

**HAWAIIAN WETLANDS
NATIONAL WILDLIFE REFUGE COMPLEX
HONOLULU, HAWAII**

**ANNUAL NARRATIVE REPORT
Calendar Year 1988**

**U. S. Department of the Interior
Fish and Wildlife Service
NATIONAL WILDLIFE REFUGE SYSTEM**

PERSONNEL - 1988
HAWAIIAN WETLANDS NATIONAL WILDLIFE REFUGE COMPLEX

Stephen L. Berendzen	Asst. Refuge Manager (Wetlands) GS-9 (PFT) [transferred to Colusa NWR]
Katherine J. Castelo	Refuge Assistant GS-6 (PFT)
Paul R. Chang	Co-op Education Student GS-5 (TFT)
Stewart I. Fefer	Refuge Complex Manager GS-12 (PFT)
Thomas E. Harvey	Asst. Refuge Manager (Wetlands) GS-9 (PFT)
Shirley A. Hernandez	Purchasing Agent GS-5 (PFT) [transferred: 10/88]
Jeff Holm	Wildlife Biologist GS-7 (PFT)
Jerry F. Leinecke	Supv. Refuges & Wildlife GM-13 (PFT)
Myra Shiratori	Purchasing Agent GS-5 (PFT) [EOD: 10/88]
Wendy A. Tashiro	Clerk-Steno GS-3 (PFT)
Anthony Texeira	Maintenance Worker WG-5 (TFT)
David H. Woodside	Maintenance Worker WG-6 (PFT)

REVIEW AND APPROVALS

Stewart I. Fefer
Submitted by Refuge Complex Manager

8/29/89
Date

Jerry F. Leinecke
Supervisor, Refuges & Wildlife Review

8/30/89
Date

Al Marmele
Pacific Islands Administrator Review

31 Aug 89
Date

Regional Office Review

Date

**HANALEI
NATIONAL WILDLIFE REFUGE
HONOLULU, HAWAII**

**ANNUAL NARRATIVE REPORT
Calendar Year 1988**

**U. S. Department of the Interior
Fish and Wildlife Service
NATIONAL WILDLIFE REFUGE SYSTEM**

INTRODUCTION

TABLE OF CONTENTS

A. HIGHLIGHTS

B. CLIMATIC CONDITIONS

C. LAND AQUISITION

1. Fee Title	NTR
2. Easements	NTR
3. Other	2

D. PLANNING

1. Master Plan	3
2. Management Plan	3
3. Public Participation	3
4. Compliance with Environmental and Cultural Resource Mandates	4
5. Research and Investigations	NTR
6. Other	NTR

E. ADMINISTRATION

1. Personnel	6
2. Youth Program	NTR
3. Other Manpower Programs	NTR
4. Volunteer Programs	NTR
5. Funding	6
6. Safety	NTR
7. Technical Assistance	6
8. Other	7

F. HABITAT MANAGEMENT

1. General	7
2. Wetlands	7
3. Forests	9
4. Croplands	9
5. Grassland	NTR
6. Other Habitats	NTR
7. Grazing	10
8. Haying	NTR
9. Fire Management	NTR
10. Pest Control	10
11. Water Rights	NTR
12. Wilderness and Special Areas	NTR
13. WPA Easement Monitoring	NTR

G. WILDLIFE

1. Wildlife Diversity	10
2. Endangered and/or Threatened Species	11
3. Waterfowl	15
4. Marsh and Waterbirds	15
5. Shorebirds, Gulls, Terns, and Allied Species	16
6. Raptors	NTR
7. Other Migratory Birds	NTR
8. Game Mammals	NTR
9. Marine Mammals	NTR
10. Other Resident Wildlife	NTR
11. Fisheries Resources	16
12. Wildlife Propagation and Stocking	NTR
13. Surplus Animal Disposal	NTR
14. Scientific Collections	NTR
15. Animal Control	NTR
16. Marking and Banding	NTR
17. Disease Prevention and Control	NTR

H. PUBLIC USE

1. General	17
2. Outdoor Classrooms - Students	18
3. Outdoor Classrooms - Teachers	NTR
4. Interpretive Foot Trails	NTR
5. Interpretive Tour Routes	NTR
6. Interpretive Exhibits/Demonstrations	18
7. Other Interpretive Programs	NTR
8. Hunting	NTR
9. Fishing	19

H. PUBLIC USE (Cont.)

10. Trapping.	NTR
11. Wildlife Observation.	20
12. Other Wildlife Oriented Recreation.	NTR
13. Camping	NTR
14. Picnicking.	NTR
15. Off-Road Vehicling.	NTR
16. Other Non-Wildlife Oriented Recreation.	20
17. Law Enforcement	NTR
18. Cooperating Associations.	NTR
19. Concessions	NTR

