exclude the goats from Mākaha Ridge Tracking Station. An ungulate management plan, provided on contract to NAVFAC PAC, suggested several fencing alternatives. The alternative that meets the requirements for facility and vegetation protection, and at the cheapest cost, includes a perimeter goat fence encompassing the majority of the installation, with the inland-facing fence line raised to exclude deer as well. As noted in RTC DOFAW.1, trial goat hunting is recommended.

DLNR DOFAW Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
DOFAW.4	Page 9-7, Section 9.3.3.2 Priority 2/Class 2 Funding 1. Shearwater Protection and Colony Enhancement	4	Please edit blue in line 32: The PMFR Environmental Coordinator would continue to support the SOS program, administered by the Kauai Humane Society, in training volunteers…	Section 9.4, Table 9-2, item 32 provides a recommendation for SOS Support and Shearwater Banding. PMRF would continue to coordinate with the Kaua'i Humane Society's SOS program along with coordinating with USFWS and DLNR-DOFAW to conduct shearwater banding training at the wedge-tailed shearwater colony at Barking Sands Beach Cottages. This training should be done prior to the onset of the Newell's shearwater fledging season.
DOFAW.5	Page 9-8, Section 9.3.3.2 Priority 2/Class 2 Funding, 3. Feral Goat Removal/Control	5	Please add the following in blue on line 8 on page 9-8: The PMRF Environmental Coordinator would coordinate with DLNR DOFAW and the Barking Sands Archery Club for the control and removal of feral goats at Makaha Ridge Tracking Station…	See RTC to DOFAW.1.
212	Page 9-13, Section 9.3.7.2 Priority 2/Class 2 Funding, 1. Feral Goat Control	6	Please delete sentence on line 7 and 8: DLNR would catch and remove the goats at no cost to the Navy. Please add: DLNR is currently evaluating the feasibility of installing herding winged fence to remove goats from the area. PMRF will institute a trial archery goat hunting program with the Barking Sand Archery Club in coordination with the DLNR DOFAW.	See RTC to DOFAW.3.

J5 - KAUA‘I INVASIVE SPECIES COMMITTEE COMMENTS ON PUBLIC REVIEW DRAFT OF PMRF INRMP

KISC Comments on the Public Review Drat of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
KISC.1	Page ES-4, Table ES-1- Port Allen	1	Although this lease from the state states that it is for warehousing and surface craft support and does not deserve consideration for resource management, I disagree. Surface craft, I believe, does tie up to the west side of the dock and therefore poses a threat of hull fouling and transport/introduction/spread of aquatic invasive species (like snowflake coral, already known to be at Port Allen). Add this site to the management plan	Comment noted. The Navy will address this in the future development of the INRMP. Section 9.4, Table 9-2, item 14 provides a recommendation for the development of a biosecurity program at PMRF.
KISC.3	Page 3-47, 1. Kiawe-Koa Haole Scrub, Line 31	3	Is this Agave sisalana or Agave foetida?	According to Char 2000a, it is *Agava sisalana.* That is how it is presented in the text.
KISC.2	Page 3-48, 4. Strand Vegetation, Line 44	2	I did not see mention here or in the appendix as the presence of Lauracea casytha (native). This plant can be seen growing up and draping other plants. It vines and is orange and green.	The plant kaunaoa pehu (*Cassytha filiformis*), also known as Lauracea casytha, of the family Lauracea is mentioned in both Pōhinahina-Naupaka Dune Vegetation and strand vegetation.

J6 - USDA COMMENTS ON PUBLIC REVIEW DRAFT OF PMRF INRMP

USDA-WS Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
USDAWS.1	General	1	Thank you for requesting Wildlife Services review of the Pacific Missile Range Facility Integrated Natural Resource Management Plan. We have no further comments to offer on the Plan.	Comment noted.

