

PEARL HARBOR NATIONAL WILDLIFE REFUGE

Island of Oahu, Hawaii

ANNUAL NARRATIVE REPORT

Calendar Year 1991

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INTRODUCTION

Little is known about the Hawaiian Islands before 1778 when Captain James Cook first sighted Oahu and Kauai. At the time of Cook's visit, the islands were divided into four kingdoms. Kamehameha, a chief, was rising to power on the island of Hawaii. By 1810, he had united all the islands into one kingdom.

Missionaries arrived from New England in 1820. They transcribed the spoken Hawaiian language into writing, translated hymns and parts of the Bible into Hawaiian, and taught the natives to read and write.

In 1835, the sugar industry was established at Koloa, Kauai. With increasing acreage and production, the need for additional labor increased. In 1852, Chinese immigrants arrived to work in the sugar fields. They were the first of a long list of immigrants, including Chinese, Japanese, Portuguese, Koreans, Germans, and Filipinos.

The pineapple industry was established near the turn of the century in Wahiawa, Oahu.

In 1900, Hawaii became a territory of the United States, and in 1959, it officially became the 50th State.

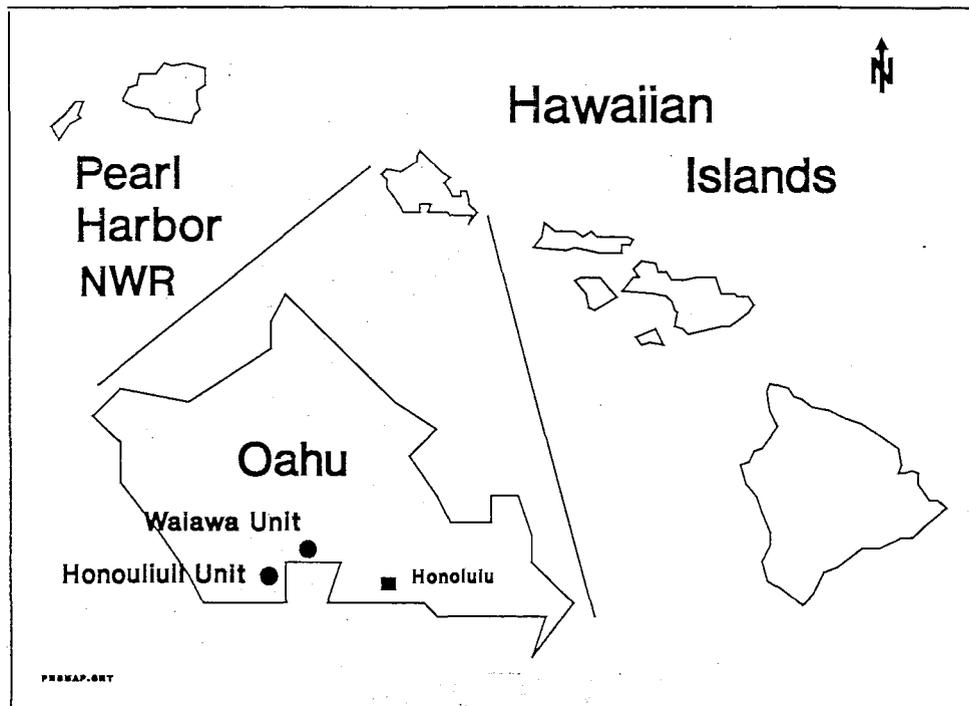
The Hawaiian islands form a chain that extends in a northwest-southwest direction. They are the summits of volcanic domes built up from the ocean floor through countless eruptions. In general, the volcanic activity moved from northwest to southeast.

The islands formed primarily in thin-bedded pahoehoe and Aa lava flows. The rocks are mostly basaltic; the basalt is about 50 percent silica. Andesitic rocks as well as volcanic ash and cinders occur in a few places. Adjacent to the ocean is a small amount of coral limestone and coral sand.

The relief of the islands varies. The once smooth volcanic domes have been weathered and eroded. The older islands are deeply dissected; their surface is one of ridges, valleys, and alluvial fans.

The Pearl Harbor National Wildlife Refuge consists of 61 acres of man-made wetland habitat in two separate units on the south shore of O'ahu, Hawai'i. The Waiawa Unit (24.5 acres) is located near the east shore of Middle Loch on the Pearl City Peninsula, within the Pearl Harbor Naval Base. The Honouliuli Unit (36.5 acres) is located along the west shore of West Loch within the Pearl Harbor Naval Base. The refuge was established in 1976 to provide habitat for three species of endangered Hawaiian waterbirds and other native wildlife that inhabit the wetland environment.

Low dikes retain shallow water impoundments on each unit. Electric pumps provide water for each of the ponds. The refuge units were constructed to partially mitigate loss of natural habitat resulting from the construction of Honolulu International Airport's reef runway. It is managed by the U.S. Fish and Wildlife Service under a cooperative agreement with the U.S. Navy.



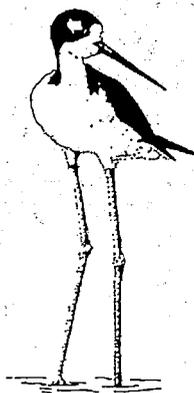
Vicinity Map

INTRODUCTION

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A. HIGHLIGHTS

- The Oahu NWR Complex office moves to Haleiwa on the north shore (Section J.3)

B. CLIMATIC CONDITIONS

The climate of Hawaii is unusually pleasant for the tropics. Its outstanding features are the remarkable differences in rainfall over short distances, the mild temperatures, and the persistence of the northeasterly trade winds.

The major climatic influences in this region are the latitude, the State lies well within the geographic tropics; the surrounding ocean, which has a moderating influence on temperature; and the Pacific anticyclone, from which the trade winds flow. Between about October and April, storms that migrate eastward across the Pacific north of Hawaii, or the storms that form nearby, occasionally bring in spells of bad weather and wide-spread heavy rains.

The most important influence on all the weather elements is Hawaii's topography. Elevations range from sea level along the coastal plains to heights of about 5,170 feet on Kauai, 4,025 feet on Oahu, 10,025 feet on Maui, 4,970 feet on Molokai. More important than mere elevation, moreover, is the ruggedness of the terrain, in which each valley bottom, slope, and steep-sided ridge has its own local climate.

RAINFALL

Over the open sea in the Hawaiian area, rainfall averages between 25 and 30 inches a year. Yet the State itself receives more than 10 times this amount in some places, and less than half in others. Each of the major islands has regions in which the mean annual rainfall approaches or exceeds 300 inches. Mt. Waialeale, on the island of Kauai, which has 486 inches of rain a year and is known as the wettest spot on earth, is only 15 miles from Barking Sands, which receives less than 20 inches annually. The principal cause of this remarkable variability is the orographic, or mountain-caused, rain that forms within the moist air from trade winds as it ascends and traverses the steep and high terrain of the islands. The resulting rainfall distribution, in the mean, closely resembles the topographic contours. The amount is greatest over windward slopes and crests and is least toward the leeward lowlands.

The lowlands obtain moisture chiefly from a few winter storms, and only negligibly from trade-wind showers. Thus, rainfall in the normally dry areas is strongly seasonal. Summers are arid. Seasonal differences are much smaller in the wetter areas, where rainfall is derived from both the winter storms and the year-round, trade-wind showers. For example, at Kaunakakai, a very dry station where the mean annual rainfall 12.5 inches, June and July together account on the average for less than 1 percent of the annual rainfall; but in Wahiawa where rainfall measures 50 inches a year, June and July account for 10 percent, and in Kahana where it measures 240 inches a year, they account for 17 percent.

The number of rainy days a year also varies widely from place to place; the number is greatest in areas where the mean annual rainfall is higher. Kaunakakai, for example, receives 0.1 inch or more of rainfall on an average of 15 days a year and 0.5 inch or more on only 6 days. In contrast, Wahiawa receives 0.1 inch or more on an average of 81 days a year and 0.5 inch or more on 25 days. Kahana receives 0.1 inch or more on an average of 200 days a year and 0.5 inch or more on 65 days.

Another source of rainfall is the deep cumulus clouds that build up over mountains and interiors on clear calm afternoons. Although such convective showers may be intense, they are usually too brief and localized to contribute significantly to the total water supply.

Hawaii's heaviest rains are brought by winter storms. Although the effects of terrain are not so obvious as in trade-wind showers, large differences in rainfall over small distances do occur, because of the topography and the path and structure of the rain clouds. Frequently, the most copious storm rains do not occur in localities that have the greatest average rainfall; nor is it uncommon during such storms for relatively dry areas to receive within a single day, or even a few hours, half or more of their mean annual rainfall. For example, downtown Honolulu has an average yearly rainfall of only 24 inches, but it has received more than 17 inches in a single day.

