

**KAULA ISLAND
SHIP-BASED SEABIRD
AND MARINE MAMMAL SURVEYS
26-28 June 2010**



**Prepared for Commander, U.S. Pacific Fleet
by NAVFAC Pacific**

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INTRODUCTION

Purposes of Kaula Island Monitoring

Seabirds

As part of the Department of the Navy's Coastal Zone Management Act consistency determination for the Hawaii Range Complex (HRC), in 2009 the Navy reinitiated seabird population monitoring at Kaula Island, an HRC munitions training range. A seabird monitoring plan for Kaula was finalized and ship-based seabird monitoring was conducted at the island in July 2009 and June 2010. Seabird monitoring will allow for detection of changes in seabird populations on Kaula Island over time, while ensuring the maintenance of military readiness.

Marine Mammals

In order to train with active sonar and explosives within the HRC, the Navy obtained a permit from the National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act and Endangered Species Act. The Hawaii Range Complex Monitoring Plan, finalized in December 2008 for implementation in January 2009 and amended in 2010, was developed with NMFS to comply with permit requirements. The marine mammal and sea turtle monitoring plan will provide science-based answers to questions regarding whether or not marine animals are exposed and reacting to Navy training. The monitoring plan will answer the following questions:

1. Are marine mammals and sea turtles exposed to MFAS at regulatory thresholds of harm or harassment? If so, at what levels and how frequently are they exposed?
2. If marine mammals and sea turtles are exposed to MFAS in the HRC, do they redistribute geographically in the HRC as a result of repeated exposure? If so, how long does the redistribution last?
3. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses? Are they different at various levels?
4. What are the behavioral responses of marine mammals and sea turtles that are exposed to various levels and distances from explosives?
5. Are the Navy's suite of mitigation measures for MFAS and explosives effective at avoiding harm or harassment of marine mammals and sea turtles?

Marine mammal monitoring at Kaula Island provides data toward answering questions 1, 2, and 5 above.

Kaula Island Background

Owner Information

Title to Kaula is held by the United States. 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), successor to the Lighthouse Service, assumed control of Kaula (Elmer and Swedberg 1971, Balazs 1979). In 1952, USCG granted the Navy a revocable permit to use Kaula Island as a munitions target, and the Navy received jurisdiction, custody, accountability and 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) Main Base, 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).

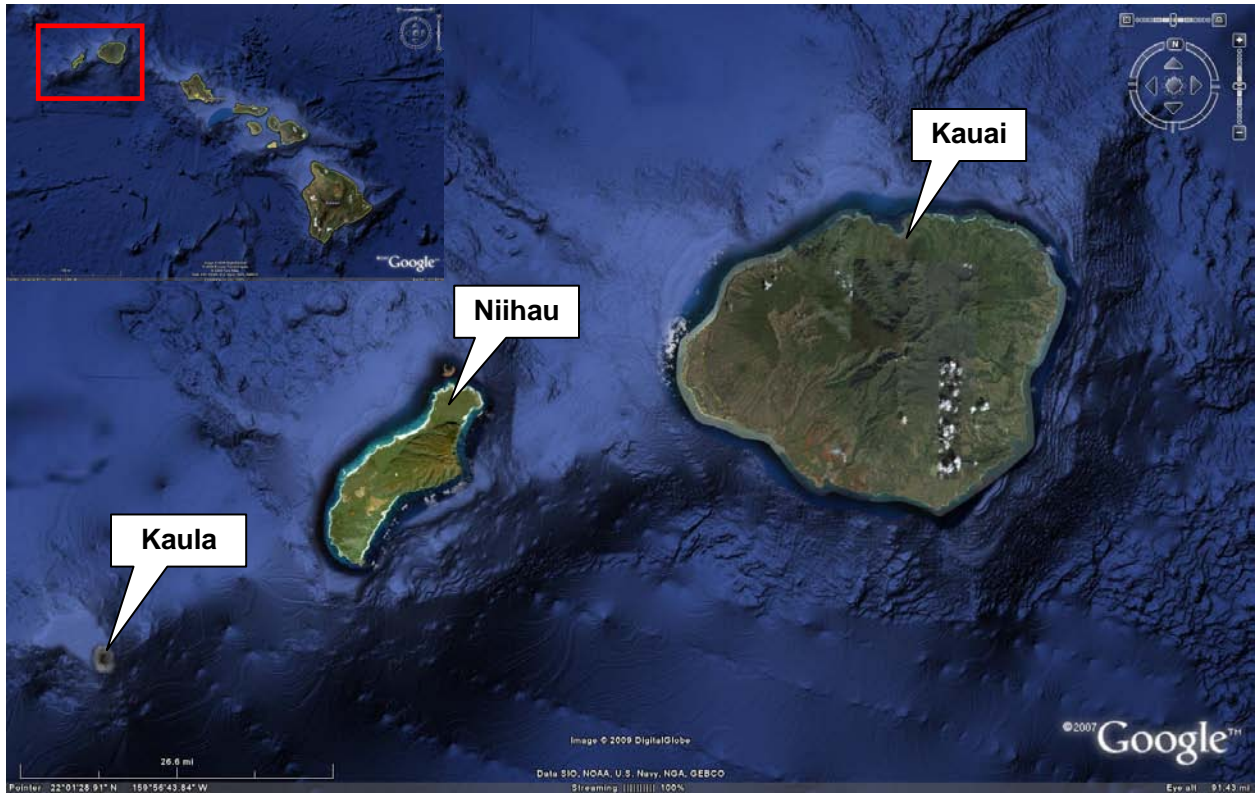


Figure 1. Location of Kaula Island relative to the main Hawaiian Islands (inset) and Kauai and Niihau (imagery from Google Earth).



Figure 2. Aerial imagery of Kaula Island January 2009 (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, the Navy has restricted its munitions training at Kaula to inert ordnance delivery and aircraft gunnery (Walker 1983, 1984).

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. Navy, U.S. Fish and Wildlife Service (USFWS), and State of Hawaii Department of Land and Natural Resources (DLNR) 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 the U.S. Navy, USFWS, and Hawaii DLNR 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 U.S. Navy, USFWS, and Hawaii DLNR 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 (*Tyto alba*) (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.

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 burrow-nesting 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 which the State has designated as a State Seabird Sanctuary (Orazio et al. 2009).

Non-native barn owls have been recorded during multiple surveys on Kaula Island, with the species reported 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 (opihī; *Heliccioniscus 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).

Marine Mammals

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 truncatus*) near Kaula (Mobley et al. 2000, Baird et al. 2003).

Ship-Based Seabird and Marine Mammal Surveys

In summary, the avian surveys on Kaula Island from 1932 through 1998 had been 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 Island were accompanied by a U.S. Navy Unexploded Ordnance Specialist (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. Therefore an alternative survey methodology was necessary.