J7 - DLNR DAR COMMENTS ON PUBLIC REVIEW DRAFT OF PMRF INRMP

DLNR DAR Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
DAR.1	General	1	1. BASH Program: The INRMP briefly describes the Navy's measures taken to reduce BASH from Laysan albatross (*Phoebastria immutablis*) nesting near their Barking Sands runway. I concur with the U.S. Fish and Wildlife Services's recommendations that the INRMP should include a much more detailed description of the BASH program, including tables that show: 1) the number of eggs removed, incubated, fostered, and successfully hatched under each of the existing treatments being used for all the years the program has existed, and 2) a display, for all years, the number of individual adult birds captured and moved (including the specific location (s), and the number of times each bird was translocated from PMRF each year.	Section 3.4.1.1 Bird Air Strike Hazard describes the current management actions for Laysan albatross. Appendix G12 includes the Barking Sands Pacific Missile Range Facility, Proposed Laysan Albatross Management Plan to Reduce Bird-Aircraft Strike Hazard Potential (NAVFAC PAC 2009b). Section 9.4 (Table 9-2, item 1) provides the Navy's recommendation for continued BASH control described in Chapter 3.
DAR.2	General	2	Because protection of native biodiversity includes genetic and spatial diversity, it may be prudent to identify and establish additional sites (e.g., Lehua Island, Makahuena Point, etc.) within Kauai County where Laysan albatross adults can be translocated to increase the spatial distribution of this species within Kauai County.	The BASH management actions, as referred to above, include translocations of eggs and subadults to other sites on Kauai's North Shore. Breeding adults have been shown to quickly return to PMRF after translocation, and are therefore no longer candidates for translocation. Translocations appear to be difficult at sites with no established breeding individuals (e.g. Makahuena Point). Lehua Islet translocations would be logistically challenging and create added stress on the translocated birds.
DAR.3	General	3	I also concur with the USFWS, that the Navy prioritize funding for additional staff to revise and implement the Navy's agreement to develop a seabird monitoring program focusing on ways to reduce negative impacts of lights, light poles, wires, towers, and other large objects on both threatened Newell's shearwaters and on endangered Hawaiian petrels.	Section 3.4.1.3 (item 1) describes current monitoring and management for Hawaiian petrel and Newell's shearwater. Section 9.4 (Table 9-2, item 4), Section 9.5 (Table 9-3, item 2), and Section 9.6 (Table 9-4, item 1) describe recommended Nocturnal Seabird Fallout Monitoring and Management.

DLNR DAR Comments on the Public Review Draft of the PMRF INRMP

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
DAR.4	Page 1-12, Table 1-3	5	Table 1-3, and section 1.9 (p.1-19) are noteworthy since DLNR/DAR has no representation on the INRMP Working Group and DAR is not considered a SAIA partner in the INRMP even though the area has significant aquatic resources, and in fact was once one of the largest wetlands in the state of Hawaii. I recommend that DAR be represented on this working group and become a SAIA partner with these sister agencies.	Table 1-3 and section 1.9 were revised to reflect DAR as part of the working group.
DAR.5	Page 2-2, Section 2.4, Achieving No Net Loss to the Military Mission	4	The concept of "no net loss", or of "net gain" is usually applied to biological integrity within ecosystems. Perhaps a much better way to express the two broad goals of "no net loss to military mission" and of "no net loss to biological integrity of the environment", is to focus on the concept of "sustainable development", where mission goals and objectives can be met and at the same time they are designed to protect and/or restore biological integrity and ecosystem form and function, they promote economic efficiency and they protect sociocultural equity; in this way the two are not mutually exclusive, but compatible. With this concept in mind, and the goal of "controlling environmental encroachment and preserving an unencumbered environment for the purposes of the Navy's mission", it may be of optimal benefit to restore the adjacent Mana wetlands and endangered waterbird habitats surrounding PMRF. Because the native Hawaiian endangered waterbirds do not pose a significant hazard regarding aircraft-bird strike, and because the restoration of wetlands around PMRF would preserve these valuable wetland and endangered waterbird habitat as an unencumbered environment surrounding PMRF. Similar, the ecological and biological benefits to the productivity of endangered waterbirds and to coastal fisheries would be significantly. Similarly the goals and objectives of wetland resources are not consistently defined with those on page 1-6, lines 30-33 (which is an excellent goal); goals are broadly defined, and objectives are more specific and must reinforce goals (reference Barber and Taylor, 1992). The mission of the INRMP should address the Navy's mission, goals and objectives in context to sustainable development concept and principles, particularly the protection and restoration of biological/ecosystem integrity, economic efficiency and social/cultural equity. By doing this the "no net loss" policy can actually be transformed to a "net gain" policy, and it will apply to both the Navy's mission and to ecosystem form and function; the two goals are not necessarily mutually exclusive. Reference: Barber and Taylor. 1992. The role of goals, objectives, and values in the natural resource management process: review of literature. N. Am. Jour. Fisheries Management. AM. Fisheries Soc.	

