

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



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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).

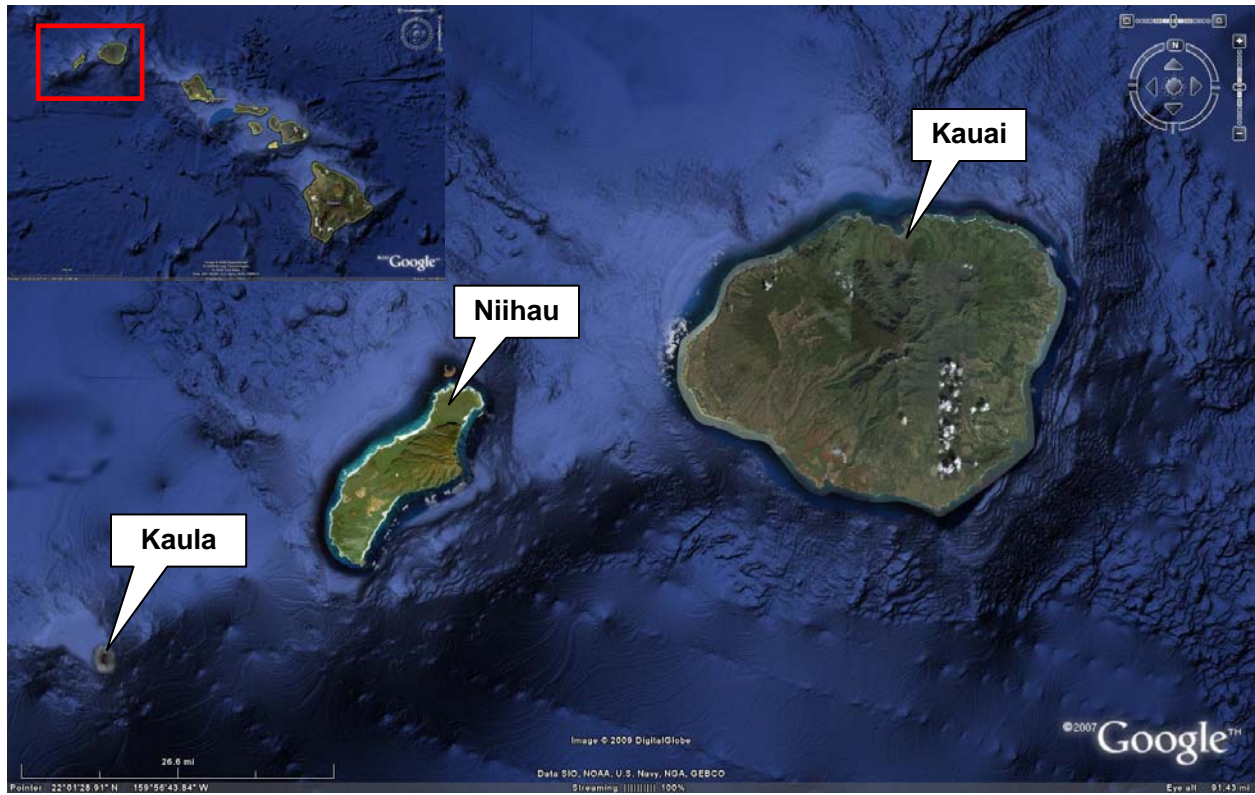


Figure 1. Location of Kaula Island relative to the main Hawaiian Islands (inset) and Kauai and Niihau (imagery from Google Earth).



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).

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 aeri ally 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; *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). 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).

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. Mixer	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	<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> (rcrded 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
Convulvulaceae	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 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.

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:

<u>Personnel:</u>	<u>Position:</u>	<u>Agency:</u>
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.