2009-2011 Ship-Based Surveys

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 carried out via vessel platform, with surveys for marine mammals conducted concurrently (Pepi et al. 2009). In 2009, surveys were conducted aboard the 133 ft (40.5 m) Research Vessel *White Holly*, with four seabird observers and one marine mammal observer collecting data (Table 1). During the surveys, the ship circumnavigated Kaula Island at approximately 2 to 4 knots, maintaining a distance of 748 ft (228 m) from the coastline. Observations of seabirds and marine mammals were conducted from a platform above the bridge, approximately 24 ft (7 m) above the water. Seabird surveys were carried out by counting birds visible on the ground and in the air. Some areas of the top of the island were not visible from the vessel. From the distance of the observation deck, 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. All marine mammal sightings during the survey periods were recorded.

A total of 11 avian species were observed at Kaula Island during the 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 (*Sterna lunata*), sooty tern (*Onychoprion fuscatus*), brown noddy (*Anous stolidus*), and white tern (*Gygis alba*)). 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.

Four species of marine mammals were observed on or near Kaula Island, including three species of odontocetes and one species of pinniped. Bottlenose dolphins and spinner dolphins were sighted off of the northwest coast of the island, within 820 ft (250 m) of the coastline. 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 (*Monachus schauinslandi*) were observed hauled out on two separate ledges on the leeward (western) side of the island (Pepi et al. 2009).

Table 1. Survey dates and personnel, Kaula Island, Hawaii, 1932-2010.*

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. Navy	Gerald Swedberg	Natural Resources Specialist
		J.S. Elmer	Operations & Readiness Officer
		H.W. Mixter	Unexploded Ordnance Escort
	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
20-21 Jan 1976	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		Yoshito Doi	Photographer
		Scott Wood	Unexploded Ordnance Escort
	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
14-15 Sep 1976	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		John Walter	Special Asst for Ecology
		Holden	Asst Operations Officer
		Unknown	Unexploded Ordnance Escort
	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
7 Mar 1978	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
	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
21-22 Aug 1978	U.S. Navy	Gerald Swedberg	Natural Resources Specialist

		Unknown	Unexploded Ordnance Escort
	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
6-8 Mar 1979	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	Unexploded Ordnance Escort
	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
19-20 Jun 1980	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		Unknown	Unexploded Ordnance Escort
		Craig Swedberg	Assistant
	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
16-18 Apr 1984	U.S. Navy	Unknown	U.S. Navy Representative
	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
1-2 Jun 1993	U.S. Navy	Tim Sutterfield	Fish and Wildlife Biologist
		Mike Nahoopii	Kahoolawe Project Officer
		Ken	Unexploded Ordnance Escort
	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
16-17 Nov 1998	U.S. Navy	Sean Cole	Unexploded Ordnance Escort
	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
18, 21 Jan 2009	Hawaii Aviation	Adam Townley-Wren	Pilot
	(civilian contractor for U.S. Navy)	Peter Gonsalves	Photographer
20-24 Jul 2009	U.S. Navy	Vanessa Pepi	Supervisory Fish & Wildlife Biologist
(Ship-based survey)		Anurag Kumar	Marine Resources Specialist
	U.S. Fish and Wildlife Service	Megan Laut	Fish and Wildlife Biologist
		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
28 June 2010	U.S. Navy	Angela Anders, PhD	Wildlife Biologist
(Ship-based survey)		Justin Fujimoto	Wildlife Biologist Intern
		Sean Hanser, PhD	Marine Natural Resource Management Specialist
		Robert Uyeyama, PhD	Marine Natural Resource Management Specialist
		Aaron Hebshi, PhD	Natural Resource Program Biologist
	U.S. Fish and Wildlife Service	Megan Laut	Fish and Wildlife Biologist
	Hawaii Dept of Land and Natural Resources	Jessica Hallman	Kauai Endangered Seabird Recovery Project Avian Technician

*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	<i>Cenchrus echinatus</i>	Introduced		x	x
	Swollen finger grass	<i>Chloris inflata</i>	Introduced		x	x
	Kukaipua'a	<i>Digitaria setigera</i>	Introduced		x	x
	Jungle rice	<i>Echinochola colonum</i>	Introduced		x	x
	Kakonakona	<i>Panicum torridum</i>	Endemic		x	x
	Bristly foxtail	<i>Setaria verticillata</i>	Introduced		x	x
		<i>Panicum lanaiense</i> (recrd by Caum (1939) easy to mistake for <i>P. torridum</i>)	Introduced	x		
Chenopodiaceae	Australian salt bust	<i>Atriplex semibaccata</i>	Introduced		x	x
	Alaweo	<i>Chenopodium oahuense</i> (formerly <i>Chenopodium sandwicheum</i>)	Endemic	x	x	x
Amaranthaceae	Slender amaranth	<i>Amaranthis viridis</i>	Introduced	x	x	x
Nyctaginaceae	Alena	<i>Boerhavia diffusa</i>	Indigenous	x	x	
Portulacaceae	'Ihi	<i>Portulaca lutea</i>	Indigenous	x	x	
	Purslane	<i>Portulaca oleracea</i>	Introduced	x	x	x
	'Ihi	<i>Portulaca villosa</i> (formerly <i>Portulaca caumii</i>)	Endemic	x	x	x
Capparaceae	Maiapilo	<i>Capparis sanwichiana</i>	Endemic	x	x	x
Leguminosae	Koa haole	<i>Leuceana leucocephala</i>	Introduced		x	x
Zygophyllaceae	Nohu	<i>Tribulus cistoides</i>	Indigenous	x	x	x
Euphorbiaceae	'Akoko	<i>Chamaesyce celastroides</i> (formerly <i>Euphorbia celastroides</i>)	Endemic	x	x	x
Malvaceae	'Ilima	<i>Sida fallax</i>	Indigenous	x	x	x
	Milo	<i>Thespesia populnea</i>	Polynesian Intro			x
Cactaceae	Pa nini	<i>Opuntia megacantha</i>	Introduced	x	x	
Plumbaginaceae	'Ilieo	<i>Plumbago zeylanica</i>	Indigenous		x	x
Convolvulaceae	Sweet koali 'ai	<i>Ipomoea carica</i>	Indigenous		x	x
	Koali 'awania	<i>Ipomoea congesta</i>	Indigenous		x	x
	Koali 'awa	<i>Ipomoea indica</i>	Indigenous	x		
Boraginaceae	Nena	<i>Heliotropium curassavicum</i>	Indigenous	x	x	x
Solanaceae	'Ohelo kai	<i>Lycium sandwicense</i>	Indigenous		x	x
	Popolo	<i>Solanum nigrum</i>	Indigenous	x	x	x
Asteraceae	Horseweed	<i>Erigeron canadensis</i>	Introduced		x	x
	Pualele	<i>Sonchus oleraceus</i>	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 land-based 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	<i>Phoebastria nigripes</i>	1 old egg	-	100	-	75	-	75	-	2	4	10
Laysan Albatross	<i>Phoebastria immutabilis</i>	-	1 old egg	150	-	100	-	100	9	33	44	60
Wedge-tailed shearwater	<i>Puffinus pacificus</i>	many burrows	4,100	-	4,000	-	800	-	1,415	980	400	200
Christmas shearwater	<i>Puffinus nativitatis</i>	-	450	-	250	-	100	25	20	60	18	-
Bonin petrel	<i>Pterodroma hypoleuca</i>	1 chick	-	-	-	-	-	-	-	-	-	-
Bulwer's petrel	<i>Bulweria bulwerii</i>	several	100	-	100	-	50	-	100	580	100	-
Red-tailed tropicbird	<i>Phaethon rubricauda</i>	common	950	-	450	60	100	40	276	209	146	15
White-tailed tropicbird	<i>Phaethon lepturus</i>	-	3	1	1	-	1	2	-	-	-	1
Masked booby	<i>Sula dactylatra</i>	common	1,000	300	1,200	125	200	400	236	202	567	350
Brown booby	<i>Sula leucogaster</i>	common	1,700	50	1,000	75	60	200	212	169	397	60
Red-footed booby	<i>Sula sula</i>	uncommon	1,300	100	150	85	200	400	344	222	1,375	1,200
Great frigatebird	<i>Fregata minor</i>	common	950	250	800	400	250	250	134	155	701	650
Pacific golden plover	<i>Pluvialis fulva</i>	several	-	10	14	-	1	2	-	21	-	15
Ruddy turnstone	<i>Arenaria interpres</i>	-	50	5	20	-	4	24	1	7	1	12
Wandering tattler	<i>Heteroscelus incanus</i>	-	-	5	1	-	1	1	-	-	-	-
Gray-backed tern	<i>Sterna lunata</i>	uncommon	2,800	-	250	1,250	50	300	4,110	1,467	35	-
Sooty tern	<i>Sterna fuscata</i>	common	16,800	2,500	1,000	130,000	2,500	50,000	28,850	83,680	27,255	200
Blue-gray noddy	<i>Procelsterna cerulea</i>	small colony	-	-	200	-	-	-	-	-	-	1
Brown noddy	<i>Anous stolidus</i>	most numerous	67,700	-	7,000	7,000	10,000	1,000	10,560	3,950	5,778	-
Black noddy	<i>Anous minutus</i>	-	100	20	100	75	200	-	-	207	6	-
White tern	<i>Gygis alba</i>	uncommon	10	10	200	40	10	-	9	12	9	-
Barn owl	<i>Tyto alba</i>	-	1	3	3	-	1	6	4	2	7	3
Japanese white eye	<i>Zosterops japonicus</i>	-	-	2	3	-	-	-	-	-	3	-
House finch	<i>Carpodacus mexicanus</i>	-	6	15	40	-	20	6	-	1	1	8
Northern cardinal	<i>Cardinalus cardinalis</i>	-	2	-	7	-	-	-	-	-	-	-
Mockingbird	<i>Mimus polyglottos</i>	-	-	-	2	-	-	-	-	-	-	-
Nutmeg mannikin	<i>Lonchura punctulata</i>	-	-	-	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.