Intensities of 2 inches of rain an hour are not infrequent, and even the dry regions on Oahu have an average recurrence interval of only 5 years or less. In many of the farming areas, hourly intensities of 2.5 inches can be expected, and over the island as a whole, 3 inches an hour is by no means rare. Hawaii's heaviest rain was more than 40 inches recorded at Kilauea Plantation, Kauai, in a 24-hour period in January 1956. Of this, 6 inches fell in 30 minutes and more than 11 inches in a single hour. Flash flooding is a recurrent problem and results in frequent damage to fields, crops, and other property.

Another important, but often neglected, source of water is that directly extracted from passing clouds by vegetation and by the soil in areas where an elevation of 2,500 feet or more brings them into the cloud belt. For example, at Lanaihale, the contribution of what is locally called "fog drip" to soil moisture appears to be about equal to that of rainfall.

At the opposite extreme, neither is drought uncommon in Hawaii, although it rarely affects more than part of even a single island at one time. Drought occurs when either the winter storms or the trade winds fail. If the winter storms fail, the leeward areas, which receive little rain from trade winds, are hardest hit. A dry winter between two normally dry summers can have very serious mountain and upland regions, including many of the sources of irrigation water. The probability of serious drought somewhere in Hawaii during any given 10-year period exceeds 90 percent.

TEMPERATURE

Mean annual temperatures in Hawaii vary between about 72° and 75° F., near sea level, decrease by about 3° for each 1,000 feet of elevation, and tend to be higher in sunny dry areas. They are higher, for example, in the leeward lowlands, than in those areas that are cloudier, wetter, and more directly exposed to the trades. The average annual temperature at Mountain View, Hawaii (1,530 feet) is 67°; at Haleakala Branch Experiment Station (2,100 feet) 66°; at Kula Sanatorium (3,004 feet), 64°; at Hawaii National Park (3,971 feet) 61°; at Haleakala Ranger Station (7,030 feet) 54°; and at Mauna Loa Observatory (11,150 feet), 45°.

The average difference between daily high and low temperatures is between 10° and 20°; the higher readings occur in areas that are lower, drier, and less open to the wind. For example, on Oahu the daily range is 10° at Ewa Plantation, 13° at Kahuku, and only 8° at Makapuu Point.

August and September are the warmest months of the year, and January and February are the coolest. The seasonal range of temperature is only 6° to 8°, which is far below the daily range. Hence, throughout the State, the temperature varies more in the course of an average day than it does from season to season. In addition, the average nighttime temperature during most of the year is below the average temperature of the coolest months.

Almost everywhere at low elevations, the highest temperatures of the year are in the low 90's and the lowest temperatures near 50°. The warmest days are usually during Kona weather, when the trade winds, which come from cooler latitudes, fail and air stagnates over the heated islands.

As an example of the role of afternoon cloudiness in holding down the maximum temperatures, Maunaloa, at an elevation of 1,100 feet in dry West Molokai, has registered 90° or above in May through November, and 96° in September, while Lanai City only a few hundred feet higher, but shielded from the afternoon sun by an orographic cloud cap, has had no temperatures higher than 88°.

WIND

The prevailing wind throughout the year is the east-northeasterly trade. The trades vary greatly in frequency, they are virtually absent for long periods at some times and blow for weeks on end at others. On the average, however, the trade winds are more persistent in summer than in winter. At Honolulu they range from a minimum of about 45 percent in January to a maximum of more than 90 percent in July, for an annual frequency of about 70 percent.

In well-exposed areas, the trades average somewhat under 15 miles an hour. They are slightly stronger in summer than in winter. A speed of 31 miles an hour is exceeded only about 2 percent of the time by the trades and 3 percent by winds from other directions.

The strongest and most damaging winds are not ordinarily the trade winds but the winds that accompany winter storms and the infrequent hurricanes. High winds are more likely between November and March and blow from almost any direction. The strongest of recent years was a gust of 103 miles an hour at Kilauea Point, Kauai, in August 1959 during Hurricane DOT, but gusts exceeding 80 miles an hour have occurred twice at Honolulu Airport since 1951 and occasionally elsewhere.

The effect of topography on the local wind is varied and profound, ranging from a complete sheltering from winds from certain directions to deflections and accelerations, that is, through passes and narrow valleys and over crests, that can transform a moderate wind into a strong and gusty one. Thus, the Hoolehua plains, the windward side of west Molokai, and the north end of Lanai are subject to severe wind erosion and occasional crop damage by strong trades funnelling between the highlands of east and west Molokai or through the channel between Molokai and Lanai. At Molokai Airport, in the central saddle, winds exceed 15 miles an hour nearly 60 percent of the time during the entire year, and more than 75 percent of the time during the summer months.

In contrast, the Kona coast of Hawaii Island is so completely sheltered by the mountains to the east that the trades are never experienced near sea level, and local land and sea breezes constitute the prevailing winds.

CLOUD COVER

On sunny trade wind days, all but Hawaii's tallest mountains are typically capped by cumulus clouds that overhang and shadow the slopes and coastal plains. The bases rest upon the crest. These clouds form within the moist marine air ascending the topographic barriers and dissipate again as the air descends to the lee. Hence, clouds are more frequent and extensive over windward coasts and mountains than over leeward plains and shores. At Honolulu Airport, which receives 22 inches

of rainfall annually and is well to the lee of the Koolaus, skies are clear (sky cover is three-tenths or less) about 26 percent of the time, and cloudy (sky cover is eight-tenths or more) about 28 percent of the time. In contrast, Lihue Airport, on Kauai's windward coast, is clear 14 percent of the time and cloudy 40 percent.

These are seasonal and diurnal variations in cloudiness. In all months of the year, probably because of solar heating, clouds tend to be more abundant during the day than at night. Widespread persistent cloudiness is principally a phenomena of large-scale winter storms. Presumably for this reason, skies are cloudy more often in winter than in summer. At Honolulu, for example, skies are cloudy on 29 percent of January days but on only 16 percent of July days. The heaviest overcast, however, seldom lasts for more than a day or two within a few intervals of blue sky and sunshine.

RELATIVE HUMIDITY

Relative humidity varies considerably with time and place. In general, is higher at night than in the afternoon and higher in rainier, cooler localities than in warmer, drier ones. As the trades reach Hawaii from cooler latitudes, the humidity is by no means as high as the tropical locale and surrounding ocean might imply. At Lihue, a windward station, the humidity ranges from about 79 percent in January to 75 percent in July, and from about 82 percent at 2 a.m. to 67 percent at 2 p.m. By comparison, the values at Honolulu Airport, on the leeward coast, average 70 percent in January, 68 percent in July, 74 percent at 2 a.m., and 58 percent at 2 p.m.

HURRICANES

Hurricanes are relatively infrequent and mild in Hawaii. Before 1950, there were no authenticated reports of hurricanes in the Hawaiian area. Four storms have approached the State, but not closely enough to affect the weather appreciably. The most damaging hurricane to strike Hawaii -- DOT, in August 1959 -- did approximately \$6 million in damage, largely on Kauai. About \$1.5 million of this amount was damage to sugarcane.

TORNADOES

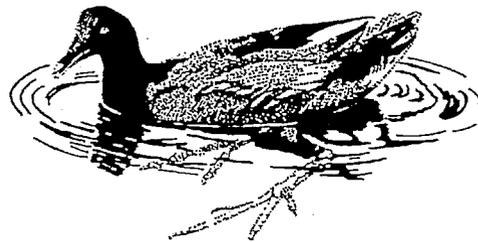
A number of funnel clouds occur over or near the State during an average year, but most either fail to reach the ground or remain at sea as waterspouts. Only rarely does a small tornado, usually much weaker than its mainland counterpart, cause even slight damage. By far the most destructive tornado of recent years was the one that roared through the small plantation town of Kaumakani, Kauai, in the early morning of December 17, 1967. The damage to houses, sugarcane, and other crops amounted to \$300,000.

HAIL

On the average, hail falls several times a year somewhere in the State, but it is only a quarter inch or less in diameter and thus does little damage. At times, however, leafy crops have been severely battered. Hail occurs most frequently between October and April, but it has been reported in every month but July. Falls usually cover only a square mile or less; only on occasion are they more widespread.

1991

Typical weather patterns occurred in 1991. Northeasterly trade winds averaging 12-14 mph blew through most of the year. Kona weather occurred periodically through fall, winter and spring months resulting in reduced winds from the south and prolonged periods of wet weather.



E. ADMINISTRATION

1. Personnel

Oahu NWR is a refuge complex within a refuge complex. The Oahu NWR is administered by the Hawaiian and Pacific Islands NWR Complex office located in Honolulu. The Oahu Complex manages James Campbell NWR and Pearl Harbor NWR on the island of Oahu, and Kakahaia on the island of Molokai. The refuge office is located on the north shore of Oahu in the small community of Haleiwa. The staff at Oahu consists of a refuge manager, wildlife biologist (co-operative education position), one permanent maintenance worker, and two temporary laborers.

The co-operative education position funded in 1987 to allow graduate research on endangered Hawaiian waterbirds was continued this year. Paul R. Chang continued in this position until June, then transferred to the Division of Law Enforcement.