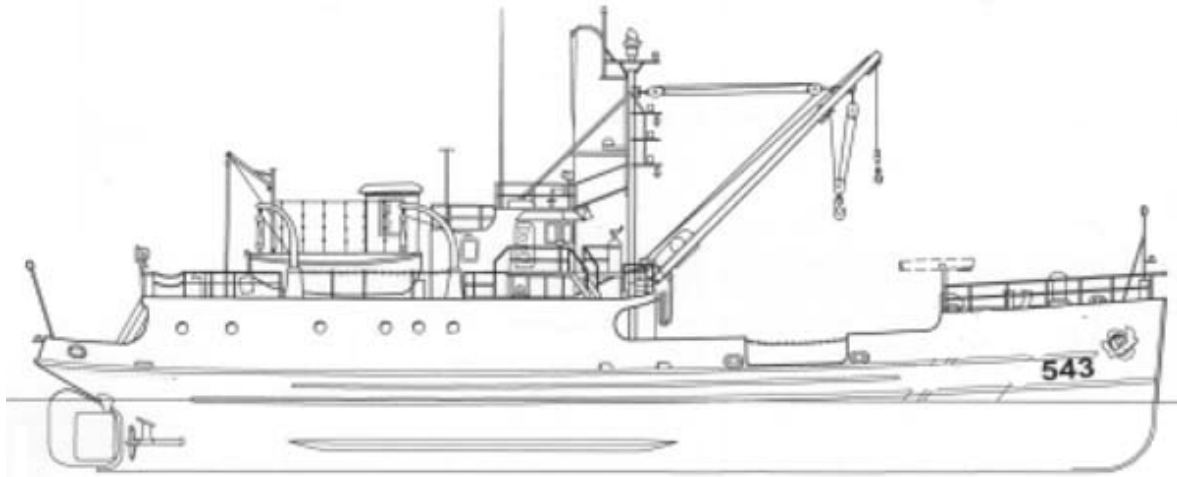


Figure 3. Profile of the R/V *White Holly*, the vessel used to conduct the July 2009 ship-based seabird and marine mammal surveys at Kaula Island.