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
DAR.5: Comment noted. The term "Achieving No Net Loss to the Military Mission" is part of Navy guidance on INRMP preparation. It is acknowledged achieving no net loss to military mission is compatible with no net loss of biological integrity of the environment. The need to control encroachment is important to maintain the ability of PMRF to meet its military mission. That is why the Navy has entered into an agreement with the State and County to preserve agricultural lands around the installation so that adjacent land uses will not prevent the Navy from meeting its military mission. The Navy has and will continue to promote through Navy volunteers the restoration of the Kawaiele wildlife sanctuary adjacent to Barking Sands. It is not clear from the comment which goals and objectives are not consistently defined with those on page 1-6. Table 2-2 provides a listing of the Natural Resources Management Areas, Goals, and Objectives.				
DAR.6	Page 3-2, Figure 3-1	6	Figure 3-1, does not depict accurate green sea turtle nesting habitat at Nohili Ditch, please include Nohili Ditch as a known green sea turtle nesting and basking area. Additionally, green sea turtles have been documented nesting in front of Naval Housing area at PMRF, please include this also. Finally, Hawaiian monk seals (HMSs) haulout on the all of the beaches adjacent to PMRF and have even pupped on the beach near the PMRF runway; these areas should also be depicted.	
RTC # DAR.6: The text on page 3-1, Section 3.1.1.2 Land Use Constraints, first paragraph, was revised to reference Figures 3-1 (Constraints [primarily military land use constraints]), 3-5 and 3-6 (Protected Animal Species Habitat), and 3-8 and 3-9 (Vegetation Types). Figures 3-5 and 3-6 show the locations of protected animal species habitat (including green turtles and Hawaiian monk seals). Unfortunately, due to the large number of military land use constraints, Figure 3-1 became too crowded to clearly depict the animal protected species habitat and critical habitat for the lau 'ehu and these are, instead, depicted on Figures 3-5 and 3-6 and 3-7 and 3-8, respectively.				
DAR.7	Appendix C		Appendix C (Dollar 2006)) states that "the absence of green sea turtle nesting activity at Nohili ditch appears to be due to natural conditions that the turtles find unsuitable…", yet turtles nested at Nohili ditch in 2007 (personal observation); green sea turtles are now starting to nest in many places on Kauai, including in front of the public pavilion at Salt Pond County Beach Park; increased nesting appears to be a function of increased adult honu population density and the fact that this species has completely recovered from over-fishing after being completely protected since 1978.	
RTC # DAR.7: Comment noted. PMRF Environmental does not have a record of turtle nesting at Nohili Ditch in 2007 and would welcome additional information from the reviewer to incorporate into subsequent updates to the INRMP. The nesting event indicated by the reviewer would not be noted in the Dollar Report (Appendix C) as that report was prepared in 2006.				

