

The Travel Guide Part 1

by Bob, May 2008



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Hawaiian-Emperor Seamount Chain

The Hawaiian-Emperor seamount chain is composed of the Hawaiian Ridge, consisting of the islands of the Hawaiian chain northwest to Kure Atoll, and the Emperor Seamounts, a vast underwater mountain region of islands and intervening seamounts, atolls, shallows, banks and reefs along a line trending southeast to northwest beneath the northern Pacific Ocean.

The seamount chain, containing over 80 identified undersea volcanoes, stretches over 3,600 miles from the Aleutian Trench in the far northwest Pacific to the Loihi seamount, the youngest volcano in the chain, which lies about 22 miles (35 km) southeast of the Island of Hawaii. The Hawaiian Islands are that portion of the Hawaiian-Emperor seamount chain that projects above sea level.

In 1963, geologist John Tuzo Wilson hypothesized the origins of the Hawaiian-Emperor seamount chain, explaining that they were created by a hotspot of volcanic activity that was essentially stationary as the Pacific tectonic plate drifted in a northwesterly direction, leaving a trail of increasingly eroded volcanic islands and seamounts in its wake. An otherwise inexplicable kink in the chain would mark a shift in the movement of the Pacific plate some 47 million years ago, from a northward to a more northwesterly direction,

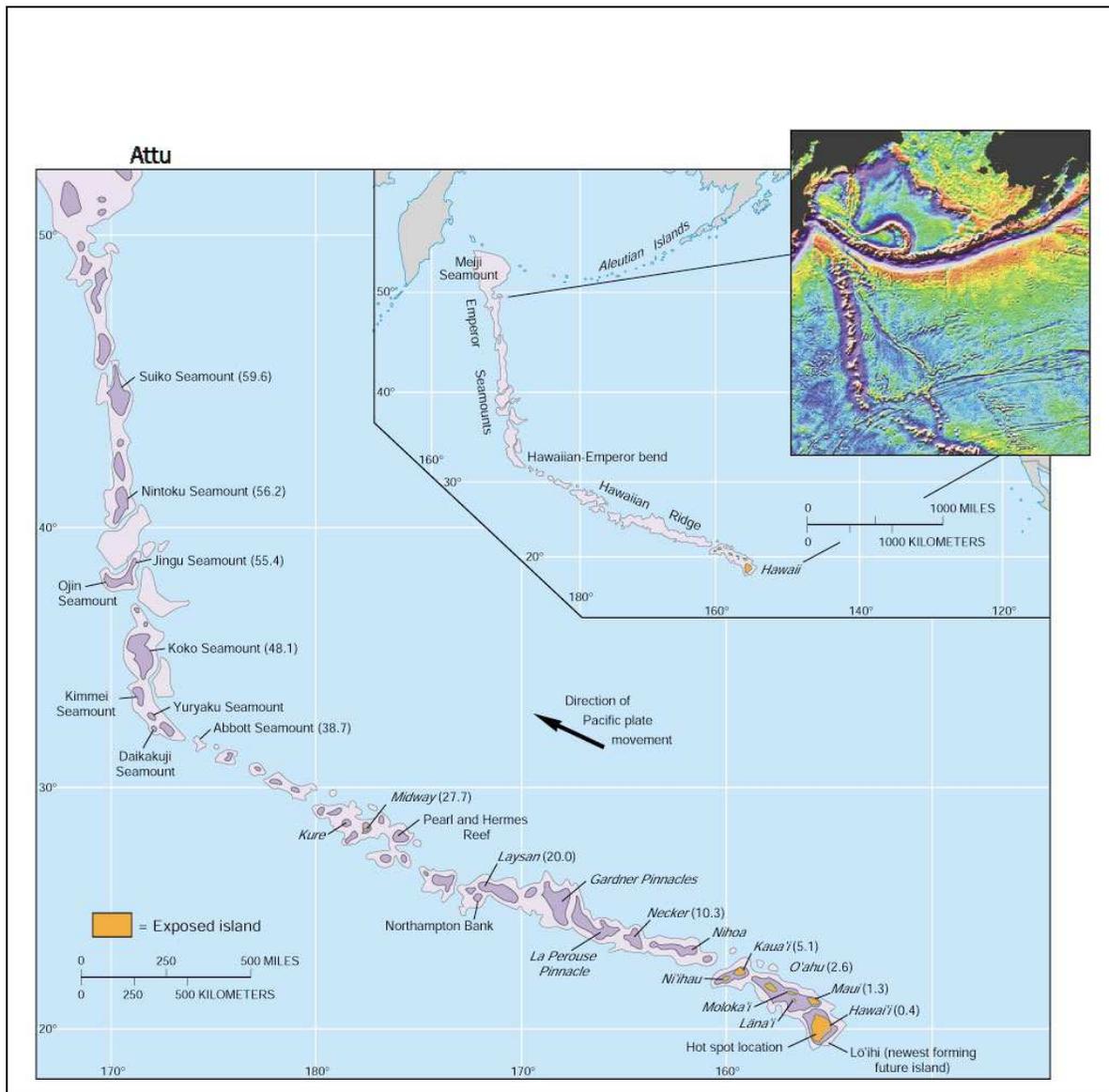
and the kink has been presented in geology texts as an example of how a tectonic plate can shift direction comparatively suddenly. A look at the USGS map on the origin of the Hawaiian Islands clearly shows this "spearpoint".

Recent research shows that the hotspot itself may be moving southward (Tarduno et al., 2003). More recent studies, mentioned below, provide evidence that the change in direction may have occurred over a period of about 8 million years.

Recent analysis of the magnetization orientation of cooling magnetite in ancient lava flows taken at four seamounts shows a more complex relationship than the textbook stationary hotspot offered. If the hotspot had remained above a fixed mantle plume during the past 80 million years, the latitude as determined by the orientation of the magnetite should be constant for each sample and should also signify original cooling at the same latitude as the current Big Island of Hawaii.

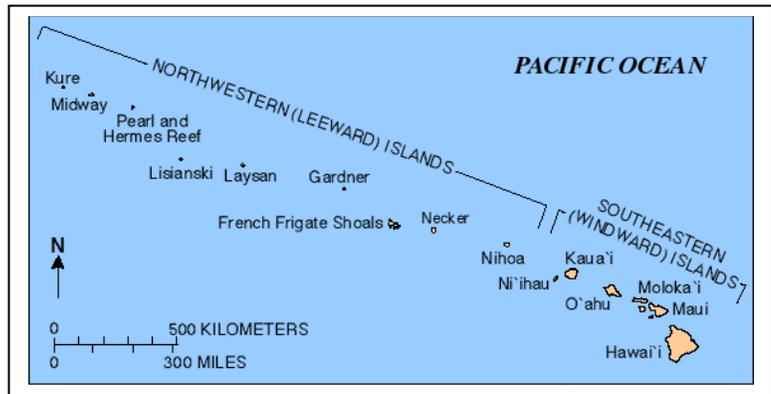
Yet more recently published argon-argon ages of rocks from volcanoes of the southern and central Emperor chain better establish the age at which the bend formed. Sharp and Clague (2006) determined that the bend initiated at about 50 million years ago, and the bending continued until about 42 million years ago. They also concluded that the bend formed from a "traditional" cause—a change in the direction of motion of the Pacific plate.

Hawaiian-Emperor Seamount Chain



Northwest Hawaiian Islands

- 156-acre Nihoa is the youngest of the NWHI, and the tallest, with 900-foot vertical cliffs. It represents the southwestern part of the island's former volcanic cone. Ancient Hawaiians might have stayed here long-term.
- 40-acre Necker Island is hook shaped and 270 feet tall at its summit. Barren of vegetation, it was used by Ancient Hawaiians for religious purposes, but not for long-term habitation.
- French Frigate Shoals is an atoll, the largest region of coral reefs in Hawaii, at 200 square miles. The atoll is home to a dozen or so small islands, Tern Island housing an airport and human habitations.
- Gardner Pinnacles is made up of two small basalt peaks, the last rocky island in Hawaii. While the island itself is tiny, the surrounding reef is expansive and diverse.
- 166-square mile Maro Reef is an extremely fertile reef system that has been described as a "coral garden."
- Laysan is a 913 acre, low, sandy island with a natural lake in its interior, one of only five such lakes in Hawaii. It has arguably the most diverse ecosystem in the NWHI, and hosts about two million seabirds of seventeen species.
- Lisianski Island, only 400 acres, is geologically akin to Laysan, without the lake. Though the island is slightly less biodiverse, the surrounding reef is very fertile.
- Pearl and Hermes Atoll is an atoll very similar to French Frigate Shoals, but with much less dry land. For this reason, it was mostly ignored by guano miners and feather hunters.
- Midway Atoll is the most commonly known of the NWHI, and is also the largest. The Battle of Midway was fought here, and the island remains permanently inhabited.



- Kure Atoll contains the 236-acre Green Island, which used to host a LORAN station and a runway, but these have since been abandoned. In terms of biodiversity, Kure is one of the less impressive of the NWHI.

Geology

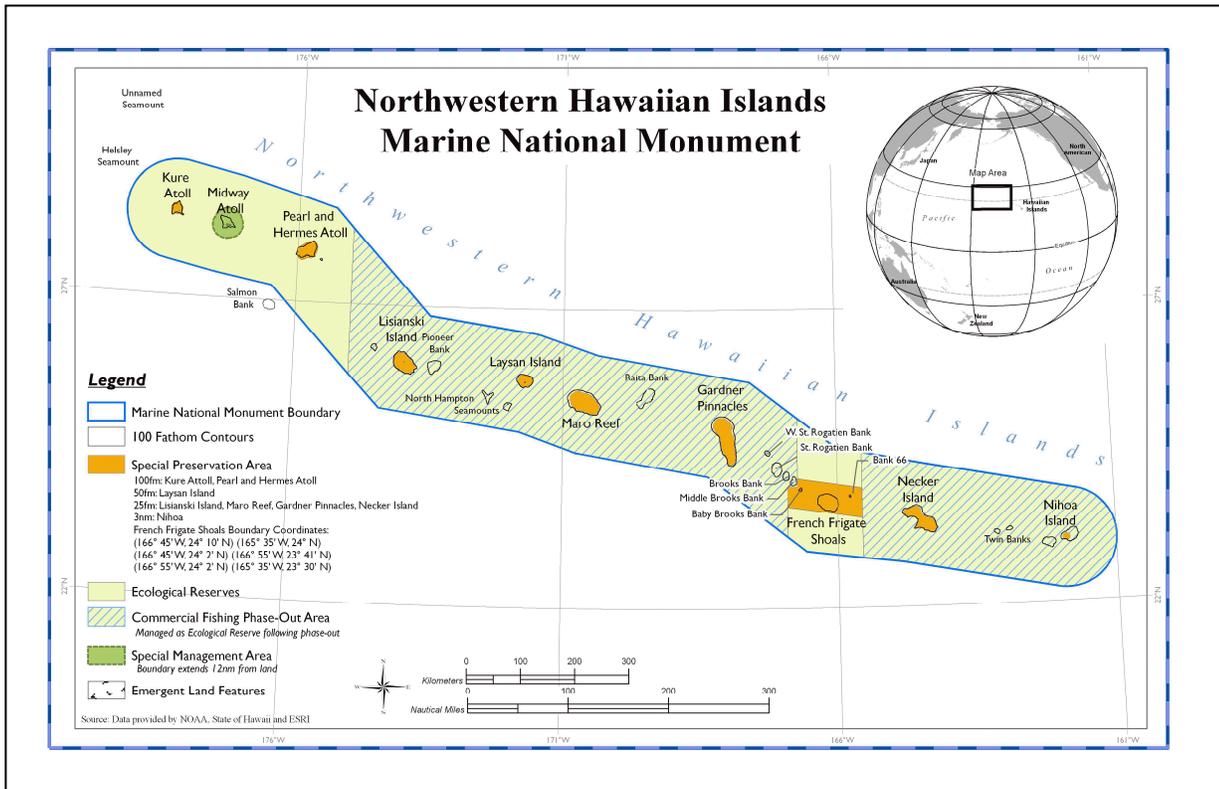
The Northwestern Hawaiian Islands were formed over the same volcanic hotspot that formed the Emperor Seamounts to the north and the Main Hawaiian Islands to the south. As the Pacific Plate moved north and later northwest over the hot spot, volcanic eruptions built up islands in a linear chain. The isolated land masses gradually eroded and subsided, evolving from high islands in the south, much like the Main Islands of Hawaii, to atolls (or seamounts) north of the Darwin Point.

Each of the NWHI are in various stages of erosion. Nihoa, Necker, and Gardner Pinnacles are rocky, basalt islands that have not eroded enough to form an atoll, or lack a substantial coral reef. Laysan and Lisianski are low, sandy islands that have been eroded longer. French Frigate Shoals, Pearl and Hermes, Midway, and Kure are atolls.

North of Darwin Point, the coral reef grows slower than the island's subsidence, and as the Pacific Plate moves northwest, the island becomes a seamount when it crosses this line. Kure Atoll straddles Darwin Point, and will sink beneath the ocean when its coral reef cannot keep up with the rate of subsidence, a destiny that awaits every Hawaiian island .

Biodiversity and endemism

The Hawaiian Islands are about 2,500 miles from North America and 3,800 miles from



Asia, and it is because of this isolation that the Hawaiian Islands have extraordinary numbers of unique species. Only a species that could fly or swim immense distances could reach the archipelago. But whereas Polynesians, and later, Europeans, have largely altered the ecosystem of the Main Hawaiian islands by introducing alien species, the ecosystems of the NWHI remain, for the most part, intact. Of the many species that live here, over 1,700 species of organisms are endemic to the Hawaiian Islands (i.e., they are found nowhere else). For this reason, the region has been dubbed "America's Galapagos."

Though not subject to nearly as much extinction as the main islands, the Leeward Islands have had their share of abuse. From the late 1800s to the early 1900s, fishermen, guano miners, and feather hunters killed most of the birds and sea life living in the NWHI. Rabbits were introduced to Laysan and Lisianski, where they multiplied and devoured most of the vegetation, permanently extinguishing several species. Fortunately, almost all of the damage was reversed, and the islands were restored largely to their pre-exploitation state.

Some of the endemic species of the NWHI include the Nihoa and Laysan Finch, the Laysan Duck (one of the rarest in the world), and the Nihoa fan palm. Other notable species are the Laysan Albatross, the highly endangered Hawaiian Monk Seal, and the Green Sea Turtle.

The only native trapdoor spiders in the Hawaiian archipelago (Nihoa spp.), recently discovered, are found only here. Most endemic species are highly vulnerable to extinction as one major catastrophic event could wipe out all of the vegetation on each small island.

Seventy percent of all coral reefs in the United States are found in the NWHI.

Exploration

It is known that the Ancient Hawaiians ventured from the main islands as far as Mokumanamana (Necker), but they might have gone further to French Frigate Shoals. However, they must have been gone by the 1700s, when Europeans discovered the islands, because the islands were deserted upon discovery. Many agricultural terraces have been found on Nihoa, proving that Hawaiians lived there long-term, but

Mokumanamana, much barer of vegetation, was probably not able to support many people for long. It is thought that the early Hawaiians only came to Mokumanamana for religious purposes.

The first of the Leeward Isles to be discovered by Europeans was Nihoa. James Colnett discovered it in 1786, although historically the credit has gone to William Douglas. Later that year, La Perouse discovered Necker, and named it for Jacques Necker, the French Minister of Finance. La Perouse then went on to discover French Frigate Shoals The last of the NWHI to be discovered was Midway Atoll, which was found by N.C. Middlebrooks in 1859. In 1925, the Tanager Expedition travelled to many of the NWHI. The islands were mapped, new species were discovered and described, and the archeological sites on Nihoa and Necker were found.

The NWHI region has been a significant center of maritime activity historically and of aircraft activity during World War II. As such, a number of ships and aircraft have been wrecked in the area. There are 52 known shipwrecks, 12 of which have been located. There are also 67 known aircraft wrecks in the area, only two of which have been located.

Naming system

Most of the islands have two names; a main one in English and one in Hawaiian. The majority of the Hawaiian names used as alternative to the English ones were created in modern times, in the same style as the ancient Hawaiians might have, had they discovered them. "Nihoa" and "Mokumanamana" are both names that were used by the Ancient Hawaiians, though; "Mokumanamana" being sometimes used in place of "Necker." The rest of the Hawaiian names are hardly used or heard and were created in modern times.

National Monument

Preservation of wildlife was of prime importance in the early 1900's and President Theodore Roosevelt signed an Executive Order on 3 February 1909 setting aside all the Northwestern Hawaiian Islands (NWHI), except Midway, as a preserve and breeding ground for native birds. This preserve, to be known as the Hawaiian Island Reservation,

was to be administered by the Department of Agriculture.

Ever since, the NWHI have been protected by the federal government in one form or another.

On June 15, 2006, President Bush established the Northwestern Hawaiian Islands (NWHI) as the Papahānaumokuākea Hawaii Islands Marine National Monument (PMNM) by Presidential Proclamation 8031, providing permanent protection for the nearly 140,000 square miles of U.S. land and waters, thereby creating the world's largest marine conservation area. It is about the size of California.

The area includes the NWHI Coral Reef Ecosystem Reserve, the Midway Atoll National Wildlife Refuge/Battle of Midway National Memorial, the Hawaiian Islands National Wildlife Refuge, and the State of Hawaii's NWHI Refuge.

The managers of the PMNM are the NOAA, the U.S. Fish and Wildlife Service (FWS), and the State of Hawaii.

Entry to the Monument is limited through a permit system, jointly administered by state of NOAA, NFWS, and the state of Hawaii. Anyone who comes to the islands must follow stringent procedures designed to protect the ecosystem.

The reefs of the Northwest Hawaiian Islands are much more diverse than those found in the Main Hawaiian Islands. Of the more than 7,000 different species that have been recorded in the Hawaiian Islands, more than half are only found in the NWHI.

The small islands in the NWHI make a vital habitat for breeding and nesting for more than 14 million seabirds. Nearly all of the world's population of Laysan Albatross return each year to the NWHI.

Hawaiian monk seals, the second most endangered pinniped in the world. The majority of the population of 1,200 seals rely on the protected isles and reefs of the Northwestern Hawaiian Islands for food and breeding grounds.

Monk Seal population 1200 and declining. To report all seal sightings, e-mail PIFSC.monksealsighting@noaa.gov.

Commercial Fishing

The only commercial fishery occurring in the Monument is the federal bottomfish fishery. This fishery operates according to the management regime specified in the Fishery Management Plan for Bottomfish and Seamount Groundfish Fisheries in the Western Pacific Region. In the NWHI, the bottomfish fishery is a hook and line fishery that targets a range of snappers, jacks, emperors, and groupers that live on the outer reef slopes, seamounts, and banks at depths of approximately 50 to 400 fathoms.

The management regime includes several precautionary measures that minimize potential effects of this fishery. For instance, the bottomfishery participants do not operate in the presence of the monk seals so as to avoid any direct or indirect effects of the fishery on the species. Also, it is known that the vessels operations do not negatively effect habitat. Finally, the annual catch limit in the NWHI is set by regulation at 300,000 lbs of bottomfish and 180,000 lbs of pelagic species. In practice, bottomfish harvest is below catch limits and is thought not to be the contributing factor to the overfishing status of the bottomfish stocks in the archipelago.

The fishery management plan divides the fishery into two zones, the Mau and Ho'omaluu. Four vessels fish the Mau zone, which includes areas east of the 165° longitude, and four vessels fish the Ho'omaluu zone, which includes areas west of the 165° longitude. All vessels offload their catch in Honolulu. A small number of foreign fishing companies use the open seas to the north and south of the EEZ surrounding the NWHI. These companies often fish the open ocean north or south of the EEZ, then transit through the island chain to fish the open ocean on the other side. Foreign fishing vessels in the open ocean also transit the Monument en route to Honolulu.

Eight commercial fishing permits are eligible for use in the Monument. The fishermen

average 2 to 10 trips per year per vessel, with duration ranging from 3 to 22 days per trip. For the most part, these vessels bottomfish around the atolls and banks at the 100-fathom depth, and troll in deep water and across banks as they transit between islands. Crew size ranges from one to four people. The proclamation allows this fishery to continue operating until June 15, 2011, at which time the commercial fishery will cease altogether in the Monument.

Cruise Ships

A small number of cruise ships have started visiting Sand Island in the Midway Atoll National Wildlife Refuge. The *Seven Seas Voyager* visited Midway once, and the *Pacific Princess* visited twice in 2004. In 2005, 2006, and 2007, one cruise ship visited the atoll each year.

Due to their size and the narrow width of the entrance channel at Midway, as well as port security requirements, cruise ships offload passengers 3 to 4 miles outside the lagoon and transport them ashore in small boats. Cruise ship passengers participate in a guided tour of the historical section of Sand Island lead by FWS staff or volunteers. Typically, a cruise ship visit begins in mid-morning, and all passengers have returned to the ship by 4:00 pm. The ship departs the SMA before sunset.

Worldwide, cruise ships constitute a large and growing industry, and like other ships, they present a potential environmental threat to the Monument. Large cruise ships can carry thousands of passengers and crew, producing hundreds of thousands of gallons of wastewater and tons of garbage each day. Monument regulations and permit requirements (which are more restrictive than other open ocean sites) appear to have discouraged cruise ship visits, and none are scheduled for 2008.

Landfills

"No Dig" areas are Land Use Controls remaining from the closure of the Navy base. These areas had soil contamination removed to a depth of 4 feet and backfilled with clean soil. The remaining control is that no digging

may occur below 4 feet, or the Service assumes all responsibility.

Additionally, Midway has several landfills left behind by the Navy. Some of these landfills were created during base closure for the disposal of construction rubble and asbestos.

Other landfills were created during Navy occupancy for disposal of materials associated with operations. Two active landfills at Midway Atoll were investigated, capped, and closed.

There are 'No Dig' areas on both Sand Island and Eastern Island. One area on Sand Island that needs continued monitoring and potentially further remediation is known as the Old Bulky Waste Landfill. This site is an uncharacterized landfill that was created by the disposal of scrap metal, used equipment, and unconsolidated waste off the south shore of Sand Island to create a peninsula approximately 1,200 feet long by 450 feet (average) wide by 9 feet high. It is surrounded on the three seaward sides by an approximately 10-foot-thick band of concrete and stone rip-rap. Wastes known to have been deposited in the landfill are metals (lead, cadmium, chromium, and nickel), gasoline, battery acid, batteries, mercury, lead-based paint, solvents, waste oil, PCBs, dioxins, furans, transmission and brake fluids, vehicles, equipment, tires, and miscellaneous debris.

The landfill was covered in approximately 2 to 2.5 feet of soil in an attempt to contain the waste. The Old Bulky Waste Landfill is eroding, and the soil placed on top is sifting into the debris, causing large holes to open up around the edge and in the center of the landfill. Additionally, burrowing birds are

bringing up buried soil and nesting below the cover.

The USCG Kure Atoll LORAN station landfill, on Green Island, was used to dispose of old electrical components and scrap metal during the USCG's 33-year tenure, which ended in 1993.

The landfill was cleaned out as part of the station closure process. The USCG remediated the landfill on Kure in 1994. The USCG excavated and put into containers soil from the landfill that exhibited a concentration equal to or greater than 25 mg/kg PCB. A total of 36 cubic yards of soil were removed from the landfill. This soil, along with six 95-gallon overpack drums of corroded capacitors, was transported off-island for disposal at the TSCA-permitted U.S. Ecology Facility at Beatty, Nevada.

Scrap metal, cable, non-liquid-containing drums, and the remaining soil in the landfill that contained debris were removed from the landfill and reinterred in a reburial pit. The depth of the reburial pit was set 15 feet bgs, which was 2 feet above the groundwater.

All metal debris and soils with concentrations below 25 mg/kg PCB were placed in the reburial pit, which was then graded to a minimum depth of 5 feet bgs, covered with a nonwoven puncture-resistant geotextile fabric, then covered with clean soil from 5 feet bgs to original grade.

Monument Regulations from the Presidential Declaration

Except as otherwise provided in this proclamation, the Secretaries shall prohibit any person from conducting or causing to be conducted within the monument the following activities:

1. Removing, moving, taking, harvesting, possessing, injuring, disturbing, or damaging; or attempting to remove, move, take, harvest, possess, injure, disturb, or damage any living or nonliving monument resource;
2. Drilling into, dredging, or otherwise altering the submerged lands other than by anchoring a vessel; or constructing, placing, or abandoning any structure, material, or other matter on the submerged lands;
3. Anchoring a vessel;
4. Deserting a vessel aground, at anchor, or adrift;
5. Discharging or depositing any material or other matter into Special Preservation Areas or the Midway Atoll Special Management Area except vessel engine cooling water, weather deck runoff, and vessel engine exhaust;
6. Discharging or depositing any material or other matter into the monument, or discharging or depositing any material or other matter outside of the monument that subsequently enters the monument and injures any resources of the monument, except fish parts (i.e., chumming material or bait) used in and during authorized fishing operations, or discharges incidental to vessel use such as deck wash, approved marine sanitation device effluent, cooling water, and engine exhaust;
7. Touching coral, living or dead;
8. Possessing fishing gear except when stowed and not available for immediate use during passage without interruption through the monument;
9. Swimming, snorkeling, or closed or open circuit SCUBA diving within any Special Preservation Area or the Midway Atoll Special Management Area; and
10. Attracting any living monument resources.

Emergencies and Law Enforcement Activities

The prohibitions required by this proclamation shall not apply to activities necessary to respond to emergencies threatening life, property, or the environment, or to activities necessary for law enforcement purposes.

Threatened and Endangered Species of the Northwestern Hawaiian Islands

Species protected under the Endangered Species Act and Marine Mammal Protection Act

Land Plants		
Loulu/fan palm	<i>Pritchardia remota</i>	Resident
Kamanomano	<i>Cenchrus agrimoniodes</i>	Resident
Ohai	<i>Sesbania tomentosa</i>	Resident
	<i>Amaranthus brownii</i>	Resident
	<i>Mariscus pennatiformis</i>	Resident
	<i>Schiedea verticillata</i>	Resident
Land Birds		
Laysan duck	<i>Anas laysanensis</i>	Resident
Laysan finch	<i>Telespyza cantans</i>	Resident
Nihoa finch	<i>T. ultima</i>	Resident
Nihoa millerbird	<i>Acrocephalus familiaris kingi</i>	Resident
Seabirds		
Short-tailed albatross	<i>Phoebastria albatrus</i>	Rare
Sea Turtles		
Olive Ridley	<i>Lepidochelys olivacea</i>	Occasional
Leatherback	<i>Dermochelys coriacea</i>	Occasional
Loggerhead	<i>Caretta caretta</i>	Occasional
Hawksbill	<i>Eretmochelys imbricata</i>	Rare
Green	<i>Chelonia mydas</i>	Resident
Marine mammals		
Hawaiian monk seal	<i>Monachus schauinslandi</i>	Resident
Humpback whale	<i>Megaptera novaeangliae</i>	Seasonal
Sperm whale	<i>Physeter macrocephalus</i>	Occasional
Blue whale	<i>Balaenoptera musculus</i>	Rare
Fin whale	<i>B. physalus</i>	Rare
Sei whale	<i>B. borealis</i>	Rare
North Pacific right whale	<i>Eubalaena japonica</i>	Rare
Spinner dolphin	<i>Stenella longirostris</i>	Resident
Bottlenose dolphin	<i>Tursiops truncatus</i>	Resident

Plants

Six endangered plant species found in the Hawaiian Islands have populations in the Northwestern Hawaiian Islands, and three of these are endemic species on Nihoa Island.

A. brownii is currently the rarest native plant on Nihoa; its populations are scattered in two valleys, and a few individuals grow at the bases of basaltic cliffs on the steep outer slopes of the two valleys.

The fan palm grows on valley floors and at the bases of basaltic cliffs, areas that are subject to flash floods. Fan Palm is known from approximately 680 plants scattered in four colonies in each of two valleys that are on opposite sides of Nihoa.

S. verticillata typically grows in soil pockets and cracks on coastal cliff faces between 30 and 242 meters. All historically known colonies of *S. verticillata* are known to be extant and have remained relatively stable.

Three additional endangered plants that are found in the main Hawaiian Islands are also found in the Northwestern Hawaiian Islands—*C. agrimonioides* var. *laysensis*, *M. pennatiformis* ssp. *bryannii*, and *S. tomentosa*.

Birds Both the Nihoa finch and the Nihoa millerbird reside year-round on the steep-sided, rocky, and shrub-covered island of Nihoa. Laysan finches are restricted to the low-elevation vegetated area of Laysan Island, although translocated populations have occupied the vegetated areas of Southeast Island and Grass Island at Pearl and Hermes Atoll.

The Nihoa millerbird is the least abundant of the endangered passerines, with an average population of 367 ± 218 . This number was derived from data surveyed most years beginning in 1967. The Laysan and Nihoa finch populations have been surveyed most years since 1966, and their mean populations are $11,217 \pm 3748$ and $3,196 \pm 925$, respectively.

No clear population trends have been observed. Factors limiting Nihoa finch and millerbird populations are primarily weather, variations in food supply, and availability of appropriate nest sites.

The Laysan duck was an additional endangered species found exclusively on Laysan Island until 2004, when 20 ducks were successfully translocated to Midway Atoll. Fossil and subfossil records reveal that Laysan ducks were widespread in the Northwestern Hawaiian Islands and the main Hawaiian Islands prior to the arrival of Polynesians.

The Laysan duck population on Laysan Island generally does not exceed 500 individuals. The population in 2005 was 459, having recovered from a recent low of 100 in early 1994. Vegetated uplands and wetlands are critical to the survival of the Laysan duck. Filling of the hypersaline lake by sand is a current threat since the lake provides important foraging habitat.

The short-tailed albatross is listed as endangered under the Endangered Species Act and is the smallest population of any albatross

species in the North Pacific. Short-tailed albatrosses once ranged throughout most of the North Pacific Ocean and Bering Sea, but were harvested to near extinction at their breeding colonies in Japan. The current worldwide population is approximately 1,700 individuals, and due to habitat management and stringent protection, the population has increased by approximately six percent per year. The primary range of this species is along the coasts, traveling between its breeding colonies in Japan, along Russia, the Aleutian Islands, and down the coast of North America. Land-based sighting records indicate that at least 15 short-tailed albatrosses have visited the NWHI over the past 60 years. Most of these sightings have been at Midway Atoll, where two individuals are present every breeding season.

Sea Turtles There are five listed sea turtles that could occur in the waters of the Monument. The Hawaiian population of the green turtle is listed as threatened under the Endangered Species Act. The leatherback, olive ridley, loggerhead, and hawksbill turtles are listed as endangered under the Endangered Species Act. The green turtle is common in the NWHI. The other turtles are rarely sighted in the Monument.

The NWHI are the primary nesting grounds for the Hawaiian green turtle, while the main Hawaiian Islands are the primary foraging grounds. Although scattered low-level nesting occurs throughout the Hawaiian archipelago, over 90 percent of the nesting is at a few sandy islets within the French Frigate Shoals. Nearshore waters contain adults that migrate to breed at these key sites. Mating occurs in the water, yet both males and females arrive on land to bask.

200 to 700 adult green turtle females nest on FFS annually. Since protection by state law in 1974 and by the Endangered Species Act in 1978, the nesting population of the Hawaiian green turtle has increased dramatically.

Hawaiian Monk Seal The Hawaiian monk seal is listed as endangered under the Environmental Species Act. It is the most endangered pinniped in U.S. waters, and the second most endangered marine mammal.

The Hawaiian monk seal is so named for its solitary nature, preferring to be alone, with the closest social bond between mother and pup.

Little is known about the Hawaiian monk seal population before the 1950s, although the species is thought to never have numbered more than a few thousand. The arrival of the first Polynesians to Hawaii probably began the reduction of the seals' range to the NWHI. Two activities in historic times are believed to have caused major declines in population: a short-lived sealing venture of the 1800s, and military activities on Kure, Midway, and FFS in the second half of the twentieth century.

Population surveys conducted since 1959 indicate that non-pup populations have declined by 60 percent. Today, the total population is estimated at 1,200 individuals. A wide variety of management actions have been implemented to improve the population trends, including removing aggressive males, relocating males to equalize the sex ratio, and rehabilitating undersized pups to improve survival.

Other Marine Mammals The great whales occur throughout the Pacific. Five baleen whales—blue whale, fin whale, humpback whale, sei whale, and Pacific right whale—and one toothed whale, the sperm whale, are listed under the Environmental Species Act. Four of the five baleen whales occur in this area of the north Pacific, but with the exception of the humpback whale, they are rare in Hawaiian waters.

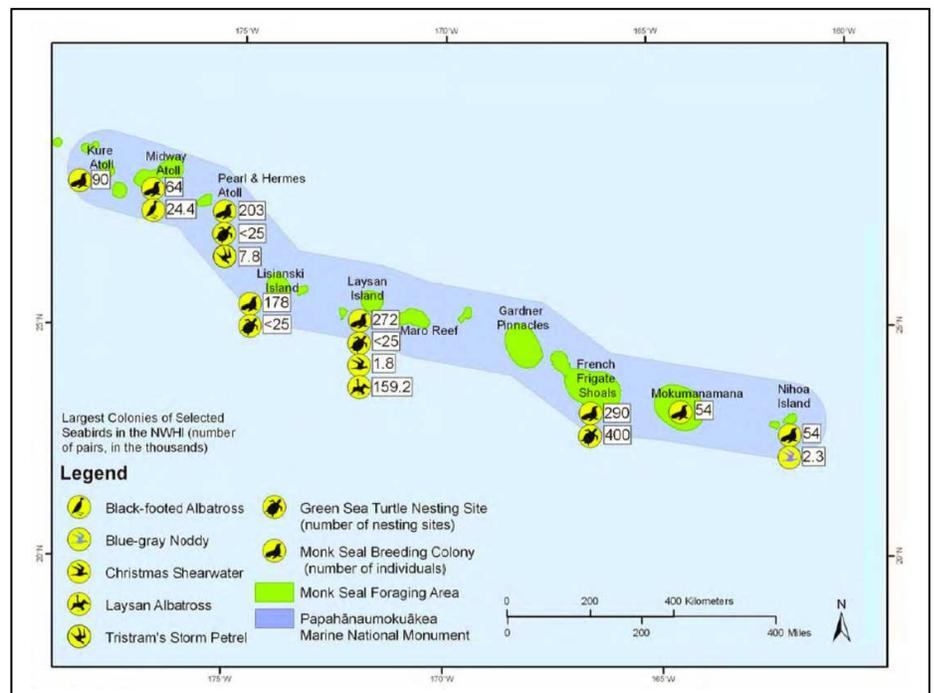
Humpback whales occur consistently in the winter but are found mainly in waters surrounding the seven main Hawaiian Islands.

Sperm whales have been sighted around several of

the NWHI, and their sounds have been recorded throughout the year in Hawaiian waters.

Spinner and bottlenose dolphins are year-round residents of the Hawaiian Islands. They are not considered threatened or endangered under the Endangered Species Act or depleted under the Marine Mammal Protection Act. While both species are widely distributed throughout the world in tropical and warm temperate waters, they are considered separate stocks from other populations due to their isolation in the Hawaiian archipelago. Both species occur from Hawaii Island to Kure Atoll.

There are an estimated 743 bottlenose dolphins and 3,184 spinner dolphins within 25 nm of the main Hawaiian Islands. (Waters beyond 25 nm of the coast or the waters of the NWHI were not surveyed, so these numbers may be small.) The largest pod of spinner dolphins within the Monument occurs at FFS, with approximately 500 individuals. Smaller pods occur at Pearl and Hermes Atoll, Midway Atoll, and Kure Atoll. While spinner dolphins have a capacity for high mobility, it appears that movements between islands are relatively infrequent, with each pod having a high affinity to a specific atoll.



Aubrey Robinson, a grandson, became owner of Niihau after Eliza's death. When he died in 1936 the island was inherited by his children, and today it is managed by two of his own grandsons, Keith and Bruce Robinson. Like previous members of their family, they continue to protect Niihau from disruptive modern influences and, in so doing, help to perpetuate the traditional Hawaiian way of life.

Niihau is the smallest of the inhabited Hawaiian Islands, having an area of 70 square miles. Known as the "Forbidden Isle", Niihau lies 17.5 miles southwest of Kauai, across the Kaulakahi Channel.

Owned by Keith Robinson and Bruce Robinson, the island has been privately owned by the Robinson family since 1864. As a result, Niihau is generally off-limits to all but relatives of the island's owners, U.S. Navy personnel, government officials and invited guests. Tourists are able to visit the island through a limited number of supervised tours, including diving, hiking, and hunting safaris. Niihau is also referred to as the "Mystery Island", the "Distant Isle" and sometimes the "Forgotten Island", as it is frequently omitted on tourist maps. The island is famous as the location for the Niihau Incident, in which a Japanese fighter pilot crashed on the island and terrorized its residents during World War II.

History

Prior to the unification of the Kingdom of Hawaii under Kamehameha I, Niihau was ruled by the aliis. Kahelelani was the first of the Niihau ali'i. His name is now used to refer to the Niihau kahelelani, the puka shell of the wart turbans (*Leptothyra verruca*), used to make Niihau shell jewelry.

Kaeo was a ruler of northern Niihau who unified the entire island after defeating his rival, a chief named Kawaihoa. A stone wall (Papohaku) was built across a quarter of the southern end to mark the boundaries of the two chiefs: Kaeo's land was identified by black stones and Kawaihoa's by white stones. Eventually, a great battle took place, known as Pali Kamakau. Kaeo's two brothers from the island of Maui, Kaiana and his half-brother

Kahekili, the King of Maui, fought the battle for Kaeo and Niihau was united under his rule. Kawaihoa was banished to the south end of the island and Kaeo moved to the middle of the island to govern. Kaeo married the noble Kamakahalei and a future king of Niihau and Kauai named Kaumualii was born in 1790. Kauai and Niihau are said to have carried the "highest blood lines" in the Hawaiian Islands.

By 1795, Kamehameha had managed to unify all of the islands except for Kauai and Niihau: two attempts to conquer those islands had failed, and Kamehameha lost many men: the dead bodies covered the beaches on the eastern shores of Kauai. Finally, in 1810, Kamehameha amassed a great fleet, and Kaumualii, the last native ali, surrendered rather than risk further bloodshed. Independence again became feasible after Kamehameha's death in 1819, but was put down when Kamehameha's widow Kaahumanu kidnapped Kaumualii and forced him to marry her. Thereafter Niihau remained part of a unified Hawaii.

In 1864, Elizabeth Sinclair (later Sinclair-Robinson) purchased Ni'ihau from Kamehameha V for \$10,000 in gold. By around 1875, Ni'ihau's population consisted of about 350 native Hawaiians, with 20,000 sheep grazing the island. This era marked the end of the art of Hawaiian mat weaving made famous by the people of Niihau. The stems of a native sedge called makaloa (*Cyperus laevigatus*) used to grow on the edges of Niihau's three intermittent lakes. These grasses were used to weave the makaloa mats of Niihau, considered the "finest sleeping mats in Polynesia". The mats were valued by ali and foreign visitors alike, but by the end of the 19th century, Hawaiians had stopped weaving makaloa due to changes in population, culture, economics, and the environment.

In 1915, Sinclair's grandson Aubrey Robinson closed the island to most outside visitors; Even relatives of the inhabitants could visit only by special permission.

Niihau played a small role during the attack on Pearl Harbor on December 7, 1941. An off-course Japanese pilot crash landed at Niihau and was captured by locals. With the

assistance of local Japanese residents, the pilot escaped, but was later recaptured and killed. The incident is referred to locally as the "Niihau Incident" or the "Battle of Niihau."

Despite the self-imposed isolation, Niihau has a long-standing relationship with the U.S. military dating from before World War II. There is a small U.S. Navy installation on the island, but no military personnel are permanently stationed there. More recently, however, the U.S. military has used the island for training special operations units, hiring the Niihauans as "enemy" trackers.



A military installation on the north end of Niihau

Many residents of Niihau had been employees of the Niihau Ranch until the Robinson family finally shut down the operation in 1999; it had not been profitable for most of the 20th century. Many of the residents ended up on federal welfare, although these benefits will expire soon. The Robinson family has been considering alternative economic options to keep their residents employed, such as an increased economic role for the U.S. military (an earlier 1999 proposal to establish a missile testing program on the island fell by the wayside), or increased tourism. Either of these would erode the relative isolation that the residents currently enjoy.

Geography

Contrary to popular belief, Niihau is not the geologically oldest of the eight main Hawaiian islands. Kaua'i, which neighbors Niihau in the north-east, is older. This is because Niihau was formed by a secondary vent that formed after the Kauai volcano was erupting. It is estimated that Kauai was formed 5.1 million years ago, while Niihau is estimated to have been formed 4.9 million years ago. Niihau consists of one extinct volcano that had a large landslide to the east.

The island is relatively arid, being situated in the rain shadow of Kauai and lacking the

elevation needed to catch significant amounts of trade wind rainfall; This is similar to the island of Kahoolawe which is in the rain shadow of Maui. And, like Kahoolawe, Niihau is subject to long periods of drought. Historical droughts on Ni'ihau have been recorded several times, one by Captain James Cook's former junior officer, George Vancouver in 1792. Vancouver had been told that the people of Niihau had abandoned the island because of a severe drought and had moved to Kauai to escape famine. It is thought that population movement from Niihau to Kauai during severe drought periods may have been common.

Kaua'i, Ni'ihau and Kaula are the eroded emergent portions of three shield volcanoes that stand in 12000 feet of water. The Kaulakahi channel separating Kaua'i from Ni'ihau is 3600 ft in depth. To the southwest, Ni'ihau is separated from Kaula by water depths of 3600 ft. Ni'ihau is the seventh largest of the eight main Hawaiian Islands with an area of 70 square miles. The center of the island is a high plateau with a maximum elevation of 1281 ft at Pānī'au. The north and east sides of the plateau are steep cliffs, varying between 180 and 300 m in height. The south and western slopes are gradual.



Lava Dikes and Pueo Point, east side of Niihau. Part of Lehua is visible at the upper left.

Twelve "lakes" exist on the coastal plain, the largest being Halāli'i Lake and Halulu Lake. The lakes normally are dry, but fill during periods of heavy rainfall. Some of the small lakes form behind the coastal sand dunes. Rainfall is low (<25 inches annually) on the western coastal plain, but increases with elevation to 30-35 inches annually on the elevated plateau and over 40 inches annually on the upper windward (NE) slopes. There are no perennial streams. Vegetation over most of the island consists of Kiawe and lowland shrubs. The steep slopes along the windward (NE) portion of the island reportedly support lush vegetation that is typical of areas experiencing higher rainfall. A small estuary exists at the mouth of the intermittent Keanauhi Stream on the west shoreline of the island.

Sandy beaches are present along much of the northwest coast. Reefs are found mainly along the western coastline. Two small uninhabited

islands lie off Ni'ihau. Lehua is located 1 km north of Ni'ihau. Kaula is located 34 km to the south-west. There is a pinnacle called "5 fathom pinnacle" approximately 3 miles WNW of Kaula Rock on the Kaula bank.

Economy

On the beaches of the island are found pupu, shells that wash onto the shores of Ni'ihau during the winter months. The sale of shells and shell jewelry provide an additional source of income for the local populace. The shells and jewelry are so popular, that in 2004, Governor Linda Lingle signed a bill to protect Niihau shell leis from counterfeiting.

Other economic activities include fishing, sheep ranching, charcoal production, and honey cultivation. Mullet farming is popular on Niihau, with ponds and lakes stocked with baby mullet which reach upwards of nine to ten pounds (4-4.5 kg) apiece before they are

harvested and sold on the islands of Kauai and Oahu.

Hunting on the island by the natives is forbidden as the Robinson family possesses exclusive hunting rights only to be granted to tourists of the island.

Culture

The population of approximately 160 residents is largely of Hawaiian ancestry. The primary language of the island is Hawaiian. Ni‘ihau is the only community that uses the Hawaiian language with an unbroken tradition since before western contact. This core of mānāleo (native first language speakers) is a valuable cultural resource, especially since there is renewed interest in reviving the Hawaiian language in communities throughout the state. Lei made locally from "Ni‘ihau Shells" are treasured cultural items.

Most residents live in the island's main settlement of Puuwai. They support themselves largely by subsistence agriculture and welfare and generally lead a rural, low-tech life. They speak the Hawaiian language, in part encouraged by terms in the purchase contract which obligated the new owners to help preserve Hawaiian culture and tradition. Niihau is the only Hawaiian island where the Hawaiian language is spoken as a primary language.

The Native Hawaiians are not isolated from the outside world, however: Niihau is subject to regular droughts that occasionally force the population to evacuate to Kauai temporarily, until their fresh water supply is replenished by rainfall. To avoid a long boat ride, the island's owners maintain an Agusta A109 helicopter for use in emergencies and for transporting Navy contractors and residents to and from Kauai. These helicopter trips are supported by its use for limited tours and safaris on the island.

A form of Ipu art is known to have developed solely on the island of Ni‘ihau. In this method, after a design is carved in the skin of a fresh gourd, it is filled with dye which, after several weeks, changes the color of the uncarved portions of the surface where the skin is intact.

Music plays a central role on the island, with a cappella singers making use of only two or three tones and changing rhythms. Ukulele and guitar playing is nearly ubiquitous among the Native Hawaiians of Niihau, and there are three separate styles of slack-key music, with an older style originating from Kohala, Hawaii.

Reef Structure, Habitat Classification

The coastline of Ni‘ihau is approximately 45 miles in length. Reefs of Ni‘ihau are poorly developed due to extreme wave energy from all directions. Reefs of Ni‘ihau probably are damaged occasionally by hurricane waves.

Hurricane Nina (November 1957) brought surf of 35 feet to Kaua‘i's southern coast.

Hurricane Iwa struck Kaua‘i in November 1982 with extensive damage to the reefs.

Hurricane ‘Iniki struck Kaua‘i in September 1992 and again caused extensive reef damage along the south and west shores.

Presumably the reefs of neighboring Ni‘ihau experienced similar destruction. Ni‘ihau does not have any substantial bays that could shelter coral development. The island is of insufficient size to protect portions of its coastline from wave refraction effects.

Extreme northwest swell frequently impacts the north and western shores of Ni‘ihau during the northern hemisphere winter. The WAM Wave Model data (Courtesy of the US Naval Oceanographic Office) as shown above for January 13, 2001 demonstrates the severity of impact. South swell impacts the southern coast during the northern hemisphere summer.

Extreme northwest swell frequently impacts the north and western shores of Ni‘ihau during the northern hemisphere winter. The WAM Wave Model data (Courtesy of the US Naval Oceanographic Office) as shown above for January 13, 2001 demonstrates the severity of impact. South swell impacts the southern coast during the northern hemisphere summer. (Click for larger view)

Few commercial dive boats are of sufficient size to cross the Kaulakahi channel and take dive tours to Ni‘ihau, but only during ideal weather and wave conditions. During 25 knot Trade Wind conditions, the NE swell can exceed 15-25 feet and conditions in the smaller dive charter and fishing charters are very uncomfortable for tourists.

Pinnacles, overhangs, underwater caves and vertical walls exist along the northwest shoreline and biologically rich reef communities are said to occur off the south end of the island. However, little scientific information is available. Where corals are found, they reportedly exist as thin veneers on limestone and basalt outcrops. High-wave energy coral communities dominated by *Pocillopora meandrina* and *Porites lobata* appear to be most common.

Commercial fishing boat crews are more capable of handling rough seas, but generally avoid crossing the Kaulakahi channel during high trade wind or north swell conditions. Consequently, fishing pressure along much of

Aquatic Activity

Private boats, commercial fishermen and dive charters occasionally visit the reefs, but visitors are not allowed to come ashore. Most of the commercial operators confine diving and snorkeling trips to the northern tip of the island.

Spectacular dive spots exist in the area around the NW portion of Ni‘ihau and Lehua Island. Vertical walls plunge to great depths, with clear water and abundant fish life. Pelagic fish such as tuna can be observed swimming close to the vertical walls.

Pinnacles, caves and other features provide interesting places to explore. Black coral is abundant and occurs as shallow as 90-feet off the north end of Ni‘ihau. Some excellent diving locations exist at the SE tip of the island, but strong currents can occur in this area.



Cape Kawaihoa, south end of Niihau

the Ni‘ihau coastline is light compared to most of the main Hawaiian Islands. The inhabitants of Ni‘ihau depend on these reefs for a large part of their subsistence. Kaula island is in use as a military target range, but only inert warheads have been employed in recent years.

Fishing pressure on the reefs is still very low in comparison to other islands. Favored target species such as kūmū, u‘u, and uhu are of large size and high abundance. However, fishing activity on the reefs has been increasing steadily over the past 25 years. The NE shoreline is a popular fishing area when weather and surf permit due to the presence of complex bathymetry and an abundance of the high-value "redfish" that inhabit holes in the reefs.

Status (Degree of Legal Protection)

There is open access to the reefs, but shoreline above high tide mark is under private ownership and trespassing is forbidden. Kaula is occasionally closed to boating during military exercises. The remoteness of this islet combined with rough sea conditions have served to protect the reefs from extensive human use.

Management Concerns (past, present and future)

Proposals for any changes in use of the island have been rejected. Human impact on the reefs at present is probably minimal. The impact of fishing by recreational and commercial fishing/dive boats coming from Kaua‘i has not been determined, but is believed to be low. However, the number of boats visiting Ni‘ihau has increased noticeably over the past 25 years.

Noteworthy Flora and Fauna

Unique marine life includes a growing population of the endangered Hawaiian Monk Seal, *Monachus schauinslandii*. This population has grown in number to about 35 animals over the past 8-10 years. From 10 to 12 pups are born on Ni‘ihau annually. Kaua‘i, in contrast, has a resident population of only about 10 Monk Seals. Monk Seals are curious, and will investigate SCUBA divers. Seals will visit divers, especially along the NW coast and at Lehua Island.

The Knifejaw (*Oplegnathus* spp.) is a fish found in Japan and the western Pacific. Two species of this genus are occasionally seen in the Northwestern Hawaiian Islands but rarely seen in the main Hawaiian Islands. Knifejaws have been observed at Ni‘ihau, although they are quite rare.

Sharks are still numerous off Ni‘ihau, and especially at Kaula. A large aggregation of grey reef sharks forms off of Ki‘i on the NE side of Ni‘ihau every May. Such aggregations probably involve breeding activity. These aggregations are common in the Northwestern Hawaiian Islands (Laysan, Necker, Nihoa), but are not known in the other main Hawaiian Islands.

Divers report the presence of a large shark that is either a white shark or a large tiger shark off Lehua. Abundant and diverse populations of reef fish, sharks, etc. are associated with the "5 fathom pinnacle" located 3 miles WNW of Kaula Rock.

Sightings of an endangered loggerhead turtle have been made in Lehua Channel. Manta rays, and other large fish are still abundant because this area is still only lightly fished. A reef coral that is rare in Hawaii (*Cosinaraea wellsi*), has been reported at a depth of 120 ft. (37 m).



Niihau

Our Private Paradise

Honolulu Star-Bulletin, 1997

Polio didn't strike Niihau. So far, neither has AIDS. Meat is free; so is the housing. The unique Hawaiian environment is mostly intact. Keith Robinson wants to keep it that way. In this essay, he reveals his perspective on the Robinson family's stewardship of Niihau—its own private paradise.

Niihau isn't the backward little stone-age concentration camp that most of the outside world probably thinks it is, but it is private. We bought Niihau fairly, squarely and honestly, and the island is our private property.

The Niihau people who live there are, legally, our guests. Unlike tenants, they pay no rent and there are no formal contractual obligations.

For private reasons of our own, we have for decades given those guests free but revocable privileges that are probably far greater than those allowed by any other landowner in America.

They are given free housing. They also have unlimited supplies of free mutton and pork, and beef is available to them at prices far below what the general public pays.

They also get free transportation on Niihau Ranch trucks and free transportation of their supplies and belongings on the Niihau Ranch barge.

For almost a century, we have reserved some 200 acres of good land for their vegetable gardens, immediately adjacent to Puuwai village. Anyone who wants to grow vegetables there has only to ask; but for about 30 years, no one has gardened there.

They have free hunting, fishing, camping and sightseeing access to every part of a relatively unspoiled private island -- probably the only place in all Hawaii and maybe even the entire United States where this occurs. We have carefully maintained the privacy of their community, and also have not permitted the kind of immigration and settlement that has submerged and destroyed the Hawaiian language and culture everywhere else in Hawaii.

From time to time, we also have established programs and policies designed to protect the health and welfare of those guests. As a direct result of this, Niihau was probably the only island in all Hawaii to escape the great polio epidemic that swept the U.S. in the 1950s.

It was also the only Hawaiian island to be totally vaccinated (for free) during the so-called "swine flu" scare some 10-15 years ago.

I suspect that, at present, it is the only Hawaiian island that has never had a case of AIDS. Our drug problem is also far smaller than those of other communities in Hawaii.

When it comes to business matters, the job opportunities on Niihau are reserved for these same guests. We preferentially hire from among them. We employ about 2-3 times as many people as we actually need.

I estimate that we have lost somewhere between \$8-9 million trying to keep people employed. This figure does not count income loss from giving free housing and free meat to a community of 150-200 people.

On top of everything else, we give these same guests a certain amount of advisory input into our affairs, and often try to accommodate their wishes.

For example, their village and favorite shell-gathering beaches have been reserved for them by wide exclusion zones in our military project planning.

To put it bluntly, I don't know of any other landowner anywhere in the United States who does nearly as much for guests as we do. During the past century, they have received an enormous amount of privileges and benefits from us.

Now, in exchange for those privileges and benefits, we do require certain things.

First and foremost, we require that they shall not do or say anything that adversely affects our constitutional right to enjoy the security and privacy of our property and business affairs.

We have been severely hammered in the past by Hawaii's ruling political machine. That situation eventually became so flagrant that, at one point, one of their bureaucrats openly and casually admitted they were deliberately discriminating against us. We now intensely distrust the political machine, and feel that the less known about our affairs, the less damage will be done to us.

In addition, the Niihau people clearly understand that the less the outside world knows about our property, the less trouble we and they will have with theft, vandalism, trespassing and destructive meddling.

Above all else, discussion with outsiders of national defense research projects being conducted on the island is taboo. The national security is to be strictly respected and upheld.

There have been times when this silence was critical. For example, part of the research that established the Distant Early Warning Line -- the great shield that first protected

Americans and the free world from surprise missile attack -- was done in intense secrecy on Niihau.

Nobody there talked, the project was successfully completed and Russia was prevented from being able to cripple the U.S. with a nuclear "Pearl Harbor."

We still require that same silence today, both to maintain our constitutional right to security and privacy, and to protect the security of any national defense projects we may undertake.

The second thing that we require of Niihau residents is that they maintain a reasonably honest, sober and moral lifestyle as long as they are living on our property. Anybody who does not do so is subject to possible expulsion.

The Robinson family operations include a one-of-a-kind upland endangered species reserve and marine endangered species preservation. Among other things, Niihau is apparently the only island in the world that has been successfully recolonized by monk seals in the present century.

I wouldn't go so far as to say that we have created a conservation empire. But the hard fact remains that a lot of things that have disappeared everywhere else still survive on our land, like endangered species, clean streams, Hawaiian-speaking communities, etc.

For more than half a century, we have managed to successfully balance all of these different and sometimes conflicting parts of our operation, including agricultural business, national defense research, environmental conservation and cultural preservation.

This work hasn't been cheap or easy, and most of the time we were being badly strained, both physically and financially. Since

we are human, we have made our share of mistakes along the way.

We often have been the target of all sorts of criticism from politicians and activists and the news media.

This situation will no doubt regularly continue. But now we are used to it. Political mudslingers, screaming activists and cesspool-diving journalists are a basic part of modern life.

But when everything else is said and done, one hard fact remains: For more than half a century, we have consistently accomplished all sorts of things, especially preservation and conservation work that none of our critics ever did. And we continue to stand squarely on our constitutional rights to do our work, especially national defense work, in the security and privacy of our own property.

In the long run, no situation has ever remained unchanged throughout human history. We will try to maintain the place as long as we reasonably can, but can obviously make no permanent guarantees.

Several years ago, after many decades of relative prosperity in the sugar business, Hawaii's economy finally began to wither under heavy government regulation and taxation.

Today the state's agricultural self-sufficiency has been completely destroyed, and hard times exist everywhere. At the moment, we have very little extra money to subsidize Niihau.

Under these circumstances, it is rather incredible that a single family has somehow managed to maintain an entire community for so long.

Keith Robinson's family owns Niihau and he is also manager of the Kauai Wildlife Reserve. Niihau was the subject of a four-page

special report in the Star-Bulletin July 14. The report was the result of a rare invitation to visit the island extended to writer Catherine Kekoa Enomoto and photographer Ken Ige.

On the Cusp

Honolulu Star-Bulletin, July 14, 1997

Keith Robinson of the Niihau Robinson family recently allowed Star-Bulletin writer Catherine Enomoto and staff photographer Ken Ige to visit the private island where few outsiders are allowed.

On Jan. 23, 1864, King Kamehameha V conveyed Niihau island to brothers Francis Sinclair and James McHutchison Sinclair for \$10,000 in gold. The census of 1860 reported a Niihau population of 647. The new owners hired members of this community and operated the island as a ranch for sheep and cattle.

One-hundred thirty-three years later, the present owner, 86-year-old Helen Robinson, and her sons, Keith Robinson, 56, and Bruce Robinson, 54, are Sinclair descendants who continue a generational legacy of employing, providing for and safeguarding the 200 native Hawaiians remaining on Niihau.

Like their forebears, the Robinsons closely restrict access to Niihau; one needs permission or an invitation to go on island. Niihauans may not speak about anything that might adversely affect the security and privacy of his family's property and business affairs, Keith Robinson explained. Residents must remain silent about national-defense research projects. And, they must have a "reasonably honest, sober and moral lifestyle" as long as they live on Robinson property. Otherwise, they are subject to possible expulsion from the island.

The island remains largely undeveloped; there are dirt roads only, and no telephone or electric lines although each home has a generator. More than 130 years of restricted access has inspired the

nicknames of "Forbidden Island" and "Island of Yesteryear," and mystique veils Niihau.

Aloha personified. We're all one family," says educator 'Ilei Beniamina about Niihauans, who have recurring surnames of Beniamina, Kanahele, Ka'ohelauli'i, Keale, Kelley, Niau, Niheu and Shintani. She is a Niihau native who currently lives on Kauai, where she's on the faculty of Kauai Community College.

Recording artist Moe Keale, whose father was born on Niihau and took him there regularly in his youth, described Niihauans as very giving, mellow, shy and humble. He said they live close to nature and they make do.

He likes to tell a story about his Niihau cousins fixing a truck without reading a manual. They dismantled the engine and laid the parts on the grass, in the order that they removed the pieces. Then, they reassembled the engine -- replacing parts in the reverse order that they took them out.

"My dad said they were never going to fix this, but at 1 o'clock in the morning I heard ehe-he ehe-he ehe-he -- and it started," Keale recalled. "What's neat about it is, they did with what they had. They are amazing, amazing people."

He describes Niihauans with one word, "aloha." He listed adjectives commonly associated with the acronym ALOHA: akahai (gentleness), lokahi (harmony), 'olu'olu (graciousness), ha'aha'a (humility), ahonui (patience).

"That's who they are," he said. "They're the perfect example of what Hawaii is."

Keale described the rhythm of Niihau's lifestyle: Residents rise before the sun and work till sundown in ranch activities of herding cattle, mending fences and "all the cowboy kine stuff." They

fish and "know where to go on that island to get 'opihi and what kinds of fish they like."

There's a supply store where people sign for staples, such as flour and canned goods. And in the evenings, families gather to make Niihau shell lei because "that is their gift they give you."

Time is fluid, Keale recalled; when people say they'll see you Tuesday, "It can be any time between sunup and sundown. There is no such thing as being late on Niihau ... Just like they navigate by the sun and moon."

A ranch barge offers supplies and free transportation without much regularity: every one to six weeks. Niihauans also have access to the ranch's twin-engine, seven-passenger helicopter for medical and other emergencies.

Keale looks at the ambience of Niihau through romantic lenses: "Niihau is what Hawaii was like a hundred years ago -- you're there in a second."

Options, decisions

TODAY, against the backdrop of a lifestyle as relaxed as the lap of gentle waves persists the pressure of economic reality plus a military presence dating to 1941. A small Army garrison had guarded the island after a Japanese pilot from the Pearl Harbor attack had landed and terrorized the community.

Fast forward to the present: The Navy is spending \$2.3 million for an environmental impact statement (EIS) on its proposal for test-missile launch sites on Kauai and Niihau. A first draft of the EIS is expected late this year.

Keith Robinson welcomes the plan, calling it a matter of getting "paid to be allowed to sit around and push buttons in black boxes."

"It's the least environmentally damaging thing I can imagine. It's a lot better than having sheep overgraze."

Also, a 6,000-foot runway could serve as a firebreak, preventing catastrophes such as happened in the 1950s, he said.

He said the ultimate decisions belong to brother Bruce Robinson, the managing agent and co-heir with Keith of Niihau Ranch, which encompasses Niihau island.

"He may occasionally solicit input (from Niihau residents). We do seek out their advice and will try to go along with their provisions. But in the end, we must live with the results, we are the owners, we are the ones being taxed."

What Niihauans themselves think about their future and about the prospect of test missiles is difficult to determine. Their shyness and humility, notwithstanding, Niihauans historically have been forbidden to discuss national-defense research projects that date to the 1958 atomic testing on nearby Johnson Island. Therefore, only two Niihauans overcame an ingrained reluctance to talk with outsiders.

For 'Ilei Beniamina, the Navy missile proposal embodies the dichotomy between the Western and Hawaiian cultures.

" 'A'ole 'ike (The Navy doesn't understand) what's important to us, what is taking our mana (spiritual power) away. They have no idea, they don't feel (the same), they don't see (the same)."

Beniamina drew on a cigarette, looked away into an indistinct future and spoke in a low, earnest voice.

"Don't water down anymore our Niihau culture," she implored. "It's so special. We are the last indigenous people that are

Hawaiian, because we have the language and that's what's left -- the remnants (of the culture). Will this change affect Niihau drastically? That's my biggest emotion."

Beniamina represented Niihau on the recent Hawaiian Sovereignty Elections Council and she acknowledged that the decision-making process among Niihauans is a microcosm of the Hawaiian sovereignty movement. It is also a time-consuming process.

"In our cultural tradition, when we're into decision making, we no'o (think); we share. This is why we take time. There's the kuka (discussion) stage. There's the pilikia (clear the air of troubles) stage. When we're all done, our decision is what becomes public."

Outsiders, she said, misinterpret the people's decisions as those of the island's owners when, in fact, "our people made the decision and gave it to Robinson."

"Actually the ho'oponopono (problem resolution) stage to come together about sovereignty, for eight different islands, takes years. Our kupuna said to let Haunani (Kay Trask) yell and scream. Everything will come out one voice.

"But work we must," she admitted, "and change. But, it doesn't have to be drastic."

On the choices facing her people, 59-year-old Niihauan "Mama" Lina Kanahale said vehemently in Hawaiian: " 'A'ole makemake" -- I don't want (the Navy on the island of Niihau).

" 'A'ole kuleana" -- It's not the property or purview (of the military)."

Hard times

NIIHAU'S near future appears dim but stable. The Robinsons confirmed they don't intend to sell

the island; they've turned down many offers -- one a huge sum by Japan interests.

Keith Robinson said, "We will try to maintain the place as long as we reasonably can, but can obviously make no permanent guarantees. Hard times exist everywhere. At the moment, we have very little extra money to subsidize Niihau."

He said he and his brother divert earnings from the Gay & Robinson Inc. sugar plantation -- of which they are among a number of owners -- to support Niihau. They employ two to three times more Niihau workers than necessary and pay minimum wage. Due to the economic downturn, the Robinsons recently have cut back workers' hours, but are trying to avoid laying off anyone.

"I estimate that up to now we have lost somewhere between \$8 million and \$9 million (over 50 years) trying to keep that community employed. This figure does not count income loss from giving free housing and free meat to a community of 150 to 200 people," he said.

Robinson said he plans to start ecotourism tours in his Kauai Wildlife Reserve to "bleed off some money to help pay for Niihau a little bit."

The family wants to sell 200 to 400 acres in Wainiha, Kauai, to raise capital; however, this land will be a hard sell because it is zoned conservation, Keith Robinson said.

Niihauans themselves might be able to work in NASA solar-plane research that soared to a height record last Monday over Niihau.

Outsiders' views

MEANWHILE, the reaction of outsiders to the prospect of Navy missiles on Niihau ranged from "it's their business" to cries for self-determination and even radical change.

In the first category are Mary Thronas, Kauai County Council chair, and Clayton Hee, chairman of the Board of Trustees of the state Office of Hawaiian Affairs.

Thronas believes that what happens on Niihau is up to the Robinsons and says the County Council is not about to get involved.

"It's a personal matter, it's their island, they own it, and they should really be the ones to decide it," she said.

Hee says, "In the case of the native speakers of Niihau, we're very concerned about them and we care deeply for them. However, we would not presume to speak for them or any other Hawaiian without being asked by them. To do so would be -- I guess the Hawaiian phrase is -- maha'oi, to put our nose where it may not be appreciated.

"There's no doubt, at least in my mind, if Niihau were owned by people other than the Robinsons, that it's very likely that the people and the language and the culture would not exist."

Hee believes that in some ways, "the Hawaiian people owe a debt of gratitude to the Robinsons for the language and the culture that exist today."

He feels the Robinsons are very connected to Niihau.

"Every time I've gone to West Waimea, their jeans were dirty with red dirt. So they're unique in the sense that as large landowners, you do not find them on Bishop Street, but under a truck repairing a

transmission or somewhere in the fields. And that sets them apart in actually participating in the labor of the land."

Others in the Hawaiian community have strident positions concerning Niihau.

Manu Boyd, a kumu hula, OHA cultural specialist and lead singer for Ho'okena said, "The people of Niihau need to decide. Their voices together with the family that owns the island need to be considered, against anything that would desecrate the geophysical, historical, social or cultural significance of the island. Because Niihau is such a personal subject to those who belong there, it's their decision."

Kauai freelance writer Sabra Kauka, who wrote on the Robinsons for a Forbes magazine article on America's top 400 families, said, "The island needs to be sovereign, to be run by the people who live there. They (Niihauans) should decide how the island should be taken care of. They're plenty smart enough to be able to do that. I think it's been a dream of theirs for a long time; they've wanted to 'own' the island.

"It's the people there who traditionally have not wanted development and intrusions in their lifestyles at all. They have been pretty strong about it. It's been the only one of the islands that has managed to pull that off. It's the only one of the inhabited islands that has managed to stave off Western development. It's because the Robinsons have been protective, but it (also) very much comes from the people. They're actually very independent."

'Colonial choke hold'

FOR such reasons, Haunani-Kay Trask, director of the University of Hawaii Center for Hawaiian Studies, opposes any Navy presence on Niihau.

"There should not be any military in Hawaii, period," she said. "But those missiles are a complete assault on the people of Niihau. They are a small, fairly isolated community, and that kind of dangerous, large development is very intrusive. It's going to be very destructive of their environment and the kind of close 'ohana relations they have with each other."

Niihau "should go back to the people who live there," Trask said. "They (Robinsons) should stop being 19th century imperialists and let the people decide their future. They should get on with the 21st century view of indigenous peoples and reparations, and give the island back to them -- free of charge. This is a real case study in tyrannical government. They're sort of like the lord of the manor; if you misbehave, you're off the island.

"Some of the people are purebloods. They have every historical reason to be freed from that colonial choke hold that they're under."

Lilikala Kame'eleihiwa, associate professor at the UH Center for Hawaiian Studies, said, "I think it's terrible that the Navy wants to do test-missile launch sites on Niihau. It's a terrible desecration of that land.

"As for the future of the island, I believe that the state ought to condemn the island to benefit the Niihau people and just turn it over to the Niihau people who live there. Since the Robinsons want to put military things on that land, they have forfeited their right to be konohiki (chief) on that land.

"I really believe that the best thing for the future of Niihau and for the Niihau people themselves is to be able to control the island. (If) they want to exclude outsiders, they want to live peacefully by

themselves, they should be afforded that right."

Hawaiian activist and physician Kekuni Blaisdell is "outraged" about the missile proposal.

Outsiders "keep telling us we need to have a growing economy and this will provide jobs for you, that we need to grow and survive. That's the way they seduce us. It's going on everywhere. So this is more exploitation and domination, which of course is the definition of colonialism, which is a crime by specific international law."

Lawyer Mililani Trask, head of the Hawaiian sovereignty group Ka Lahui Hawaii, said, "I am opposed to, and Ka Lahui already passed a resolution against, militarizing any lands within the archipelago."

She suggested enlisting experts to assess and develop marketing plans for economic ventures with a unique Niihau flavor, such as Niihau shell jewelry, weavings, music and tropical fish.

"You can't have economic development and growth when the position is to remain insular and alienated from others. The bottom line for economic growth is economic commercialism and social intercourse," Trask said.

Kihei Niheu of the Big Island's Pu'ukapu Hawaiian Homestead, whose father was a Niihau native, wants descendants to become involved in the discussion.

"I really want to organize. I think the descendants should get together and start talking about how can we help our homeland. We gotta start communicating with the people who are still there -- economic activity, how to develop a solar industry there, things like that.

"Why is it they don't have solar panels for their families?" Niheu asked. "Why don't they have their own property? Why doesn't the

state step in and condemn some land for our people there, so every kanaka maoli (native Hawaiian) in the island has their own property, to give them a sense of independence? And some of us want to go back; why won't they allow us to go back?" he said.

OHA trustee Haunani Apoliona tempered the debate by suggesting an open discussion of issues with the people of Niihau.

"Maybe people should ask them what they want. Maybe their perspective is framed by what they know living there. There's so many levels in this thing; it's not simply black and white.

"It's that dilemma of balance. The word for the century is balance, because there are so many overlapping, superimposed priorities. Whatever alternative is chosen, I hope there is a balance of lifestyle, of economic situation, of the needs of the people as well as the people who are responsible for that island."

And, while Niihau basks in its blue-gray-green ocean, Keith Robinson frets.

"It's an enormously complex situation," he said. "It's stressful. I lie awake at night wondering if we've done the right thing."

A taste of the forbidden

FROM the 1,200-foot-high shorn-away volcano on its eastern face to the tiniest rare and valuable shells on its western shore, Niihau is a remote island of simple natural beauty.

The isle is about a 15-minute helicopter ride from Port Allen. As the chopper approaches Niihau, the island's profile resembles a mahimahi with a high square forehead pointing right, its body tapering left. A closer view reveals low plains sweeping down on both sides.

The high, central cliff mass is one-half of a volcano crater, whose other half is submerged in the ocean. Visible along the crater face are lava trails and ridges, many worn smooth from wind and wave action.

At the north tip of Niihau reposes Lehua island, a crescent-shaped crater rising out of the sea.

This day the helicopter circles Niihau slowly, scoping out vestiges of a half dozen fishing-hunting cottages of the Robinson family, which owns the island. A few military outposts, radar facilities and other widely scattered building ruins relieve the semi-desert scape. The ubiquitous kiawe twists in long clumps over the ground and rises in tufts like banshees' gray hair standing on end.

The chopper lands near Kawaihoa, a cinder cone on the southern tip of the island. No human-made edifices distract from the colors, textures, diversity and wonder of nature. The serene, austere environment magnifies one's senses to the environment's simple offerings.

Breezes waft over the dry, sunny landscape. Gold and blue Pa'u O Hi'iaka blossoms peek amid the white shale crunching underfoot. The tide pools taste brackish.

Along the coastline are chalky rocks streaked with rust and lava stalagmites formed by the incessant crash of

waves. The sea growls and swooshes against the cliffs. Sea spray teases and tickles one's skin.

A red cardinal and orange birds chatter in the kiawe. Amid the shale lie green tufts of hinahina, or beach heliotrope, and bleached droppings of sheep -- like handfuls of white raisins.

Sea detritus -- the garbage of modern living -- is scattered along Keanahaki Bay in piles chronicled in bygone news photos. The array includes a laundry board, ship's ropes, nets, Styrofoam floats, a Spam can, massive logs and plastics objects in shades of blue, turquoise, yellow, orange, black and brown. Fisher's glass balls hide amid the detritus -- seven are found this day.