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

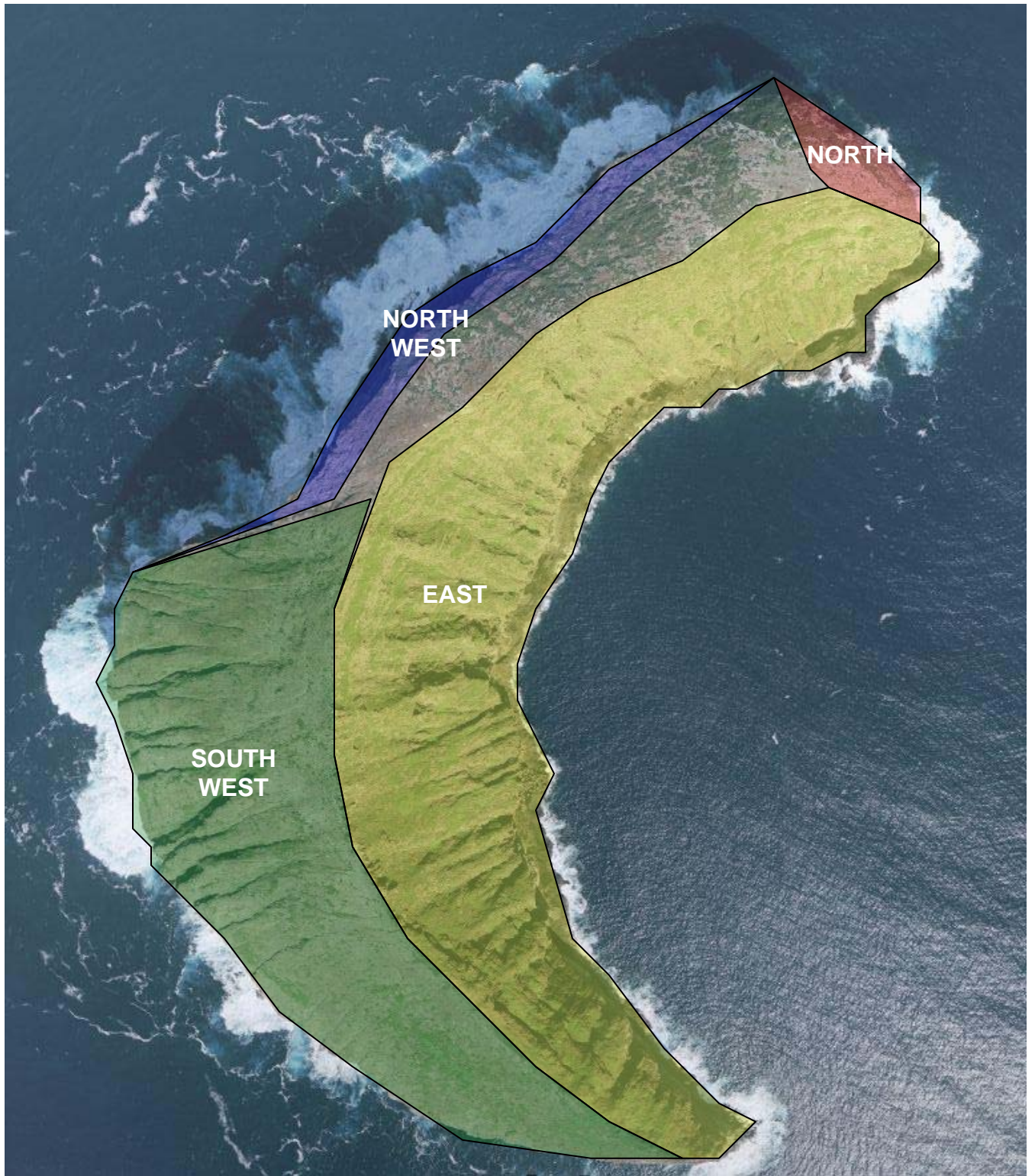


Figure 5. Survey quadrants defined on Kaula Island for the 21-22 July 2009 seabird surveys.

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	<i>Puffinus pacificus</i>	16	8	7	21
Bulwer's petrel	<i>Bulweria bulwerii</i>	1	0	1	1
Red-tailed tropicbird	<i>Phaethon rubricauda</i>	31	32	8	53
Masked booby/red-footed booby	<i>Sula dactylatra, S. sula</i>	820	286	494	1,026
Brown booby	<i>Sula leucogaster</i>	112	132	19	205
Great frigatebird	<i>Fregata minor</i>	131	45	71	170
Gray-backed tern	<i>Sterna lunata</i>	1	0	1	1
Sooty tern	<i>Sterna fuscata</i>	6,169	1,043	5,435	7,363
Brown noddy	<i>Anous stolidus</i>	711	656	270	1,465
White tern	<i>Gygis alba</i>	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.