2010 SHIP-BASED SURVEYS

Methods

As in 2009, ship-based surveys were conducted for seabirds and marine mammals at Kaula Island in 2010. Marine mammal surveys were also conducted in the waters between Kauai and Niihau, and a seabird species list was compiled for birds observed between Niihau and Kaula Island. Marine mammal surveys were conducted from 26-28 June (one week prior to the beginning of 2010 Rim of the Pacific (RIMPAC) training exercises), and seabird surveys were conducted on 28 June 2010.

Seabird Surveys

On 28 June, seven biologists, including five from the U.S. Navy, one from USFWS, and one from Hawaii DLNR, conducted seabird surveys at Kaula Island from the Motor Vessel *Searcher*. The M/V *Searcher*, a 96 ft (29.3 m) ship capable of sleeping a scientific crew of 8, has an observation deck above the bridge, placing observers approximately 20 ft (6 m) above the surface of the water (Figure 3). Of the biologists conducting the seabird surveys, two from the U.S. Navy and those from USFWS and Hawaii DLNR were seabird biologists, with experience conducting surveys of Pacific seabird species throughout the Hawaiian Archipelago.

The M/V *Searcher* departed Port Allen, Kauai, on the evening of 27 June and anchored for the night off of the island of Niihau. The *Searcher* departed Niihau at first light on 28 June and arrived at Kaula Island at 08:00. A list of all seabird species observed between Niihau and Kaula Island was compiled. For the seabird survey at Kaula, the island was divided into north, northwest, southwest, and east quadrants, with section boundaries defined by the island's terrain (Figure 4). From the shipboard vantage point, the top of the island was difficult to survey. During the surveys, six biologists conducted counts of seabird species from the observation deck above the bridge, with one observer also recording data (Figure 5). One biologist photographed examples of seabirds present on the island and in the air. Observers used 7x50 hand-held binoculars.

During the survey, as with the 2009 ship-based survey, the M/V *Searcher* circumnavigated Kaula Island at approximately 2 to 4 knots, maintaining a distance of approximately 750 ft (228 m) from the coastline. Seabird survey methods used in 2009 were repeated during the 2010 survey, with birds counted on land and in the air. Each observer was assigned one or two species to survey. Because of their relatively high abundance on the island, sooty terns and masked and red-footed boobies were counted by two observers simultaneously. The mean of the counts of the two observers was then calculated for these species. The two white booby species (masked boobies and red-footed boobies) were often difficult to distinguish from the distance of the observation deck, such that these two species were combined during the survey.

Surveys were conducted during two circumnavigations of Kaula Island, with the first survey period occurring from 08:36 to 09:20, and the second survey period taking place from 09:44 to 10:24. For all species, the mean and standard deviation of counts from the first and second

circumnavigations were calculated, and relative abundance was compared to results of surveys from previous years.



Figure 3. Stern view of the M/V *Searcher* showing three decks, including the top covered observation deck or flying bridge.