Farther down the beach, two slumbering Hawaiian monk seals loll in the surf. They lift their heads occasionally to stretch a neck muscle or check each other's location and two staring humans.

A pile of 'opihi shells documents a recent finders-keepers feast. Beside the bay yawns a 6-by-10-foot cave, once servants quarters when the Robinsons stayed at a hunting lodge - now lying in ruins nearby.

Then, the helicopter heads west for Nonopapa, site of a once-busy sheep-shearing corral. The chopper passes over bleached branches of a dead breadfruit tree, standing in a sinkhole half surrounded by a low stone wall. (Niihauans traditionally planted breadfruit and sweet potatoes in sinkholes, possibly to deflect winds; that is the only example apparent.)

The western shoreline is a series of coves, headlands, reefs, white sand beaches and increasingly shallower bays.

At Nonopapa, warm winds kick up, howling across the 18-mile-long isle that's shaped like the monk seal that inhabits its shores. The minty-lavender fragrance of kokohakakai (vitex, a beach herb) scents the solitary beach streaked with horse-hoof marks, seal burrowings and the tiny, multicolored columbella known

as rare Niihau shells. It's thrilling for a city dweller to crawl on hands and knees and in every scoop, find a dozen wonderful shell gems.

One slakes one's thirst with cool water and sits beneath ironwood pines while contemplating the sweep of azure sky and gray-green ocean. A fishing boat is anchored offshore, its body rolling in the stronger winds.

Next, the chopper flies inland and steers clear, for privacy reasons, of the Niihauans' village at Pu'uwai. A dozen amber buildings are visible in the distance.

The chopper buzzes over muddy brown lakes and reservoirs, some with cattle knee deep in water, and a dozen Arabian horses dancing in a large, fenced corral. A family of four black feral pigs prances along a bay. Further are the remains of a heiau, black rock outcroppings and more kiawe.

At Nanina in the North, seven people -- four adults, a girl about 10 years old and two preschool-aged boys -- lean against a white Humvee. They look like a local family from Nanakuli, Waimanalo or Papakolea. The men wear jeans and cowboy hats and boots. The children are barefoot and wear cotton shorts and shirts. An older woman carries a hand-held radio that looks like a large cell phone.

The Niihau tour is curtailed to medevac Lindsey Kelley to Kauai. He was stapling fence wire and a misfired staple hit near his eye.

The chopper takes on Kelley's family of four. The full cabin is warm and close; the whirl of helicopter propellers is deafening; the smell of diesel fuel is slightly nauseating.

Over the earphones, passengers hear Keith Robinson's comforting words to Kelley: " 'A'ole rub" (Don't rub) and something about "maka'ani'ani" (eyeglasses).

The return trip is anxious because the helicopter's speed drops when the chopper flies into 30 mph winds across the Kaulakahi Channel.

(Kelley later underwent immediate surgery at a Waimea clinic and his vision was saved.)

A passenger glances back at the receding volcano remnant on the isle's eastern face, and a Hawaiian proverb comes to mind about this remote place of enduring language, culture, spirit and beauty:

"Ni'ihau i ke kiku." Niihau leans back firmly.

It means: Niihau people are independent.

Privileged few view by invitation only

The Robinson family owns Niihau, much like you own your house and plot of land. And as you invite people to your home, so the Robinsons control access to the island; you need an invitation to go there.

The state Attorney General's office says, however, that the island's shoreline is public up to the vegetation line, which is defined as the highest reach of waves during normal high tides.

Keith Robinson refutes that assertion. He says his forebears bought Niihau in 1864 under the Hawaiian monarchy and they never relinquished the island's konohiki (chiefly) rights written in the monarchy deeds.

Such private-property rights, granted during the monarchy, extend to submerged lands below the beach.

Moreover, Robinson said Niihau is a federally registered endangered-species habitat for up to 90 Hawaiian monk seals, which are shy of humans and easily scared off.

The Kauai Police Department says it will arrest only trespassers who go above the vegetation line.

If you'd like to get to go on Niihau, you may want to either get permission or take a helicopter tour.

To seek permission, fax a written request to Bruce Robinson, Niihau Ranch, 1-808-338-1463.

If you have enough money, you can get to Niihau on a helicopter tour or a hunting safari.

The Niihau Helicopter Inc. tour flies visitors over the island, with views of rare Hawaiian monk seals, wild pigs and sheep. For the privacy of residents, the craft does not pass over Pu'uwai village.

The helicopter touches down at Nanina on the north coast where visitors may swim, sun, explore, gather shells, photograph and picnic.

Tours are 9 a.m. to 1:30 p.m. six days a week. Cost is \$250 per person, based on groups of four or five; groups can be arranged.

The Niihau Safari offers a hunting license, gun, guide, two skimmers, ground transportation and lunch. There's a guarantee of two quarries -- any combination of sheep and wild pig.

Safaris are from 6:30 a.m. to 5 p.m. six days a week. Cost is \$1,500 per person, based on one to four in a party.

Niihau

Owner: Helen Robinson, 86; managed by Bruce Robinson, 54, her younger son, who along with brother Keith, 56, is heir to the island.

Size: 18 miles long by 6 miles at the widest point; 69.5 square miles or 44,455 acres. (The Robinson family's holdings on Niihau and Kauai place it among Hawaii's top five land owners with 101,029 acres in fee.)

Location: 17.2 miles across the Kaulakahi channel from west Kauai

Population: 230 (1990 census); currently 150 to 200 people, depending on vacations, sickness, gatherings on Kauai and trips, as to Las Vegas. Niihauans have recurring surnames of Beniamina, Kanahele, Ka'ohelauli'i, Keale, Kelley, Niau,

Niheu and Shintani. (Ishimatsu Shintani, born in Japan, went to work on Niihau in 1910, married a Hawaiian woman and remained there after her death. In 1960, he became Niihau's first alien to gain U.S. citizenship.)

Major community: Pu'uwai, in west-central Niihau

Commercial enterprise: Cattle, helicopter tours, hunting safaris, Niihau shell jewelry

Military involvement: Navy maintains an unmanned radar facility on the island

Utilities: Homes have electrical generators, and some televisions and VCRs although live TV reception is bad; there are no telephones.

Weather: Warm, windy, semi-arid; similar to Oahu's weather, except with more temperature extremes -- ranging from 42 to 110 in the shade

Fresh water source: Rain -- 60,000 gallons used daily, half each for domestic uses (from catchment) and agricultural uses (from lakes)

Major beach: Keawanui, 3.5 miles long -- Hawaii's second longest beach after Waimanalo Beach

Nurturing 'natives'

Keith Robinson, the family's 'black sheep,' is of a breed as rare as the Hawaiian plants he raises.

By Catherine Kekoa Enomoto
Star-Bulletin

KEITH Robinson, a 55-pound bale of fencing wire slung across his 5-foot-10, 165-pound frame, scampers swiftly down the sides of valleys and up steep ridges.

"Hey, you, hurry up!" he barks over his shoulder at his companions as they struggle along the trail behind him on this humid afternoon.

Robinson, with his Gary Cooper looks, blue eyes, hard hat and machete, is hiking through his 100-acre Kauai Wildlife Reserve at the junction of the Maha'ikona and Kawaipapa valleys of western Kauai.

The reserve is accessible only by foot and everything Robinson needs to care for it has to be hauled in on his back.

There he devotes the same care and diligence in preserving native Hawaiian plant species as his family has in supporting and protecting the people and island of Niihau.

In fact, Robinson refers to the 80 varieties of endangered plants he nurtures in the reserve as "natives" and speaks of them as if they are people -- actually, recalcitrant children whose best interests he is resigned to protect. He shakes his head and calls them "terrible rare" and "bloody rare."

The 56-year-old Robinson toils in the reserve eight hours a day, six days a week. He chain saws and burns away encroaching forests of guava, hau and kukui, then plants, waters, sprays and monitors the natives.

His natives include brilliantly colored blossoms that bloom and seed nowhere else in the world, 12-foot rare native trees that are being nurtured into their 80-foot potential, and fragile and frilly plants, one of which (*Cyanea pinnatifida*) will flower outdoors for the first time in some 30 years. He anticipates growing 100 endangered Hawaiian plant species by the new millennium.

From his work come tens of thousands of seeds from these endangered species which he distributes without charge to such organizations as the state Department of Land and Natural Resources and the Lyon Arboretum.

Robinson comes from hard-working, stubborn yet prosperous Anglo-Scottish stock that emigrated to Hawaii from New Zealand in the 1860s. They came as farmers and ranchers.

He is the great-great-grandson of Elizabeth McHutchison Sinclair, often cited as buyer of Niihau, although her sons' names appear in the land records. The purchase price of \$10,000 was paid in an estimated 1,000 ounces of gold. Family members were personal friends of the royal family and opposed the 1893 American overthrow of the Hawaiian monarchy.

Robinson's mother, Helen Robinson, 86, inherited Niihau island. The Sinclair-Gay-Robinson family lands once included Lanai island, but the Gay branch bought it and eventually lost it to the Doles. The descendants also own most of the Makaweli ahupua'a, a pie-shaped watershed running from mountain to sea in western Kauai. Family interests have encompassed sugar, pineapple, cattle and sheep. The family's wholly owned Gay & Robinson Inc. cultivates some 6,000 acres in sugar on Kauai.

Bruce, 54, Keith's younger brother, is Niihau Ranch's managing agent. He is also second in command for the Gay & Robinson sugar plantation and a principal with Niihau Helicopter Inc. He is married to a Niihauan and has, by two marriages, six children ranging in age from toddler to 20-something.

Keith describes his brother as quiet, patient and a hard-working genius who "looks so worn out. He's just stretched terribly thin on all three fronts." He says he and Bruce are close and enjoy a good working relationship, but "as much as possible I keep my nose out of things and let him do his work."

The elder Robinson is the self-admitted "family black sheep, outcast. I'm comfortable with that role. I'm off by myself doing my own thing."

That own thing is his reserve. Keith, like Bruce, graduated from the University of California at Davis, studying agronomy and ranch management.

He was foreman on Koolau Ranch on Kauai for seven years, then a commercial fisher for seven years.

He's a bachelor. His old, brown truck tells an eloquent story: It is a rusty, leaking pickup piled with gardening equipment and old newspapers.

"I am like a bear in a cave," he says. "I have no time for niceties."

His cache at the reserve that holds sprayers, buckets and other equipment reveals his workaday foodstuff -- a bottle of dry roasted peanuts. When he's thirsty he drinks from a waterfall because "Robinson family lands are among the last places in Hawaii where you can safely drink pure, unspoiled water directly from mountain streams."

Keith lives with his mother in the relatively modest ranch home in Makaweli in west Kauai where he grew up. He's gentle but distracted with his mother; she is sweet and unnoticing. The family includes an old horse, Fresno, that meanders untethered in the yard, and a friendly ranch dog, Tippy.

The house is adjacent to the Niihau Helicopter hangar. The chopper stirs up red dust, which blankets the house.

Robinson is talkative, opinionated and unabashedly Christian. He is for free enterprise and less government. He's trim, balding, ornery and polite; he calls himself a dinosaur while a Niihau cowboy described him as "the last of the old-fashioned Robinsons."

Once past his straightforward, un-P.C. way of speaking, he reveals an honest person of strong conviction. He says he allowed the Star-Bulletin on Niihau as a preemptive strike.

"I did it defensively to get our side on the public record. Whenever possible I try to avoid the media; in the long run it causes nothing but problems. Personal publicity is an incidental thing to maintaining a defensive posture against environmental and any other wackos."

He likened the Navy's proposed test missiles to blanks. "These are basically target rockets. When I

think of missiles I think of an intercontinental ICBM that's got a nuke on it and it's flying out of a silo. This is a glorified firework that comes off a 10- to 15-foot-long launcher. It goes out there and pretends that it's an Iraqi SCUD and they shoot at it."

Of his family's commitment to Niihauans he admitted, "There is a certain, shall we say, ethic ... We've been trying for years to just be a steady force.

"But at this point, neither Bruce nor the Niihau people have a great many options left. Even if the Navy does come in, the federal project faces two years of very grim financial sledding before the first real financial benefit shows up."

At the bottom of the reserve, Robinson tosses corn to wild chickens and pheasants that inhabit the area. Then the hike starts: a strenuous haul through thick, prickly brush; over and up rocky slopes, some of them almost vertical -- and slippery. He stops every few yards and discourses on the "natives," naming each by genus and species.

"You have no idea what it's like carrying a backpack and 10-foot spray boom and spraying every single plant every two to four weeks, fighting the leaf hopper," he says chidingly, like a tender-gruff geezer.

"A friend looked at my work and says, 'Keith, all this proves is that you're crazy. No sane man would work this hard.'

"I tend to think he's kind of right. When I am gone the reserve will collapse. When Bruce is gone, the monk seals will evaporate from Niihau.

"There are so many things that we just support as a matter of course -- wildlife conservation, watershed preservation, monk seals on Niihau, a Hawaiian-speaking community on Niihau, trying to keep the Hawaiians satisfied when the monk seals are eating their fish.

"Who knows what will happen in this day of steadily rising taxes and government hostility to private landowners? All these conflicts and juggling acts. Eventually it gets very stressful and expensive."

But in the family's enterprising tradition, Robinson plans to start eco-tourism tours through the Kauai Wildlife Reserve within the next one to four years. He will charge \$100 per person for the privilege of scrambling after him up the slopes while he shouts "Hurry up!"

He's a character with Cooper looks, Cousteau drivenness and absent-minded professor self-deprecation.

"I'm just a tired old has-been with one foot in the grave and the other on a banana peel," he laughs.

Lehua Crater

Lehua is a small, crescent-shaped island about 1000 meters off the north end of Niihau.

The uninhabited, 284-acre island is a tuff cone that is part of the extinct Niihau volcano.

Lehua Island is a Hawaii State Seabird Sanctuary. As a sanctuary, many activities are prohibited on the island, but entry is not prohibited. Lehua provides habitat for at least 16 species of seabirds, as well as some non-native rats and rabbits.

When weather and wave conditions permit crossings from Kauai, Lehua is a noted destination for snorkeling and scuba diving. It is also well known for its unusual geological formation dubbed "the keyhole". Located in one of the crescent's narrow arms, this is a tall, thin notch cut from one side, all the way through to the other side of the arm.

The United States Coast Guard maintains Lehua Rock Light on the highest point of the island, at a height of 704 feet (215 m).

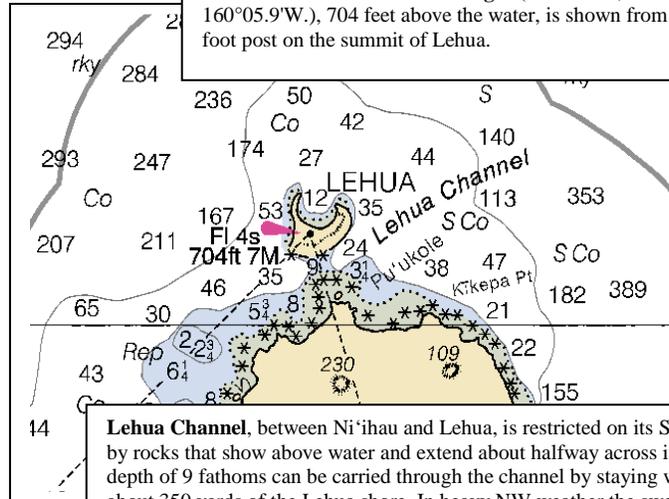
A 2003 archaeological survey located and mapped stone platforms and ahu (rock cairns). One site is over 800 years old. Ancient Hawaiians may have visited Lehua for fishing and feather collecting.

Recent surveys estimated approximately 50,000 seabirds are on Lehua. Seventeen seabird species are present, including eleven species nesting or attempting to nest on the island.

Some of the bird species found include Laysan and Black-footed Albatross, Red-footed and Brown Boobies, Red-tailed Tropicbirds, Hawaiian Petrels, Band-rumped Storm Petrels, and Newell's and Wedge-tailed Shearwaters. Migratory shorebirds also visit the island.

Twenty-three species of native plants exist on

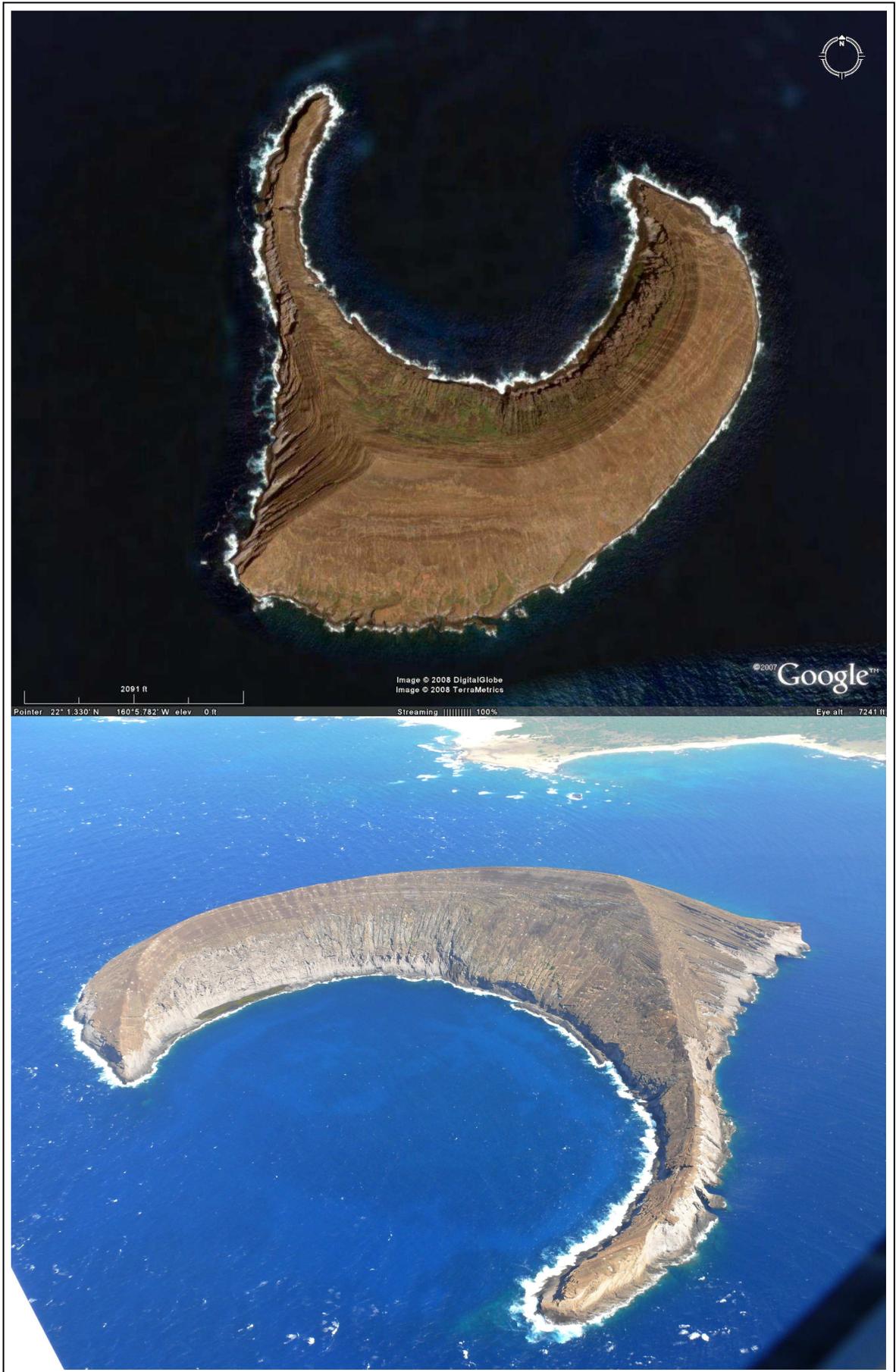
Lehua, about 0.6 mile off the N end of Ni'ihau, is a small rocky, crescent-shaped island, with the crescent open to the N. The E and W points are low, rising gradually to an elevation of about 700 feet near the center of the island. On the W point is a natural arch. **Lehua Rock Light** (22°01.1'N., 160°05.9'W.), 704 feet above the water, is shown from a 10-foot post on the summit of Lehua.

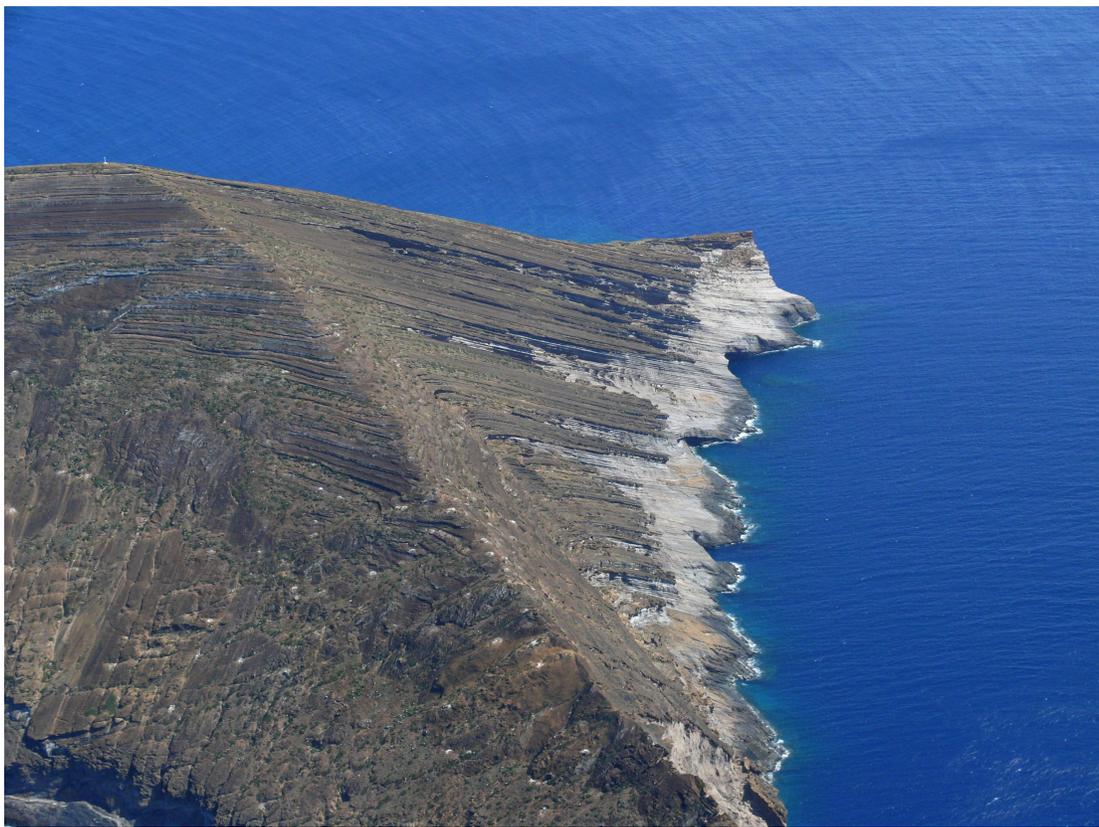


Lehua Channel, between Ni'ihau and Lehua, is restricted on its S side by rocks that show above water and extend about halfway across it. A depth of 9 fathoms can be carried through the channel by staying within about 350 yards of the Lehua shore. In heavy NW weather the swell almost breaks in the passage, and, as little is to be gained by using the channel, vessels should pass N of Lehua Island. The current through the channel varies with the tide and sets in both directions with a velocity of about 1.5 knots. To the E of Lehua Channel vessels should give the N coast of Ni'ihau a berth of 0.5 mile; to the W the clearance should be about 1 mile.

the island, although Lehua is now dominated by introduced weeds. At least thirteen native insect species are present, including twelve found only in Hawaii. Monk seals are also seen in the waters around Lehua and will occasionally haul out on Lehua's rock ledges.

Rats and rabbits, both alien species, were first documented on Lehua in the 1930s, but it's uncertain exactly when they were introduced to the island or who brought them. As part of the Lehua Ecosystem Restoration Project, rabbits were eradicated in 2005. Plans are underway to eradicate rats.



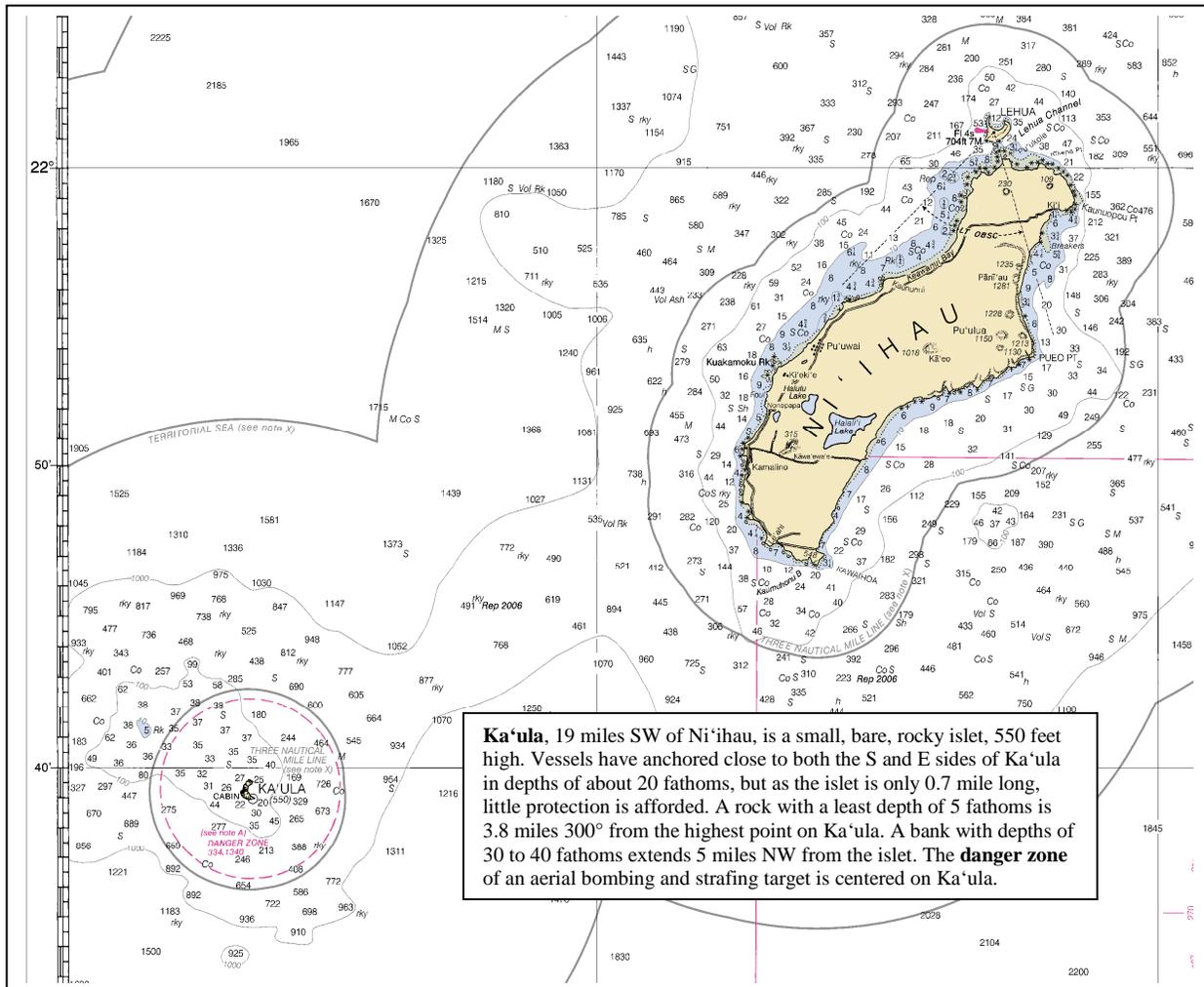
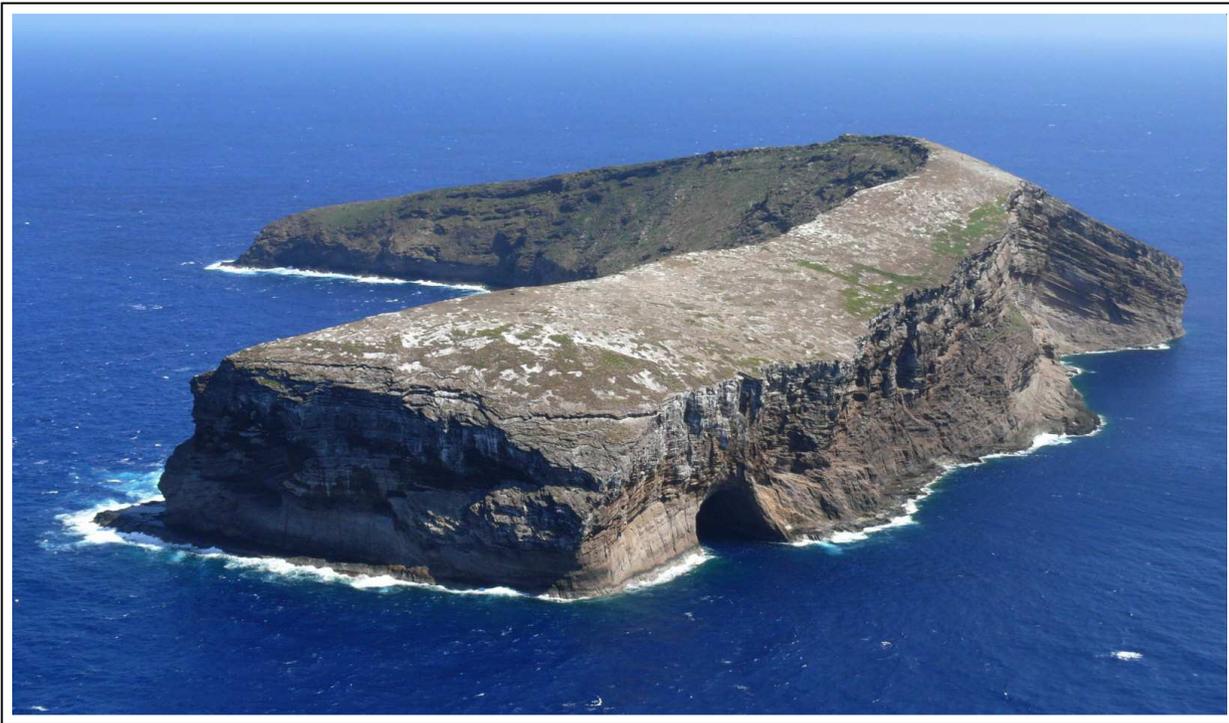


Lehua Crater



Lehua Crater. The keyhole is visible in the top photo.

Kaula Rock



Physical Features

Kaula is a tuff crater that lies 23 miles west-southwest of Kawaihoa Point on Ni'ihau. It was formed by the underwater eruption of a volcanic vent and the subsequent erosion of the resulting tuff cone. The islet is about 540 feet at its high point and a little over 130 acres in size. Geographically and biologically, it could be considered to be part of the Northwest Hawaiian Islands. A large sea cave is located on the northwest end of the island.

Regulations

The Navy forbids landing on Kaula without a special permit. They currently use Kaula as a target range for non-explosive ordnance. However, past target practice used live ordnance so there is a risk that unexploded ordnance remains on the islet and in surrounding waters. Kaula is subject to Hawaii regulations protecting State Seabird Sanctuaries. Federal law also protects seabirds, shorebirds, and threatened or endangered species.

Birds

Kaula has historically been renowned for the number of its nesting seabirds and is still possibly the largest and most diverse seabird colony in the main Hawaiian Islands. The Tanager Expedition sailed around Kaula in July 1923 but did not land. The first on-island survey of birds and plants was conducted by Edward Caum in August 1932. Neither of these early surveys made estimates of bird numbers but both reported dense bird populations. DOFAW and U.S. Fish and Wildlife Service conducted fairly regular wildlife surveys from 1971 to 1984. The most recent surveys were done in 1993 and 1998. Unfortunately, the last survey conducted close to peak nesting season was in 1993 so the current condition of the colony is unknown. Past surveys at peak nesting season estimated over 100,000 seabirds of 18 different species on Kaula, placing it on a par with the Northwestern Hawaiian Islands. Sooty terns (*Sterna fuscata*), Brown noddies (*Anous stolidus*), Booby (*Sula*) species, and Wedge-tailed shearwaters (*Puffinus pacificus*) have historically been the most numerous birds. Black-footed albatross (*Phoebastria nigripes*) and Laysan albatross (*Phoebastria*

immutabilis) both nest on Kaula. Updated surveys are urgently needed.

Plants

Kaula gets little rainfall during much of the year, causing much of the vegetation to dry out. During the rainy winter months, the vegetation reappears. Thorough botanical surveys were conducted in the early 1930s and in the 1970s but not since then. These early surveys found 31 species of plants, about half of which were native, including two rare endemic species. The current condition of the vegetation is unknown and new surveys are needed.

Insects

Limited insect collections were made in 1932 and 1971. Because these collecting efforts were minimal and the last one was over 30 years ago, Kaula's insect fauna is virtually unknown. A thorough survey is much needed.

Marine Organisms

State biologists conducted limited intertidal and nearshore fish surveys in 1971 and 1976, concentrating on the long wave-cut terrace on the east side of the island. Bishop Museum, NOAA and the State of Hawaii conducted a joint marine survey in July 2006. Survey results are not yet available. Because of its distance from the main islands and the fact that boat access is restricted by the Navy, it is likely that Kaula's marine resources don't suffer as much from overfishing as other areas in Hawaii.

Human Uses

The frequent mention of Kaula in Hawaiian oral traditions shows that they were well aware of its existence. Visitors in the 1920s reported finding stone structures that may have been heiau. Niihau fishermen reportedly honored the shark god Kuhaimoana at heiau located above the seacave on the northwest end of the island. Although there is no evidence of any permanent settlements, Hawaiians likely visited to fish and to harvest seabirds, feathers and eggs. Stories tell that Kaula was also the source of a certain type of stone highly valued for making octopus lures. A lighthouse was completed on Kaula in 1932 and functioned until 1947. The Navy has used Kaula as a target range since at least 1952.

The public has periodically protested this use but the Navy continues target practice using inert ordnance. Despite objections by the Navy, The State of Hawaii included Kaula on the list of State Seabird Sanctuaries in 1978 after making a legal determination that the islet belonged to the state. The ultimate determination of land ownership may require a court decision.

Threats

Ongoing Navy use of Kaula for target practice poses unquantified threats to seabirds, terrestrial species, and nearshore marine species. The lack of baseline (pre-bombing) biological survey data makes it impossible to quantify the level of disturbance and mortality that has occurred since target practice first started some time during or shortly after World War II. In recent years, the Navy has denied requests by state and federal wildlife biologists to conduct surveys so the current condition of the resources is also unknown.

and worldwide, they are a serious threat to multiple species on Kaula and should be eradicated. Introduced Barn owls (*Tyto alba*) are also present and pose a threat to nesting seabirds by eating chicks and adults.

History of Kaula Rock

[This was probably written in the 1930's or 1940's.]

There are a few legendary accounts of Hawaiians who visited the island but no evidence of extensive human habitation is known. The lighthouse men, when they finally succeeded in reaching the summit, in July, 1925, found on the northern part of the crest the remains of two stone structures, which might have been heiaus (temples). On the concave (east) side, just below the summit, they also found a shelter cave across the mouth of which was a low wall, suggesting that it, too, had been used by visiting Hawaiians.

The establishment of a light on the inaccessible summit of Kaula forms one of the



Introduced rodents, probably Polynesian rats (*Rattus exulans*), have been seen on Kaula since the 1930s. Rodents were most recently observed in 1998, the last time that biologists were on Kaula. Based on the severe impacts rats have had on island ecosystems in Hawaii

most interesting and important events in the history of that seldom-visited islet. The need for a light there has been felt for several years, because the island lies close to the direct route of vessels bound for the Orient. In 1921 Superintendent A. E. Arledge visited the

island on the lighthouse tender Kukui, but was unable to find a landing place, although the sea was moderately calm. He gave copies of the pictures which he took at that time to the German geologist, Immanuel Friedlaender, who published a paper on the geology and topography of the island in a German scientific journal. Friedlaender interpreted the photographs as showing that Kaula consists of ash or tuff ejected at two different times, and that it forms about a quarter of the circular rim of a crater, the rest of which has disappeared.

On July 1, 1923, the U.S.S. Tanager, returning from a scientific cruise to the northwest Hawaiian islands, circled the island, and a ship's boat rowed along the lee side and into the sea cave at the northeast end. At that time the writer reached his nearest approach to the island by touching the wall of the cave with a boat hook. No official landing was made, although two or three of the more daring members of the party succeeded in getting ashore on a rocky ledge, from which they could only work their way a few yards up the cliff face. A few photographs and long-range observations were made from the ship.

Lighthouse superintendent Ralph R. Tinkham also visited the island in 1923, without being able to make a landing. George Gay, manager of the Niihau Ranch, is credited as being the first white man to have landed on the island, having swum ashore several years previous. He was unable to get off again through the breakers, and had to remain on the islet over night, until rescued by a Hawaiian crew in an outrigger canoe next day.

In order to learn more about the island, an airplane photograph was urgently desired. In November, 1923, Brigadier General William Mitchell was in Hawaii inspecting army air corps. He volunteered to get pictures of Kaula. That was before the days of inter-island flights, so the plane had to be loaded onto the lighthouse tender Kukui and transported to Koloa, where it had to be taken apart in order to get it ashore in small boats. Meanwhile Commander John Rodgers, in command of the local naval air service, learned about General Mitchell's plans. That same spirit of rivalry which marks the Army-Navy game made its appearance. Why should the Navy let the

Army run off with the honour of being the first to fly a plane over and photograph Kaula? So two navy flying boats were loaded on the Pelican and another minesweeper, and they set off for Kauai. There one of the two planes was safely launched; and while the army plane was being made ready at a small field near Eric Knudsen's beach house, on the morning of November 8, Lieutenant E. Chourre piloted the navy plane over Kaula so that photographer B. L. Houser was able to take the first picture of the islet from the air. Later a number of photographs were made by the 11th Photo Section, U.S. Army, from which Mr. Tinkham was able to construct maps and plans for the development of the light project.

In 1925 a party under the direction of lighthouse superintendent Fred A. Edgecomb, succeeded in making a landing on July 10, and worked until the 21st building a trail and ladder to the summit. On August 21, 1931, lighthouse engineer Neil W. Wetherby, while making a reconnaissance, was washed off the cliff from a spot 30 feet above sea level. An old Hawaiian in the party maintained that this has happened because he had not first rowed into the sea cave to pay his respects to the shark god which dwelt there and ruled the islet. In spite of this omission he wasn't seriously hurt, and returned on August 2, 1932, with a carpenter, mechanic and six labourers, to complete the installation of the derrick, shelter houses and light. The light finally was put in commission on August 18, 1932.

During this period, August 16 to 19, Dr. Harold S. Palmer, professor of geology at the University of Hawaii, and E. L. Caum, botanist with the Hawaiian Sugar Planters' Experiment Station were guests of the Lighthouse Service on the island, and made a study of the geology, plants, and bird life. Dr. Palmer describes the geologic formation of the island. He outlines its geologic history as follows: First, volcanic eruption built up to about sea level the platform upon which the islet now stands. Then this was eroded away, and corals grew upon the summit of this planed-off mountain peak. After that there was a second period of volcanic activity and a tuff cone was formed with its highest side toward the west. This tuff crater-rim next was eroded

by wind, waves, and running water from rainfall, the waves cutting a submarine terrace almost around the island. The level of the sea then dropped about fifteen feet below the wave-cut terrace. And finally the present cycle of erosion took place. It is the wave-cut sea cliff which turns the stream-cut of gulches into hanging valleys, and makes the faces of Kaula so difficult to climb.

Mr. Caum, discusses the vegetation and the bird life. Fifteen species of plants were found growing on Kaula. A grass (*Panicum lanaiense*), an amaranth weed (*Amaranthus viridus*), a new species of purslane (*Portulaca caumii*), the common purslanes (*Portulaca lutea* and *aleracea*), puncture vine (*Tribulus cistodes*), and a spurge (*Euphorbia celastoides*) were the most abundant species of plants.

The noddy tern (*Anous stolidus*) was the most abundant species of bird. Other birds were the white tern, the Necker Island tern (called the small grey tern throughout the central Pacific), the sooty tern, the grey-backed tern, Bulwer's petrel, wedge-tailed shearwater, red-tailed tropic bird, the blue-faced, red-footed and common boobies, frigate birds, and the golden plover.

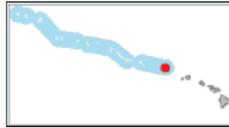
Mr. Caum also collected specimens of fifteen species of insects; two kinds of ants, two of wasps, four species of flies, two of lady beetles, a moth, a leafhopper, a thrip, an embiid, and some pseudoscorpions.

The lighthouse personnel also have captured specimens of a rat and a mouse, and report dry-wood termites in lumber on the island.

The light atop Kaula is the second highest under jurisdiction of the United States Lighthouse Service, being 562 feet above sea level. It is exceeded in height only by the Lehua light, 707 feet, off the northern end of Niihau. Lights at such elevations are only possible in regions, such as Hawaii, where there are no fogs. The Kaula light consists of a double 375 mm. acetylene beacon lantern, a type developed in Hawaii by M. Peter, Lighthouse Service mechanic. Each of the two lanterns has a 480 candle power light, visible at least 12 miles. The height is such that under

exceptional conditions of clearness, it may be seen at a distance of 27 miles at sea level. The upper light is automatically turned on when the sun stops shining on it. Should it burn out, the lower light would automatically turn on. The lights are supplied with gas from storage tanks lower down on the west side, where a hoist can lift the heavy tanks from the shore. Two independent pipes, each 1500 feet long, supply the gas to the lights. Each of the two tanks holds enough gas to keep the light burning for fifteen months. The light could keep burning for two and a half years without refuelling, if necessary.

Nihoa



Nihoa, also called Bird Island and Moku Manu, is located about 120 miles northwest of Niihau and 280 miles from Honolulu. It is the summit of a huge volcanic peak, only about 900 feet of which remains exposed above the sea. The island consists of 173 acres of land surrounded by 220 square miles of coral reef. Nihoa is part of Papahānaumokuāke a Marine National Monument.

Radiocarbon dates from Nihoa date habitation there from at least the 7th century AD. This

remote land of rugged cliffs and steep valleys provided a home for Hawaiians between until 1700 AD. More than 80 cultural sites are known, including habitation terraces and bluff shelters, religious places, agricultural terraces, and burial caves. Many of the mea makamae (cultural objects) and structures Ancient Hawaiian archaeological site.associated with these wahi pana (cultural places) are similar to many found throughout the Main Hawaiian Islands. It is believed that the abundance of natural resources and at least three freshwater seeps may have supported as many as 175 people between 1000 and 1700.

Nihoa is the tallest of the Northwestern Hawaiian Islands, with two peaks, 895 feet Miller's Peak in the west, and 852 feet Tanager Peak in the east. This exposed summit in shape resembles half of a cowboy's saddle, Miller's Peak being the pommel, and Tanager Peak its upcurved back.

The island about 1,500 yards long and 300 to 1,000 yards wide. It can be compared only to

half a saddle as the northern side drops off sheer in a nearly perpendicular cliff. Near its middle this cliff is 360 feet high; but both ends of its 1,500 foot length reach a height of over 800 feet. In places it appears to overhang. The western side of the island also is a cliff, which forms a right angle with the north face. The cliff also continues around the curve of the east end.



Captain William Douglas, the second Western explorer to find Nihoa, describes it as "the form of a saddle, high at each end, and low in the middle. To the south, it is covered with verdure; but on the north, west, and east sides it is a barren rock, perpendicularly steep..." . Its jagged nature gives the island its name, Nihoa, which means "tooth" in the Hawaiian language.

The southern side of the island slopes upward in a series of six shallow valleys. A low cliff borders Adams Bay. The foot of the southern slope has been cut into to form a bench of terrace, ten to fifty feet wide and from four to eight feet above mean sea level. In the west, much of the bay is a small sandy beach. Breaking waves prevent this from being a good landing place. The best spot at which to land is a rocky shell near the centre of the south slope. Here, in smooth weather, landing is not dangerous in the morning. The sea frequently becomes a little rougher in the afternoon, and in stormy weather landing is practically impossible.

Geology

Nihoa is 7.2 million years old, and was once a large island before erosion wore it down to its current size. Six valleys slant down from north to south, meeting at the south side of the island: West Valley, West Palm Valley, Miller Valley, Middle Valley, East Palm Valley, and East Valley.

Nihoa is the remnant of a once much larger volcanic cone, according to Professor Harold S. Palmer, who reported upon the island's geology in Bishop Museum Bulletin 35, 1937. Its summit, as one can tell from the dip of the lava state, formerly was higher and to the northeast of the present summit. The entire northern portion of the island has been eroded away. At present the waves are still cutting back the foot of the cliff, so undermining the face that it falls from above, most of the material being carried away as it falls. The rocks are composed of both dike and flow basalt, some high in olivine crystals. No ash, bombs, or tuff have been found.

Several interesting features occur on Nihoa. Dog's Head Peak (358 ft) is named for its likeness. Pinnacle Peak (626 ft) is a volcanic dike created when less resilient rock was eroded away and harder rock was open to the elements. The only flat area on the island is called Albatross Plateau, just below Miller's Peak. The Devil's Slide is a particularly impressive geological feature, a narrow cleft descending 700 feet irrespective of the surrounding elevation. Extending northward from Albatross Plateau, it ends at the vertical cliffs with a 190 foot drop straight down to the ocean below. In this chasm, rare ferns grow, along with several endemic species, including a giant cricket.

Ecology

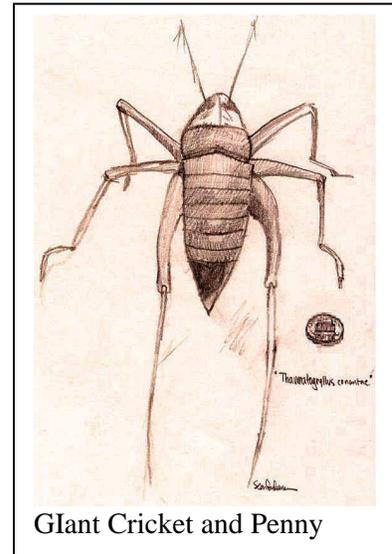
Birds occur in vast numbers on Nihoa. Black-footed albatross have a colony on the summit, dome-shaped plateau; Bulwer's petrel and wedge-tailed shearwaters occupy caves and burrows; red-tailed tropic birds hide beneath bushes; and the large frigate birds, three kinds of boobies, and five kinds of terns nest in places from the ground to the crowns of the loulu palms. In addition to these sea birds are two species of native land birds, the finch and

the miller bird, both endemic species, found only on Nihoa, but related to species on Laysan.

In contrast to the bare cliffs of the north, the southern slopes appear brownish or greyish-green in colour from their vegetation. Most of the ridges are covered with two kinds of grass (*Eragrostis variabilis* and *Panicum torridum*). The valleys are densely carpeted with greyish shrubs, mainly *Chenopodium sandwichicum* and *Solanum nelsoni*, among which are scattered ilima bushes (*Sida fallax*) and ohai, a leguminous shrub (*Sesbania tomentosa*). The only large plants are a few small clumps of loulu fan palms (*Pritchardia remota*), of which about 500 were counted in 1923, not including seedlings. Specimens of twenty flowering plants were collected by the Tanager Expedition, in 1923.

Nihoa is a sanctuary for many endemic species, including:

- *Pritchardia remota* fan palm, the only tree on the island
- Nihoa Millerbird
- Nihoa Finch
- Nihoa Conehead Katydid
- Nihoa Carnation
- *Sesbania tomentosa*
- the amaranth *Amaranthus brownii*
- the trapdoor spider Nihoa mahina
- *Thaumtogryllus conantae*, a giant cricket found in the Devil's Slide area
- species of *Achatinella*, genus of tree snail
- *Plagithmysus nihoae*, a long-horned beetle
- *Eupelmus nihoaensis*, a wasp
- *Hylaeus perkinsiana*, Perkin's yellow-faced bee
- a total of 72 terrestrial arthropods



Because of Nihoa's small size, most of its endemic organisms are endangered, as one single disaster such as an island-wide fire or an introduction of invasive species could wipe out the whole population. One such invasive species is grasshoppers; from the period between 1999 and 2003, grasshoppers devastated much of the vegetation on the island and posed a real threat to the continued health of plants on Nihoa. The following year, the numbers decreased and the vegetation became lush again. The grasshoppers probably came to Nihoa by way of wind from Kauai.

Basalt underlies most shallow water habitats surrounding Nihoa. Limu (algae), wana (sea urchin), and opihī (limpet) inhabit these shallow waters, while sharks and jacks hover in deeper waters offshore. The submerged coral reef habitat covers about 142,000 acres with seventeen species of stony corals documented. Sheer basaltic cliffs on the north side of the island continue underwater, plunging vertically to great depths. Due to strong wave action and lack of protected areas encrusting corals are the dominant coral species found here, and they exist mostly in waters deeper than forty feet. Fishes uncommon or rare in the main Hawaiian Islands but typical of the NWHI, such as spotted knifejaws (*Oplegnathus punctatus*), are often seen at Nihoa.

Prehistoric human habitation

Although difficult to imagine today, this remote land of rugged cliffs and steep valleys provided a home for Hawaiians between 1000 and 1700 A.D. More than 80 cultural sites are known, including habitation terraces and bluff shelters, religious places, agricultural terraces, and burial caves. The abundance of natural resources and at least three freshwater seeps may have supported as many as 175 people between 1000 and 1700 A.D.

So many new and interesting archaeological sites were discovered on Nihoa in 1923 that the Tanager expedition made a return visit the following year with scientists who made a thorough archaeological survey. In 1997, a native Hawaiian group returned the human bones to Nihoa that had been removed from the island decades earlier.

Many of the old house sites and terraces used for cultivation were cleared as well as mapped. A total of 66 sites are reported upon by Kenneth P. Emory in Bishop Museum Bulletin 53, 1928, together with an interesting discussion of the agriculture and type of culture which must have existed on the island. The total of twelve acres of cultivated terraces might have produced 48 tons of sweet potatoes a year. These, with fish, might have been sufficient to feed quite a population, even the 175 persons which the number of house sites suggests. But the real problem was that of water, there being only three small seeps, none of which gave water fit to drink in 1923.

Early exploration

The first Westerner to discover Nihoa was



USFWS/Craig Rowland

Nihoa Millerbird



Nihoa Finch

Captain James Colnett of the Prince of Wales, on March 21, 1788. As he was later captured by the Spanish and went mad in prison, the discovery was once widely accredited to Captain William Douglas of the Iphigenia, who sighted Nihoa almost a year later at 3 o'clock on the morning of March 19, 1789.

The barque Columbia, Captain Peter Corney, with 60 native Hawaiians on board, passed close to Nihoa on April 17, 1817, but did not land.

By the end of the 18th century, Nihoa had been forgotten by most Hawaiians. In 1822, Queen Kaahumanu and her husband King Kaumualii traveled with Captain William Sumner in two or three small vessels to find Nihoa, as her generation had only known the island through songs and myths. They found the island and annexed it to the Hawaiian group.

Later, King Kamehameha IV sailed there to officially annex the island as part of the Kingdom. Finally, in 1885, Princess Liliuokalani made a pilgrimage to Nihoa with her 200-person entourage. At one point, a luncheon was cut short when one of the party set off a brush fire by accident. The group tried to flee the island, but the rising tides made it difficult and several boats were flooded, destroying some of the photographs taken.

On April 23, 1857, King Kamehameha IV and Governor Kekuanaoa landed from the schooner *Manuokawai*, Captain Paty, and again took possession of the island. This was following a visit of the French ship *Eurydice*.

Careful determinations of the position of Nihoa, or Bird Island, as it was called, were made by the United States Survey schooner *Fenimore Cooper*, Lieutenant John M. Brooke, in January, 1859.

In 1885 the steamer *Iwalani* made an excursion run from Honolulu to Kauai and Nihoa, with a party of about 200, chief among whom was Princess Liliuokalani. In the party

were Sereno E. Bishop, to make geological observations and a map; Sanford B. Dole, to observe the birds; Mr. Jaeger, to collect plants; and Mrs. E.M. Beckley, as representative of the Hawaiian Government Museum. While the excursionists roamed all over the island, Mr. Bishop laid out a base line and commenced making a survey, with the help of Mr. Rowell, who set out flags on the peaks. The survey was cut short, however, and the visitors had to take to their boats in a hurry, when someone carelessly set fire to the dry vegetation, and much of the slope was burned over. Much difficulty was experienced in getting back onto the ship, because of which but few scientific specimens were obtained. Among those preserved are a stone bowl, stone dish, and coral rubbing stone now in Bishop Museum.

The British ship *Hyacinth* made soundings about Nihoa in September, 1894, but there is no record at hand as to observations on the island.

Carl Elshner states in his account of the leeward islands, that in 1910 several sailors from the U.S. Revenue Cutter *Thetis* swam ashore at Nihoa. Also that in 1913, Lieutenant W.N. Derby, known to many in Hawaii as the genial commander of the U.S. Coast Guard Cutter *Itasca* at the time the first colonists were taken to islands in American Polynesia in 1935, a sailor swam ashore to secure rock specimens, the surf being too rough to land with a boat. The bit of sand beach appropriately has been called Derby's Landing.

In June, 1923, camp was made in a cave just above the landing place. Here were found two soya tubs, a bottle of soya, decayed rice bags, and Japanese straw coats, indicating that Japanese fishermen had camped there. C.S. Judd and H.S. Palmer made a plainable survey map of the island, a copy of which is here reproduced. Dr. Alexander Wetmore, representative of the U.S. Biological survey, made a careful study of the bird life, while several Honolulu scientists collected and studied the plants, land shells, marine life, and geology.

The archaeological parties worked on Nihoa from July 9 to 13, 1924, clearing several terraces and house platforms and exploring a total of 66 archaeological sites. The numerous ethnological specimens which were discovered on the island, and which suggest at least a semipermanent residence at one time, are preserved in Bernice P. Bishop Museum.

Coastal Pilot

Nihoa (23°03'N., 161°55'W.), a barren, rocky, and uninhabited island, is about 120 miles NW of Ni'ihau. The island was discovered by Captain Douglas of the British vessel IPHIGENIA on April 13, 1790. The low, stone walls of ancient Polynesian ceremonial sites still remain on the island. The island is inhabited by a number of species of sea birds and two extremely rare land birds.

Nihoa is about 0.8 mile long and 0.2 mile wide. The E, N, and W sides are high and precipitous; the S side is much lower and its slopes are more gradual. **Millers Peak**, 910 feet high and the highest point on the island, is near the NW end. **Tanager Peak**, 874 feet high, is near the NE end. The SE and SW sides of the island



The cliffs of Tanager Peak, Nihoa, Northwestern Hawaiian Islands. View from Miller's Peak looking east

terminate at points on either side of **Adams Bay**. In the bay are three small bights; the westernmost has a sand beach, and the shores of the other two are rocky ledges. There is deep water, close to all sides of the island.

The safest anchorages are between the 15-and 20-fathom curves W and SW of the island, but the holding ground is poor. The middle cove of Adams Bay probably affords the best landing, but the surge is considerable and great care must be taken in landing anywhere on the island. During heavy NW weather landing is very dangerous. A steep trail leads from the middle cove to the top of the bluff. At the foot of the

bluff is a seepage of water that is not suitable for drinking purposes except in emergencies.

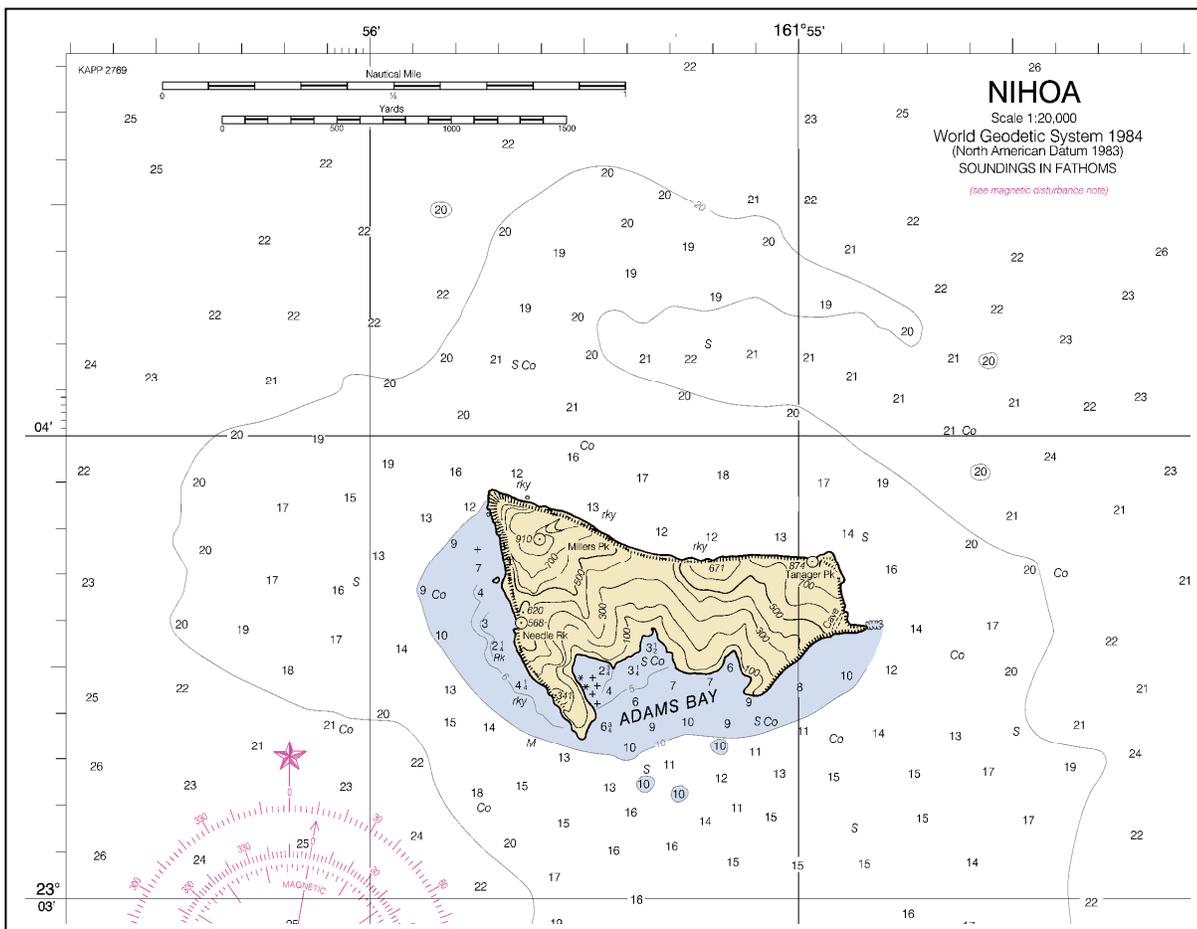
Currents

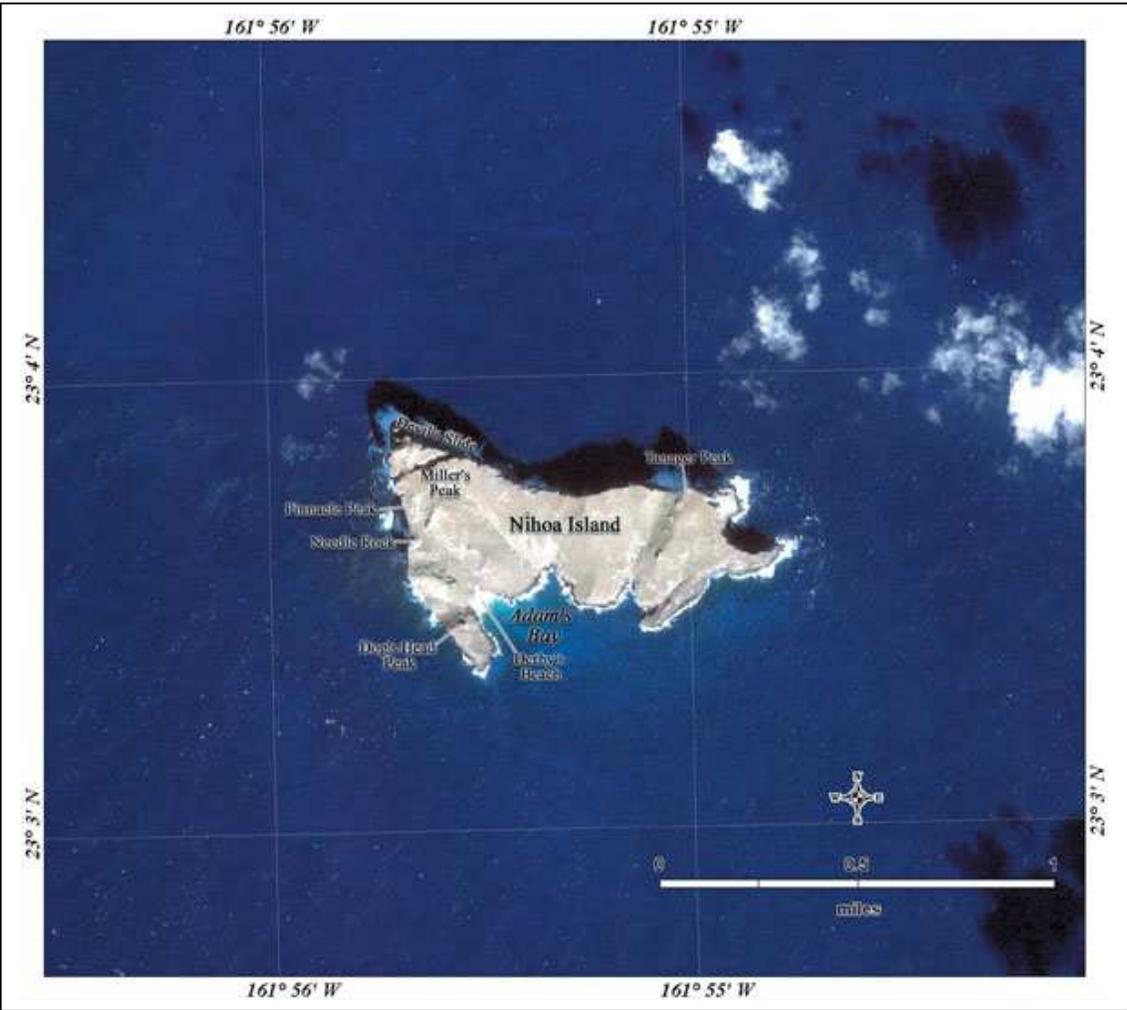
The prevailing current sets W in the vicinity of Nihoa. Current observations taken about 0.2 mile W of the island show a nontidal flow of about 0.2 knot setting WSW combined with a tidal current of nearly 0.5 knot at strength setting N and S. The N strength of the tidal current occurs about 6 hours after the local transit of the moon and the S strength at about the time of local transit. The velocity measured was nearly 2 knots and set S.

Local magnetic disturbance

Differences from normal variation of as much as 33° have been observed on Nihoa.

Nihoa is near the SW end of a bank which is about 18 miles long in a NE-SW direction 10 miles wide and has depths of 14 to 36 fathoms, except for a reported depth of 6½ fathoms at the westernmost extremity. Another bank, the center of which is about 18 miles WSW from Nihoa, is about 14 miles long in an E-W direction, 9 miles wide, and has depths of 15 to 25 fathoms, except for an 11-fathom depth about 2 miles SE of its center, and a 14-fathom depth about 6 miles SSE of its center, reported in 1968. A bank about 54 miles SE of Nihoa has a least depth of 32 fathoms except for a reported depth of 19 fathoms at its S end; the positions of the reported depths are approximate and caution is advised. The two banks 57 and 70 miles W of Nihoa have least depths of 29 and 33 fathoms, respectively. The edges of the bank slope steeply to much greater depths. A 9-fathom shoal is about 5 miles NW of the E bank.







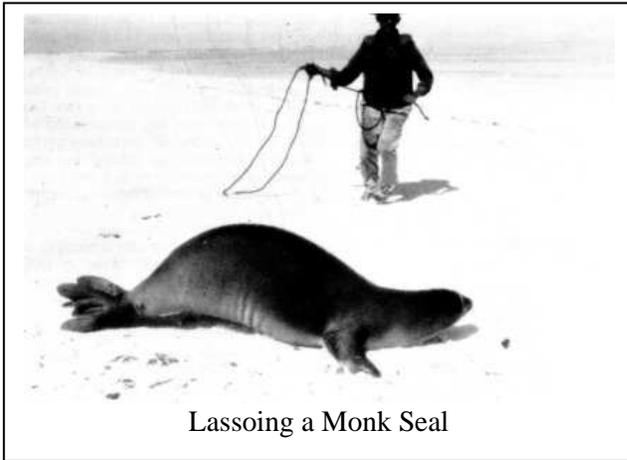
Ilima (*Sida fallax*) on Nihoa Island



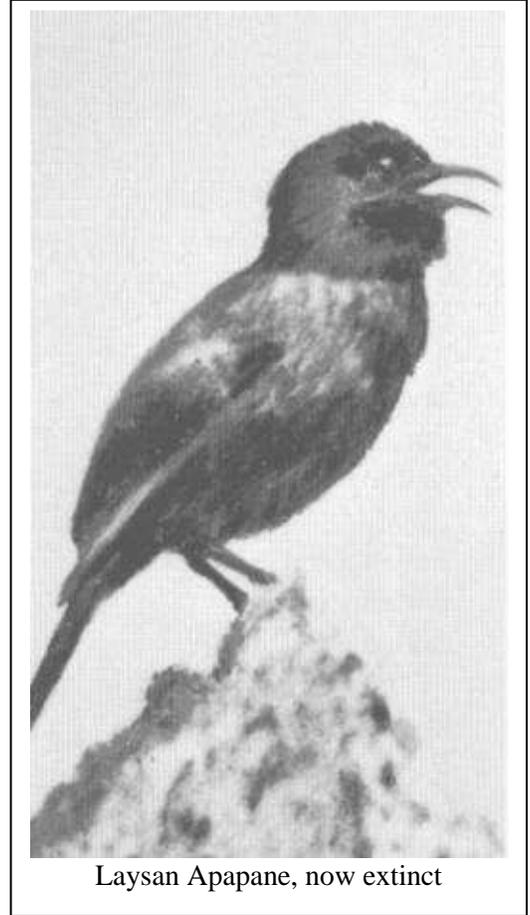
Nihoa Island

The Tanager Expedition

The 1923 Tanager Expedition, under Captain Samuel Wilder King of the USS Tanager, was a survey of the Northwestern Hawaiian Islands and their plant and animal life, as well as their geology. They then traveled to the Marshall and Line Islands. Archaeologist Kenneth Emory who later worked at the Bishop Museum for sixty years, was a member of the expedition, as was the noted herpetologist Chapman Grant.



Lassoing a Monk Seal



Laysan Apapane, now extinct

Over 100 archaeological sites were found and documented, including ancient religious sites and houses on Nihoa and Necker Island. Numerous new species were discovered and named, such as the Laysan Finch. Many specimens of endangered species were captured and brought back to laboratories as well. The crew also were one of the few people in history to witness a species extinction. When they spent a month on Laysan studying the endemic Laysan Apapane, a violent and sudden storm ravaged the island. After the storm, the crew concluded that the last three specimens of the Apapane had been killed in the storm.

The expedition also exterminated the last of the rabbits that devoured vegetation and caused extinction on Laysan.



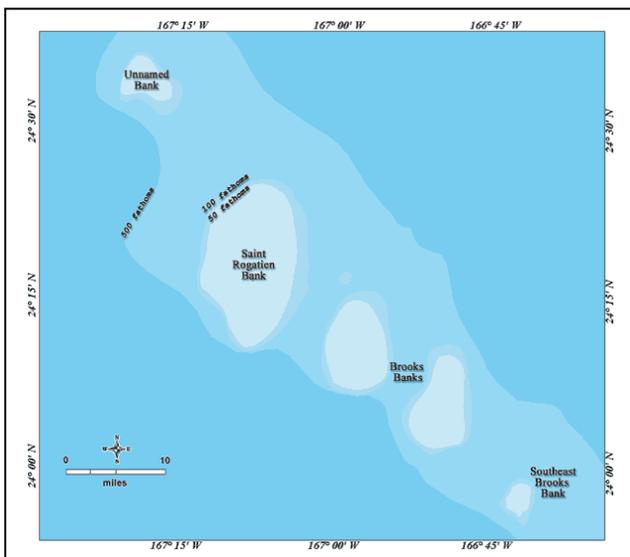
The *Tanager* was a converted minesweeper from the First World War.

Banks and Seamounts

There are approximately 30 submerged banks in the Northwestern Hawaiian Islands. Up until recently very little was known about the banks beyond that they were shield volcanoes formed at the hotspot. Some scientists believe that many of the banks act as "stepping stones" for marine organisms to migrate in the region. The bank areas provide extensive habitat for bottomfish and a few are known to provide foraging habitat for endangered Hawaiian monk seals. Large precious corals, such as gold, pink and black are also found in the deep waters of the banks. These corals are not light gathering but strain the surrounding waters for food.

The first Hawaiian coral reefs originated around the oldest islands. Many of these islands are now seamounts sunken to great depths. Other seamounts have never emerged above the ocean's surface. Guyots are sunken volcanoes that became flat topped seamounts. Fish and precious corals may be concentrated near the tops of seamounts or guyots.

St. Rogatien, Brooks Banks, and other unnamed banks surrounding French



Frigate Shoals. Little is known about these bank areas, except that Hawaiian monk seals have been observed foraging in these areas, probably for eels. The Hawaii Undersea Research Laboratory plans to visit these banks

in several deep sea dives beginning in 2002 to build a greater understanding of the areas.

Raita Bank is just west of Gardner Pinnacles. The crest or top of Raita Bank is about 60 feet from the ocean surface. Bottom habitats of relatively shallow banks such as Raita tend to be barren when compared with more sheltered coral reef environments. Recent surveys revealed less than 1% live coral cover in the shallow portions of Raita Bank, with the bottom scoured by wave action and strong currents. Raita is one of the larger banks in the NWHI, and there is much yet to be discovered about this area.

Pioneer Bank is only 22 nautical miles from Neva Shoals, and the features combine to form a major coral reef ecosystem rich in biodiversity and with a variety of marine habitats.

Coast Pilot

Brooks Banks and **St. Rogatien Bank** are a group of five coral banks between French Frigate Shoals and Gardner Pinnacles. The banks extend 50 miles in a NW direction, have depths of 11 to 59 fathoms, and are separated by channels several miles wide and more than 100 fathoms deep. The largest of these banks lies 60 miles 305° from La Perouse Pinnacle, is about 12 miles in diameter, and has depths of 12 to 56 fathoms. The southeasternmost bank, the smallest in the group, is 27 miles 297° from La Perouse Pinnacle, is about 2 miles in diameter, and has depths of 28 fathoms. The northwesternmost bank is 75 miles 311° from La Perouse Pinnacle, is about 6 miles long and 4 miles wide, and has depths of 30 to 43 fathoms.

Unprotected anchorage can be had on the shoaler areas, but the holding ground is only fair. The sand and coral bottom is plainly visible. There are no known dangers.

