KAULA ISLAND
AERIAL PHOTOGRAPHY SEABIRD SURVEY
18-21 JANUARY 2009

Photograph: Walker and Associates

Prepared for Commander, Pacific Fleet
December 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).

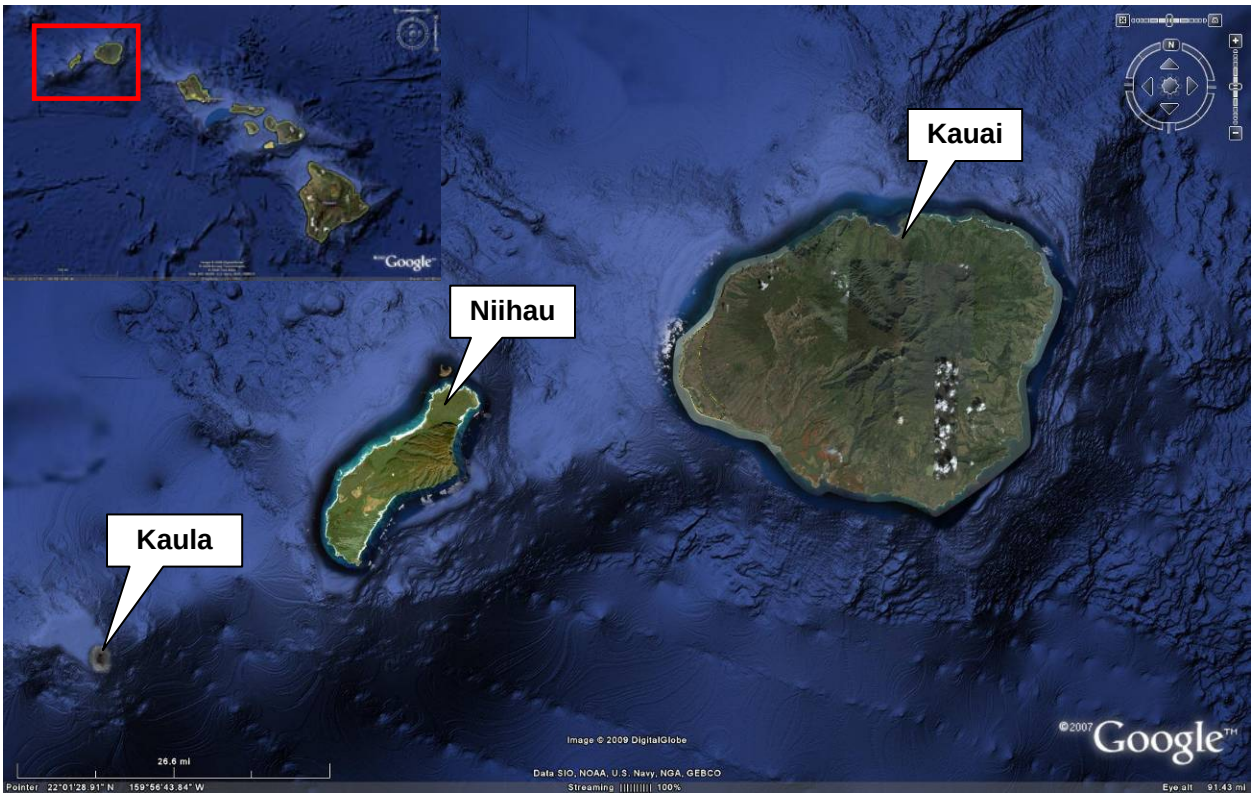

Figure 1. Location of Kaula Island relative to the main Hawaiian Islands (inset) and Kauai and Niihau (imagery from Google Earth).

Figure 2. Aerial imagery of Kaula Island, 18 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). 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

Eleven avian surveys were conducted on Kaula Island between 1932 and 1998. In August 1932, 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 (Table 1; Caum 1936, Palmer 1936). Caum developed the first avian species list for Kaula Island based on his 1932 visit. The next avian survey of the island was conducted in August 1971, with biologists from the U.S. Fish and Wildlife Service (USFWS), State of Hawaii Department of Land and Natural Resources (DLNR), and U.S. Navy visiting Kaula to assess effects of munitions training exercises on nesting birds and document the status of the breeding seabird populations (Table 1; Elmer and Swedberg 1971). Avian surveys were again conducted in 1976, with biologists from USFWS, Hawaii DLNR, and the Navy visiting Kaula in January and September of that year (Table 1; DON 1976a, DON 1976b). 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.