Comment No.	LINE NO. , TABLE NO., OR FIG. NO.	ITEM NO.	COMMENTS	ACTION
DAR.8	Appendix C		Also, (appendix C, 6.0), Dollar offers a potential solution to the existing suspended organic mater and terrigenous sediments being discharged at Nohili and Kawaiele ditches, by "restoring the (portions of) wetlands adjacent to the terminal reaches of these (man-made) ditches"; on the contrary, I would recommend "restoring the dynamited limestone reef/beach rock that was blasted to drain the Mana wetland, removing the drainage ditches, and restoring the ecological integrity of a significant portion of the Mana wetlands; this significant ecosystem restoration project would accomplish one of the Navy's primary goals (protecting unencumbered adjacent lands), it would restore the form and function of one of the largest wetlands in the state, it would provide excellent feeding and nesting habitat for Hawaiian endangered waterbirds, it would provide excellent nursery and feeding habitat for many species of euryhaline fishes and invertebrates, and it would increase the productivity of coastal fisheries and improve overall coastal water quality by functioning as a huge biofiltration and sedimentation basin; it would be a win-win for both the DoN, for the State of Hawaii , for natural resources restoration, and for the public trust and the general public.	
RTC # DAR.8 Comment noted. Restoring the entire Mana Plain to a wetland is beyond the scope of the Navy's purview and may create a net loss to PMRF's military mission if portions of Barking Sands base become inundated . However, the Navy is working with DLNR on its plans to restore the Kawaiele Wetland at the adjacent Kawaiele Wildlife Sanctuary and is intending to enlist volunteers in the restoration of the wetland.				
DAR.9	Appendix G3 and G9		Appendix G3 (Ka'ula Draft Seabird Monitoring Program) and G9 (Sea Turtle Stranding Response Protocol for PMRF) were not included on the CD of "appendices" in my copy of the review draft. I suggest that these be included for our review, and that the Navy include a "Hawaiian Monk seal monitoring program", similar to the draft seabird monitoring program for Ka'ula as it relates to the use of inert ordinance use on Ka'ula as a target, specifically addressing the physical impacts on nesting/resting seabirds and on seals hauled out on ledges around Ka'ula located near existing targets.	
RTC # DAR.9: Comment noted. Appendix G3 begins on page 339 and ends on page 343 of the pdf of the CD containing the document appendices for the Public Review Draft. Appendix G9 starts on page 367 and ends on page 369 of the pdf of the CD containing the document appendices of the Public Review Draft. The Navy has developed a monitoring plan, Hawaii Range Complex Monitoring Plan December 2008, to provide marine mammal and sea turtle monitoring related to Hawaii Range Complex activities include use of inert ordnance at Ka'ula Island (Table 9-6, item 1).				

APPENDIX K
NI'IHAU ADDENDUM

Integrated Natural Resource Management Plan
Niʻihau Addendum

Pacific Missile Range Facility

Islands of Kauaʻi, Oʻahu, and Kaʻula, State of Hawaiʻi

Commander, Navy Region Hawaii
December 2012

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1.0 Introduction and Overview

Niʻihau Island Aerial Photo

This Addendum has been prepared in accordance with and is officially incorporated as part of the 2010 PMRF INRMP to address the proposed critical habitat designations for monk seals on Niʻihau.

Niʻihau Island (photo 8-1) is approximately 13 km (8 mi) wide by 29 km (18 mi) long with an area of 72 mi2 (186.5 km2). The Navy leases approximately 1,170 ac (473.5 ha) of land on the northeastern corner of the island. The island, located 17 nm (32 km) southwest of Kauaʻi, is privately owned and operated by Niʻihau Ranch (DON 1998).

Niʻihau has been owned by a single family, the Robinsons, since 1864. Niʻihau residents live in the traditional Hawaiian community of Puʻuwai, and speak their own dialect of the Hawaiian language. They maintain a subsistence lifestyle with fishing, hunting game (pigs and turkey), and collecting shells from local beaches for Niʻihau leis. The Robinson family is closely involved with the residents and has provided housing and horses for work and transportation. The Robinsons' Niʻihau Ranch also provides employment for some island residents. The Ranch currently produces cattle, sheep, and honey. Most of the land is devoted to grazing for the estimated 1,600 cattle. The Niʻihau residents are located in a village on the west-central part of the island. Niʻihau residents engage in important shoreline subsistence fishing and gathering of unique shell for their Ni'ihau leis along much of the island's shore line.

Lehua Island is just north of Niʻihau and is designated as a conservation use district by the State of Hawaii and is part of the Hawaiian Island State Seabird Sanctuary. Certain activities are prohibited within the sanctuary, except by agents of the board and except as authorized by the board or its authorized representative. Access to Niʻihau and Lehua is restricted and there are no public recreational facilities. Island residents on Niʻihau have access to the entire island for recreational opportunities. Diving tours are offered in the waters near Niʻihau and Lehua by several outfitters on Kauaʻi.

1.1 Military Operations and Activities

PMRF currently operates radar units, optics, and electronic warfare sites on Niʻihau (Figure 8-1). PMRF also flies AEGIS drone targets along the east coast of the island away from inhabited areas. The Navy leases an area on the northeast corner of the island; however, the Navy has a relationship with the island landowner such that any part of island may be used for future Navy training activities, with prior permission from the land owner. Navy activities on the island include, or may include as future requirements dictate, island-wide downed pilot training, helicopter terrain flight operations, electronic warfare exercises, special warfare operations training, target and interceptor launches, amphibious landings, helicopter landing areas, and unmanned aerial vehicle contingency landing support. These activities may take place on land, in the near shore environments, and low level altitudes above land or sea.