Currents

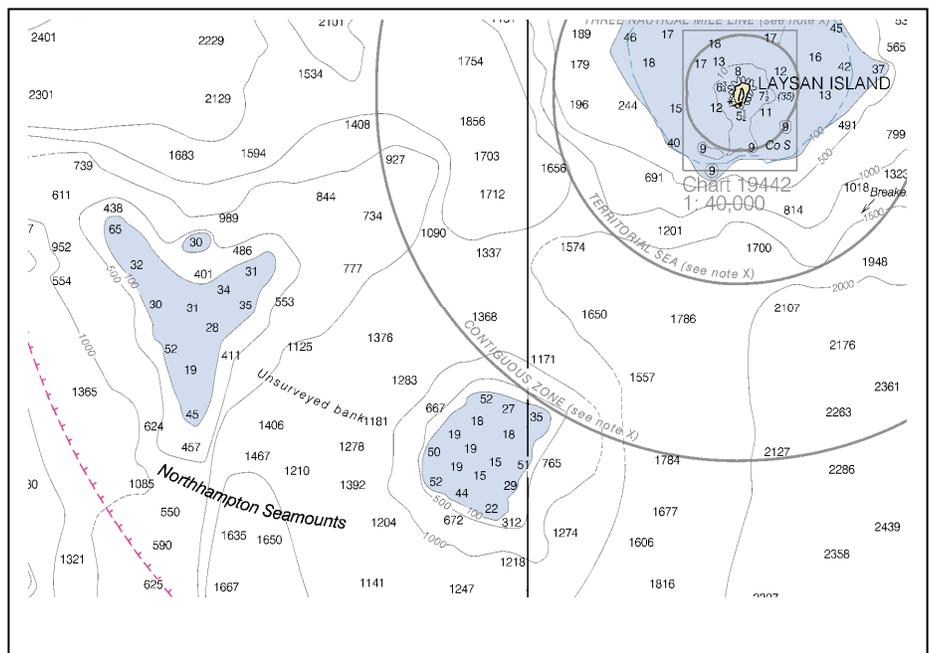
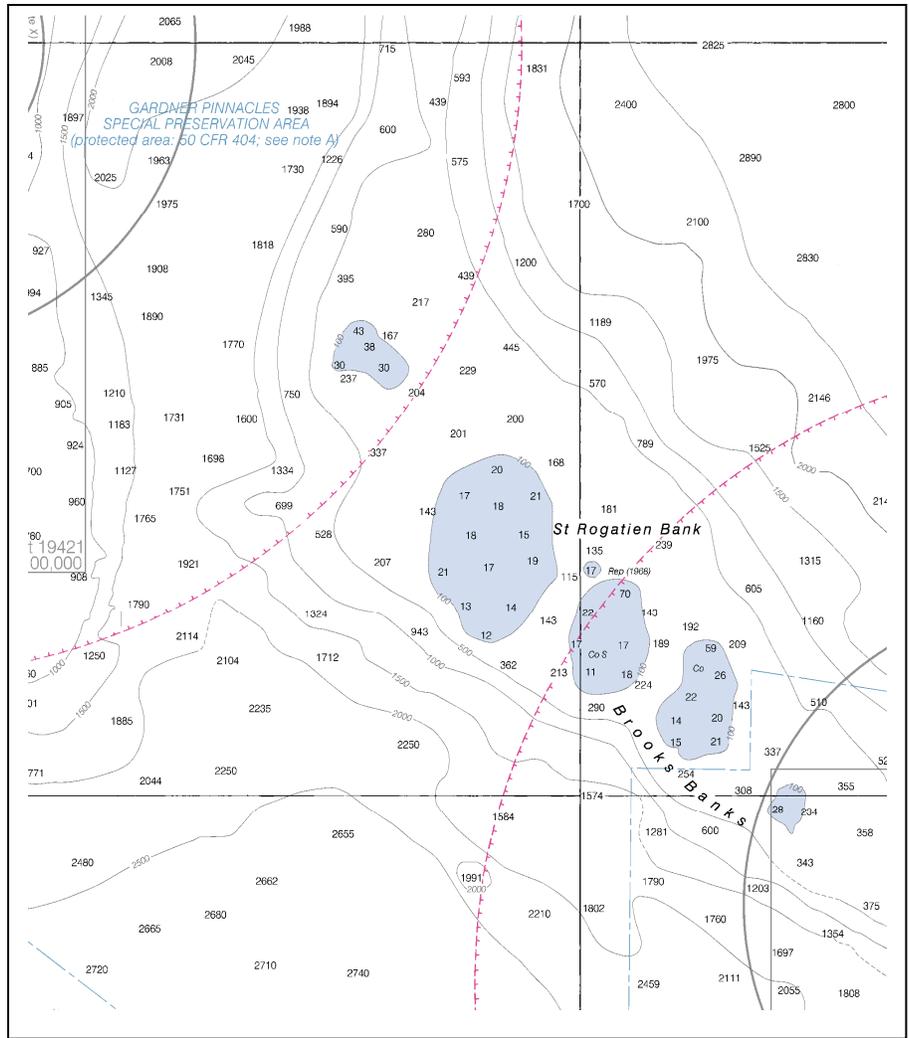
The oceanic flow is variable, but usually sets W. Sixty half-hourly current observations indicate a NW nontidal current of about 0.5 knot, combined with a tidal current of 0.8 knot at strength. The tidal current is somewhat rotary, turning clockwise. The largest velocity observed was nearly 1.5 knots setting W.

Raita Bank (25°32'N., 169°28'W.), is about 85 miles 291° from Gardner Pinnacles. It was discovered in 1921 by the French schooner RAITA. The bank is about 20 miles long in a NNE direction and has a maximum width of about 10 miles.

Depths range from 9 to 20 fathoms, and the sand and coral bottom is plainly visible under ordinary weather conditions. At the 20-fathom curve, the bottom drops off rapidly to great depths. In heavy weather, the swells seem to lump up slightly over the shoaler areas, but there are no known dangers. Large schools of ulua fish and sharks have been observed on the bank. Anchorage can be had on the bank in the open sea with fair holding ground.

Currents

Variable currents are reported in the vicinity of Raita



Necker Island

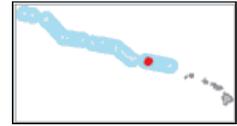
About 155 miles northwest of Nihoa lies Necker Island, a 46-acre basalt island. In the 20th century, Necker Island was given the name Mokumanamana, meaning "bird island." The official name remains Necker Island. There is also a Necker Island in the British Virgin Islands.

Necker Island narrow ridge of volcanic rock about 1,300 yards long, east and west, by a tenth as wide. From the western end a narrow spur extends about 200 yards northward, like the bone point on a Hawaiian trolling hook.

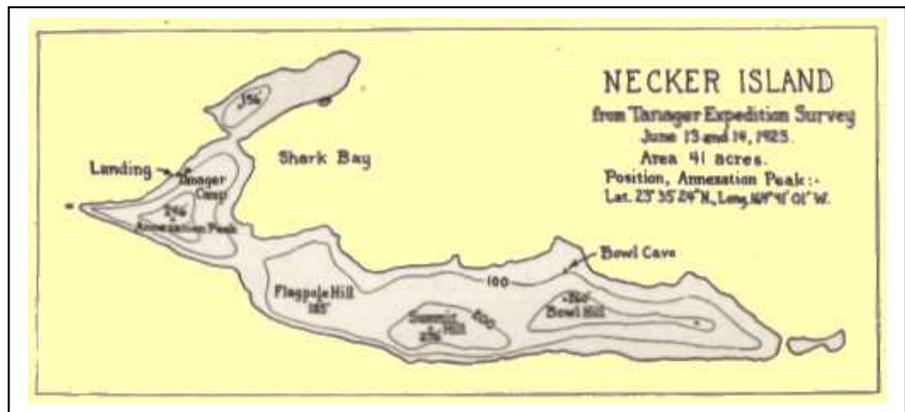
The main crest undulates in a series of five hills. The westernmost of these, called Annexation Hill, is 246 feet high; the next, Flaggpole Hill, 185 feet; the middle one, Summit Hill, 276 feet; the next Bowl Hill, 260 feet; and east of that a narrow ridge, slightly over 200 feet high.

The spur, the highest point of which is 156 feet above sea level, forms with the main stretch of the island a shallow, rocky cove called Shark Bay. During the greater part of the time the water in this bay is too rough to

provide a landing, as it faces both wind and current. West of the spur, however, is a small lee where landing can be made on rocky shelves in moderately calm weather.



Although the island small, it has a large surrounding marine habitat -- about 600 square miles. Large offshore areas include Shark Bay on the north side, West Cove and Northwest Cape as well as miles of shallow reef to the southeast.



The high point of Necker Island is 277 feet.

Archeology

Necker Island is known for its archeological and cultural sites, including 33 religious sites and 17 shelter caves. These cultural sites are thought to date primarily before the habitation sites on Nihoa Island were abandoned in the eighteenth century.

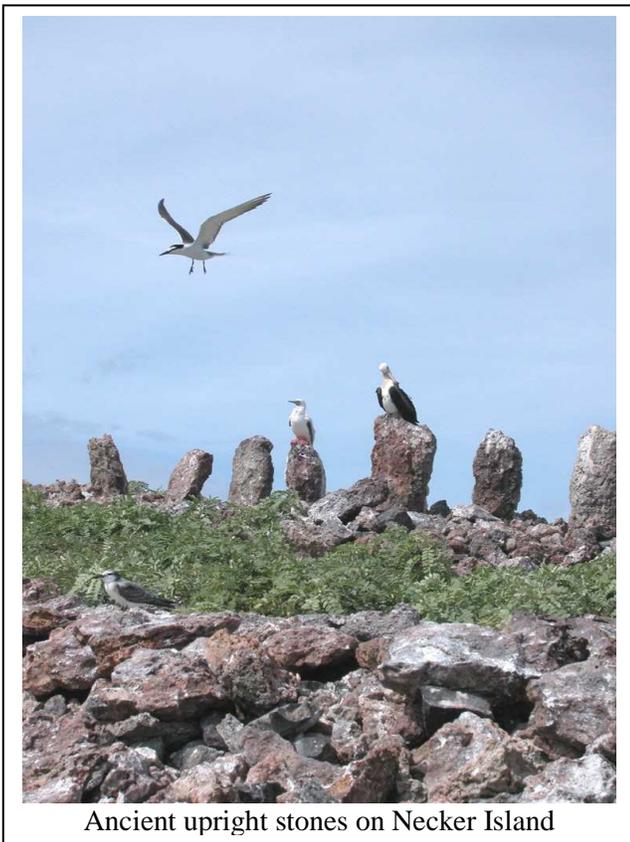
Because the island is small, dry, and has little soil suitable for agriculture, Hawaiians probably traveled to Necker Island from Nihoa and other Hawaiian Islands primarily for religious purposes. It has also been theorized that the



shrines which line the spine of the island may have been used for navigational purposes during the great trans-pacific voyages of the early Hawaiians and Polynesians. In addition to constructing shrines, Hawaiians made ki'i pohaku or stone human images while on Necker Island. More than 11 of these stone ki'i are known. Other activities that took place on the island are indicated by the production and use of stone adzes, grindstones, stone bowls, and fishing tools.

History

Necker Island appears to have been unknown to the Hawaiians at the time of its discovery by La Perouse on November 4, 1786. This



Ancient upright stones on Necker Island

famous French navigator sailed within a third of a league of the island on his passage westward, noting the perpendicular cliffs, white with the droppings of birds, the absence of trees, and the violence of the sea, which made it impossible to land. He called it Ile Necker, in honour of Monsieur Jacques Necker, French Minister of Finance under Louis XVI.

John Turnbull, who visited the Hawaiian islands, December 17, 1802 to January 21, 1803, in the British ship Margaret, mentions in his account of the voyage that he had two Hawaiians, who had been engaged to dive for pearls on a reef in the leeward Hawaiian islands, had landed on Necker, and had their curiosity aroused by a "range of stones, placed with some regularity in the manner of a wall, and about three feet high." Apparently they were the first persons to set foot on Necker Island in modern times.

In 1857, Kamehameha IV sent Captain John Paty to claim Necker Island for the Kingdom of Hawaii. His claim was contested until 1894, when the island was annexed by Hawaii's Provisional Government.

Lieutenant J. M. Brooke visited Necker during January, 1859, and determined its position. During the summer of 1859, Captain N.C. Brooks, of the Hawaiian barque Gambia, on a sealing and exploring voyage, passed the island, but makes no mention of landing, although he states that "a ravine makes down from the southeast end of the rock, where at some seasons there is water. A boat may land in good water at the foot of this gulch."

In 1894, Captain J. A. King was commissioned by Sanford B. Dole and authorised to annex Necker Island in the name of the Provisional Government of Hawaii. On board the Hawaiian steamer Iwalani, Captain William K. Freeman, the expedition arrived off Shark Bay on Sunday morning, May 27, 1894, at 11 a.m. and landed immediately.

The landing party consisted of Captain King, Captain Freeman, Benjamin H. Norton, and nine sailors. A flagpole was erected on Annexation Hill, the Hawaiian flag hoisted, and Captain King read the annexation proclamation. In the course of their exploration of the island the party found some stone images and noted the stone platforms with their rows of upright stones. Fragments of six images were collected during the four hours spent on the island. Copies of seven photographs, taken at the time by B. H. Norton, engineer of the Iwalani, are now preserved in Bishop Museum.

On September 24, 1894, H.B.M.S. Champion, Captain Rooke, landed a party on Necker Island. They collected four more images, two of which are now in the British Museum, London.

On July 12, 1895, Captain King headed another expedition to Necker, on the Revenue Cutter Lehua, to map the island and see if additional images could be found. Dr. William T. Brigham, first director of Bishop Museum, went to make scientific observations, but discovered no additional images. The survey and map were made by F.S. Dodge, of the Hawaiian Government survey. Professor W. D. Alexander was also a member of the party.

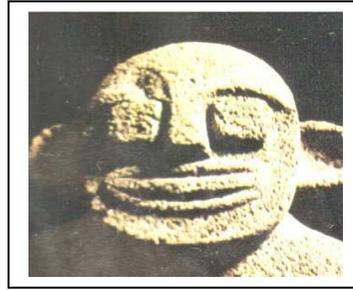
Several other landings were made during the following quarter century, including two by George N. Wilcox, two by officers of the U.S. Revenue Cutter Thetis (1910 and 1913), H. L. Tucker and excursion party in 1917, and the late Gerrit P. Wilder, warden of the Hawaiian Islands Bird Reservation, on the lighthouse tender Kukui, October 6, 1919. Mr. Wilder found the leg of an image.

The Tanager Expedition put two parties ashore between June 12 and 29, 1923. At this time a plane-table map was made by Charles S. Judd and Dr. H. S. Palmer, and a careful study was made of the plant and animal life by other members of the party. The Tanager made another visit to Necker, July 14 to 17, 1924, with a party which made a thorough archaeological survey.

Officially Necker Island is part of the City and County of Honolulu, it having been one of the islands acquired by the United States from the Republic of Hawaii, July 7, 1898. On June 2, 1904, it was leased for fishing purposes for 21 years. February 3, 1909, it became a part of the Hawaiian Islands Bird Reservation.

Biology

Terrestrial animal life on Necker Island includes the blue gray noddy, land snails, wolf spiders, bird ticks, and 15 endemic insects.



Dr. Harold S. Palmer, in 1923, estimated that the rainfall might be 20 to 25 inches a

year. Two small seeps of water, strongly tainted with guano, together might furnish ten gallons of water a day.



View from the Top of Necker Island

Marine life includes gray reef sharks, manta rays and sixteen species of stony corals. Hawaiian monk seals are seen on the island's rocky shores. A great abundance and diversity of sea cucumbers, sea urchins, and lobsters are found in Shark Bay.

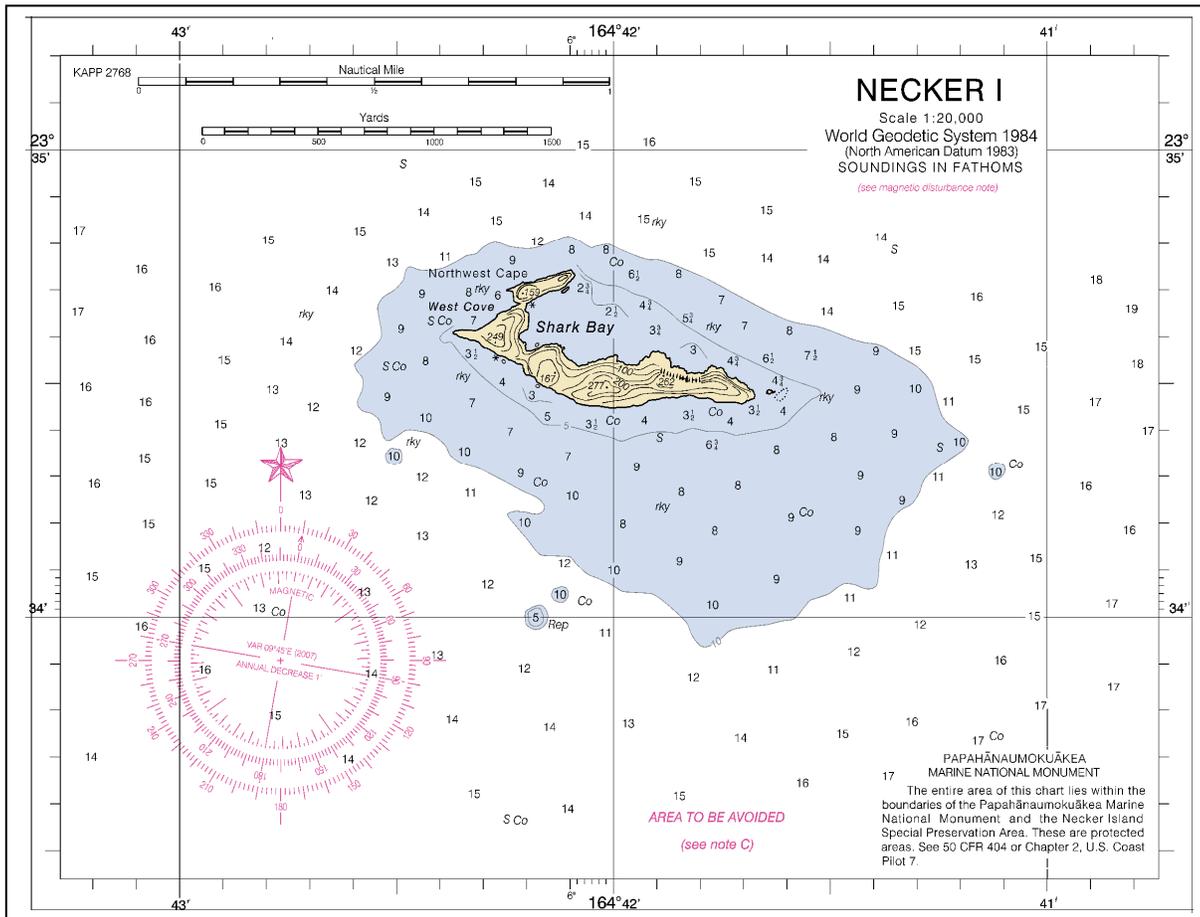
Little coral life exists in the shallow areas due to the constant wave action that scours the underwater basalt, yet Necker Island is the most easterly island in the Hawaiian archipelago where table corals are found.

Most reef life is found in holes and elevated areas protected from the currents.

Below the shallow reef are extensive deeper "shelves" that extend many miles from the island, especially to the southeast. These broad offshore areas are used for commercial fishing and a large percentage of the gray snapper landed in the state comes from these shallow banks.

Rules

Visiting Necker Island is permitted only for scientific, educational and cultural purposes in order to protect its significant natural and cultural resources. Approval must be given by the U.S. Fish and Wildlife Service and is mostly granted to those doing cultural and scientific activities.



Nihoa and Necker Islands

By Dennis Kawaharada

In 1822, Ka'ahumanu and a royal party including Kaumuali'i, Liholiho, Keopuokalani and Kahekili Ke'eaumoku, visited Ni'ihau and heard chants and stories about an island called Nihoa, to the west of Kaua'i, the direction from which the winter rains came:

'Ea mai ana ke ao ua o Kona,
'Ea mai ana ma Nihoa
Ma ka mole mai o Lehua
Ua iho a pulu ke kahakai

The rain clouds of Kona come,
Approaching from Nihoa,
From the base of Lehua,
Pouring down, drenching the coast.

Intrigued, Ka'ahumanu organized an expedition and sailed in two or three boats under Captain William Sumner to visit the island. They landed on the once inhabited, but long deserted island 150 miles WNW of Kaua'i and annexed it to the Hawaiian kingdom. The waterfront area around Ka'ahumanu Street in Honolulu was named Nihoa in honor of the visit. The island was annexed to the Hawaiian Kingdom again by Kamehameha IV, who landed on the island in 1857. In 1885, Queen Lili'uokalani, with 200 excursionists, visited Nihoa on the steamer 'Iwalani, and brought back artifacts—a stone bowl, a stone dish, a coral rubbing stone, and a coral file (Emory 8-11).

Nihoa, jutting up from the sea beyond sight of Kaua'i and Ni'ihau, is the westernmost place in this tradition of Kaua'i geography. It has come to stand for "one who bravely faces misfortune": "Ku paku ka pali o Nihoa i ka makani"—"The cliffs of Nihoa stand strongly against the wind" (Pukui, 'Olelo, No. 1924). "Nihoa" means "firmly set," or "toothed," "serrated," possibly a reference to its jagged profile; from one side, it looks like a molar, standing isolated at sea. (In Micronesia, an island seen from a departing canoe, just before the island disappears from sight is called a "tooth," and serves as a final landmark to orient the canoe on its voyage.)

Nihoa is a mile long, a quarter mile wide, and 900 feet high on its east end. It was designated a wildlife refuge by Theodore Roosevelt in 1906. It is inhabited by insects, monk seals, two species of land birds, a finch and a millerbird, found nowhere else, and numerous seabirds (terns, boobies, petrels, shearwaters, albatrosses, tropic birds, and

frigate birds). Today, access is controlled by the U.S. Fish and Wildlife Service and landing, except for scientific study and cultural purposes, is prohibited.

Nihoa was once inhabited by the kanaka maoli, sometime between 1000 and 1500 A.D. About 35 house sites, 15 bluff shelters, 15 heiau, and 28 agricultural terraces have been identified on the island (Emory 12; Cleghorn 21-22). Various artifacts have also been collected, including fishhooks, sinkers, cowry shell lures, hammerstones, grindstones, adzes, and coral rubbing stone (Emory 38-50). The evidence seems to indicate permanent or semi-permanent settlement.

Living on the island would have been difficult. Surveys have discovered only three seeps of water, all contaminated with guano (Emory 12). Tava and Keale report a tradition of Ni'ihau that a spring called Waiakanohoaka provided good, sweet water (102), but this spring has not been located. The freshwater on the island comes from the estimated 20-30 inches of rain that falls annually from passing squalls (Cleghorn 26).

Archaeologists surmise that the terraces were planted with sweet potatoes, a crop requiring less water than thirsty taro. They estimate that the 12-16 acres under cultivation might have supported about 100 people (Cleghorn 25). Fish, shellfish, crabs, lobsters, turtles, and seals, as well as seabirds and their eggs, are abundant sources of food. Cleghorn speculates that the food and water supply was sufficient for subsistence, but that the lack of firewood would have created a hardship (26). The only tree on the island is the loulou palm. Archaeologist Kenneth Emory of the Bishop Museum counted 515 palms when he landed in 1923. Its fan-like leaves were used for plaiting, and its trunk could have been used for building shelters or for firewood. But if the trees were cut down for firewood, the supply would have eventually been depleted.

Without the numerous kinds of plants in the forest of the larger islands (e.g., koa, 'ohi'a, hau, hala, olona, wauke), the settlers could not have provided themselves with canoes, wood containers, nets, fishing line, clothing and blankets, mats, and medicines. The colony was probably supplied with these products from Kaua'i or Ni'ihau. Several gourd fragments have been found; other bowls and containers were carved from stone.

Landing on the island is difficult. High, sheer cliffs prevent landing on the east, north, and west sides; the island slopes down to the south, but the

shoreline is rocky and unprotected from the surge of southerly swells. Large vessels anchor offshore, and those who wish to land have to go in on a smaller boat or swim ashore. In ancient times, small canoes could have been carried up onto the rocky coast on calm days. If the canoes used to reach the island were somehow damaged in the rough surf, the settlers would not have been able to repair their canoes with resources from the island. They would have been trapped until other canoes arrived from Ni'ihau or Kaua'i.

Partial skeletons of men, women, and children have been found on the island, and two burial sites located. The journey of spirits to the afterworld (in the west, toward the setting sun) would have been shorter from this western outpost than from the islands to the east. The name of a place on the island where spirits of the dead departed for the afterworld is still remembered: it was called Mau-loku ("Continuous falling"; Pukui et al Place Names).

How the island was discovered is not known—possibly by fisherman working the seas west of Kaua'i, or following seabirds to gather their feathers or eggs. Red feathers were coveted for making sacred objects, and the red-tailed tropic bird is one of the seabirds that nests on Nihoa. Polynesians traveled great distances to obtain such feathers: one Marquesan tradition tells of a 1200-mile voyage, from Hiva Oa to Rarotonga, to obtain the red feathers of a kura bird; and the voyaging chief Hema is said to have sailed back to Kahiki to obtain a girdle of red feathers for his son Kaha'i.

Once discovered, the island became a part of the economy of Ni'ihau, an island relatively limited in resources. The traditions of Ni'ihau say that the people of that island were frequent and perhaps long-term visitors to collect loulu palm wood for spears and a grass called Makiuku, which could be used for cordage and stuffing (Tava and Keale 102).

Another motive for visiting the island is suggested by the chant of Ni'ihau describing the Kona rain clouds coming from Nihoa and soaking the west coasts of Kaua'i and Ni'ihau. Small, low islands like Ni'ihau and also the leeward coasts of high islands like Kaua'i depend on the heavy rains of annual Kona storms to bring life to their crops. But if the storms stay west or pass to the north without reaching Hawaii, as they sometimes do, droughts and, in ancient times, famine, could occur. Could the people of Ni'ihau or leeward Kaua'i have sailed west to get closer to the source of these rain clouds or the deities who controlled them in order to pray for rain and make offerings? Water represented life

and wealth in ancient Hawaii, and such a voyage might have been worth the effort and the risk.

One hundred and fifty miles west of Nihoa is an island called Necker. This island is smaller and has even fewer resources than Nihoa. There are no trees and no soil. Yet the island is covered with some 33 heiau (Emory 59). Several stone images, the largest around 16 inches high, were found by visitors in historical times. The images look like gingerbread men—flat, neckless, with round faces, from which eyes, noses, mouths, and ears protrude (Emory 125, Illustrations XX-XXII). Who or what these images represent is unknown.

The Hawaiian name for Necker has been lost. But Teva reports that there are four names remembered on Ni'ihau of islands beyond Nihoa: Mokuakamohoali'i, Hanakaieie, Hanakeaumoe, and Ununui (103). Mokuakamohoali'i, "Island of the Shark God Kamohoali'i," is a possible name for Necker, as the largest geographical feature on this island is a bay called "Shark Bay." Kamohoali'i was the king of sharks and brother of the volcano goddess Pele. The Pele migration is said to have come from the west, with Kamohoali'i serving as the navigator.

Cleghorn suggests that in addition to going to Necker for gathering resources such as bird feathers and eggs, the visits may have had a ritualistic purpose: the heiau could have belonged to a bird cult, similar to the one on Rapa Nui (Easter Island) (61). But the heiau and statues could also have been used in rain-god worship. And as in the kachina rituals of the American Southwest, the rain deities might have been associated with ancestral spirits who return each year in the form rain clouds from their homes in the west. (The winter rains of the American Southwest come from the west, as they do in Hawaii.) In either case, birds and rain clouds are metaphorically connected with each other in Hawaiian chant. Beckwith notes, "The cloud hanging over Ka'ula is a bird which flies before the wind:

The blackbird begged,
The bird of Ka'ula begged,
Floating up there above Wa'ahila"
(The Hawaiian Romance of Laieikawai, p. 323).

Nihoa would have been a stop on the way to or from Necker. Annual visits to Necker during the spring and summer trade wind season could have been made, when food would have been abundant on and around Nihoa and Necker. A Ni'ihau tradition suggests such was the case: "The Ni'ihauans sailed to Nihoa in the spring, returning

to Ni'ihau in the fall on the Kona winds" (Tava and Keale 102). The same sailing strategy could have taken them to Necker. After landing on Necker, prayers and offerings could have been presented to the deities. Then the pilgrims could have fished, hunted birds, collected eggs, and built or maintained heiau. When a cold front approached, the canoes could head back to Ni'ihau or Kaua'i on the southwesterly winds that precede the front or the northerly winds that follow.

Any downwind sail with the prevailing winds is a risky undertaking, because unless the wind shifts, the sail home involves tacking into the wind, something which the keel-less Polynesian canoes would have great difficulty doing. The risk is weighed against the importance of the potential benefits of going to the downwind destination. For a community dependent on farming, drought could be disastrous. If one of the sources of the life-giving waters of Kane was westward, was it worthwhile to sail west to present offerings and prayers to a god who brought life-giving waters? For a time in Hawaiian prehistory, the answer was apparently yes; then, perhaps after dry-land taro and sweet potato cultivation in areas with limited

rainfall had improved enough so that famine was no longer a seasonal threat, such voyages became unnecessary.

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French Frigate Shoals



French Frigate Shoal is a crescent-shaped reef on a circular platform about 18 miles in diameter, about 480 miles northwest of Honolulu. This reef forms a barrier against winds and currents around the north and east sides of the platform. The south and west sides of the platform are covered by water which averages a hundred feet in depth. Near the center of the platform stands a small rocky pinnacle, La Perouse Rock.

The formation of this platform was described by Dr. Harold S. Palmer in 1923; paraphrasing this account we might say that once upon a time a high volcanic peak, perhaps fifteen miles in diameter, rose above the waves in this area. Rain and waves eroded its slopes and coast until all of it that now remains above the sea is La Perouse Rock, 500 feet long, 80 feet thick, and 122 feet high, and its companion, 350 feet to the northwest, which is 100 feet long, 40 feet wide, and 10 feet high.

Corals grew upon the platform which the waves had carved, until they formed a sweeping curve of reef 17 miles from tip to tip and 5 miles wide in the middle. On this reef sand and coral debris is continually being shifted from place to place and piled into little islets; elsewhere there is shallow lagoon.

We know that these islets are being built up and washed away, for in 1859, when a survey was made by Captain N.C. Brooks of the Hawaiian barque *Gambia*, there were five rather large coral islets, while in 1923, when the Tanager Expedition surveyed the shoal, more than thirteen small ones were found.

The 1923 map shows their location at that time, with the names that were given to them. The islets doubtless have shifted their position again by now.

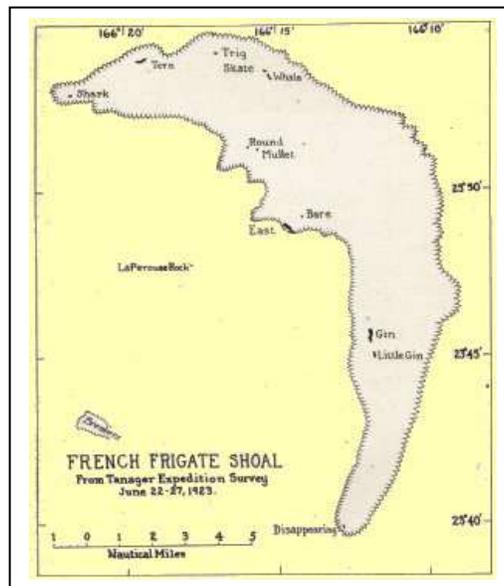
In the lee of this crescent-shaped reef the water is calm and smooth when the trade wind blows, as it does most of the time. This has

been found a safe landing place by several flights of sea planes which have flown there from Oahu during the past half dozen years.

The reef also breaks the force of the waves against the rocky remnant of the once lofty dome, and is helping to preserve it. In certain lights and from certain directions La Perouse Rock resembles a ship under full sail, but this resemblance to a frigate is not what gave the shoal its name.

History

The gallant French navigator, Jean Francois de Galaup comte de la Perouse, with his two vessels, *Broussole* and *Astrolabe*, was

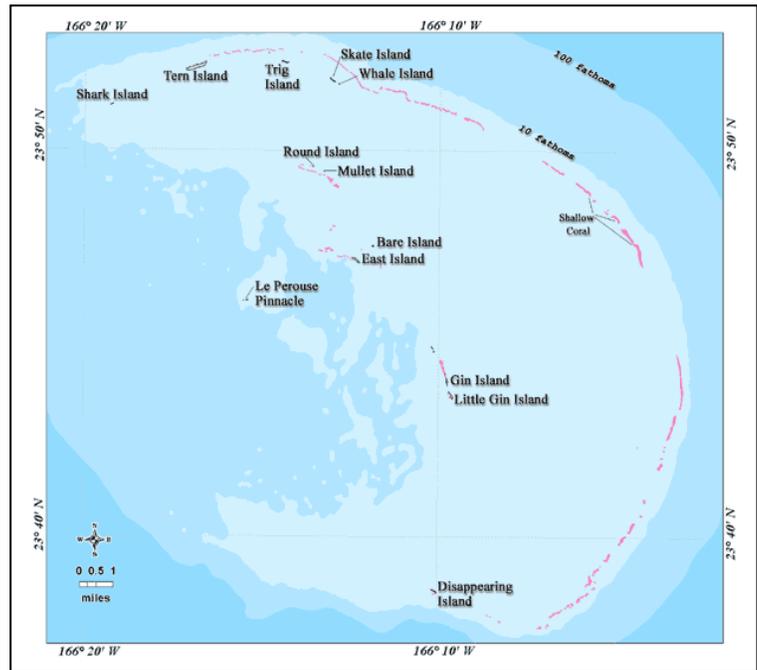


westward bound from California on a voyage of discovery. The presence of large numbers of sea birds -- boobies, man-o'-war birds, and terns -- had put them on the alert for a sight of land, and on November 4, 1786, they had discovered Necker Island. After making a survey of the shoals to the west of this lonely rock, the two vessels proceeded westward.

"Since our departure from Monterey," runs the entertaining narrative, "we had never experienced a finer night, or a more pleasant sea; but this tranquillity of the water was among the circumstances which had nearly proved fatal to us.

"Toward half past one in the morning we saw breakers at the distance of two cables length a-head of my ship. From this smoothness of the sea they made scarcely any noise, and some foam only, at distant intervals, was perceptible. The *Astrolabe* was a little farther off, but she saw them at the same instant with myself.

"Both vessels immediately hauled on the larboard, and stood with their heads south-southeast; and as they made way during their manoeuvre, our nearest distance from the breakers could not, I conceive, be more than a cable's length."



La Perouse goes on to describe how the next day a careful survey was made of the shoal, which the discoverer named "Basse des Frigates Francaises, shoal of the French Frigates, because it has nearly proved the final termination of our voyage." This discovery was made in November 6, 1786.

In August 1838 a United States Exploring Expedition put to sea under command of Lt. Charles Wilkes. This expedition spent some six months in the Hawaiian area; on 3 December 1841 they sighted French Frigate Shoals but were unable to land due to bad weather.

In early October 1858 the U.S. Schooner *Fenimore Cooper*, commanded by Lt. John M. Brooke, U.S. Navy, left San Francisco to sound out a route via Hawaii to Japan for a possible underwater telegraph cable. The *Fenimore Cooper* visited French Frigate Shoals from 3 to 7 January 1859; Brooke took depth soundings and charted the various islets for the first time. More importantly, however, Lt. Brooke took formal possession of French Frigate Shoals for the United States on 14 January in accordance with the U.S. Guano Act of August 1856.

Brooke also reported the discovery of guano at French Frigate Shoals, a fact which produced much excitement in Honolulu among guano investors. The bark *Gambia* sailed to the

Shoals on 5 March 1859 and on the 23rd the American clipper ship *Modern Times* also set sail. Both ships returned with disappointing news concerning the size of the deposits and the cost of their removal.

The first wreck recorded on the Shoals was of the American whaling ship *South Seaman*, which wrecked on 13 March 1859. Fortunately the Hawaiian schooner *Kamehameha IV* was in the area and brought back to Honolulu 12 of the *South Seaman's* crew. The remaining 30 or so crewmen were left on one of the islands until the *Kamehameha IV* (chartered by the American consul) returned to pick them up.

The *Gambia*, under the command of Captain N.C. Brooks, again visited French Frigate Shoals in late April or early May 1859. While at the Shoals, Brooks noted an abundance of seals, turtle, fish, and birds.

On 14 April 1867 French Frigate Shoals was the site of the shipwreck of the bark *Daniel Wood*. All of the crew managed to reach one of the islands.

On the 16th Captain Richmond, the second mate, and 6 men embarked for Honolulu in one of the ship's whaleboats, leaving 27 shipmates behind. They landed at Honolulu on the 24th.

The U.S.S. *Lackawanna* was dispatched by the American Consul to rescue the rest of the crew. On 20 May the schooner *Malolo* sailed for the Shoals in search of the wreck of the *Daniel Wood*. The *Malolo* returned to Honolulu on 22 June without finding a trace of the wrecked ship.

When U.S. Naval Hydrographic Office Maps 2, 3 and 4 showing the entire Northwestern Hawaiian Islands in detail were published in 1867, other countries became interested. The Japanese soon began to fish in the area. The Japanese-owned American-chartered schooner *Ada*, working out of Yokohama, visited French Frigate Shoals from February to May 1882. It left the Shoals with a cargo of sharks' flesh, fins and oil, turtle shells and oil, and birds' down.

The North Pacific Phosphate and Fertilizer Company was interested in mining guano on the central Pacific islands. A letter from J.P Hackfeld, secretary of the company, dated 6 January 1894, to James A. King, Minister of the Interior of the new Republic of Hawaii, requested that King order the lease by public auction of French Frigate Shoals, Kure, Midway, and Pearl and Hermes Reef for a term of 25 years and that the purchaser should have the exclusive right to mine guano, phosphate, fertilizers, and other materials.

The islands were leased on 15 February 1894 for a period of 25 years to the North Pacific Phosphate and Fertilizer Company. This company was also granted exclusive rights to the guano deposits provided they would be worked within five years; otherwise, the rights would revert to the Hawaiian government. Since the Pacific Guano and Fertilizer Company never worked French Frigate Shoals, their guano rights presumably reverted in 1899.

In order to obtain clear titles to the northwestern islands for the Republic of Hawaii, President Sanford B. Dole on 9 July 1895 appointed James A. King, Minister of the Interior, Republic of Hawaii, as Special Commissioner to take possession of French Frigate Shoals. On that same date, King sailed from Honolulu on the Revenue Cutter *Lehua*, commanded by Captain Berry, in pursuance of President Dole's commission.

The *Lehua* sighted the rock islet of French Frigate Shoals on 13 July, and King landed and took possession; on a nearby sand island they planted the Hawaiian Flag.

The U.S. Navy, as well as other U.S. Government agencies, became interested in the Northwestern Hawaiian Islands in the late 1890's and early 1900's. Hawaii became a United States Territory on 30 April 1900. In 1902 the U.S. Fish Commission Steamer *Albatross* stopped at the Shoals; among their activities was wildlife survey.

Preservation of wildlife was of prime importance in the early 1900's and President Theodore Roosevelt signed an Executive Order on 3 February 1909 setting aside all the Northwestern Hawaiian Islands, except Midway, as a preserve and breeding ground for native birds. This preserve, to be known as the Hawaiian Island Reservation, was to be administered by the Department of Agriculture.

Subsequently, U.S. Revenue Cutter Service vessels were used to patrol the area for bird poachers. The USRC *Thetis* made several trips to the islands from 1912 to 1916. The USS *Hermes* visited in 1918 on a similar inspection survey.

In 1914 the USS *Rainbow* conducted a hydrographic survey outside of the reef. The subsequent map, first printed in June 1915, is considered to be the first modern map of French Frigate Shoals.

As part of a biological survey of central Pacific islands, the Tanager Expedition, with 11 scientists, visited the atoll from 22 to 28 June 1923. Alexander Wetmore was the field director for this survey; his unpublished field

notes reveal details on the avifauna present as well as a description of each island. Many scientific collections were made. This survey was the first overall scientific survey of French Frigate Shoals.

In 1923 the sand islets had a total area of about 46 acres, of which 17 acres were covered with a sparse growth of grass and other low vegetation, a total of six species of herbs and vines. Their highest elevation was 10 to 12 feet; most of the islets were lower. Their population consisted of thousands of sea birds, most of them terns.

With a calm sea it was quite possible to land on the southwest side of La Perouse Rock. But the precipitous slopes were so crumbly and slippery with bird guano that no one cared to climb to the top.

Rock samples showed that this remnant core consists of olivine basalt, very similar to that which makes up much of the rest of the great chain of volcanic mountains, the summits of which form the islands of the Hawaiian group.

Biology

The reef system at French Frigate Shoals supports 41 species of stony corals, including several species that are not found in the main Hawaiian Island chain. More than 600 species of marine invertebrates, many of which are



endemic, are found here as well.

More than 150 species of algae live among the reefs. Especially diverse algal communities are found immediately adjacent to La Perouse Pinnacle. This has led to speculation that an influx of additional nutrients — in the form of guano — is responsible for the diversity and productivity of algae in this environment. The reef waters support large numbers of fish. The masked angelfish (*Genicanthus personatus*), endemic to the Hawaiian Islands, is relatively common here. Most of Hawaii's green sea turtles travel to the shoals to nest.

The small islets of French Frigate Shoals provide refuge to the largest surviving population of Hawaiian monk seals, the second most endangered pinniped in the world. The majority of the population of 1,400 seals rely on the protected isles and reefs of the Northwestern Hawaiian Islands for food and breeding grounds.

The islands are also an important seabird colony. 18 species of seabirds nest on the islands, most of them (16) of them on Tern Island. Two species, the Blue-gray Noddy and the Brown Booby, nest only on La Perouse Pinnacle. The island also is the wintering ground for several species of shorebird.

A three-week research mission in October 2006 by NOAA led to the discovery of 100 species never seen in the area before, including many that are totally new to science. The French Frigate Shoals project is part of the Census of Coral Reef Ecosystems of the International Census of Marine Life.

Coast Pilot

French Frigate Shoals, about 85 miles W from Necker Island, is a crescent-shaped atoll about 17 miles long in a NNW direction. It was discovered by La Perouse on November 6, 1786, the day after leaving Necker Island, and like that island, was annexed to Hawaii in 1895. The atoll consists of a coral reef with a number of small, bare, sand islets on it, and is flanked by a volcanic rock and numerous coral heads and reefs. It is home to many sea birds, seals, turtles and other fish and wildlife all protected by Federal Law.

La Perouse Pinnacle and Tern Island are the best landmarks. The other islands are of little assistance in navigation due to their constantly changing size and shape and low elevations. Shark Island has been observed to be particularly unreliable in this regard.

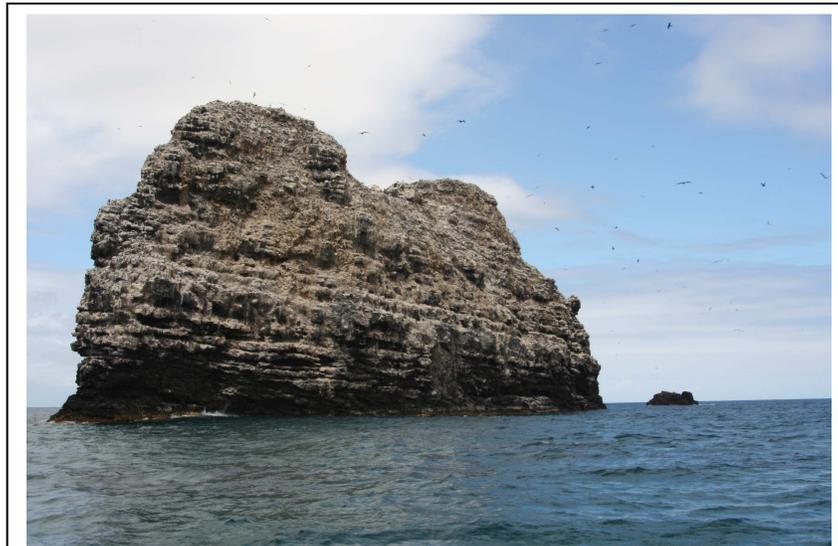
The crescent reef is double, and the outer and inner arcs bound a lagoon that is 1 to 6 miles wide. At its midpoint the windward reef lies about 8 miles from a line joining the tips of the crescent; the leeward reef is about 5 miles from this line. The windward reef is nearly continuous and can be plainly seen in the daytime for a considerable distance by vessels approaching from the N, E or SE. The sea practically always breaks over the reef, and during the few times it is not breaking, the green shoal water inside the reef is seen in ample time to avoid danger. The bottom slopes uniformly from the reef to the 100-fathom curve 1 to 2 miles off, and there are no known dangers from N through E to S of the windward reef.

The leeward or inner reef, however, is broken in many places and in normal weather is

seldom marked by breakers. The lagoon between the reefs is very foul with numerous coral heads, some just under the surface of the water.

A bank with depths of 8 to 20 fathoms extends about 8 miles W from the midpoint of the inner reef, where it then drops off rapidly to great depths.

La Perouse Pinnacle (23°46'N., 166°16'W.), a volcanic rock about 60 yards long, 20 yards wide, and 122 feet high, lies about midway between the tips of the crescent and W of the leeward arc of the reef. The rock is so steep and rugged that is almost inaccessible. From a distance its guano-coated outline resembles a brig under sail. A small detached lava rock about 9 feet high lies off the W side of the pinnacle. The points of the crescent reef, as indicated by the ends of the line of breakers, bear about 170° and 310° from La Perouse Pinnacle. La Perouse Pinnacle is reported to be the first object sighted, generally, when approaching the atoll, and that it is usually



La Perouse Pinnacle

picked up on radar at 12 to 15 miles.

Shark Island, the northwesternmost of the sand islets, lies 6 miles NW of La Perouse Pinnacle. A coral reef fringes the island. **Tern Island**, about 2 miles ENE of Shark Island, is marked by two 40-foot towers, low concrete buildings, a wooden telegraph pole, and four large trees. The island and buildings are visible at 8 and 5 miles, respectively. There are no facilities on the island.

East Island, 3 miles ENE of La Perouse Pinnacle, is a low sand bar 600 yards long in a NW direction and about 100 yards across. Reefs that are awash most of the time extend a mile W and 0.2 mile S from the island; the S reef seldom breaks. A coral head that sometimes breaks is 0.6 mile S of East Island. NE and E of the island are numerous coral heads and reefs.

Extreme caution must be exercised when navigating in the vicinity of these islets because of the numerous coral heads.
Channels

The principal approach to Tern Island is through a natural channel that leads to a lagoon and anchorage SE of the island. Entry into the lagoon is through an opening in the reef indicated by the 3¼-fathom sounding in 23°51'09"N., 166°16'27"W., on chart 19402. Mariners are advised that attempting entry into the lagoon requires extensive local knowledge, good sea and weather conditions, and the sound judgment to recognize when conditions allow committing the vessel to a course through the reef opening.

Anchorage

The best holding ground SW of French Frigate Shoals is in depths of 13 to 15 fathoms, sand bottom; in lesser depths the bottom is mostly coral. There are no all-weather anchorages for large vessels, but the conformation of the reef is such that some protection can be found from choppy seas and ground swell. Small vessels can find good protection from most weather behind the shoals and coral heads.

Routes

Vessels approaching French Frigate Shoals from the N, E, or SE in the daytime should have no difficulty in picking out the outer reef from a considerable distance off. La Perouse Pinnacle, plainly visible from outside the reefs in clear weather, is reported to make a good radar target at 19 miles. From the S, the reef is not so easily seen. The sea may not break over the shoals, and although the bottom is plainly visible close in, the shoals might not be detected from a short distance. The 100-fathom curve is only about 0.5 mile from the shoals.

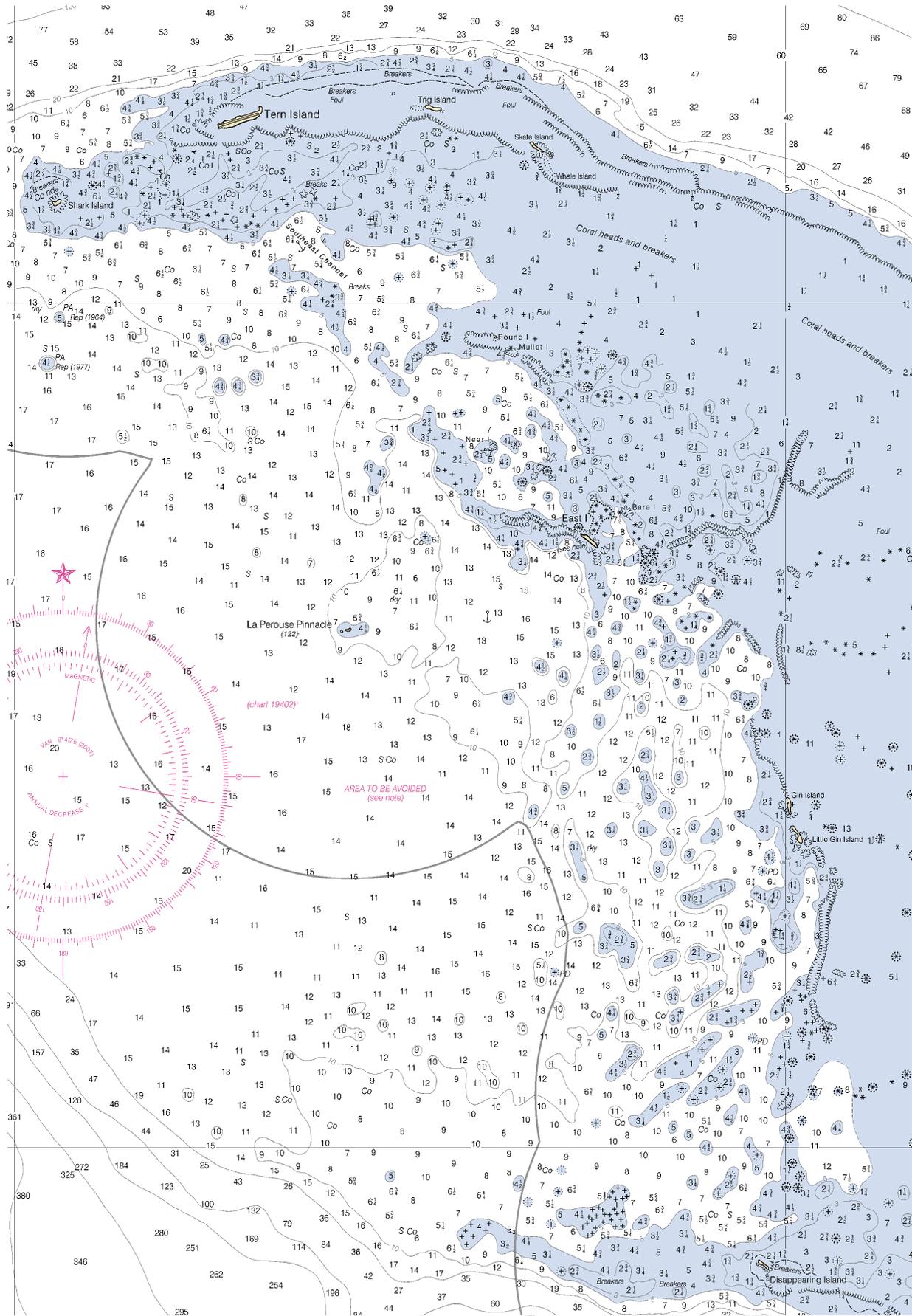
Currents

A prevailing current sets W in the vicinity of French Frigate Shoals, but variable currents have been noted. A SW current of 2 knots has been measured. A 1-day series of half-hourly

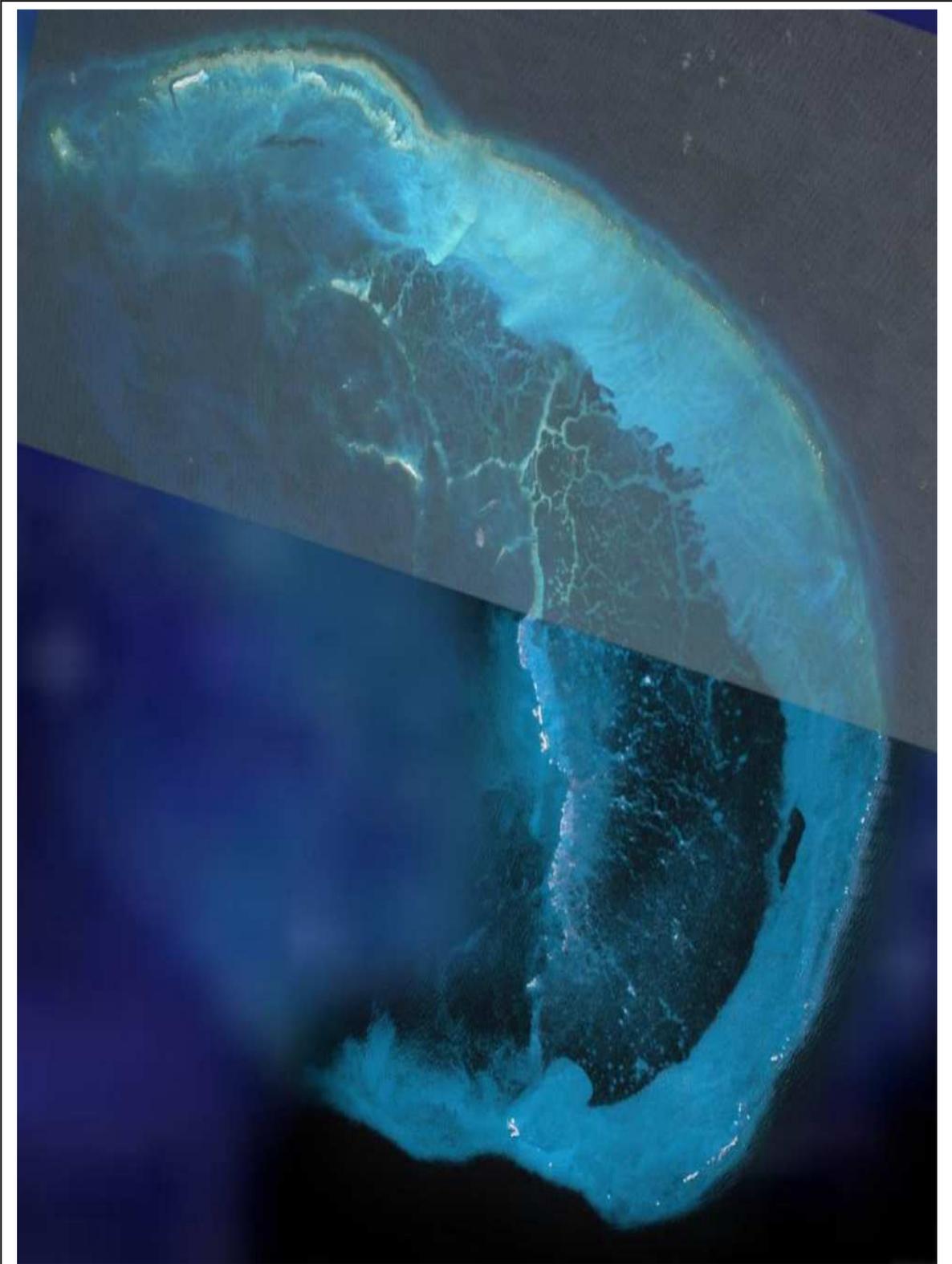
current observations taken 0.7 mile W of the S end of the shoal during a period of small wind velocity shows practically no current.

Weather, French Frigate Shoals and vicinity

The NE trades prevail throughout the year, but W blows can be expected during the winter. The average wind velocity is 12 knots, with monthly averages of about 16 knots in December to 9.5 knots in August. Gales have been experienced in July and September. Occasional heavy showers of short duration cut visibility to about 2 miles (4 km).



French Frigate Shoals (fathoms)



French Frigate Shoals

Tern Island

Tern Island was originally only a few hundred feet long, but was expanded during World War II by dredged coral from 11 acres to 42 acres, with a 3,100' x 275' runway and a ramp area to accommodate 24 single engine aircraft. The Tern Island runway is currently 3000' x 200'.

Barracks, a fuel depot, and a LORAN station were constructed over the years. The barracks still house five to ten people, including FWS managers, volunteers, researchers, and monk seal field teams.

History

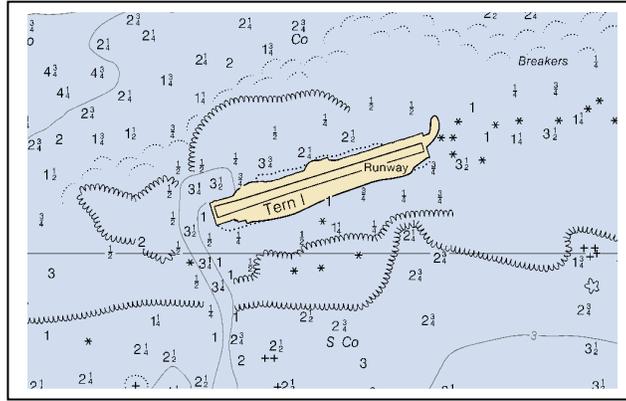
In World War II, Japan made plans to use French Frigate Shoals to refuel seaplanes from submarines in the sheltered waters of the atoll, as part of their attack on Midway Island.

Such a refueling was successfully carried out in 1942 by two H8K Emily flying boats, which were refueled by a submarine within the French Frigate Shoals atoll.

The seaplanes then mounted a bombing raid on Pearl Harbor, although they were thwarted from hitting their targets by inclement weather.

Later in 1942, elements of the 5th Seabee Battalion arrived on Tern Island to begin construction of an airfield.

To make the island large enough to accommodate landing planes, the Navy enlarged the island by building a retaining steel wall, blasting and dredging a channel around the island, and using the blasted coral to fill in the wall. The result was an island shaped like an aircraft carrier.



The island was originally only a few hundred feet long, yet was expanded by dredged coral to create 3,100' x 275' runway and a ramp area sufficient for 24 single engine aircraft.

The expanded island's area encompassed 27 acres, of which 20 were taken up by the airfield.

On the meager remaining land, partially buried Quonset Huts were erected to serve as housing, painted white to blend in with the surrounding coral. The typical complement was 118 men, who rotated from Pearl Harbor on a three month tour.

The station was commissioned in 1943 as an auxiliary of NAS Pearl Harbor. It served as an



Laysan Albatross and Monk Seal on Tern Island

emergency landing strip and refueling stop for

fighter squadrons transiting between Hawaii and Midway, and provided surveillance of the surrounding area. It was protected by a variety of anti-aircraft artillery.

In 1946 the island was swept clean by a tsunami, after which point the base was closed by the Navy.

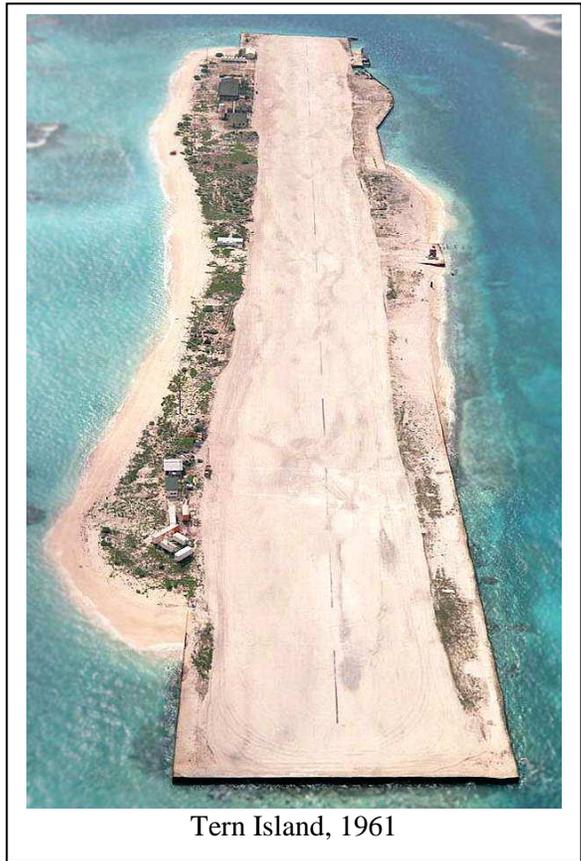
In 1952, the Coast Guard built a LORAN station on the island, along with a 20-man supporting facility. The runway was used for weekly mail & supply flights. The Coast Guard installation continued in operation until 1979.

From 1961 to 1963, the Pacific Missile Range had a portable tracking station located at one end of the island, operated by the Bendix Radio company and staffed with 6-10 people. They tracked both US and Soviet spacecraft, including the first Soviet manned mission.

The Pacific Missile Range personnel lived in the Quonset Hut located about halfway down the runway, and later, during the Starfish atomic tests, two house trailers were shipped to the island.

The Tern Island runway was used by specially equipped C-130s from Hickam Air Force Base. The C-130 had a rig hanging out the rear cargo door that was usually used for snagging in mid-air the parachute of a descending Discoverer satellite capsule.

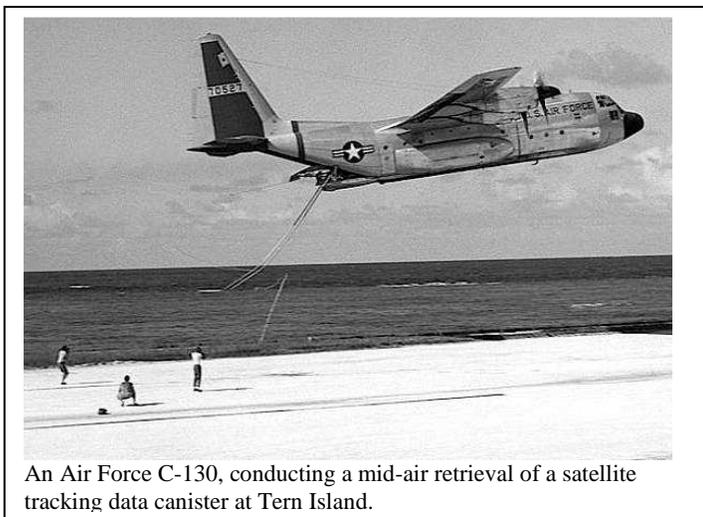
When the French Frigate Shoals tracking



Tern Island, 1961

installation obtained data from a particularly important track, The data tapes would be put in a fiberglass canister, attached by a nylon rope to a grappling hook at the top of a pole erected on the runway. This would be snagged by the C-130 in mid-air above the runway.

The C-130s did not land on French Frigate Shoals because the coral sand would be ingested in the engines when the props reversed.



An Air Force C-130, conducting a mid-air retrieval of a satellite tracking data canister at Tern Island.

After the Pacific Missile Range left Tern Island, tracking was conducted on specially outfitted ships such as the USNS Longview.

USFWS

In 1979, the U.S. Fish and Wildlife Service took over management of Tern Island. Tern Island is maintained as a field station in the Hawaiian Islands National Wildlife Refuge.

It provides critical breeding habitat to millions of nesting seabirds, endangered Hawaiian Monk Seals, and threatened Hawaiian Green Sea Turtles. The

infrastructure on Tern Island, inherited from the US military, enables scientists to use Tern Island as a base for research.

Because of its remote location, and the sensitivity of the breeding animals to human disturbance, the general public is not admitted on Tern Island. Only specially permitted biologists and researchers are allowed on the island. If you want to go, try volunteering for the USFWS. You'll have one of the most memorable experiences of your lifetime.

All Tern Island residents are housed in the old coast guard barracks. In addition to dormitory-style bedrooms and bathrooms, the barracks contain a common room, kitchen, and food storage room. The kitchen is equipped with the basics (minus electricity-greedy appliances) and cooking is done on a propane stove. A several-month supply of canned and dried food is stored carefully in a large pantry. Island residents cook communally on a rotating schedule and usually eat together.



Seabird colony with Great Frigatebirds, Red-tailed Tropicbird, Red-footed Boobies, Sooty Terns and Black Noddies. Tern Island, French Frigate Shoals.

Transportation and supplies

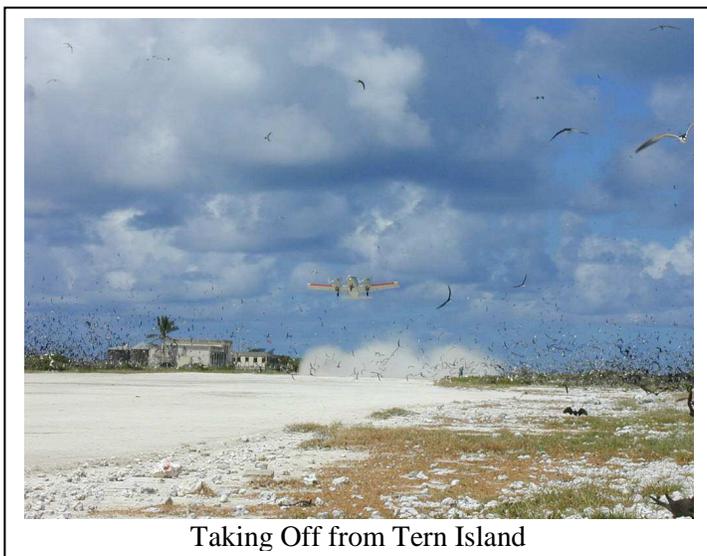
Everything and everyone arrives on Tern in one of two ways: by boat or plane. The "Sarah K", usually piloted by Bob Justman, flies between Honolulu and Tern about once a month. It shuttles scientists to and from the island, carries mail, and occasionally brings groceries. Heavier items or larger field crews arrive by boat. Large ships anchor well outside of the reef, so smaller boats shuttle the equipment and personnel between the island and ship. "Receiving" occurs at the dock, where heavy items are lifted up and out of the boats using a crane.

Tern's new dockElectricity and water

The main source of electricity on the island is a bank of solar panels located on the roof of the barracks. A back-up dielsel generator is used only when needed, usually after consecutive cloudy days. Fresh water is generated through a reverse osmosis system, and most of the solar-powered electricity goes to this important task.

Communications

Residents on Tern communicate with the outside world in a few different ways. Mail arrives and leaves about once a month by plane. Satellite phone, an expensive option, is used for short conversations or for sending brief emails. Single side-band radio is used



Taking Off from Tern Island

regularly to communicate with the USFWS office in Honolulu.

Additionally, thanks to the Marine Turtle Research Program, Tern Island is now equipped with a high speed online connection. This connection is via a large satellite dish which has been installed primarily for transmitting remote operated video camera feed from East Island to specific users in Honolulu. When it is not being used for operating the camera, the system can be used to access the internet (pretty much only at night when the camera cannot "see" anything and therefore there is nothing to transmit).

The Seawall Project

In the 1940's, the US Navy created Tern Island. The Navy built a steel wall in



dimensions similar to an aircraft carrier. The navy blasted a channel in the coral reef around the island and used the coral rubble to fill in the wall like a giant sandbox. Now, 70 years later, the seawall is rusting and falling apart. The rusted wall can trap animals behind it. Every single morning, a USFWS volunteer or staff person walks the length of the wall to find and rescue any animal that may have become trapped behind the wall. The island is eroding away, decreasing the valuable habitat used by the birds, seals, and turtles, and jeopardizing the field station. Furthermore, the erosion is exposing potentially harmful chemicals left by US military and US Coast Guard operations. Those chemicals are washing into the fragile coral reef ecosystem surrounding the island. To rectify these



problems, the USFWS has spent millions of dollars to replace key sections of the wall. In 2004 approximately one third of the wall was replaced with rock, but funding ran out before the entire wall could be completed.

Nesting Seabird Monitoring Study

Since the 1970's, the USFWS has been monitoring the numbers of nesting seabirds on Tern Island. Because the island is so small, it is possible to census the entire population of any given seabird on the island. In addition, more in-depth studies are conducted on White Terns, Red-tailed Tropicbirds, Red-footed Boobies, Black Noddies, and Masked Boobies. For these species, a biologist/volunteer collects detailed information about nests, eggs, chicks, and fledglings within set plot areas on the island. The data are extrapolated to assess the breeding success of the species across the entire north Pacific.

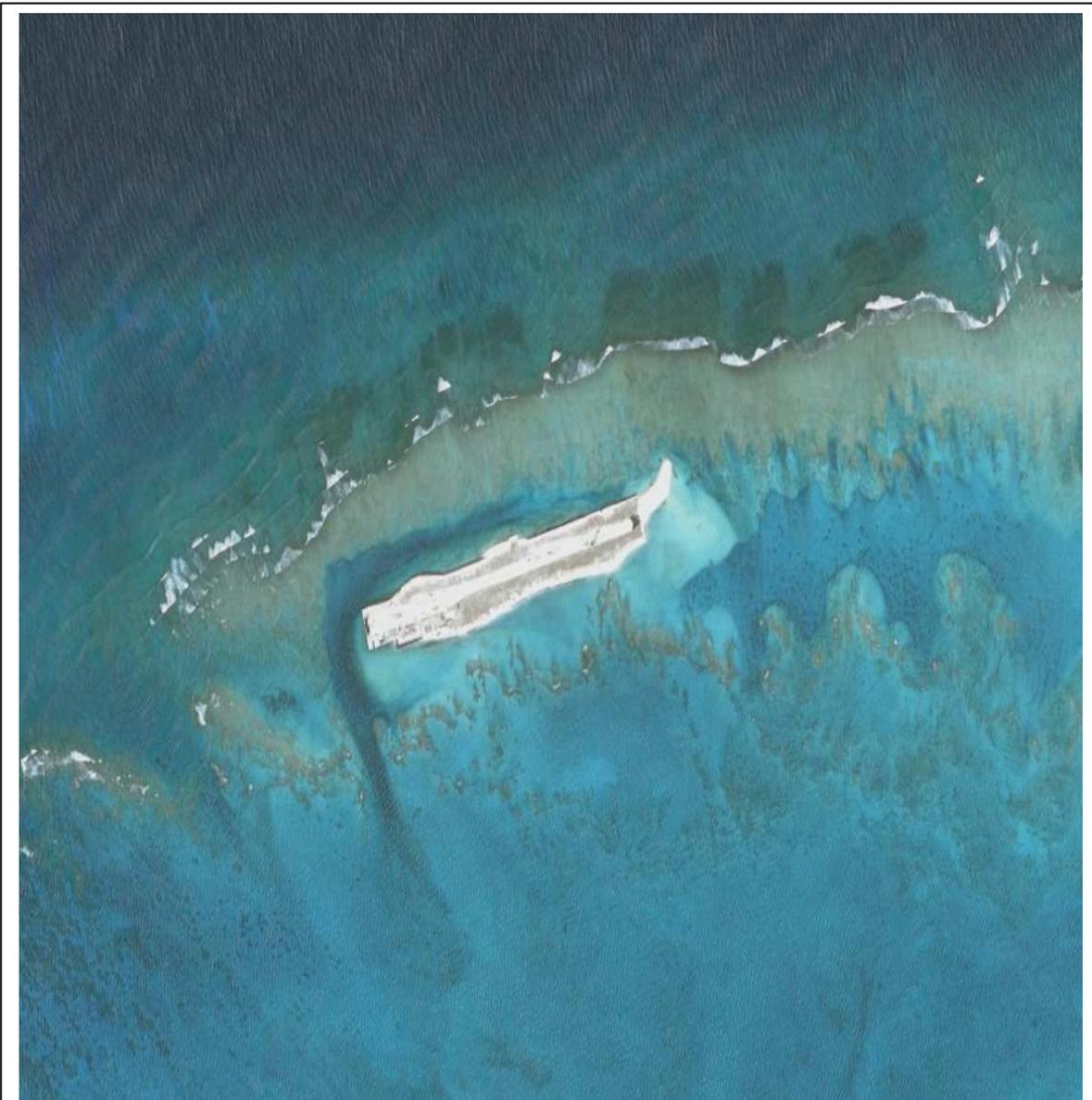
To "band" a bird is to put a small metal



bracelet around its leg. Each band has a unique identification number. When a banded bird is found or recaptured, the band number can be referenced to find out where the bird was hatched, when it banded, how old the bird is, etc. In one example, the fisheries industry is recording the band number seabirds found dead in fishing nets and lines. Scientists are using the information to better understand the number of birds being killed, their feeding range, and their age structure. The Tern banding station banded more Laysan and Black-footed Albatrosses than anywhere else in the Pacific (more than 2,250 birds in 2002). In addition, USFWS volunteers and staff banded hundreds of Black Noddies, Brown Noddies, Red-footed Boobies, Masked Boobies, White Terns, Wedge-tailed Shearwaters, and Bulwer's Petrels.

Boating on the shoals

Most researchers use Tern Island as a base from which to study the animals within the entire French Frigate Shoals. For example, USFWS staff and volunteers travel regularly to other islands to count and band seabirds. National Marine Fisheries Service staff travel daily to other islands on the atoll to census and monitor Hawaiian monk seals. The biologists use small boats to travel from island to island. Conditions are typically windy and wavy, but the unusual calm day can be a real treat.