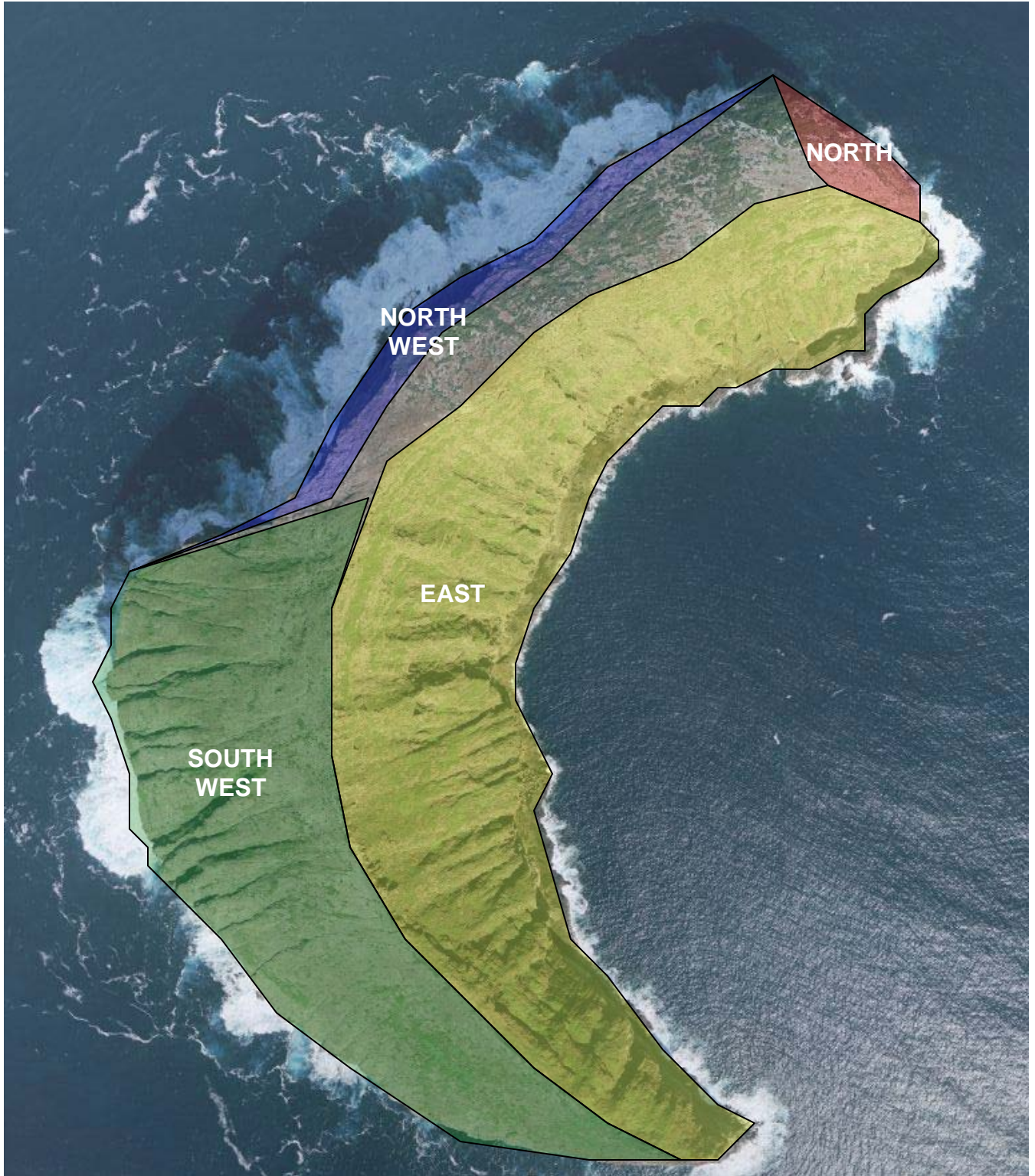


Figure 4. Survey quadrants defined on Kaula Island for the 28 June 2010 seabird surveys.



Figure 5. Biologists conducting seabird surveys at Kaula Island from the M/V *Searcher* 28 June 2010.

Marine Mammal Survey

Marine mammal surveys were conducted from the M/V *Searcher* from 26-28 June 2010. These dates were prior to the RIMPAC major training exercise, and therefore were intended to provide a baseline survey of marine species presence. The waters of the survey area included PMRF areas W186, W187, and W188 (Figure 6). Three biologists from the U.S. Navy, including two marine natural resource management specialists and a wildlife biologist intern, carried out the marine mammal surveys (Table 1). On the morning of 26 June, biologists boarded the M/V *Searcher* at Nawiliwili Harbor, Kauai, and conducted one day of marine mammal surveys in W188 between Kauai and Niihau, eventually rounding the northern end of Niihau. In the evening, the vessel anchored off of the west coast of Niihau.

On the morning of 27 June, the vessel resumed a marine mammal survey beginning by rounding the southern end of Niihau, and biologists surveyed the waters of W186 between Niihau and Kauai. The vessel returned to Kauai, at Port Allen, on the afternoon of 27 June, where the four seabird biologists embarked. The marine mammal survey was then continued throughout daylight hours along a direct transit to again anchor off of the west coast of Niihau. On the morning of 28 June, a marine mammal survey was conducted on transit to Kaula Island. Upon reaching Kaula Island, the vessel circumnavigated the island twice at a distance of approximately 750 ft (228 m) from the coastline, and marine mammal sightings in W187 were recorded concurrently with the Kaula Island seabird survey. After completion of the seabird and marine

mammal surveys at Kaula Island, the dedicated marine mammal survey was again resumed (including areas of W186) as the vessel made its final transit to Port Allen, where all biologists disembarked.

For all marine mammal surveys, data collection protocols and forms generally followed those used during previous vessel-based marine mammal surveys conducted in conjunction with naval exercises in the HRC (Smultea et al. 2007, 2008a, 2008b). The primary goals of this project were to locate and identify marine mammals and sea turtles observed before a training exercise (2010 RIMPAC). Of the three Navy biologists conducting the surveys, one was being trained through a Navy internship program, and the other two biologists were experienced with marine mammal line-transect survey methodology; had experience in field identification of subtropical Pacific marine mammal and sea turtle species; were knowledgeable of marine mammal biology and behavior; and had previous experience conducting marine mammal observations from vessels.

Observations were made from the observation deck of the M/V *Searcher*, where the approximate observer eye-level height was 7.97 m above sea level (Figure 7). Distance to the horizon from this height was ~8 nm. A canopy structure covered the flying bridge to minimize exposure of observers and equipment to sun and rain. Each observer rotated through three stations at 30-minute intervals: port observer, data recorder, and starboard observer. The data recorder also was able to make opportunistic observations. The observers scanned continuously from abeam to the bow. The left and right observers were each equipped with a pair of “Big Eyes” 25 x 50 binoculars, securely mounted on pedestals located on the port and starboard forward corners of the flying bridge. All three biologists were also equipped with 7x hand-held reticled binoculars. The two observers were equipped with digital voice recorders and digital cameras, one with a 200 mm zoom lens, and the other with a 400 mm zoom lens. The survey was conducted in “passing mode,” that is, the vessel was not diverted from the track line in the case of sightings; an MMPA scientific research permit was not required as sightings were not approached. Once a sighting occurred, all three observers on duty were assigned the task of projecting independent estimates of group composition using a minimum, maximum, and best estimate approach. The average of the “best” estimates from the three observer team was then recorded for group size.

Except for the portion of the cruise devoted to the seabird survey at Kaula Island, marine mammal observations occurred during all daylight hours during acceptable survey conditions (Beaufort <7 and no rain or other environmental conditions impeding the ability to sight marine mammals near the vessel). Survey lines on the first day of 26 June transited PMRF warning areas W-186 and W-188, and focused on waters off the west coast of Kauai in a modified sawtooth pattern, and the survey effort continued afterwards on the subsequent transit to the west coast of Niihau to anchor for the night (Figure 8). Survey lines on 27 June transited W-186, and consisted of perpendicular transits across undersea slopes to deeper waters southwest of Niihau and southeast of Kauai, as the vessel made its way to Port Allen for the boarding of the biologists for the seabird survey; the vessel again anchored off the west coast of Niihau for the evening (Figure 9). Survey lines on 28 June were opportunistic and transited W186 and W-187, consisting of the transits to Kaula Island, as well as from Kaula Island on the return to Port Allen for disembarkation (Figure 10).