Table 1: STAFFING - OAHU NWR COMPLEX
FY '87 - '91

	<u>Permanent</u>		<u>Temporary</u>
	<u>Full Time</u>	<u>Part Time</u>	
FY 87	3	0	2
FY 88	3	0	2
FY 89	3	0	2
FY 90	4	0	3
FY 91	3	0	2

OAHU NWR COMPLEX STAFF

1. Jim Glynn	- Refuge Complex Manager	GS-11
2. Paul Chang	- Wildlife Biologist (Co-operative Education Position) Transferred to Division of Law Enforcement 6-29-91	GS-9
3. George Fisher	- Maintenance Worker	WG-7
4. Dean Takayama	- Laborer (TFT - NTE 1 yr.) E.O.D. 8-12-91	WG-3
5. Robert Rawlins	- Laborer (TFT - NTE 1 yr.) E.O.D. 12-02-91	WG-3

4. Volunteers Program

Biologist Chang supervised Sierra Club volunteers clearing mangrove at Honouliuli unit on January 27th.

5. Funding

The Oahu National Wildlife Refuge Complex budget is allocated by the Hawaiian and Pacific Islands Refuge Complex project leader. The FY '91 budget for the Oahu NWR Complex was split between the 3 refuges on Oahu and Molokai.

6. Safety

No reported accidents occurred this year.

In November, maintenance worker Fisher and laborer Takayama traveled to Kilauea Point NWR for basic heavy equipment operator safety training on the 18-19th. The course was instructed by Dale Green of Klamath Falls NWR.

7. Technical Assistance

Refuge staff participated in semi-annual, state-wide waterbird surveys, and assisted other various agencies with resource-related concerns or problems. The Fish and Wildlife Enhancement, Honolulu Field Office frequently asked advice regarding review of Environmental Impact Statements and

Environmental Assessments pertaining to wetlands, waterbirds or any wetland mitigation projects. Refuge staff were also involved in proposed planning of other projects that may impact existing refuges, such as industrial parks, aquaculture facilities and golf courses. Projects involving the Pearl Harbor area included the West Loch Estates housing development and monitoring a mitigation plan for a watercress farm development adjacent to the Waiawa Unit of the refuge.

Intensive coordination between our Habitat Enhancement Office and the City and County resulted in significant mitigation measures involving the West Loch Estate Housing Development in Honouliuli. The City and County has agreed to provide the following mitigation measures: providing a visual screen of native shrubs along the boundary of the refuge; providing a 300 foot buffer zone between the refuge and the housing development with trees planted in this buffer zone; gates will be constructed to limit pedestrian traffic in the area adjacent to the refuge; fishponds adjacent to the refuge will be improved as habitat for waterbirds; and a fence will be constructed around the refuge to minimize animal entry within the refuge.

In February, manager Glynn and biologist Chang visited Kaloko - Honokohau National Park on Hawaii island at the request of the superintendent to assess and provide management recommendations for Kaloko and Aimakapa ponds.

Biologist Chang assisted the Department of Land and Natural Resources on forest bird counts from April 22 through 26 on the proposed Oahu Forest NWR area. An odd bird which might have been an endangered Oahu Creeper was sighted on the Kipapa trail.



Ruddy Turnstones

F. HABITAT MANAGEMENT

1. General

Pearl Harbor National Wildlife Refuge consists of two units. Waiawa Unit, 24.5 acres, and Honouliuli Unit, 36.5 acres, for a total of 61 acres.

This two-unit, 61-acre refuge consists primarily of shallow man-made impoundments surrounded by service roads (one-lane, gravel) and a partial scrub forest buffer zone 30 to 50 feet wide. A 7-foot high chain link fence surrounds each refuge unit. Water levels in the individual impoundments are maintained by electric pumps.

Dominant vegetation includes: Batis maritima, Brachiaria mutica, Pluchea indica, Scirpus spp., Echinochloa crus-galli, and Bacopa monnieri.



The Waiawa Unit

2. Wetlands

Waiawa Unit

Water levels in ponds A and B are maintained by pumping spring water via a long-abandoned concrete sewer line originally constructed by the U. S. Navy. The springwater enters the sewer line outside of the refuge through an accidental break made by a backhoe operator and exits the pipe at the mouth of Waiawa Spring where it is pumped into the refuge.

Honouliuli Unit

Water levels in the three Honouliuli Unit impoundments are maintained by pumping from a 12-foot deep well with a 3-hp vertical shaft pump.

Both refuge units were manipulated by partial dewatering during stilt nesting season to provide nest and brood habitat. Precise water level control and fluctuations must be conducted and monitored to provide optimum breeding and rearing habitat.

Vegetation and water manipulations were made in both units to control undesirable vegetation, and enhance growth of desirable plant species. Mechanical and chemical means were used to thin vegetation or release seed from clumped monotypic vegetation. Spraying followed by burning was used to prevent the spread of California grass into ponds and reduce predator habitat. Water regulation and manipulation was utilized for flooding undesirable plants at critical times, allowing germination of annual plant seeds, and enhancing the growth of new vegetation.

3. Forests

Both units of the refuge have introduced tree and shrub species that present management problems. Some areas are densely covered by kiawe (Prosopis pallida), a type of mesquite; koa-haole (Leucaena leucocephala), and fleabane (Pluchea). This vegetation is fast growing and must be cleared from fence lines yearly or it will destroy the fences. Another tree species, the mangrove, grows on the Pearl Harbor side of the units in the brackish wetlands. This species presently impedes a drainage ditch at the Waiawa Unit, preventing effective management and threatens to become a problem at Honouliuli.

9. Fire Management

No prescribed burning or wildfires occurred on the Pearl Harbor refuge this year.

10. Pest Control

Vegetation control is a year-round maintenance task. Herbicide spraying is used to control exotic vegetation on the roads, dikes and fence lines. Roundup and Rodeo are used per manufacturers instructions.

G. WILDLIFE

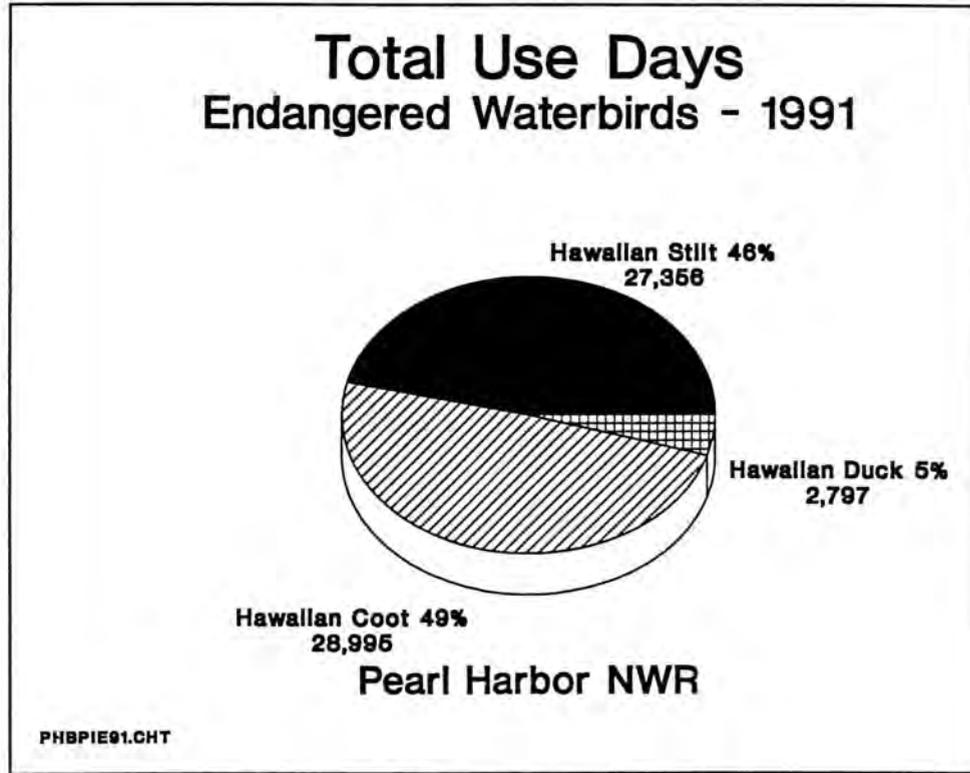
1. Wildlife Diversity

Habitat manipulations conducted on the refuge are intended not only to provide optimal habitat for endangered waterbirds, but to maximize habitat diversity to the benefit of all native and migratory wildlife species that use Hawaiian wetlands. The four endangered waterbirds collectively require and use a wide variety of habitats (see species accounts below).

2. Endangered and/or Threatened Species

The Pearl Harbor NWR is part of a wetland complex centered around the Waipio Peninsula sugar settling basins. The settling ponds provide abundant food for many stilts and shorebirds, as well as lesser numbers of coots and ducks. Some stilts nest at these settling ponds, but most nesting occurs on the refuge units. Both coots and stilts move between the settling ponds and refuge units, but most territorial birds remain on refuge units during the breeding season unless water or food conditions force them to go elsewhere. Most birds using the settling ponds are non-territorial birds that "float" among settling ponds and occasionally visit refuge units when food is more plentiful.