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

Date	Agency	Survey personnel	Title
16-19 Aug 1932	University of Hawaii	Harold S. Palmer	Professor of Geology
	Hawaiian Sugar Planters' Experiment Station	Edward L. Caum	Botanist
17-18 Aug 1971	U.S. Fish and Wildlife Service	Eugene Kridler	Wildlife Administrator
	Hawaii Dept of Land and Natural Resources	Ronald Walker	District Biologist
		David Woodside	Non-Game Biologist
		Thomas Telfer	Wildlife Biologist
		Richard Kaneyama	Aquatic Biologist
		Michael Fujimoto	Aquatic Biologist
		Ralph Daehler	District Forester
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		J.S. Elmer	Operations & Readiness Officer
		H.W. Mixter	Escort
20-21 Jan 1976	U.S. Fish and Wildlife Service	Palmer Sekora	Refuge Manager
	Hawaii Dept of Land and Natural Resources	Ronald Walker	Wildlife Branch Chief
		David Woodside	Non-Game Biologist
		Thomas Telfer	Wildlife Biologist
		Kenji Ego	Fisheries Branch Chief
		Michael Fujimoto	Aquatic Biologist
		Ralph Daehler	District Forester
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		Yoshito Doi	Photographer
		Scott Wood	Escort
14-15 Sep 1976	U.S. Fish and Wildlife Service	Fred Zeillemaker	Biologist
	Hawaii Dept of Land and Natural Resources	Ronald Walker	Wildlife Branch Chief
		David Woodside	Non-Game Biologist
		Thomas Telfer	Wildlife Biologist
		Kenji Ego	Fisheries Branch Chief
		Henry Sakuda	Marine Section Chief
		Ralph Daehler	District Forester
		Robert Hommon	State Archaeologist
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		John Walter	Special Asst for Ecology
		Holden	Asst Operations Officer
		Unknown	Escort
7 Mar 1978	U.S. Fish and Wildlife Service	Eugene Kridler	Wildlife Administrator
		Kimberly Wright	Special Agent
	Hawaii Dept of Land and Natural Resources	Timothy Burr	Wildlife Biologist
	U.S. Navy	Gerald Swedberg	Natural Resources Specialist
		C.C. Gage	Officer-in-Charge
		Phil Hinkle	Investigating Officer
		Becker	Public Affairs Officer
		Thomas Morrison	Legal Counsel
		Myers	Photographer
		Wykoff	Corpsman
21-22 Aug 1978	U.S. Fish and Wildlife Service	John Sincock	Wildlife Biologist
		Darrell Herbst	Botanist
		James Bartee	Special Agent-in-Charge
	Natl Oceanic and Atmospheric Admin	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 and Walker and Associates	Unknown	Pilot
	(civilian contractors for U.S. Navy)	Unknown	Photographer

*1932-1979 information from DON (1980).

AERIAL PHOTOGRAPHY SEABIRD SURVEY 18-21 JANUARY 2009

The avian surveys conducted 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.

Methods

In order to conduct additional seabird surveys on Kaula Island in the absence of direct access to land, in January 2009, the Navy contracted Hawaii Aviation and Walker and Associates to obtain high-resolution aerial digital imagery of Kaula via small airplane. Color and infra-red photographs were taken by Walker and Associates using a Zeiss RMK A 15/23 camera and Zeiss Pleogon A2/4 lens.

Aerial color images were taken of Kaula on 18 January 2009. Flight altitude ranged from 2100 to 6000 ft, providing aerial imagery scales ranging from 1 inch = 350 ft to 1 inch = 1000 ft. Information on the start- and end-times of flight transects, aircraft ground speed, imagery scale, flight line direction, and number of color exposures taken are listed in Table 2 and Appendix 1.

Table 2. Details of aerial color images taken of Kaula Island by Hawaii Aviation on 18 January 2009.