Due to the open-ended nature of the lease agreement, it is not possible to delineate with certainty the areas on Ni'ihau which will be used for future Navy operations other than the Northern leased parcel, Perch Site, and the Radar Site. This addendum therefore focuses on coastal areas where Navy vessels come ashore on a regular basis for maintenance and resupply visits and where landings would be likely to occur during future training activity.

1.2 Areas covered by the INRMP

Areas of Ni’ihau covered by the PMRF INRMP include the Navy leased area in the northeast corner of the island (Figure 1) and coastal areas where beach landings may occur. Specifically, this includes all non-cliff coastal areas that have either a beach or accessible flat, rocky area and that are outside of the reserved areas (Figure 1). The width of the coastal area covered by the INRMP includes the distance from 1.5 meters depth at low tide (determined by the draft of potential Navy vessels landing on shore), through the water’s edge, and into the terrestrial environment 5 m inland from the shoreline described by the upper reaches of the wash of the 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).

2.0 General Environment

A general discussion of the physical geography of the Hawaiian Islands is presented in Section 2.2.1 of the INRMP. Ni‘ihau Island is located at 21° 54’ North latitude and 160° 10’ West longitude, approximately 17nm (32 km) southwest of Kaua‘i. Ni‘ihau is an elongated, northeast-southwest trending volcanic island with an approximate area of 72 mi^2 (186.5 km^2). The east-central portion of the island is flanked by coastal plains to the north, west, and south. Volcanic cones are prominent at each end of the island: Kawaihoa at the southern tip and Lehua, now an island, at the northern end.

The summary below of the general environment of Ni‘ihau was taken from the Pacific Missile Range Facility Enhanced Capability EIS, 1998.

2.1 Topography, Geology and Soils

The volcanic uplands of Ni‘ihau attain a maximum elevation of 390.4 m (1,281 ft) at Paniau, and form dramatic sea cliffs greater than 304.8 m (1,000 ft) in elevation along 4.8 km (3 mi) of the eastern coastline. Seventy-eight percent of Ni‘ihau is less than 152 m (500 ft) in elevation.

Geology and soils are considered earth resources that may be adversely affected by proposed activities. This resource is described in terms of existing information on the land forms, geology, and associated soil development as it may be subject to erosion, flooding, mass wasting, mineral resource consumption, contamination, and alternative land uses resulting from proposed construction and launch activities.

2.2 Water Resources

There are no perennial streams on the island. Surface runoff following winter rains collects in lakes; however most of the water evaporates. One of the lakes receives some spring inflow. All of the lakes are at elevations within a few feet of sea level. Several small springs and seeps are also located on the island at elevations of approximately 152 m (500 ft) above sea level. There are also seep areas at Keanahaki and Kaumuhonu at the 2 m (6.5 ft) elevation level.