Tern Island

The French Frigate Shoals, Lentz

by Lt. Jerry M. Lentz, US Coast Guard
(Retired)

Welcome. This web page is dedicated to the preservation of marine life, particularly the Hawaiian Monk Seal and the Green Sea Turtle. There is quite a bit of material on the internet about French Frigate Shoals and these particular sea creatures but there is little to actually show what this unusual and beautiful location is like. This page will take you on a tour of the main island, Tern Island, as it appeared in 1966/1967 while it was inhabited by 20 Coast Guardsmen. Within the Coast Guard, French Frigate Shoals was the ultimate isolated duty, often referred to when threats were made to ship someone to the middle of nowhere. Today, the island is inhabited by a small research team of 2 biologists. You cannot visit the island on your own because all the islands from Nihoa to the Pearl & Hermes Reef are part of the Hawaiian National Wildlife Refuge and any intrusion is strictly forbidden.

Geological History. French Frigate Shoals are the remains of what was probably a rather large island a million or so years ago. As all the Hawaiian chain is doing, it is slowly drifting westnorthwestward away from the subterranean source which most recently created the Big Island of Hawaii and is currently pushing up a new island from beneath the sea eastsoutheast of Hawaii. As the original island drifted, it also slowly sank beneath the sea but as it sank, coral formed and grew at a rate fast enough to keep up with the sink rate. A crescent shaped barrier reef had formed and encircled the central lagoon on its northern and eastern sides. The shoal area itself is about 30 miles across and part of the original mass of the island, La Perouse Pinnacle, still protrudes above the sea. La Perouse rises vertically about 120 feet above sea level, 7 miles south of Tern Island.

Coast Guard lore on the island indicated that the area was discovered several hundred years ago by a French Naval Officer, Jean comte de la Perouse, who literally stumbled onto the area by accident and spent several months shipwrecked on the shoal until the crew could repair the ship. A more accurate history, based on archives of the Smithsonian can be found on Wake Forest University's Tern Island History site. Among the natural islands that I was aware of was a small uninhabited sand bar we called Shark Island about a mile or so W of Tern Island. It is about the same size that Tern Island was before World War II. Several miles to the east were two islands we

called Whale and Trig, although material I've seen recently refers to them as Whale and Skate. Going towards La Perouse about 5 miles brought you to East Island, the original site of the Coast Guard station. During my stay I visited Shark, Whale and Trig by means of our 16 foot recreational boats.

The Military and French Frigate Shoals. Prior to World War II, the area had no particular strategic value. During the early part of the war, the Japanese occasionally used it to refuel seaplanes from a submarine. In one instance a seaplane raid on Pearl Harbor was refueled from this location. When they tried to do this again, after the Battle of Midway, they found that a complete Naval Air Station had been constructed by the U.S. That attack plan was cancelled. The shoal was now an important emergency stopover and navigational point for aircraft flying between Hawaii and Midway. Tern Island had been enlarged from the size of a tennis court to an airfield bearing the resemblance of an aircraft carrier flight deck, 3300 feet long and 400 feet wide. Eventually, the Coast Guard would take over the site and operate a low frequency radiobeacon and a double-pulsed Loran A station until the phase-out of Loran A. The station also served as a monitor station for the Central Pacific Loran C chain which had transmitter sites at Kure, Johnston, and Hawaii Islands. When Loran A was shut down, LORMONSTA Honolulu assumed the Loran C monitoring functions and the Coast Guard left French Frigate.

The Role of French Frigate Shoals during the early days of Space Flight. During the period of 1961-1963 the Pacific Missile Range (PMR) had a portable tracking station located at one end of Tern Island. Mr. Bill Wood was with Bendix Radio and assisted in operation of the tracking equipment. The information in this segment comes from his e-mail.

PMR had between 6 and 10 people aboard Tern during that very busy time, including a including a Navy CPO who had managed the Pearl Harbor Officer's Mess prior to retirement. The Coast Guard wisely let him run the mess deck for a year or so. The coasties were very sad to see him leave in 1963.

PMR tracked not only the USAF Discoverer spacecraft but also the Soviet Union's space efforts, including their first manned mission. The PMR lived in the arctic quonset hut located about halfway down the runway on Tern Island then, later, during the Starfish atomic tests, two house trailers were manufactured and shipped to the island. After PMR left, the trailers were moved to a

location between the barracks and the signal/power building and became housing for the E-6 and above and the Commanding Officer.

After PMR left Tern Island, tracking was conducted on specially outfitted ships such as the USNS Longview on which Mr. Wood was assigned from 1963-1966. USAF helicopters assigned to these ships would occasionally pay a visit to French Frigate Shoals if they were within easy range. (The photo above was taken on one such visit. J.Lentz)

On another occasion, a Navy pilot had to eject from his aircraft and one of the USAF helos picked him up and brought him to Tern Island. A Navy S-2 from Barbers Point flew out to pick him up. I (J. Lentz) was on duty at the time and although I had my camera loaded and handy, ffsxfer1.jpg was the best view I could get of the transfer from my workplace.

These next photos were provided by Mr. Wood who provides an interesting story behind the black marks at the end of the runway visible in several of them. tern1lra.jpg (128K) shows the entire length of Tern Island in vivid detail and was left as a large file to preserve the detail. The PMR site is at the bottom of the photo. tern2lra.jpg (78K) was also left fairly large and uncropped in order to show the beauty of the shoal waters in the central lagoon. skidmrk2.jpg shows the PMR site. The story behind the skidmarks will be forthcoming on the French Frigate Shoals Aviation & Space History page.

The Military and the natural Marine Life. This paragraph represents my own personal views and does not reflect any official views of the U S Navy or U S Coast Guard. French Frigate Shoals is a natural marine environment for a number of species of birds and sea life. Many of the natural inhabitants of the shoal do not do well in the presence of man, particularly the Hawaiian Monk Seal. Seals covered the beaches on the uninhabited islands of the shoal but they were very rare on Tern Island. The presence of 20 humans and 3 seal-chasing German Shepherds took care of that. But were we really depriving the animals of their rightful home? To put things in a more realistic perspective, the Navy built that island out of bottom dredgings and they were the original inhabitants from the day of its creation. The Navy represented the "Indians" and the encroaching turtles, birds, and seals were the "settlers" coming into Indian territory in their covered wagons. So there were surely many casualties. But in the long run, the humans gave much more than they took. The military greatly enlarged the nesting areas

available in the shoal and it is my opinion that this additional area far outweighed the number of wildlife casualties. Now that the military is off the island, seals have become abundant on Tern Island's man-made mile of beachfront. This is as it should be. They put up with us for years and in payment, they get to have the new island! It should be mentioned that while the Coast Guard was on the island, all of us who were stationed there were told repeatedly that we were on a Wildlife Refuge and that ALL species were protected.

The Sharks. While I was there, the local information was that the sharks that could occasionally be seen were Sand Sharks that fed off the bottom and were not a particular threat to humans. Information I have found on the internet does not mention Sand Sharks but does say that the area is the territory of the man-eating Tiger Shark. Wish we had known that! We went swimming just a couple of dozen yards from where another sailor would have a baited shark hook in the water. We caught a couple of sharks off the northwest corner of the island during the year but I don't recall ever actually seeing any swimming around Tern Island or seeing a fin break the surface. However, I saw a sight on one of our boat trips that I will never forget!

One day, a group of us got together in one of the 16-foot boats and headed over to Whale Island. It had been a couple of months since our last boat trip and we needed a change of scenery. As we approached Whale Island, we could see something in the water surrounding the island - in fact, a LOT of somethings. As we drew closer we could see that all these black specks were sharks, hundreds of them. At 100 yards off the beach, the water was about 8 feet deep and we were right on the edge of the school of sharks. One swam beneath our boat and it was easily more than half the length of our boat - over 8 feet. We retreated and began to circle around to the windward side of the island looking for a clear path to the beach. Every route in from where we were would have taken us directly over the top of about 20 sharks. As we began to get a view down the other side, we could see that the island was completely encircled. We could see hundreds of seals up on the beach but it appeared that for every seal on the beach, there was a shark in the water. We cancelled our plans to make a landing and returned to Tern Island. The Hawaiian Monk Seal population probably got hammered that day, perhaps losing a hundred or more to the sharks as hunger overcame the danger and they began to enter the water.

The Birds. The uninhabited islands were home to thousands of nesting sea birds, including the

famous Frigate Bird. We didn't pay them much attention and couldn't tell one from another as they flew around the island except for the Frigate Bird with its pterodactyl-like wing shape. I got there in August and there was not a Gooney to be found. A couple of months later, they arrived in swarms. We were entertained for hours with their mating rituals and the associated dancing and unusual cooing sounds. We would watch them fly ever so gracefully with their wingtips sometimes just barely grazing the water and leaving a faint ripple. I watched one crash into the beach. He slid halfway up the beach on his belly, got his feet down and started running to maintain his momentum, and when he got to the crest of the beach, he was airborne again. Another one caught the tip of a 35-foot fiberglass antenna with his wing root. It spun him around and he found himself with his back to the antenna and his beak pointed at the ground. He slid down the entire length of the antenna, shook himself off, and decided to walk the rest of the way.

A bird that stayed on the island year round was the Fairy Tern. These were beautiful snow white birds and were about the size of a robin. Whenever a hiker would start around the island, several of these birds would tag along (as seen above) and hover downwind and just out of reach. Never could figure out the reason for this unusual behavior. During a walk around the island, one or two more may join the group and one or two may leave but they were always there. Occasionally, one of these docile birds would get trapped inside the barracks, usually in the mess hall and usually at night. They would stay out of reach until they realized they could not find their way out then it seemed that they "allowed" themselves to be captured. They would come down to within reach, allow one of us to approach and when we made contact with one hand underneath and one hand on top, they would immediately tuck in their wings and wait patiently until we carried them outdoors. No struggle, no panic!

The traditional Gooney Bird (Laysan Albatross) was the only one that nested in the scrub brush around Tern Island but with their arrival came another variety, the black-footed albatross. It was chocolate brown and except for color, seemed to behave just like the black and white albatross. Of all the albatross, about 1 in 30 was this black albatross. As summer approached, all the adults left and the babies rapidly became full grown and shed their baby down. A certain percentage were sickly or deformed and they expired over a period of time. Spring time was generally wet and windy and when the wind would pick up, you could see hundreds of sets of gooney bird wings flapping in

the breeze as the chicks responded to their natural instincts to test their wings and the wind. One by one, they taught themselves how to fly and by the time July came around and I was preparing to leave, the island was again devoid of Gooneys. I only saw one bird struck by an aircraft. A gooney flew over a departing HU16E and caught the very edge of the propellor arc. The aircraft was undamaged and I doubt the pilot even knew it happened but the Gooney shot straight up in the air and fell limp to the runway behind the aircraft.

The Trees and Insects. The photographs show a clump of trees by the barracks. These were believed to be Ironwood trees, transplanted at the time the island was constructed.

Insects were scarce but what was there was distinctive. We had ants! Sometimes lots of them! ANYTHING left laying about, if it was edible, would soon be found by the ants. I never saw an anthill or knew where they came from but they were there. And we had occasional flies, not just regular house flies but what we called "rubber flies". In appearance, they looked like regular house flies. Their rubbery bodies were well suited to camping out in the feathers of Gooney birds. Ordinary fly swats were useless against them. If you didn't physically crush them, they would get up and fly away!

Cement Blocks and Shifting Sands. When I first arrived, it was summertime and there was a wide sandy beach by the boat house and recreation hall. One of the crew who was nearing the end of his year told me of giant cement blocks beneath the sandy beach. My reaction was something like, "Yeah, right." Then winter came and things changed. The beach by the boat house began to recede drastically and the blocks appeared. At the same time the water at the opposite end of the island, off the northeast end of the runway next to the seawall, became very shallow, shallow enough to wade around that end of the island. As summer returned, it became very deep next to the northeast seawall and the beach by the boat house (at the southwest corner of the island) filled in again, covering the cement blocks.

The Hawaiian Monk Seal. Monk seals were abundant on the other islands in the shoal area. They were scarce on Tern Island, mainly because of the three German Shepherds. I was unable to photograph a Monk seal at rest because usually when I walked the island the dogs would tag along and when they went after a seal, there was no stopping them. They were attacking seals long before I got there and they continued long after I left. The only photos I have are the dogs attacking

a seal and one of a dead seal that washed up on the beach when I happened to be hiking alone (no dogs). The big male, Ferd, had a permanent limp in one back leg. The story was that he had followed a seal into deep water and the seal turned the tables on him. In the attacks I witnessed, the seal always managed to get back into the water and the dogs would not follow beyond water's edge.

The Green Sea Turtles. Turtles could occasionally be found on the beaches of Tern Island. The ones we found were apparently basking rather than laying eggs. Information I have found on the internet indicates that they only lay eggs at night. The nighttime eruption of turtles is something we witnessed from time to time. Since we were kind of dumb about turtles and lights, we never made any attempt to hide our lights. Consequently, we would occasionally find ourselves in the midst of a swarm of baby turtles. We would gather them up in boxes, buckets, or whatever we could find and carry them to the beach. In the one photo I have of a turtle, I am standing in front of the turtle to provide a size reference for the photographers in our crew. At no time was the turtle physically contacted.

Spotted Eagle Rays. We occasionally spotted one or more rays cruising slowly along the north shore of Tern Island. These creatures were huge, some appearing to have a wingspan approaching 10 feet. Follow the link below to Patrick Ching's beautiful representation of these rays. I could probably pick the exact spot from where he witnessed that scene. The largest group I saw at one time was three and they would frequently break the water with a wingtip as shown in Mr Ching's painting.



The Weather. You couldn't ask for better weather anywhere. My duties included keeping the weather records and we had a maximum/minimum thermometer, wet and dry bulb thermometers, a rain gauge, a barograph, a genuine mercury barometer and an anemometer. The coolest night in a year's time was a low of 53 degrees and the warmest day reached 88. The trade winds would sap the heat from your body. With the temperature in the mid 70s late in the afternoon and a steady 20 mph wind, you wore a heavy windbreaker when you walked the island or you suffered.

The clear air and lack of light pollution gave night skies like you would only see from a ship. I saw more meteors there than I have anywhere else.

Winter storms seemed to be more of a threat than hurricanes, the same as the main Hawaiian Islands. One night a strong storm passed north of us and heavy surf came over the barrier reef and swept our garbage dump across the runway. In several locations, a small amount of water was swept halfway across the runway. Two and a half years after I left, the island was swept by another similar but much stronger storm. A helicopter from a New Zealand frigate rescued the Coast Guardsmen from the roof of the transmitter building during the height of the storm. The island was awash and much equipment and crew's personal belongings were damaged or destroyed. The runway was rendered unusable with the debris.

Albatross Wanderings

By Carl Safina, Audubon Magazine, 2001

When 1.2 million birds of the same species breed on a few tiny islands, how do they find food? If they're albatrosses, they take to the sky. Scientists tracked one mother who flew 38,706 miles in four months to feed her chick.

I have to say, the bird I'm trying to admire is not the most engaging one I've ever met. She's been sitting on her single egg for nearly two weeks now--there are nests on the ground all around us--and incubating albatrosses seem detached from reality. In a place without predators, they need not remain alert. And they're not interested in you. They just sit, day upon week.

Perhaps this one's dreaming of the glorious day when her mate will relieve her, when she'll spread her wings and sail across the lagoon, beyond the reef's towering breakers, out upon the open ocean, and

What happens next is the unbelievable part. The new findings have staggered ornithologists. Albatrosses endure a life so extreme that until recently it was scarcely imagined. But now we're beginning to understand this life better, thanks to Wake Forest University professor Dave Anderson and graduate student Patty Fernández. For the past two years they've been working here on Tern Island--a tiny speck roughly 500 miles northwest of Honolulu--using satellite-tracking transmitters to discover where Hawaiian albatrosses go during their breeding season.

Nesting albatrosses cover longer distances when foraging than any other bird. In fact, almost everything about them is long. Their long, narrow wings make them long-distance gliding machines. Wandering and royal albatrosses wield the longest wingspans in nature--about 11 feet each. Their reproductive cycle is long, too. The two albatross species that nest on Tern Island, the black-footed and the Laysan, don't begin breeding until they're eight years old. Courtship lasts two full years, and the breeding season stretches eight months--longer in some species. Eggs are incubated for about two months. Males and females incubate in shifts as long as three weeks. The death of a mate costs the survivor one full breeding cycle, and many healthy breeders nest only every other year. A chick may pip the egg for as long as six days before finally emerging. A large chick may wait two weeks for a meal. After fledging, young albatrosses remain at sea for several years, never landing upon a solid

surface, perhaps not even glimpsing land. With good luck, an albatross may live five decades or longer.

Not least of their lengthy attributes is the distance one must go to see them nesting. The roughly two dozen albatross species (the taxonomy is unsettled) inhabit all oceans except the Arctic and the North Atlantic. The Hawaiian Islands are the most geographically isolated in the world, and the most isolated parts of the archipelago are the Leeward, or Northwest Hawaiian, Islands, which stretch in dots and dabs for 1,200 miles northwest of what we think of as Hawaii. The Hawaiian Islands National Wildlife Refuge was established by executive order of President Theodore Roosevelt in 1909, to protect the birds from plume hunters, egg collectors, and guano miners. Plume hunters alone killed millions of albatrosses in the North Pacific. Now these tiny islands are crammed with 14 million birds of 19 species, including some 60,000 black-footed and 600,000 Laysan albatross pairs--virtually the entire breeding populations of those species.

Tern Island is part of an atoll called French Frigate Shoals. Arriving by air, this world seems elemental: a blue disk of sky above, a blue disk of sea below, and clouds creamed between--a seabird's world. Three hours from Honolulu with the morning sun behind you, French Frigate Shoals appears as a turquoise smudge in that blue ocean. Waves break into lacy foam on its 17-mile semicircle of reef and sandy islands.

Tern is an odd little island, less than a mile long and perhaps an eighth of a mile wide, militarily modified during World War II to serve as a kind of terrestrial aircraft carrier. Its middle third is all runway, its two outer thirds all bird colony. Most of the "shoreline" is a low wall of rusty metal. But as the plane door opens, this artificial aspect vanishes amid the dazzling action of seabirds by the tens of thousands and the din and dancing of courting albatrosses.

Most of the albatrosses arrive here in November, the males about a week before the females. When previously mated albatrosses reconnect, they generally skip the prolonged courtship of their youthful past. Well-acquainted mates may copulate within an hour of their reunion. Then they go to sea for about 10 days. The female lays her soda-can-size egg a day after arriving back at the colony. Then she leaves--usually the same day--and the male sits on the egg for three solid weeks, until she returns. Then he goes to sea for three weeks. After that it's two weeks on the egg for dad, a week for mom, and five days for dad.

With all those alternating periods of activity and inactivity, the birds' bodily condition fluctuates dramatically. Male Laysans, the more studied of the two albatross species on Tern Island, show up weighing nearly seven and a half pounds; females weigh close to seven. A male loses about half a pound in the first 10 days or so, then regains much of it at sea. When the female lays that big egg, she instantly loses 10 percent of her body weight, but she regains it at sea during the male's first incubation shift. Meanwhile, without food or water, he's getting lighter. Albatrosses with an infertile egg or a no-show mate have incubated for more than 100 days in vain. Once they lose a third of their weight, hunger forces desertion. But in a normal incubation, the chick stages its slow-motion breakout after about 65 days.

The Laysan albatross closest to the barracks where I'm staying is a female with a satellite transmitter on her back; I've begun referring to her as Amelia. Her chick hatches on February 6, while her mate is at sea. When he comes to relieve her three days later, Amelia launches herself from the runway and strikes northward over the reef's breakers. Each day, the satellite interrogates the transmitter, then beams Amelia's coordinates to Anderson's North Carolina laboratory. The transmitter's dialogue with the satellite tells us for certain where she is, how far she flies in which direction, and when she shifts course. But we also know enough to sketch a plausible picture of what she might be doing and experiencing.

An hour after Amelia leaves, the last visual trace of French Frigate Shoals falls away. Amelia's brain contains a compass--unlike the human brain--and an accurate clock. And, of course, she has those wings. Albatrosses usually spend 80 to 90 percent of their time at sea flying, day and night. What to us is trackless blue ocean is to Amelia a familiar mosaic, riddled with signs. As we know that a supermarket will hold food, children will fill the schoolyard, and a bus will appear at the bus stop, Amelia knows the sea's vast and changing neighborhoods.

She sticks near the sea surface like an oceangoing bloodhound, sifting scents. She skillfully reads the terns and frigate birds that occasionally cross her line of vision. Terns flying low, in a straight line, have found fish and are commuting. They are worth following. Terns 50 feet above the water are searching, as she is. If it's late in the day, a pod of dolphins is worth following; a hunt may erupt, making fish available. Diving flocks of terns and boobies signal tuna; tuna signal eating-size flying fish, plus a worthwhile area in which to linger after

dark for squid. A line of weeds or flotsam--marking the border between two water masses--is the best place to find floating objects with flying fish eggs attached. If the breeze is off a border like this, the wafting scent may tell Amelia of an unseen meal miles away. She knows when to keep going and when patience will pay.

The ocean swells roll and fall away beneath her. Amelia's flight mimics them as she rises 20 feet or so, her belly to the wind, then turns and lets gravity pull her downward and forward like a wind-driven snowflake. Her wing tip etches into the sea, creating a thin track that vanishes in moments. She goes like this for hours, wings quivering against the breeze. She averages 15 miles an hour, double that when the wind blows up. The broodiness gone, she is now keenly alert.

When the wind drops in the late afternoon, Amelia rises on her own power, flapping more than she'd prefer. As her breast muscles pull down the long bones of her wings, thrusting her feathers forward into the air, she uses up more of the energy she's here to replenish. By now she's flown 165 miles east from Tern Island, and by the look of her straight track, she's found nothing. Abruptly, she alters course, from east to northwest.

Most of the night she flies steadily, though half of her brain is asleep. By dawn Amelia is 115 miles due north of Tern Island. All day she searches the sparse tropical sea, working 124 miles westward. The more food she finds, the more she feels that new chick pulling, like a downy rubber band. Nearly 156 miles from Tern Island, after two days at sea, she suddenly sets course directly for home. For 10 hours she sails straight to her unseen nest and baby. It is February 11.

Amelia and her mate exchange brief greetings, and dad leaves on his own overnight foraging foray. Their chick, unveiled to sunshine, lifts its wobbly head and opens its stubby bill to a V. This ritual stimulation makes Amelia retch on cue. She leans forward, centers her gullet on the V, and fills the chick with gooey regurgitated food. Then she settles in to brood.

Amelia has been losing weight since her chick hatched. She's taken four foraging trips, logging 506, 99, 876, and 2,388 miles. Her devotion shows: Her chick has grown vigorous and healthy. But she has put all her surplus energy into the chick, and now she's seriously hungry. She sets out again on February 26, after just a few minutes' rest from her most recent trip. She walks slowly to the runway, turns into the southerly wind, cranks herself into the air, and puts the wind behind her. It's a good

start, because this will be a longer trip (see "Amelia's Flight Plan," page 76). The small size of her chick makes her begin by looking for food nearby. For four days Amelia dallies, first heading northwest for 170 miles, then looping back southeast before heading 80 miles northeast. She's not finding much, and she's traveling continuously. For an albatross, it's no way to make a living.

An hour before dawn on March 3, Amelia catches a whiff of something different. It's the smell of fat, very faint. Not blubber, not the feast of a dead whale. This mild aroma is from sea foam, the whipped fat of diatoms whose microscopic bodies have been broken by rough seas. The foam drifts along the border between two water masses in a very subtle line called a drift line. It's invisible in the dark, but the scent is familiar enough, and it rouses Amelia to full wakefulness. She knows from experience that following this smell will eventually yield squid, fish, and fish eggs. She's finally on to something.

Amelia passes through the scent upwind, and the air goes pure salty again. She turns, and the aroma resumes. She begins weaving along its line of origin, hunting in the shine of mid-ocean starlight with eyes nearly as dark-adapted as an owl's.

At the water boundary she sees a few lantern fish, the blinking lights along their bodies flickering signals to one another. They're too small for her to catch, but Amelia knows their presence means squid--squid that have followed the lantern fish 1,000 feet up from the depths since sunset. In the inky water, those puckering hunters will become the hunted.

Amelia sees a small pod of squid rushing the lantern fish, several of them successfully. As the squid maneuver their wriggling victims toward their beaks, they blush to warn their school-mates away from their hard-earned meals. Thus occupied, they fail to detect Amelia's night-cloaked approach.

She plows in heavily, and puffs of ink explode in the water. The squid scatter safely--all but one. As the lantern fish and their pursuers drift downward with the first light, an ailing squid lingers at the surface. Amelia lands and paddles forward, nailing it on her bill.

At sunrise Amelia is 400 miles north of Tern Island and a little east. The shining sea stretches away like a gold-threaded tablecloth. A strong wind has dissipated the drift line to an indistinguishable gradient, scattering anything that would be food. She turns north, then stops to forage almost exactly where she was about a week ago. Her last,

marginal trip worked well enough for the chick, but what worked well enough then doesn't work now. It's a week later, farther into Amelia's hunger and loss of weight. Her devotion to home wavers. Her blood chemistry is signaling to her brain. The long averaging process of natural selection steps in, as though whispering, "No chick benefits from a mother starved to death." The seesaw between maternity and hunger tips, and hunger wins.

Amelia will go for food--real food. She ignores every faint cue from this clear, warm ocean about small snacks or fish eggs here and there. Amelia is no longer foraging. Now she is truly traveling. And she knows exactly where she's headed: due north, to the edge of cold water. For the first time in months, Amelia will fully unfurl.

On a favoring wind, she sails nearly 600 miles in 30 hours. The sea temperature slowly, slowly drops. Amelia crosses out of the Tropical Water Mass, the northward limit of 68-degree Fahrenheit water. Several hours later, she zooms past the Subtropical Frontal Zone, then the Subtropical Central Pacific Water Mass. She's now at the southern border of a major transition zone between the warm-hearted central Pacific and the chill subarctic.

Amelia slows along this edge, 1,000 miles from Tern Island. The cooler water is friendlier to drifting single-celled plants--phytoplankton--and so is greener. It has lost its tropical clarity, and with it the tuna and the tropical seabirds. In six days at sea, Amelia has flown from latitude 23 degrees north to latitude 40 degrees--the distance from southern Baja California to Eureka, California.

She scrutinizes the greener water. She backtracks toward the south, following a 100-mile meander in the current, then loops back as the meander swings north again. But she's still traveling many miles between mouthfuls. She breaks off her search and again swings straight north, skimming wave after wave, until an additional 180 miles of water flow between her and Tern Island. She is now on the northern edge of that broad transition zone called the North Pacific Current.

This fountain of change flows across the entire northern Pacific Ocean, waving like an unmanned fire hose. It separates the warmer and more saline subtropical water from the cooler and fresher subarctic water. It originates in the western Pacific as the Kuroshio Current, sweeps past Japan, and undulates eastward to Vancouver, British Columbia. It then flows south as the California Current, keeping the coastal ocean cold all the way to southern California.

Amelia is foraging at the Subarctic Front, where the water dips to 54 degrees. The air is chilly. This is the wintry kingdom of fulmar, herring, and salmon. Few marine animals can handle both this world and the solar realm of frigate birds, flying fish, and tuna. But albatrosses do. For the first time since she arrived at Tern Island, Amelia feels fully at home.

She works this zone for five days, searching for concentrated scents, temperature gradients, and other signs of life. She moves west into the current for 225 miles one day, 250 the next. Then, finally, she finds what she's looking for. The water is squirming with squid. Amelia spends three days loading up, putting on weight and storing extra food. With her belly full, the seesaw between maternity and hunger tips again--and this time maternity wins.

She lights out on a compass heading that will take her directly home and flies for 40 hours--600 miles, nonstop. She crosses back into subtropical water and spends a day zigzagging 100 miles to the southwest, probably feeding along a weak front between two water masses. Then she streaks toward Tern Island again. She smells the air growing saltier and warmer as she bores back into the tropics. After an additional 630 miles in 42 hours, she crosses French Frigate Shoals' thundering reef and lands clumsily on Tern Island. It is March 14. After 16 days at sea on a 4,200-mile odyssey, she feels as though her body is still gliding with gusts and swaying to swells. She waddles over and calls to her surprisingly large chick, who immediately responds. "That you?" "Yes, alive."

Amelia hasn't seen her mate in weeks, but by the looks of the chick, dad, too, has been faithful to his duties. The chick is big enough now to be aggressive, and it hasn't been fed in about a week. It practically attacks Amelia, whining and battering her bill with its own hooked beak. Amelia regurgitates a sizable squid and several meaty fish chunks in the first payload. This goes a long way toward filling the chick, which suddenly pauses to swallow the meal, mucousy strings of goo dangling from the corners of its mouth.

After the briefest pause, the chick demands more. This time the meal comes as a liquefied high-calorie oil, stored from food Amelia caught at the beginning of her journey. The noisome oil is unique to albatrosses and their relatives, the petrels and the shearwaters. It squirts from Amelia in a strong brown stream. No chick could ask for more.

But this one does. In maternal devotion, Amelia pours her heart out. The chick quiets, briefly. Her parental duties discharged, Amelia walks away. She surveys the noisy island, the birds of many species crisscrossing overhead, the younger albatrosses courting and dancing with youthful ardor--and no adult responsibilities. Amelia's seen it all before. She registers only that her chick is alive and vigorous, and that means one thing: It will need more food. In a mere 10 minutes she's on the runway, good for takeoff.

It's mid-May, and 65 percent of the Laysan and black-footed albatross eggs laid on Tern Island have hatched chicks that have survived their first three months. The young Laysan albatrosses weigh as much as the first-arriving adult males did, and they're 25 percent heavier than their overworked fathers. For the beleaguered parents, this marks the low point in bodily condition.

On May 27 Amelia returns from a two-week trip of 5,600 miles. Her big chick seems crazed with hunger. This is its last major growth spurt. Its bones are building, as are its thousands upon thousands of feathers. It needs enough nutrients to make those feathers thick, insulating, waterproof, and tough enough to endure a couple of years' punishment in the salt and sun and wind and water.

The chick batters Amelia so aggressively that she tries ducking away at first. But its tantrum stimulates her to disgorge. The chick scissors in, squealing and quivering with excitement. Out comes a large squid. A large flying fish. Fish eggs. Finally, a stream of oil, until Amelia is cleaned out. She rests a few hours. For the moment, life is thick. For her chick, graduation is on the horizon.

But Amelia will not be attending. When she leaves the next day, May 28, her parenting will be finished. Her chick will face whatever lies ahead alone.

As the parents leave Tern Island, the chicks lose weight for the first time. They hunker quietly, conserving energy and water, growing in place like melons. In a couple of weeks, when they begin exercising their wings, they will lose more weight. It's a timed free-fall.

By mid-June Amelia is beyond the North Pacific, on the back side of the Aleutian Islands. This is Albatopia, the promised land, the land of milt and herring--herring swarming to breed, herring injured by whales or nicked by nets, herring whose eggs glow on every strand of kelp like caviar at a wedding. Amelia no longer thinks about her chick, 2,000 miles away.

Back at Tern Island, the albatross chicks have spent the past two weeks exercising their wings, leaping and flapping. Finally, this morning, some other scientists and I are watching fledgers. A chick, lofted by the breeze, leaves the berm for the first time, flapping with all it's got. It lands in the turquoise lagoon. Now begins the usual terror of adolescence: the race between learning and luck.

We're not the only ones gathered for this event. Soon a big, square snout, followed by an awkwardly gaping mouth, breaks the surface two feet from the goose-size fledgling.

The bobbing bird peers at it quizzically with wings half opened. In a clumsy rush, the nine-foot tiger shark charges its intended prey-and shoves it aside with its bow wave. The shark turns, and on its next approach the chick, finally alarmed, actually pivots to bite the huge snout, which again misses because of the pillow of water it is generating. The scene plays in excruciating slow motion. With each pass the shark grows more determined, and the chick grows more alarmed. Just ahead of the next oncoming bulge, the chick patters and flaps safely into the air. Several other chicks are bobbing nearby, and when the next fledger hits the water it attracts another big tiger cruising near shore. This chick does not read the message in time, and on the shark's third pass it gets its jaws around the bird's body. The albatross, pecking furiously, vanishes. A slick of oil and some feathers appear at the surface.

In the days that follow, one of 10 fledglings will nourish a tiger shark. That's the deal evolution has made with the albatross: heavy mortality among the young in exchange for long life and extraordinarily high natural rates of adult survival-93 to 95 percent from about age 8 through at least age 20. A lot of albatrosses live much longer, though scientists aren't sure exactly how long. Many of the birds now living have been wearing bands for 40 years, outlasting some of the original researchers.

Outside the reef, the atoll's slopes drop away sharply, and less than a mile from the shallow turquoise lagoon, the ocean is so deeply blue that it looks purple. A lone Laysan albatross is paddling those cobalt swells, and only the sleek, uniform darkness of its mantle-no sun-bleached wear and tear-tells me the bird is a freshly minted chick. It opens its perfect wings, the breeze lifts it, and it strides northward on the propelling wind, getting smaller and smaller. If a multitude of luck holds, in a few years it may again swing its feet down to touch dry land.

Marine ecologist Carl Safina founded the Living Oceans Program of the National Audubon Society in 1993. Last year he won both a MacArthur Fellowship and the Lannan Literary Award for nonfiction.

The Hand of Man

Albatrosses eat just about anything they can swallow or hook their bills into, and for millions of years, this behavior served them well. Nowadays, it gets them in trouble. Nesting colonies are often littered with puked-up cigarette lighters, plastic bottle tops, toy soldiers, toothbrushes, and other flotsam that albatrosses have eaten and fed to their chicks. In some cases a chick eats so much plastic that there's little room in its stomach for food. You can often tell where a chick has died by the pile of colorful plastic that used to be its stomach.

The birds get in trouble with commercial fishing fleets, too. Through the 1980s and into the '90s, hungry albatrosses found a lot of dead fish and squid tangled in driftnets, which were 30 to 40 miles long and hung down 40 feet into the ocean. The nylon webbing made for dangerous dinners, killing some 4,400 black-footed and 17,500 Laysan albatrosses a year until the United Nations outlawed the nets in 1993.

The main threat today is longlines. Five to 80 miles long, depending on the type of fish being sought, they're baited with thousands of hooks each. When longlines are let out behind a moving boat, the birds try to snatch the bait before the line sinks. Sometimes they get hooked. Longlines are causing some albatross populations, especially in the Southern Ocean, to decline 1 percent a year. The wandering albatross is listed as endangered in Australia, and 20 albatrosses are on the Red List of the International Union for the Conservation of Nature.

Longliners can fish without killing birds. Fishermen in Alaska, for instance, use a system of streamers that scare birds from the bait until the line sinks out of reach. Birds will follow the boat avidly but will not swoop in among the dangling lines and splashing floats. The Alaska fishermen initiated the regulations themselves: They feared closure of their fishery if too many endangered short-tailed albatrosses were killed; they also felt that protecting birds was the right thing to do.

Albatross populations as a whole cope well with food scarcities and predators. But evolution leaves them unequipped to deal with high or even moderate adult mortality--the kind that usually comes at the hand of man.

--C.S.

Gardner Pinnacles



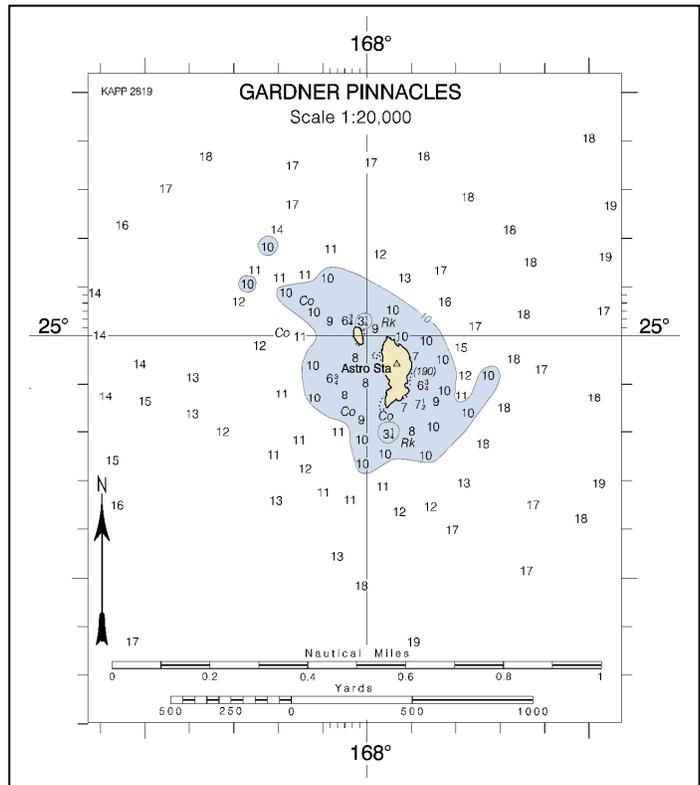
Probably the most barren and hardest to land on of all the islands of the Hawaiian chain are the Gardner Pinnacles. The pinnacles are made up of two volcanic peaks a total of five acres in area, located 108 miles northwest of French Frigate Shoals. Underwater shelves reach outward from the pinnacles and extend over an area of more than 900 square miles.

An Astronomical Station, a survey point determined by astronomical observations, is located on Gardner Pinnacles.

History

These isolated, barren rocks, were discovered on June 2, 1820, by the American whaler Maro of Nantucket, under command of Captain Joseph Allen. Incidentally, this vessel has the distinction of being the first of the many whalers to enter Honolulu harbour. Apparently Captain Allen did not make a landing on Gardner Pinnacles, for he greatly overestimated the size of the island, reporting it as being a mile in circumference and 900 feet high, with two large rocks at its southwest point.

In 1857 Captain John Paty visited Gardner in



the Hawaiian exploring vessel *Manuokawai*. He reported that the island lies 607 miles west-northwest from Honolulu and that it "is merely two almost inaccessible rocks, 200 feet high, extending north and south about one-sixth of a mile. A bank extends off to the southwest some 15 or 20 miles. The bottom seemed to be covered with detached rocks, with sandy spaces between; I had 17 fathoms of water 10 miles south of the island," he says. "I think fish are plentiful on the bank."



A number of other vessels sighted the pinnacles during the middle part of the 19th century, reporting them by such names as *Man-of-War Rock*, *Pollard Rock*, and *Pollard Island*. There are also various spellings of Gardner, but the United States Board of Geographic Names has decided Gardner Pinnacles is official.



Positions were given for the island by Captain Stanikowitch and by Lieutenant Brooke, U.S. Navy. The latter describes the island as an inaccessible rock 170 feet high, with a base about 600 feet long, and a smaller rock close to its southwest extremity, from which a reef makes out one-half mile. He notes the bank as having 17 to 20 fathoms of water and extending from the island on all sides, to the westward about 5 miles and southwest more than 8 miles.

Captain F.D. Walker visited Gardner in the Kaalokai, June 9, 1891. In his entertaining "Log" (published in 1909) he writes as follows:

"At noon we sighted Gardner Island, and at 2.30 were up to it.

"Gardner Island is simply a rock one hundred and seventy feet high, or thereabouts, densely covered with birds. Hundreds of frigate birds sailing majestically around it, watching with keen interest the results of the tropic birds' labours ..." He goes on to describe at length the manner in which these "highway robbers" of the bird islands harass the smaller birds as

they return from fishing, and make them drop their hard-earned food, which they immediately swoop down on and catch in mid-air.

"We fired a gun and the reverberation was like distant thunder. The whole colony of birds arose, and the air was clouded with them," Captain Walker continues.

There is no anchorage. The swell of the ocean breaks heavily even when the sea is calm. On the island's precipitous sides, the backwash or reflux rushes out a long way, making an experiment to land a very dangerous undertaking. To the westward there are a few detached rocks about seventy feet high. I could find no outlying dangers in our cruise around it, and as we could find nothing interesting or instructive to be gained, we took our departure at dusk and shaped our course for Maro Reef."

Professor Harold S. Palmer, of the University of Hawaii, in Bernice P. Bishop Museum Bulletin 35, 1927, describes the topography and geology of the island. He was not a member of the Tanager Expedition party which landed in May, 1923, but bases his

descriptions upon field notes, sketches, and collections made by Dr. Stanley C. Ball, of the Bishop Museum staff. He says:

"Gardner consists of two islands which from the west or east appear as a single island, flanked by smaller northern and southern peaks. The smaller, northern peak belongs to the lesser island, which lies some 50 yards west of the north end of the larger island. A small, jagged rock rises a few feet above sea level in the channel between the two islands. Landings were made on both islands. Though it was necessary to swim to the smaller island it was possible to land directly from the surf boat onto the larger island, one or two men jumping ashore each time the waves brought the boat in and before it was fended off ..."

He goes on to describe the geologic formation of the island in some detail. All of the rocks observed on Gardner were fine-grained, dark basalt, except some weathered material thought to be tuff. All this was of volcanic origin. In cracks were found vein-like fillings of light-coloured phosphate material; and there were crusts of lime. Bird droppings were everywhere.

Dr. Palmer suggests that Gardner Pinnacles are the remains of an island which was formerly much larger, perhaps intermediate in size between Kahoolawe and Lanai, with an area of about 80 square miles. This island has been carved away by wind, rain, and waves until only the hard core of its volcanic dome remains. The island is at present surrounded by submarine banks which extend off from it about 5 miles on the east, north and west, and 10 to 12 miles on the south. This great oval has an area of about 125 square miles. The accompanying sketch map and profile above are based upon those published by Dr. Palmer from Dr. Ball's field observations on the island.

The botanists of the Tanager Expedition were able to take the day off. The steep slopes of Gardner Pinnacles are bare of vegetation, except for small pockets of purslane (*Portulaca*), and algae on the lower, moist surfaces. The late Gerrit P. Wilder collected a small sample of the *Portulaca*, but the specimen refused to dry, which is usual with

this fleshy herb, and it is not positively known which of two species of purslane it is.

The insect collectors of the party apparently also took a holiday, although Dr. Ball and Major Chapman Grant managed to collect two small flies, a moth, the case of another moth, and one earwig. They also reported seeing mites, spiders, centipedes and isopods among the loose rock, but unfortunately did not catch any.

Of archaeological remains there were none. In fact, it is doubtful if many persons have set foot upon the steep, slippery slopes, which are so hard to approach.

Official estimates of the heights of the three conical pinnacles, two on one base and one on the other, are 90, 100 and 170 feet, the water passage being between 90 and 170 foot peaks. But nautical charts give the maximum height as 190 feet.

The island became an "integral part of the United States" on July 7, 1898, and a part of the Hawaiian Islands Bird Reservation on February 3, 1909.

Biology

Gardner Pinnacles is known for its abundance of giant opihi, the endemic Hawaiian limpet. The islands' rocky inter-tidal areas are an ideal habitat for opihi. Twenty-seven documented species of stony coral are distributed throughout the pinnacles' reef system. *Acropora* table corals have been noted on the leeward side, while tube, stony, and soft corals have been found throughout the reef. The underwater shelves around Gardner Pinnacles provide habitat for some of the highest recorded numbers of fish species in the Northwest Hawaiian Islands. It is interesting to note that the number of coral species found at Gardner is nearly twice that found at the similar basalt islands of Nihoa and Mokumanamana. Also, many main Hawaiian fish species not found at other NWHI areas are found here.

Gardner Pinnacles is home to seabirds, insects, and only one species of plant, the succulent sea purslane. Scientists have

Blue gray noddies. observed 19 species of seabirds, 12 of which breed on the steep cliffs, including the rare blue gray noddy.

Despite its small size and isolation, the island has a surprisingly wide array of insects. Spiders, mites, moths, centipedes, flies, beetles, isopods and earwigs, among others, are found on Gardner Pinnacles. Recently a researcher visiting the island found what he believes are two new species of spiders. He also found a third spider previously not known to inhabit Gardner Pinnacles.

Coast Pilot

Gardner Pinnacles (25°00'N., 168°00'W.) are 120 miles NW of La Perouse Pinnacle. They were discovered by Captain Allen of the whaler MARO in June 1820. The pinnacles are solid, volcanic, rocky islets; the larger pinnacle is 190 feet high and about 200 yards in diameter, and the smaller about 100 yards from the NW side of the larger. The rocks are barren of vegetation and are covered with guano, giving them a snow-capped appearance. The only off-lying dangers are a small rock just off the NW side of the larger pinnacle and two 20-foot patches, one of which is about 100 yards S of the larger pinnacle and the other just N of the smaller pinnacle. From an E approach, the pinnacles are reported visible at a distance of 20 miles.

Anchorage can be had anywhere on the bank which surrounds the pinnacles, but there is no protection; in general, the holding ground is poor. In comparatively smooth weather, landings can be made just N of the bight on the W side of the larger pinnacle. Because of its exposed position, most times the surf breaks high up its sides and landings are extremely hazardous and generally impossible. Some sea birds nest on its higher elevations.

Currents

Current observations taken at a number of locations in the vicinity of Gardner Pinnacles show a WNW oceanic drift of about 0.2 knot combined with a rotary tidal current, turning clockwise, of 0.2 knot at strength. Velocities of about 2 knots setting WSW were measured during E winds.

Gardner Pinnacles lie near the NE side of a bank about 50 miles long, in a N-S direction, and about 20 miles wide near the N end. The

bank has depths of 10 to 25 fathoms, and the sand and coral bottom is plainly visible.

Maro Reef



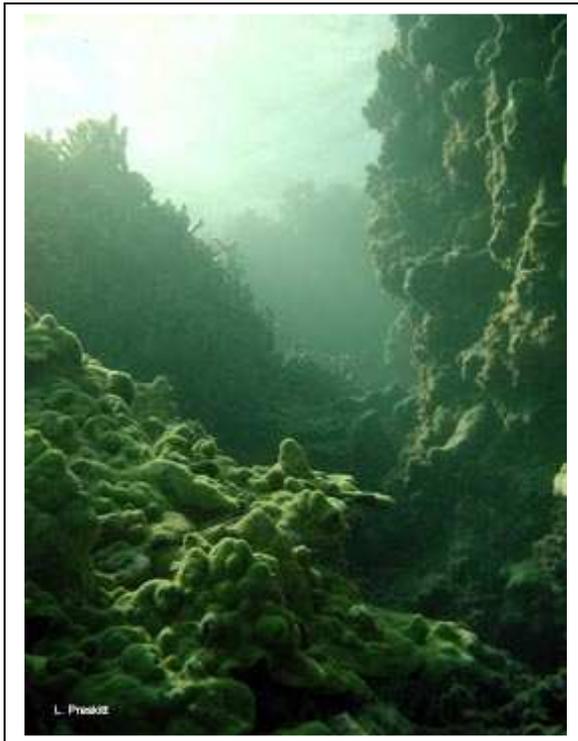
Maro Reef is a largely submerged coral atoll located about 145 miles WNW of Gardner Pinnacles.

It is the largest coral reef in the Northwestern Hawaiian Islands, over 700 square miles. Unlike the classic ring-shaped atoll, Maro is a complex maze of linear reefs that radiate out from the center like the spokes of a wheel. It is named after the whaling ship Maro, which traveled these waters in 1820.

Marine habitats of Maro Reef range from sandy lagoons to steep reef slopes, large coral heads, ocean pinnacles, and patch reefs. Gaps in the reef cause waves to sweep into the lagoon clouding some areas with silt and sand.

Maro Reef is very large and hard to navigate, making it difficult for scientists to study. Historic sailing vessels found the area equally treacherous, and castaways lost at Maro Reef were forced to set out to the northwest in search of Laysan Island.

Maro Reef has a greater abundance and



diversity of coral than most any other reef

system in the NWHI chain with 37 species of stony corals documented by coral scientists during the 2000-2001 NOWRAMP Research expeditions. Coral species include rice corals, *Montipora capitata* and finger corals, *Porites compressa*.

Maro Reef has a large amount of the hard, pink crusty algae that grows on coral called "coralline algae" that acts like cement and holds the coral together in high surf.

The reefs support numerous butterflyfish and surgeonfish species. Large ulua and omilu have been seen in the reef's open waters, along with white-tip and gray reef sharks. Large schools of six to eight foot Galapagos sharks are also a common sight in the reef's shallow waters.

Coast Pilot

Maro Reef (25°25'N., 170°35'W.), is about 60 miles W of Raita Bank. It was discovered by Captain Allen of the whaler MARO in June 1820. The large, oval-shaped, coral bank is about 31 miles long in a NW direction and about 18 miles wide. The center of the bank is a large area of reefs awash. This broken area, about 12 miles long in a NW direction and 5 miles wide, is extremely foul, with many coral heads awash and channels of deep water between. Only one very small rock, about 2 feet high and on the N side of the reef, shows above high water. The broken part of the reef is practically always marked by breakers. The wide shelf of the bank is outside the broken part of the reef.

Breakers, or the light blue-green color of the area within the broken portions of the reef, give the first warning of the proximity of danger. All maneuvering in the vicinity of the broken area must be done with extreme caution and with the sea and light such that shoal spots can be seen and avoided. Ordinarily, spots with less than 6 fathoms of water are plainly visible.

There are no known dangers more than 3.3 miles from the general outline of broken portions of Maro Reef, thus leaving a navigable shelf with depths of 12 to 20 fathoms on all sides but the NE where depths of 7 to 10 fathoms are found.

Laysan Island



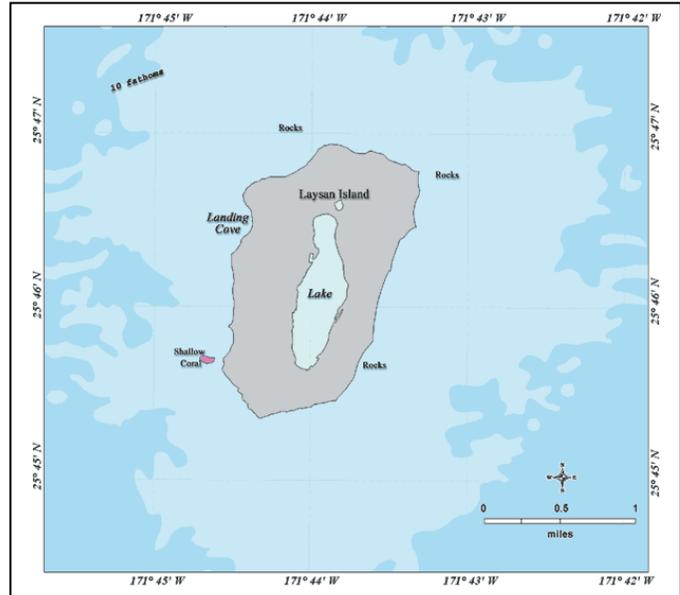
At 1,015 acres, Laysan is the second largest land mass in the Northwest Hawaiian Islands (NWHI), just behind Sand Island at Midway Atoll. It is about 1 mile wide and 1.5 miles long and shaped like a poi board. The island was formed from geologic forces pushing upward and by coral growth. It has fringing reefs and a hypersaline (very salty) lake in the middle of the island, the only lake in the island chain, and one of only five natural lakes in all of Hawaii.

The island's easy access and large number of seabirds made it a base for traders of guano (bird droppings used as fertilizer) and feather harvesters in the late 1800s and early 1900s. Although the practices were declared illegal, poachers killed hundreds of thousands of birds and caused dramatic changes in the island's ecosystem.

Remnants of guano piles remain from this era. Rabbits and guinea pigs released in the early 1900s devastated the island's vegetation. These events caused a public outcry which led to the creation of the Hawaiian Islands Bird Reservation by President Theodore Roosevelt in 1909.



Laysan has the fullest complement of all the bird species in the NWHI. Huge populations of seabirds nest and migratory shorebirds visit including Black-footed and Laysan albatross, Christmas and wedge-tailed shearwaters, and bristle-thighed curlews. Following the devegetation caused by rabbits, several land



birds became extinct including the Laysan honeycreeper and millerbird, but two endemic land birds remain -- the hardy Laysan finch and Laysan duck. Of the 75 native invertebrate species found on Laysan, 15 are endemic.

Surrounding the lake, the beautiful encircling white sand beach is topped by dry coastal grasses. Sedges grow thick near the lake's edge. Over 30 kinds of plants live on Laysan. In addition to the koloa, the Laysan duck is Hawaii's "other" native duck species. This striking endemic duck has developed a fascinating eating habit: it runs on mud flats while snapping at swarms of brine flies to retrieve its meal.

Much of the shoreline at Laysan is composed of upraised, old coral reef,



Collecting Guano on Laysan Island

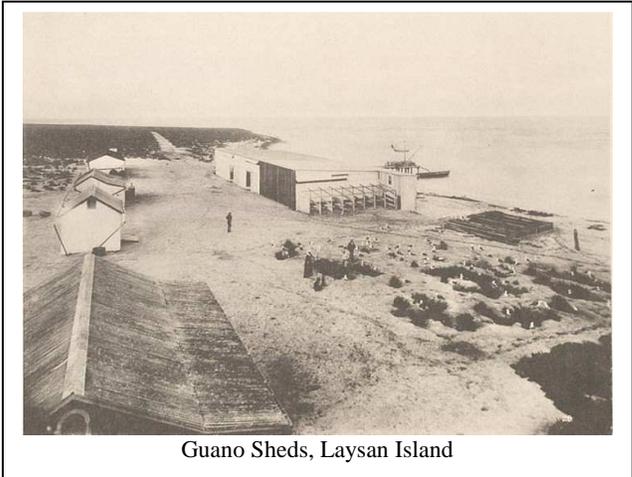
level, and its depth formerly was more than fifteen feet. But so much sand has drifted into this basin, while the island was denuded of vegetation, that now it is probably much shallower.

William Alanson Bryan has suggested that Laysan once was a small atoll, the whole of which was elevated with reference to ocean level. It is surrounded by coral reefs, which on the western side are indented to form a snug landing place for small boats, with a safe anchorage off shore, so long as the trade winds blow and this is the lee side.

The island is shaped like a large Hawaiian poi-pounding board or oval serving dish, about a mile wide by two miles long, north and south. Some authorities have estimated its size as larger. But the careful survey made in April 1923 by the Tanager Expedition made the maximum length 9375 feet and greatest width 5580 feet, which in land miles is one and four-fifths by a trifle over one. The accompanying map is from this survey, after the original by Major Chapman Grant.

The surface is composed of loosely packed coral sand, with beds of coral reef and phosphate rock on the south and west sides. The beaches rise abruptly from the water's edge to a height of 15 to 18 feet, then flatten out to a maximum height of 30 to 40 feet, and then slope gradually downward to a central depression, part of which is occupied by a salty lake without connection with the sea. The surface of this lake is somewhat above sea

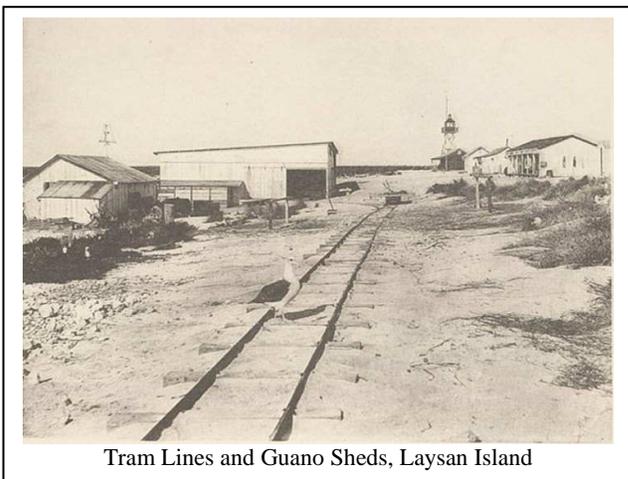
This island is reported to have been an American discovery, but the details are not



Guano Sheds, Laysan Island

available. Not knowing of the earlier visit, Captain Stanikowitch, who sighted the island on March 12, 1828, named it Moller Island after his ship.

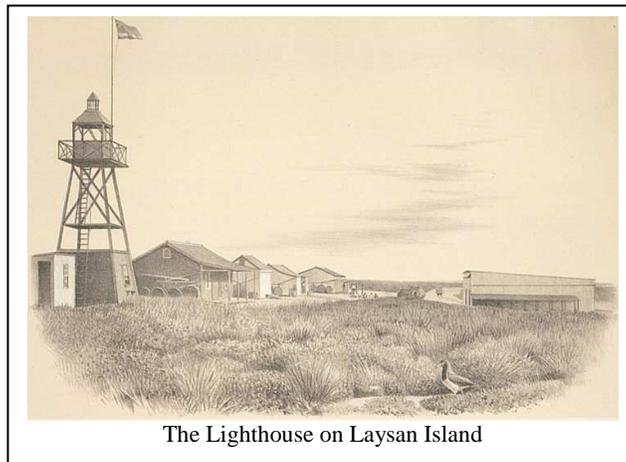
On May 1, 1857, Captain John Paty annexed the island to the Hawaiian kingdom in the course of his famous fifty day voyage of discovery aboard the Hawaiian schooner *Manuokawai*. Said Captain Paty in his report:



Tram Lines and Guano Sheds, Laysan Island

"This is a low sand island 25 to 30 feet high, 3 miles long and 1.5 broad. The surface is covered with beach grass, and half a dozen palm trees were seen. It has a lagoon in the center (salt) 1 mile long and half a mile wide, and not a hundred yards from the lagoon abundance of tolerable good fresh water can be had by digging two feet. Near the lagoon was found a deposit of guano.

"The island is literally covered with birds; there is, at a low estimate, 800,000. Seal and turtle were numerous on the beach, and might easily be taken. They were evidently unaccustomed to the sight of man, as they would hardly move at our approach, and the

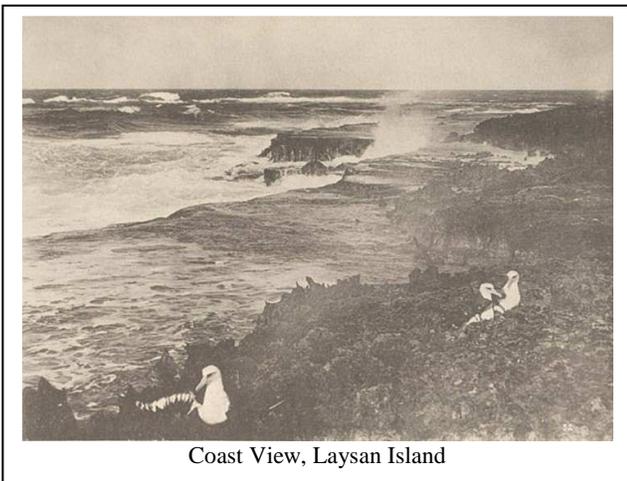


The Lighthouse on Laysan Island

Fertilizer Company. The period of active guano digging lasted from 1892 to 1904. During this time numerous vessels visited Laysan, making the hazardous run up through poorly charted reefs, to carry away loads of guano, or to take provisions to the little colony of guano diggers. Not all vessels survived the trips. The wooden barque *Ceylon* was wrecked on Laysan in July, 1902.

On May 1, 1904, the schooner *Robert Lewers* made a last trip to Laysan for the final cargo of guano for Hackfeld and Company, which firm gave up the lease shortly after this. The manager of the guano digging, Max Schlemmer, continued to live on the island until November, 1915.

About 1903 Captain Schlemmer introduced rabbits to Laysan, partly, it is said, to augment his food supply, and partly, according to Professor Home Dill, to start a rabbit canning business. The first stock included Belgian hares and large white domestic English rabbits. The result of this cross produced a

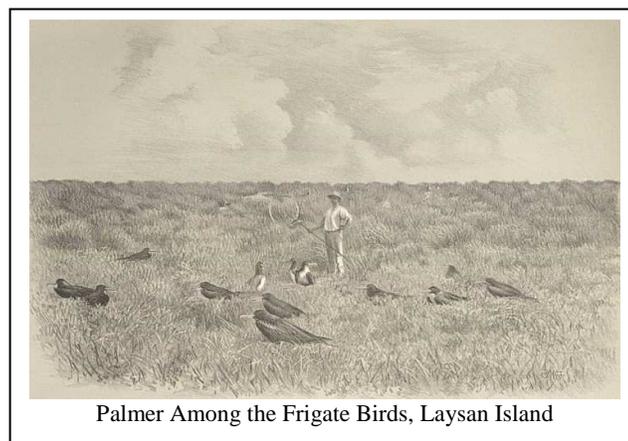


Coast View, Laysan Island

birds were so tame and plentiful that it was difficult to walk about the island without stepping on them . . . Fish, too, are plentiful."

In 1859 Lieutenant J. M. Brooke visited Laysan in the ship *Fenimore Cooper*, and drew a map of the island, on which two palm trees are marked on the east shore of the lagoon. The map now is preserved in the Territorial Survey Office in Honolulu. Later the same year Captain N.C. Brooks visited Laysan in the barque *Gambia*. He gives brief notes concerning the island, stating that it "is covered with a luxuriant growth of shrubs," and that "there are five palm trees on the island, and I collected 25 varieties of plants, some of them splendid flowering shrubs .. "

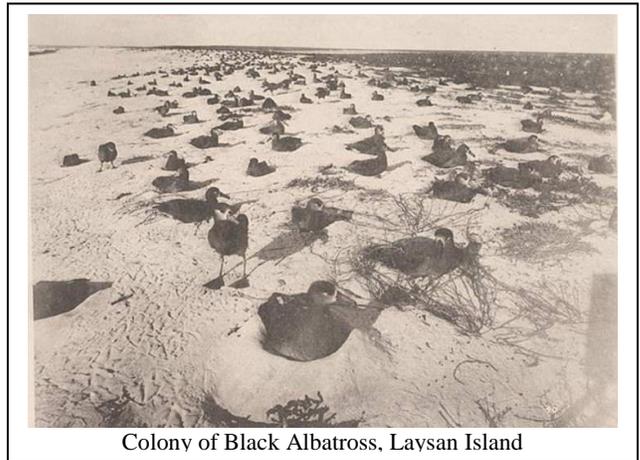
On March 29, 1890, Laysan was leased by the Hawaiian Kingdom for a period of twenty years to the North Pacific Phosphate and



Palmer Among the Frigate Birds, Laysan Island

breed which would have delighted the heart of a geneticist. At all events, they bred prolifically, for within six years the island was overrun with them. They ate off much of the green vegetation. They lived anywhere and everywhere, under bushes, in holes with the shearwaters and petrels, and in burrows of their own.

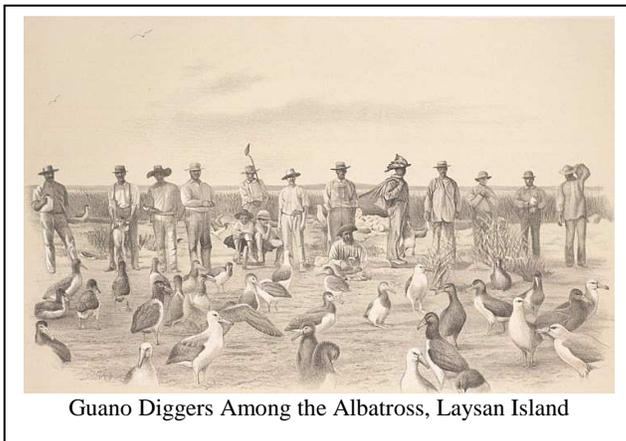
Domestic Guinea pigs also were introduced by Captain Schleimner, but although they bred well, their destructiveness was as nothing compared with the rabbits. Conditions became much worse on Laysan than those described on Lisianski. Literally every green leaf on the island was devoured, except the tobacco patch. Without vegetation to hold the sand and to



Colony of Black Albatross, Laysan Island

Lovers of bird life in Hawaii complained to Washington, and in February 3, 1909, President Theodore Roosevelt, by executive order, set aside all of the islands from Kure to Nihoa, with the exception of Midway, as the Hawaiian Islands Bird Reservation, a sanctuary within which it is unlawful to kill or molest the birds. Thus, when a party of Japanese poachers landed on Laysan and Lisianski in the spring of 1909, they were promptly arrested by the revenue cutter *Thetis* and taken to Honolulu for trial.

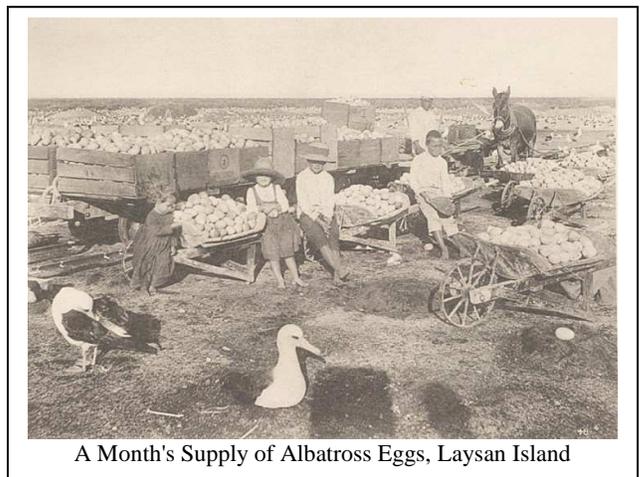
In 1911 a scientific party from Iowa State College visited Laysan to study the bird life and gather material for what has been made a splendid habitat group of sea birds. The party consisted of Professor Homer R. Dill, H.C. Young, C.J. Albrecht, photographer, and C.A. Corwin, artist, who spent 42 days on the island, and William Alanson Bryan, who joined the party for six days. The *Thetis* took the party to Laysan on April 24 and called for it again June 5.



Guano Diggers Among the Albatross, Laysan Island

afford shelter for the birds the island quickly became an almost uninhabitable desert, and the great population of birds were threatened with extinction.

On top of all this came the feather collectors, parties of Japanese who slaughtered great numbers of Laysan albatross and other birds for their plumage, with which to trim hats.

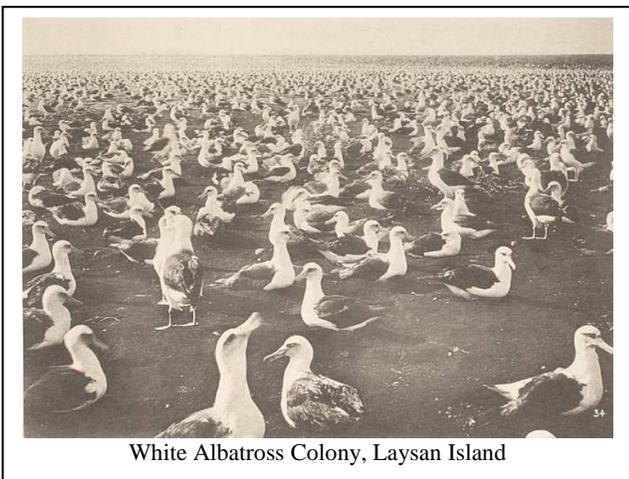


A Month's Supply of Albatross Eggs, Laysan Island



Professor Bryan, at the time of his previous visit to Laysan in 1902, had estimated the bird population as close to ten million. In 1911 his estimate was about a tenth that much. This was born out by the actual bird census made by the Iowa party. They found the number to be 1,016,224, by species as follows: sooty terns, 333,900; grey backed terns, 50,000; noddy terns, 5,500; Hawaiian terns, 3,000;

Bonin Island petrels, 1,000; Sooty petrels, 3; red-tailed tropic birds, 300; blue-faced boobies, 65; red-footed boobies, 125; Christmas Island shearwaters, 75,000; wedge-tailed shearwaters, 100,000; frigate or man-o'-war birds, 12,500; Laysan teal, 6; Laysan flightless rails, 2,000; wandering tattlers, a very few; bristle-thighed curlew, 250; Pacific golden plover, 2,000; turn-stones, 2,500; Laysan honey eaters, 300; Laysan finches, 2,700; and a few miller birds. (These do not add up to the total given.)



White Albatross Colony, Laysan Island

Various other scientific expeditions visited Laysan. The first of these was Henry Palmer's visit in June, 1891, collecting birds for the Hon. Walter Rothschild of Tring, England. This collecting trip formed the basis of the first volume of Rothschild's Avifauna of Laysan and the neighbouring islands, published in London in 1893. George C. Munro, of Honolulu, was Palmer's assistant, and he has penned an interesting account of his ten days observations on the island in "Myriad-nested Laysan", Asia for October, 1930, as well as numerous notes in issues of

the Elepaio, official organ of the Honolulu Audubon Society.

The next scientific visit was that of Dr. H. H. Schauinsland, in 1896. He collected many interesting specimens, most of which were worked upon by German scientists. He described his visit in an entertaining little book, "Drei Monate auf einer Koralleninsel", published in Bremen in 1899.

The U.S. Fish Commission's ship *Albatross* visited Laysan in 1902, and a very complete record of the bird life is presented by Dr. Walter K. Fisher, in the Fish Commission Bulletin for 1903.

Carl Elschner presents observations in 1915, especially analysis of the salinity of the lagoon, which he found to be 9.1% chlorides of sodium and potassium.



These Laysan Finch chicks weren't big on the whole sit-up-straight thing and are quite possibly retarded.

The Tanager Expedition parties spent more than a month on Laysan during the spring of 1923. This expedition was sponsored jointly by the U.S. Biological Survey, the Navy Department, and B. P. Bishop Museum. One of its main objects was to kill off the remaining rabbits, which was done. The scientists found that the island had been transformed into a desert of sand. Only four species of plants remained of the 26 species previously reported. A report on the vegetation in Bishop Museum Bulletin 81, also summarises the earliest notes made by C. Isenbeck, physician on the Moller in 1828, and later accounts.

Fish have been reported as extremely abundant about Laysan, Crawfish and other forms of marine life also abound along the reef. Large turtles, formerly common along the beaches, still visit the island occasionally to lay eggs and sun themselves. This was the type locality for the



Sooty Tern on Laysan Island

native Hawaiian seal, *Monachus schauinslandi*, now rare. Max Schlemmer reported killing seven during fifteen years residence on the island.

Of insects, the species which breed in dead birds are especially abundant. These include blow flies, ants, and dermestid beetles, which must have been exceedingly abundant at the time that hundreds of thousands of birds carcasses were thrown out on the sands to rot. They were reported as very troublesome in 1911, and they came back in numbers in the packages of specimens collected by the Tanager Expedition.

Now that the enemies of the island are no more, and that new plants have been set out to take the places of those which became extinct, the island is beginning to "comeback". A scientific party, return on Templeton Croker's yacht *Zaca*, in December, 1936, reported that conditions, while not yet back to pre-poacher and pre-rabbit optimum, were greatly improved. So we have hopes that, after many misadventures, Laysan once more may become a "Paradise Isle of the Hawaiian Islands Bird Reservation."

Coast Pilot

Laysan Island (25°46'N., 171°44'W.) is a low sand island about 65 miles WNW of Maro Reef. The island is 1.6 miles long in a N-S direction, about 1 mile wide, and 35 feet in elevation at its highest point near the N end. In the center of the island is an extremely hypersaline, foul-smelling lake about 0.9 mile long. The island, mostly soft white sand, is partly covered with low vines and grass, and walking over it is tiring because of innumerable sea-bird nesting holes. The island is marked by an ironwood tree behind a wooden refuge warning sign on the W side of the island, and by a grove of coconut palms on the N edge of the lake. The rock which bares about 3 feet, located on the reef NW of the island presents a good radar target in mild weather. The wreck of a steel fishing boat is on the S shore of the island in 25°45.4'N., 171°44.4'W., but does not present a good radar target. Water can be obtained by digging shallow wells. The island is uninhabited and is seldom visited. As with other islands in the Leeward Islands, an entry permit is required. It



Red Footed Booby

is home to countless sea birds. Millions of flies make a visit there unpleasant most of the year.

A coral reef, a few hundred yards wide, fringes the island. About 0.3 mile off the NW shore is a small, sharp rock, about 3 feet high. Coral heads, covered with 4 to 7 fathoms of water, are numerous in the area within 1 mile of the island. The sand and coral bottom can usually be seen in depths less than 10 fathoms, and often in greater depths. When approaching closer than 1 mile, a sharp lookout must be maintained to detect the coral heads.

Vessels can anchor in depths of 8 to 15 fathoms 1 to 1.5 miles off the island on all sides, depending upon which side affords the best protection. During the trades, anchorage can be had 0.5 to 1 mile off the W side in depths of 8 to 15 fathoms, fair holding ground. In 1976, the Coast Guard Cutter *MALLOW* found good anchorage in 45 feet of water, sand and coral bottom, in 25°46'22"N., 171°45'15"W., with the ironwood tree bearing 084°, 1,390 yards. However, the anchor chain is subject to fouling on the coral heads because of the rotary currents. The coral heads are large and present a problem to vessels as they can foul ground tackle. It may be advisable to remain underway while attempting to land a small boat. Small craft drawing not over 12 feet can lie at anchor inside the reef and off the ironwood tree on the W side of the island, but this anchorage affords no protection from W winds. In February-March 1978, the NOAA Ship *TOWNSEND CROMWELL* found anchorage with good holding ground, sand and coral bottom, and fair protection from strong W and NW winds accompanied by heavy seas and swell in 25°46.3'N., 171°43.0'W. and 25°45.8'N., 171°43.5'W. Surf of 10 to 15 feet

was observed breaking on the W side of the island, and a 3- to 5-foot surf was observed on the reefs on the E and NE side.