Transect start time	Transect end time	Flight altitude	Ground speed	Imagery scale	Flight line direction	Number of exposures taken
09:41:43 hrs	09:42:27 hrs	3600 ft	175 ft/sec	1 in=600 ft	South to north	5
09:48:00 hrs	NA	3400 ft	NA	1 in=570 ft	(humpback whale photo)	1
09:56:18 hrs	09:56:37 hrs	2100 ft	167 ft/sec	1 in=350 ft	West line: south to north	4
10:00:02 hrs	10:00:26 hrs	2100 ft	180 ft/sec	1 in=350 ft	East line: north to south	5
10:03:09 hrs	10:03:36 hrs	2100 ft	158 ft/sec	1 in=350 ft	Center line: south to north	5
10:11:02 hrs	10:11:44 hrs	3550 ft	173 ft/sec	1 in=590 ft	South to north	5
10:19:48 hrs	10:20:03 hrs	6000 ft	194 ft/sec	1 in=1000 ft	Overall stereo pairs	3

Aerial infrared imagery was taken of Kaula on 21 January 2009. Flight altitude ranged from 2100 to 3600 ft, providing aerial imagery scales ranging from 1 inch = 350 ft to 1 inch = 600 ft. Information on the start- and end-times of flight transects, aircraft ground speed, imagery scale, flight line direction, and number of infra-red exposures taken are listed in Table 3 and Appendix 2.

Table 3. Details of aerial infra-red images taken of Kaula Island by Hawaii Aviation on 21 January 2009.

Transect start time	**Transect end time**	**Flight altitude**	**Ground speed**	**Imagery scale**	**Flight line direction**	**Number of exposures taken**
11:31:08 hrs	11:31:49 hrs	3600 ft	179 ft/sec	1 in=600 ft	South to north	5
11:34:51 hrs	11:35:35 hrs	3600 ft	169 ft/sec	1 in=600 ft	North to south	5
12:07:00 hrs	12:07:36 hrs	3600 ft	194 ft/sec	1 in=600 ft	South to north	5
12:13:17 hrs	12:13:46 hrs	2200 ft	145 ft/sec	1 in=366 ft	Northeast to southwest	5
12:16:10 hrs	12:16:30 hrs	2100 ft	142 ft/sec	1 in=350 ft	Southeast to northwest	4
12:20:52 hrs	12:21:23 hrs	2100 ft	138 ft/sec	1 in=350 ft	Northeast to southwest	5

Results

Due to altitude restrictions and capabilities of the photographic equipment used, resolution of the digital images of Kaula Island was not high enough to positively identify seabird species or accurately estimate seabird population sizes (Figures 2 through 4).

RECOMMENDATIONS FOR FUTURE MONITORING

Although land-based surveys of the seabirds breeding on Kaula would provide the most accurate species lists and population estimates, and would allow for more accurate assessments of the population trends over time, alternative methods such as aerial photography or ship-based seabird surveys are more useful than is a complete absence of surveys at Kaula Island. Aerial photography that would allow for higher-resolution imagery through lower flight altitude (using an unmanned aerial vehicle, for example) or higher-resolution photographic equipment would be ideal. If such surveys are not possible, ship-based seabird surveys provide some level of information on species presence and absence and indices of population size over time. 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. Too, because breeding phenology varies between species, surveys conducted twice per year - once during the winter months and once during the summer months - would be most useful in determining species presence/absence and assessing indices of population changes over time for the seabird species breeding on Kaula Island.

Figure 3. Color aerial photograph of Kaula Island taken 18 January 2009 (Walker and Associates). Photograph has been zoomed and cropped. The white dots visible in the photograph are birds (most likely a booby species), but the resolution of the photograph does not allow for identification of species, and additional zooming results in the photograph becoming pixelated.

Figure 4. Infra-red aerial photograph of Kaula Island taken 21 January 2009 (Walker and Associates).

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Appendix 1. Details of aerial color images taken of Kaula Island by Hawaii Aviation and Walker and Associates on 18 January 2009.