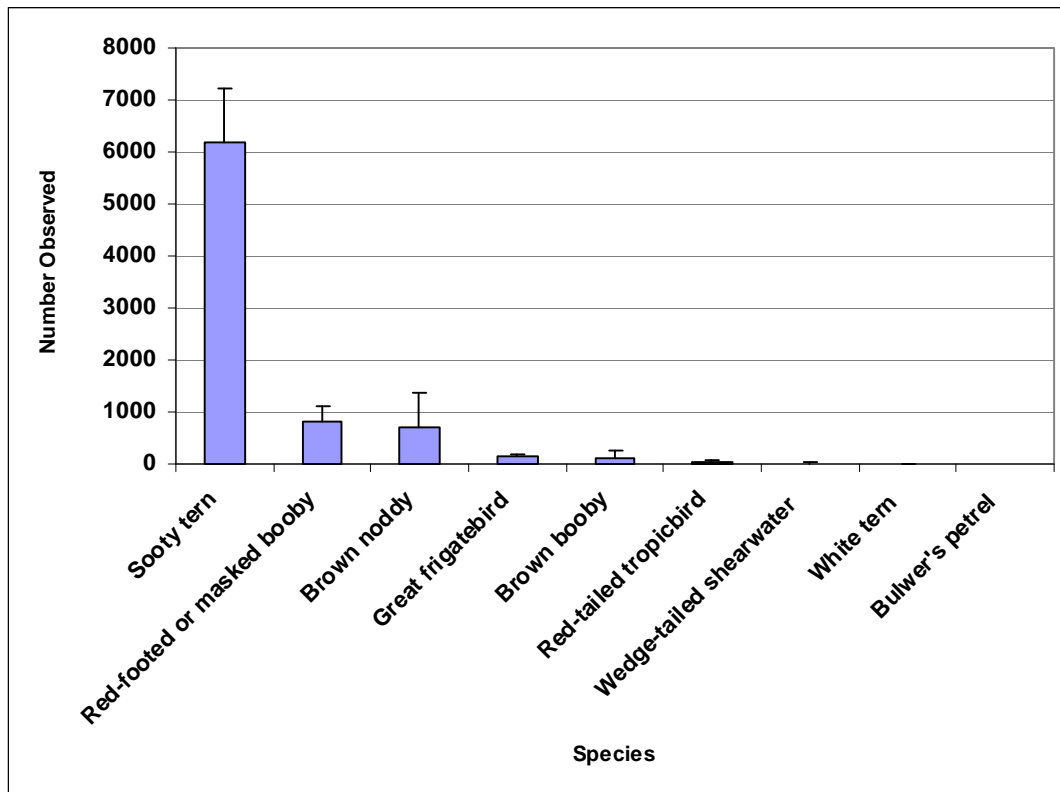


Figure 10. Numbers of individuals of seabird species observed during the 21-22 July 2009 Kaula Island ship-based surveys.



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.