During NE and SE weather, the best landing can be made off the ironwood tree on the W side of the island on a sloping sandy beach. An alternate landing site on the W side of the island is about 0.5 mile S of the primary landing site, where the reef narrows close to shore. A poor landing can be made near the NE end of the island during light W winds. Caution is advised when attempting a landing on this side of the island. Clear sand beaches are almost nonexistent, and approaches to the beach must be made between breakers on the outer reef and the shore. Summer is the best for landing, as the NE trades prevail during this period.

Currents

A current velocity of about 1 knot and a rotary tidal current, turning clockwise, have been reported. The current is believed to depend to a great extent upon the wind. In 1976, the Coast Guard Cutter MALLOW observed the current to round the S side of the island in a clockwise direction on the flood; and to round the N tip of the island in a counterclockwise direction on the ebb.

Laysan Island is just SE of the center of a circular bank 14 miles in diameter, with depths of 9 to 23 fathoms, beyond which the water deepens rapidly.

Northampton Seamounts, unsurveyed seamounts with a least known depth of 15 fathoms, are about 35 miles SW of Laysan Island.



Laysan Island

From Rothschild's "Avifauna of Laysan"

Henry Palmer's 1891 visit to Laysan Island.

I. THE ISLAND OF LAYSAN.



INTRODUCTORY NOTES.

SCATTERED about in a north-westerly direction from the Sandwich Islands are a number of small islands, rocks, and reefs—namely, Necker Isle, French Frigate Shoals, Gardner Island, Maro Reef, Lisiansky, Laysan or Moller Island, and some others. Although ornithologists have had their eyes on these islands for a long time, they had not been trodden by the foot of any ornithologist until I sent my collector, Henry Palmer, to explore them.

From the results of his collecting-tour it was evident that none of these islands are inhabited by land-birds, except Laysan or Moller Island. This island is therefore by far the most interesting one to ornithologists.

The island was named Moller by Capt. Stanikowitch, in 1828, after his vessel; but it had been discovered before by an American ship and received the name of Laysan, under which it is best known at the present time. (See Findlay, 'North Pacific Ocean and Japan Directory,' p. 1113.)

Captain Brooks, in 1859, describes it as follows:—"Laysan Island is in lat. 25° 46' N., long. 171° 49' W., is 3 miles long and 2½ miles broad, and covered with a luxuriant growth of shrubs. It is surrounded by a reef about half a mile from the land. Outside of this reef there is a bank 5 miles wide, on which I found from 14 to 19 fathoms water. There is a boat-passage inside the reef nearly the whole way round the island, the only obstruction being on the south and S.E. sides. Good landing can be found anywhere, excepting on the south and S.E. sides; good anchorage anywhere on the west side; the best, however, is about half a mile from the S.W. point, in from 8 to 12 fathoms water. It can be approached from any point of the compass, no dangers existing within half a mile of the reef.

"There is a lagoon on the island, about 1 mile long and half a mile wide, with 5 fathoms

a

water in the centre, and coral bottom. On the shores of this lagoon I found salt of good quality.

"There are (1859) five palm-trees on the island, 15 feet high, and I collected twenty-five varieties of plants, some of them splendid flowering shrubs, very fragrant, resembling plants I have seen in gardens in Honolulu. I saw on the beach trunks of immense trees, probably drifted from the N.W. coast of America. The island contains about 50 acres of good soil. It is covered with a variety of land- and sea-birds; some of the land-varieties are small and of beautiful plumage. Birds' eggs were abundant.

"There is a very small deposit of guano on the island, but not of sufficient quantity to warrant any attempts to get it. Dug a well and found very good water. The reefs here abound in fish and turtle."

But a long time before, in 1834, the well-known German traveller and ornithologist, F. H. von Kittlitz gave, in the 'Museum Senckenbergianum,' vol. i. pp. 117 *et seq.*, a highly interesting account of Laysan and some of the other islands, and a list of all the birds that were observed.

Unfortunately Herr von Kittlitz was on board the 'Senjawin' and not on the 'Moller,' which visited the islands in March 1828, "at the commencement of the breeding-season of the innumerable birds which live on these lonely spots, and are especially plentiful on the small flat island that was then discovered for the first time, and was named Moller, after the ship."

"Unfortunately," Herr von Kittlitz proceeds to say, "nobody on board the 'Moller' was able to do anything of importance for natural history; but the ship's surgeon, Herr C. Isenbeck, did his best to bear all he saw in mind, and to prepare and keep as many of the birds, which were mostly caught by hand, as the very unfavourable circumstances allowed him to do. The following notes are written down from his and his companions' reports given to me when we met later in Kamtschatka."

I here translate the most important information given by Kittlitz, *i. e.*:—

"The crew of the 'Moller' did not land on the rocky island of Necker, but they saw enormous quantities of different birds around it. They were too far off to recognize the species.

"Herr Isenbeck landed on Gardner, although the landing was very difficult and dangerous, and a very small part of the island only was accessible. Most of the birds kept to the inaccessible high part, and therefore very few eggs were found.

"On March 12 (24) Herr Isenbeck landed on Moller (Laysan), which was originally a coral-island with a long reef round it. It seems that it was raised higher and became a real island from the accumulations of the birds' excrements. It is covered with a strong bushy kind of grass and partly with low shrubs, between which a few pigmy palms had grown up. Although there was no fresh water on the island, there were not only sea-birds but also several land-birds, as the following list will show. Most of the larger birds were already breeding, or had paired at least.

"On the 22nd of March (April 3), when on Lisiansky Island, they again found all the larger birds as on Laysan, and mostly breeding; but none were found that they had not seen on Laysan.

"The following is the list I was able to compile from the information I had received:—

- "1. *Diomedea (an exulans?)*¹. Albatross: white, with flesh-coloured bill, varying with white; grey and black wings. Plentiful on Gardner, where they seemed to live on the highest parts, Moller and Lisiansky, where they lived in a like manner to no. 2. Its voice resembles somewhat that of most of the Gulls, but is not so strong, and more like a cackle with a howling sound in it.
- "2. *Diomedea (an fuliginosa?)*². Albatross: chestnut-brown, with black bill and feet; bill with a white line along it; size about the same as no. 1. Common on Laysan and Lisiansky, living on the flat ground: extremely foolish and fearless; can be caught with the hands; must run a good distance before being able to get up, and stands still if coming across anything. If two meet they bow to each other, uttering a low cackling. When Herr Isenbeck met one he used to bow to it, and the Albatrosses were polite enough to answer, bowing and cackling. This could easily be regarded as a fairy tale; but considering that these birds, which did not even fly away when approached, had no reason to change their customs, it seems quite natural. The voice is similar to that of no. 1. Its nest is a lump of earth, with a hole in the middle, in which the single egg is placed with the point downwards³. The breeding-season was over on Laysan; only bad eggs were found, but a good many young ones, which were covered with grey down and fed with fish by both parents.
- "3. *Tachypetes aquilus*. Obviously the same as Buffon's figure of the Great Frigate-bird, which is the real *Pelecanus aquilus* of Linné. The specimens found here, of which Herr Isenbeck has preserved several of both sexes, are especially beautiful, with large bright red crop in the male and rich metallic gloss on the long narrow feathers on the back, which are much less conspicuous in the female. The latter is also a little smaller, and has the throat covered with white feathers, instead of having the bare crop of the male. The male blows out the crop like a ball when flying in the air, and this is said to be a very peculiar sight. A single such bird only was seen over Gardner, but very many on Moller, where they sat in pairs on the nests, and were so little shy that they were often caught with the hands. No eggs were as yet found on Laysan, but many on Lisiansky. A single egg only is in each nest, of the size of a Goose's egg, and not very pointed; white in colour. The nests were loose structures of twigs placed on the bushes.
 "The sailors further remarked that, like the Swifts, they firmly believed the Frigate-birds were unable to fly up off flat ground, but always throw themselves off the higher rocks so as to be able to use their huge wings. This gives one good reason to suppose that they are also unable to swim, or at all events do so very reluctantly. [Mr. Hartert, however, who has seen these birds in numbers in the West Indies, saw them fly up easily from the bushes and scrub, and a bird he wounded swam very well.—W. R.]
- "4. A species of *Frigate-bird* that has not yet been distinguished from the *Tachypetes aquilus*; but although similar to the common species in size and proportions, differs from it in

¹ *Diomedea immutabilis*, Rothsch.—W. R.

² *Diomedea chinensis*, Temm.—W. R.

³ Palmer gives no record of this, which is so contrary to all other observations, that I firmly believe he could not have overlooked it.—W. R.

having the abdomen mostly white, the feathers of the back rounded, the head sometimes pure white, sometimes overspread with rusty yellow, the bill red and lacking the great gular pouch. I would consider this, without doubt, an immature plumage of the former species, if there were not so many varieties that one appears to be able to distinguish the old and young of this form, and none of them have a trace of the long and pointed glossy feathers on the back. Since the officers of the 'Moller' clearly recognized the two different species, one is induced to believe that they are better distinguished in life and by their habits than they seem to be in museum cabinets. It must be admitted that this does not make the difference quite certain, but renders it very probable; since both forms were always found on the same islands, but not in company, the white-headed variety can certainly not be the winter plumage.

"This variety was common on Gardner Island, while the other was rare; it flew generally very high, together with the *Phaëton*, and did not cry. On Moller and Lisiansky, on the other hand, where the other was common, this form was scarce, not in pairs, and not nesting; it was often seen sitting or running on the rocks, but mostly flying very high.

- "5. *Phaëton* (an *candidus*?), with white, somewhat broad tail-feathers; seen singly near Gardner, only flying very high. The voice was similar to that of *Ph. phœnicurus*, which has some resemblance to that of our *Larus ridibundus*. The visitors to Gardner mentioned as a very remarkable sight the persistent flight of one of these birds with a Frigate-bird, that tried in vain to steal a fish from it that it had just caught.

"Here, too, the *Phaëton* was not seen sitting or swimming. This is probably the most persistent flier of all the birds in existence, although its wings have not the enormous appearance of those of the Albatrosses, for example, which are so often seen resting on the water, but which can by no means be compared with the *Phaëton* in rapidity and lightness of flight. I have seen innumerable *Phaëtons*, especially of the red-tailed species, which never showed the slightest intention to swim, and they frequent chiefly those parts of the sea where not a single rock is to be found, so that they cannot possibly rest on dry land at night-time. I have also never seen or heard that a *Phaëton* rested on a ship at night, as other birds, for example the species of *Sula*, so often do. Very likely the *Phaëton* sleeps whilst swimming, and spends the rest of its life, except the breeding-season, on the wing. At least this applies to *Phaëton phœnicurus*, which I observed so often, and which, in the Pacific Ocean, is common in both the Tropics, but especially in the northern Tropic, north of which, contrary to its general habits, it ranges up to 40 degrees in the Pacific.

- "6. A species of *Carbo*?¹, of about the size of *Pelecanus piscator*; chestnut-brown. Not very numerous on Moller, where it nests on the above-mentioned palm-trees. Three nests, built of twigs, were placed on one tree; the birds were sitting on the nests in pairs and showed little fear. They were just then sitting on two eggs each, about the same size as those of the Lapwing, grey in colour and spotted. This bird was also seen on Lisiansky.

- "7. *Pelecanus piscator*, L. White, with blackish wings; bill bluish, with red gular skin, with

¹ *Sula sula* (Linn.).—W. R.

a black triangle in the female; feet red. Rather common on Moller and Lisiansky: breeds in colonies on the beach; lays one egg only without nest, which is fiercely defended by the parents; these eggs were white in colour and of an excellent flavour. At the time of the visit they were fortunately not yet set.

- "8. *Larus*, sp., perhaps *argentatus*, L. A large Gull, with flesh-coloured beak. Seen in great numbers flying round the top of Gardner Island; later on Moller and Lisiansky too.
- "9. *Sterna* (?)¹, about 9 inches long; white, with greyish wings, back, and crown; tail with two long lateral rectrices. This bird was termed a Petrel by Herr Isenbeck and his companions; but this did not correspond with the fact that they would recognize it on seeing my *Sterna kamschatica*, for then it ought to have a black crown, which, however, may be absent in winter, as is the case with several Terns. The eggs which the travellers believed to belong to this species were found together in numbers, without nest, in caves and fissures of the rock; they were about as large as the eggs of domestic Pigeons, much compressed at the blunt end, greyish, and spotted with brown.
- "10. A *Petrel*² about 9 inches long; all over deep chestnut-brown, with blackish bill and feet, and a cuneate tail. Only seen on Gardner.
- "11. Another *Petrel*³, a little larger; breast, abdomen, and neck white; upper surface mixed white and brown; the forked tail only moderately emarginate. Seen on all three islands. On Moller it was sitting under the scrub in pairs, and was so little prepared for the intrusion that several were trodden upon. Eggs were not found.
- "12. A species of *Duck*⁴, with no conspicuous plumage, living in small flocks on Moller and Lisiansky, but not breeding.
- "13. A species of "*Saipe*"⁵ (most probably a *Totanus*), which the observers were unable to describe. In flocks on Moller and Lisiansky, and by no means shy.
- "14. A species of *Sandpiper* (perhaps *Tringa minuta*); also in flocks on Moller and Lisiansky. [Perhaps *Calidris*?—W. R.]
- "15. A kind of *Fowl*⁶, about as large as a Ptarmigan; mixed grey and brown; running on the ground, singly, but at the same time rather numerous, on Moller and Lisiansky; very rapid and rather shy. Eggs were not found.
- "16. A small *Sparrow-like bird*⁷, brownish grey above, yellowish green below. Only found on Moller, where it was often seen running on the ground under the grass very quickly. One, however, was knocked down with a cap.
- "17. A small *red bird*⁸ with black wings. On the same island, where it is not very common; flying round the bushes.

¹ *Haliplana lunata*, Peale.—W. R.

² *Puffinus nativitatis*, Streets.—W. R.

³ *Puffinus cuneatus*, Salvin.—W. R.

⁴ *Anas laysanensis*, Rothsch.—W. R.

⁵ *Totanus incanous* (Gm.).—W. R.

⁶ Although the description is very different, nothing else can be meant but *Porzana palmeri*, Froh.; but at the present time it does not exist on Lisiansky Island.—W. R.

⁷ *Telespiza*.—W. R.

⁸ *Himatione frerehi*, Rothsch.—W. R.

"18. A *small bird*¹, somewhat resembling a Humming-bird; like it hovering in the air. Brownish, glossy greenish from beneath. Also seen only on Moller. It would be very curious if this should prove to be a Humming-bird.

" *Birds observed on each of these Islands.*

" Gardner Island:

1. *Diomedea* (no. 1). Very common.
2. *Tachypetes* (no. 3). Single.
3. *Tachypetes* (no. 4). Common.
4. *Phaeton* (no. 5). Single.
5. *Larus* (no. 8). Very common.
6. *Sterna* (no. 9). Numerous.
7. *Procellaria* (no. 10). Numerous.
8. *Procellaria* (no. 11). Numerous.

" Besides these an enormous number of larger and smaller birds were seen, which appeared to be Gulls and Petrels.

" Moller Island (Laysan):

1. *Diomedea* (no. 1). Common.
2. *Diomedea* (no. 2). Common.
3. *Tachypetes* (no. 3). Common.
4. *Tachypetes* (no. 4). Not numerous.
5. *Carbo* (no. 6). Not numerous.
6. *Pelecanus* (no. 7). Common.
7. *Larus* (no. 8). Common.
8. *Procellaria* (no. 11). Common.
9. *Anas* (no. 12). Rather common.
10. *Totanus?* (no. 13). Rather common.
11. *Tringa?* (no. 14). Rather common.
12. Fowl-like bird (no. 15). Rather numerous.
13. Sparrow-like bird (no. 16). Rather common.
14. Small red bird (no. 17). Single.
15. Humming-bird ?? (no. 18). Single.

" *Note.*—On the beach several small Seals and very large Sea-Turtle were found. [Seal = *Otaria ursina*.]

" Lisiansky:

" All the same birds as on Moller to no. 12 inclusive. The three last-named small birds were not seen. It seems as if they had come through an extraordinary accident to that island."

¹ There is no such bird on the island.—W. R.

DIARY OF HENRY PALMER.

From May 5th to August 18th, 1891.

May 5 & 6 (Honolulu).—These two days were spent in looking for a vessel for my expedition and obtaining permission from the Laysan Guano Company to collect on their islands.

May 9.—Arranged with Capt. Walker for the trip and put my things on board. I am very nervous, as he lost his last vessel among these same islands; but I must go with him, as this is the only chance.

May 10 & 11.—I spent these days in preparing for my voyage and in hunting up a Captain Rosskill, who had brought three living specimens of the Laysan-Island Rail to Honolulu.

May 12.—I went to see the Rails and bought two of the three specimens. As there was no steamer leaving for Europe, I was obliged to kill and skin them. On the journey from Laysan they had been fed on canary-seed and potatoes.

May 21.—It is now a little more than a week since I last wrote in my diary, but I was too disgusted at the innumerable delays and crotchets of Capt. Walker. Yesterday only did we get the schooner alongside the wharf, so many alterations and improvements had to be made; but now everything is settled, and if the weather is favourable we start to-morrow.

May 23.—At last everything is ready and I am once again on the water, bound for the islands I have to explore. This evening we have anchored 30 miles from Honolulu to get everything straight before going right out to sea.

May 24.—At sea. Nothing to note.

May 25.—Weather fine, but heavy sea running. I expect to-morrow to reach Niihau, or Bird Island.

May 26.—Reached Bird Island at 2 o'clock, but the swell was too heavy to land. We sailed all round it before leaving. There seemed to be any quantity of sea-birds on it. The island itself is only a large rock with very scanty vegetation; all I could see were two small groups of some kind of palms. While sailing round the island some Gannets came and settled on our bowsprit, and I caught three of them, all of one kind, although I saw another species flying round. I here mention the various species of sea-birds we saw on Niihau as far as I could identify them:—

2 species of Albatross. [Probably *Diomedea immutabilis*, Rothsch., and *Diomedea chinensis*, Temm.—W. R.]

2 species of Gannet. [*Sula sula* and *S. piscator*.—W. R.]

3 species of Petrel. [These are probably the same as those of Laysan.—W. R.]

6 or 7 species of Tern. [Probably *Anous stolidus*, *A. hawaiiensis*, *Halipiana fuliginosa* ad. and juv., *A. cinereus*?, *Gygis candida*, and *H. lunata*.—W. R.]

A small flock of Akekeke came flying off the island when we were opposite the landing-place, took a circle round, and disappeared. [*Streptilas interpres*, L.—W. R.]

In the evening I saw another flock of these birds flying the same way as the vessel was steering and as though they were migrating to another island. I also noticed some Red-tailed Tropic-birds [*Phaëton rubricauda*.—W. R.] flying round the island, and their love-making in

the air was accompanied by some peculiar evolutions. The male, on approaching the female, swung his tail from side to side and up and down, almost doubling it up under him, and this it continued for a long time.

May 30.—On account of the very bad weather we have had since Wednesday I have been unable to write my log, but I take notes as I go along, which I here record. On the 27th at sea all day and nothing to note.

May 28.—Passed and sailed round Necker Island. A strong wind and a heavy sea made landing impossible. Necker Island is a large rock with no vegetation whatever upon it; nearly all round its sides appeared perpendicular, except one small place on the S.W. side, where in calm weather I believe I could have landed, but I did not see the use of staying round this island for an indefinite period to await a calm sea: we therefore made straight for French Frigate Islands, where we have just anchored (May 30), but cannot land yet on account of the surf. All the way from Niihau we have seen plenty of the same species of sea-birds I have mentioned before, but yesterday, for the first time, I saw a Storm-Petrel [*Thalassidroma?*—W. R.].

French Frigate Islands are simply large low sandbanks with little or no vegetation on them. There is also one rock a hundred and twenty-five feet high, which it is perfectly impossible to land on, but it is covered with sea-birds.

May 31.—This evening I have camped out on one of the sandbanks, the ship being three miles off. This bank is literally covered with birds, chiefly two species of Tern. Most of their young are nearly ready to fly, some even are flying. Besides these Terns there are a few Gannets and Albatross. My assistant and I have to-day carefully examined all the birds on this shoal, inspecting eggs, young, &c. The White-breasted Tern (*Haliplana fuliginosa*) lays only one egg and deposits it anywhere on the sand; their young are of a dark brown colour with spots, and are the same bird which I mistook for a different species on Niihau (cf. *autea*, p. vii).

The other Tern mentioned above also lays one egg only, but seems to prefer the centre of small growing bunches of grass to deposit it on. A few of the Gannets are still incubating, although some young birds are almost ready to fly. They lay their eggs on the sand, two in number, and the egg is extremely small for the size of the bird. We also found what I believe to be Albatross eggs, but as we could not identify the parents I did not collect any. There are also a few "Uili" (*Totanus incanus*) on the island, and I also saw a few "Akekeke" (*Streptilas interpres*) when we landed. There were also a lot of turtle on the islands; but the photographs will give a better idea of the immense number of sea-birds on these shoals than anything I can write.

June 1.—All to-day I have been busy skinning and preserving specimens. Capt. Walker came off from the ship to us and talks of remaining till the 5th; but as our water has almost all leaked out, it depends on what provisions he sends to-morrow whether I can stay on the sandbank or not. To-day we obtained specimens of a Petrel which breeds here, and so I believe I have obtained every species of bird that breeds on this island.

June 2.—Capt. Walker sent a boat this morning to say he intended at once to change his anchorage to another island, so I went on board again about mid-day.

June 3.—We left our anchorage this morning, sailed round the rock, and cast anchor

again in the evening off two small sandbanks. As I saw no birds on them I did not go on shore. Captain Walker's sons, however, went and found a few turtle and Boobies (*Sula sula*). We went quite close to the previously-mentioned rock, and, on firing a rifle, among the birds that got up I saw a pair of another species of Tern I had not got and also a third species of Gannet.

I see further ahead an island apparently full of birds, which I hope to reach to-morrow, as the weather is now nice and fine.

June 4.—Weighed anchor and sailed up to the island I have just mentioned. It is only a rather larger sandbank than the one we had just left. There were plenty of birds on it, but chiefly the same as I had got before, though the young of the Black Albatross were much more plentiful. I also got another species of Petrel which was sitting on the ground, but only obtained one out of the pair I saw. Here I also found the White Gannet [*Sula piscator*.—W. R.] nesting. This bird builds a nest among, and made of, some species of vine growing on the island, and the nest is not unlike those of the Shags (*Phalacrocorax*). All the nests I examined were very similar and built in the centre of the vine, round and flat, and about six inches above the ground. Each nest had only one egg. The young of the Pied Tern (*Anous fuliginosus*) were all much younger than on the island I had been before, very few being able to fly. The large Petrel, of which there were a few stragglers on the former island, were here very plentiful, sitting on the sand in pairs. There were also a few Frigate-birds round about, but I did not trouble to shoot any, as, according to report, they are very plentiful on Laysan Island.

June 5.—At 6 in the morning I went on to the island again, as we were to leave at 11 o'clock. While turning up some turtle-shells that had been heaped up by a shipwrecked crew, I discovered a third species of Petrel sitting on its egg; of this we obtained ten or eleven besides six eggs. I also obtained some more of the Petrel I got one specimen of yesterday. Of the large Petrel I saw several males in the act of copulation, so I have no doubt they will soon commence to lay. I saw several of them in their burrows in the sand.

June 6.—We continued our journey last night and are now bound for Gardner Island. The weather is very calm. Unfortunately my assistant (Munroe) is ill with "La Grippe," and it is so terribly hot that I hardly know what to do with my skins. The young birds in down I cannot do anything with, which is very discouraging, but in future I shall put them in spirit.

June 7.—At sea. Weather very calm. Hope to reach Gardner Island to-morrow.

From June 7th to June 13th we were occupied in beating round for Gardner Island, having experienced bad weather and for some time had lost our course. Owing to the rough sea there was no possibility of landing on Gardner Island, and the only birds I saw were the White Tern (*Gygis*), the Grey-backed Tern [*Haliplana lunata*.—W. R.], the Tropic-bird, and the Frigate-bird. On the 13th we lay in a dead calm, and I fear we may be a long time before we reach Laysan, and all this delay is owing to bad management on board.

June 16.—At last we reached Laysan, having sighted it just after daylight. From what I can see of the island I am in hopes that I shall be able to make up a little of the lost time, for, to my great delight, the island appears quite alive with birds, especially the Rail, which, although I had been told was tolerably plentiful, to my intense astonishment literally

covers the island. Everywhere one walks this little creature hurries out of your way. [This Rail is *Porzana palmeri*, Froh.—W. R.]

Before going into particulars about the birds I think it best to give a description of Laysan Island, as I found it.

The island is a simple atoll with a lagoon in the centre, which Mr. Freeth (the governor of the island and manager of the Guano Company) tells me has comparatively little water in it at the present time, although I consider there are quite 100 acres under water¹. With the exception of the lagoon the island is covered with vegetation, consisting chiefly of a coarse kind of grass about three feet high and small thick scrub between four and five feet high. Here and there are bare patches entirely covered with young Albatrosses, Terns, and Petrels, and under the grass and scrub it is just the same, almost at every step you sink into the burrow of some bird. Mr. Freeth took me to the guano-field on the tram-line he has built, and he had to send a man on ahead to clear the track of the young Albatrosses. I have seen so many birds and have been so excited that I must leave my description of them till I have seen more at my leisure.

June 17.—Have spent the day catching and skinning birds; I will not try to give a description of their habits until I have seen more of the birds; there are so many that it makes one quite confused. A most touching thing occurred: I caught a little red Honey-eater [*Himatione freethi*.—W. R.] in the net, and when I took it out the little thing began to sing in my hand. I answered it with a whistle, which it returned and continued to do so for some minutes, not being in the least frightened.

June 18.—I and my assistant went about the island and collected some eggs and birds. I shot four Ducks, which, besides the Curlew, are the only birds which cannot be caught with a hand-net. Mr. Freeth has just told me his little boy caught one of the Finches this morning and then got an egg and offered it to it; the bird broke and ate the egg while being held in the boy's hand. This^{*} would give you an idea how tame all the birds are here.

June 19.—Again the day was spent in collecting and preparing birds. While out this morning both my assistant and I saw a little Rail break and eat an egg. We had disturbed from its nest a Noddy (*Anous*), immediately the Rail ran up and began to strike at the egg-shell with its bill, but the egg being large and hard he was quite a long time before making a hole. The Rail would jump high into the air and come down with all its force on the egg, until it accomplished the task, which once done the egg was soon emptied. By this time the Tern came back and gave chase, but in vain. At the beginning I ran after the Rails with the net, but soon found that it was much better to put the net edgeways on the ground, when the very inquisitive Rails would run up to look at it, and then were easily caught.

June 20.—To-day I packed up two boxes of birds to go by the 'Mary Foster' (guano-ship) to Honolulu.

June 21.—While walking about the island I turned some of the Frigate-birds which had young off their nests. Scarcely had I pushed one off when another Frigate-bird would rush up, seize the young one, fly off and eat it. Sometimes the parent bird would give chase, but it always ended in one or the other eating the young bird. I could scarcely believe my own

¹ I am told that on analysis the water in this lagoon proves to be three times as salt as ordinary sea-water.

eyes, so I tried several, but they would even take young birds out of the nest which were almost fully feathered.

June 23.—I have spent half the day hunting for the eggs of the Rail, but although we found several nests which I believe were Rails' nests, there were no eggs in any of them. My assistant saw one of the red Honey-eaters holding a moth with its claw, which it pulled to pieces and ate.

June 24.—My assistant and I went out again this morning searching for eggs of the land-birds, and I am pleased to state that we found two nests of the Rail. One nest contained three eggs, the other an egg and a small chick. Since bringing the eggs home, the one found with the chick has hatched into a young Rail, which I have put in spirits. I now have Rails of every size from the egg upwards. I also found a Finch's nest with two young in it, which I have put in spirit, also an egg with them. We also found two nests of the "Flycatcher" [*Aerocephalus familiaris*.—W. R.].

June 26.—To-day I spent in catching live Rails to take on board with me, and if all is well we leave to-morrow. I have collected specimens of all birds found on the island, with the exception of those previously obtained on Kauai. Mr. Freeth has done everything he possibly could for me, and I have a nice lot of specimens. A small fly on the island has given me a great deal of trouble with my skins. Almost before the birds were dead they were fly-blown. It is the smallest blowfly I have ever seen, but does quite as much damage as the larger ones. A small beetle also caused me a great deal of anxiety, laying its eggs in the skins. I am now trying some insect-powder Mr. Freeth gave me.

June 27.—We are leaving to-day for Lisiansky Island.

June 29.—I have just arrived and am in camp on Lisiansky Island. As yet I have not been round the island, but from what I can see round the tent there is vegetation on the island, but nothing in comparison to that on Laysan. As we before found on all the islands, the Pied Tern (*Anous fuliginosus*) is in great abundance here, but the young are very small. There are also young White-breasted Albatross [*Diomedea immutabilis*.—W. R.], large Gannet [*Sula cyanops*.—W. R.], Grey-capped Tern [*Anous hawaiiensis*.—W. R.], and the Petrels. These are all the birds I can see close round the tent.

June 30.—I have made a thorough inspection of the island to-day, but the only additional species of birds I saw was the White and Brown Gannet (*Sula sula*), which I saw when passing Bird Island. This, to distinguish it when writing my diary, I will call the "Brown Gannet." I perceived them flying about on the weather side of the island, and shot all I saw. They seem to be rather shy, but that may be because they are not breeding, for I found the other two species of Gannets much more shy when not breeding. This "Brown Gannet" is much the scarcest of the three species on all the islands I have visited hitherto. Another to me strange fact is the large preponderance of males, all those I shot being of this sex. The White-breasted Albatross are here in thousands all over the island, but the dark one [*Diomedea chinensis*, Temm.—W. R.] is very scarce. There are only a few on the weather side of the island, but, as before mentioned, the Pied Tern is by far the most numerous of any bird here. On Laysan Island they call it the "Wideawake Tern," which is a very good name for them, for night and day they keep up a continual cry, and some are always to be seen flying about. The large Gannets (*Sula cyanops*) are sitting with their young all along the beach, some of the

latter being just able to fly. The small Gannets (*Sula piscator*) are sitting on their nests, which are built on some small scrub that is growing round what I believe at one time must have been a lake, on the south side of the island. This scrub, although it does not grow so high, is, I think, the same as that found on Laysan, and which, with the exception of two or three small spots only, grows round this dried-up lake. The Frigate-birds are here also in large numbers. They have their nests on the scrub round the lake. It is very interesting to watch them getting their food: in the daytime they soar about all over the island, and every now and then one of them picks up a young Tern, then a number of others chase him and keep taking the prey one from the other till at last it is eaten or drops to the ground; but they generally make for the sea with their prey, as it is easier for them to pick up when dropped than on land. When soaring they hardly seem to move a wing, and sometimes I have seen them cleaning and picking their feathers as they floated along in the air. In the evening, just before sunset, they hover close round the island waiting for the Petrels and other birds to come home with food, when they give chase and do not leave the unfortunate bird until it has disgorged some if not all of its food. I have seen Petrels when thus chased drop on the water from sheer exhaustion, but even then the Frigate-bird would not leave it till it has disgorged. In addition to these birds there are a few "Noio" and Grey-backed Terns on the island, also a few Curlew in poor plumage, some "Akekeke" (*Streptilas interpres*), Kolea (*Charadrius fulvus*), "Ulili" (*Totanus incanus*), and three species of Petrels, but there is no sign of any land-birds.

July 1.—This morning, on searching for some more of the "Brown Gannet," I was fortunate enough to obtain two females and two young, but I could find no eggs, and these were the only young ones on the island. When skinning the Brown Gannets I found they had much larger brains than *Sula cyanops*, which is almost twice as large. The female of the Brown Gannet is also larger than the male, and has different coloured soft parts. While out to-day we came across some of the small Gannet (*Sula piscator*) asleep on some bushes, with their heads hanging straight down. The first one I saw I thought was dead. The young Gannets also when sleeping on the sand stretch their necks out straight.

July 2.—My assistant to-day killed a seal, which I am trying to prepare for a specimen. I had shot two before, but their skins were too much injured. (The skin of the seal unfortunately was lost.) On returning to the tent we captured two young albino Albatrosses. This seems very singular, as we had examined during the voyage thousands upon thousands of young Albatrosses and seen no variation among them. Now the only bird seen on my voyage of which I have no specimens is the little Grey Tern [*Anous cinereus*, very likely.—W. R.].

July 4.—Left Lisiansky for Pearl and Hermes Reef.

July 6.—With a nice breeze all the way from Lisiansky we made these islands this morning. We have spent all day trying to get into the entrance of a sort of lagoon formed by the coral-walls round the central island, which is a mere sandbank with no vegetation.

July 8.—Left Pearl and Hermes for Midway Island, having spent the last two days at anchor in a perfectly calm sea, three or four miles away from the island, but Capt. Walker, in spite of all I could do, refused to put me ashore. I know these waters are very dangerous,

on account of the coral-rocks, but the water was so calm that I consider he had no excuse for not landing me in the small boat.

July 11.—It has taken us till to-day to reach Midway Island, although it is only 60 miles from Pearl and Hermes. Soon after we anchored in the bay, I came ashore. What I am now on is what is known as Sand Island. This island is almost bare and has hardly any birds: the two or three I saw were of the same species as I had seen all through the voyage. Although this island is comparatively large, it is the most desolate place I ever was on. There is hardly any vegetation except a few tufts of grass on the south end, and in rough weather most of the island is under water. This is the place where Captain Walker was wrecked in the 'Wandering Minstrel,' and was fourteen months on the island before a passing ship relieved him. There is a house, originally built by an American Surveying Expedition, but it has been much altered and rebuilt by various shipwrecked crews. Wreckage is strewn about all over the island; in one place there is almost the whole of a schooner lying on the beach, which Captain Walker tells me was the 'General Seigel': an account of this wreck I find is hung up in a bottle in the house, together with directions for obtaining food and water, for the use of any future shipwrecked crew.

About 100 yards from the house is a graveyard, with crosses marked with the names of the sailors buried there. Altogether I cannot imagine a more melancholy picture than this island presents. As there are no specimens of any kind to be got here, I shall go on board to-night and arrange to go to the other island, which, together with this one, forms the so-called Midway Island, though really the proper name for these two shoals is Brooks Island and Lower Brooks Island. We sighted a schooner to-day, but cannot yet make out anything further.

July 12.—I came back on board, and the schooner we sighted has put in alongside of us. She is the 'Charles G. Wilson,' of San Francisco, just come from the Caroline Islands.

July 13.—Have just landed on Brooks Island, which is 4 miles from the ship. The scrub is thicker here than on any of the islands yet visited, and about five feet high, also the grass is much coarser than on Laysan. The island is about $1\frac{1}{2}$ mile long by $\frac{3}{4}$ of a mile wide. I have wandered all over it, but have seen no species of bird different from what I have collected on the other islands. However, the Red-tailed Tropic-bird is more plentiful on this island, but Albatrosses are very scarce; also the little White Tern [*Gygis*.—W. R.] was very abundant here. My assistant found a rookery of the Brown Gannet and was fortunate enough to get two eggs. There are three or four houses here chiefly built of grass, but in a very dilapidated condition. Captain Walker's son liberated on this island a pair of Laysan Island Rail and a Finch.

July 14.—To-day was spent in collecting a few specimens. Both my assistant and I saw an adult White-breasted Albatross feeding a young of the black species [*Diomedea chinensis*.—W. R.]. I am quite sure of this, as we were close to the birds at the time, although from having seen old birds drive away all other young from the one they were feeding, I still believe they know their own young. The White Terns (*Gygis*) I notice do not sit on their eggs like most birds, but stand up and cover the egg between their legs by drawing the breast-feathers over it, which has made some people believe that it puts its egg in a pouch to incubate it.

July 15.—To-day I spent in hunting for eggs and young birds. I found one nest, with

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two eggs in, of the Brown Gannet, and a number of young; but to my surprise I found the old birds belonging to these just as shy as those without eggs or young, so, in spite of my former statements, I must come to the conclusion that this is a shy species. The nests were built of grass on the ground and each nest contained two eggs, but I never found more than one young one in a nest. To-day I saw for the first time some of the Frigate-birds chasing the Red-tailed Tropic-birds.

July 16.—I have nothing of interest to report to-day, except that I watched the small White Tern (*Gygis*) feeding its young. The adult bird brings small fish to the young in its bill, and the young one takes it from its mouth. One I saw had no less than four in its beak at once: I cannot understand how it can catch fish while it already has some in its bill; I could never see them in the act of fishing, in order to find out.

July 17.—I am once more on board. Owing to losing my tape and rule I was unable to measure any of the birds from the two shoals of Midway Island.

July 18.—Started for Maro Reef.

July 20.—Captain Walker has changed his mind and is going straight back to Honolulu.

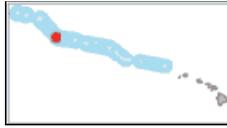
From July 21st to the 18th of August.—We spent all this time in going back to Honolulu from Midway Island. We saw a few birds of well-known sorts round the vessel all the way, and I caught several specimens. The only bird I saw fresh was a large brown Gull (probably a Skua). I had a terrible time with the skins, nothing seemed to kill the beetles (*Dermestes*), for unfortunately the whole vessel swarmed with them. I believe I saw also another species of Petrel as we neared Kauai; it was large with white breast and brown back. A Kolea (Golden Plover, *Charadrius fulvus*) flew also round the ship, and considerably astonished me by settling on the water several times to rest.

August 18.—At last we have reached Honolulu after a month's dreadful journey from Midway Island. I never was more pleased in my life than when I found myself on shore in Honolulu once more.

So ends three months' suffering under the famous Captain F. D. Walker.

NOTE.—I have given this Diary as fully as possible, only cutting out such parts that I considered of no interest to anyone but myself, such as details of expense, quarrels with the captain, &c. Of course I had to condense the matter to some extent.—W. R.

Lisianski Island



About 20 million years ago, geologic forces raised the tip of a huge coral bank above sea level, about 115 miles west of Laysan Island.

Today, Lisianski Island is about 381 acres. Its highest point is a sand dune about 40 feet above sea level. Though the island is small, the reef area to the southeast, called Neva Shoals, is huge, covering 378 square miles, an area nearly the size of Oahu.

It is a low, flat sand and coral island, about a mile and a quarter long, north and south, by three-quarters of a mile wide. A V-shaped ridge of sand on the northern half, reaches a height of 30 to 40 feet. On the south is a narrow crescent of sand dune, 20 feet high. Between is a depression, lower even than the rim, ten feet above sea level, which surrounds the island. Formerly this basin is thought to have contained a lagoon or shallow lake. The island is situated on the northern edge of a large reef platform which extends several miles to the south.

Biology

A Hawaiian gourd calabash was spotted on the beach of Lisianski in 1805, when the ship Neva ran aground there.

A ship picking up survivors of a shipwreck introduced mice to the island in 1844. Rabbits were introduced later, and along with mice, they devastated the island's ecology and are believed to have caused the demise of the Laysan rail.

Feather collecting began on Lisianski about 1904. In response to public outcry about the feather trade, Theodore Roosevelt established the Hawaiian Island Bird Reservation, which included Lisianski, in 1909. An armed party landed on the island in 1910. They arrested feather poachers and confiscated and destroyed about 1.4 tons of feathers, representing 140,400 birds.

Today, Hawaiian monk seals and green sea turtles are common visitors to Lisianski's sandy white beaches. Migratory shorebirds seen on the island include the kolea (golden plover), ulili (wandering tattler), and kioea (bristle-thighed curlew). Nearly three-fourths of the Bonin petrels nesting in Hawaii make this island their home. In some years, more than a million sooty terns visit Lisianski.

Reef fishes of the nearshore waters are abundant and diverse. Researchers have found predators near Lisianski's reefs such as sharks to be very aggressive. Even ulua (Trevally jacks) will harass divers and small boats. The reefs of Lisianski and surrounding Neva Shoals are called "coral gardens" by some scientists because of their abundance of coral and the variety of growth forms assumed by their colonies, including structures resembling



Lisianski Island

spires, castles, and a variety of other shapes. Twenty-four different species of coral were found in one major survey at Lisianski.

A wide variety of algae are commonly found close to the island, and some researchers think that this results from guano (bird droppings) washing into the ocean and providing nutrients for the algae.

History [written in the 1930s-1940s]

Lisianski Island has been called several names in the past: Pell, Lassion, Sapion; and Laska, Lasan Rahys, and Neavas also probably apply.

The island was discovered at 10:00 p.m. on October 15, 1805, when the Russian exploring ship *Neva*, commanded by Captain Yurii Lisianski grounded on one of its reefs on the eastern side. Only by throwing overboard the guns and other heavy objects was the vessel refloated. Hardly were they again in deep water when a sudden squall once more drove them onto an even more dangerous reef. By discarding cables, anchors, and the rest of their heavy objects, the *Neva* again was floated before the evening of the 17th. The next day, fortunately, was calm and all the heavy articles were recovered safely.

Going ashore on the 18th, Captain Lisiansky found numerous birds, large seals, turtles, and quantities of fish. The sandy surface, he noted, was full of

holes (shearwater burrows) which were concealed by creeping plants. No fresh water was found. A quantity of shells, corals sponges, and other specimens was collected, and huge redwood logs were seen on the beach. In his journal Captain Lisiansky says that "this island promises nothing to the adventurous voyager but certain danger." He concludes his account of it by saying: "To the southeast point of the bank where the vessel grounded, I gave the name of *Neva*; while the island itself, in compliance with the unanimous wishes of my ship's company, received the appellation of Lisiansky."

A dangerous shoal, 7.5 miles SE and .5 S from the east side of the island, was reported by Captain Stanikowitch in 1827.

Captain John Paty, in the course of an exploring expedition to the islands N.W. of Oahu, on the Hawaiian schooner *Mauokawai*, visited the island on May 11, 1857. He reported the surface covered with coarse grass, and also the finding of fresh water by digging five feet at the centre of the former lagoon basin. Birds, fish, seal, and turtle, he said, were abundant, but not so plentiful as at Laysan.

He gave directions for approaching the island from a point west of the south end, steering into a lagoon-like area within the reef through a narrow break marked by two large patches of breakers, north and south of each other and three quarters of a mile apart. Within the reef and in the lee of the island good anchorage was to be found in 4 to 8 fathoms of water one half to one and a half miles from the beach. The detached rocks which surround the island and which are numerous in this lagoon-like area, make a careful lookout necessary.



On the island he found some wreckage on which the name "Holder Borden" was carved. This vessel was wrecked in November, 1844, on what was called Pell's Island. As no island has been found in the

position given by Captain Pell of the whaling ship *Delaware*, it has been concluded that Pell and Lisianski were one and the same.

In 1859 Lisianski was visited by Captain N.C. Brooks, in the Hawaiian barque *Gambia*. He furnishes navigators with considerable information about the surrounding reefs: A bank extends several miles to the south, shoaling from 19 to 8 fathoms near the reef. The island should not be approached from the south, Brooks states.

On the east and north sides the reef is about a mile from the island. On the west it extends in a curve to 2.1/2 miles, with a lagoon within. The *Conahassett*, as well as the *Holder Borden*, was lost on this reef, according to Brooks. He recommends that the best approach is from the north and west, and gives detailed directions.

A two-foot tide was reported, as well as a strong current, the direction depending upon the wind. The low, southern part of the island, he said was overgrown with shrubs (which probably means *Scaevola*). He reported finding a notice, dated April 27, 1859, left by

the ship San Diego, taking possession of the island for parties in San Francisco.

On June 29, 1891, Captain F. D. Walker visited Lisianski in the schooner Kaalokai. He reported in his entertaining "Log" that much of the island was covered with low scrub brush, behind a beautiful sand beach 100 feet wide. Seals were sleeping on the beach, large mullet swam in shoals, everywhere, and gird life was plentiful. "The island is a little paradise, or could be made one, at a moderate cost," he writes. He estimated that a thousand tons of good guano remained in the dry lagoon. Contrast these accounts with reports of conditions a quarter of a century later.

The island was leased by the Hawaiian kingdom to the North Pacific Phosphate and Fertiliser Company for 20 years from March 29, 1890. Carl Elschner, who visited the island in 1915, reported that some guano had been shipped, but only the best, much phosphatised sand and soil remaining in the depressed area.

At some time prior to Elschner's visit, rabbits had been introduced, probably from Laysan, whence they had been brought by Max Schlemmer. Left to themselves and without enemies, the rabbits had thrived for a time, multiplying in geometric proportion, as rabbits can. Soon the food supply began to be inadequate for the huge population.

Writing in the Honolulu Advertiser for June 1, 1923, the late Larrin A. Thurston presents a vivid picture of what must have been taken place. There was a frantic search for food; then the rabbits became cannibals, the old devouring the young. He depicts a gruesome scene of a last newborn skinny rabbit being devoured by the last starving mother rabbit.

Elschner saw the island at about its worst. "Dreary and desolate," he called it, with the only vegetation a single tobacco patch, the remnant of that set out by Max Schlemmer,

and two poorly-looking specimens of *Ipomoea*. With no plants to hold the sand, the birds were threatened with extinction. No fresh water was obtainable, shallow wells yielding only brackish water.

It may have been this, or a similar account, which finally prompted the U.S. Biological Survey, custodian of the bird reservation, to "do something about it." They cooperated with Bernice P. Bishop Museum and other scientific institutions in Hawaii in sending an expedition to the north-western Hawaiian islands, on the U.S.S. Tanager, in the spring of 1923. Many rabbits were killed off on Laysan, but when the party reached Lisianski they found the rabbits all dead and the vegetation beginning to come back. There was a patch of bunch grass (*Eragrostis*) at the north-west corner and a few scattered plants of pickle weed (*Sesuvium*), purslane (*Portulaca*) and a local variety of a low, branching, native Hawaiian annual (*Nama*). The late Gerrit P. Wilder, honorary warden of the bird reservation, planted seeds of *Barringtonia* trees at that time, but none is known to have survived.

The only other important event in Lisianski's history has to do with the slaughter of birds. The trouble began (or rather, first became noticed officially) early in 1904, when a party of over 75 Japanese landed on the island. The presence of the party was reported by Captain Niblack of the U.S.S. *Iroquois* in April, 1904, and the U.S. Revenue Cutter *Thetis*, Captain O. C. Hamlet, was dispatched on May 8, to bring them off. It reached Lisianski June 16, and found the party well housed in four thatched-roof shacks, but with only a little rice and dried tern meat left, and consequently not at all unwilling to leave. Several hundred packages of dried bird's wings could not be removed at the time and were left on the island.

The leader of the bird poachers told Acting Governor Atkinson that the party had been stranded on the island when the schooner, *Aju*, sank. He said that they had put up a signal of distress, seen by the *Taiyo Maru*, which had spared them some provisions and removed one of their party. With such a story, and as no law was found which protected the birds, there was no prosecution.

Both the Territorial and the Federal Governments thought that they ought to claim the bird feathers, which were valued at \$20,000; but before Captain Weisbarth, who had been sent to get them, could reach the island, they all had been removed, probably by the schooner *Wiji Maru*, which had been active in bird-killing, and had been warned away from Midway in June. This vessel later was wrecked on Pearl and Hermes Reef, part of the crew being found on Lisianski in September, 1904, together with part of the crew of the *Tanzi Maru*.

Reports of such slaughter of birds stirred up extensive interest in bird protection. An appeal was made to Washington, and in 1909 President Theodore Roosevelt initiated a joint resolution in Congress, which set aside the islands from Nihoa to Kure, with the exception of Midway as the Hawaiian Islands Bird Reservation.

So it was that, when the U.S. Revenue Cutter *Thetis* visited these islands in January, 1910, and found 15 Japanese bird killers on Laysan and 8 on Lisianski, they were promptly arrested, brought to Honolulu on February 2, and turned over to the United States Marshal, charged with poaching.

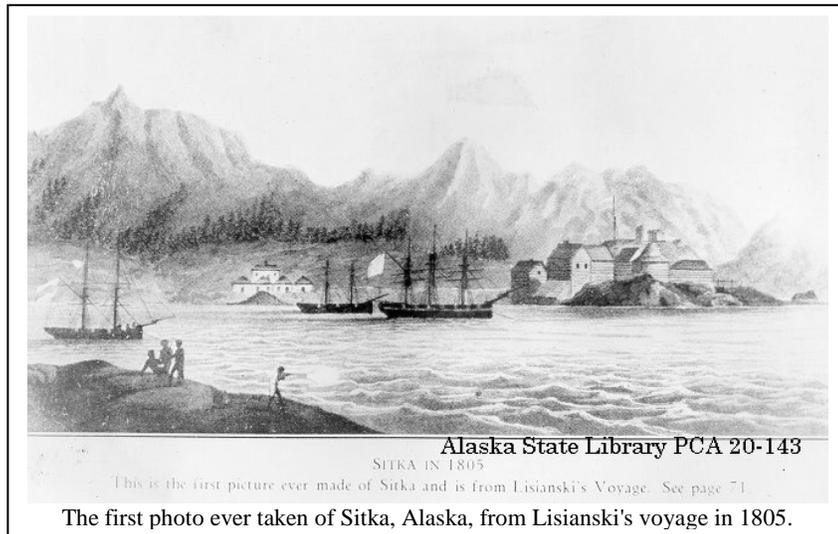
Today, with poaching at an end, the rabbits exterminated, and the vegetation again spreading over its low sandy surface, Lisianski once more is becoming a populous bird sanctuary.

Yurii Lisianski

In 1805, Russian Captain Yurii Lisianski (also Yuri or Urey, also Lisiansky) took a load of furs on the *Neva* from Alaska to Canton China on his Voyage Round the World (1803-1806).

When he happened by the Northwest Hawaiian Islands, his ship grounded on a reef on the east side of what is now called Lisianski Island.

Yuri Fyodorovich Lisianski was born August 13, 1773 and died March 06, 1837. He was an officer in the Imperial Russian Navy and explorer.



In 1786 he graduated from the Navy Cadet Corps and took part in the Russo-Swedish War (1788-1790). During 1790-1793 he served in the Baltic Fleet. During 1793-1799 he sailed British ships all over the globe.

In 1803-1806 Lisianski, as the commanding officer of the sloop-of-war *Neva*, took part in the first Russian circumnavigation of the Earth headed by Krusenstern.

They started from Kronstadt, but the ships split after visiting Hawaii and Lisianski headed to Alaska. In 1804 the *Neva* visited Easter Island, and later that year, was essential in defeating the Tlingit in the battle of Sitka, Alaska.

In 1805 he met Krusenstern again in Macau, but they soon separated. Also in 1805, he was

the first to describe the Hawaiian monk seal on the island which now bears his name.

Eventually, the Neva was the first to return to Kronstadt on July 22, 1806. For this feat Lisianski was awarded in various ways, including the decoration with the Order of Saint Vladimir of the 3rd degree.

Lisianski was buried at Lazarev Cemetery of the Alexander Nevsky Monastery, St. Petersburg.

Coast Pilot

Lisianski Island (26°04'N., 173°58'W.) is a small, low, sandy island, about 120 miles W of Laysan Island. Captain Lisianski, of the Russian ship NEVA, discovered the island on October 15, 1805, when his ship grounded on the reef and was nearly wrecked.

The island is about 1.2 miles long in a NNW direction, 0.5 mile wide, and 20 feet in elevation at its highest point on the NE side. The shores are white sand except for two stretches of rock ledge at the waterline on the E side of the island. Behind the sand beach, the island is overgrown with vines and bushes. One coconut palm tree in the NE part of the island is prominent from N.

In 1976, a small boat was reported wrecked on the NE end of the island and two groves of palm trees were observed near the middle of the island. Brackish water may be obtained by digging shallow wells. Large numbers of sea birds nest on the island, and, as at Laysan, large numbers of flies make a stay there unpleasant.

Although the island is uninhabited and seldom visited, a permit is required for landing as the

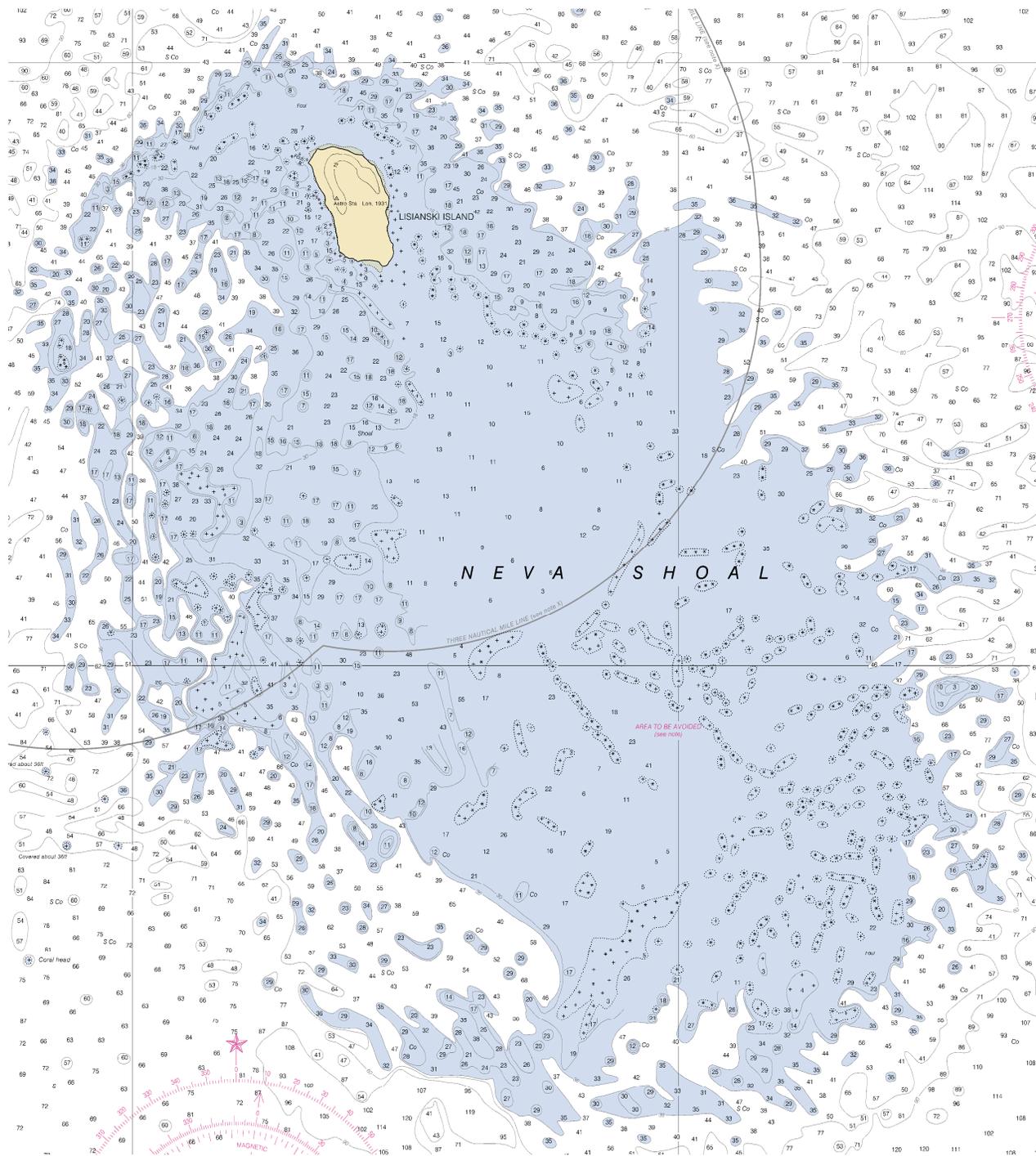
Hawaiian Monk seal is protected here. Visits should be made during the summer, when the NE trades prevail, but small-boat landings have been made on the E side of the island at other times, although this is very risky.

A reef circles around to the SW from off the N side of the island. It is marked near its offshore end by a coral ledge that bares at times and over which the seas break. The S end of this ledge is 1.7 miles 260° from the N end of the island. About 0.5 mile SW of this point is another ledge which is marked by a breaker in most weather. Midway between these ledges or breakers is a passage leading to the lagoon between the island and the reef. The passage has an uneven bottom with depths of 11 to 22 feet. About 350 yards SW of the N ledge is a small shoal with a depth of 3 feet over it. These shoal spots are easily seen and avoided by small boats making the passage into the lagoon, but vessels should not enter without local knowledge. Once inside, anchorage can be had in depths of 3 to 6 fathoms, taking care to avoid the scattered coral heads with only a few feet of water over them. The coral heads are large and vessels anchoring here are cautioned because of the danger of fouling the ground tackle. Landing can be made on the W side and S end of the island in all but SW and W weather.

Neva Shoal, with innumerable coral ledges, extends about 8 miles SE from Lisianski Island. This reef, which is about 4 miles wide, has its W extremity about 4 miles SSW of the island. The S end of the reef is usually marked by breakers, and many of the ledges break in almost all weather. The shoal has areas of deeper water between the ledges, and small boats can maneuver but with difficulty over many parts of the reef. It must be avoided entirely by larger vessels.

In addition to Neva Shoal, there are many coral heads with depths of 3 to 6 fathoms over them within 3 miles of all sides of the island. A small coral ledge, with an islet on it and nearly always marked by breakers, is 2.7 miles 254° from the S end of the island. Between this ledge and the island are depths as great as 8 fathoms and a scattering of coral heads, some of which are nearly awash.

The lagoon could be entered between this ledge and the ledge marking the S side of the previously described opening 1 mile N. A rock covered 14 feet, about 1.5 miles NNE of the island, is marked by breakers only during heavy weather. Under favorable conditions dangerous coral heads can be seen for several hundred yards.



Anchorage

Anchorage can be had in trade-wind weather about 3 miles W of the island in depths of 11 to 15 fathoms, sand and coral bottom, with the N end of the island bearing 080°. During SW weather, vessels can find anchorage 3 to 4 miles E of the N end of the island in depths of 8 to 15 fathoms. Small boats can anchor in the lagoon, as described previously.

Vessels may approach to within 3 miles of Lisianski Island from the N on courses between 270° and 090°. The island and Neva Shoal should be given a wide berth when passing S of them, as the island is seldom seen from the S limits of the shoal. Vessels approaching from the SW should keep about 5 miles W of the meridian of the island until the island bears 090°, and then approach the anchorage.

Currents

One-half day of current observations taken 3 miles W of Lisianski Island indicate a rotary tidal current, turning clockwise, of 0.8 knot velocity at strength. A prevailing NW current is reported in the vicinity of the island.

Lisianski Island and Neva Shoal lie just SE of the center of a bank about 25 miles long in a NW direction and about 15 miles wide. Outside the reefs, general depths on the bank are 9 to 47 fathoms.



Lisianski Island

Pearl and Hermes Atoll



Pearl and Hermes Atoll is a true atoll that is primarily underwater and has numerous islets, seven of which are above sea level. While total land area is only 80 acres, the reef area is huge, over 450 square miles. The atoll is ever-changing, with islets emerging and subsiding.

The atoll was discovered in 1822 when two English whaling ships, the Pearl and the Hermes, wrecked on the reef during a storm. Since then at least six other vessels have been lost in the area. In 1854, King Kamehameha III claimed the atoll for the Hawaiian Kingdom. Due to the atoll's small land base, it was largely spared the ravages of miners and feather hunters.

The low islets of Pearl and Hermes Atoll are exposed to occasional overwashing by high seas. Today, resource managers occupy a seasonal field camp at the atoll.

Biology

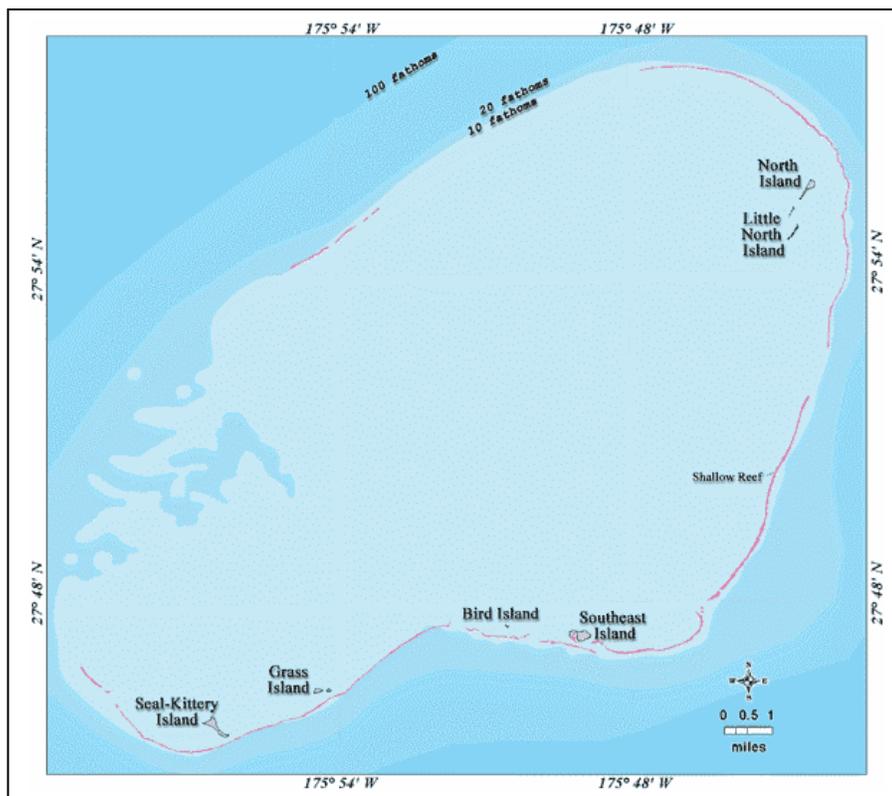
When Westerners first arrived, the atoll

abounded with birds. Presently, about 160,000 birds from 22 species are seen. They include Black-footed albatrosses, Tristram's storm petrels, and one of two recorded Hawaiian nest sites of Little terns. Endangered Laysan Finch were introduced in 1967 in an attempt to establish a "back-up" population in case disease, natural disaster, or other calamity exterminated the only other population in the world at Laysan.

The sandbar islets support coastal dry grasses, vines, and herbal plants, including 13 native species and 7 introduced species. The plants survive because they are salt-tolerant and able to recover from frequent flooding events.

Many fish species abound at the wreck site of the Quartette, formerly USS James Swan, a WORLD WAR II Liberty ship lost in 1952. Though vessel losses and wreck deterioration often cause extensive mechanical damage to reefs, some remains can serve a more benign role as "artificial" fish habitat.

Hawaiian monk seals and sea turtles breed and feed at Pearl and Hermes, and it is a mating area for spinner dolphins. The atoll has the highest standing stock of fish and the highest



number of fish species in the NWHI. These include saber squirrelfish, eels, Galapagos sharks, sandbar sharks, ulua (big jacks), angelfish, aweoweo (bigeyes), uhu (parrotfish), and numerous lobsters. In addition, angelfishes considered rare in the rest of the Hawaiian archipelago, such as the masked angelfish (*Genicanthus personatus*) and the Japanese angelfish (*Centropyge interrupta*) are commonly seen at Pearl and Hermes Atoll.

Hiding between the unique reef and lagoons are very unusual

invertebrate habitats. For example, several sponges collected recently may be new to science! Thirty-three species of stony corals have been documented here.

Black-lipped pearl oysters, at one time very common, were harvested in the late 1920s to make buttons from their shells. Over-harvested, the oysters were nearly eliminated, and today few remain even long after their harvesting was declared illegal in 1929. Today, 70 years after cessation of commercial harvest, only a few more than 1,000 individual pearl oysters have been documented in the lagoon.

While there has been less human impact on this atoll than others in the NWHI, problems with marine debris and the occasional shipwreck still occur. In 2003 over 90 tons of marine debris was removed from the reefs at Pearl and Hermes. Minimizing human contact may preserve the wildlife and marine life in this extensive reef ecosystem.

History

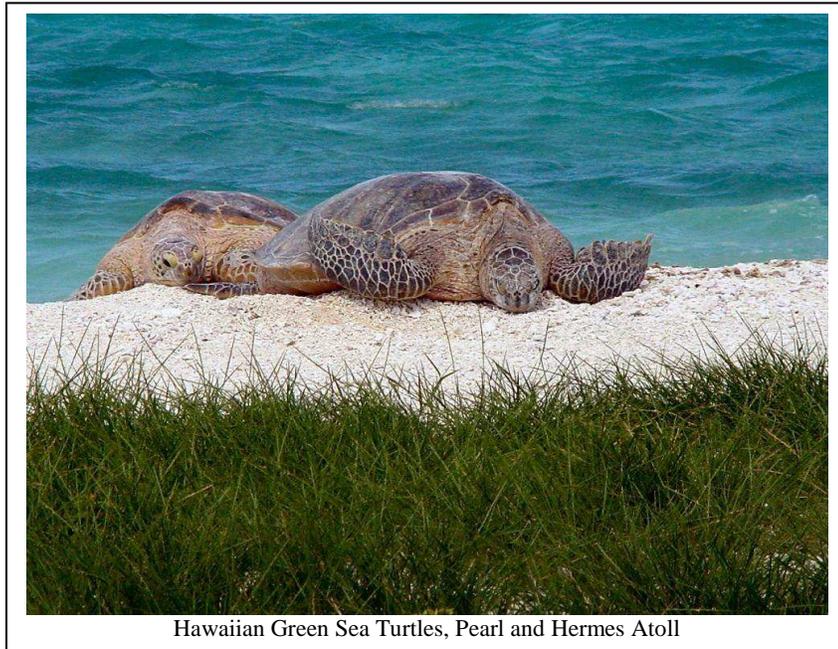
The discovery of pearl oysters in the lagoon of Pearl and Hermes Reef by Captain William Greig Anderson in 1927, did more to put this lonely atoll on the map of the Hawaiian archipelago than any other event during the 105 previous years of its history.

Bill Anderson was the skipper of the *Lanikai*, an auxiliary schooner engaged in catching fish for the Hawaiian Tuna Packers. His finding a large bed of a species of pearl oyster which has been named *Pinctada galtsoffi* opened up a new but short-lived industry for the Territory.

A new concern, the Hawaiian Sea Products Co., Ltd., was quickly organized. They purchased the *Lanikai*. With permission of the Governor of Hawaii they erected several buildings on one of the small islets in the lagoon, and with the help of Filipino divers

they gathered several tons of pearl shells. These were brought to Honolulu, about 1,100 miles away, and sold to manufacturers of pearl buttons in San Francisco and New York.

On February 3, 1909, as part of the Hawaiian Islands Bird Reservation, Pearl and Hermes



Hawaiian Green Sea Turtles, Pearl and Hermes Atoll

Reef had been set aside as a bird sanctuary, and had been placed under the care of the Bureau of the Biological Survey of the U.S. Department of Agriculture. In 1929 the Hawaiian Sea Products Company made application to this Bureau for a lease to Sea Products Company made application to this Bureau for a lease to the atoll. They wanted to establish a fishing station, complete with cold storage plant. They wished to obtain exclusive fishing rights to the lagoon. But a similar application was filed by the Hawaiian Tuna Packers, and there was reason to believe that this might be followed by other requests to work lagoons in the Hawaiian chain.

In order to protect the newly discovered pearl oyster bottoms from possible destruction, the Territorial Government requested the U.S. Bureau of Fisheries to outline methods for their conservation and development. Acting on their advice, the Territorial Legislature passed an act making unlawful to "take, collect, molest, or destroy any kind of pearl oyster" in Hawaiian waters, and appropriating \$2,500 to

provide for a survey of pearl oyster fisheries in the waters under jurisdiction of the Territory.

Such an amount of money was altogether too small to finance such a survey, but the United States Navy Department "loaned" the use of the U.S.S. *Whipporwill*; the Bureau of Fisheries made their expert, Dr. Paul S. Galtsoff, available; and with the assistance of two Honolulu boys, Northrup S. Castle and John F. Reppun, and two Filipino divers, who previously had been employed in the lagoon, the survey was made during the summer of 1930.

An entertaining account of the survey and its findings can be read in Dr. Galtsoff's report, which was published by Bernice P. Bishop Museum as Bulletin 107, 1933. Only the recommendations which resulted need be recounted here. There were:

1. To forbid commercial fishing for pearl oysters in Pearl and Hermes Reef for a period of not less than five years.
2. To resurvey the bottom of Pearl and Hermes Reef in 1935.
3. To establish at Pearl and Hermes Reef a pearl oyster reserve from which oysters could be taken only by permission of the Government and exclusively for the purpose of transplantation and cultivation.
4. To continue biological observations on the rate of growth, spawning, and setting of this species.
5. To employ a marine biologist capable of carrying out these studies.
6. To encourage the cultivation of pearl oysters in the Territory of Hawaii by private citizens.

Most of these have been forgotten. Thus ended, for the time, the pearl oyster industry begun at Pearl and Hermes Reef. But the oysters are still there, and some day they may be sufficiently abundant to allow some to be harvested.

The rest of the atoll's history is not at all spectacular, except for its curious discovery on the night of April 26, 1822. According to the account published in "The Friend" for October, 1876, page 86, the Pearl and the Hermes, two English whalers, were cruising these waters in company. On that fateful night both ran aground on the reef within ten miles of each other. The crews of both ships made their way to one of the small Islands in the lagoon and established a camp. After much labour and many hardships, they built out the wreckage a 30-ton vessel which they named the Deliverance, and navigated it safely to Honolulu. The carpenter, James Robinson, later established a shipbuilding business at what is now part of Pier 13. He built Robinson's wharf, and was the first of a distinguished Honolulu family.

Captain John Paty visited the atoll, May 19-20, 1857, mapping it and determining its position. Captain N.C. Brooks, cruising in the barque Gambia. In 1858, stopped and made observations, reporting 12 small islands. In 1867 the atoll was surveyed by the U.S.S. Lackawanna, producing a chart which shows but two islands.

On February 15, 1894, it was leased by the Provisional Government of Hawaii for a period of twenty-five years to the North Pacific Phosphate and Fertiliser Company, which made little use of it. On February 3, 1909, it was made part of the Hawaiian Islands Bird Reservation. In 1912 it was visited by the U.S. Revenue Cutter Thetis. Carl Elschner, a chemical engineer who accompanied this trip, makes various geological observations in a popular account published serially in the Honolulu Advertiser in 1915 and reprinted as a 68 page booklet. He makes the statement that the san islets in the lagoon seen constantly to be shifting in number, structure and location, the highest having an elevation of but twelve feet.

In April, 1923, Pearl and Hermes Reef was visited and explored by a scientific party on the U.S.S. Tanager. Dr. Alexander Westmore, than of the U.S. Biological Survey Bureau studied the birds while several Honolulu scientists collected plants, insects, and marine animals. The reef and lagoon were mapped,

showing four islets with vegetation and several sand spits. The map differs in several respects from that reproduced with this chapter, which is adapted from the maps published in Dr. Galtsoff's report. Scientific reports concerning this expedition were published by Bernice P. Bishop Museum.

The reef encloses a lagoon which measures seventeen miles long by ten miles wide, or about 43 miles in circumference. The reef is continuous on the east side but on the south there are some breaks: the main entrance, deep enough to admit small vessels, at least a short way into the lagoon, and a pass for small boats near the Southeast Islet. The northwestern third of the rim consists of a line of coral head and patches of reef, interspersed with deeper water. Within the lagoon are depths of up to 104 feet, with extensive reef formations, some extending for two or three miles in a nearby straight line, others forming miniature atolls.

The islets are devoid of trees, except for some ironwoods (*Casuarina*) planted in 1928, which may not have survived. In 1923 the three southern islands were found to be very small, hardly more than ten feet high, supporting only bunch grass and low herbs. North Island, although larger, had on it only the same kinds of plants, eleven species in all. There was a slight depression in the eastern part of southeast island in which fresh water collected after rains: Brackish water could be obtained by digging shallow wells.