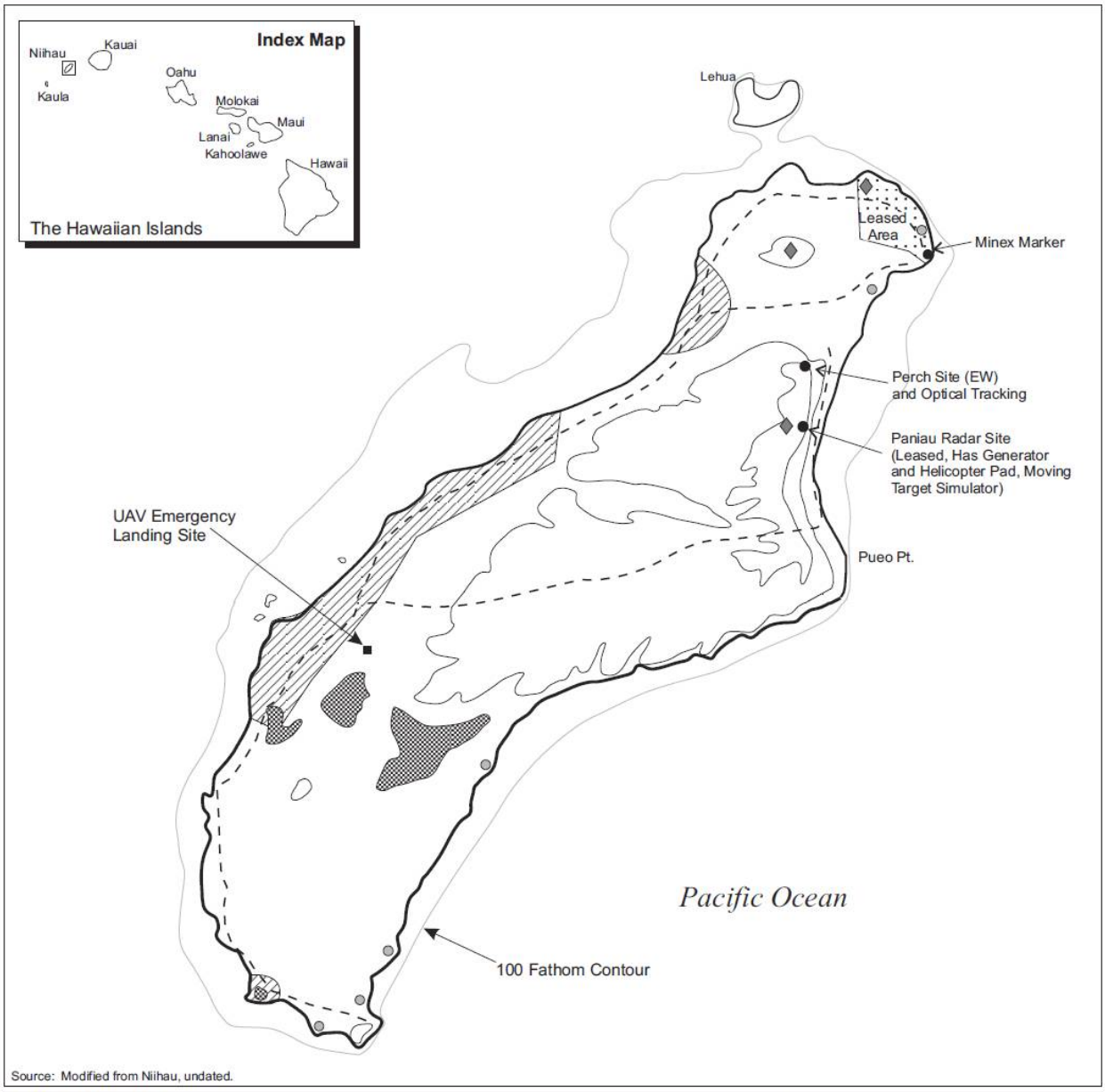
Groundwater occurs in beach sand, calcareous dunes, alluvium, eolianite, and the Kiekie and Paniau volcanic series. Water samples were collected from 57 wells and waterholes. Only three wells yielded water sufficiently low in salt for drinking.

2.3 Vegetation and Wildlife

Non-native plant species and plant communities dominate the vegetation on Ni‘ihau. Kiawe forest dominates coastal and inland areas forming dense thickets in many locations. On the northern lowland areas, the kiawe forest is more open and forms a mixed coastal dry community

Figure 1 – Ni‘ihau Island

with an extensive shrub understory of ‘ilima (*Sida fallax*). A dry coastal community, koa haole



shrubland, occurs at scattered locations at higher elevations on the island. In some locations the koa haole canopy is so thick and grazing pressure of feral sheep and pigs so intense that there is little, if any, herbaceous understory. Small mixed stands of eucalyptus (Eucalyptus sp.) and common ironwood (*Casuarina equisetifolia*) occur in a few sheltered areas at higher elevations. Ironwood also occurs in coastal areas near the ocean. Scattered individuals of naio (*Myoporum sandwicense*) also occur at higher elevations in a mixed kiawe/koa haole shrub association. A coastal dry herbland/grassland community is present along the northeastern coastal region of Niʻihau.

The wildlife on Niʻihau is dominated by non-native species such as feral pigs, sheep, cattle, horses, donkeys, turkeys, quail, pheasants, and peacocks. Large numbers of pigs and sheep freely roam the island. The common bird species are introduced species such as the spotted dove (*Streptopella chinensis*), cardinal (*Cardinalis cardinalis*), and mynah. The migratory Laysan albatross (*Diomedia immutabilis*) nests on Niʻihau, but its success is limited by depredation of habitat by feral pigs.