Oahu Sugar leases the settling pond land from the U. S. Navy, and they use the ponds for settling the solids out of sugar cane wash water. The milling operation closes for 3 months during the winter, and for nearly 2 months no water flows into the settling ponds. As settling ponds evaporate and dry, the dependent birds may be without foraging habitat if rains don't maintain mudflats and moist-soil areas.



Endangered Species - Total Use Days

Table 2: ENDANGERED WATERBIRD USE DAYS
PEARL HARBOR NWR
FY 1991

Endangered Waterbird Annual Use Days			
	Honouliuli	Waiawa	Refuge Total
Hawaiian Stilt	22,879	4,477	27,356
Hawaiian Coot	10,653	18,302	28,995
Hawaiian Moorhen	0	0	0
Hawaiian Duck	1,413	1,384	2,797
Total	34,945	24,163	59,108

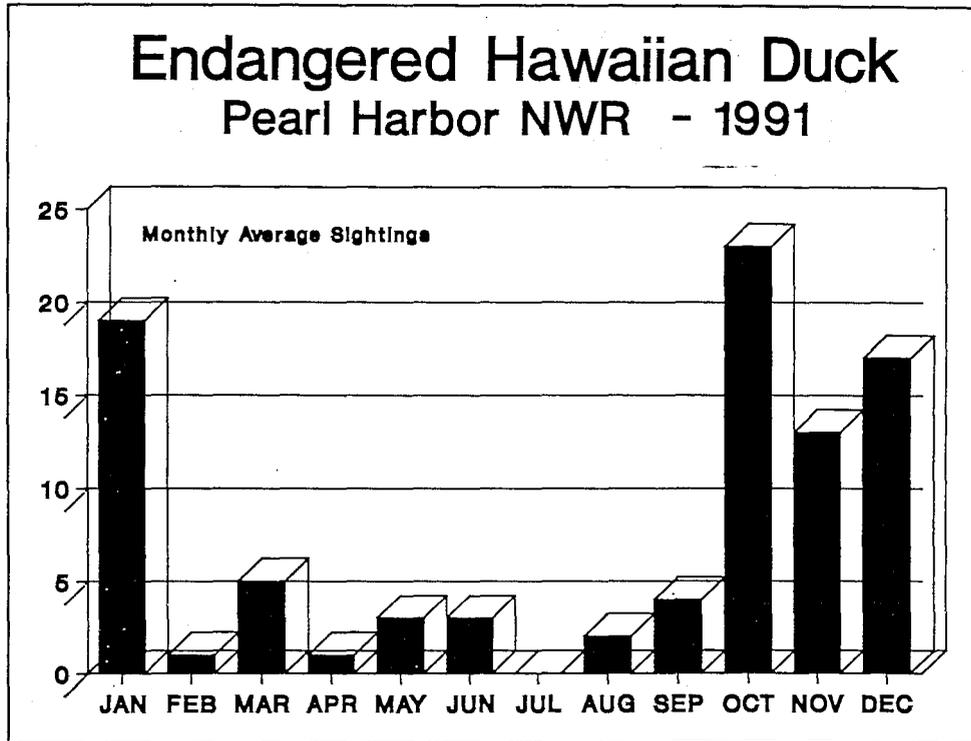
Hawaiian Duck ("Koloa")

Refuge staff observed an average of 8 koloa on the Pearl Harbor NWR and a high of 13 during 1991.

Identification of true koloa in the field is a problem due to high variation in plumage characteristics and size overlap with mallard hens. Hybridization of koloa and feral mallards does occur and is becoming a problem of great concern. Future inquiry into practical management of mallards and hybrids deserves effort in order to maintain a genetically intact koloa species.



Hawaiian Duck or Koloa



Sightings By Month



Hawaiian Duck

Hawaiian Coot ("Alae ke'oke'o")

Refuge coot numbers fluctuated widely throughout the year, with a low of 17 and a peak of 70 birds.

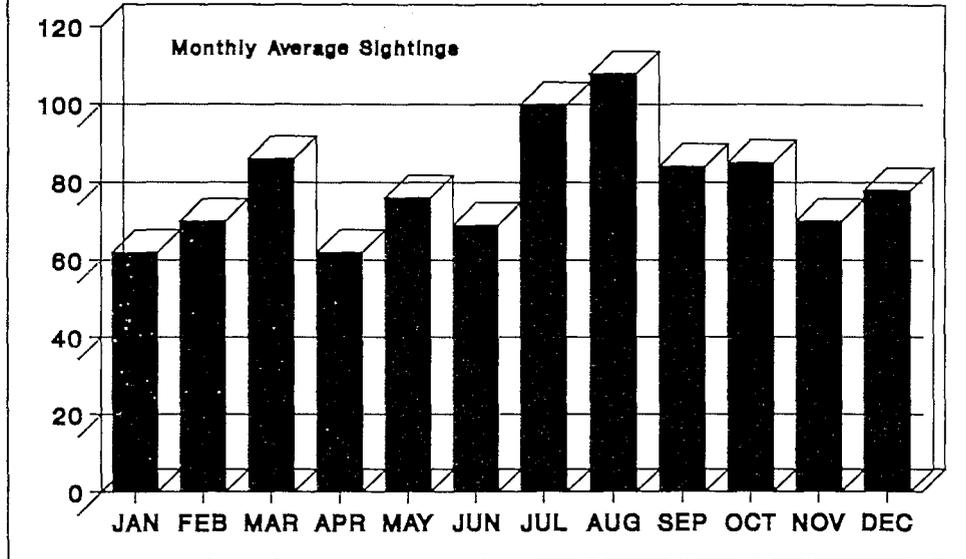
Coots use Honouliuli impoundments and the protected area of the West Loch of Pearl Harbor adjacent to the refuge. Pond 2 is most valuable to coots by providing excellent interspersed vegetation and water for nesting, feeding and cover.



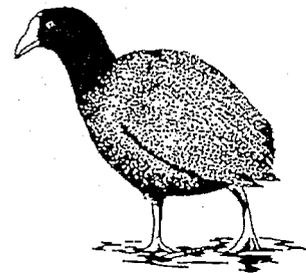
Hawaiian Coot or 'Alae ke'oke'o

Successful pairs of breeding coots require a territory that can be defended from intra- and interspecific competitors while also providing all nutrient requirements for egg production and chick growth, as well as adult maintenance. Most successful territories have a core area of permanent water with perennial plant species that provide cover and invertebrates, and peripheral areas that produce annual vegetation and provide periodic abundances of food.

Endangered Hawaiian Coot Pearl Harbor NWR - 1991



Sightings By Month

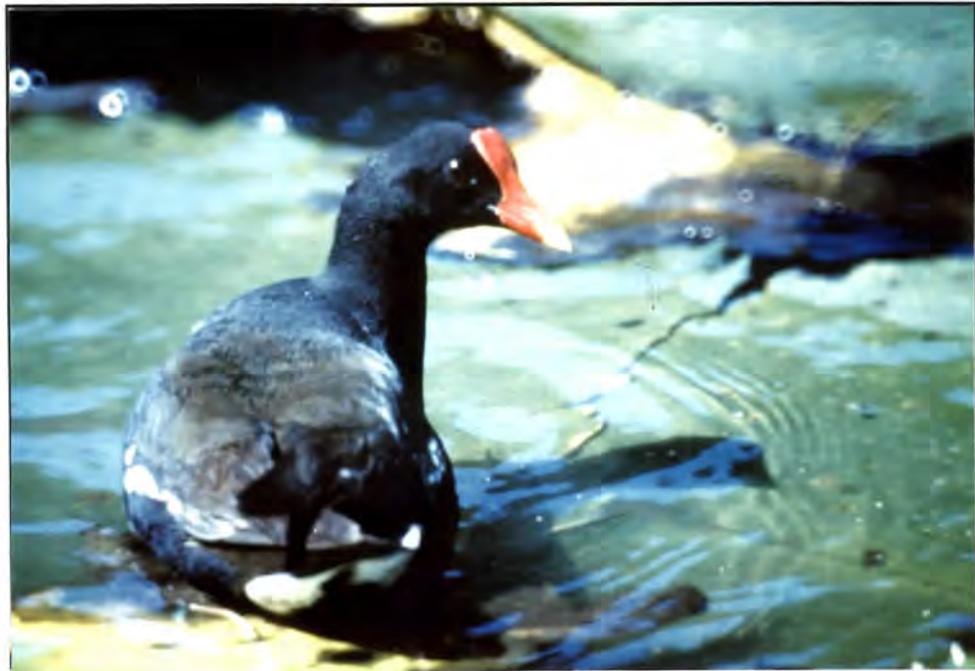


Hawaiian Coot

Hawaiian Moorhen ("Alae'ula")

Hawaiian moorhens were documented in the Waiawa Unit for the first time in 1988. The presence of moorhens may indicate that efforts to lower the salinity of this unit are increasing its suitability for this species. However, interspersed vegetation and open water will need to increase for this unit to become more desirable to moorhens.