The sand bars were bare of vegetation, and appeared to be constantly shifting their position under the action of wind and wave.

The rich marine life was studied by the Tanager Expedition in 1923; by Dr. Galtsoff in 1930, and by Dr. Victor Pietschmann, a Bishop Museum fellow from Vienna, in 1928.

Coast Pilot

Pearl and Hermes Atoll, about 145 miles NW of Lisianski Island, is an extensive oval-shaped atoll about 40 miles in circumference, 17 miles long in a NE direction, and 9 miles wide. The reef was discovered on April 26, 1822, by the British whalers PEARL and HERMES, which were wrecked on the same

night within 10 miles of each other. Within the outer reef is a lagoon in which are numerous coral reefs with deep water between. The remains of a wreck stranded on the E side of the reef are still visible, but over the years most have been beaten down by breakers. There are no known dangers outside the heavy breakers on the outer reef.

Within the outer fringing reef are several small islets, most of which are on the S side; the exception is **North Island**. There are also several sandbanks that are awash at high water. **Southeast Island** (27°47'N., 175°49'W.) is the largest of the group; five other named islands are scattered along a 7-mile stretch to W. Though uninhabited and vegetated by low plants and shrubs, a permit is required for landing as the Hawaiian Monk seal is protected here. Large numbers of sea

The 6-mile opening on the NW side of the outer reef has depths of 1 to 6 feet between the numerous coral heads, and is hazardous to negotiate with a small boat. The small-boat channel between Southeast Island and **Bird Island**, next islet to the W, has a least depth of 4 feet; the channel between Bird Island and **Sand Island** has 19 feet. The eastern portion of the lagoon is maze-like and could be dangerous to the navigator without local knowledge. Caution is advised when making entry.

Anchorage

Anchorage can be had off the W entrance to the lagoon in depths of 8 to 12 fathoms, or on the E side of the reef. Vessels have anchored midway between the S entrances and about 0.6 mile off Bird Island in depths of 25 fathoms.

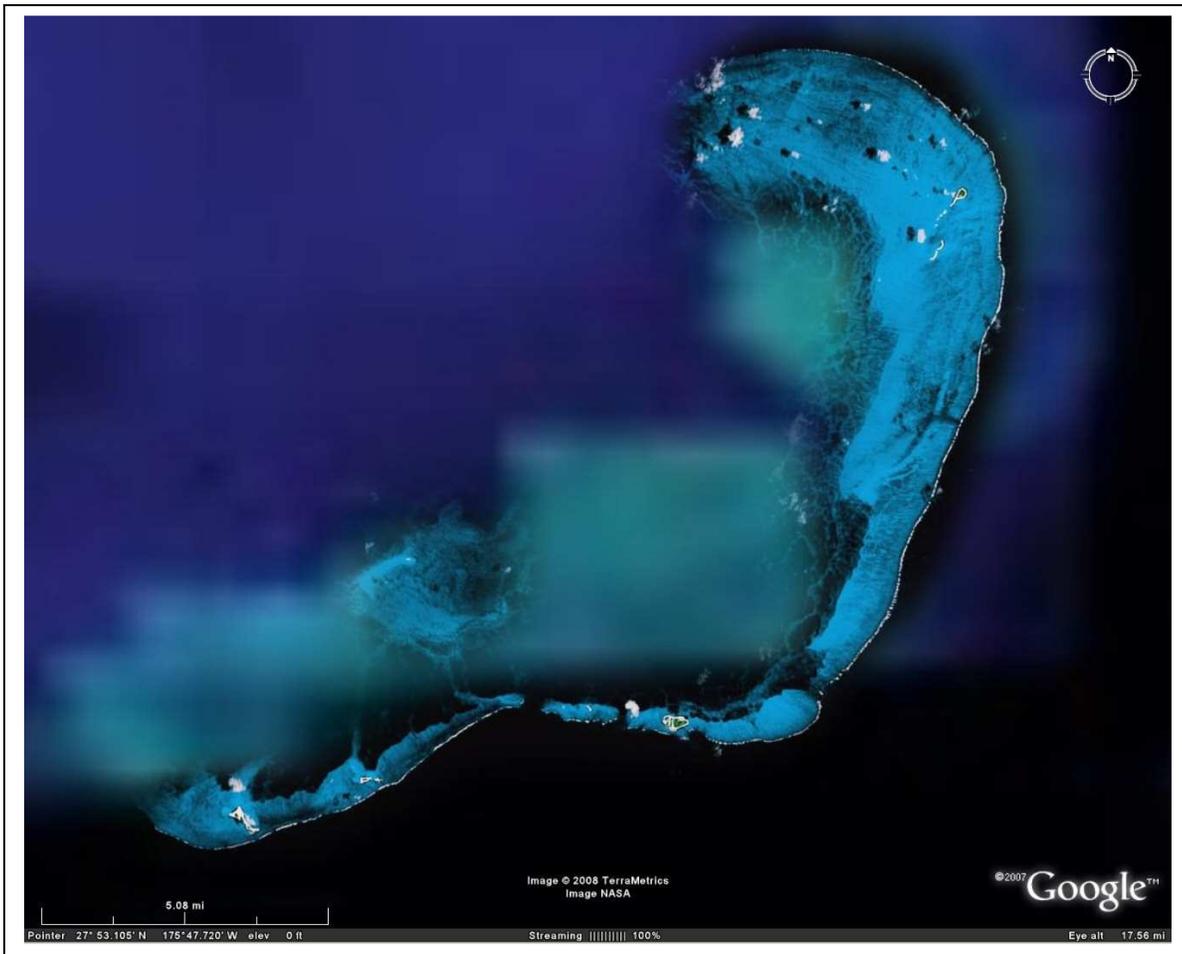
Currents

The current appears to set N between Lisianski Island and Pearl and Hermes Atoll.

Salmon Bank is about 60 miles SW from Southeast Island on Pearl and Hermes Atoll. The least known depth on the bank is 30 fathoms.

Gambia Shoal, position doubtful, is about 50 miles WNW of Southeast Island on Pearl and Hermes Atoll. The shoal has a depth of 14 fathoms, and the bottom can be plainly seen. About 25 miles N of the charted position of Gambia Shoal is **Ladd Seamount**, a bank with a least known depth of 35 fathoms.





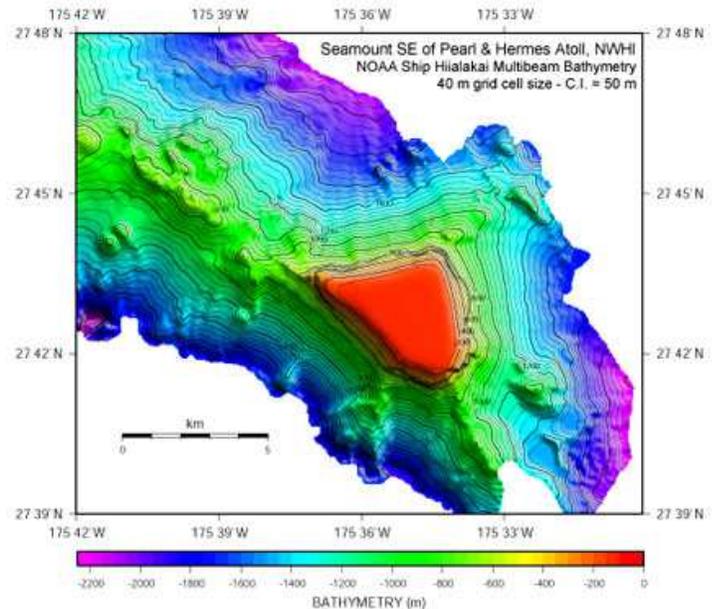
Mapping an Unnamed Seamount SE of Pearl and Hermes Atoll

By Jonathan R. Weiss
Seafloor Mapping Specialist
NOAA Coral Reef Ecosystem Division

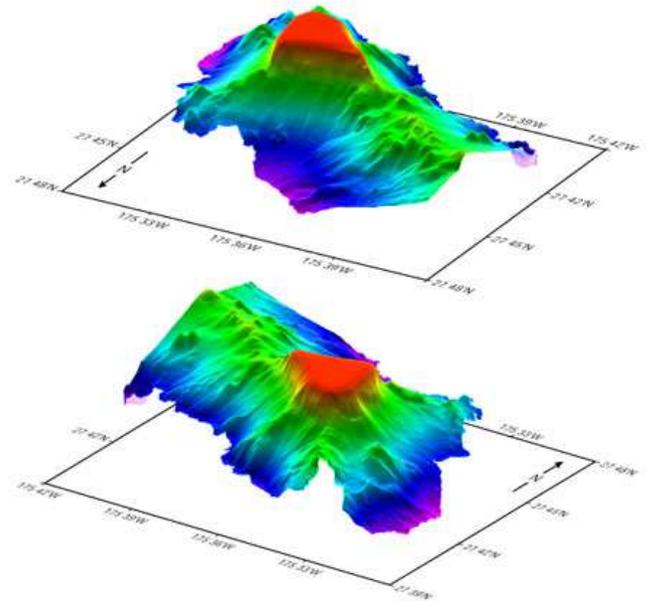
Multi-beam mapping aboard the NOAA Ship Hiialakai during the recent coral bleaching Cruise in the Northwestern Hawaiian Islands (NWHI) has enabled NOAA scientists to create images of the seafloor such as these, in locations where little data were previously available. For example, prior to the cruise, the seamount in these images, located southeast of Pearl and Hermes Atoll, NWHI, was unmapped and only one forty fathom (-73 m) sounding existed in its vicinity.

There is over 2000 m of relief between the top of the seamount at -105 m and the surrounding seafloor. The northwest-trending ridge connecting the seamount to Pearl and Hermes atoll suggests a linked geologic history between the two submarine mountains. The small peaks on top of the ridge might suggest the presence of ancient volcanic centers and the hummocky topography on the north face of the ridge may be slump blocks. Additional linear ridges radiate from the northern and southwestern apices of the triangular-shaped seamount in a fashion similar to submarine volcanic rift zones such as the southeast rift zone of the active Kilauea Volcano on Hawaii Island. The flat-topped nature of the seamount suggests it was planed off by erosion at sea level tens of millions of year ago and has since subsided to its present depth as the Pacific tectonic plate moves to the northwest.

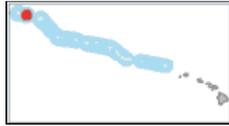
In addition to the geologic significance of the data, it is of biological and resource management importance as well. For example, the location of the newly mapped seamount is associated with monk seal foraging sites, and the data around Pearl and Hermes Atoll will aid in NWHI Coral Reef Ecosystem Reserve boundary determination. This is just one of many exciting new pieces of information gained through the combined efforts of NOAA's National Marine Sanctuary Program and Coral Reef Ecosystem Division.



3D Perspective Views of a Seamount SE of Pearl & Hermes Atoll, NWHI, V.E. = 2x



Midway Atoll



Midway, the best known of the Northwestern Hawaiian Islands (NWHI), is a circular-shaped atoll with three small islets (Sand, Eastern, and Spit) on the southern end of a lagoon. While its land area is small, about 2.4 square miles, the atoll has an area of about 134 square miles.

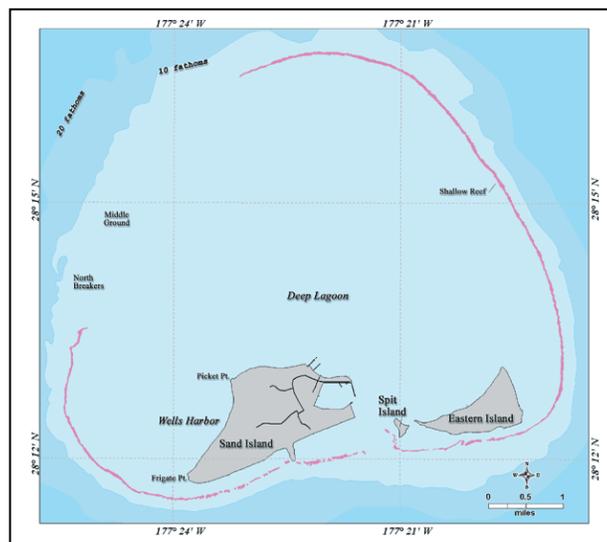
Midway Islands have become the most famous locality in the northwestern part of the Hawaiian archipelago. This atoll crowns the summit of one of the last peaks in this huge mountain chain. It is 1150 nautical miles northwest of Honolulu, 90 miles beyond Pearl and Hermes Reef, and 50 miles east of Kure, the final island of the chain.

The atoll consists of a nearly circular rim of coral reef, about 5 miles in diameter, enclosing a lagoon, the central portion of which ranges in depth from 25 to 50 feet, surrounded by a considerable expanse of shallower water. Much of the reef, especially on the northeast, forms a continuous flat-topped wall, six to fifteen feet wide and standing some five feet out of the water. Some of it consists of irregular rocks, just about reaching the surface, and the west side, to the north of Seward Road, which gives entrance to Welles Harbour, is open, with only a few patches of reef.

Close to the southern rim of the atoll lie two low islands. Sand Island, the larger, measures a mile and a half long by a mile wide, and has a hill which reaches a maximum elevation of 43 feet, topped by a light. Formerly composed of nearly bare sand, man has planted grass, shrubs and trees upon it until now much of it is well wooded. Eastern Island is triangular in shape, about a mile and a quarter long by three-quarters of a mile wide. Composed of more compact soil, it has supported a growth of low shrub, including native species, since long before its discovery, and consequently it has been called Green Island. Between these two there used to be a small passage, with a break in the south reef, such that a row boat might get through into the lagoon.

Captain N.C. Brooks of the *Gambia* sailed to the atoll in 1859. After Brooks, the United States annexed it as the first insular possession to be claimed outside the U.S. continent. Early visitors included the castaway crews of several large sailing vessels, such as the American-built bark *Carrollton*. Survivors built low huts on the treeless island and awaited rescue by (infrequent) passing vessels. Other people made their way to Midway during the late 1800's primarily to collect feathers and eggs.

The United States recognized the strategic importance of Midway as early as 1870, when efforts were begun to clear a southern channel into the calm lagoon. It was clear that



Midway's geographical position as a "stepping stone across the Pacific" made the island a critical link in cable communications (1903) and as an early transpacific PanAmerican seaplane stop (1935). Work began on the military facility at Midway in March 1940.

During World War II, Midway served as an important naval air station and submarine refit base. The atoll was attacked twice, first of December 7th 1941, and again during the pivotal Battle of Midway, June 4th-6th 1942. A successful American intelligence operation tipped the US forces to the planned attack, and a small US task force was able to surprise and defeat the Japanese invasion fleet bound for the atoll. Many interpret this battle as the watershed moment in the tide of the Pacific War. Though the major carrier-based actions took place to the north, a fierce air battle was

waged over Midway and Eastern Islands themselves.

During World War II, Midway became a major U.S. military base. The atoll was attacked twice, once on December 7, 1941, after the attack on Pearl Harbor, and again during the pivotal Battle of Midway, which turned the tide of the War in America's favor. The atoll was designated as the National Memorial to the Battle of Midway in 2000.

During the Cold War Era Midway served as the staging point for defensive air patrols along the Distant Early Warning (DEW) Line. With the increasing use of satellite observation, such patrols became unnecessary, and in 1996 the once strategic naval base was turned over to the U.S. Fish and Wildlife Service to be managed as Midway Atoll National Wildlife Refuge.

A massive U.S. Navy clean up prior to their departure removed tons of debris, leaky fuel tanks, and lead paint, as well as rats. Today a fulltime Refuge staff administers a small visitor program, cares for its wildlife, restores native plant life, and protects historic resources.

Landscape of Midway Atoll

Nearly 30 million years ago, Midway began as a volcanic island, created over the hot spot in the earth's crust that now supplies the Island of Hawaii with its lava. As the Pacific plate marched to the northwest, the forces of wind, water and changing sea level eroded the island until it disappeared beneath the ocean surface. A fringing reef, made largely of the calcareous skeletons of coral and coralline algae, formed around the island's edge, creating an atoll. As

the island disappeared, the reef continued to grow. Today, the basalt that was once Midway is more than 500' below the ocean surface.

One day, Midway Atoll will also vanish beneath the waves.

The movement of coral sand within the atoll over time created three islands, now known as Sand, Eastern and Spit. Wind and water erosion continue to change the shape and size of these islands. Before the first sailing ship crossed Midway's horizon, the islands were wind-blown sandy dunes, covered with native shrubs and grasses. Slow growing, sun-loving plants such as naupaka (*Scaevola*), bunch grass



(*Eragrostis*) and puncture vine (*Tribulus*) thrived in the harsh, salty environment. The ironwood trees (*Casuarina* spp.) which are now distributed on Midway's islands all were derived from plantings in the last century.

Midway lies near the most northern limit of coral growth. Although coral diversity is less than in more tropical climates, some species (e.g. *Pocillopora*, *Porites*) are abundant. Deep chasms, caves and corridors in the reef create habitat for a wide variety of fish, several of which are unique to Midway.

Two distinct seasons mark Midway's climate. December, January and February tend to be cool, windy and wet, with the temperatures dropping into the low 60s. Most of the 42 inches of annual rainfall fall in winter months. May through October months tend to be warm and sunny, with most summer days in the high 80s. Weather in spring and fall months is more variable.

Midway Island Today

About 60 people are currently stationed on Midway Island, down from a maximum of about 5,000 in the 1940's and 1950's.

In July 1903, the first trans-Pacific cable was completed. It was routed along the NWHI, coming ashore at Midway Atoll. The only actively used cable, the Trans-Pacific Cable No. 1, was installed in 1964 and linked Hawaii to Guam. The cable runs the length of the island chain from Oahu to Midway, where it comes ashore. From Midway it continues to Wake Island before terminating in Guam. The cable continues to be used for scientific purposes.

The Midway Atoll interim visitor services plan designates areas that are both open and closed to the public. Closed areas ensure public safety and maximum protection for wildlife. Most roads are open to the public. Trails are listed as closed, open by guided tour only, or open.

Trails generally follow existing paths, roads, or the edges of aircraft runways. Visitors are free to walk on paved and gravel roads, walkways, and marked trails, but areas such as the fuel farm and pier, power plant/utility building complex, construction and rehabilitation sites, and aircraft runways and service areas are off limits to visitors. Bikes and golf carts are also used.

Utilities

A new fiber optic distribution system was constructed during 2006/2007 in the core area of Sand Island, Midway Atoll. The satellite antenna was relocated and refurbished in October 2007. Satellite service was upgraded to T-1, and work to install a new VOIP phone system was completed in March 2008.

The drinking water source on Midway Atoll consists of a rainwater collection and distribution system. Rainwater is collected in a pond then pumped to storage tanks following a significant rain shower. The storage volume is approximately 12,000,000 gallons.

A new drinking water treatment system and distribution main were constructed and

became operational in October 2005. The design daily use rate for the new system is 100 gallons per day/person, or 20,000 gallons per day total for a design capability of 200 people.

This new water distribution pipeline was connected to existing lateral pipes at selected buildings through the core area of town but need to be extended to serve newly constructed or remodeled facilities located outside of the new water main.

The old system was left in place to provide water for fire-fighting activities and to serve the Inner Harbor and Cargo Pier areas. This water is not treated to drinking water standards. The storage tanks in the R-1 area provide water for both the new and old systems, but the old system leaks approximately 10,000 gallons per day.

The existing sanitary wastewater system at Midway Atoll is composed of central septic tanks and drainfields. Stormwater intrusion and suspected groundwater infiltration has overloaded the current system.

Work has been performed to eliminate stormwater intrusion, and a new sewer system and treatment and disposal system have been designed for certain facilities located in the core area of town. A dispersed septic design is preferred over the existing central septic in sensitive habitat areas and bird nesting sites.

Electrical power at Midway Atoll is supplied by a diesel generator power plant. Two generators that operate in automatic duplex mode were installed and began operating in 2005.

In most cases, only one generator is needed to meet the island's demand. If one generator exceeds capacity, the second generator automatically comes online and automatically shuts off when electrical demand reduces.

A new fuel tank farm was constructed in 2007 with a capacity of 450,000 gallons. The tank farm stores a sufficient amount of fuel to operate electrical generators, vehicles, and aircraft for a year.

Solid waste disposal practices in Midway Atoll include the temporary storage of waste in open plastic containers with periodic collection via stake bed truck.

The solid waste is then burned in an oil-fired incinerator, dependent on the availability of waste fuel, or burned in an unlined openair pit and ashes are disposed of in the existing landfill/dump. The existing incinerator has been modified to burn waste oil, but the island does not generate enough waste oil to operate the incinerator on a daily basis. Alternatively, daily waste is burned in an open pit.

Aluminum cans are collected, compacted and sent to a recycling facility in Hawaii.

Glass is collected, crushed, and buried in the landfill/dump. The existing landfill used for solid waste disposal is limited in its capacity and the types of waste it can safely handle. The landfill, which is only used when an item cannot be incinerated, contains general household/food waste or wood materials.

Quick Facts About Midway

Midway Atoll is not your typical national wildlife refuge. Nowhere in the Refuge System are the lives of wildlife and human residents so intertwined. It is, in many respects, a little city, with all the structures, utilities, and types of equipment that are needed to function in support of the resident human community. At one time, the facilities at Midway supported more than 5,000 people. While the current resident population is less than 30, much of the original infrastructure remains in place.

- Roads - 10 miles paved and 2 miles gravel
- Seawalls - nearly 18,000 ft. of sheet piling seawall and breakwater
- Runways - one usable runway/one taxiway (Sand); one emergency and two unusable runways (Eastern)
- Telephone - satellite system and 9+ miles of line supporting on-island system
- Electrical - 2-1800 Kilowatt hours, 1970s vintage generators; and a new 1998 Caterpillar 1800 Kilowatt hour generator; nearly 120,00 ft. of above-ground

electrical line and nearly 20,000 ft. of street light line

- Buildings - nearly 120 buildings, including Cable company buildings (1904), maintenance shops, hangars, warehouses, barracks, residences, cold storage, theater, gymnasium, etc. Most built between 1941-1960.
- Fuel - 2- 2.1 million gallon jet petroleum #5 storage tanks, 5 (66,500 gal) MOGAS (gasoline) tanks, 5 tank truck refuelers, 9,000 ft. of fuel spill boom / skimmer / vacuum truck. Average approximately 170,000 gal JP5 and 3,000 gal MOGAS usage/month.
- Water - 126 acre catchment basin; 3-4.2 million gallon storage tanks, 2 treatment reservoirs, one 161 ft. water tower, 41,000 ft. of underground water line
- Sewage - 20,280 ft. of underground line, lift stations and offshore outfall; added septic/leach field system in October, 1997.
- Recreation - tennis courts, bowling alley, gymnasium, weight room, racquetball courts, theater, satellite TV broadcasting one station
- Historic - 63 historically significant buildings, facilities, sites and structures, such as runways, bunkers, ammo huts, gun emplacements, pillboxes, etc.

Midway Residents

Midway is a very special refuge for wildlife, but it is the role that people have played and will continue to play that makes this place come alive. The stories of discovery, adventure, mystery and heroism echo through the historic buildings.

Former residents recall, with mixed emotions, the times in their lives when Midway figured so prominently and the "sense of community" that developed on this remote island. The rich cultural diversity among today's residents makes the living experience more rewarding and memorable for all of us. Our new visitors are captivated by the experience and become friends of the refuge and lasting partners in the success of this project.

Although Midway was "home" last century to squatters, its first "legal" residents were Marines sent to stop the wanton commercial

exploitation of birdlife. The employees of the Commercial Pacific Cable Company made a comfortable home amongst the blowing dunes of Sand Island. They were followed in the mid-thirties by Pan Am employees, sent to this remote island to build a prefab hotel in support of the short-lived Clipper operation that spanned the Pacific. The late thirties brought soldiers preparing for war and commission of Naval Air Station, Midway Island on August 1, 1941. From that point forward, the Navy "community" of residents would develop and manage Midway's islands.

At times, the number of enlisted personnel and dependents would exceed 3,000 people. Tours of duty with dependents were typically 18 months, or 12 months if dependents were not present. Most military personnel and a small number of civilians lived in barracks. It was a complex military organization and a bustling community as well.

On their off hours, residents took advantage of the diversity of recreational pursuits, such as diving, swimming, fishing, baseball and other team sports. Bicycles (or "horses" as they were called) quickly became the transportation of choice. The George Cannon school provided classes for dependent children grades 1-12. A chapel provided worship services for most major faiths. Residents shopped at a Navy Exchange, found medical help in the Station Hospital, listened to a local radio and TV station and watched movies in the Station Theater.

Biology

Nearly two million birds of 19 species nest on Midway. The atoll has the largest Laysan albatross colony in the world. Other birds include black-footed albatross, red-tailed tropicbirds, white terns, black and brown noddies, shearwaters, and Bonin petrels. One of the rarest visitors is the endangered short-tailed albatross.

Three-fourths of Midway's plant species were introductions. These include weeds, ornamental shrubs, exotic vegetables, and trees such as coconut palms and ironwood. Major efforts are underway to control alien species and restore native habitats.

The waters abound with dolphins, monk seals, and green sea turtles. More than 250 species of fish live in its waters, including hapu`upu`u (the Hawaiian grouper usually caught at depths exceeding 150 ft in the MHI, but often seen at diving depths at Midway), ulua (jack), kumu (goatfish), and sharks. Beyond the reefs are pelagic fishes such as tuna and marlin.

Despite 100 years of human impact, the reef at Midway is rich and diverse. Sixteen species of stony coral have been reported, and scientists believe there may be many more. Marine habitats, including spurs, grooves, and sand channels, are home to several algae, seagrass meadows, urchins, bi-valve clams, sponges and more. Two species of seagrasses are found at Midway, one of which is a Hawaiian endemic, and the second species is one not previously recorded from the Hawaiian Islands.

History [mostly written in 1930s-40s]

Midway was discovered July 8, 1859, by Captain N.C. Brooks of the Hawaiian barque *Gambia*, and by him called Middlebrook Islands. An account of this discovery, reprinted from the *Polynesian* of August 13, 1859, appears in the *Paradise of the Pacific* for October, 1936 on page 23.

Captain Brooks took possession of the two islands in the name of the United States, a peculiar proceeding in view of the flag of his vessel, owned by B.F. Snow of Honolulu. Had he given the editors of the *Polynesian* a less glowing account of the new discovery, we would be inclined to believe the story that Captain Brooks kept the discovery secret so that he might sell the information to the North Pacific Mail and Steamship Company, who were on the lookout for a mid-Pacific coal depot for the vessels on the oriental run.

However that may be, the Pacific Mail Steamship Company did learn about the atoll, and eight years later succeeded in having the American government send the U.S.S. *Lackawanna* to make a careful survey. With considerable ceremony, on Wednesday, August 28, 1867, in compliance with the orders of the Secretary of the Navy, formal possession was taken of what was termed

Brooks' Island. Wrote Captain William Reynolds, Commander of the Lackawanna:

"It is exceedingly gratifying to me to have been thus concerned in taking possession of the first island ever added to the dominion of the United States beyond our shores, and I sincerely hope that this will by no means be the last of our insular annexations. I ventured to name the only harbour at this island after the present Honourable Secretary of the Navy (Welles), and to call its roadstead after the present Honourable Secretary of State (Seward)."

In 1870 the United States Congress appropriated \$50,000 to be spent blasting a 600-foot wide ship channel through the reef into the lagoon, doubtless at the insistence of the Pacific Mail Steamship Co., and based on observations made by the Lackawanna. The U.S.S. Saginaw was detailed to carry the divers and equipment to Midway, arriving there on March 24, 1870. Dredging operations proceeded during the summer of 1870, but weather was so bad that at the end of the seven months little had been accomplished, the funds were nearly exhausted, and the project had to be given up.

A full account of how the Saginaw was wrecked on Kure Island, on its way back to Honolulu, has been given by George H. Read, in his book the *Last Cruise of the Saginaw*.

On November 16, 1886, the little fishing schooner General Seigel, Captain Jacobsen, at anchor in Welles Harbour, was hit by a sudden gale and went to pieces on the reef. The gruesome adventures of its seven castaways, and how one of their number, Adolph Jorgensen, was left behind by his companions, is a well-known story, made famous by "John Cameron's Odyssey."

So also is the story of the manner in which, when Jorgensen was about to be rescued by the 467-ton schooner Wandering Minstrel, that vessel also was wrecked in almost the same spot. Five of the crew made off in one of the boats and were never heard of again. John Cameron, Jorgensen, and a Chinese boy, in another of the boats, succeeded in making the

trip from there to Jaluit via Mille Island, 1540 miles away in the Marshall Islands.

Captain F.D. Walker appeared to have intentionally wrecked the Wandering Minstrel on Midway, and Jorgensen was not such a bad fellow, just a little pupule. On the other hand, if we accept the statements of Captain and Mrs. Walker (one version of her account appears in the *Paradise of the Pacific* for November, 1936, pages 27-29), Jorgensen was a killer, and Cameron was but little better.

Naturalists visited Midway around the turn of the century. Henry Palmer, bird collector for Hon. Walter Rothchild, in July, 1891; and William Alanson Bryan, in August, 1902. The latter gives the last account of observations made on the island prior to the Cable Company installations, made later that same year and during 1903.

The schooner Julia E. Whalen was wrecked on Midway, October 22, 1903, while bringing supplies to the newly established cable station. The British barque Carrollton, with a load of coal from Newcastle for Honolulu, was lost on Midway, December 28, 1906. The crew was rescued by the cable ship Restorer. The Pacific Mail S.S. Mongolia went aground on the western side September 16, 1906, but succeeded in getting off again even before the arrival of the ships Buford, Iroquois, and Restorer, which went to her aid from Honolulu.

One might ask why so many wrecks have occurred on Midway. The reason is that the atoll is very low and hard to see, and also that it is subject, especially in the winter, to sudden and severe storms. Although only 400 miles further north than Honolulu, Midway is no longer in the tropics, and has a much more temperate climate, which in winter becomes quite cold. This, together with the heavy winds, which drive loose sand into every nook and corner, rule out this island as a winter resort but in summer the climate is delightful.

Perhaps the outstanding fact about the natural history of Midway is the great change which Sand Island has undergone through the efforts of man. When the cable station was established there were no trees or shrubs and

scarcely any herbs on the island to hold the shifting sand in place.

Daniel Morrison went to Midway as superintendent of the cable station in 1906, remaining until 1921. When he first arrived in 1903, he said that Midway was unfit for human habitation, and then initiated the long process of introducing hundreds of new species of flora and fauna to Midway.

He imported a coarse grass (*Ammophila arenaria*) from the wind-swept beaches near San Francisco, and with it succeeded in holding the sand in place. He set out ironwood trees (*Casuarina equisetifolia*) in 1907 as windbreaks, and numerous other kinds of ornamental and useful trees, shrubs and herbs. Ship loads of soil (an estimated 9,000 tons) were brought from Honolulu and Guam, and used to encourage the 3-acre vegetable gardens and other useful growth. Mr. Morrison also imported canary birds and Laysan finches in 1906, and fostered the flightless rails, which also had been introduced from Laysan.

The island has been turned into quite a beauty spot, with livestock, poultry, lawns, and airy spacious quarters for the cable personnel, and now a good hotel to attract the visitor, who also might be interested in the excellent fishing.

The Tanager expedition, which explored the northwestern Hawaiian islands in 1923, obtained a few specimens from Midway. To these have been added notes and specimens by Dr. D.R. Chisholm and others. There has also a lengthy record of the plants, birds, insects, and fishes of the island and its adjacent waters, some of which have been published in Bishop Museum Bulletins 26, 27, 31, and 81, and other publications.

Pan American Airways established an airport at Midway, beginning in 1935. Shops, warehouses, power plant, water tanks, and a northern hotel with large refrigerators, electric lights and other modern conveniences, were built on the northeast end of Sand Island. With the commencement of rapid and direct air service between Manila and California via Guam, Wake, and Honolulu, danger was seen

of the transportation of insect pests and plant diseases. To counteract this the Hawaiian Sugar Planters' Association established an "insect filter." Fred C. Hadden, entomologist, went to Midway on November 24, 1936. His duty is to inspect and fumigate the clipper planes going in both directions. Already he has headed off insect pests which might have done considerable damage to agriculture in Hawaii. C. E. Pemberton describes this work in the *Paradise of the Pacific* for January, 1937; and Mr. Hadden has written an interesting article on Midway and its bird life.

During the past few years there has been a sudden awakening of interest in Midway on the part of the U.S. Army and Navy. But in keeping with our decision not to include any mention of military installations or of efforts of the enemy to destroy these, we will say nothing more. But this is not the first time that Midway has been guarded by American forces. Edwin North McClellan, writing in the *Honolulu Advertiser* of September 16, 1927, reminds us that in March 1904, Marines were ordered to Midway to "protect property and guard the cable employees from marauders who might visit the islands to kill the sea birds." A detachment arrived on Midway on May 2, 1904, and set up two six-pounders; but they were withdrawn in the spring of 1908.

By Executive Order, dated February 14, 1941, Midway was made a national defense area. It had been under the jurisdiction of the United States Navy Department since January 20, 1903; and never officially had been part of the Territory of Hawaii.

Midway and the Clipper Era

In 1935, China Clipper operations began. This large flying boat, run by Pan American Airlines, island-hopped from San Francisco to China, providing the fastest and most luxurious route to the Orient, and bringing tourists to Midway until 1941.

Midway was a stop-over for the famous "China Clipper" flying boats. Pan American Airlines built a hotel with a swimming pool for overnight passengers to rest before continuing their trans-Pacific flights.

Only the rich could afford a Clipper trip, which in the 1930s was over three times the annual salary of the average American. Folks like Earnest Hemingway had the honor of meeting the goonies face to face. The large seaplanes landed in the quiet atoll waters and pulled up to a float offshore. Tourists were loaded onto a small powerboat which whisked them to a pier, where finally they would ride in "woody" wagons to the Pan Am Hotel or "Gooneyville Lodge."



Over the years, Pan Am used several different models of "Clippers". The book, "Wings to the Orient", deeply details the associated aviation history for those who wish to explore the design variations further.



Based at Treasure Island in San Francisco Bay, the Clippers flew from Honolulu to Midway, then on to Wake, Guam, Manila, and Macau. Other routes were also explored, especially with the onslaught of the Pacific war, which ended Clipper operations at Midway on December 8, 1941.

In 1947, a Clipper landed at Midway again, in the faded hope that somehow the Clipper days could be revived, but with the new aircraft technology developed during World War II, the days of the Clipper were over.

World War II and Later

After the Battle of Midway, the Japanese fell back into a defensive posture for the

remainder of World War II, and never threatened Midway again. Immediately after the battle, Eastern Island became the launching point for bombing attacks against Japanese-held Wake Island. Flying at 2,500 to 8,000 foot altitudes, B-24 Liberators dropped 500-pound bombs on Wake Island, with the largest effort occurring during the nights of December 22/23, 1942. The total length of the mission, from Hawaii, staging from Midway and return, was over 4,300 nautical miles. No aircraft were lost.

In July 1942, the first Naval Construction Battalion onto Midway began work on the new airstrip on Sand Island. They start with the massive clean up of damaged caused by the Japanese bombing and numerous construction projects. Throughout

the remainder of the war, SEABEES would continue construction of important facilities such as the submarine base. Private contractors were brought back to Midway to dredge and create the inner harbor and mooring basin for both submarines and surface vessels. Besides building and maintaining Midway, the fighting SEABEES were also responsible for its defense and played an important part in Midway's wartime community.

Midway's submarine base was of great strategic importance in the entire Pacific picture and of operational importance to submarines based at Pearl Harbor. Situated 1,200 miles west of Oahu, Midway's

replenishing facilities added 2,400 miles to the cruising radius of the boats, which saved eight days and precious fuel. Rather than returning to Pearl Harbor, U.S. submarines received fuel, refit/repairs, and ammunition at Midway. Midway's submarine base, which was commissioned in July 1942, provided the submariners rest and recuperation, which included sports, USO shows, talent shows, mail, news, movies, fresh fruit, ice cream, and real beds in the Pan Am "Gooneyville" Hotel.

The first submarine tender to be stationed at Midway was the *Fulton* from July through October 1942. Midway's submarine base personnel worked in conjunction with the submarine tenders, and they had the capacity to refit up to four submarines at a time. This capacity was similar to the ability of a single submarine tender. In 1944, in addition to the tenders working in the the submarine basin/inner harbor, a 2,500-ton floating Auxiliary Repair Dry Dock (ARD) arrived. The ARD provided Midway's Submarine Base almost the same capability to repair/refit submarines as Pearl Harbor's Submarine Base.

The "Silent Service" was partially responsible for the U.S. bringing the war in the Pacific to a quicker close. Despite early nagging problems of defective torpedoes, the Submarine Force destroyed 1,314 enemy ships in the Pacific, representing fifty-five percent of all enemy ships lost and a total of 5.3 million tons of shipping. Out of 16,000 U.S. submarines, the force lost 375 officers and 3,131 enlisted men in 52 submarines, and although this was a tragic loss, it was still the lowest casualty rate of any combatant submarine service on either side in the 1939-1945 conflicts. A total of 15 submarines were lost from Midway. These submarines last touched on U.S. soil or in U.S. controlled waters at Sand Island - Midway Atoll. A total of 1,203 submariners were lost from Midway and are on "Eternal Patrol".

In 1950, the Navy decommissioned Naval Air Station Midway, only to re-commission it again to support the Korean conflict. Again, Midway supported Far Eastern operations. Thousands of troops on ships and planes stopped at Midway for refueling and emergency repairs.

During the Cold War, the U.S. established a super secret underwater listening post at Midway in an attempt to track Soviet submarines. These sensitive devices could pick up whale songs for miles and the facility remained top-secret until its demolition at the end of the Cold War.

Crucial to the new radar technology tracking system during the Cold War, Midway served as a primary base for the "Pacific Barrier" operation, providing a radar line from Midway Atoll to Adak Island as part of the DEW (Distant Early Warning) Line.

Continuous coverage for each 14-hour run necessitated a staggered flight schedule, with radar planes called "Willy Victors" leaving Midway every 4 hours. Antenna fields covered the islands.

With about 3,500 people living on Sand Island, Midway supported the Vietnam effort. The Officer-in-Charge house or "Midway House" was used in June 1969, when President Nixon met "secretly" with Republic of South Vietnam President Thieu.

In 1978, the Navy downgraded Midway from a Naval Air Station to a Naval Air Facility and large numbers of personnel and dependents began leaving the island.

With the conflict in Vietnam over, and the introduction of spy satellites and nuclear submarines, Midway's significance to National security began to diminish.

Midway Cleanup

In 1988, Midway Atoll became an "overlay" national wildlife refuge, still subject to primary jurisdiction of the Navy. In 1993, Naval operations shutdown completely.

As part of the Base Realignment and Closure process and associated transfer agreement with the Fish and Wildlife Service, the Navy assumed responsibility for cleaning up environmental contamination at Naval Air Facility Midway Island.

Following extensive field investigations and sample analyses, removal actions were conducted at 10 sites.

1,390 cubic yards of PCB-contaminated soil were excavated and treated. 1,578 cubic yards of DDT/DDE contaminated soil were excavated and treated. In addition to surface contamination, leaking and out-of-service fuel tanks caused extensive petroleum contamination of groundwater and subsurface soil.

132 underground and above ground storage tanks (some as large as 2.2 million gallons) were removed. Several miles of petroleum pipeline was drained and removed. 10,657 cubic yards of petroleum-contaminated soil were excavated and treated. 90,000 gallons of petroleum product were extracted from the groundwater.

Other contamination and wildlife hazards were identified and became a significant focus during the cleanup process.

111 buildings and other structures were demolished. Two active landfills were investigated, capped, and closed. Large amounts of metal debris were removed from shorelines and other wildlife habitats. Deteriorating asbestos materials and lead-based paint were removed from dozens of structures. Hundreds of batteries, compressed gas cylinders, and other metal debris were removed from near-shore waters.

Several programs were initiated to restore wildlife habitat impacted by the closure operations and to secure historically significant buildings. These projects are ongoing under Fish and Wildlife Service management.

Rats were eliminated from Eastern Island and, more recently, from Sand Island. The Navy provided funding to the Fish and Wildlife Service for the development of a native plant nursery, and initiator of an habitat restoration effort.

Clean up crews secured windows, doors, and other openings on several historic buildings and structures.

In 1992 and 1994, federal cultural resource surveyors from Washington D.C. assessed the historical significance of all the structures. 78 properties were determined to be eligible for nomination to the National Register of Historic Places.

A monument erected by the International Midway Memorial Foundation lists all American forces involved in the Battle of Midway. Many units suffered heavy losses including two-thirds of the combat planes that took off

from Midway and half of their crewmen.

During the transfer ceremony from the Department of Defense to the Department of the Interior in April of 1997, the Secretary of the Navy said "we've traded guns for gooneys", and hopefully Midway will never need to be used for war purposes again, but instead, a place for wildlife research and recreation, and to protect the memory of those who sacrificed their lives here, so that we can protect our environment today.

In August of 1996, Midway opened to public visitation. On October 31, 1996, President Clinton signed Executive Order 13022 putting Midway under Department of Interior jurisdiction. The formal transfer occurred during a ceremony on April 6, 1997. On June 30, 1997, the last Navy personnel boarded a C5-A cargo plane, and left Midway to the goonies.

Recently, several agencies, including the Fish and Wildlife Service, cooperated in an aggressive effort to collect abandoned net material and other marine debris that threatens seals, turtles and seabirds. About 15 tons of debris was collected from Midway's reefs alone by Service staff and volunteers.



Navy contractors returned to Midway in May 2001 to deal with a contaminant problem. On this project, they disassembled and landfilled an abandoned tug and barge lying in shallow water next to the Bulky Dump on the south side of the island. These vessels were removed because they were the suspected source of elevated PCBs in nearby marine sediments. IT Corporation also built a giant water filtration system to process sediments dredged from the site. IT planned to return to Midway to install an impermeable barrier along the cargo pier to mitigate fuel seepage into nearshore waters.

Chronology of Midway

5 July 1859. Captain N.C. Brooks of the Hawaiian Bark Gambia discovers the atoll. Islands were named "Middlebrook Islands".

28 August 1867. Captain William Reynolds of the USS Lackawanna takes possession of the atoll for the United States. Midway becomes the first offshore islands annexed by the U.S. government.

20 January 1903. Due to recurring complaints of Japanese squatters and poachers, President Theodore Roosevelt places the atoll under the control of the Navy.

20 April 1903. Commercial Pacific Cable Company's first contingent arrives on island.

June 1903. U.S. Navy ejects Japanese poachers and squatters and appoints Commercial Pacific Cable Company as island custodians.

4 July 1903. The first "around the world" cable message was sent via Midway by President Roosevelt. The message took nine minutes.

12 April 1935. Pan American World Airways sets up an air base for weekly Trans-Pacific Flying Clipper Seaplane service.

March 1940. Private contractors start construction of the runways on Eastern and other infrastructure on Sand Island in preparation for possible hostilities.

1 August 1941. U.S. Naval Air Station Midway is commissioned.

7 December 1941. Two Japanese destroyers, the "Midway Neutralization Unit," shelled Midway. Four men were killed, including the war's first Marine Corps recipient of the Medal of Honor, Lieutenant George Cannon.



Debris Pile at Midway Atoll, Collected in 2003

3-6 June 1942. Japanese launched an attack against Midway in the hope of engaging and destroying the U.S. aircraft carriers and occupying Midway. U.S. Fleet aircraft ambushes the Japanese Fleet north of the islands inflicting heavy losses (four aircraft carriers), thus turning the tide of the War in the Pacific.

15 July 1942. The submarine base at Midway is commissioned. The base was of great strategic importance in the entire Pacific arena and of operational importance to submarines based at Pearl Harbor.

1955-1965. Midway plays host to squadrons of Super Constellation "Willy Victor" radar aircraft and crews that played the role of the eyes and ears of the Nation forming the

Distant Early Warning line in coordination with radar picket ships.

8 June 1969. U.S. President Nixon and South Vietnam President Thieu conduct secret meetings in the Midway House - the Commanding Officer's residence.

October 1978. Naval Air Station Midway re-designated Naval Air Facility and dependents begin to depart. As many as 4,000 personnel and dependents were stationed here at the height of the Cold and Vietnam Wars.

23 November 1985. Pan American B747 "China Clipper II" visits Midway to commemorate the 50th anniversary of the first China Clipper flight.

22 April 1988. Midway Atoll is designated as an overlay National Wildlife Refuge.

30 September 1993. Naval Air Facility Midway is "operationally closed" and the Navy initiates plans for environmental cleanup of the atoll.

31 October 1996. President Clinton signs Executive Order 13022 transferring jurisdiction of Midway Atoll from the U.S. Navy to the Department of the Interior.

3 April 1997. Secretary of the Navy John Dalton presents the "key to Midway" (in the shape of a Laysan Albatross) to Interior Assistant Secretary Bonnie Cohen. In his speech, Secretary Dalton celebrated "trading guns for goonies" on Midway Atoll.

30 June 1997. The last U.S. Navy personnel stationed on Midway Atoll depart.

4-7 June 2002. Veterans commemorate the 60th Anniversary of the historic Battle of Midway on Sand Island.

15 June 2006. Presidential Proclamation 8031 issued by President Bush creating Northwestern Hawaiian Islands Marine National Monument, including Midway Atoll. It is the largest marine conservation area on earth.

2 March 2007. In Honolulu, First Lady Laura Bush announced Papahānaumokuākea Marine National Monument as the new name of the site after a visit to Midway Atoll.

Coast Pilot

Midway Islands, 1,150 miles WNW of Honolulu, were discovered in 1859 by Captain N. C. Brooks, an American shipmaster on the Hawaiian vessel GAMBIA; possession was taken on behalf of the United States on September 30, 1867, by Captain William Reynolds of the U.S.S. LACKAWANNA. The circular atoll is 6 miles in diameter and encloses two islands. The coral reef does not completely enclose the lagoon; there is a natural opening on the W side, and another opening has been dredged on the S side. The reef rises abruptly from deep water and there are no off-lying rocks or shoals; breakers mark all seaward sides of the reef. The enclosed islands average 12 feet high with a maximum height of 45 feet. Numerous birds, especially albatross, nest on the islands and are sometimes a hazard to landing or departing airplanes.

The Midway Islands, not part of the State of Hawaii, are under the administration of the Department of the Interior **Midway Atoll National Wildlife Refuge** established by Executive Order No. 13022 of October 31, 1996. Copies of the Executive Order directing the **Management and General Public Use** of the National Wildlife Refuge System can be obtained from Refuge Manager, Hawaiian/Pacific Islands National Wildlife Refuge Complex, U.S. Fish and Wildlife Service, 300 Ala Moana Boulevard, P.O. Box 50167, Honolulu, HI 96850.

Requests for emergency entry of vessels in distress should be made by any means possible to the Joint Rescue Coordination Center (JRCC), Honolulu, Hawaii (808-541-2500). JRCC will then obtain entry approval or denial from the USFWS Refuge Manager and provide a response to the requester.

Non-emergency entry requests must be approved in advance by contacting the USFWS Refuge Manager. Additionally, the Midway harbormaster can be reached by VHF-FM radio channel 16.

Eastern Island, at the SE end of the atoll, is triangular in shape, about 1.2 miles long, and 6 to 12 feet high.

Sand Island, on the S side of the atoll, is about 2 miles long in a SW direction and is composed of white coral sand. Prominent from offshore are the towers, tanks, and radio masts of the naval installations and a group of trees on the N side of the island. An aerolight is on top of the tallest tank in the N central part of the island.

Welles Harbor is the area inside the gap in the barrier reef on the W side of the atoll. The harbor was formerly used to a considerable extent as an anchorage by ships calling at Midway, but since the dredging of the ship channel and harbor between Sand and Eastern Islands, Welles Harbor is little used. Navigation in this area should not be attempted.

Channels

Marked dredged channels through the S reef lead to deepwater basins on the E and NE sides of Sand Island, and to a small-craft basin on the W side of Eastern Island. The entrance channel is marked by a lighted buoy, unlighted buoys, and a 359.5° lighted range. (**Consult the United States Fish and Wildlife Service for latest controlling depths in channels and alongside piers.**)

Anchorage

The established anchorage area is NE of Sand Island. Outside anchorage is available in depths of 15 to 25 fathoms E of the main channel sea buoy; this anchorage is fair during NE winds, but should not be attempted during winds from other quadrants. Anchorage S of Sand Island is prohibited to avoid possible fouling of the San Francisco-Honolulu-Midway- Guam-Manila cable.

Routes

Vessels approaching Midway Islands are reminded that entry into the Midway Atoll National Wildlife Refuge is prohibited without prior approval. In approaching from any direction, vessels will remain 3 miles off until S of the entrance. Then vessels should steer a course to pass through a position (28°09'25"N., 177°21'15"W.) about 2 miles S of Midway Channel Entrance Lighted Buoy 1, then steer a N course heading directly between Sand and Eastern Islands until the channel is made out, then steer on the range. Due to the prevailing E winds and W set of

current, caution must be exercised in entering. Drift and leeway should be anticipated, and sufficient speed should be maintained at all times to control the vessel. (See discussion of currents in the channel.)

Radar Navigation

Radar and visual contact have been frequently made with the radio towers on Sand Island at distances in excess of 20 miles.

The best radar returns are the SE edge of Sand Island, the stranded wreck on E edge of the entrance channel, the radio towers on Sand Island, an unlighted platform on the N side of the atoll, and the W tip of Eastern Island.

Tides

The mean range of tide is 0.8 feet and the diurnal range of tide is 1.2 feet at Midway Islands. The generally calm waters inside the reef are occasionally subjected to strong surge, and they can be extremely agitated by winter gales.

Currents

The current off the main entrance channel usually sets W with a velocity of about 2 knots. Within the channels, the current changes direction with velocities of 2 to 8 knots, depending on the weather; extreme caution is necessary to avoid being carried outside the channel limits. It is reported that during heavy gales Welles Harbor is full of strong currents caused by the sea forced over the reefs. Weather, Midway Islands and vicinity

During the summer the winds are generally variable and light, either from NE, SE, or SW until about the middle of July, when fresh to strong NE trades set in, continuing through July and August. SW winds are always accompanied with a low barometer, rain, and squalls. Rain also comes occasionally with NE and SE winds and a high barometer. NW winds following SW storms generally indicate clearing weather.

During the winter from October to April, gales frequently occur, working around from SE through SW to NW. Occasionally a few days of fine weather will prevail, but a rough W sea is always present.

The average temperature at Midway is 73°F (22.8°C). The average maximum is 76°F (24.4°C) while the average minimum is 68°F (20°C). The record high is 92°F (33.3°C)

recorded in September 1979, July and August 1984, and August 1987. The record low is 49°F (9.4°C) recorded in January 1980. On average, only one day each year is 90°F (32.2°C) or warmer and 137 days each year are 80°F (26.7°C) or warmer.

Precipitation is moderate at Midway and averages 41.3 inches (1050 mm) each year. June is the driest month and January the wettest. On average, six thunderstorms each year affect Midway.

Pilotage, Midway Islands

Pilotage regulations are currently under development for Midway. Vessels required by law to have a licensed master should consult the Captain of the Port, Honolulu (808-522-8264 ext. 352) to determine specific pilotage requirements. Pilots are not required for public vessels of the United States.

Harbor facilities

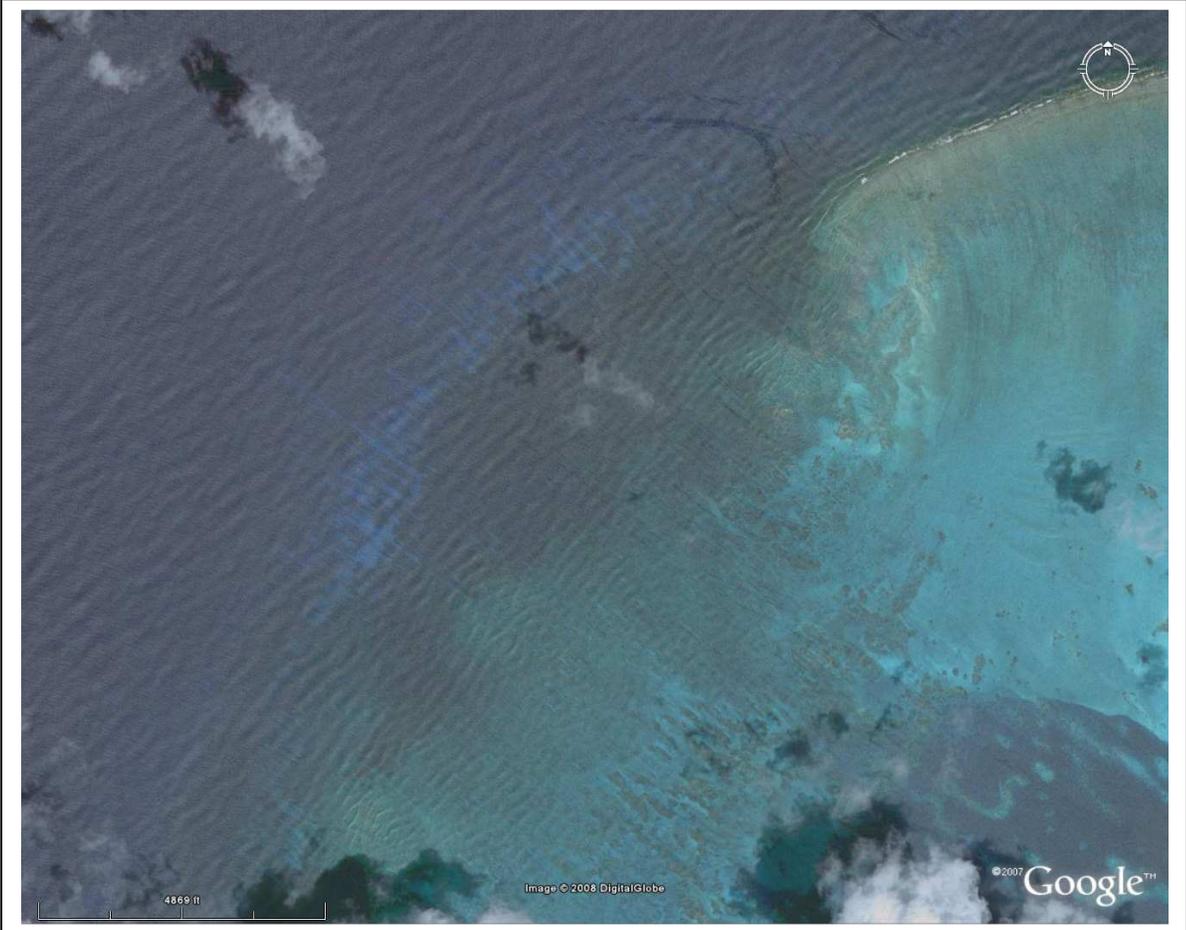
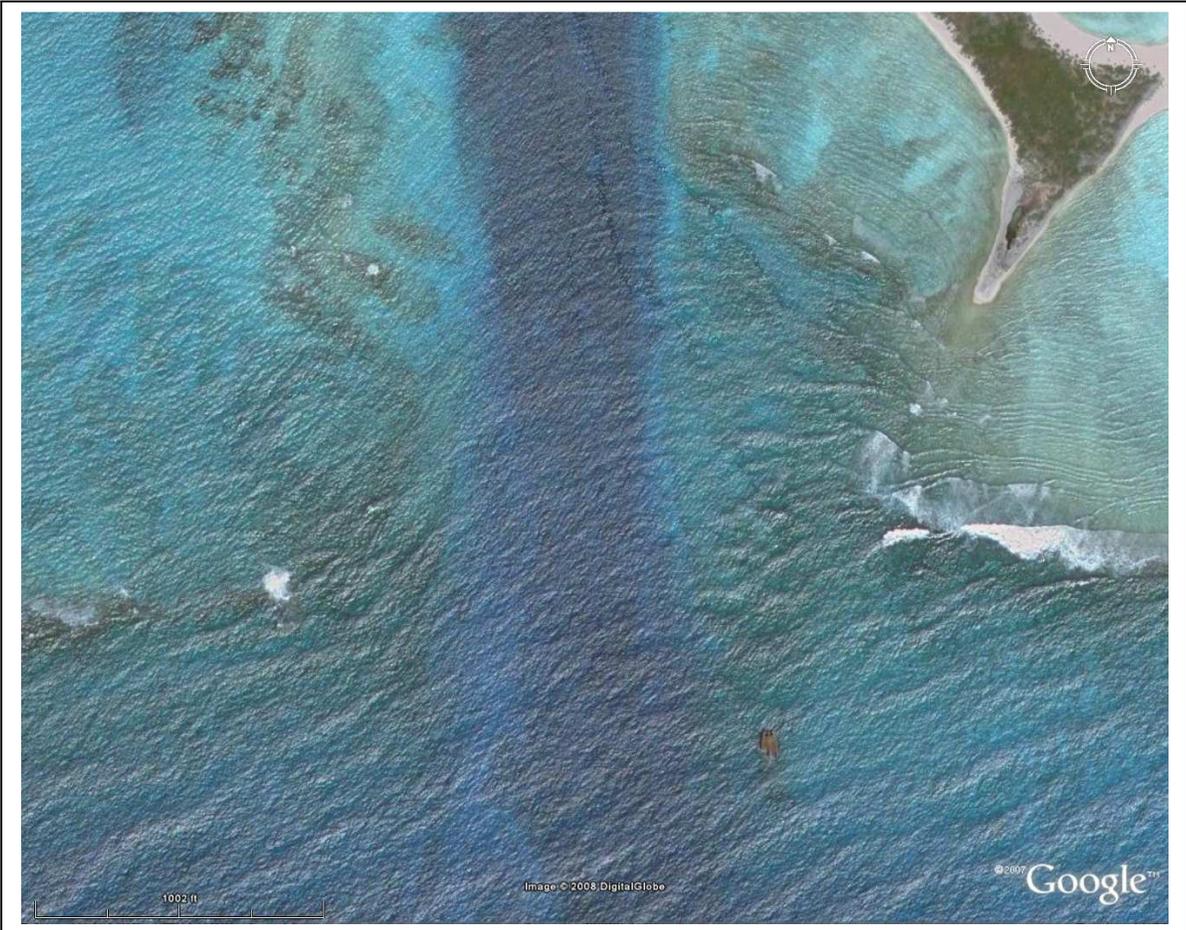
Two deepwater piers are on the NE side, and one smaller pier is in the inner harbor on the E side of Sand Island; a small-craft pier is on the W side of Eastern Island.

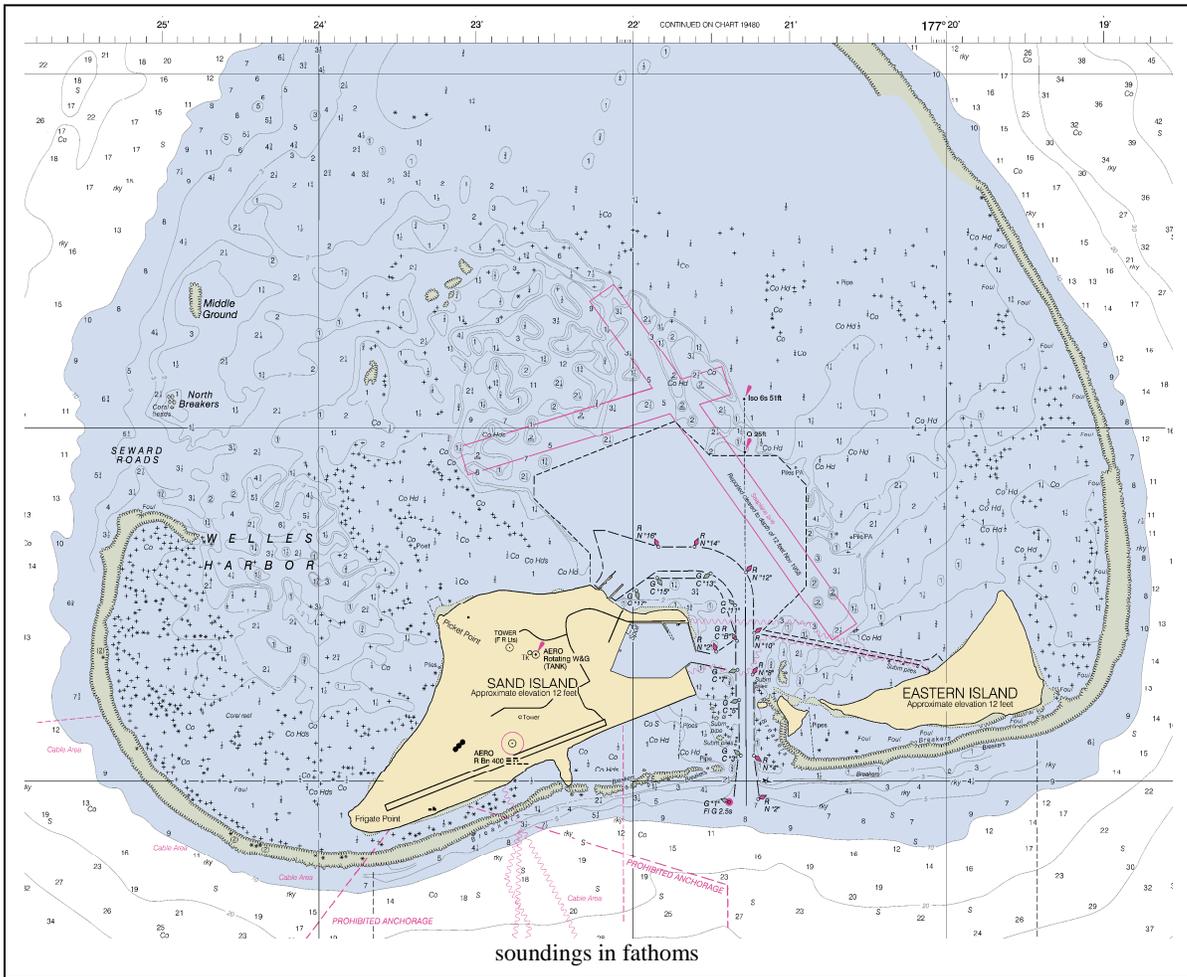
Provisions, jet fuel (JP-5), and water are not available for commercial use, except in case of emergency. Limited emergency repairs can be made to vessels, but there are no drydocking facilities. Tugs are available; there is a 20-ton mobile crane for use in emergencies.

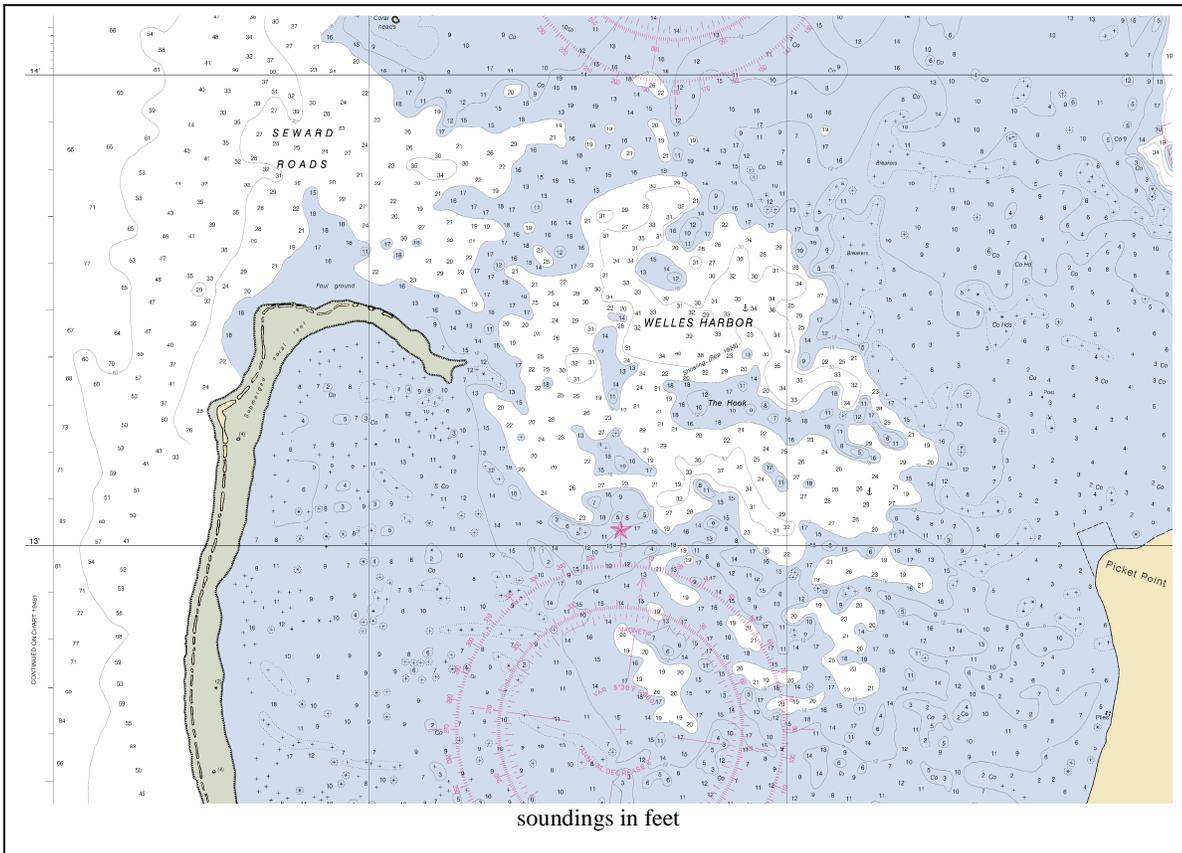
Nero Seamount is about 30 miles WSW from Midway Islands. Nero Seamount, formerly Pogy Bank, extends about 8.5 miles in an E-W direction, about 7 miles in a N-S direction, and has a least depth of 37 fathoms.











soundings in feet

Midway Airport, Henderson Field

FAA INFORMATION EFFECTIVE 10 APRIL 2008

Location

FAA Identifier: MDY
Lat/Long: 28-12-13.2170N / 177-22-46.2690W
28-12.220283N / 177-22.771150W
28.2036714 / -177.3795192
(estimated)
Elevation: 13 ft. / 4 m (estimated)
Variation: 10E (1985)
Zip code: -11,-11,-11

Airport Operations

Airport use: Open to the public
Activation date: 12/1946
Sectional chart: HAWAIIAN ISLANDS
Control tower: no
ARTCC: HONOLULU CONTROL FACILITY CENTER
FSS: HONOLULU FLIGHT SERVICE STATION
NOTAMs facility: MDY (NOTAM-D service available)
Attendance: 0800-1700
Wind indicator: lighted
Segmented circle: no
Lights: DUSK-DAWN
ACTVT HIRL RY 06/24 FREQ 126.2.
Beacon: white-green (lighted land airport)
Landing fee: yes
Fire and rescue: ARFF index A

Airport Communications

CTAF: 122.9
WX AWOS-3: 118.325 (808-674-8237)
ADVSY: 126.2 257.8
EMERG: 121.5 243.0

* NO ATCT OPNS. INBD ACFT CTC 100 NM OUT FOR ADVISORIES. FREQ 126.2 MONITORED 0800-1700 AND DURING APPROVED ACFT OPNS.

Nearby radio navigation aids

NDB name	Hdg/Dist	Freq	Var	ID
MIDWAY	at field	400	10E	MDY -- -- -- --

Airport Services

Oil available: CTAF NOT MONITORED CTC FREQ 126.2.
Parking: tiedowns
Bulk oxygen: NONE

Runway Information

Runway 6/24
Dimensions: 7904 x 200 ft. / 2409 x 61 m
Surface: asphalt, in good condition

Weight bearing capacity:

Single wheel: 195.0
Double wheel: 260.0
Double tandem: 390.0
Runway edge lights: high intensity

	RUNWAY 6	RUNWAY 24
Latitude:	28-11.848500N	28-12.323848N
Longitude:	177-23.573517W	177-22.202617W

Elevation:	12.8 ft.	6.8 ft.
Traffic pattern:	left	left
Runway heading:	059 magnetic, 069 true	239 magnetic, 249 true
Markings:	nonprecision, in poor condition	nonprecision, in poor condition
Visual slope indicator:	12-box VASI	
Touchdown point:	yes, no lights	yes, no lights
Obstructions:	none	30 ft. trees, 800 ft. from runway, 400 ft. right of centerline, 34:1 slope to clear

Airport Ownership and Management from official FAA records

Ownership: Publicly-owned
 Owner: US DOI FISH & WILDLIFE SVC
 300 ALA MOANA BLVD., RM. 5-231, BOX 50167
 HONOLULU, HI 96850
 Phone 808-792-9548
 Manager: MR. DAVID RYAN
 1082 MAKEPONO ST.
 HONOLULU, HI 96819
 Phone 808-674-1237

DAVID RYAN - EMAIL: MIDWAYAIRPORT@AMERICANAIRPORTS.NET FAX: 808-693-8036
 AMERICAN AIRPORTS CORPORATION
 AIRPORT FAX: (808)674-8036

Airport Operational Statistics

Aircraft operations: 226/year *
 42% transient general aviation
 40% air taxi
 12% military
 5% commercial

* for 12-month period ending 05 November 2006

Additional Remarks

- ARPT CTC 0800-1700 (808) 674-1237. EMERGENCY PAGER 24 HRS (480) 768-2500 ID 881631492770.
- SCHEDULED ACFT OPNS PERMITTED ONLY DURG HRS OF DARKNESS NOV-JUN DUE TO HEAVY BIRD ACTIVITY.
- EXCEPT WHEN NECESSARY FOR TKOF AND LNDG, ALL ACFT MAINTAIN MIN ALT OF 1500 FT MSL WITHIN 5 MI OF ARPT.
- WATER HAZARD ON TWY A DURING AND AFTER RAIN.
- BE ALERT FOR HEAVY BIRD STRIKE HAZARDS AT ALL TIMES.
- CURRENT BIRD ACTIVITY STATUS AVBL DURING INITIAL CTC INBOUND AND PRIOR TO TKOF AND LDG ON FREQ 126.2.
- FREQ 126.2 MONITORED 0800-1700 DAILY AND DURING APPROVED ACFT OPNS.
- USE FREQ 126.2 FOR ALL INBOUND AND OUTBOUND COMMUNICATIONS.
- PPR FOR LDG FM ARPT MGR 24 HRS IN ADVANCE DUE TO HEAVY BIRD ACTIVITY CALL (808) 674-1237.
- FUEL AVAILABLE FOR EMERGENCIES ONLY CTC AMGR 808-674-1237.

Shipwrecks on Midway Atoll

USS Macaw

The USS Macaw (ASR-11) was a 250-foot submarine rescue ship and featured heavy lifting and deep-sea diving capabilities, including the McCann Rescue Chamber.

Class and type: Chanticleer
Displacement: 1780 tons
Length: 251 ft 4 in
Beam: 42 ft
Draught: 14 ft 3 in
Speed: 16.5 kts
Complement: 102 officers and enlisted
Armament: 2 3", 2 dct.



The USS Macaw

Macaw departed for Midway Island

Macaw was sunk at Midway Island on February 12, 1944 while attempting to rescue USS Flier (SS-250) that had run aground, 16 January 1944.

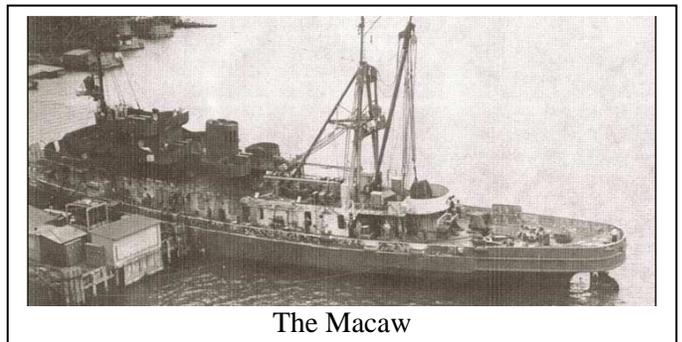


Other assets were soon mobilized from Pearl Harbor, and the submarine was freed from the reef...but the Macaw remained hard aground and threatening to block the channel, then a critical passageway for the sub refit base at Midway.