2.3.1 Threatened and Endangered Species

This section provides a summary of the federally-listed threatened and endangered species at Niʻihau Island. Table 1 provides a listing of the federally-listed threatened and endangered species.

Table 1 Federally-Listed ESA Species at Niʻihau Island

Latin Binomial	Common Name	Regulatory Status
Anas wyvilliana	Hawaiian Duck (Koloa)	endangered
Gallinula chloropus sandviciensis	Hawaiian Common Moorhen	endangered
Fulica alai	Hawaiian Coot	endangered
Himantopus mexicanus knudseni	Hawaiian Stilt	endangered
Monachus schauinslandi	Hawaiian monk seal	endangered
Chelonia mydas	green sea turtle	threatened
Pritchardia aylmer-robinsonii	Loʻulu	endangered
Brighamia insignis	Olulu	endangered

There are four federally-listed endangered bird species that are found in and around the lakes on the southern part of Niʻihau: (1) Hawaiian duck or koloa (*Anas wyvilliana*); (2) Hawaiian moorhen or alae ula (*Gallinula chloropus sandwichensis*); (3) Hawaiian coot or alae keʻokeʻo (*Fulica alai*); and (4) Hawaiian stilt or ae o (*Himantopus mexicanus knudseni*).

The federally-listed endangered Hawaiian monk seal uses the coastline to haul out, bask, and pup. Section 3.3.1.1 provides a general description of Hawaiian monk seals as well as their range and habitat, feeding habits, reproduction, and threats to the species.

The threatened green sea turtle has been observed to come ashore on selected beaches and occasionally nests at some of these locations.

Pritchardia aylmer-robinsonii is an endemic and endangered species of the palm family (Arecaceae) historically found at three sites in the eastern and central portions of the island of Niʻihau. Trees were found on Kaʻali Cliff and in Mokouia and Haʻao Valleys at elevations between 70 and 270 m (230 and 890 ft). The most recent observations indicate two plants still remain on Kaʻali Cliff. Originally a component of the Coastal Dry Forest, this species now occurs

only in a rugged and steep area where it receives some protection from grazing animals (US Fish and Wildlife Service 1996).

Brighamia insignis, ʻōlulu, is an endemic and endangered species of Hawaiian lobelioid known historically only from Kauai and Niihau. Critical habitat has been designated for *Brighamia insignis* in three units totaling 2,043 hectares (5,047 acres) on Kauai and one unit totaling 144 hectares (357 acre) on Niihau. This designation includes habitat on state and private lands. On Niʻihau, a population was known from Kaʻali Cliff, but has not been observed since 1947. (US Fish and Wildlife Service 1996; Division of Forestry and Wildlife Fact Sheet)

2.3.2 Threatened and Endangered Species occurring within areas covered by the INRMP

Only the Hawaiian Monk Seal and Green Sea Turtle occur within areas covered by the INMRP. Hawaiian Monk Seals and Sea Turtles may be present both on land up to the terrestrial boundary and in the ocean within the 1.5 m depth zone.

Table 2 Federally-Listed ESA Species within areas covered by the INMRP

Latin Binomial	Common Name	Regulatory Status
Monachus schauinslandi	Hawaiian monk seal	endangered
Chelonia mydas	green sea turtle	threatened

2.4 Cultural Resources

The Island of Niʻihau is private property. Archaeological resources information is limited to notes in the Bishop Museum and cultural resource surveys conducted for the U.S. Navy. Restricted public access to Niʻihau has allowed the coastline and beaches to remain in their natural state. Given the traditional uses of beaches and coastlines by native Hawaiians, the fact that the beaches in Niʻihau are accessed only with permission of the landowners, and that Niʻihau is undeveloped private property, it would be prudent to assume that any coastal or sandy dune area on the island can be considered to be potentially sensitive in terms of pre-historic, historic, and traditional cultural resources.

Archaeological work on the island was initially conducted by Mr. John F.G. Stokes of the Bishop Museum in 1912. A reconnaissance survey conducted in May 1987 by Dr. William Kikuchi of the Kauai Community College has probably been one of the most intensive searches for Hawaiian sites on Niʻihau. This survey was restricted to the northeastern portion of the island. The findings support Kikuchi's hypothesis that the northeastern portion of the island was not attractive for permanent habitation. The principal reason seems to have been a lack of water either from springs or from rainfall. Even in historic times, permanent habitation has not been established in this region. Numerous agricultural-type sites and associated temporary shelters suggest that this region, above a 30.5-m (100-ft) elevation, could have supported crops and may have been used during travel to and from the coast or shore areas which provided an abundance of shellfish, fishes, crustaceans, seaweed, and seabirds.