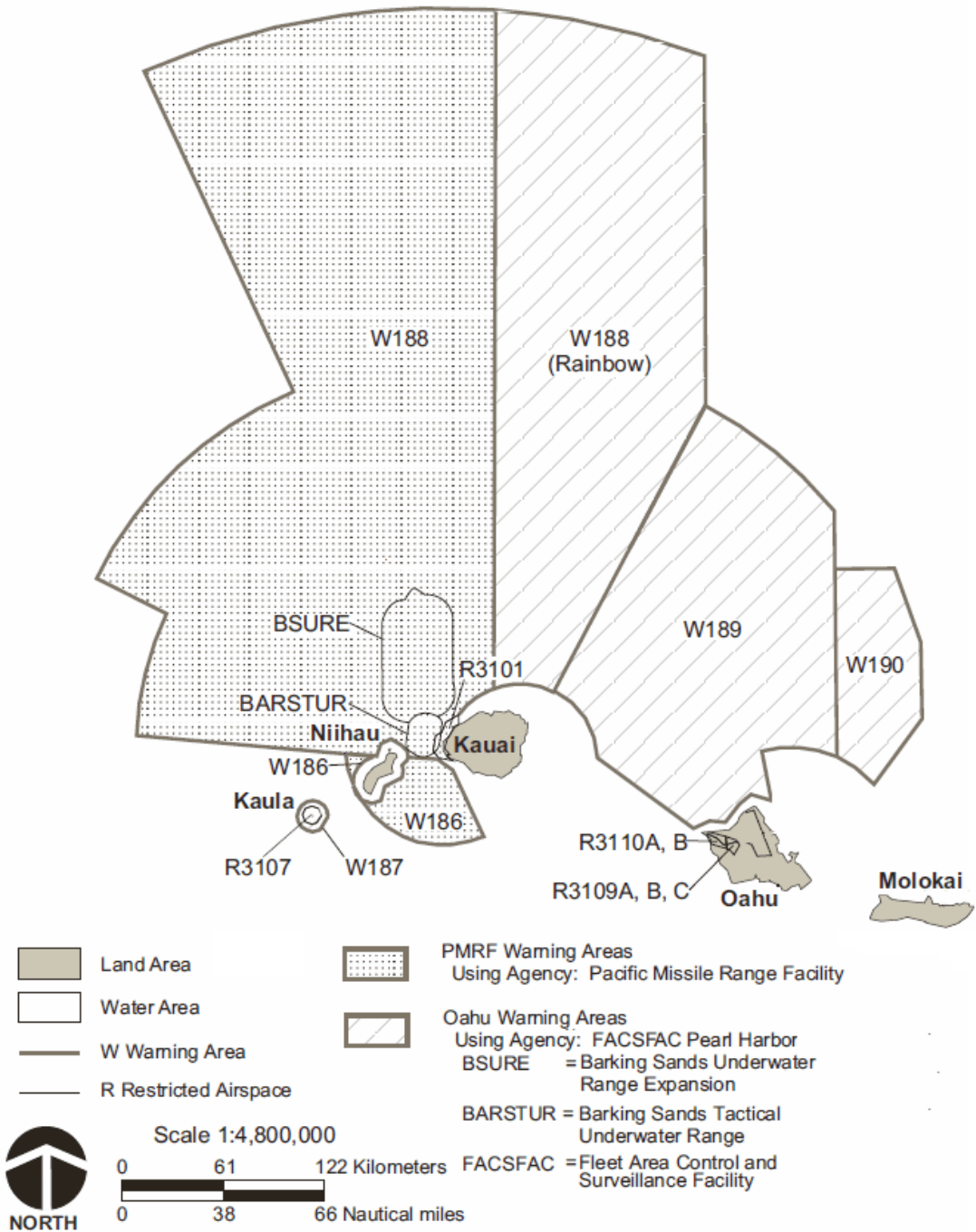


Figure 6. Depiction of PMRF Warning Areas W186, W187, and W188 in relation to the Hawaiian Islands.



Figure 7. Flying bridge and port big-eye binocular. The starboard big eye is beyond the camera view to the right.



Figure 8. Survey track of 26 June. Nawilili Harbor to west coast of Niihau. Map imagery from Google Earth.

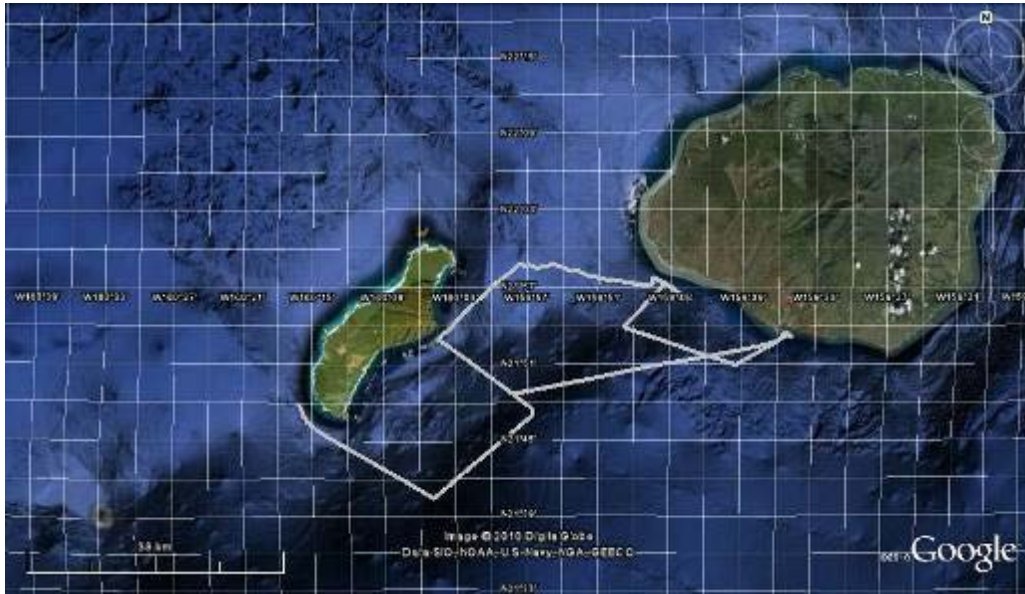


Figure 9. Survey track of 27 June. West coast of Niihau, survey to Port Allen, then transit back to west coast of Niihau. Map imagery from Google Earth.