During the salvage operations of the salvage ship, a powerful storm swept in and, in the late hours of February 13th, 1944, the Macaw began to list and slide backwards into deeper water. The salvage crew on board abandoned ship. Most were rescued the next day, clinging to buoys and

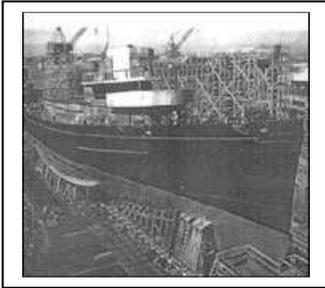
Macaw was laid down 15 October 1941 by the Moore Dry Dock Co., Oakland, California; launched 12 July 1942; sponsored by Miss Valnessa Easton of Berkeley, Calif.; and commissioned the same day, Lt. Comdr. P. W. Burton in command.

Departing California 28 August 1943, after shakedown and training exercises, Macaw steamed in convoy to Espiritu Santo, arriving 2 October. Thence proceeding to Funafuti, via Wallis Island, she charted previously unknown reefs. She anchored off Funafuti on the 16th and remained until 13 November when she was ordered back to Pearl Harbor. Spending only a short time in Hawaii,



The Macaw

reef rock, but five, including the Macaw's commanding officer Paul Burton, were never recovered.



Salvage divers from the USS Shackle spent hundreds of man-hours setting demolition charges and cutting away Macaw's superstructure, in

order to clear the channel. Her hull and twisted superstructure debris were surveyed by NOAA archaeologists during the 2003 field season.

The USS Flier (after Midway)

USS Flier (SS-250), a Gato-class submarine, was the only ship of the United States Navy to be named for the flier, a round sunfish widely known in the United States. Her keel was laid down by Electric Boat Company of Groton, Connecticut. She was launched on 11 July 1943 sponsored by Mrs. A.S. Pierce, and commissioned on 18 October 1943 with Lieutenant Commander John D. Crowley in command.

Flier reached Pearl Harbor from New London, Connecticut, on 20 December 1943, and prepared for her first war patrol, sailing 12 January 1944. Damage suffered in a grounding near Midway Island necessitated her return to the west coast for repairs, and on 21 May she sailed again for action, heading for a patrol area west of Luzon. She made her first contact on 4 June, attacking a well-escorted convoy for five merchantmen. Firing three torpedoes at each of two ships, she sent a large transport to the bottom and scored a hit on another ship, before clearing the area to evade countermeasures.

On 13 June 1944, Flier attacked a convoy of 11 ships, cargo carriers and tankers, guarded by at least six escorts. The alert behavior of the escorts resulted in severe attack on Flier before she could observe what damage she had done to the convoy. On 22 June, she began a long chase after another large convoy, scoring four hits for six torpedoes fired at two cargo ships that day, and three

hits for four torpedoes launched against another cargo ship of the same convoy the next day.

Sunk by a mine

Flier put in to Fremantle, Australia, to refit between 5 July 1944 and 2 August, then sailed on her second war patrol, bound for the coast of Indochina via the Lombok Strait, Macassar Strait and Balabac Strait. At about 2200 on 12 August, as she transited Balabac Strait on the surface, she struck a naval mine. Traveling at 18 knots (33 km/h), she disintegrated and sank in less than a minute, but several of her crew got out of her.

Treading water in the darkness, the survivors took muster by shouting out their names. Fourteen had survived, meaning that 72 officers and men had gone down with Flier.

Although they knew that they were only three miles from land, they could not orient themselves in the overcast night. Commander Crowley directed the survivors to tread water until they could determine direction.

Moonrise was five hours later. By the time it became light enough to see a small island, six more of the crew died and the sea had become choppy. Unable to keep the survivors together, Commander Crowley ordered Lieutenant Liddell, Ensign Jacobson, RTC Howell, FCR2 Tremaine, QM3 Russo, MoMM3 Baumgart, and MoMM3 Miller to each make their own way to the beach. At about 1600 on 13



August, eighteen hours after the explosion, seven survivors met on Mantangula Island; Miller was unaccounted for.

Escaped crew fights for survival on island

They slept that night burrowed into the sand, then began building shelter the next morning. Their exploration discovered that Mantangula had no fresh water; they must travel to another island or die of thirst. The officers were familiar with their area from studying navigational charts and knew that the two best possibilities were Balabac Island to the west and Bugsuk Island to the east. They decided on Bugsuk, and began constructing a raft. While foraging for materials, they met Miller, who had come ashore on the eastern tip of the island and spent the night alone. Construction of the raft continued through the day as the survivors grew weaker from thirst. They spent a second night on the island.

The next morning, searchers found two coconuts, which were shared by all -- and transpired to be the only food or drink they would have for days. They set out on their raft for Byan Island on the way to Bugsuk that afternoon at low tide. Two men rode the raft and steered with paddles while the others swam pushing it. They reached Byan exhausted, and collapsed on the beach.

The next morning, the party crossed Byan and the channel separating it from Gabung Island, where they passed the next night. The following day was the worst they experienced. They were blistered by sunburn; their feet were lacerated and poisoned by coral; they were plagued by stinging insects; in the four days since their submarine had hit the mine, the only thing they had had to eat and drink had been one-quarter of a coconut each. They made good time on the next crossing because the water was shallow enough to allow wading rather than swimming, though at the price of further injuring their feet on the coral bottom.

Finally reaching Bugsuk, the survivors came ashore into a small coconut grove where they partially relieved their thirst and hunger. Bugsuk had been inhabited in the past; the party explored several empty buildings and discovered a cistern full of fresh water. They slept that night in one of the abandoned buildings.



Meeting up with guerrillas

The next morning, Ensign Jacobson awoke before the others and encountered a young Filipino, a member of the guerrilla "Bugsuk Bolo Battalion." He led the survivors to their headquarters where about 20 more guerrillas were encamped. Here the survivors had their first hot meal in many days, fish and rice, cooked by the guerrillas.

Some of the guerrillas were a party from Palawan Island who had come to Bugsuk to search for possible survivors of a lost submarine. The survivors were disappointed to learn that they were referring not to Flier but rather Robalo (SS-273), lost three weeks earlier in this same vicinity. The search party transported the survivors to Cape Buliluyan on Palawan, a three-day boat ride. There they rendezvoused with another party of guerrillas who had been scouting Balabac for Robalo survivors. After several more days traveling up the east coast of Palawan, they reached their base at Sir John Brooks Point. Also at the

base was a United States Army coastwatcher unit, recently landed by a submarine, which readily agreed to send a message to Commander Seventh Fleet.

While they waited for help to arrive, the survivors were moved some five miles (8 km) into the mountains, to a trading post owned by an American, Mr. Edwards. In the cooler mountain environment, the survivors began recovering from their ordeal.

The survivors arranged with Commander Seventh Fleet a date for pick-up by submarine and a recognition signal, and arranged with a Moro native to borrow a motor launch.

Rescue rendezvous

When the rendezvous date arrived, 30 August 1944, eight other refugees joined the party to be rescued. However, the plan was hampered by the presence of a Japanese merchantman anchored near the rendezvous point. Rather than use the agreed-upon signal light, which might be seen by the merchant, they used hand-cranked radio. Redfin (SS-272) received the signal and surfaced nearby. The submarine gave the guerrillas a generous assortment of food, lubricating oil, medical supplies, small arms ammunition, and all the spare shoes and clothing they had

aboard as reward for helping the survivors.

After the refugees and survivors were aboard, and the Moro's motor launch was out of danger, Redfin

attacked the anchored merchantman by gunfire, but was unable to do significant damage before the ship weighed anchor and got underway. Redfin gave up the attack and set course for Darwin.



The Flier survivors were thence flown to Perth where Crowley made his report and was awarded the Legion of Merit for organizing and leading their escape. Liddell, Howell and Russo also received awards for displaying initiative and resourcefulness in the escape. All eight were awarded the Purple Heart Medal.

The Carrollton

The scattered remains of the once-graceful sailing ship Carrollton now lie on the reefs at Midway Atoll. The Carrollton was built in 1872 by the Arthur Sewall Shipyard in Bath, Maine. Bath-built down-easters were some of the most celebrated commercial sailing vessels of their day. Sewall ships, though not the fastest, were proven economic winners in the



Diving the Carrollton

long-haul maritime trades of the mid and late 19th century.

In the midst of her career in the Pacific lumber, grain, and coal business, the Carrollton was accidentally lost on December 26th, 1906, when she ran bow-on onto the reef at Midway while en route from NSW Australia to Honolulu with a load of coal. All of her crew were saved, but the vessel was a total loss. Carrollton is one of eight other Sewall-built sailing vessels lost in the Pacific.

Today a large variety of artifacts from the shipwreck lie scattered over an area almost 1,000 feet long. Anchors, windlasses, anchor chains, fasteners, piping, bollards, glass, rigging, stanchions, sheathing, winches, pintles, gudgeons, an auxiliary boiler, and a portion of the ship's cargo of coal, testify to the sea's power to break apart what the best wooden shipwrights once created. The reef and artifact remains were surveyed by NOAA archaeologists during the 2003 field season,

and further documented with high definition video footage in 2005.

Midway Dive Sites

Cargo Pier (Shore or Boat Dive) 35 feet Beginner

This is an excellent snorkel or dive for marine life and wreck enthusiasts. The current pier is built over the wreckage of another providing a home to an incredible number of schooling, rare, and cryptic fishes, big Jacks, Whitetip Reef sharks, Green Sea Turtles, and colorful sea slugs. Visibility is usually less than 25 feet.

Tug Pier (Shore Dive) 35 feet Intermediate

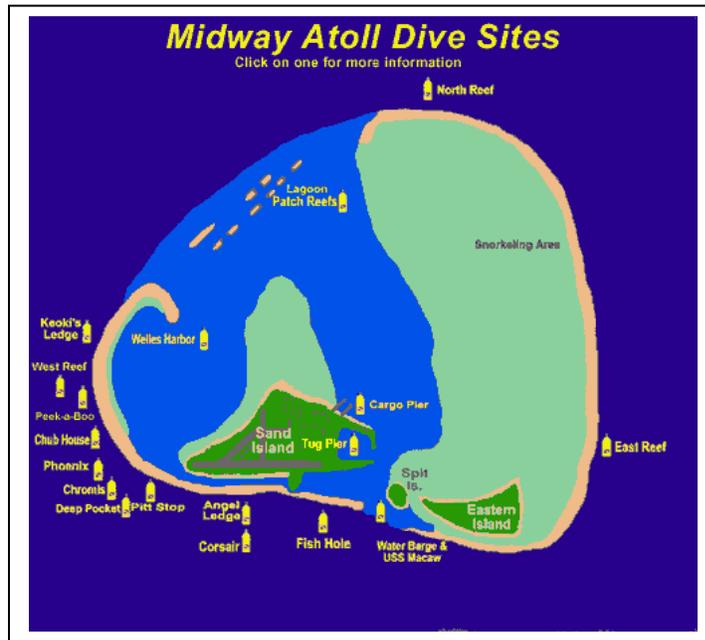
The Tug Pier is rarely dived since visibility within the harbor is rarely greater than 20 feet. It is very similar to the Cargo Pier but very creepy and dark. The rare Calf Cowry is seen here during night dives feeding upon sponge. Whitetip Reef sharks, Giant trevally, Amberjack, Hawaiian Spiny Lobster, Dragon morays, and nudibranchs frequent this area.

Welles Harbor / Lagoon Patch Reefs 15 to 50 feet Beginner

Numerous patch reefs within the lagoon are home to a variety of hard corals and associated fishes, mollusks, and lobsters. Bottom composition varies from massive coral heads to rubble and sand. Despite lower water clarity in the lagoon (25 to 50 feet), divers may encounter Spinner dolphins, Manta rays, Eagle rays, Monk seals, and Tiger Sharks at any time. Rarely dived since much better can be expected at the Cargo Pier and outside the barrier reef.

Water Barge Wreck 12 to 20 feet Intermediate

A dive around this partially submerged Ferrocement water supply barge is only possible during calm conditions at high tide. It broke free of its towline in 1957 and is a prominent landmark on Midway's south reef. It is an excellent subject for wide-angle photography, with sunlight streaming through numerous "windows" in addition to a massive amount of schooling chubs, goatfishes, and flagtails. Rare fishes include large Barred and Spotted



Knifejaws, and Green Sea Turtles. Five minutes from the harbor and accessed from the USS Macaw mooring buoy.

Uss Macaw Shipwreck 20 to 60 feet Intermediate

Remnants of a 250 foot Submarine Tender in the main channel. The scenic bow lays at an angle over sand and rock in 25 feet of water. A mass of steel plates and pipes extend to the stern at 55 feet. The ship ran aground in 1944 while salvaging a submarine where the Water Barge now rests. After a large storm, the Macaw was swept into deeper water 100 meters west of the Water Barge. It too can only be visited during calm days at high tide. Titan Scorpionfish, Spiny Lobster, Yellowbar Parrotfish, Hawaiian Morwongs, and Moray Eels are common here.

Fish Hole 30 to 60 feet Beginner-Intermediate

Midway's biggest and most popular shallow dive with lots of interesting marine life. This is where most visitors make their first dive and it's a great location for wide-angle and close-up photography. Good place to see Hawaiian Groupers, Hawaiian Morwongs, Whiskered Boarfish, Spotted Knifejaws, Regal Parrotfishes, Manta and Eagle Rays, numerous Galapagos Sharks, and an occasional Tuna. Visibility is excellent during low tide.

Angel Ledge 70 to 110 feet Intermediate-Advanced

The best location to observe rare fishes. A quarter-mile long ledge of finger coral and rubble teeming with many species of angelfishes, damselfishes, wrasses, scorpionfishes, eels, Thompson's Anthias, Schlegel's Groupers, and others. The propeller of the Corsair is located nearby (the bulk of the aircraft is 200 yards offshore). Subject to current.

F4U Corsair Airplane Wreck 116 feet Advanced

Inverted fuselage and wings of a U.S. Navy fighter that collided in mid-air during a training mission in 1943. It rests upon a sandy bottom 200 feet west of a mooring and underwater telephone cable, making this an advanced dive with limited bottom time. The wreck is home to many rare species including Hawaiian Longfin Anthias, Japanese Angelfish, Psychedelic Wrasse, Bluespotted Scorpionfish, Schlegel's Grouper, Whitemargined and Dragon Morays, Lobster, and more. Large Wahoo, or Ono, may be seen above the wreck during safety stops. Subject to current.

Pitt Stop 20 to 80 feet Intermediate

Two dives from a centrally located mooring. Home to a school of Giant Trevallies weighing 60 to 120 pounds just beyond the surf zone at 20 feet, a spectacular arch/cavern at 50 feet, and canyons leading to a deep reef at 80 feet. Other interesting animals include Whitescaled Squirrelfish, Hawaiian Turkeyfish, many Galapagos Sharks, Thomas's Urchin, and occasional Hawaiian Monk Seals. Subject to easterly swell and current.

Deep Pocket 75 to 100 feet Intermediate-Advanced

An unusual reef eight feet high with a labyrinth of small tunnels and rubble pockets. Home to Hawaiian Longfin Anthias, Boarfish, Whitescaled Squirrelfish, and Maze Tobies. Subject to strong currents.

Chromis 35 to 90 feet Intermediate

Excellent dive within a large forked canyon with a high overhang frequented by a school of Thicklipped Jacks. Several caverns and tunnels with Yellowfin, Whitetip, and

Murdjan's Soldierfish, Hawaiian Turkeyfish, Sunset Basslet, Hawaiian Longfin Anthias, and deep-sea Orange Cod. It is a good location for shark photography, especially during a safety stop. Subject to strong currents.

Phoenix 35 to 80 feet Intermediate

A fun dive with several geologic features. The mooring is located near the hidden entrance to a large dome inhabited by rare Black Trevallies, Squirrelfishes, Spotted Burrfish, and Polkadot Nudibranchs. A tall mushroom-shaped outcrop to the west provides shelter for Bigeye Trevallies, a Whitemargined Moray, and Hawaiian Turkeyfishes, and a large canyon to the east is home to Crosshatch Triggerfishes, big Whitesaddle Goatfishes, and Masked Angelfishes. Subject to strong currents.

Chub House 25 to 60 feet Intermediate

A stretch of reef with numerous ledges and tunnels bordered by white sand offshore. Named for the enormous schools of chubs that frequent the area. Also known for schools of Bluefin Trevallies, Lined Coris, and Masked Angelfish in relatively shallow water. Occasionally subject to strong currents.

Peek-a-Boo 30 to 60 feet Intermediate

Arches and swim-through's loaded with chubs, squirrelfishes, goatfishes, knifejaws, and large Bigeye Trevallies. This is a large shallow reef of many canyons with white sand channels. Subject to strong currents and ever-present surge.

Keoki's Ledge 15 to 60 feet Beginner-Intermediate

The most dramatic limestone formations Midway has to offer. Deep canyons, caverns, swim-through's, arches, walls, and a large chamber in 20 feet housing a school of Black Trevallies and an occasional Giant Trevally. This is an excellent location for wide-angle photography. Although less populated than the south reef, exciting animals pass through here, such as Hawaiian Monk Seals, Spinner Dolphins, Tiger Sharks, and Tuna. Divers may also witness the great Convict Tang migration that lasts for hours, starting in the late afternoon. Currents are generally absent or mild.

West Reef 15 to 60 feet Intermediate

The West Reef is a rarely explored region with rugged canyons that extend from the reef front to sand at 80 feet. Relatively clear water and mild currents during summer months. Less marine life than the south reef.

North Reef / East Reef 15 to 80 feet Intermediate

The North and East Reefs are also rarely explored and require a considerable cruise around or through the lagoon. Broad ridges and canyons that extend from the reef front to sand at 80 feet, with another ledge at 110 feet. Moderate visibility and less marine life than the south reef. Normally subject to easterly wind and swell, with moderate current.

Snorkeling Within the Lagoon 3 to 15 feet Beginner

The majority of Midway's lagoon shallows are sand and rubble, with large patches of ancient limestone with a few living corals. The best location for snorkeling is located to the northeast, adjacent to the emergent barrier reef. The sheltered waters here provide the best conditions for Lobe, Cauliflower, and Purple Rice Corals to survive the harsh winter surf and low water temperatures. Along with colorful corals, snorkelers encounter colorful butterflyfishes, big Spectacled Parrotfishes, Bluespined Unicornfishes, tangs, goatfishes, wrasses, Spotted Eagle Rays, bright red Slate-Pencil Urchins, and occasional Hawaiian Monk Seals.

The Battle of Midway

Preparations for Battle

March 1942 to 4 June 1942 -- Overview

By March 1942, Japanese Navy strategists had achieved their initial war goals much more easily than expected. They had therefore abandoned the prewar plan to then transition to a strategic defensive posture, but there was still dispute on how to maintain the offensive. Moving further south in the Pacific would isolate Australia, and possibly remove that nation as a threat to the freshly-expanded Japanese Empire.

However, the American island base at Midway was also an attractive target, and the Doolittle Raid on Japan prompted a decision to attack there as the next major offensive goal. Midway was a vital "sentry for Hawaii", and a serious assault on it would almost certainly produce a major naval battle, a battle that the Japanese confidently expected to win. That victory would eliminate the U.S. Pacific fleet as an important threat, perhaps leading to the negotiated peace that was Japan's "exit strategy".

The Japanese planned a three-pronged attack to capture Midway in early June, plus a simultaneous operation in the North Pacific's Aleutian Islands that might provide a useful strategic diversion. In the van of the assault would be Vice Admiral Chuichi Nagumo's aircraft carrier force, which would approach from the northwest, suppress Midway's defenses and provide long-range striking power for dealing with American warships. A few hundred miles behind Nagumo would come a battleship force under Admiral Isoroku Yamamoto that would contain most of the operation's heavy gun power. Coming in from the West and Southwest, forces under Vice Admiral Nobutake Kondo would actually capture Midway. Kondo's battleships and cruisers represented additional capabilities for fighting a surface action.

Unfortunately for the Japanese, two things went wrong even before the Midway operation began. Two of Nagumo's six carriers were sent on a mission that resulted in the Battle of

Coral Sea. One was badly damaged, and the other suffered heavy casualties to her air group. Neither would be available for Midway.

Even more importantly, thanks to an historic feat of radio communications interception and codebreaking, the United States knew its enemy's plans in detail: his target, his order of battle and his schedule. When the battle opened, the U.S. Pacific fleet would have three carriers waiting, plus a strong air force and reinforced ground defenses at the Midway Base.

Japanese Air Attack on Midway

4 June 1942

At 0430 in the morning of 4 June 1942, while 240 miles northwest of Midway, Vice Admiral Chuichi Nagumo's four carriers began launching 108 planes to attack the U.S. base there. Unknown to the Japanese, three U.S. carriers were steaming 215 miles to the east. The two opposing fleets sent out search planes, the Americans to locate an enemy they knew was there and the Japanese as a matter of operational prudence. Seaplanes from Midway were also patrolling along the expected enemy course. One of these spotted, and reported, the Japanese carrier striking force at about 0530.

That seaplane also reported the incoming Japanese planes, and radar confirmed the approaching attack shortly thereafter. Midway launched its own planes. Navy, Marine and Army bombers headed off to attack the Japanese fleet. Midway's Marine Corps Fighting Squadron 221 (VMF-221) intercepted the enemy formation at about 0615. However, the Marines were immediately engaged by an overwhelming force of the very superior Japanese "Zero" fighters and were able to shoot down only a few of the enemy bombers, while suffering great losses themselves.

The Japanese planes hit Midway's two inhabited islands at 0630. Twenty minutes of bombing and strafing knocked out some facilities on Eastern Island, but did not disable the airfield there. Sand Island's oil tanks, seaplane hangar and other buildings were set

afire or otherwise damaged. As the Japanese flew back toward their carriers the attack commander, Lieutenant Joichi Tomonaga, radioed ahead that another air strike was required to adequately soften up Midway's defenses for invasion.

U.S. Attacks on the Japanese Carrier Striking Force

4 June 1942

While their aviators flew back from Midway, the Japanese carriers received several counterstrikes from Midway's own planes. Faced with overwhelming fighter opposition, these uncoordinated efforts suffered severe losses and hit nothing but sea water. Shortly after 0700, torpedo attacks were made by six Navy TBF-1s and four Army Air Force B-26s. Between 0755 and 0820, two groups of Marine Corps bombers and a formation of Army B-17s came in. The only positive results were photographs of three Japanese carriers taken by the high-flying B-17s, the sole surviving photos of the day's attacks on the Japanese carriers.

Meanwhile, a tardy Japanese scout plane had spotted the U.S. fleet and, just as Midway's counterattacks were ending, reported the presence of a carrier. Japanese commander Vice Admiral Chuichi Nagumo had begun rearming his second group of planes for another strike on Midway. He now had to reorganize that, recover the planes returning from Midway and respot his flight decks to launch an attack on the U.S. ships. Nagumo's force barely missed having enough time.

In the hour after about 0930, U.S. Navy planes from the carriers Hornet (CV-8), Enterprise (CV-6) and Yorktown (CV-5) made a series of attacks, initially by three squadrons of TBD torpedo planes that, despite nearly total losses, made no hits. The sacrifice of the TBDs did slow Japanese preparations for their own strike and disorganized the defending fighters. Then, at about 1025, everything changed. Three squadrons of SBD scout bombers, two from Enterprise and one from Yorktown, almost simultaneously dove on three of the four Japanese carriers, whose decks were crowded with fully armed and fueled planes that were just starting to take off. In a few

minutes, Akagi, Kaga and Soryu were ablaze and out of action.

Of the once-overwhelming Japanese carrier force, only Hiryu remained operational. A few hours later, her planes crippled USS Yorktown. By the end of the day, though, U.S. carrier planes found and bombed Hiryu. Deprived of useful air cover, and after several hours of shocked indecision, Combined Fleet commander Admiral Isoroku Yamamoto called off the Midway operation and retreated. Six months after it began, the great Japanese Pacific War offensive was over.

Japanese Attacks on USS Yorktown

4 June 1942

After the 4 June mid-morning U.S. Navy attacks on the Japanese carrier force, only the Hiryu remained operational. Shortly before 1100 she launched eighteen dive bombers, escorted by six fighters, to strike a retaliatory blow. At about noon, as these planes approached USS Yorktown (CV-5), the most exposed of the three American aircraft carriers, they were intercepted by the U.S. combat air patrol, which shot down most of the bombers. Seven, however, survived to attack, hitting Yorktown with three bombs and stopping her.

While Yorktown's crew worked to repair damage and get their ship underway, a second force left Hiryu, this one consisting of ten torpedo planes and six fighters. Though the U.S. carrier was moving again by 1430, and even launched more fighters, the Japanese aircraft penetrated heavy air and gunfire opposition to hit Yorktown with two torpedoes, opening a huge hole on her midships port side. The stricken ship again went dead in the water and took on a severe list. Concerned that she was about to roll over, her Captain ordered his crew to abandon ship.

Actions and Activities After 4 June 1942

Following the 4 June attack on Midway's facilities and the day's great battles between opposing aircraft carrier forces, the Japanese briefly considered continuing their campaign. However, as the full extent of their disaster became clear, they began a general retreat.

After a brief withdrawal to avoid the risk of a night action, the two remaining U.S. carriers pursued the enemy forces, unsuccessfully attacking a destroyer on the 5th.

On 6 June, U.S. planes found and attacked two Japanese cruisers, sinking the Mikuma. Meanwhile, USS Yorktown had remained afloat. A salvage party returned to try to save her, but this effort was thwarted on the afternoon of the 6th, when a Japanese submarine found and torpedoed the carrier and the accompanying destroyer Hammann. The battered, gallant Yorktown sank the following morning.

As Battle of Midway combat activities gradually wound down, PBY patrol seaplanes and ships busied themselves rescuing downed aviators, the last of whom was recovered on 21 June. A U.S. submarine found two Mikuma survivors, and 35 of Hiryu's crewmen were picked up on 19 June. Earlier, men from Yorktown and Hammann had been taken to Pearl Harbor, where reinforcements were being forwarded to Midway and the nearby carriers. USS Saratoga (CV-3) arrived from the west coast on 6 June with a full load of aircraft. She quickly returned to sea, en route to join Enterprise and Hornet. Later in the month, fresh Marines were landed at Midway, which remained an important U.S. base for the rest of World War II, and beyond.

Aftermath

After winning a clear victory, and as pursuit became too hazardous near Wake, American forces retired. Japan's loss of four out of their six fleet carriers, plus a large number of their highly trained aircrews, stopped the expansion of the Japanese Empire in the Pacific. Only Zuikaku and Shōkaku were left for offensive actions. Japan's other carriers, Ryūjō, Junyo, and Hiyo, were light carriers with small airwings, comparatively poor effectiveness compared to fleet carriers, and insufficient speed to operate with a task force.

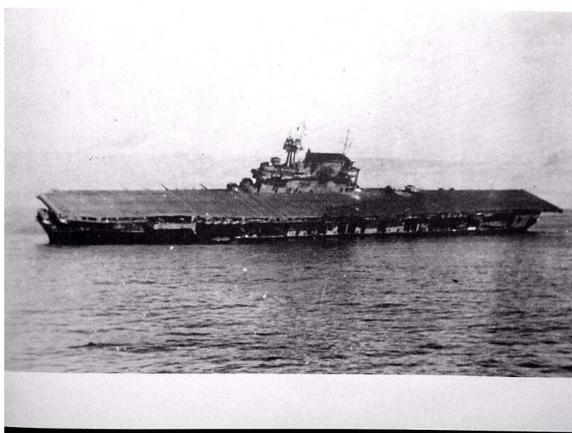
World War II Midway Photos



Submarine Pipefish (SS-388), crew photo Midway Island, 1945



Photo # 80-G-414423 USS Yorktown hit by Japanese aerial torpedo, 4 June 1942
USS Yorktown (CV-5) is hit on the port side, amidships, by a Japanese Type 91 aerial torpedo during the mid-afternoon attack by planes from the carrier Hiryu, 4 June 1942. Photographed from USS Pensacola (CA-24). Yorktown is heeling to port and is seen at a different aspect than in other views taken by Pensacola, indicating that this is the second of the two torpedo hits she received. Note very heavy anti-aircraft fire.



USS Yorktown (CV-5) lists heavily after she was abandoned during the afternoon of 4 June 1942. Note that two F4F-4 Wildcat fighters are still parked on her flight deck, aft of the island.



Photo # 80-G-32242 Battle of Midway: Japanese torpedo planes pass USS Yorktown
Two Type 97 shipboard attack aircraft from the Japanese carrier Hiryu fly past USS Yorktown (CV-5), amid heavy anti-aircraft fire, after dropping their torpedoes during the mid-afternoon attack, 4 June 1942. Yorktown appears to be heeling slightly to port, and may have already been hit by one torpedo. Photographed from USS Pensacola (CA-24). The destroyer at left, just beyond Yorktown's bow, is probably USS Morris (DD-417).



Photo # 80-G-32301 USS Yorktown stopped & burning, 4 June 1942

USS Yorktown (CV-5) dead in the water after being hit by Japanese bombs on 4 June 1942. The ship was hit shortly after noon. This view was taken about an hour later, with fires still burning in her uptakes but other immediate repairs well advanced. F4F-4 fighters that had been parked at the forward end of the flight deck during the attack have been respotted aft, in take off position. Two SBD-3 scout bombers can be seen through the open sides of her after



Photo # 80-G-414422 Burning Japanese cruiser Mikuma, 6 June 1942

Japanese heavy cruiser Mikuma, photographed from a USS Enterprise (CV-6) SBD aircraft during the afternoon of 6 June 1942, after she had been bombed by planes from Enterprise and USS Hornet (CV-8).

Note her shattered midships structure, torpedo dangling from the after port side tubes and wreckage atop her number four eight-inch gun turret.



Photo # 80-G-312019 View from USS Yorktown during Battle of Midway

USS Astoria (CA-34) steams by USS Yorktown (CV-5), shortly after the carrier had been hit by three Japanese bombs, during the Battle of Midway, June 1942, shortly after she was hit by three Japanese bombs. Dense smoke is from fires in her uptakes, caused by a bomb that punctured them and knocked out her boilers.

Both guns are manned and ready. Projecting bars beyond the gun barrels are aircraft parking outriggers. Note open sights on the guns and splinter shield plates, fastened together with bolts.

Taken by Photographer 2nd Class William G. Roy from the starboard side of the flight deck, just in front of the forward 5"/38 gun gallery.



Photo # 80-G-79974-1 Hiryu survivors on USS Ballard, June 1942

Japanese prisoners of war on board Ballard (AVD-10) after being rescued from a lifeboat two weeks after the Battle of Midway. They were members of the aircraft carrier Hiryu's engineering force, left behind when she was abandoned, 5 June 1942, and had escaped in one of her boats just as she sank

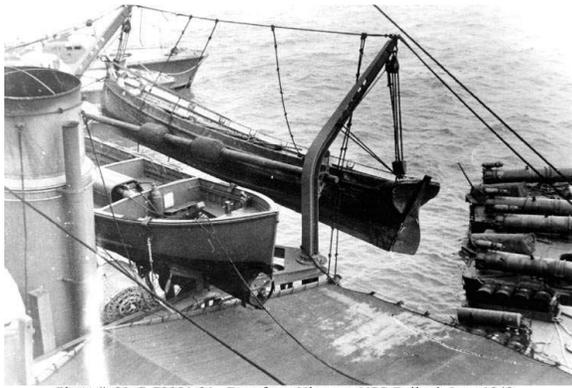


Photo # 80-G-79981-21 Boat from Hiryu on USS Ballard, June 1942

Cutter from the sunken Japanese aircraft carrier Hiryu, suspended from the starboard boat davits of Ballard (AVD-10), at Midway circa late June 1942. This boat had been picked up on 19 June, along with its occupants, who became prisoners of war. PT-25 and PT-30 are among the 77-foot ELCO-type PT boats visible in the right and left background. Note Ballard's motor whaleboat, cane fender, dark-colored awnings and smokestack details.



Photo # 80-G-79984-28 Hiryu survivors landing on Midway, June 1942

Japanese prisoners of war, survivors of the aircraft carrier Hiryu, are brought ashore at Midway following their rescue from an open lifeboat by Ballard (AVD-10), 19 June 1942. After being held for a few days on Midway, they were sent on to Pearl Harbor on 23 June. Note Marine guards at left and in the center background, armed with M1903 "Springfield" rifles.

Photo #: 80-G-79984-28 (#2) Hiryu survivors under guard on Midway, June 1942



Japanese prisoners of war under guard at Midway, after being rescued from a lifeboat two weeks after the Battle of Midway. They were members of the aircraft carrier Hiryu's engineering force, left behind when she was abandoned, 5 June 1942, and had escaped in one of her boats just as she sank.



Photo # 80-G-41686 VT-6 TBDs on USS Enterprise, during Battle of Midway Torpedo Squadron Six (VT-6) TBD-1 aircraft are prepared for launching on USS Enterprise (CV-6) at about 0730-0740 hrs, 4 June 1942. Eleven of the fourteen TBDs launched from Enterprise are visible. Three more TBDs and ten F4F fighters must still be pushed into position before launching can begin.

The TBD in the left front is Number Two (Bureau # 1512), flown by Ensign Severin L. Rombach and Aviation Radioman 2nd Class W.F. Glenn. Along with eight other VT-6 aircraft, this plane and its crew were lost attacking Japanese aircraft carriers somewhat more than two hours later.

USS Pensacola (CA-24) is in the right distance and a destroyer is in plane guard position at left.



Photo # 80-G-32315 View from USS Pensacola, during the Battle of Midway
View looking astern on USS Pensacola (CA-24) as she steams to the aid of USS Yorktown (CV-5) during the early afternoon of 4 June 1942.

Ships following are probably USS Benham (DD-397), at left, and USS Vincennes (CA-44). Wake at far right is probably that of USS Balch (DD-363). These four ships were detached from Task Force 16 to augment the screen of the nearby Task Force 17 after Yorktown was hit and temporarily stopped by Japanese dive bombers.

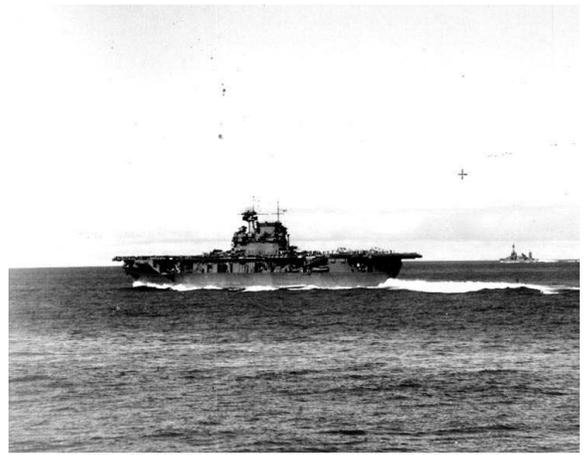


Photo # 80-G-32225 USS Enterprise during the Battle of Midway
USS Enterprise (CV-6) steaming at high speed at about 0725 hrs, 4 June 1942, seen from USS Pensacola (CA-24). The carrier has launched Scouting Squadron Six (VS-6) and Bombing Squadron Six (VB-6) and is striking unlaunched SBD aircraft below in preparation for respotting the flight deck with torpedo planes and escorting fighters. USS Northampton (CA-26) is in the right distance, with SBDs orbiting overhead, awaiting the launch of the rest of the attack group. Three hours later, VS-6 and VB-6 fatally bombed the Japanese carriers Akagi and Kaga.



Photo # 80-G-12146 USS Pensacola landing Marines at Midway, 25 June 1942
Disembarks Marine reinforcements at the Sand Island pier, Midway, on 25 June 1942.

Note m1903 "Springfield" rifles and other gear along the pier edge. The Sand Island seaplane hangar, badly damaged by Japanese air attack on 4 June 1942, is in the left distance, with a water tower beside it.

The surviving Torpedo Squadron Eight (VT-8) TBF-1 "Avenger" (Bureau # 00380) can be seen on the beach, in line with the water tower.



Photo # 80-G-11636 Damaged F4F at Midway after battle, June 1942
Damaged and partially disassembled Grumman F4F-3 "Wildcat" fighter on Sand Island, Midway, around 24-25 June 1942.

This plane, a unit of Marine Fighting Squadron 221, was flown by Captain John F. Carey, USMC, during the squadron's attack on incoming Japanese planes on the morning of 4 June. Carey was wounded in this action.

Several other planes are visible right background, including F2A-3 "Buffalo" fighters.

This view looks roughly southwest from near the foot of the Sand Island pier. The seaplane hangar, which was heavily damaged by Japanese bombs on 4 June, is in the left background. Note truck in the middle distance, following a Marine sentry through a gap in the barbed wire defenses.



22635 A C

Photo # USAF 22635 AC USAAF B-17s at Midway, 3-4 June 1942
 U.S. Army Air Force B-17E "Flying Fortress" bombers take off from the airfield on Eastern Island, Midway Atoll, on 3-4 June 1942.

Plane in the center is an early-model B-17E, with a Bendix remotely controlled belly turret.



Photo # 80-G-32320 USS Hammann sinking, 6 June 1942, seen from USS Yorktown
 USS Hammann (DD-412) sinking with stern high, after being torpedoed by Japanese submarine I-168 in the afternoon of 6 June 1942.

Photographed from the starboard forecastle deck of USS Yorktown (CV-5) by Photographer 2nd Class William G. Roy. Angular structure in right foreground is the front of Yorktown's forward starboard 5-inch gun gallery.

Note knotted lines hanging down from the carrier's flight deck, remaining from her initial abandonment on 4 June.

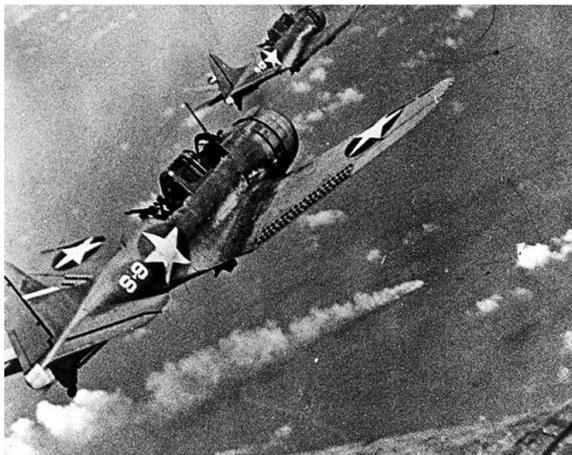


Photo # 80-G-17054 SBDs over the burning Japanese cruiser Mikuma, 6 June 1942
 SBD "Dauntless" dive bombers from USS Hornet (CV-8) approaching the burning Japanese heavy cruiser Mikuma to make the third set of attacks on her, during the early afternoon of 6 June 1942.

Mikuma had been hit earlier by strikes from Hornet and USS Enterprise (CV-6), leaving her dead in the water and fatally damaged.

Photo was enlarged from a 16mm color motion picture film. Note bombs hung beneath these planes.



Photo # 80-G-312018 On board USS Yorktown after she was hit by dive bombers
 Scene on board USS Yorktown (CV-5), shortly after she was hit by three Japanese bombs on 4 June 1942. Dense smoke is from fires in her uptakes, caused by a bomb that punctured them and knocked out her boilers.

Taken by Photographer 2nd Class William G. Roy from the starboard side of the flight deck, just in front of the forward 5"/38 gun gallery. Man with hammer at right is probably covering a bomb entry hole in the forward elevator.

Note arresting gear cables and forward palisade elements on the flight deck; CXAM radar antenna, large national ensign and YE homing beacon antenna atop the foremast; 5"/38, .50 caliber and 1.1" guns manned and ready at left.

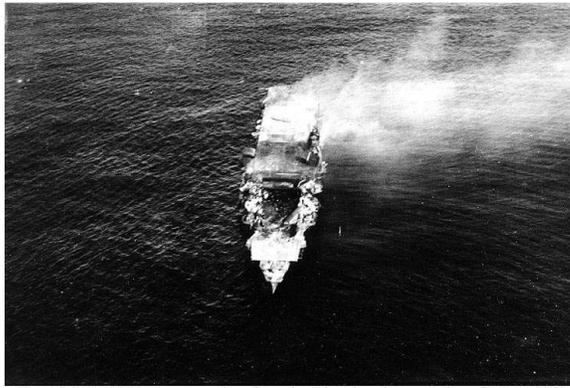


Photo # NH 73065 Japanese aircraft carrier Hiryu burning, morning of 5 June 1942
 The burning Japanese aircraft carrier Hiryu, photographed by a plane from the carrier Hosho shortly after sunrise on 5 June 1942. Hiryu sank a few hours later.
 Note collapsed flight deck over the forward hangar.

Donation of Kazutoshi Hando, 1970.

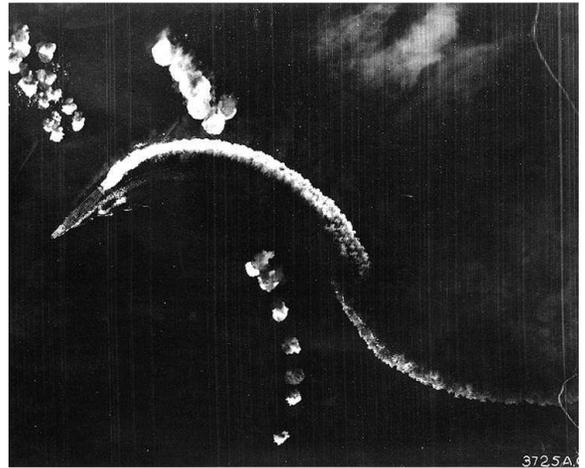


Photo # USAF 3725 AC Hiryu under B-17 attack during Battle of Midway
 Japanese aircraft carrier Hiryu maneuvering during a high-level bombing attack by USAAF B-17 bombers, shortly after 8AM, 4 June 1942.

Note ship's flight deck markings, including Katakana identification character "hi" on her after flight deck.



Photo # 80-G-17056 Oil tanks burning at Midway after Japanese attack, 4 June 1942
 Burning oil tanks on Sand Island, Midway, following the Japanese air attack delivered on the morning of 4 June 1942.

These tanks were located near what was then the southern shore of Sand Island. This view looks inland from the vicinity of the beach.

Three Laysan Albatross ("Gooney Bird") chicks are visible in the foreground.



Photo # 80-G-451086 Midway is., with Eastern I. in foreground, Nov. 1941
 Aerial photograph, looking just south of west across the southern side of the atoll, 24 November 1941. Eastern Island, then the site of Midway's airfield, is in the foreground. Sand Island, location of most other base facilities, is across the entrance channel.



Photo # 80-G-17081 Damaged Midway seaplane hangar, 4 June 1942
 Firefighting crews at work in the burned-out seaplane hangar on Sand Island, Midway, following the 4 June 1942 Japanese air attack.

What appear to be Packard PT Boat engines are in the rubble in the left background.



Photo # 80-G-17057 Damage at Midway after Japanese attack, 4 June 1942
 Damage on Sand Island, Midway, following the Japanese air attack delivered on the morning of 4 June 1942.

This view, probably photographed from the powerplant roof, looks roughly southwest, along what was then Sand Island's southern shore. Building in the foreground is the laundry, which was badly damaged by a bomb. Oil tanks are burning in the distance.

Note pilings and surf in the left distance.

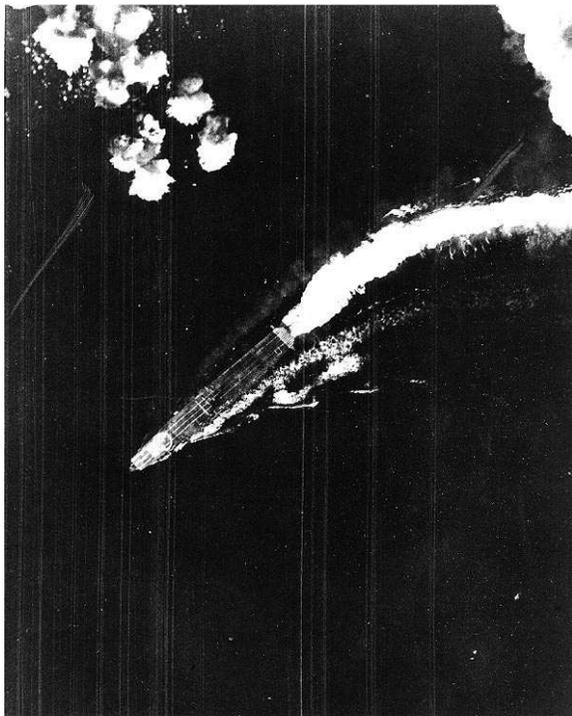
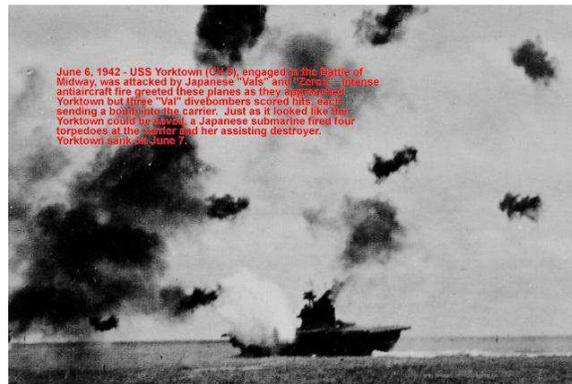


Photo # USAF 75712 AC Hiryu under B-17 attack at Midway
 Japanese aircraft carrier Hiryu maneuvering during a high-level bombing attack by USAAF B-17 bombers, shortly after 8AM, 4 June 1942.

Note ship's flight deck markings, including Katakana identification character "hi" on her after flight deck.



June 6, 1942 - USS Yorktown (CV-5), engaged in the Battle of Midway, was attacked by Japanese "Vals" and "Zeros". Intense anti-aircraft fire greeted these planes as they approached Yorktown but three "Val" divebombers scored hits, each sending a bomb into the carrier. Just as it looked like the Yorktown could be saved, a Japanese submarine fired four torpedoes at the carrier and her assisting destroyer. Yorktown sank on June 7.

June 6, 1942 - USS Yorktown, engaged in the Battle of Midway, was attacked by Japanese "Vals" and "Zeros". Intense anti-aircraft fire greeted these planes as they approached Yorktown, but the Val divebombers scored hits, each sending a bomb into the carrier. Just as it looked like the Yorktown could be saved, a Japanese submarine fired four torpedoes at the carrier and the assisting destroyer. The Yorktown sank the next day.



ARD-8 floating drydock, flooded to allow a submarine in the dock, date unknown, Midway Island

Specifications:

Displacement	4,200 t.(lt)
Length	482' 7"
Beam	71'
Draft	5'
Armament	2 single 20mm gun mounts
Complement	6 Officers, 125 Enlisted

Transferred under the Security Assistance Program to Peru in 1980

Post-War Midway Photos

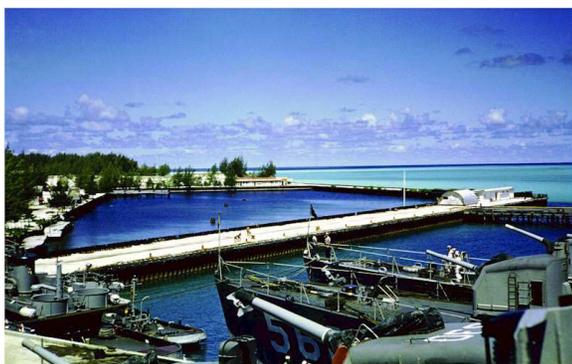
Photo # NH 97388 USS Los Angeles mans the rails in honor of U.S. dead at Midway, circa 1959



USS Los Angeles (CA-135) "Officers and men of U.S.S. Los Angeles honor U.S. dead at Midway" (quoted from the original photo's caption). Photo was presumably taken off the Midway Islands. The original print bears a stamped date of 27 April 1959.



Midway Island July 1956.



Midway Island July 1956.



Destroyers docked at Midway in 1954.



Eastern Island is the other sizable patch of land on Midway Atoll. It served as our primary air base during the Battle of Midway in early June 1942, supporting three crossing runways. The island was set aside as a bird sanctuary in 1970 and no Navy personnel were allowed on it. Note the Norfolk Pines growing up through the concrete pavement!



F-20 GI1002 over Midway Island



During the late stages of the Cold War VP-31 was NAF Midway's biggest "customer," with most of our trans-Pacific training flights stopping here to rest and gas up. In August 1990 I snapped this picture of four Black Knight P-3s parked on the transient ramp. The aircraft are (closest to farthest): RP-16, RP-00, RP-10 and RP-03.



From early October until August of the following year Midway Atoll belongs to the Laysan Albatross, colloquially termed "Gooney Birds" by Navy personnel. 90% of Laysan Albatrosses breed here. Returning adult albatrosses remember where they were hatched years previous and make their nest in precisely the same spots, even if paved over by concrete or asphalt! The darker specimens are the immature birds that are not large enough to fly the thousands of miles needed to survive over the open sea for 3 to 4 years before returning to nest (that's right, they don't land for 3 to 4 years!).



This shows the enormous Gooney Bird statue on Midway's Sand Island, next to the World War II memorial with its 5-inch-38 caliber shore battery rifle. Marine First Lieutenant George H. Cannon was awarded a posthumous Medal of Honor for dying at his post while returning fire with this weapon against Japanese warships on December 7, 1941, the day Pearl Harbor was bombed over 1000 miles away.



Midway ended its military career as a Naval Air Facility, without medical services or dependents. The atoll was the scene of a titanic naval battle on June 4-5-6, 1942, when the combat radius of piston-engine warplanes made the island strategically valuable. Located 1300 sea miles west northwest of Pearl Harbor it served as an important resupply base for our submarines during World War II, saving them 2600 additional miles on each war patrol. The base was expanded during the late 1950s as a Distant Early Warning (DEW) base, then mothballed in the late 1970s, when satellites took over the DEW role. NAF Midway was turned over to the US Fish & Wildlife Service in 1997.

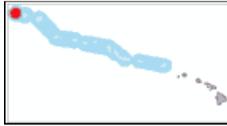


Aerial view of Sand Island at Midway Atoll. This was a gas-and-go stop for land-based Navy aircraft on most trips to WESTPAC. The enormous runway here was all constructed after World war II, when Midway became an important DEW base.



The United States permanently occupied Midway in 1903, during laying of the first TransPacific cable. This is one of the original structures, dating from 1906, but subsequently used by Pan American Airlines when they began using Midway as a stopover on their trans-Pacific flights in 1936. An old graveyard lies behind this abandoned structure.

Kure Atoll



Kure Atoll (or Ocean Island) is the most remote of the Northwestern Hawaiian Islands, and the northern-most coral atoll in the world. Kure is an oval-shaped atoll, which is 6 miles at its maximum diameter and 55 miles west-northwest of Midway Atoll at the extreme northwest end of the Hawaiian archipelago.

Along the south side of the lagoon is Green Island. To the west of Green Island are a chain of small elongated sandbars collectively known as Sand Island.

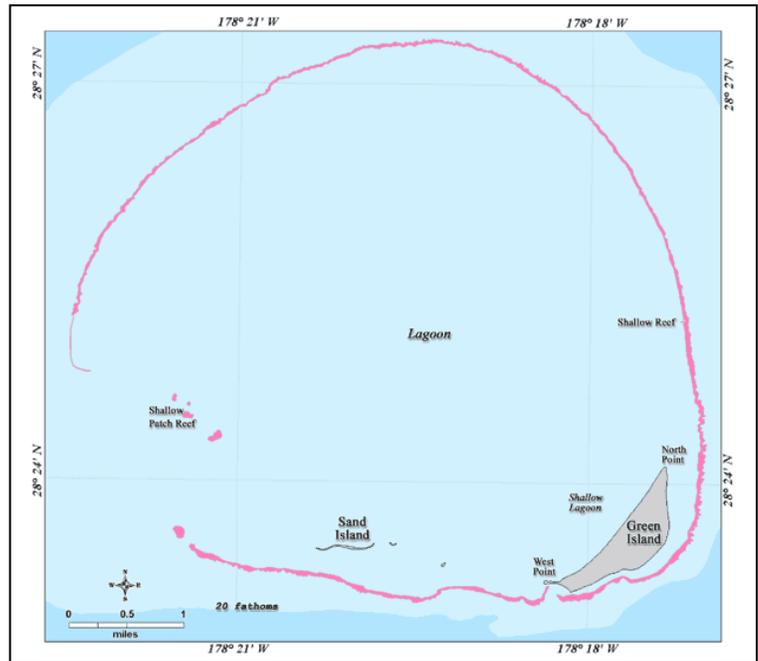
Green Island is about a mile long by less than half a mile wide, about 320 acres. It occupies the southeast corner of the lagoon. It is somewhat crescent-shaped, and is bordered all around by a nearly continuous line of sand dunes, which rise steeply from the waters edge to a height of up to twenty feet above the sea. The dunes are highest on the northeast end, those on the south and east reaching an elevation of only about ten feet.

Within there is a trough depression, the floor of which is about eight feet above sea level. The western point terminates in a long sand-spit.

The dunes and most of the interior of Green Island are covered with a dense, almost impenetrable stand of beach *Scaevola*, a much branching, coarse shrub, with large, glossy green leathery leaves, small white "half flowers", and pithy white fruits the size of small marbles. On Green Island this shrub reaches a height of five to six feet. The shrub is called "naupaka kai" by the Hawaiians, and is a familiar low beach plant on the main islands. It has been nicknamed "beach magnolia" by persons on Midway. It is an abundant, widespread littoral plant throughout the Pacific. Toward the eastern end there is an open grassy area of about twenty acres, surrounded by the barrier of *Scaevola*. Here are found most of the other species which

make up Kure's flora of thirteen kinds of vascular plants.

Between Green Island and the lagoon entrance there are generally two other islets, lying close to the southern reef. They are low mounds of sand and broken coral, usually devoid of vegetation. In 1923, when the atoll was visited and explored by the Tanager Expedition, the



more western was about a mile long by a quarter of a mile wide, and ten feet high. The shape of all three islets differ on maps made at different periods, such as that made by the U.S.S. *Lackawanna* in August 1867, and that by Captain Brown, of the ship *Gledstanes*, published in the *Hawaiian Spectator* for July, 1838. This would suggest that much shifting of sand has been done by storms.

The southern portion of the reef is scarcely awash at low tide. But most of the rest of its circumference is covered with a line of coral boulders which protrude above the water. The waves break heavily on the northern and eastern curve of the reef during normal trade wind weather. At such times vessels may anchor off the west side in eight to twelve fathoms of water. At times of storms the reef must present an awesome sight.

Green Island is a nesting area for shearwaters, petrels, tropicbirds, boobies, frigatebirds,

albatrosses, terns and noddies. It is also a wintering area for a variety of migratory bird species from North America and Asia.

Prior to 1827 Kure Atoll was visited by a half a dozen ships, and given a new name after each visit. Beginning in 1837, numerous ships have run aground on the reefs at Kure (previously known as Cure Island), and crews were stranded on the atoll for up to nine months at a time, eating monk seals, turtles and seabirds to survive while they constructed smaller craft to make the long passage back to the settled Main Hawaiian Islands. Like many locations in the NWHI, Kure is a low and inconspicuous feature, only unreliably located by historic charts of the past, a submerged and often unseen

hazard. Some of Hawaii's oldest known shipwrecks, such as the USS Saginaw (1870) and what may be the whaleship Parker (1842) lie undisturbed at Kure Atoll.

On September 20, 1886, the ship Waialeale arrived at Kure and James Boyd took possession of the island in the name of King Kalākaua and the Hawaiian Kingdom. The ship's crew built a shack and left provisions and water tanks for shipwrecked sailors. In 1894 the island was leased for guano mining, but no mining was ever done. Kure Atoll was acquired by the United States of America as part of the Territory of Hawaii on July 7, 1898. In 1909, President Theodore Roosevelt made Kure part of the Hawaiian Islands Bird Reservation, reserving the atoll for the Department of Agriculture as a preserve for native birds.

Despite its northern location and relatively cool waters, the aquatic habitats of Kure house a diversity of corals and large invertebrates such as echinoderms, crustacea and mollusks. Twenty eight species of stony corals have been documented at Kure and the atoll has almost 80,000 acres of coral reef habitat. The turquoise waters of the lagoon and near-shore reefs support large schools of dolphins, jacks,



Brown Boobies on Kure Atoll

sharks, goatfish, and chub, as well as dragon morays, knifejaws, masked angelfish and rare native grouper. Recent aquatic surveys have identified rare fish species and behaviors seldom seen in the Main Hawaiian Islands, raising additional questions about the effects of human activities on marine ecosystems.

Kure Atoll is an important pupping and resting area for Hawaiian Monk seals. The Kure Atoll sub-population of monk seals apparently declined during the 1960s due to increased human disturbance from the Coast Guard station, but has been increasing in recent years. The monk seal population size at Kure is currently about 100-125 animals.

The atoll lies in the path of a major Pacific current, resulting in tons of fishing nets and debris washing up on the reefs and beaches, which pose an entanglement hazard for monk

seals, turtles, seabirds, fish and lobsters. In 2003 alone 2700 pounds of marine debris was removed from Kure, including 997 pounds removed from accumulation study areas that were cleaned of all marine debris just the year before. These accumulation study areas, called HERZ or High Entanglement Risk Zones, are important indicator areas for how quickly marine debris is accumulating in areas that are known to be frequented by monk seals.

Kure is the northernmost coral atoll in the world, placing it at the Darwin Point. Scientists theorize that where coral growth occurs at a slower rate than the subsidence of the atoll, the atoll will sink below the surface with no further possibility of a coral connection. Kure's coral is still growing slightly faster than the island is subsiding. Further north and west, the Emperor Seamounts foretell the future of Kure and all of the Hawaiian Archipelago. The seamounts lie in water too deep and cool for coral growth. As Kure Atoll continues its slow migration atop the Pacific Plate, it too will eventually slip below the surface.

History [written in the 1930's-1940's]
Captain Kure, a Russian navigator, is said to have discovered the atoll, but no authentic account of this is available.

The British ship Gledstanes, Captain Brown, was wrecked on the weather side of the reef, July 9, 1837. The whole ship's company lived on Green Island until December 15. Then Captain Brown and eight seamen sailed east-southeast in a schooner which they built with great toil from fragments of the wreck.

After many hardships they reached Honolulu and, through the help of the British Consul, a vessel was sent to Kure which brought off the rest of the officers and crew. On September 24, 1842, the American whale ship Parker also was wrecked on Kure, the crew being rescued in a similar manner in May, 1843.

In the history of Kure the most remarkable shipwreck was that of the U.S.S. Saginaw. This vessel had been sent to Midway in March 1870, with a party of divers and engineers who were to dredge a passage through the reef into the lagoon. After the \$50,000 appropriated by the United States Congress for the job had been spent, with the work only part done, the plan was abandoned. Before returning to San Francisco Captain Sicard decided to visit Kure to see if there had been any more shipwrecks on the island.



The night of October 28-29 was clear and the wind fair, as the Saginaw steamed slowly across the intervening fifty miles, planning to arrive at daybreak. At 2.30 a.m. the engine was stopped.

A short time later the lookout sighted breakers ahead, and the engine was started in reverse. But within a few minutes the steam connection burst, and in a very short time the helpless vessel had drifted onto the east reef.

The waves pounded so hard that soon the hold was full of water, and at 5.00 a.m. word was passed to abandon ship. All of the 93 members of the crew and dredging party were gotten safely ashore, but comparatively little was salvaged from the ship before she broke up, except some water-soaked food and a small boiler, which later was very useful in distilling water.

Lieutenant Talbot and a volunteer crew of four, two of whom were divers, set off in the specially decked and fitted Captain's gig. They made the voyage to Kauai in thirty days, after incredible suffering, having encountered three severe gales in which they lost their oars and provisions overboard. They were so weak that, in trying to get ashore near Hanalei the boat capsized and all but William Halford, the coxswain, were drowned.

He succeeded in getting word to Honolulu, so that, through the kindness of the Hawaiian Government, the steamer Kilauea was dispatched on December 26, reached Kure on January 3, 1871, and brought the remainder of the party safely to Honolulu on the 14th.

The Dunnottar Castle, a British ship, was wrecked on Kure July 15, 1886. The crew managed to reach Kauai by boat, but several lives were lost in making a landing.

As a result of this, King Kalakaua sent Colonel J. H. Boyd as his Special Commissioner to Kure. On September 20, 1886 he took possession of the island, then called Moku Papapa, for the Hawaiian government. The King caused a rude house to be built on the island, with tanks for holding water and provisions for any other unfortunates who might be cast away there. But the provisions were stolen within a year, and the house soon fell into ruins.

The provisional Government of Hawaii leased the island to the North Pacific Phosphate and

Fertiliser Company for 25 years from February 15, 1894; but no extensive guano digging was done.

Kure was one of the islands acquired by the United States on July 7, 1898, when Hawaii



became a Territory. In April 1909 it was made part of the Hawaiian Islands Bird Reservation.

Bird life is less abundant on Kure than on other islands of the chain. The island is overrun with rats, but they could hardly account for the scarcity of sea birds, as a peaceful balance generally is established between this kind of "Polynesian rat" and sea birds. The Hawaiian or hair seal, *Monachus schauinslandi*, was frequently found on Kure, and turtles are said to be common. Thirty-five species of insects were identified from specimens collected by the Tanager Expedition, which visited the atoll in April, 1923, and made a careful biological survey.

Recent Developments

During World War II, several military bases were built on Kure Atoll. On the south-side of the island, a 4000 ft. coral-paved runway was constructed.

The Navy undertook a major expansion of its air facility on Midway Atoll during the 1950s, and in 1960 the Coast Guard established a LORAN station at Kure Atoll with two 518 foot masts. The Coast Guard station was occupied year-round.

The Coast Guard closed the LORAN station at Kure Atoll in 1992 and removed all but two of



Blackside Hawkfish at Kure Atoll

the manmade structures by 1993. Since then the runway has deteriorated and is no longer useable. Today, up to six people are stationed at Kure Atoll for seasonal work.

Rats on Kure Atoll were eradicated in 1993-1994. Seabirds species that were wiped out by the rats are starting to return. All ground nesting seabirds that were repressed by the rats are increasing in numbers. Ants are now being baited to improve seabird reproductive success.

Coast Pilot

Kure Atoll (28°25'N., 178°20'W.) is 50 miles WNW of Midway Islands, which it closely resembles both in formation and appearance. Kure Atoll is 4.5 miles in diameter, and a nearly continuous coral reef encloses a lagoon in which reefs and coral heads alternate with deep water. A mile-wide break in the SW side of the barrier reef provides an entrance of sorts to the lagoon.



Anchorage

Good anchorage in 15 fathoms may be found on the NW side of the atoll.

Entry upon Kure Atoll must be approved by the State of Hawaii, Department of Land and Natural Resources and Commander, 14th Coast Guard District, Honolulu, HI. These restrictions apply to all civilian and military agencies as well as individuals.

Green Island, on the SE side of the atoll, has a highest elevation of 20 feet and is covered with scaevola brush.

The island is a wildlife refuge and entry upon the island must be by approval of the State of Hawaii Department of Land and Natural



Hawaiian Cleaner Wrasse at Kure Atoll

Resources. This restriction applies to civilian and military agencies as well as individuals. The Coast Guard has reported that Green Island presents a good radar target at 22 miles and the reef line presents a good target at 7.5 miles. Another good radar target, reported by NOAA Ship TOWNSEND CROMWELL, is a large wreck in about 28°27.0'N., 178°18.9'W., on the NE side of the atoll. W of Green Island are small sand islets, the largest of which is 8- to 10-foot-high **Sand Island**. These islands continually shift and change with weather and sea action.

The best anchorage is on the W side, at the SW corner of the atoll with depth of 8 to 15 fathoms, rocky bottom. Boats may then be taken to a concrete pier with 3 to 5 feet alongside, located at about the midpoint of the lagoon side of Green Island. Vessels also anchor about 0.3 to 0.5 mile SSW of the S tip of Green Island in depths up to 15 fathoms. Landings can be made in good weather through a break in the reef to a sand beach at the SW tip of Green Island; depths to the landing are 5 to 6 feet between small coral heads and ledges.

A bank with depths of 20 to 30 fathoms surrounds Kure Atoll. No dangers have been observed outside the reef; however, the reef is inadequately surveyed. From the appearance of the islands, it may be assumed that they are sometimes visited by severe storms, the sand being thrown into numerous cones and pyramids.

Currents

A set to the S has been observed between Kure Atoll and Midway Islands. In the vicinity of Kure Atoll a continuous E current of about 2 knots during W weather has been reported.

Weather

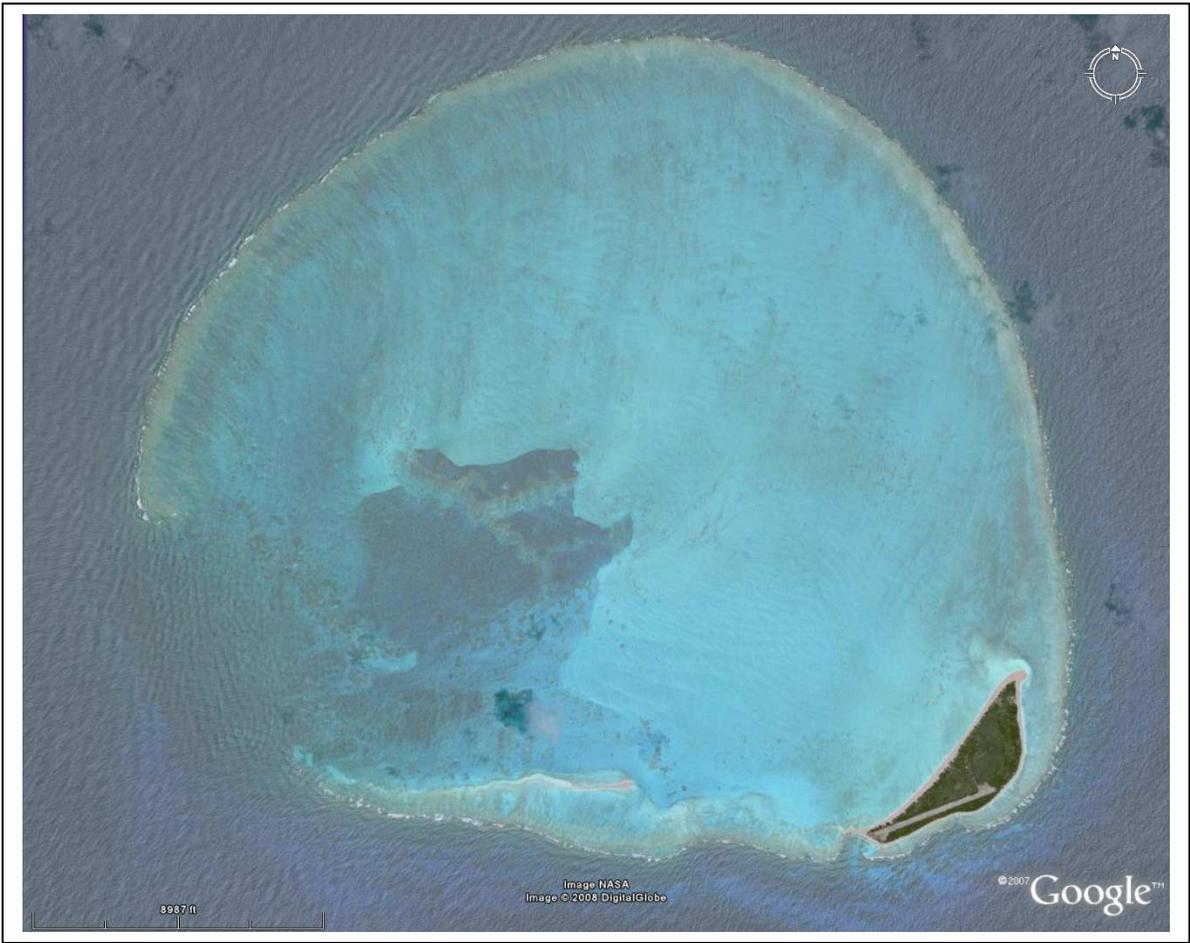
Weather for Kure Atoll is similar to that for the Midway Islands.

In 1923, breakers were reported observed about 180 miles S of Kure Atoll in about 25°23'N., 178°04'W., by the American vessel ETHAN ALLEN. The master reported that the swell appeared to mount up and occasionally break as though over a shoal extending for about 2 or 3 miles in an E-W direction.



The pier at Green Island: it is the only habitable island of the atoll, and several monk seal scientists live here in 4-month stints, much like Laysan.





Shipwrecks on Kure Atoll

There are seven known wrecks on Kure Atoll: the British whaleship Gledstanes (1837), the American whaleship Parker (1842), the USS Saginaw (1870), the Dunnottar Castle (1886), the modern Japanese fishing vessel Hoi Maru (2002), and the Paradise Queen II.

The largest wreck is located in the northwest corner. It is of a Taiwanese vessel of 10,000 tonnes, running on the reef in 1980. But I can't find confirmation of this.

The Dunnottar Castle

The Dunnottar Castle, a 258-foot three masted sailing ship, was bound for Wilmington, California from Sydney, Australia with a cargo of coal.



On July 15, 1886, malfunction of the ship's clock threw off calculations of its location badly enough that it hit the reef, before sailors realized they were off course.

When they ran aground, they spent hours tossing coal over side trying to lighten the ship. The stricken vessel could not be refloated, and the crew abandoned ship for the nearby deserted island.

After abandoning the ship, the chief officer and six seamen took one of the boats and made a 52-day passage to Kauai. While they were gone, the majority of the 28-man crew were rescued from the island by the ship Birnam Wood and deposited in Valparaiso, Chile.



Dunnottar Castle

Meanwhile, back in Honolulu the steamer Waialeale was jointly chartered by the British commissioner in Honolulu and by the Kingdom of Hawaii and sent on a (now redundant) emergency mission to the distant atoll. Only the three dogs which had been left behind, two terriers and a retriever, were there to be rescued. There was more to this trip, however. Hawaiian officials, suspecting that the British might use the occasion to annex the island, shared the expedition expenses and instructed Commissioner James Boyde to take formal possession of Kure Island.

Subsequently, a "life protection station" was constructed at Kure for the benefit of future castaways. This station included emergency water tanks, a small house with rainwater drainage system, and coconut trees. Thus, the wreck of the Dunnottar Castle precipitated the Kingdom of Hawaii's official presence at Kure Atoll, the northwestern extreme end of the entire archipelago, our most remote coral atoll.



Anchor of the Dunnottar Castle

Cynthia Vanderlip, an experienced field researcher who has spent many years returning to the atoll and conducting dolphin counts over time was conducting surveys with the pod living in Kure's lagoon, which includes over a hundred members. On July 2, 2004 waters were calm; vision was pristine, with excellent visibility. Her team had followed the dolphins to the opening of the atoll. When looking down in the mirror-like waters, Cynthia's brother, Brad, a volunteer for the US Fish and Wildlife Service, noticed a large wreck laying under their small boat, a wreck that even Cynthia not seen before.

It turned out that no one had seen it before. She notified the maritime archeologists onboard the NOAA launch HI-1, who quickly checked out the site, and concurred in that it was a site even new to them. The archeologists then invited the educators to check out this previously undiscovered site.

We felt extremely fortunate to be able to dive on a wreck the second day after it was discovered, after 120 years under the sea.

Our group of educators reached the wreck site just a few hours after the maritime archeologist had seen it for the first time since 1886. And the magnitude of the wreck was enough to leave a lasting impression on novices like us, only recently introduced to the field of maritime archeology.

Normally, you see archeologists study at length the significance of many small pieces that litter a wreck site. It is only their experience and combined work that can bring all those numerous pieces together in a cohesive picture, a drawing that they arduously put together after many hours of painstaking labor underwater. It is only in this

drawing, which they do on a page several feet long, that the rest of us can see all of the significant details.

But this wreck was a bit different. It laid there, in the seafloor in all of its immensity, in a manner that fully displayed its former sailing glory. The Dunnottar Castle was a large ship – almost 260 feet in length – and was built in 1874. Home ported in Scotland, it was bound from Sydney, Australia to Wilmington, California, with a load of coal. Because it struck the reef at full speed, it lodged itself securely on the outside of the Kure Atoll.



Dunnottar Castle

When free diving this wreck site, resting at a depth of about 25 feet, we could see much of the structures still mirroring the original layout of the ship. Large metal frames rested on the bottom of the seafloor, stretching for over a hundred feet of us. More than a century after its aquatic burial, the anchor, one of the most emblematic pieces of any ship, was found laying upright on the sea floor.

Watching these metal pieces encrusted by corals and home to fish, it is easy to not think about the historical context of the ship, and the wreck. But

every wreck has a story, and the wreck of the Dunnottar Castle story has links to the history of the Hawaiian Kingdom.