No moorhens were seen on the Pearl Harbor NWR this year. Typically, 2 pairs of moorhen use the refuge.



Hawaiian Moorhen or 'Alae'ula

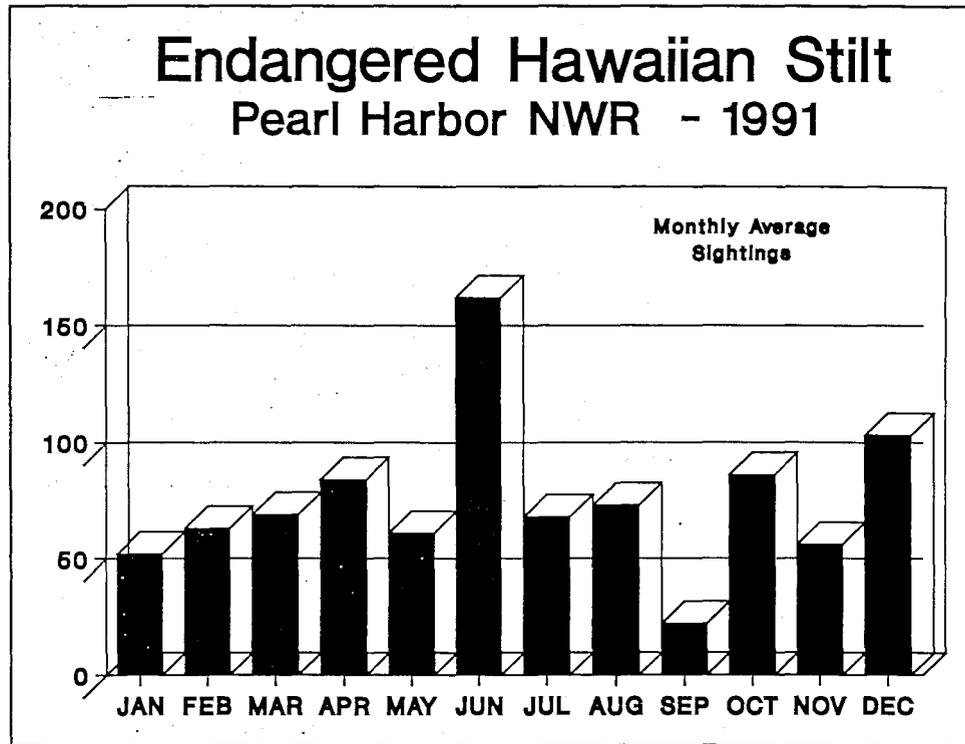
Hawaiian Stilt ("Ae'o")

During 1991, populations of endangered Hawaiian stilt at the Waiawa Unit fluctuated with flood availability. During low tides, stilts commonly leave the Unit to feed on exposed tidal mudflats. Total counts fluctuated between 6 and 25 birds.



Hawaiian Stilt or Ae'o

Stilt use of the Honouliuli Unit reflects changing availability of feeding habitat as it recovers from major alterations by heavy equipment. Numbers ranged from 13 birds in September to 137 in June. This unit is a primary nesting location for Hawaiian stilts. It is expected that past and ongoing impoundment projects will greatly increase the level of stilt nesting in this area.



Sightings By Month

Manipulation of moist-soil impoundments for stilt nesting creates favorable conditions for annual plant species such as millet and makai which provide cover for stilts, as well as cover, food and nesting habitat for other waterbirds. A slight drawdown at the onset of stilt breeding season provides small humps of mudflat or nesting islands. Additional drawdown provides mudflat and shallow water areas for the earliest hatching stilt chicks. Minor fluctuations of water levels ("pulsing") results in an increase in the availability of Gambusia, Tilapia and invertebrates as they are stranded in small depressions in the mudflats.

3. Waterfowl

Wintering and migrating waterfowl use both units of the refuge during the spring, fall, and winter months. Numbers of pintail and shoveler have decreased dramatically since 1987 when as many as 30 shovelers and 40 pintails were observed.

During 1991, high counts for shoveler and pintail were 25 and 52, respectively.

Average shoveler and pintail use was 4 and 10, respectively.

4. Marsh and Waterbirds

The native black-crowned night heron is fairly common in this area. This species is highly mobile and opportunistic, exploiting temporary food sources as they become available. Numbers increase during periods of drawdown, when crawfish, fish, and frogs are stranded in small pools, however a few individuals are always present in the vicinity of refuge impoundments. Heron numbers increased in 1991 (24) over those observed (15) in 1990. There are usually 3 to 5 heron nests in the mangroves west of the refuge.

Cattle egret use of this area tends to be sporadic, again, relative to availability of food. The high count for the Waiawa Unit was 4 in August. The high count for the Honouliuli Unit was 65 in November.

5. Shorebirds, Gulls, Terns, and Allied Species

Both units of the refuge provide habitat for wintering and migratory shorebirds. The most common shorebirds during spring, fall and winter months are the lesser Pacific golden plover, ruddy turnstone, sanderling and wandering tattler. Occasionally western sandpipers are seen on these units also. High counts for plovers were comparable to past years with a peak of 47 on the Waiawa Unit and 46 on the Honouliuli Unit in August.

A least tern and a common tern were present on the Honouliuli Unit in August.

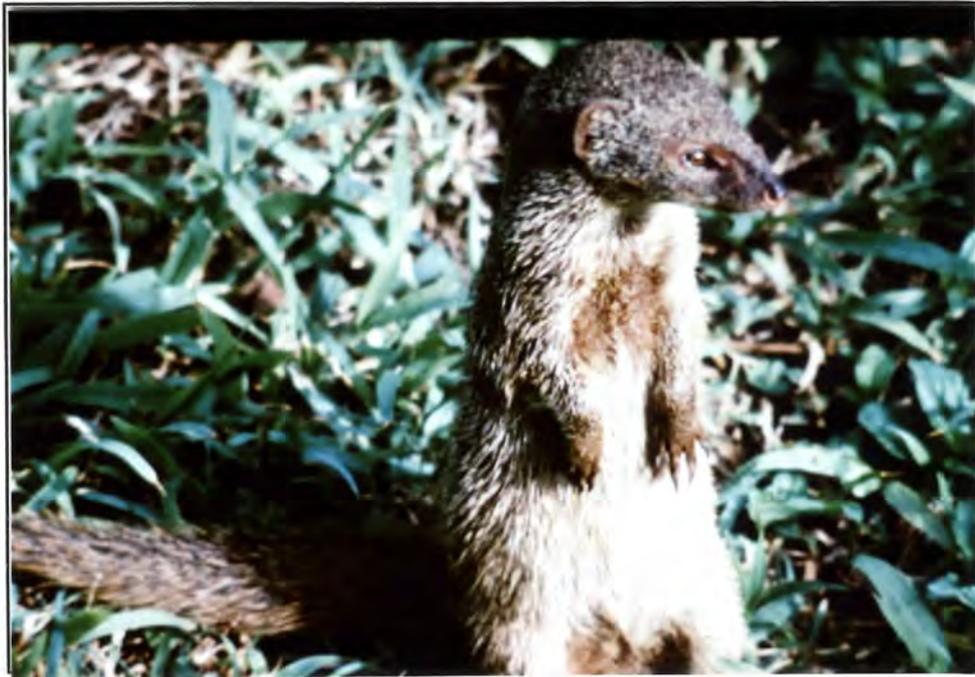
6. Raptors

Occasional observations of a barn owl were made on the Waiawa Unit in 1991. This species was introduced to prey on rats and mice in sugar cane to hopefully decrease the impacts of rodents on cane production.

15. Animal Control

The mongoose is a prolific animal that is quite an efficient predator of water bird nests and young. Trapping efforts seem to be effective for short-term control over small areas. Heavy trapping pressure will remove most of the animals from an area, however populations usually return to pre-trapping levels within 2-3 weeks.

Live traps were set to catch mongooses, cats, rats and dogs.



Mongoose

17. Disease Prevention and Control

Manager Glynn and biologist Chang attended a disease workshop from the 12th - 14th on Hawaii island.

H. PUBLIC USE

1. General

Public use of the refuge during 1991 was limited to specific requests by school groups, local birding groups and individuals interested in visiting the refuge for educational purposes such as photographic documentation or wildlife observation.

2. Outdoor Classrooms

The refuge was visited by 15 groups for a total of approximately 450 students, during the year. Refuge staff and local primary and secondary school teachers conducted the tours. Most school groups visit during the late fall and winter months when many migrant birds are present to observe, most ponds are full, and stilt are not yet nesting--when disturbance could impact them.

11. Wildlife Observation

Five groups toured the refuge during 1991 for the purpose of wildlife observation.