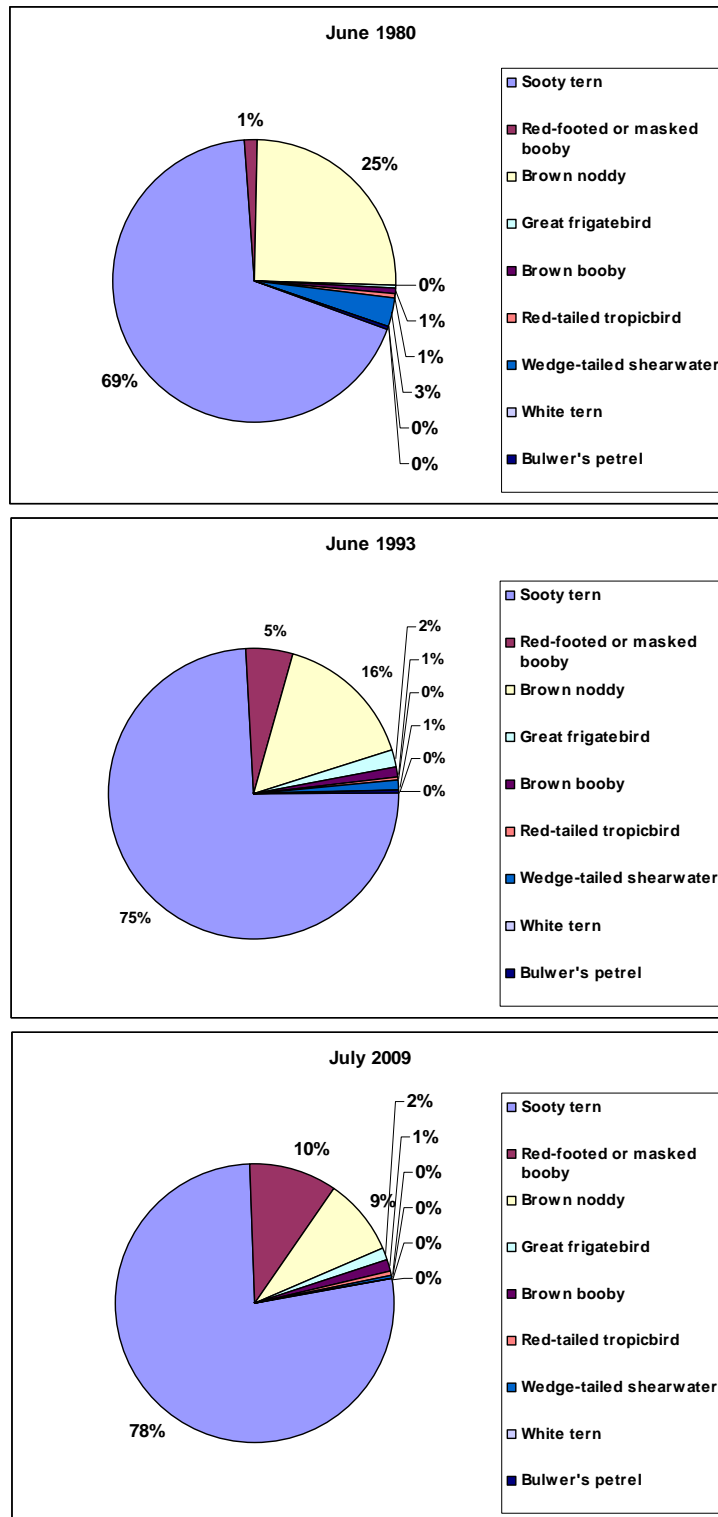


Figure 15. Relative species abundance of seabirds observed during the June 1980, June 1993, and July 2009 Kaula Island surveys. The 1980 and 1993 surveys were conducted on land, while the 2009 survey was conducted from a ship platform.

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	<i>Stenella attenuata</i>	6
Bottlenose dolphin	<i>Tursiops truncatus</i>	12
Spinner dolphins	<i>Stenella longirostris</i>	15-20
Hawaiian monk seal	<i>Monachus schauinslandi</i>	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.

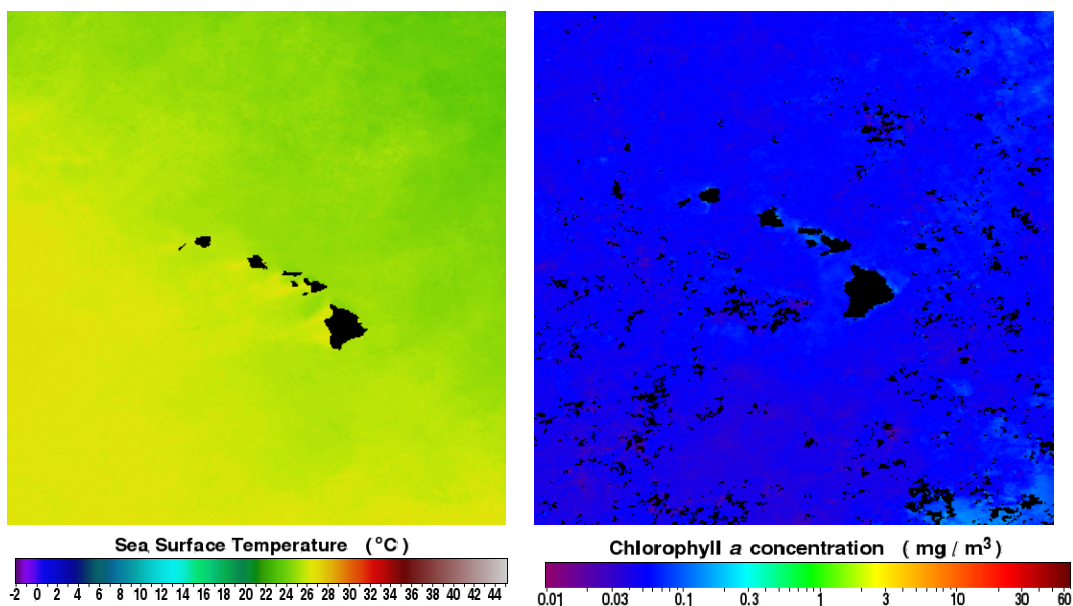


Figure 18. Sea surface temperature and chlorophyll *a* concentration (an index of primary productivity) during the month of July 2009 (figures accessed 27 July 2009 at <http://oceancolor.gsfc.nasa.gov/>).

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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