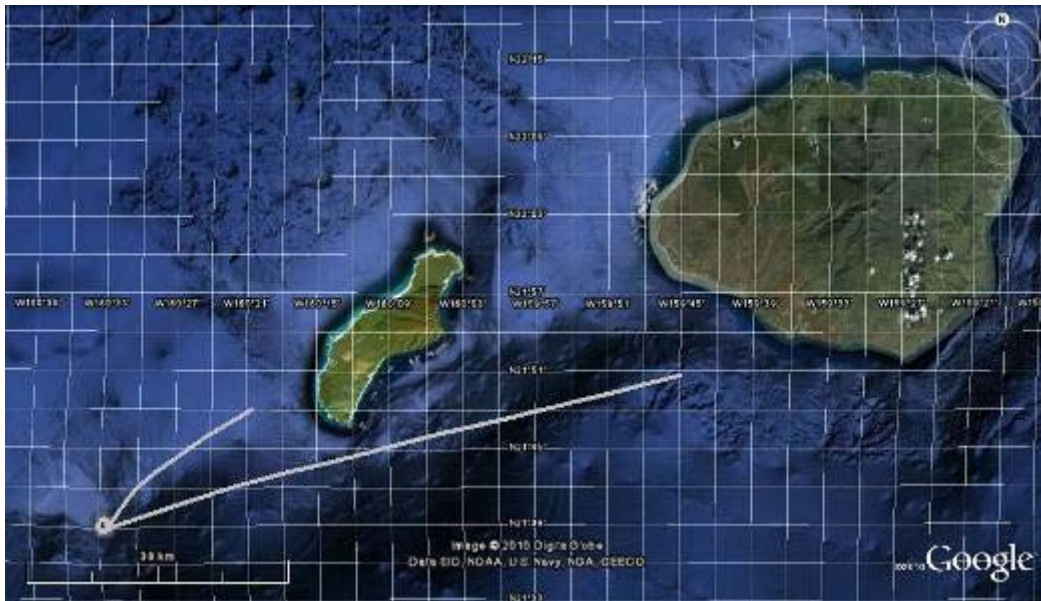


Figure 10. Survey track of 28 June. West coast of Niihau, two circumnavigations of Kaula Island (lower left), and return survey to Port Allen. Map imagery from Google Earth.

Results

Seabirds

Thirteen species of seabirds were observed between Niihau and Kaula Island on the morning of 28 June 2010. These included five Procellariiformes species (wedge-tailed shearwaters, Christmas shearwaters (*Puffinus nativitatis*), Newell's shearwaters (*Puffinus auricularis newelli*), Bulwer's petrels, and band-rumped storm-petrels (*Oceanodroma castro*)); three Pelecaniformes species (red-tailed tropicbirds, red-footed boobies, and great frigatebirds); and five tern species (gray-backed terns, sooty terns, brown noddies, black noddies, and white terns).

During the surveys of Kaula Island, a total of 11 seabird species were observed from the M/V *Searcher* (Table 4). These included one Procellariiformes species (Bulwer's petrel (*Bulweria bulwerii*)), five Pelecaniformes (red-tailed tropicbird (*Phaethon rubricauda*), masked booby, brown booby (*Sula leucogaster*), red-footed booby, and great frigatebird (*Fregata minor*)) and five tern species (gray-backed tern, sooty tern, brown noddy (*Anous stolidus*), white tern, and blue noddy (*Procelsterna cerulea*)) (Figures 11-15). All species observed in 2010 had been recorded during the 1932 -2009 surveys (no new seabird species were observed in 2010). Sooty terns were present in the greatest numbers, followed by masked and red-footed boobies, brown noddies, and great frigatebirds (Table 4 and Figure 18). Sooty terns were observed primarily on the southwestern slope of the island (Figure 13 and 14), masked and red-footed boobies in the stream-carved ravines (Figure 11), and brown noddies and white terns on the cliffs (Figures 15 and 16). Great frigatebirds were seen nesting on the northern slope of the island. Seabirds were not nesting on the southeastern tip (1000 ft) of the island used by the Navy as a munitions training target (Figure 17).

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 land-based seabird surveys. However, relative numbers of individuals of the species seen in 2010 can be compared to survey results from past years. Figure 17, below, indicates the relative abundance of species observed during the June surveys of 1980 and 1993 and the July 2009 ship-based survey, the survey periods most comparable to the June 2010 surveys in terms of species' breeding phenology. During all four survey years, sooty terns were by far the most abundant species. Brown noddies were observed in relatively greater numbers in 1980 and 1993 than in 2009 and 2010, and masked and red-footed boobies were seen in smaller numbers in 1980 and 1993 than in 2009 and 2010. However, these differences are 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 of these three species over time.

In terms of absolute species abundance during the 2010 surveys, 3,382 sooty terns were estimated to be present on Kaula Island (Table 4). This number is lower than the number detected in July 2009 (6,169). During the summer months of June and July, the sooty tern

population on Kaula Island consists of both adult birds and juveniles that are no longer being attended by their parents. Great frigatebirds act as predators of juvenile sooty terns, and it may be that the increase in numbers of frigatebirds on Kaula in 2010 (430, relative to 131 in 2009) may have led to a decrease in the number of sooty tern juveniles on the island. An attempt at separate counts of adult and juvenile sooty terns in future years may help to elucidate reasons for variations in total population sizes between years.

The low numbers of wedge-tailed shearwaters and Bulwer's petrels observed in 2009 and 2010 are likely due to the fact that these burrow- and crevice-nesting species are active nocturnally at the breeding colonies, such that daytime observations of the island from a ship platform are not comparable to surveys conducted on land. Similarly, daytime surveys of Kaula Island result in low detection of brown boobies, which leave the island in the morning to forage and return in the evening to roost. Numbers of brown noddies and white terns detected in 2010 were similar to those seen during the ship-based survey in 2009. One tern species, the blue noddy, was observed in 2010. This species had been seen on Kaula during land-based surveys in 1976 and 1998, and its presence in 2010 may indicate the absence of barn owls on the island during the survey period, as barn owls are known to reduce or temporarily extirpate local blue noddy breeding colonies in Hawaii via predation on adults.

Table 4. Seabird species observed, and the means, standard deviations, and ranges of numbers of individuals counted at Kaula Island during the July 2009 and June 2010 ship-based surveys.

Common name	Scientific name	July 2009				June 2010			
		Mean # observed	Standard deviation	Minimum	Maximum	Mean # observed	Standard deviation	Minimum	Maximum
Wedge-tailed shearwater	<i>Puffinus pacificus</i>	16	8	7	21	0	0	0	0
Bulwer's petrel	<i>Bulweria bulwerii</i>	1	0	1	1	1	1	0	1
Red-tailed tropicbird	<i>Phaethon rubricauda</i>	31	32	8	53	3	1	2	3
Masked /red-footed booby	<i>Sula dactylatra, S. sula</i>	820	286	494	1,026	850	67	775	907
Brown booby	<i>Sula leucogaster</i>	112	132	19	205	1	1	0	1
Great frigatebird	<i>Fregata minor</i>	131	45	71	170	430	28	410	450
Gray-backed tern	<i>Sterna lunata</i>	1	0	1	1	3	3	1	5
Sooty tern	<i>Sterna fuscata</i>	6,169	1,043	5,435	7,363	3,382	663	2,913	3,851
Brown noddy	<i>Anous stolidus</i>	711	656	270	1,465	705	78	649	760
White tern	<i>Gygis alba</i>	10	2	8	11	9	9	2	15
Blue noddy	<i>Procelsterna cerulea</i>	0	0	0	0	1	1	0	2
Totals		8,001	--	6,313	10,315	5,385		4,752	5,995



Figure 11. Adult and nestling red-footed boobies (*Sula sula*) on Kaula Island, 28 June 2010.