HAWAII AVIATION Color 2444 (times indicated are HST)

18Jan09 start @09:41:43 hrs./Ground Speed 175' per sec./end @09:42:27
(5) expos. H=3,600'/1"=600' **f4/400** Kaula Rock flight line S>N
f377 'External Event 2'
f378 'External Event 3'
f379 'External Event 4'
f380 'External Event 5'
f381 'External Event 6'

start @09:48:00 hrs. (f382 & f383)
(2) expos. H=3,400'/1"=570' **f4/400** Humpback Whale activity W of Kaula Rock approx. 0.7 nm

start @09:56:18 hrs./Ground Speed 167' per sec./end @09:56:37
(4) expos. H=2,100'/1"=350' **f4/400** Kaula Rock (West line; S>N)
f384 'External Event 9'
f385 'External Event 10'
f386 'External Event 11'
f387 'External Event 12'

start @10:00:02 hrs./Ground Speed 180' per sec./end @10:00:26
(5) expos. H=2,100'/1"=350' **f4/400** Kaula Rock (East line; N>S)
f388 'External Event 13'
f389 'External Event 14'
f390 'External Event 15'
f391 'External Event 16'
f392 'External Event 17'

start @10:03:09 hrs./Ground Speed 158' per sec./end @10:03:36
(5) expos. H=2,100'/1"=350' **f4/400** Kaula Rock (Center line; S>N)
f393 'External Event 18'
f394 'External Event 19'
f395 'External Event 20'
f396 'External Event 21'
f397 'External Event 22'

start @10:11:02 hrs./Ground Speed 173' per sec./end @10:11:44
(5) expos. H=3,550'/1"=590' **f5.6/200** Kaula Rock flight line S>N
f398 'External Event 23'
f399 'External Event 24'
f400 'External Event 25'
f401 'External Event 26'
f402 'External Event 27'

start @10:19:48 hrs./Ground Speed 194' per sec./end @10:20:03
(3) expos. H=6,000'/1"=1,000' **f5.6/200** Kaula Rock Overall stereo pairs
f403 'External Event 28'
f404 'External Event 29'
f405 'External Event 30'

Appendix 2. Details of aerial infra-red images taken of Kaula Island by Hawaii Aviation and Walker and Associates on 21 January 2009.

HAWAII AVIATION Color 1443 - HAS Images, Inc. processing on 23Feb09
FedEx Tracking #9124 1018 8468

Roll Loaded 20Jan09 – (4) front blanks fired (f435-f438)

21Jan09 start @10:17:06 hrs./157' per sec./end @10:18:55 (f439 to f448)
(10) expos. H=3,950'/1"=600' **f4/300** Waimea Bay to Kaiwikoele Stream (mauka)
ABGPS External Events: 1 thru 10

start @11:31:08 hrs./Ground Speed 179' per sec./end @11:31:49 (f449 to f453)
(5) expos. H=3,600'/1"=600' **f4/400** Kaula Rock flightline (S>N) *No Shadows on Island*
ABGPS External Events: 11 thru 15

start @11:34:51 hrs./Ground Speed 169' per sec./end @11:35:35 (f454 to f458)
(5) expos. H=3,600'/1"=600' **f4/300** Kaula Rock flightline (N>S) *Shadows*
ABGPS External Events: 16 thru 20

start @12:07:00 hrs./Ground Speed 194' per sec./end 12:07:36 hrs./ (f459 to f463)
(5) expos. H=3,600'/1"=600' **f4/400** Kaula Rock flightline (S>N) *Shadows*
ABGPS External Events: 21 thru 25

start @12:13:17 hrs./Ground Speed 145' per sec./end 12:13:46 hrs./ (f464 to f468)
(5) expos. H=2,200'/1"=366' **f4/400** Kaula Rock flightline (NE>SW) *Shadows*
ABGPS Events: 26 thru 30

start @12:16:10 hrs./Ground Speed 142' per sec./end 12:16:30 hrs./ (f469 to f472)
(4) expos. H=2,100'/1"=350' **f4/400** Kaula Rock flightline (SE>NW) *Shadows*
ABGPS External Events: 31 thru 34

start @12:20:52 hrs./Ground Speed 138' per sec./end 12:21:23 hrs./ (f473 to f477)
(5) expos. H=2,100'/1"=350' **f4/400** Kaula Rock flightline (NE>SW) *Shadows*
ABGPS External Events: 35 thru 39