Seven of the crew members, including its Chief Officer, took one of the surviving boats and sailed, for 52 days, to Kauai. Upon being informed of the tragedy, the British Commissioner in Honolulu organized a rescue mission. But Hawaiian officials feared that the British might take the opportunity to claim Kure Atoll, and offered to pay for part of the rescue mission, also sending a commissioner to claim it for Hawaiian Kingdom. The concern over a British claim of Kure in relationship to the Dunnottar Castle wreck



Dunnottar Castle

adds meaning to its discovery on July 3, the day before America celebrates its independence.

The rescue mission came back to Honolulu with the same amount of people it had sailed out with. No survivors were found on the atoll, except for two fox terriers and a retriever. Maritime archeology, unlike the terrestrial counterpart, almost always involves a tragic event. But there was no further tragedy on the Dunnottar Castle. All of the survivors had been picked up earlier by a passing vessel and were on route to Chile. Upon arrival, on September 20, 1886, Kure Atoll was claimed for the Kingdom of Hawai'i by James Boyde. To help future castaways, this rescue mission built a structure and left water and supplies, and also planted coconuts, kukui trees, monkey pod trees, and others. Concerns about introducing alien species did not run very high back then.

USS Saginaw

The USS Saginaw captures a critical period of American involvement in the Pacific, an historic vessel of the "old steam navy."

The *USS Saginaw* was a transitional vessel, a paddle wheel steam sailing sloop. Launched in 1859 for anti-piracy patrols in China, she was later deployed to the Pacific Squadron during the Civil War.

The *Saginaw* served in the East Indian squadron protecting American citizens in China and Japan and suppressing pirates. In 1862 she joined the Pacific squadron and operated on the West Coast to prevent Confederate activity. Her cruises took her to many ports in Mexico and Central America.

The *USS Saginaw* served as the supply ship for the team of engineers and divers who took up the six-month task of blowing a passage through the reef at Midway when it to be made into a coaling station for the Pacific Mail Steamship Company. At the end of this operation, the acting Captain, Lieutenant Commander Montgomery Sicard ordered that Ocean (Kure) Island, a known navigational hazard, be checked for castaways during the return to Honolulu.

The Officer on Deck, Ensign Gorst, was first to hear the breakers and see the surf. Topsails were immediately taken in and both anchors let go, but the ship was bilged in 10 minutes, and within an hour water flooded the engine room and doused the boilers.

The castaways established a camp ashore, and the ship's gig was modified and manned by five volunteers to make the journey east. Ninety three survivors waited on Green Island. Coxswain William Halford was the only one to survive the violent surf landing at Kalihi Kai on Kaua'i after a rough 31 day passage.

His Majesty Kamehameha V lent the royal steamer Kilauea to the American minister at Honolulu for the rescue mission, and the



USS Saginaw (sketch)

remaining crew were picked up on January 3, 1862.

The wreck of the *Saginaw* was discovered in 2003 by a NOAA research team. Among the most interesting discoveries in exploring the wreck was that the ship's sounding lead rests in perfect condition. Such heavy lead sinkers would have been (should have been) swung over the side to mark the depth when approaching shallow waters. It appears as if there was little warning preceded the *Saginaw's* impact. The artifacts' debris trails graphically record the initial strike, the ship's bow subsequently being swung to seaward by the breakers, and the eventual breakup of the entire vessel.

The Parker

The New Bedford whaler *Parker* was lost on September 24, 1842 at Kure Atoll during a fierce storm. The seas crashed through the cabin windows at 2:00 AM, and immediately the vessel went onto the reef. The ship had struck on the north side of the atoll and became a complete wreck in under an hour, very few provisions (1 peck of beans, 15 pounds of salted meat) being hastily salvaged by the unlucky survivors.

Cutaway masts and some of the floating spars were fashioned into a crude raft, for the lowered boats had been stove in by the seas. It took the exhausted men eight days to drift and warp this raft to the island on the southeastern side of the atoll. There, some of the ship remains of the wrecked British whaler *Gledstanes* (lost in 1837) provided firewood and building materials. The *Gledstanes'* dog, having gone wild during his years of isolation, provided some variety in the crew's diet of seabirds and seals, however brief.

The castaways spent a hard eight months fighting for survival on the low island at the atoll. 120 Laysan albatross took flight with inscribed wooden tallies fixed to their legs in an attempt to alert rescuers. More than 7,000 seabirds were killed for food and some 60 seals as well. What impact did this have on the species at the atoll? Fortunately for the original inhabitants, the Captain and a few others were finally picked up from Ocean (Green) Island on April 16, 1843 by the ship

James Stewart. The rest of the crew remained on island until May 2, when they were rescued by the New Bedford whaler *Nassau* and taken to Honolulu.

The Paradise Queen II

The 87-foot vessel was fishing for lobster around Kure Atoll when it went aground on October 16, 1998 on the seaward side of the fringing reef crest, southeast of Green Island. At the time of the grounding the vessel was reported to be carrying 11,000 gallons of diesel fuel and a combined volume of 500 gallons of hydraulic fluids and oil. The vessel was also carrying about 3,000 pounds of frozen lobster tails, 4,000 pounds of bait, 1,040 plastic lobster traps and 11 miles of lobster pot mainline.

The vessel was an 87 foot lobster fishing vessel of American registry. As of 2000, the largest piece of the broken hull continued to sit atop a coral bank approximately 75 yards offshore. Further down the shoreline, approximately a quarter mile away, the vessel's wheel house sat on the sand, surrounded by jumbles of fishing and cargo nets.

In addition, nearly 600 lobster traps were piled on shore alongside hundreds if not thousands of lead fishing weights. In addition, insulation material and miscellaneous cargo, like life jackets, are still scattered across the beach, marked with the name of the vessel.

The education team also saw remains of the polypropylene main line that broke up on the reef and shredded into wisps of shattered fiber. Also remaining is a large tangled ball of line near the bow of the wreck that was unsuccessfully removed by the time the salvage operation terminated.

According to Ethan Shiinoki, DLNR wildlife staffer, "the debris continues to move around the island." Shiinoki spent 10 weeks on Kure this past summer. When he returned on this trip and did a shoreline assessment of the island, he noticed a few large pieces of debris, presumably parts of the vessel, located 150 yards further west than they had been two months ago.

According to a field report filed November 5, 1998, by DLNR wildlife officials, it was found that although a considerable volume of wreck debris washed onto the reef and into nearshore waters, luckily, "the apparent impact of the Paradise Queen II shipwreck to Kure Atoll appeared to be light." The debris consisted of large amounts of plastic lobster traps, polypropylene line, lobster bait, bait containers, clothing, deck planking, wood trim, bottles of food items, polyurethane insulation and various other loose and broken objects.

Although the impact of the wreck was reported to be relatively minor, there was evidence of injury to marine resources, including physical damage to the reef and possible mortality of spiny lobsters and spiny puffer fish. Noticeable signs of reef damage were recorded by aquatic biologists who assessed the site immediately after the wreck occurred. They reported broken coral and uprooted coralline algae structures. They guessed that the source of these damages were the result of the weighted lobster traps which rolled around in the surf before being recovered.

"Although the wreck doesn't appear to be causing continued harm to marine life, it remains a physical scar and reminder of the effects human impacts can have on wildlife sanctuaries such as Kure," said Shiinoki. "It is critical for the success of these remote refuges to remain isolated from human presence. Aside from the immediate harm shipwrecks can do to the coral reefs and marine life, they can also cause long-term damage if they reintroduce rats or harmful alien plants to the island which can wreak havoc on the atoll's entire ecosystem."

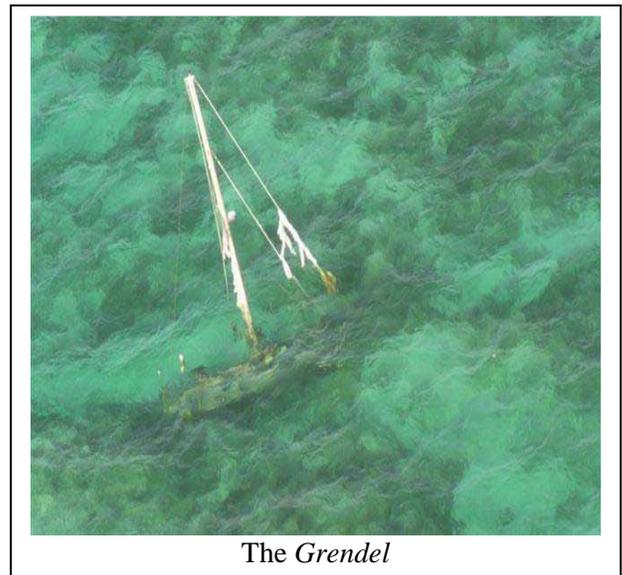
According to another report filed by DLNR wildlife officials, the reason the boat wasn't pulled off the reef was because the ship's owner did not allow government responders to remove the ship immediately after it ran aground. Once the ship broke apart, removal became impossible. It was also reported that the ship's owner did not have enough insurance to cover the cost of salvage and removal.



Hiei Maru, Kure Atoll

The Hiei Maru

In 2002 the Hiei Maru ran aground on the outer edge of the reef, but it was during such a ferocious storm that the ship broke in half, and the bow was actually carried over the reef crest by the waves, and deposited on the inner part of the atoll, where it can be seen protruding out of the water. Wrecks often become prime real estate for fish, looking for shelter. Schooling fish tend to be attracted to the many hiding places a wreck provides – there were nehu (Hawaiian anchovy), yellowfin goatfish, and yellowstripe goatfish in abundance, the first one being over a hundred fish.



The *Grendel*

The Grendel

On June 1, 2007, a grounded vessel named *Grendel* was discovered inside Kure Atoll's lagoon on the northeast reef. The owner of the 33-foot steel hulled sailboat was lost at sea.

Metal debris from the vessel was found on the reef extending along a 500' path from the vessel northeast to the emergent reef, indicating that the vessel entered the lagoon over the northeast reef. The level of fouling on the steel hulled sloop suggested that the vessel wrecked approximately 3-4 months earlier in February or March.

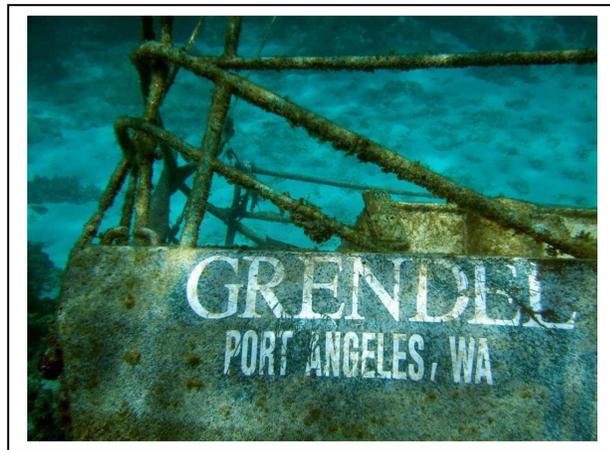
The vessels sails, sheets and lines were tangled around the mast, stays, and railings creating a wildlife entanglement hazard. Approximately 275 pounds of entanglement hazards were removed using snorkeling gear. A battery, 300 pounds of chain, three anchors, and several broken pieces of metal were also removed from the site. The wreck was scheduled for removal in spring 2008.

From Kure Atoll: "This past year, a brand-new, unmanned sailboat sank near the middle of the atoll; it is an eerie place. The inside is littered with personal belongings: a carved wooden alligator pinned awkwardly in a high corner, a water-heavy leather boot, an open guitar case but no guitar.

"For those who've forgotten their Brit Lit course material, Grendel is the monster in Beowulf. He is a bitter outcast who massacres some Anglo-Saxons while they are partying without him; Beowulf(a mere mortal) comes to kill Grendel-- he does so by ripping Grendel's arm off at the shoulder. Grendel retreats to his home in the marsh and dies alone. Woo! Awesome story!

"I highly recommend the contemporary novel, Grendel; it tells the story of Beowulf from Grendel's point of view. I am sympathetic to the beastly thing. And to the owner of this sailboat.

"Here is the word on the street: the guy who owned and sailed Grendel had made the crossing from Washington to the S. Pacific 25 times; he was 70 this year. No one knows when or where the sailboat suddenly sailed alone. Pretty amazing."



Birds of Midway Atoll

Fifteen species of seabirds nest each year on islands within the Midway Atoll National Wildlife Refuge. The total population of nesting seabirds is nearly 2 million. For a more in-depth look at Midway's bird fauna, please click on one of the items listed below:

Midway features the world's largest colony of Laysan Albatross (nearly 300,000 nesting pairs) and the largest colonies of Red-tailed Tropicbirds, Black Noddies and White Terns within the Hawaiian archipelago. One very rare species at Midway is the Short-tailed albatross, or "Golden Gooney" which last nested successfully on Sand Island in 1962. The various seabird species that do nest at Midway divide the limited habitat by selecting different sites to lay their eggs, such as burrows under the ground, surface sites in the open or under the vegetation and perches within shrubs or taller trees. Midway's native (or indigenous) bird fauna also includes a small variety of arctic nesting shorebirds, such as Bristle-thighed Curlews and Ruddy Turnstones, and a long list of vagrant species that have been observed in small numbers over the years.

Short-tailed Albatross

(*Phoebastria albatrus*)

The largest and only white-bodied albatross in the north Pacific. Golden, yellow cast on head and nape. Upper wings: white with black primaries, secondaries, and tertiaries. Under wing: white with black leading and trailing edges. White tail with black fringe. Large, pink bill with blue tip and black boarder around the base. Pale bluish feet and legs. Length: 84-91 cm (33.6-36.4 in); wingspan: 213-229 cm (7-7.5 ft); average life span: 12-45 yrs.



Midway Population

The first Short-tailed Albatross was observed at Midway between 1936 and 1941. Since then, between one to three individuals has been observed every year. In recent years, two sub-adult Short-tailed Albatross have been observed on Sand and Eastern Islands (band #015 and #051). Bird #015 was banded as a chick in 1982 and #051 was banded in 1986 or 1989 (both in Japan). Disputable reports have indicated possible successful nesting activity in 1961 and 1962 on Midway (Fisher 1983).

History

Short-tails breed on Torishima, an island owned and administered by Japan. They have also been observed (non-breeding behavior) on Minami-Kojima in the Senkaku Islands of Southern Ryukyu Islands, also owned and administered by Japan.

The Short-tail population dropped dramatically due to feather hunters in the late nineteenth century. Over 5 million adults were hunted and killed. In 1939, their breeding grounds in Torishima were buried under 10-30 meters of lava as a result of a volcanic eruption. Population numbers dropped to 10 nesting pairs. The world population of Short-tailed Albatross is currently estimated at 2000 birds.

Feeding Habits

Surface feeders. Diet consists of flying fish eggs, shrimp, squid, and crustaceans. Feed primarily during daybreak and twilight hours. Have been known to forage as far as 3,200 km (1,988 miles) from their breeding grounds.

Range

The short-tail range overlaps with black-foot and Laysan albatross, covering most of the Northwestern and Northeastern Pacific Ocean.

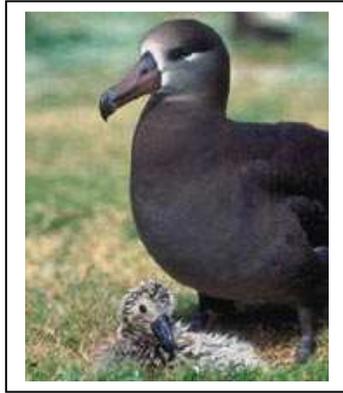
Breeding

The average age of first breeding is 6 years. Short-tailed Albatross are monogamous and have been known to create a new pair bond if original mate disappears or dies. Return to natal colony or may disperse to breed (e.g., adults on Midway Atoll). The first adults return to the colony in late October. Short-tails build their nests with surrounding sand, shrubbery or volcanic debris. Lays one egg. Incubation lasts approximately 65 days and is shared by both parents. Both adults feed the chick by regurgitating a mixture of flying fish eggs and squid oil. Sometime between late May and mid-June, chicks are almost full-grown and adults begin to abandon their nests. Chicks fledge soon after the adults leave the colony.

Black-footed Albatross

(*Phoebastria nigripes*)

Dusky brown body and mantle with white border around base of bill and under tail; black feet. Length: 64-74 cm (25.6-29.6 in); wingspan: 193-216 cm (6-7 ft); average life span: 12-40 yrs.



Midway Population

Midway Atoll has the second largest Black-footed Albatross population in the world. In 1998, the total number of breeding pairs on Sand, Eastern, and Spit Islands was 20,240 (9,687; 10,542; 11; respectively)

Feeding Habits

Diurnal surface feeders. Unlike the Laysan Albatross, whose retinas possess a high level of rhodopsin enabling better night vision, the black-foots have limited nocturnal vision. Diet consists primarily of flying fish eggs. They also feed on squid and crustaceans. Squid, which float to the surface during darkness, are much more accessible to Laysans. Black-foots, on the other hand, rely on flying fish eggs, which are easier to locate during the day. The competition for food between Black-footed and Laysan Albatross is reduced due to this difference in prey items and feeding behavior.

Black-foots usually stay at least 20-30 kilometers offshore during the non-breeding months (July - November). During these months birds are distributed throughout the northwestern and northeastern Pacific.

Breeding

Monogamous. If one of the mates should disappear or die, a new pair bond is created. Nests are made up of pieces of surrounding grasses, sand, or shrubbery. Black-foots

like to nest in more open, less vegetated areas as compared to Laysans. The majority of their nests are located near beaches. Breeding begins in early November. One egg is laid and incubation lasts about 65 days. Both male and female incubate the egg. Incubation starts with the females who usually stay for a short two day span. The male then takes over, sometimes as long as three weeks. If the egg is infertile or breaks during incubation, relaying will not occur during that year.

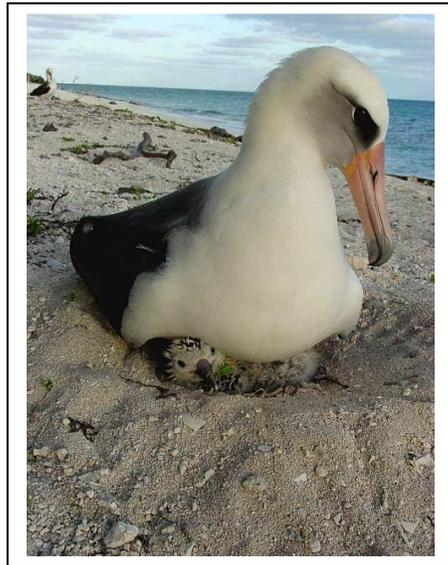
Black-foot chicks begin to hatch in mid-January. Chicks live on a diet of flying fish eggs and squid oil. Both adults feed the chick by regurgitation. The chick will peck at the lower beak of the parent which stimulates the parent to regurgitate. The rich squid and stomach oil is filled with fatty acids and nutrients that can sustain a chick for a number of days while the parent goes out to sea in search of more food. Fledging occurs 4-5 months after hatching (June and July). Similar to the Laysans, the parents will often leave before the chicks have reached their full juvenile plumage. Relying on their fat reserves, the chicks survive on land, practicing take-offs until they master flight. Sub-adults return to their natal colony when three years of age but do not mate and nest until at least age five.



Laysan Albatross

(*Phoebastria immutabilis*)

White head, neck, and underbody. Black mantle and upperwings. Underwings have black margins and irregular streaks on converts. Dark eye patch. Bill varies from gray to yellow with darker tip; pink legs/feet. Length: 79-81cm (31.6-32.4 in); wingspan: 195-203 cm (6.4-6.7 ft); average life span: 12-40 yrs.



Midway Population

Seventy-one percent of the world's population nests on Midway. In 1996, about 387,854 breeding pairs of Laysan Albatross nested on all three islands of Midway Atoll (Sand: 182,574; Eastern: 203,871; and Spit: 1,409).

Feeding Habits

Primarily nocturnal feeders. Laysans are surface feeders. Therefore feed on anything that floats on the surface of the water; squid, fish, crustaceans and flying fish eggs.

Laysans usually stay at least 20 to 30 kilometers offshore during the non-breeding months (July - October). During these months Laysans are distributed throughout the northwestern and northeastern range of the Pacific.

Breeding

Monogamous. If one of the mates should die, they will most likely create a new pair bond. Nests are made up of surrounding grasses, dirt or shrubbery and are piled into large mounds that form a nest cup. Laying begins in mid-November. One egg is laid and incubation lasts about 65 days. Incubation starts with the female

who usually stays for a short two day span. The male then takes over for as long as three weeks. During the month of December the number of incubating males outnumber that of incubating females 15:1. If the egg is infertile or breaks during incubation, re-laying will not occur that year.

Chicks hatch during late January to mid-February. Chicks live off a diet of flying fish eggs and squid oil, a product that is rich in fat. Both parents will feed the chick by regurgitation and will often leave them for several days while they obtain food out at sea. The rich squid and stomach oil is filled with fatty acids and nutrients that can sustain a chick for the number of days between feedings.

Fledging occurs 5-6 months after hatching (mid-June through late July). Parents will often leave before the chicks have reached their full juvenile plumage.

Sub-adults return to their natal nesting colony after spending 3 - 5 years at sea. Elaborate courtship dances take place throughout the colony while these young birds search for a mate. Mating and first nesting usually occurs by age 6-8.





Laysan Albatross



Laysan Albatross

Christmas Shearwater

(*Puffinus nativitatis*)

Medium-sized, chocolate brown bird with a short, rounded tail, black bill and dark, brown legs. Length: 35-38 cm (14-15 in); wingspan: 71-81 cm (28-32 in); average life span: 10-11 years.

Midway Population

A population of approximately 166 nesting pairs was observed on Eastern Island (1998). In 1998, a small number of Christmas Shearwaters were heard and seen on Sand Island. Christmas Shearwaters breed in low numbers on small islands throughout the central Pacific.

Vocalization

Vocalization takes place throughout the night, often continuing 1-2 hours after sunrise. Birds can often be observed calling in paired flights. Their sounds are similar to the Wedged-tailed Shearwaters: moans and groans, but with a more nasal gurgling quality at the beginning of their call.

Feeding Habits

Feeds primarily in association with large predatory fish such as skipjack tuna. These fish drive the larval forms of fish to the surface. Christmas Shearwaters locate larval food such as mackerel scad, flying squid, goat fish and squirrel fish most likely by using their sense of smell. Christmas Shearwaters capture prey by plunging into water and chasing it.

Breeding

Birds are believed to be monogamous. Birds return at dusk and are active in courtship around dawn. There is much nocturnal activity in breeding colonies, however, they are quiet during the day and thus, are rarely seen. They arrive at breeding grounds in late February and begin to lay eggs by the end of April.

A simple nest is built with small twigs or leaves on the ground-surface under dense

vegetation, such as native naupaka (*Scaevola sericea*). A single, white egg is laid.

Incubation period ranges from 50 to 54 days. Both parents share in the incubation, taking about a five day shift on the nest, while the mate is feeding at sea.

Chicks are fed stomach oil and partially digested fish as frequently as once every 24 hours for about the first two months. It takes about 100-115 days for chicks to grow and fledge. Adults will not desert their chicks before fledging. Shearwaters depart their breeding grounds by November.



Wedge-tailed Shearwater

(*Puffinus pacificus chlororhynchus*)

Dark brown to brownish-grey above with white underparts except dark wing margins and undertail-coverts. A wedge-shaped tail and a slender, slate-grey hooked bill. Legs and feet are flesh colored. Length: 41-46 cm (16-18 in); wingspan: 97-104 cm (38-41 in); average life span: 10-11 years.



Midway Population

Approximately 1,000 nesting pairs nest on Sand and Eastern Islands (Harrison, 1990). Wedge-tails breed widely in the tropical and subtropical waters of the Indian and Pacific Oceans.

Vocalization

Loud groans, moans and wails resulted in island residents giving them the name "moaning bird". Vocalizations occur primarily at night in breeding colonies.

Feeding Habits

Wedge-tailed Shearwaters feed during the day singly or in multi-species flocks. Consumes larval forms of goat fish, mackerel scad,

and flying squid driven to the surface by schools of predatory fish (e.g., skipjack tuna).

Breeding

Monogamous. Strictly nocturnal over breeding colony. Their courtship ritual begins shortly after arrival in late March. A pair will sit head to head, often near their burrow entrance, vocalizing two-part wailing duets. Returning to the same nest site each year, Wedge-tails nest in shallow burrows, one to two meters in length.

A single, large, white egg is laid in a nesting chamber at the end of burrow. Egg laying occurs throughout the month of June. No relaying will occur if an egg is lost. Incubation period averages 53 days with both parents alternating shifts on the egg, with each shift lasting as long as 12 days.

Chicks hatch during late-July through late August. Parents feed regurgitated squid and stomach oil to chicks. Feeding takes place every 24 hours and is brief visits during the first week. Fledging occurs in approximately 100-115 days. Parent desertion of the chick typically occurs shortly before fledging.



Bonin Petrel

(*Pterodroma hypoleuca*)

Grey-black back and head. Forehead, chin, and throat white. Underparts white with partial grey collar extending from nape. Underwings white with dark margins and diagonal bar extending from carpal inward across coverts. Wedge-shaped tail. Flesh colored legs and feet with black toes. Length: 30 cm (12 in); wingspan: 63-71 cm (25-28 in); average life span: 15 years..

Midway Population

Approximately 51,493 nesting pairs nest on Sand Island (Moore 1998). Since rat eradication efforts on Eastern and Spit Islands were initiated in 1994, some nesting activity (6-10 nests) has been observed on these two islands since 1996. With the eradication of rats on Midway's islands, nesting birds have rapidly expanded into new areas. Only breeds in the Northwestern Hawaiian Islands or the Bonin and Volcano Islands of Japan.

Feeding Habits

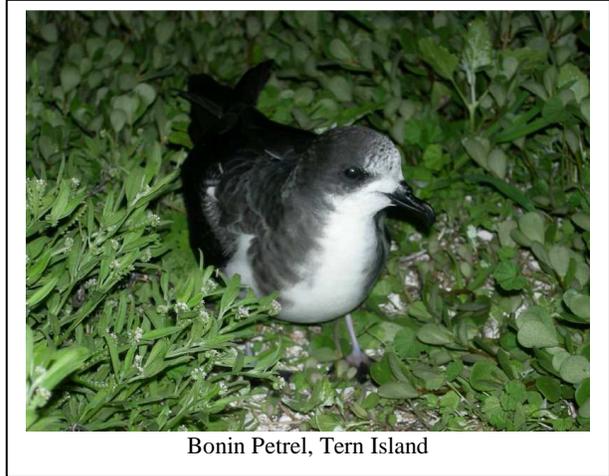
Feed alone or in small groups, primarily at night. Feed on small fish and squid probably by dipping or surface-feeding. Occasionally associate with feeding Wedge-tailed Shearwaters, Sooty Terns, and Great Frigatebirds.

Breeding

Strictly nocturnal over breeding grounds. Monogamous. Return to same burrow every year. Adults arrive in August and spend the fall months courting, establishing pair bonds, excavating burrows, and nest building.

Bonin Petrels nest in burrows that can be as long as three meters and one meter deep, usually in sandy areas. A single, white egg is laid in the nesting chamber at the end of the burrow. No relaying will take place if the egg is lost. Incubation duty is shared by both adults and lasts about 49 days.

Chicks begin to hatch in early March. Parents feed chicks by regurgitating concentrated stomach oil (similar to Albatross). Parents average one feeding every two nights.



Fledging occurs approximately 82 days after hatching. By the end of June, adults and chicks have departed the nesting colonies.

Bulwer's Petrel

(*Bulweria bulwerii*)

Bulwer's Petrels are a long-winged storm petrel with brown plumage that generally hold their bills downward. Their tails are longer than other storm petrels and are usually held at a point. Their flight patterns are characteristically buoyant and erratic with wings held stiffly bowed. Bulwer's Petrels are generally solitary when at sea. They usually fly within a few feet of the water and often make a series of stiff flaps before each short twisting glide.



They Breed on islands across the north Pacific from east of China to Hawaii, and live in Tropical and subtropical seas. They feed on Planktonic food items.

Red-tailed Tropicbird

(*Phaethon rubricauda rothschildi*)

Mature birds have mostly white plumage. Conspicuous black stripe from gape, curving towards and passing through eye. Strong decurved, bright, red, heavy beak. Legs/feet blue-grey with webs distally black. White tail with long, red, central rectrices (36-55 cm). Length: 44-47 cm (17-18 in), 80-102 cm including tail streamers; wingspan: 104 cm (41 in); average life span: 16 years.

Midway Population

In 1984, about 5,000 nesting pairs were estimated to breed on all three islands of Midway Atoll, the largest nesting population within the Hawaiian islands. Red-tailed Tropicbirds nest in the Hawaiian Islands and disperse widely in tropical and subtropical areas of the Indian and Pacific Oceans.

Vocalization

A guttural squawk in varying intensities and high whistle like screeches.

Feeding Habits

Usually feeding during the day, Red-tailed Tropicbirds are solitary feeders and rarely fish within sight of land. The Red-tailed Tropicbird dives, wings half-folded, into the water to catch their prey. Red-tails consume mostly fish (flying fish, mackerel, dolphinfish, balloonfish) and squid. Their diet is about 4/5 fish and 1/5 squid.

Breeding

Perform complex aerial courtship displays. Acrobatics consist of flying backwards, vertical displays and circles. Pair bonding behavior is minimal. Birds begin breeding

after four years of age.

Nest year round with peak activity from March through August. Adults generally return to the same nest site each year. Nest sites are usually located in sheltered areas from the sun (base of a tree, in shrubs, next to a structure). The female lays a single egg, ranging in color from brown to purplish black, allowing them to recognize and retrieve their own eggs. Relaying can occur if the first egg is lost or infertile. Incubation period varies from 39-51 days. Both parents incubate the egg. Lacks brood patch. Average incubation shift lengths range from 8-9 days. During the first few weeks after hatching, chicks are attended and fed by one of its parents in shifts similar to those during incubation. Nestlings are brooded almost continuously for the first week. Feeding takes place on an average of every 17 hours. Unlike other Pelecaniformes, adults regurgitate food by putting their bills down the gaping chick's throat.

The chick-rearing period can range from 77 to 123 days. Chicks reach adult weight in six weeks. In 11 weeks, wing exercising begins and in 12-13 weeks, Fledging occurs. Chicks fledge with a dark gray bill and white and gray plumage.



White-tailed Tropicbird

(*Phaethon lepturus dorotheae*)

Adult birds have mostly white plumage with long, white, tail streamers (33-40 cm). Tail feathers are visible while the bird is in flight as compared to the Red-tailed Tropicbird. Black eye-stripe from gape curving towards and passing through eye. Diagonal black stripe across upperwings. Yellowish to orange bill. Legs/feet are yellowish with black webs. Length: 38-40 cm (15-16 in), 71-81 cm (28-32 in) including tail streamers; wingspan: 89-94 cm (35-38 in); average life span: 16 years.

Midway Population

In 1998, two known breeding pairs nested on Sand Island. Constant monitoring aids in accurate counts and identification of nesting sites which are difficult to locate because of their scattered distribution.

Feeding Habits

Typically solitary feeders though sometimes seen in pairs. With folded wings, white-tails hit the water and completely submerge to seize and swallow prey before flight. Prey consists of fish and squid.

Breeding

Courting birds fly in parallel, with streamers from bird above turned downward toward mate. Fly together in shallow glides. Begin nesting at four years of age.



Nest year round with peak activity from March through October. Primarily a cliff or cavity nester. On Midway, birds nest in cavities of tree limbs, root bases of ironwood trees (*Casuarina equisetifolia*) and/or other secluded spots. A single egg is laid and incubated (40-42 days) by both adults. Lacks brood patch. Average incubation shift lengths range from about 4-8 days. Chicks are tightly brooded for the few days after hatching. Unlike other Pelicaniformes, adults regurgitate food by putting their bills down the gaping chick's throat. Average chick fledge times vary between 10-12 weeks.

Brown Booby

(*Sula leucogaster*)

Adults chocolate brown with white underwing coverts and belly. Sexes distinguishable by face, bill, and leg color. These parts are yellow in females and are grayish green in males, which in addition, have a bluish throat. Juveniles have plumage similar to adults except that belly and under wing covert color is light brown. Length: 71-76cm (28-30 in); wingspan: 137-145 cm (54-57 in); life span: max. known age 16 years

Midway Population

Brown Boobies were considered the most common booby at Midway in the 1930s. Currently they are uncommon at the atoll. Rats (*Rattus rattus*), which have now been eradicated from Midway, are implicated in their decline. In late 1999, the first nest since 1963 was recorded.

Feeding Habits

Feeds by plunging head first into the water from the air. Usually forages near shore, often within 80 km of breeding grounds. Solitary feeder. Primary prey item is flying fish. Feeding generally occurs during daylight hours.

Breeding

Breeding season occurs between March and November. Breeds colonially. Nests are located on the ground and consist of a shallow depression surrounded by twigs or other vegetation. An average of two chalky white eggs are laid. Lacks brood patch and instead incubates with feet. Parents share incubation duties. Average incubation shift is 12 hours. Incubation period averages 43 days. Siblicide exhibited by chicks. The first egg hatches several days before the second. The first chick to hatch ejects the second chick from the nest shortly after it emerges from the egg. Chick feeding occurs on average once every 17 hours. Fledging occurs 85-103 days after hatching. Post-fledging care and feeding continues for one to two months.



Masked Booby

(*Sula dactylatra*)

Largest of the boobies. Adult birds are white with dark brown or black flight and tail feathers. Bill color is yellow and feet are yellowish gray. Facial skin is gray-black. Sexes are similar in appearance. Juveniles are generally grayish brown with white underparts. Adult plumage is attained by the third year. Length: 74-86cm (29-34 in); wingspan: 152cm (62 in); life span: max known age 20 years

Midway Population

Masked Boobies nest in small numbers at Midway and no historical information indicates that they were previously more numerous. There are generally less than five nesting attempts per year.

Feeding Habits

Feeds by plunging head first into the water from the air, sometimes diving from as high as 30m. Feeding areas are usually many miles from land. Feeds primarily on fish and squid.



Feeding birds are often associated with schools of large predatory fish, such as tuna. Feeding generally occurs during daylight hours.

Breeding

Breeding season occurs between February and August. Breeds colonially. Nests are located on the ground and consist simply of a shallow depression. Begins breeding at four years of age. Monogamous. Two chalky white eggs are laid. Lacks brood patch and instead incubates with feet. Parents share incubation duties. Average incubation shift is 9.5 hours. Incubation period averages 43 days. Siblicide exhibited by chicks. The first egg hatches four

to nine days before the second. The first chick to hatch ejects the second chick from the nest shortly after it emerges from the egg. Chick feeding occurs once or twice a day. Fledging occurs 109-151 days after hatching. Post fledging care and feeding continues for one to two months.



Red-footed Booby

(*Sula sula rubripes*)

Smallest of all boobies. Polymorphic; few seabirds display such a variety of color phases. Legs/feet red. Bill is pale blue. Juveniles are wholly brown or blackish gray with black bill and facial skin. Grey legs. Immature have patchy underwings without definite pattern, white back, mottled gray-brown head, and red or brownish legs. Length: 66-77 cm (26-30 in); wingspan: 91-101 cm (36-40 in); average life span: 22 years.

Midway Population

Midway island's Red-footed Boobies are a white color morph. Adult birds have white body and tail plumage. Upperwings have black primary and greater secondary coverts. About 444 pairs nest on Eastern Island (1998).

Feeding Habits

Feeds by diving vertically into the water and rarely within sight of land. May dive up to 30 meters to pursue prey. Prey primarily on flying fish and squid. Feeds singly or in mixed species flocks. Feeds anytime during the day and after dark.



Breeding

Breeding season ranges from late January through September. Nests are built of twigs and sticks exclusively on tops of shrubs. Naupaka (*Scaevola sericea*) and tree heliotrope (*Tournefortia argentea*) are commonly used shrubs on Midway. May nest in same shrubs as Great Frigatebirds (*Fregata minor*).

Begin breeding at four years of age.

Monogamous. A single, chalky, white egg is laid. Re-laying can occur if first egg is lost. Lacks brood patch. Incubates with feet. Male and female share incubation duties. Individual incubation shifts average about 24 hours. Incubation period ranges between 42-45 days. Chick feeding occurs once every 16-18 hours. Fledging ranges between 95-101 days after hatching. Post-fledging care and feeding can continue for one to four months.

Great Frigatebird

(*Fregata minor palmerstoni*)

A large bird, with long, slender wings. A deeply forked, tail and long, pale blue/grey to blackish hooked bill. Adults have mostly black plumage. Adult males have a red inflatable throat pouch. Legs/feet red to reddish-brown. Females have white breasts and on average are larger than males. Legs/feet pink to reddish-pink. Juveniles have rusty to white heads and throats. Length: 86-100 cm (34-40 in); wingspan: 206-230 cm (81-91 in); average life span: 30 years.

Midway Population

About 95 pairs nest on Eastern Island (1998). Great Frigatebirds range widely within tropical Indian and Pacific Oceans.

Feeding Habits

Lacking the ability to take off from water, frigatebirds snatch prey from the ocean surface using their long, hooked bills. Prey primarily consist of fish and squid. Juveniles and adults



Immature Great Frigatebird *Fregata minor* with Sooty Tern chick snatched from a breeding colony.

often obtain food by piracy from boobies, tropicbirds, and shearwaters. Frigatebirds often supplement their diet by this type of harassment.



Breeding

Frigatebirds begin to breed after nine years. Females do not breed every year because it takes a year and a half to raise a chick. Males are believed to breed every year (with a second female). Fidelity to nest sites and mates is low.

Male breeding displays include inflation of crimson throat pouch, spread wings and head shaking. A single egg is laid on a platform nest built on top of shrubs (naupaka [*Scaevola sericea*] and tree heliotrope [*Tournefortia argentea*]). Both parents develop a brood patch and incubate the egg for about 55 days. Incubation shift change averages every three days.

Newly hatched chicks are naked and brooded by parents to protect them from the sun or rain. By one month, both parents leave the nest to search for food. Feedings occur about once every 18 hours. Chicks attempt their first flight between 120-145 days. Young will depend on parents, usually the female, for food for up to 18 months after fledging.



Displaying Male Great Frigatebird

Brown Noddy

(*Anous stolidus pileatus*)

Medium size, dark, brown bird. Adults have ashy-white forehead and crown sharply demarcated from black lores, merging evenly into gray nape. Long, narrow, wedged-shaped tail. Bill is black and stouter than the Black Noddy. Legs/feet dark brown. Weigh twice as much as black noddies. Young noddies have a more restricted white cap on forehead than adults. Length: 40-45 cm (16-18 in); wingspan: 79-86 cm (31-34 in); Average life span: 25 years.

Midway Population

In 1984, about 1,000 pairs nested on Sand and Eastern Island. The Brown Noddy breeds in tropical waters of Atlantic, Indian, and Pacific Oceans.

Vocalization

Low-pitched guttural calls. Vocalizes at nest and in flight.

Feeding Habits

Primarily feed by plunge diving. Feed offshore over schools of large predatory fish that drive small fry to surface. Feeds mainly on small fish (i.e., goatfish, flying fish) and squid. Often feeds in mixed species flocks.

Breeding

There is limited information on age at first breeding. Age of first breeding ranges between 3-6 years. Mates display characteristic "nodding" to one another. Courtship feeding is performed by the female begging from the male. The male may courtship feed the female several times a day. "Fish flights" occur, in which one bird transfers a fish to its partner.

A single egg is laid in a nest built on the ground or in a tree. On Midway, they have adapted to nesting in ironwood trees (*Casuarina equisetifolia*), naupaka (*Scaevola*



sericea), and on the ground. Fidelity to nest site is high.

Incubation length ranges between 33-36 days. Both parents incubate. Incubation shift lengths varies between geographical locations. Within the Hawaiian islands lengths range between 14-30 hour shifts. Fledging occurs between 40-56 days after hatching (Kure island). Chicks reach adult weight in 18 days. Most chicks outweigh parents in six weeks. Chicks are capable of short flights before reaching full wing development, and will flee if alarmed. Post-fledging feeding continues for several weeks.



Black Noddy

(*Anous minutus melanogenys*)

Forehead and crown grayish white, extending back on the head. Forked tail slightly grey. Remaining plumage brown. Appears blacker than Brown noddy. Longer, thinner bill and whiter cap with straighter demarcation at lores than in Brown Noddy. Black legs and feet. Length: 35-39 cm (14-15 in); wingspan: 66-72 cm (26-28 in); average life span: 16-18 yrs.



Midway Population

In 1984, about 6,000 nesting pairs were documented on Sand Island. Largest population in the Hawaiian Islands. Widely distributed in tropical Pacific and Atlantic Oceans.

Feeding Habits

Inshore surface feeders. Change diet with seasons. Feed on small fish brought to the surface by predatory fish such as tuna and jacks.



Breeding

Courtship consists of head nodding and fish transfers. Extensive nests are built in trees with grasses, leaves, and twigs. Old nests are sometimes renovated and reused. On Midway, noddies have adapted to nesting in tall ironwood trees (*Casuarina equisetifolia*). In the absence of ironwood trees, noddies nest in naupaka (*Scaevola sericea*) and beach heliotrope (*Tournefortia argentea*) shrubs in the Northwestern Hawaiian Islands. One speckled egg is laid. Incubation lasts

approximately 36 days. Incubation shifts average about one half day.

Chicks are brooded for several days after hatching with feedings approximately once every 11 hours. After about three weeks adults spend little time with chicks, except for feeding. Chicks are fed regurgitated fish or whole fish as they get older.

Fledging occurs approximately 36 days after hatching. Post-fledging feeding continues for several weeks.

Nesting occurs throughout the year on Midway, with peak activity in January, February and July and August.

Sooty Tern

(*Sterna fuscata oahuensis*)

Upperparts, legs, and bill black. Underparts and forehead white. Long, narrow wings and deeply forked tail, with white edged outer feathers. A black stripe running through eye to base of bill. Length: 41-45 cm (16-18 in); wingspan: 86-94 cm (34-37 in); average life span: 32 years.

Midway Population

Approximately 45,000 nesting pairs on Eastern and Spit Islands were documented in 1984. Wide distribution throughout tropical oceans.



are conducted over nesting area prior to settling down to lay eggs. Nesting locations change slightly from season to season. A single speckled egg is laid on ground. No nest is prepared.



Incubation period averages 30 days. Individual incubation shifts are approximately five days. Heat stress may cause terns to abandon eggs for short periods to drink seawater. Sooty terns are easily disturbed by human activity, and repeated disturbance may result in permanent abandonment.

Chicks are shaded by parents during hot hours and brooded only when cool. Chicks are fed every 16 hours with

Vocalization

Incessant high pitched, screeching wacky-wack calls.

Feeding Habits

Skim water, take food on the wing, rarely touching down on the ocean. Poor oil glands, can become waterlogged if they alight on water for long duration. Feed offshore with predatory fish that drive smaller fish to the surface. Flying fish (primarily) and other fish constitute diet. Seem to feed extensively at night.

Breeding

Breeding takes place from April through September. Birds start to breed 6-8 years of age. Highly ritualized and vocal aerial displays



regurgitated food. Parents locate chicks through vocalizations, and will feed only their own. Fledging occurs at about eight weeks. Offspring continue to be fed by parents for several weeks after fledging.

Grey-backed Tern

(*Sterna lunata*)

Similar to Sooty Terns, except back, wings, and tail feathers gray. Head and eye-stripe are black. White forehead extends further back behind the eye than the sooty tern. Bill and legs black. Characteristic posture somewhat crouched and bent over when standing, with wings and tail pointing upward. Length: 35-38 cm (14-15 in); wing span: 73-76 cm (29-30 in); average life span: 18 years.



Midway Population

Approximately 507 nesting pairs (1998) breed on Eastern and Spit Islands. Gray-backed Tern populations are confined to central, tropical Pacific Ocean.

Vocalization

High pitched screeching. Softer and less harsh than the Sooty Tern.

Feeding Habits

A plunge diver, the Gray-backed Tern does not depend on predatory fish to drive prey to surface. Diet consists of sea striders, crustaceans, juvenile flying fish, cowfish, and goat fish.

Breeding

Gray-backs arrive and lay eggs shortly before Sooty Terns on Midway (late February). They lay a single speckled egg on small depressions on the ground, usually against low vegetation or debris. Breeds singly or in loose colonies.

Mean incubation period is 32 days. Both parents incubate egg. Incubation shifts range from 7-18 hours. Chicks are raised for about 46 days by both parents. Young Gray-backs remain at their nesting colonies up to six weeks after fledging.

White Tern (*Fairy Tern*)

(*Gygis alba rothschildi*)

Entire body is white with black eye-ringing creating the appearance of large eyes. The thick bill is mostly black with blue at the base. Legs and feet are slate blue, with yellow to white webs. The tail is shallowly notched. Sexually monomorphic. Length: 28-33 cm (11-13 in); wingspan: 70-87 cm (27.5-34 in); average life: 16 to 18 years.

Midway Population

In 1984, about 7,500 breeding pairs nested on Sand and Eastern Islands, the largest population in the Northwestern Hawaiian Islands. The White Tern is the smallest tern species found at Midway Atoll. Breed throughout tropical and subtropical Pacific, Indian, and South Atlantic Oceans.

Feeding Habits

Feed primarily on juvenile or smaller fish (e.g., goat-fish, flying fish, dolphin fish, half-beaks and needle-fish). Feeds alone or in mixed species flocks. Dives down to surface for prey, but does not submerge. This bird carries prey crosswise in its bill.

Breeding

Breeding begins at age 3-5. Peak breeding activity takes place in late spring and summer. No nest is built and a single speckled egg is laid on a small depression on a branch, roof or other surface. Incubation period averages 36 days.

Both parents incubate the egg. Incubation shifts range between 48-72 hours. After hatching, the brooded chick is fed about every three hours. Unlike many other seabird chicks that receive regurgitated food, only whole fish or squid is fed. Sharp clawed feet, enable this chick to hang on to branches in high winds.



Chicks average 48 days from hatching to fledging. After fledging, chicks move farther away from nest site, returning only to feed. Post-fledging feeding continues for about two months.

Quick Reference to Seabirds and Shorebirds of Midway Atoll

Seabirds - Dedicated Parents

Long before the first human set foot on Midway Atoll, seabirds swarmed over these tiny remote islands each year to nest and raise their young. The Laysan albatross sacrifices coordination on land for its long, narrow wings which efficiently help it speed across its open ocean home.

To survive in salty surroundings, seabirds developed specialized glands that concentrate the salt from their blood and eliminate it from their bodies. Scientists call members of the albatross, shearwater, and petrel families "tubenoses", for the prominent "nostrils" on their bills.

Midway's seabirds mate for life, and may spend 40 years with their monogamous partner. Due to the great amount of energy and time required to nurture the young from egg to fledgling, both parents strive together to raise just one chick each year. The mates take turns sitting on the egg and tending the chick, often going for two weeks without food. While one incubates, the other scours the sea for sustenance.

Shorebirds - Mighty Migrators

In contrast with seabirds, shorebirds spend "winter vacation" on Midway and most of their lives on land, taking to the open ocean only to migrate between nesting and wintering grounds. Midway offers them a rest stop on their route between nesting areas in Alaska and Siberia and wintering sites in the South Pacific, and some stay for several months.

Ethical Wildlife Viewing

Though certainly tolerant, abundant and easily observable, Midway's birds still need protection from unnecessary disturbance, especially during nesting. Please watch them from a distance, and if a bird changes its behavior because of your presence, back away, and move on.

How to Use the Checklist

This checklist gives a brief description of the bird's most likely to appear on Sand Island or in the lagoon, an interesting fact about each species, the islands in the atoll where the bird nests, and the months of the year when adults (A) and chicks (C) dwell here.

A good, basic field guide to use in conjunction with the list is *Hawaii's Birds*, published by the Hawaii Audubon Society. For more information on seabird ecology, see *Seabirds of Hawaii*, by Craig Harrison.

Albatross

Laysan Albatross

Description: large bird with white body, black back and wings, and dark eye markings

Midway supports the largest Laysan albatross colony in the world, with 388,000 mated pairs, or about 70% of the world's breeding population.

Nests: Sand, Eastern, Spit

A: Oct - Jul C: Jan - Aug

Black-footed Albatross

Description: large dark gray bird with white around bill and under eye

Unlike the Laysan albatross, it prefers windswept, sandy spots away from human habitation. With 22,000 pairs, Midway boosts the second largest nesting population in the world.

Nests: Sand, Eastern, Spit

A: Oct - Jul C: Jan - Aug

Petrels and Shearwaters

Bonin Petrel

Description: dark gray back and wings; sooty gray head and neck; white forehead and underparts

Nests in underground burrows that can be one meter deep and three meters long. Nicknamed the "nightbird" due to its nocturnal habits.

Nests: Sand, Eastern

A: Aug - Jun C: Mar - Jun

Wedge-tailed Shearwater

Description: upper parts dark brown to brownish gray; throat and underparts white

Nocturnal bird that nests in shallow burrows or on the surface. Feeds on larval fish driven to the water's surface by predatory fish like skipjack tuna. Its eerie, moaning call haunts many seabird colonies.

Nests: Sand, Eastern
A: Apr - Nov C: Aug - Nov

Tropicbirds

Red-tailed Tropicbird

Description: all white with red bill and two long, thin, red tail feathers

Its shrill screams earned it the name "bosun bird" from sailors who felt it sounded like a bosun's whistle. Midway supports the largest nesting population in Hawaii of these aerial artists whose courtship displays include mid-air wheeling, gliding, and circling.

Nests: Sand, Eastern, Spit
A: Year-round C: Mar - Oct

Boobies

Red-footed Booby

Description: large white bird with black wing tips, bluish bill, and distinctive red legs and feet

Smallest of all boobies, it plunges 30 feet down into the ocean in search of food, preferring flying fish and squid.

Nests: Eastern
A: Year-round C: Mar - Oct

Frigatebirds

Great Frigatebird

Description: large black bird with long, slender wings and deeply forked tail. Males have bright red inflatable throat patch

So highly adapted for flying, it cannot swim or walk; only perch and fly. Although it can

catch its own prey, Hawaiians named it "Iwa" or thief, since it forces other birds to drop their prey, which it takes for itself in mid-air.

Nests: Eastern
A: Mar - Oct C: May - Nov

Terns and Noddies

Gray-backed Tern

Description: back, wings, tail gray; underparts white; head and eye stripe black; narrow wings and deeply forked tail

Lays a single egg on the ground in loose colonies on the fringes of sooty tern colonies.

Nests: Eastern, Spit
A: Feb - Oct C: Jun - Oct

Sooty Tern

Description: upper parts, legs, and bill black; underparts and forehead white; black eye stripe; long, narrow wings and deeply forked tail

Spends first five years of life in flight. Skims water, takes food on the wing, and rarely sits on the ocean. Depends on tuna to chase its prey to the surface.

Nests: Eastern, Spit
A: Feb - Oct C: Jun - Oct

White Tern

Description: pure white with blue and black bill and large dark eyes rimmed with black feathers

Curious bird that lays a single egg directly on a tree branch. Sharp-clawed chicks hold onto their precarious nest sites.

Nests: Sand, Eastern
A: Year-round C: Mar - Aug

Brown Noddy

Description: dark brown with gray-white forehead and crown; long, narrow wedge-shaped tail

Ground-nesting bird named for its courtship display, which includes head nodding and fish transfers from one mate to the other.

Nests: Sand, Eastern

A: Apr - Dec C: Jun - Oct

Black Noddy

Description: similar in appearance to brown noddy except smaller and darker; white on forehead and crown more distinct

The largest colony of black noddies in the Hawaiian Island chain nests in trees of Midway Atoll.

Nests: Sand

A: Year-round C: Jan - Aug

Plovers

Pacific Golden Plover

Description: gold, black, and white spotting on wings and back; white stripe over eye and down neck; short black bill

A powerful migrant capable of flying almost 2,800 miles non-stop, from Alaska to Hawaii, over open ocean.

A: Year-round, but abundant in spring and fall

Sandpipers

Bristle-thighed Curlew

Description: larger brown bird with long, down-curved bill, rusty-colored tail

Hardy bird that nests on the barren tundra in mountainous regions of Alaska.

A: Year-round, but abundant in spring and fall

Ruddy Turnstone

Description: small bird with bold black and white pattern on wings, black "necklace"

Named for its feeding behavior, it uses its strong neck and bill to turn over stones in search of prey.

A: Year-round, but abundant in spring and fall

Some occasional and rare species

- Short-tailed Albatross
- White-tailed Tropicbird
- Masked Booby
- Brown Booby
- Wandering Tattler

Seabird Weight and Wing Comparison

Species	Mass(lb)	Mass(kg)	Wingspan(ft)	Wingspan (cm)
Black-footed Albatross	6.2	2.8	6.3-7.0	193-213
Laysan Albatross	5.3	2.4	6.7	203
Dark-rumped Petrel	0.96	0.434	3	91
Bonin Petrel	0.39	0.176	2.1-2.3	64-71
Bulwer's Petrel	0.22	0.099	1.9	58
Sooty Storm-Petrel	0.19	0.084	1.8	56
Wedge-tailed Shearwater	0.74	0.338	3.2	97
Christmas Shearwater	0.78	0.356	2.7	81
Newell's Shearwater	0.85	0.388	2.5-3.0	75-90
White-tailed Tropicbird	1	0.455	2.9-3.2	89-96
Red-tailed Tropicbird	1.4	0.624	3.7	112
Masked Booby	4.8	2.16	5	152
Brown Booby	3	1.34	4.5-4.8	137-145
Red-footed Booby	2.4	1.11	3.2-3.4	97-102
Great Frigatebird	3.2	1.44	7.5	229
Gray-backed Tern	0.32	0.146	2.4	74
Sooty Tern	0.44	0.198	2.8	86
Blue-gray Noddy	0.12	0.053	1.5	46
Brown Noddy	0.45	0.205	2.8	84
Black Noddy	0.24	0.108	2.3	71
White Tern	0.24	0.111	2.3	71

Midway Atoll Bird List and Seabird Population Estimates

Updated December 24, 2006 J. Klavitter

Summary of all birds found at Midway. Symbols used for species status:

1) Resident (R), present all year, but not necessarily breeding; 2) Migratory Breeder (M), breeds at Midway, but departs for the rest of the year; 3) Visitor (V), includes passage migrants as well as vagrants; 4) Winter Resident (W), resident at Midway Atoll during the nonbreeding season; 5) Introduced (I); currently nests on Midway; 6) Endangered (E); and 7) Extinct/Extirpated on Midway (X).

ALBATROSS DIOMEDIDAE		
Laysan Albatross	<i>Phoebastria immutabilis</i>	M
Black-footed Albatross	<i>Phoebastria nigripes</i>	M
Short-tailed Albatross	<i>Phoebastria albatrus</i>	M, E
Salvins Albatross	<i>Thalassarche salvini</i>	V

PETRELS & SHEARWATERS PROCELLARIIDAE		
Northern Fulmar	<i>Fulmarus glacialis</i>	V
Bonin Petrel	<i>Pterodroma hypoleuca</i>	M
Bulwer's Petrel	<i>Bulweria bulwerii</i>	V
Jouanin's Petrel	<i>Bulweria fallax</i>	V
Flesh-footed Shearwater	<i>Puffinus carneipes</i>	V
Wedge-tailed Shearwater	<i>Puffinus pacificus</i>	M
Buller's Shearwater	<i>Puffinus bulleri</i>	V
Christmas Shearwater	<i>Puffinus nativitatis</i>	M
Newell's Shearwater	<i>Puffinus (auricularis) newelli</i>	V
Sooty Shearwater	<i>Puffinus griseus</i>	V
Little Shearwater	<i>Puffinus assimilis</i>	V

STORM-PETRELS HYDROBATIDAE		
Leach's Storm-petrel	<i>Oceanodroma leucorhoa</i>	V
Tristram's (Sooty) Storm-petrel	<i>Oceanodroma tristrami</i>	V

TROPICBIRDS PHAETHONTIDAE		
White-tailed Tropicbird	<i>Phaethon lepturus</i>	R
Red-tailed Tropicbird	<i>Phaethon rubricauda</i>	R

BOOBIES SULIDAE		
Masked Booby	<i>Sula dactylatra</i>	M
Brown Booby	<i>Sula leucogaster</i>	M
Red-footed Booby	<i>Sula sula</i>	M

CORMORANTS PHALACROCORACIDAE		
Pelagic Cormorant	<i>Phalacrocorax pelagicus</i>	V

FRIGATEBIRDS FREGATIDAE		
Great Frigatebird	<i>Fregata minor</i>	R
Lesser Frigatebird	<i>Fregata ariel</i>	V

HERONS, EGRETS ARDEIDAE		
Cattle Egret	<i>Bubulcus ibis</i>	V

Intermediate Egret	<i>Egretta intermedia</i>	V
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SWANS, GEESE, DUCKS ANATIDAE		
Greater White-fronted Goose	<i>Anser albifrons</i>	V
Emperor Goose	<i>Chen canagica</i>	V
Snow Goose	<i>Chen caerulescens</i>	V
Canada Goose	<i>Branta canadensis minimus</i>	V
Tundra Swan	<i>Cygnus columbianus</i>	V
Gadwall	<i>Anas strepera</i>	V
Eurasian Wigeon	<i>Anas penepole</i>	V
American Wigeon	<i>Anas americana</i>	V
Mallard	<i>Anas platyrhynchos</i>	V
Blue-winged Teal	<i>Anas discors</i>	V
Northern Shoveler	<i>Anas clypeata</i>	V
Northern Pintail	<i>Anas acuta</i>	V
Garganey	<i>Anas querquedula</i>	V
Eurasian Green-winged Teal	<i>Anas crecca crecca</i>	V
American Green-winged Teal	<i>Anas crecca carolinensis</i>	V
Redhead	<i>Aythya americana</i>	V
Common Pochard	<i>Aythya ferina</i>	V
Tufted Duck	<i>Aythya fuligula</i>	V
Greater Scaup	<i>Aythya marila</i>	V
Lesser Scaup	<i>Aythya affinis</i>	V
Harlequin Duck	<i>Histrionicus histrionicus</i>	V
Long-tailed Duck	<i>Clangula hyemalis</i>	V
Black Scoter	<i>Melanitta nigra</i>	V
Bufflehead	<i>Bucephala albeola</i>	V
Common Goldeneye	<i>Bucephala clangula</i>	V
Merganser species	<i>Mergus sp.</i>	V
Laysan Duck	<i>Anas laysanensis</i>	I

OSPREY PANDIONINAE		
Osprey	<i>Pandion haliaetus</i>	V

HAWKS, KITES, EAGLES ACCIPITRIDAE		
Black Kite	<i>Milvus migrans</i>	V
Steller's Sea Eagle	<i>Haliaeetus pelagicus</i>	V
Red-tailed Hawk	<i>Buteo jamaicensis</i>	V
Northern Harrier	<i>Circus cyaneus</i>	V

CARACARAS, FALCONS FALCANIDAE		
Peregrine Falcon	<i>Falco peregrinus</i>	V
Merlin	<i>Falco columbarius</i>	V

RAILS, COOTS RALLIDAE		
Laysan Rail	<i>Poranual palmeri</i>	I, X
Common Moorhen	<i>Gallinula chloropus</i>	V
American Coot	<i>Fulica americana</i>	V

LAPWINGS, PLOVERS CHARADRIIDAE		
Black-bellied Plover	<i>Pluvialis squatarola</i>	V
Pacific Golden-Plover	<i>Pluvialis fulva W</i>	
Mongolian Plover	<i>Charadrius mongolus</i>	V

Semipalmated Plover	<i>Charadrius semipalmatus</i>	V
Common Ringed-Plover	<i>Charadrius hiaticula</i>	V

STILTS AND AVOCETS RECURVIROSTRIDAE

Black-necked (Hawaiian) Stilt	<i>Himantopus mexicanus</i>	V,E
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SANDPIPERS, PHALAROPES SCOLOPACIDAE

Greater Yellowlegs	<i>Tringa melanoleuca</i>	V
Lesser Yellowlegs	<i>Tringa flavipes</i>	V
Marsh Sandpiper	<i>Tringa stagnatilis</i>	V
Wood Sandpiper	<i>Tringa glareola</i>	V
Wandering Tattler	<i>Heteroscelus incanus</i>	W
Grey-tailed (Polynesian) Tattler	<i>Heteroscelus brevipes</i>	V
Spotted Sandpiper	<i>Actitis macularia</i>	V
Whimbrel	<i>Numenius phaeopus</i>	V
Bristle-thighed Curlew	<i>Numenius tahitiensis</i>	W
Bar-tailed Godwit	<i>Limosa limosa</i>	V
Ruddy Turnstone	<i>Arenaria interpres</i>	W
Red Knot	<i>Calidris canutus</i>	V
Sanderling	<i>Calidris alba</i>	W
Western Sandpiper	<i>Calidris mauri</i>	V
Long-toed Stint	<i>Calidris subminuta</i>	V
Pectoral Sandpiper	<i>Calidris melanotos</i>	V
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	V
Dunlin	<i>Calidris alpina</i>	V
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	V
Ruff	<i>Philomachus pugnax</i>	V
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	V
Common Snipe	<i>Gallinago gallinago</i>	V

SKUAS, GULLS, TERNS, SKIMMERS LARIDAE

Laughing Gull	<i>Larus atricilla</i>	V
Franklin's Gull	<i>Larus pipixcan</i>	V
Black-headed Gull	<i>Larus ridibundus</i>	V
Bonaparte's Gull	<i>Larus philadelphia</i>	V
Herring Gull	<i>Larus argentatus</i>	V
Slaty-backed Gull	<i>Larus schistisagus</i>	V
Silver Gull	<i>Larus novaehollandiae</i>	V
Glaucous-winged Gull	<i>Larus glaucenscens</i>	V
Glaucous Gull	<i>Larus hyperboreus</i>	V
Black-legged Kittiwake	<i>Rissa tridactyla</i>	V
Arctic Tern	<i>Sterna paradisaea</i>	V
Little Tern	<i>Sterna albifrons</i>	M
Least Tern	<i>Sterna antillarum</i>	M
Gray-backed Tern	<i>Sterna lunata</i>	M
Sooty Tern	<i>Sterna fuscata</i>	M
Black Tern	<i>Chlidonias niger</i>	V
Brown (Common) Noddy	<i>Anous stolidus</i>	R
Black (Hawaiian) Noddy	<i>Anous minutus</i>	R
White (Fairy) Tern	<i>Gygis alba rothchildi</i>	R

AUKS, PUFFINS, MURRES ALCIDAE

Parakeet Auklet	<i>Aethia psittacula</i>	V
Horned Puffin	<i>Fratercula corniculata</i>	V

Japanese Murrelet	<i>Synthliborsmphus wumizusume</i>	V
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DOVES, PIGEONS COLUMBIDAE		
Rock Dove (Domestic Pigeon)	<i>Columba livia</i>	I, E

CUCKOOS, ROADRUNNERS, ANIS CUCULIDAE		
Oriental Cuckoo	<i>Cuculus saturatus</i>	V

BARN OWLS TYTONIDAE		
Barn Owl	<i>Tyto alba</i>	V

TYPICAL OWLS STRIGIDAE		
Short-eared Owl	<i>Asio flammeus</i>	V

SWIFTS APODIDAE		
Fork-tailed Swift	<i>Apus pacificus</i>	V

LARKS ALAUDIDAE		
Eurasian Skylark	<i>Alauda arvensis</i>	V

SWALLOWS HIRUNDINIDAE		
Barn Swallow	<i>Hirundo rustica</i>	V

THURSHES TURDIDAE		
Eye-browed Thrush	<i>Turdus obscurus</i>	V

STARLINGS STURNIDAE		
Common Myna	<i>Acridotheres tristis</i>	I

EMBERIZIDS EMBERIZIDAE		
Snow Bunting	<i>Plectrophenax nivalis</i>	V

FINCHES CARDUELINAE, DREPANIDINAE		
Common Redpoll	<i>Carduelis flammea</i>	V
Common Canary	<i>Serinus canarius</i>	I
Laysan Finch	<i>Telespyza cantans</i>	I, E, X

OLD WORLD SPARROWS PASSERIDAE		
House Sparrow	<i>Passer domesticus</i>	I, E

Midway Atoll resident and migratory breeding bird species, population estimates, average nesting density estimates, weights, wingspans, and time of day when the bird is most active (day verses night).

Species	Population estimate (nesting pairs)	Total population estimate (Pyle 2001)	Average nesting density. All habitats combined. (nests/ha)	Wingspan (m) (Harrison 1983)	Peak flight activity
Laysan Albatross (<i>Diomedea immutabilis</i>)	487,527 ¹ (2005)	1,462,581	1180	2.0	Day
Black-footed Albatross (<i>Diomedea nigripes</i>)	24,085 ¹ (2005)	72,255	55	1.9 - 2.1	Day
Short-tailed Albatross (<i>Diomedea albatrus</i>)	0 ¹ (2002)	2	0	2.1 - 2.3	Day
Bonin Petrel (<i>Pterodroma hypoleuca</i>)	32,066 ²	96,198	86	0.6 – 0.7	Night
Wedge-tailed Shearwater (<i>Puffinus pacificus</i>)	1,000 ³	3,000	3	1.0	Night
White-tailed Tropicbird (<i>Phaethon lepturus</i>)	6 ¹	18	< 1	0.9 - 1.0	Day
Red-tailed Tropicbird (<i>Phaethon rubricauda</i>)	5,000 ³	15,000	13	1.0	Day
Masked Booby (<i>Sula dactlyatra</i>)	2 ¹	5	< 1	1.5	Day
Brown Booby (<i>Sula leucogaster</i>)	1 ¹	3	< 1	1.3 – 1.5	Day
Red-footed Booby (<i>Sula sula</i>)	563 ⁴	1,689	2	0.9 – 1.0	Day
Great Frigatebird (<i>Fregata ariel</i>)	87 ⁴	261	< 1	2.1 – 2.3	Day
Gray-backed Tern (<i>Sterna lunata</i>)	315-487 ⁴	945-1,461	1	0.7 – 0.8	Day
Sooty Tern (<i>Sterna fuscata</i>)	45,000 ³	135,000	120	0.9	Day
Little Tern (<i>Sterna albifrons</i>)	NA	NA	NA	0.5 – 0.6	Day
Brown Noddy (<i>Anous stolidus</i>)	1,000 ³	3,000	3	0.8 – 0.9	Day
Black Noddy (<i>Anous minutus</i>)	6,000 ³	18,000	16	0.7	Day
White Tern (<i>Gygis alba</i>)	7,500 ³	22,500	20	0.7 – 0.8	Day
Laysan Duck (<i>Anas laysanensis</i>)	NA	102 Dec 2006			Night

¹ Population estimates determined from mean incubation counts.

² Breeding population based on direct counts.

³ Population estimates were taken from Fefer et al. (1984).

⁴ Breeding population was calculated through burrow occupancy density estimates.

NA – no information available.

Seabird Species Known to Breed in the Northwestern Hawaiian Islands

Common Name	Species	Estimated Number of Breeding Birds
Black-Footed Albatross	<i>Phoebastria nigripes</i>	111,800
Laysan Albatross	<i>Phoebastria immutabilis</i>	1,234,000
Bonin Petrel	<i>Pterodroma hypoleuca</i>	630,000
Bulwer's Petrel	<i>Bulweria bulwerii</i>	180,000
Wedge-Tailed Shearwater	<i>Puffinus pacificus</i>	450,000
Christmas Shearwater	<i>Puffinus nativitatis</i>	5,400
Tristan's Storm-Petrel	<i>Oceanodroma tristrami</i>	11,000
Red-Tailed Tropicbird	<i>Phaethon rubricauda</i>	18,400
White-Tailed Tropicbird	<i>Phaethon lepturus</i>	8
Masked Bobby	<i>Sula lepturus</i>	3,400
Red-Footed Booby	<i>Sula sula</i>	15,800
Brown Booby	<i>Sula leucogaster</i>	800
Great Frigatebird	<i>Fregata minor</i>	19,800
Little Tern	<i>Sternula albifrons</i>	20
Gray-Backed Tern	<i>Onychoprion lunatus</i>	86,000
Sooty Tern	<i>Onychoprion fuscatus</i>	3,000,000
Blue Noddy	<i>Procelsterna cerulean</i>	7,000
Brown Noddy	<i>Anous stolidus</i>	150,000
Black Noddy	<i>Anous minutus</i>	26,000
White Tern	<i>Gygis alba</i>	22,000
Total		5,971,428

Mountains of Hawaii

	Feet	Meters
Hawaii		
Mauna Kea	13,796	4,205
Mauna Loa	13,679	4,169
Hualalai	8,271	2,521
Kaumu o Kaleihohie	5,480	1,670
Kilauea (Uwekahuna)	4,093	1,248
Kilauea (Halemaumau Rim)	3,660	1,116
Kahoolawe		
Puu Moaulanui	1,483	452
Puu Moaulaiki	1,434	437
Molokini	160	49
Maui		
Haleakala (Red Hill)	10,023	3,055
Haleakala (Kaupo Gap)	8,201	2,500
Puu Kukui	5,788	1,764
Iao Needle	2,250	686
Lanai		
Lanaihale	3,366	1,026
Molokai		
Kamakou	4,961	1,512
Olokui	4,606	1,404
Kalaupapa Lookout	1,600	488
Mauna Loa (Kukui)	1,430	436
Oahu		
Kaala	4,003	1,220
Puu Kalena	3,504	1,068
Konahuanui	3,150	960
Tantalus	2,013	614
Olomana	1,643	501
Koko Crater (Kohelepelepe)	1,208	368
Nuuanu Pali Lookout	1,186	361
Diamond Head	760	232
Koko Head	642	196
Punchbowl	500	152
Kauai		
Kawaikini	5,243	1,598
Waialeale	5,148	1,569
Kalalau Lookout	4,120	1,256
Haupu	2,297	700
Sleeping Giant (Nonou)	1,241	378

Niihau		
Paniau	1,250	381
Lehua	699	213
Kaula	548	167
Nihoa		
Millers Peak	903	275
Necker Island		
Summit Hill	276	84
French Frigate Shoals		
La Perouse Pinnacles	120	37
Gardner Pinnacles	190	58
Maro Reef	awash	awash
Laysan Island	40	12
Lisianski Island	40	12
Pearl and Hermes Atoll	10	3
Midway Islands	12	4
Kure Atoll	20	6

Waterfalls of Hawaii

	Sheer Drop (feet)	Cascade (feet)	Horizontal Distance (feet)
Hawaii			
Kaluahine	...	620	400
Akaka	442
Waiilikahi	320	...	6
Maui			
Honokohau	...	1,120	500
Waihiimalu	...	400	150
Molokai			
Kahiwa	...	1,750	1,000
Papalaua	...	1,200	500
Waialele	...	500	150
Oahu			
Kaliuwaa	80	1,520	3,000
Kauai			
Waipoo (2 falls)	...	800	600
Awini	...	480	500
Hinalele	280
Wailua	200

Fish Aggregating Devices

(FADs) along the coastal waters of the main Hawaiian Islands make the area very popular with commercial and recreational fishermen. For reasons unknown, fish in the N and W Pacific Ocean frequently gather in schools under floating objects. FADs may be as sophisticated as floating devices, often buoys, with electronic equipment attached for tracking or as crude as floating logs or other objects. The FADs in Hawaiian waters, established by the state, are yellow, 6 feet across at the base, and show a quick flashing yellow light atop a 5-foot steel pole. The buoys display 12-inch white letters. These buoys frequently break loose and/or become unlighted. Mariners are advised to use caution when in the vicinity of the FADs.

Polynesian-English Geographic Glossary

Akau.....	north
Ana.....	cave
Awa.....	bay, cove
Hale.....	house
Hana.....	bay
Heiau.....	place of worship, temple
Hema.....	south
Hikina.....	east
Hono.....	bay, cove
Kai.....	sea
Kapu.....	prohibited
Komohana.....	west
Kona.....	leeward
Koolau.....	north
Kowa.....	channel, strait, sound
Lae.....	cape, point
Lapa.....	ridge
Loko.....	pond
Lua.....	crater, pit
Mauna.....	mountain, hill, peak
Moana.....	ocean
Moku.....	islet, island, rock
Pali.....	cliff, peak, point
Pele.....	volcano
Pohaku.....	rock
Puu.....	hill(s), mountain, peak
Wai.....	water
Waialele.....	waterfall