Figure 12. Red-tailed tropicbirds (*Phaethon rubricauda*) on Kaula Island, 28 June 2010.



Figure 13. Sooty terns (*Sterna fuscata*) on Kaula Island, 28 June 2010.



Figure 14. Sooty terns (*Sterna fuscata*) on Kaula Island, 28 June 2010.



Figure 15. Brown noddies (*Anous stolidus*) on Kaula Island, 28 June 2010.



Figure 16. White terns (*Gygis alba*) on Kaula Island, 28 June 2010.



Figure 17. Munitions training target area at southeastern end of Kaula Island, 28 June 2010. No birds were observed nesting in this area.

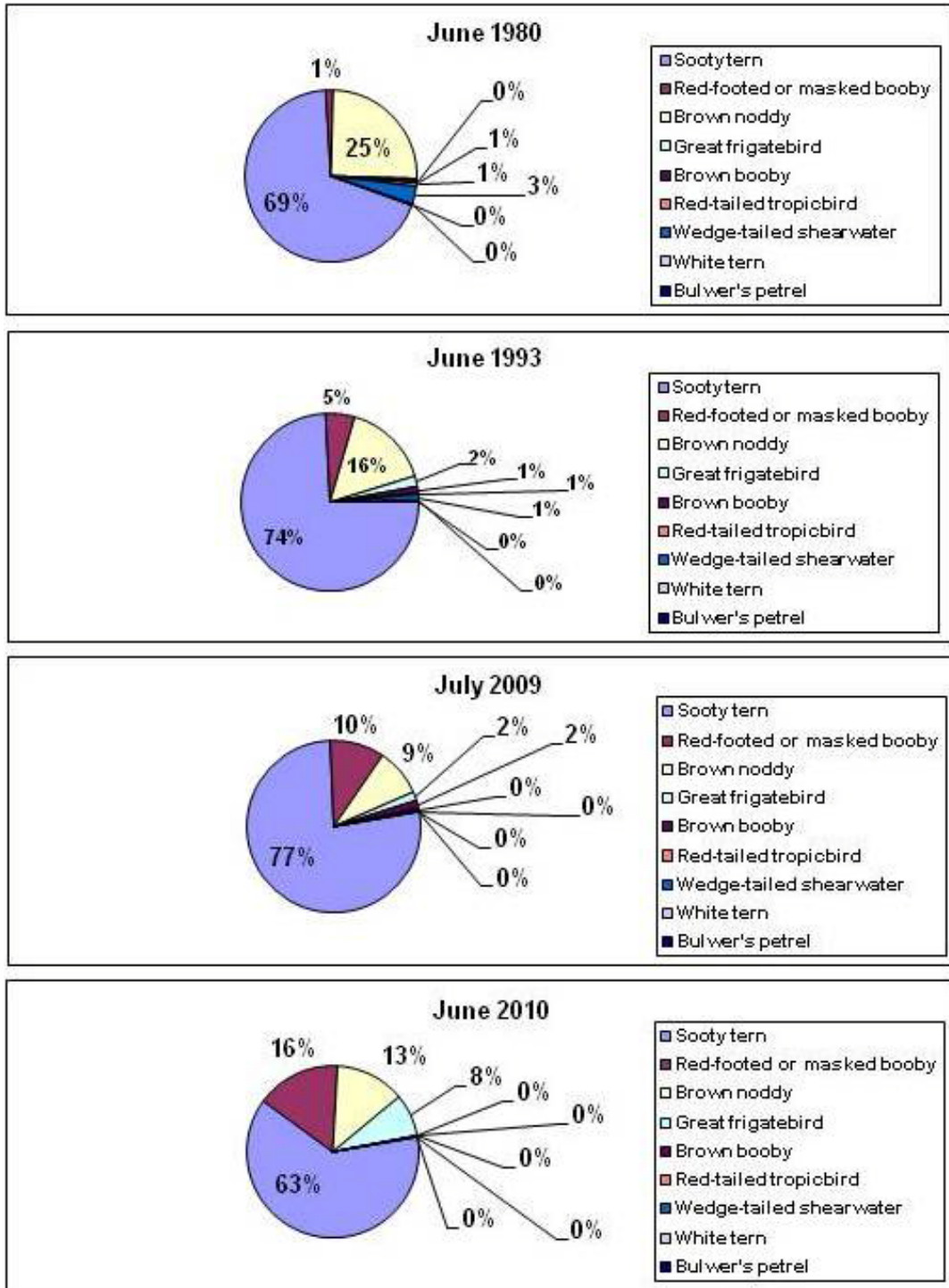


Figure 18. Relative species abundance of seabirds observed during the June 1980, June 1993, July 2009, and June 2010 Kaula Island surveys. The 1980 and 1993 surveys were conducted on land, while the 2009 and 2010 surveys were conducted from a ship platform.

Marine Mammals

A total of seven marine mammal groups (all cetaceans) were sighted during the 26-28 June 2010 observations (Table 5). A total of 290.8 km of transect length was surveyed on-effort over a total of 20.4 hrs of effort for the survey team. Summed across the two observers of the three-biologist survey team, the total observer man-hours performed on-effort was 40.8 hrs (Table 6).

Two of the seven sightings were made during off-effort periods. One of these was a bow-riding group of unidentified dolphins sighted only by the crew of the vessel during an off-effort period due to rain. The other was a group of bow-riding bottlenose dolphins, also initially sighted by the crew before biologists began observational effort for the day; the species identification of this sighting was subsequently confirmed by the biologists.

The remaining five groups were sighted on-effort by the biologist observers during on-effort periods. Four of the cetacean sightings were confirmed to species and consisted of one group of bottlenose dolphins, one group of rough-toothed dolphins (*Steno bredanensis*), one group of spinner dolphins (Fig. 19), and one group of false killer whales (*Pseudorca crassidens*) (Fig. 20). The remaining on-effort sighting was of an unidentified cetacean. No sea turtles were sighted, and no Hawaiian monk seals were observed hauled out on Kaula Island, nor swimming in the water. A calf was sighted within the group of false killer whales, and although the survey was conducted in “passing mode,” photographs of moderate quality were opportunistically obtained of their dorsal fins (Fig. 21). The spinner dolphin group was bow-riding, and several animals within this group were sighted with unidentified white material trailing from the flukes (Fig. 22), pectoral fins, or visible on the melon.