I. EQUIPMENT AND FACILITIES

2. Rehabilitation

Vegetation control is a year-round maintenance task. Herbicide spraying was used to control exotic vegetation on the roads, dikes and fence lines.

Mowing dikes and roads and cleaning of water control structures and water delivery systems was performed throughout the year.

4. Equipment Utilization and Replacement

A new Kubota slope mower tractor was delivered on June 5th. This tractor will improve the predator control program by reducing the thick California grass stands on dike slopes.

5. Communications Systems

A telephone system was installed in the newly acquired Haleiwa office on June 12th.

A fax line and fax machine was installed at the Haleiwa office in October.

J. OTHER ITEMS

1. Cooperative Programs

Refuge staff assisted the state with the annual Winter Water Bird Survey on January 10th.

On August 29th, Fisher and Takayama assisted the state with the Annual Summer Water Bird Survey.

3. Items of Interest

Jan - Refuge staff attended Aviation Flight Safety training.

Mar - Regional office contract specialist Tamara Swerdlik and refuge staff met with owners of the Xcel building in Haleiwa to discuss procurement of office space on the 6th.

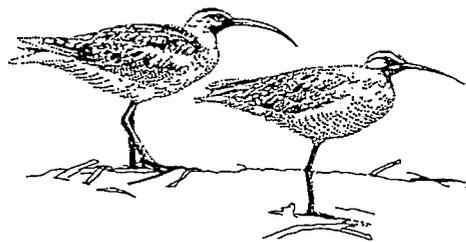
Apr - On the 18th, the Oahu NWR Refuge Complex office staff relocated to the Xcel building in Haleiwa on the north shore. The office was previously at the Federal building in downtown Honolulu.

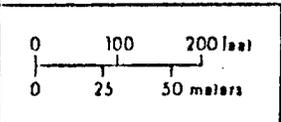
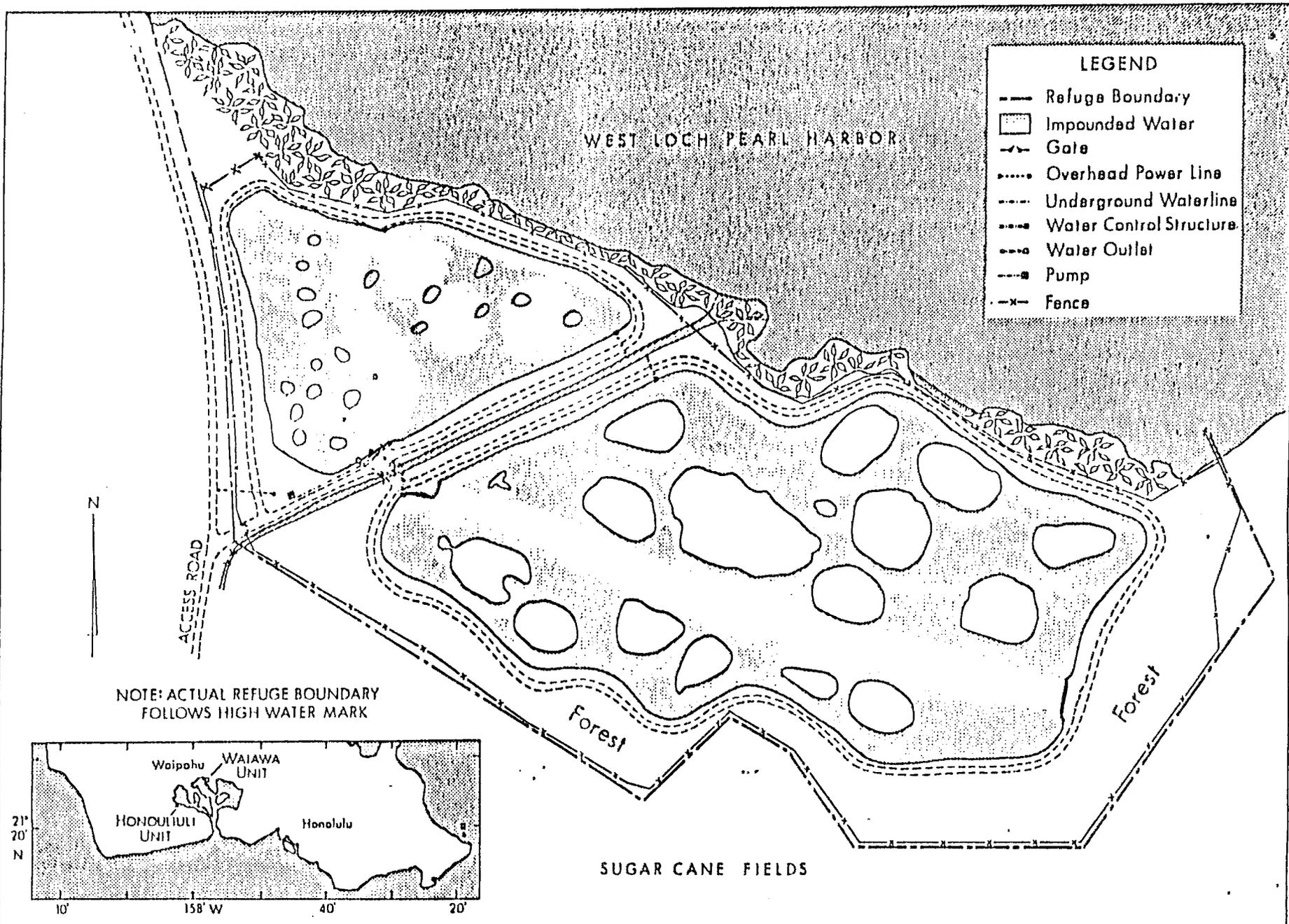
Jun - Maintenance worker Fisher completed pesticide applicator certification training on the 28th.

Jul - Maintenance worker Fisher attended Introduction to Wordperfect computer training 10-11th.

4. Credits

This report was written and edited by Johnny Beall.





HONOULIULI UNIT PEARL HARBOR NATIONAL WILDLIFE REFUGE
 Pearl Harbor, Island of Oahu, Hawaii

UNITED STATES
 DEPARTMENT OF THE INTERIOR
 Fish and Wildlife Service

LEGEND

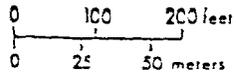
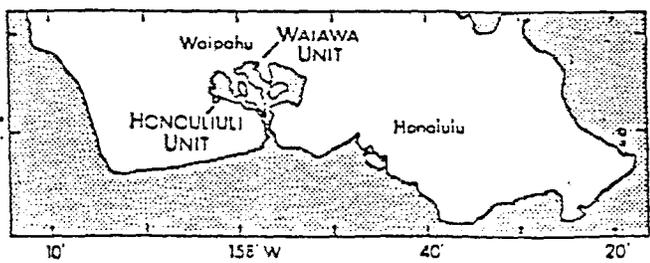
- Refuge Boundary
- Impounded Water
- ⌒ Gate
- Overhead Power Lines
- - - Underground Waterline
- Water Control Structure
- ⌒ Water Outlet
- ⌒ Pump
- ⌒ Sump
- - - Fence

WAIAWA ROAD

MIDDLE LOCH PEARL HARBOR



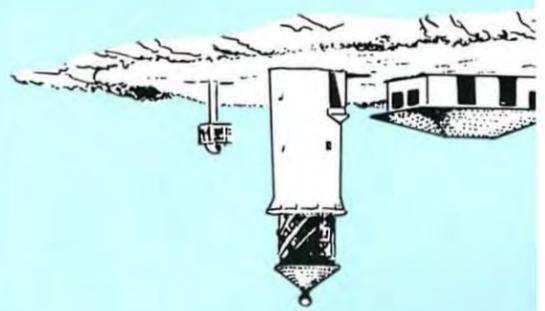
NOTE: ACTUAL REFUGE BOUNDARY
FOLLOWS HIGH WATER MARK



WAIAWA UNIT
PEARL HARBOR NATIONAL WILDLIFE REFUGE
Pearl Harbor, Island of Oahu, Hawaii

UNITED STATES
DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service

Natural history books is offered at the lighthouse. These hours will be expanded as staff and volunteers are available. NWR is open to the public Sunday through Friday. m. These hours will be expanded as staff and volunteers are available.



of wedge-tailed shearwaters and red-footed at Kilauea Point. You may also see other seabird as the Laysan albatross, the great frigatebird, and tropicbird.

located 1 mile north on a paved road from Kilauea highway on the north coast of Kauai, Hawaii.

at Kilauea Point NWR describe some of the wildlife of the five wetlands refuges and the six remote island refuges and their significance are briefly described.

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es in 1979.

uilt in 1913 and placed on the National Register of scenery and the historic old lighthouse. The light and marine mammals, to photograph and enjoy the visitors come to Kilauea Point each year to view



HAWAIIAN AND PACIFIC ISLAND NATIONAL WILDLIFE REFUGE



A diverse group of migratory shore birds also winters in Hawaii. They visit wetland refuges where suitable mudflats or shallow water habitats are available. Pacific golden plovers, sandpeppings, wandering tattlers and ruddy turnstones are most common.