Several potentially historic structures and features were noted as a result of the initial cursory reconnaissance survey of potential facilities siting locations. This included an abandoned U.S. Coast Guard Long-range Aid to Navigation (LORAN) station located on the southwestern corner of the island. The station is composed of two deteriorated buildings (a standing quonset hut and the remnants of a wooden structure with metal cross-bar supports). A radial engine from a B-25 that crashed at this location was also observed near the Coast Guard site. The site is heavily

vegetated and is habitat to feral pigs. Other historic structures and building foundations related to early ranching activities on the island were also observed during the cursory reconnaissance survey. The locales where the historic sites were observed during this survey are no longer under consideration for any project activity.

Traditional cultural resources were observed at one potential facility site in the northern area. This particular site is no longer under consideration for project activities. No traditional resource area or areas associated with traditional values or beliefs were identified in the other potential facility siting areas. Niʻihau's elders were consulted with regards to selection of these areas in order to ensure that traditional cultural values and beliefs would not be compromised by any proposed actions at these locations.

3.0 Current Management

All Navy activities are consistent with the following management strategies implemented by Niihau Ranch including:

- Restricted access (access is limited to guest entry; some areas of the island are banned)
- Feral animal control (periodic removal close to shore areas)
- No dogs allows on the island
- No All Terrain Vehicles (ATVs) allowed on island (for the preservation of sand dunes).

3.1 Additional Management Actions

The Navy will fund an additional management action to include monk seal and green sea turtle monitoring efforts within the coastal areas covered by the INRMP and within the reserved areas. The monitoring effort is expected to contribute to existing data on the status of local populations of these species. It will be a recurring project, programmed for funding each year with an estimated initial cost of approximately $20,000 to $25,000. Table 3 provides an estimate of the cost breakdown.

Table 3 Monk Seal Monitoring Cost Breakdown

Task	Description	Estimated Cost
Labor	Labor for monk seal monitoring. Estimated weekly frequency (8 hours/week/year for one person) – but may be adjusted as needed.	$ 7,500
Transportation and supplies	Vehicle rental and supplies for monitoring and recording data (camera/binoculars/etc).	$10,000
Training	Labor (40 hours/year for 4 people) and transportation to attend training sessions provided by resource agencies.	$ 5,000
Quarterly Reports	Labor (16 hours x 4 reports)	$1,200
	TOTAL	$23,700

For monk seals, individual seals will be identified and monitored. Monitoring data collected will be based on long-term identification of individual seals and will allow for tracking trends such as abundance, survival, birth rate and movements between islands. This will provide a better

understanding on the population status in the MHI as a whole and help determine what habitat the different seals are using and for what purposes

With the permission of Ni’ihau Ranch, the Navy will support a program to document where and when individual seals occur on land and photograph them to document distinguishing natural marks (e.g., scars), tags or other identifying features. Photographs and data will be collected weekly and submitted to Navy and NMFS in the form of a report each quarter. Incidences of deaths and other notable findings (hookings, entanglements and injuries) will be included in the monitoring effort and quarterly reports. All training on photographic and data collection methods will be provided to Ni’ihau residents by NMFS at a location to be determined by Ni’ihau Ranch. All subsequent data analysis on data provided each quarter will be done by NMFS. All data, analyses, and resulting reports will be shared freely between Ni’ihau Ranch, NMFS, and Navy.

Similar data will be collected on any sea turtles observed on land, as well as sea turtle nests. Training on sea turtle monitoring and sea turtle nest data collection will also be provided to Ni’ihau residents at a location to be determined by Ni’ihau ranch.

This project will be programmed starting fiscal year 13. The Navy will contract Ni‘ihau ranch to perform the field work and data collection for the monitoring effort and NMFS will provide training for monk seal and green sea turtle ecology and useful identification techniques.

Metrics for this project include quarterly monitoring reports submitted from Ni’ihau Ranch to the Navy and NMFS at the end of each 4 month monitoring period.

4.0 References

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