Sightings per unit effort (SPUE) were calculated as the total number of marine mammal sightings divided by the total effort (hours and km). For this survey, the SPUE was equal to 1 sighting per 4.07 hours and 58.16 km (Table 6). All sightings and their locations with reference to survey tracks are depicted in Figure 23.

Table 5. Summary of marine mammal sightings

Species	Group size	Date	Time
	(Min/Max/Best)		
<i>Steno bredanensis</i>	3/3/3	26 June	10:09
Unidentified cetacean	1/-/-	26 June	10:29
Unidentified dolphin*	(15)	26 June	15:53
<i>Tursiops truncatus</i> *	2/2/2	27 June	06:40
<i>Tursiops truncatus</i>	1/2/2	27 June	07:40
<i>Stenella longirostris</i>	7/13/8	28 June	08:33
<i>Pseudorca crassidens</i>	3/3/3	28 June	11:46

* = off-effort sighting made by Searcher crew. Species identification of off-effort sighting on 27 June confirmed by biologists

Table 6. Summary of survey effort

<u>Date</u>	<u>Survey time</u>	<u>Effort time</u>	<u>Transect length</u>
26 June	0853-1249	3 hr 56 min	55.7 km
27 June	0707-1328	6 hr 21 min	90.4 km
27 June	1441-1712	2 hr 31 min	34.0 km
27 June	1747-1831	0 hr 44 min	11.3 km
28 June	0714-0833 ¹	1 hr 19 min	19.3 km
28 June	1030-1601	5 hr 31 min	80.1 km
TOTAL:		20 hr 22 min	290.8 km
		(man-hour total ² : 40 hr 44 min)	
SPUE³:		1 sighting/4.07 hrs	1 sighting/58.16 km

¹ 0833-1030: bird survey consisting of two circumnavigations of Kaula Island

²Total survey effort by man-hours across two observers (from among the three-person Navy biologist survey team structured as two observers and one data recorder)

³Sightings per unit effort



Figure 19. Sighting of *Stenella longirostris* during circumnavigation of Kaula Island ~748 ft (228 m) from shore on 28 June 2010.



Figure 20. Sighting of *Pseudorca crassidens* 28 June 2010. Calf sighted within group.



Figure 21. Dorsal fins from *Pseudorca crassidens* sighting. Left: adult, Center: mother, Right: calf.



Figure 22. Unidentified white material on *Stenella longirostris*.

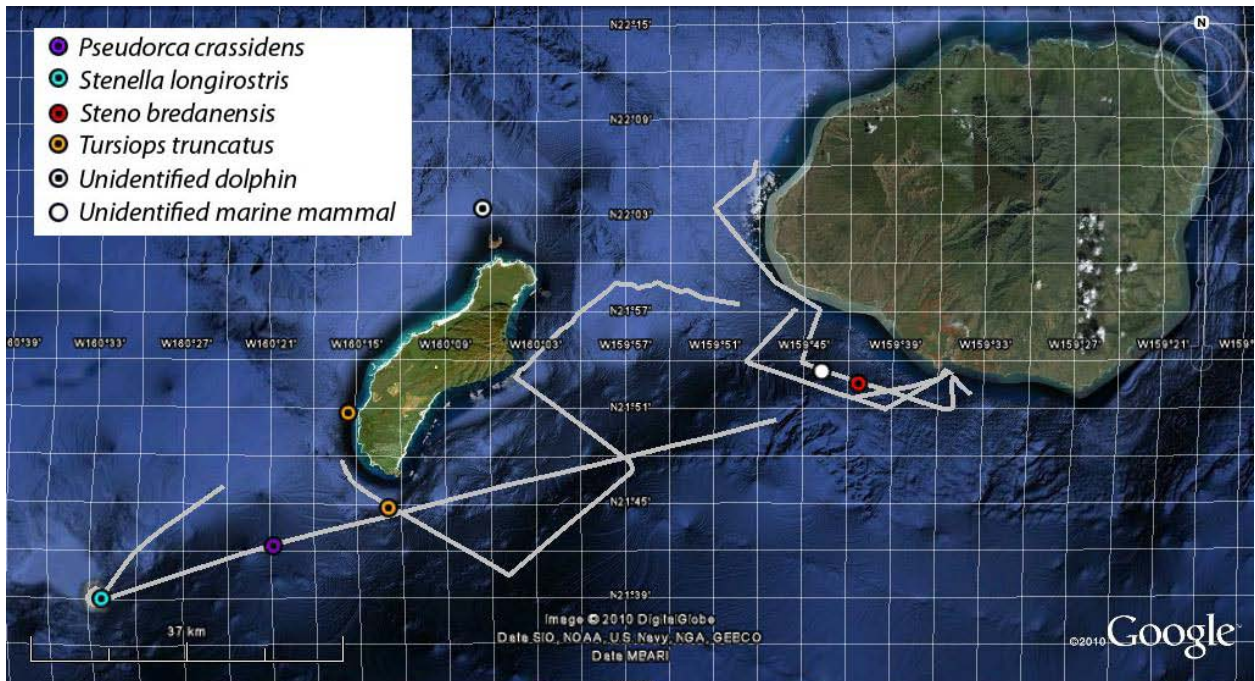


Figure 23. Marine mammal sightings. Sighting locations are superimposed upon on-effort survey tracks. Map imagery from Google Earth.

CONCLUSIONS

Seabirds

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 June or July). 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. A viable seabird monitoring program at Kaula Island in future years will be facilitated by continuing the key elements from the current and previous-year vessel surveys, including: access to a suitable vessel (such as the R/V *White Holly* or M/V *Searcher*), participation in the surveys by biologists from multiple agencies, and a consistent protocol for surveys between years including approaching the island to within 750 ft (228 m) of the coastline. Once sufficient survey data are collected to determine trends, survey frequency may be re-evaluated and discussed with appropriate regulatory agencies. Additionally, if improved technologies (e.g. high resolution aerial imagery) emerge that may provide higher fidelity data, ship board surveys may be replaced with other methods.

Marine Mammals

Few data are available from intensive marine mammal surveys specific to the waters surrounding the Niihau-Kauai project area, and only three surveys have extended to Kaula Island (Mobley et al. 2000, Baird et al. 2003, Pepi et al. 2009). This survey is the second of a series of surveys planned to be conducted in conjunction with Kaula Island seabird surveys, following Pepi et al. (2009). Therefore data resulting from this survey may be considered to be the early portion of an anticipated continuation of a long-term effort in progress to characterize the marine mammal and sea turtle populations in the Kaula Island, as well as Niihau-Kauai, area.

The cooperative combination of marine mammal and sea turtle survey effort with long-term vessel-based seabird surveys of Kaula Island have proven to be a fruitful, cost-effective, and productive research tool. The continued collection of data in these waters are therefore anticipated to be a relatively long-term effort that can provide baseline information regarding seabird, marine mammal, and sea turtle populations in the Navy exercise areas.

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