Black-crowned night herons are common residents of the Hawaiian Islands. They feed on fish and invertebrates but may also take young waterbirds.

More than two dozen species of ducks and geese occasionally migrate to Hawaiian wetlands for the fall to spring seasons. The most common species are pintails and northern shovellers that breed in North America.

Mainland Migrants and Other Residents also Benefit from Hawaiian Wetlands.



- Shorebirds like plover, tattler, turnstones and sandpeppings also make the same annual migration from the mainland that waterfowl do.
- The native birds are joined from September to April by pintails, shovellers and other waterfowl that migrate thousands of miles from Canada, Alaska or Russia.
- The Hawaiian duck, Hawaiian noddie, Hawaiian gannet and Hawaiian booby are found only on the main Hawaiian Islands—they don't migrate to the mainland.

Some Interesting Facts About Hawaiian Waterbirds and Wetlands

All birds using the Hawaiian wetlands need appropriate foods and freedom from disturbance. The endangered waterbirds that only nest in Hawaii also need protection from predators.

A dependable water supply is necessary to support the waterbirds. Controlling water levels in various ponds can create conditions favorable for certain plants, insects and other organisms which in turn are food for the birds.

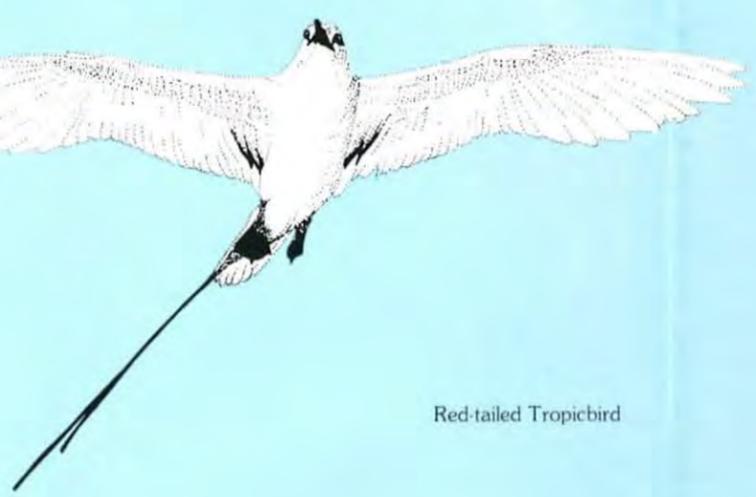
Creating artificial islands in refuge ponds separates bird nesting areas from dogs, cats and mongoose. Mammal-proof fences afford protection from feral dogs.

Habitats are Acquired and Managed to Enhance Waterbird Use

Formerly more common and more widely distributed, these species have experienced population decline due to continuing loss of habitat, introduced predators and, to some extent, harvest by man. Although celebrated in legends of early Hawaiians, these species were collected for feathers and food, and more recently were hunted for sport until protected prior to World War II. Housing and resorts continue to expand into existing or potential marsh habitat in the Hawaiian Islands. The natural variety of habitats and quality of water and food supply was greater in the past before the wetlands were converted to other uses.

Habitat Loss and Predators Endanger the Waterbirds

THE WETLAND REFUGES



Red-tailed Tropicbird

Baker Island NWR—This island lies just north of the equator approximately 1,600 miles southwest of Honolulu. The 340-acre island is surrounded by 31,397 acres of submerged land included in the Refuge. Like the Hawaiian Islands NWR, Baker Island has a history of commercial guano harvest late in the 18th century and was occupied by American forces during World War II. The island supports four migratory seabird species.

Howland Island NWR—This island is located within 200 miles of Baker Island in the central Pacific. Both islands are vegetated by grasses, prostrate vines and low-growing shrubs. Howland contains 400 acres of emergent land and 32,150 acres of submerged land within the three mile limit of the Refuge. Guano harvest operations ceased in 1878. This island enjoyed some fame this century when an airstrip was built in 1937 for Amelia Earhart's ill-fated flight. Today Howland Island NWR supports eight species of migratory seabirds.

Rose Atoll NWR—The atoll is the easternmost emergent land in the Samoan Archipelago and is among the smallest of all atolls in the world. Two small islets, less than 20 acres in total size, are protected by a square reef, dominated by coralline algae. The largest of the two islets supports a dense forest of *Pisonia* and *Tournefortia* trees, and these trees provide cover and nest sites for 12 species of migratory seabirds. Threatened green sea turtles frequently nest on the two islets and feed in the central lagoon. Among the diverse marine fauna in the lagoon are numerous fish species and a population of giant clams. The Refuge, which includes the islets, the entire lagoon and surrounding reef, was established in 1974. It is managed cooperatively by the U.S. Fish and Wildlife Service and the American Samoa Government. At 14½ degrees south latitude it is the southernmost refuge in the National Wildlife System.

For more information:
 U.S. Fish and Wildlife Service
 300 Ala Moana Blvd., Rm. 5302
 P.O. Box 50167
 Honolulu, Hawaii 96850
 (808) 541-1201



Masked Boobies



U.S. Department of the Interior
 Fish and Wildlife Service



THE REMOTE ISLAND REFUGES

Some Facts About Remote Pacific Islands and Wildlife

Over 5 million seabirds (18 species) nest on less than 2,000 acres on the northwestern Hawaiian Islands.

Many seabirds roam the Pacific Ocean for several years before returning to remote islands to nest.

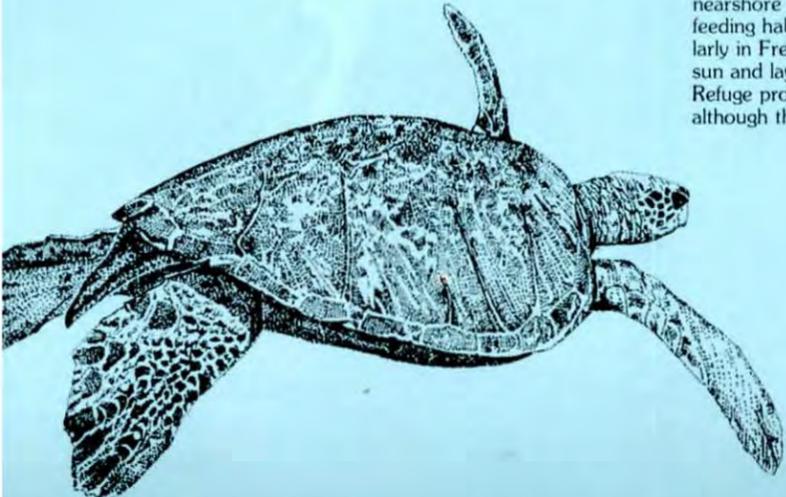
Frigatebirds fly continuously when at sea. Their feathers won't repel water like some other seabirds. To supplement the fish they catch, frigatebirds frighten boobies and shearwaters and take their food. Hawaiians called them Iwa, which means "thief".

Albatrosses don't nest until they are about seven years old. They will choose their mates and nest together each year for life. They may live over 30 years.

250,000 acres of submerged reefs surrounding 1,800 land acres of the remote Hawaiian Islands NWR provide habitat for fish and other life which in turn feed millions of seabirds.

Green Sea Turtles that nest on Pacific islands may roam several hundred miles in search of feeding areas.

As an experiment albatrosses were flown blindfolded to Alaska, San Francisco, Los Angeles, Australia and other points. Upon release they flew back to Midway Island (1,500 miles west of Honolulu) within 10 days.



Remote Island NWRs—Tiny Wildlife Oases in the Vast Pacific Ocean

Mere dots in the vast ocean, the remote mid-Pacific islands host breeding monk seals, turtles and millions of seabirds. They nest on rocky islands and islets among coral atolls.

The marine environment on the remote island refuges is largely undisturbed by commercial exploitation and consequently many species are unusually abundant. The relatively pristine nature of the nearshore waters and the importance of this habitat to seals, turtles and seabirds led to the inclusion of large bodies of protected lagoon and nearshore waters into the boundaries of various remote island refuges.

There are more than 14 million seabirds of 18 species on the Hawaiian Islands NWR alone. Sooty Terns are the most abundant nesters on the remote islands. Also common are albatrosses, shearwaters, petrels, tropicbirds, frigatebirds, boobies, and noddies.

The terrestrial habitat of the Hawaiian Islands National Wildlife Refuge is shared by endemic land birds on the small islands of Nihoa and Laysan. The Nihoa finch and Laysan finch are representatives of the unique Hawaiian honey creeper subfamily that includes several more species in the main Hawaiian Islands. The Nihoa millerbird is an endemic representative of an old world warbler family confined in distribution to this 168 acre island. A close relative formerly found on Laysan Island is now extinct, as is a flightless rail and honeycreeper that inhabited the same island. All three birds were indirect victims of a short but devastating period of human exploitation for guano and feathers which was stopped early in this century when this refuge was established. One additional species, the Laysan duck, barely survived this period and has made a significant comeback.

The Hawaiian monk seal is another endangered species confined in distribution to the Hawaiian Islands NWR. Beaches and rocky shelves on several islands provide space to haul out and rear their pups, while nearshore waters within and adjacent to the Refuge provide critical feeding habitat. These seals share the beaches of sandy islets, particularly in French Frigate Shoals, with green sea turtles that bask in the sun and lay their eggs in sand pits during the summer months. The Refuge provides the primary breeding habitat for the green sea turtles, although the species ranges widely into the main Hawaiian Islands.

Managing Remote Islands for Wildlife.

The remote island refuges are manipulated only where it is necessary to control predators, exotic plants or other factors adversely affecting the habitat or resident wildlife. Public access is severely restricted because of the history of abuse and slow recovery of these vulnerable areas when disturbed. Even research activities are closely scrutinized to minimize unnecessary disturbance and are confined largely to projects likely to yield important management data. A refuge field station is operated at Tern Island in the French Frigate Shoals, Hawaiian Islands NWR.

Remote Island Refuges

Hawaiian Islands NWR—This Refuge, the oldest and largest in the complex was designated in 1909 by President Theodore Roosevelt. The Hawaiian Islands NWR includes all the emergent rocky islands, sandy islets and major atoll lagoons between Nihoa Island and Pearl and Hermes Reef in the northwestern portion of the Hawaiian Archipelago. In total, nearly 1,800 acres of emergent land and over 250,000 acres of submerged land are included. Remnants of prehistoric occupation by early Polynesians are also protected on Nihoa and Necker Islands.

Johnston Atoll NWR—This Refuge is located 825 miles southwest of Honolulu. The Refuge is managed cooperatively with the Defense Nuclear Agency. Twelve species of seabirds breed on four islands within the atoll. The reef community in the lagoon supports diverse marine life including green sea turtles. The atoll was first protected as a federal bird refuge in 1926, although it has been used extensively as a military installation since 1939.

Jarvis Island NWR—Jarvis is part of the Line Islands Archipelago and is located just below the equator, 1,300 miles south of Honolulu. The island is about 1,100 acres in size. The Refuge also includes 36,419 acres of adjacent submerged lands. Like Baker and Howland the island is believed to have been discovered by European sailors early in the 18th century and was also exploited for its guano resources. Eight species of migratory seabirds are known to nest on Jarvis Island. Feral cats were at one time found on all three of the equatorial refuges where they preyed heavily on nesting seabirds. They were successfully eradicated from Baker in 1964 and Jarvis in 1983. All three islands were designated as National Wildlife Refuges in 19

Four Endangered Waterbirds are Found on the Wetland Refuges

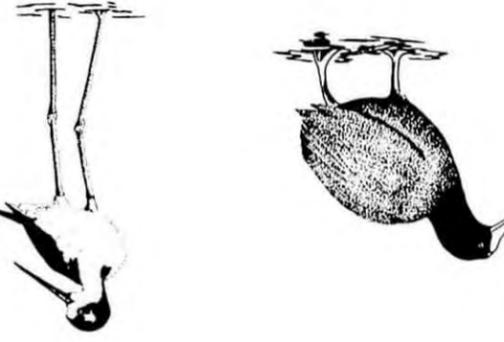
Wetland refuges on the main islands support four endangered waterbirds that are unique to Hawaii.



Hawaiian Duck or Koloa Maoli—is similar to though smaller than the common mallard. **Koloa Maoli** are most common on Kauai where they inhabit natural and artificial ponds, streams, ditches and marshes.



Common Moorhen (Hawaiian Gallinule)—is related to the coot and is found in similar habitats. It is distinguished by its bright red bill and forehead. Its Hawaiian name is **'Alae Ula**.



American (Hawaiian) Coots—are easily recognized by their white floating nests built from aquatic vegetation. Their Hawaiian name is **'Alae Ke'oke'o**.



James Campbell NWR (Oahu)—This Refuge was established in 1977 through the lease of 142 acres of land in two major parcels from the James Campbell Estate. The Refuge includes the spring-fed Punamano Pond and a series of remnant cane wash water settling basins known collectively as Kii Unit. Prior to the closing of the Kahuku Sugar Mill in 1971, these settling basins provided important habitat for stilts, coots, and gallinules. This habitat is being restored and enhanced through major modifications to the impoundments and water system to provide manageable nesting and feeding areas. The Refuge is open to the public on certain weekends and at other times by special permit.

Pearl Harbor NWR (Oahu)—This 40-acre Refuge was established in 1977 on Navy lands in an effort to compensate for loss of still feeding habitat when a reef runway was added to the Honolulu International Airport. The Honolulu Unit was constructed at the site of remnant salt evaporation ponds through the excavation of new ponds with several nesting islets. Similar habitat was created for the Waiawa Unit at the northwest side of Waiawa Peninsula. These units were created primarily for Hawaiian Stilt, but other resident and migratory birds use them also. The Refuge is open by special permit only.

Public Uses are Limited by Size of Refuges

Public use of wetland refuges is limited because the areas are small and human visitors can disturb the endangered birds.

Acts and Figures of Wetland Refuges

Hanalei NWR (Kauai)—This Refuge established in 1972 includes 917 acres of the lush Hanalei valley. Taro is commercially raised on a portion of the Refuge by permittees. A by-product of this system is good habitat for all four endangered waterbirds. A new taro system replacing the historic hand-dug irrigation ditches has limited the acreage of taro and other wetlands to increase. The Refuge is not open to the public. An interpretive overlook on the state highway north of the Refuge explains the Refuge values and affords a spectacular view.

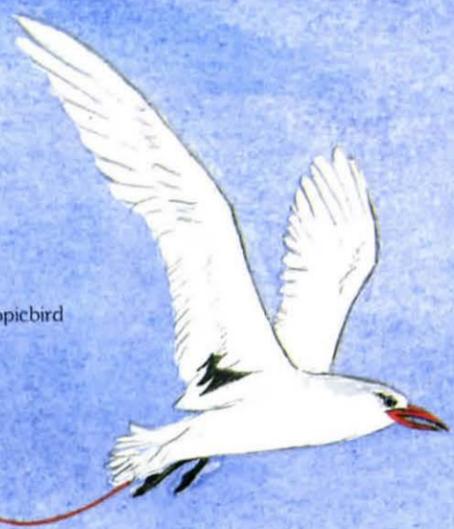
Huleia NWR (Kauai)—In 1973 approximately 240 acres of rippled slopes and bottom lands along the Huleia River were purchased to provide additional waterbird habitat. The Refuge includes ponds formerly in taro and rice that will be modified extensively to attract endemic waterbirds to new breeding and feeding areas. The Refuge lies adjacent to the famous Menehune Fish Pond, a registered national historic landmark. The Refuge is not open to the public. It can be seen from the Menehune overlook along the road.

Molokai NWR (Molokai)—This Refuge, established in 1976, includes a remnant inland freshwater fish pond along the south coast of Molokai. This pond was expanded in 1983 to enhance habitat for and coots. The county of Maui operates a small beach park on

HAWAIIAN AND PACIFIC ISLAND



Red-tailed Tropicbird



Laysan Albatross



Hawaiian Islands NWR
French Frigate Shoals



Huleia NWR



Johnston Island NWR
Red-footed Boobies

Hawaiian Monk Seals, Green Sea Turtles and million seabirds come from all over the Pacific Ocean to nest or rear young on the remote, island-Pacific islands.



Baker Island NWR
Howland Island NWR



Niihau Millerbird



Black-footed Albatrosses



Jarvis Island NWR
Sooty Tern Colony



Sooty Terns



Hawaiian Monk Seal



Bottlenose Dolphin



Brown Booby



Green Sea Turtle

Achilles T



Gray-backed Tern



Bonin Petrel

S NATIONAL WILDLIFE REFUGES



Hanalei NWR



Kilauea Point NWR



James Campbell and Pearl Harbor NWRs



Kakahaia NWR

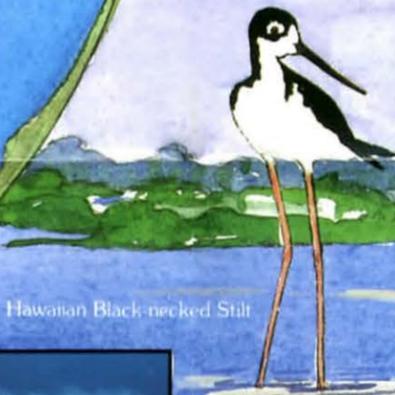


Great Frigatebird



Northern Pintails

Marshes and ponds on the main Hawaiian Islands support endangered resident waterbirds and migrating waterfowl and shorebirds from the North American mainland and other continents.



Hawaiian Black-necked Stilt



Rose Atoll NWR



Pacific Golden Plover



Sanderlings



Wandering Tattler



Common Moorhen (Hawaiian Gallinule)



Hawaiian Coots



Hawaiian Duck (Koloa Maoli)



Black-crowned Night Heron



Acropora Coral



C. HOLLEN