I. EQUIPMENT AND FACILITIES

1. New Construction.	20
2. Rehabilitation.	NTR
3. Major Maintenance	25
4. Equipment Utilization and Replacement	26
5. Communications Systems.	26
6. Computer Systems.	NTR
7. Energy Conservation	NTR
8. Other	NTR

J. OTHER ITEMS

1. Cooperative Programs.	NTR
2. Other Economic Uses	NTR
3. Items of Interest	NTR
4. Credits	26

K. FEEDBACK

INTRODUCTION

Hanalei National Wildlife Refuge (Refuge) was established in 1972 and consists of 917 acres of river bottom land, taro ponds, pastures, wetland impoundments and wooded slopes in the Hanalei Valley on the north coast of Kaua'i, Hawai'i. Seasonally flooded areas, the Hanalei River, taro ponds and the wetland impoundments provide maintenance and production habitat for four species of endangered waterbirds and other wildlife. Taro farmers are under Special Use Permit and farm approximately 120 acres of the Refuge.



The Hanalei National Wildlife Refuge is located five miles upstream of the Hanalei River mouth and encompasses both river bottom land and wooded upland slopes. (FWS files)

The following rainfall data were recorded at Princeville Ranch weather station, 1/2 mile north of the Refuge. This station is nearest Hanalei Refuge and provides the most representative rainfall data.

1988 RAINFALL DATA FOR HANAIEI
NATIONL WILDLIFE REFUGE

Month	Amount (inches)
January	11.10
February	2.18
March	7.68
April	5.51
May	8.72
June	1.66
July	5.11
August	5.13
September	4.67
October	4.61
November	11.27
December	9.45
<hr/>	
TOTAL ANNUAL RAINFALL	77.09
MEAN MONTHLY RAINFALL	6.42

C. LAND ACQUISITION

3. Other

The Refuge received a letter from the State of Hawaii, Department of Lands and Natural Resources, Division of Land Management, regarding the potential sale of the abandoned China ditch above the Refuge adjacent to the Hanalei River. Apparently, the State was inquiring as to whether or not there was interest in this portion of the abandoned ditch as landowners adjacent to the ditch had inquired as to whether the State would be willing to sell this area. Residents living adjacent to the ditch were concerned that the lack of maintenance of the ditch has resulted in the ditch serving as a breeding ground for mosquitoes. The Refuge responded that the area should be maintained for potential future use in the event that the existing China ditch intake did not perform.

D. PLANNING

1. Master Plan

The draft of the Master Plan for the wetland Refuges within the Complex raised concern from the State of Hawaii, Department of Land and Natural Resources regarding potential adverse effects on several archaeological and historic sites. In response to these comments and in order to comply with Section 106 of the National Historic Preservation Act, we entered into a Memorandum of Understanding with the Environmental Section of the U.S. Army Corps of Engineers (Corps) during 1987. According to this agreement, a Corps staff archaeologist will prepare an addendum to the Master Plan, addressing possible effects on historic sites and measures to mitigate these effects, if necessary. During 1988, the Service redirected the Corps of Engineers Archeologist's efforts to an archeological study of Hanalei Valley where the Service proposed development of waterbird impoundments. The archeological work relating to the Master Plan was not completed as scheduled during 1988. The Corps archeologist is still planning to conduct this work and Refuge staff awaited completion at year's end.

2. Management Plan

A management plan development schedule for the wetland refuges was agreed upon by Refuge and Regional Office staff. By year's end, a draft of the Waterbird Population Monitoring Plan and the Waterbird Nesting and Production Monitoring Plan were prepared for review. Prescribed Burn Plans were completed and fire permits received from the County of Kauai.

3. Public Participation

As part of the Environmental and Cultural Resources review process for the development of the wetland impoundments in the Refuge, the Environmental Assessment was sent to several public groups including; The Hanalei Project, University of Hawaii, Honolulu Poi Co., Residents of Hanalei, Kauai Community College, The Nature Conservancy, Hawaii Audubon Society, Conservation Council of Hawaii, and the Sierra Club of Hawaii. Results of consultations were positive with respect to implementation of our planned impoundment development.

The Water Quality Certification and Section 404 Permit for the wetland filling required announcement of the project in the local and statewide newspapers.

4. Compliance With Environmental and Cultural Resource Mandates

During March 1988, Refuge Managers Fefer and Harvey attended a training session conducted by the Advisory Council on Historic Preservation on Federal Projects and Historic Preservation Law. This was appropriate as a construction project required compliance with archeological resource preservation laws.

During 1988, the Refuge proposed to construct two wetland impoundments totalling 48 acres. These impoundments were to be built in existing wetlands and necessitated the placement of fill material on one acre of seasonally flooded wetland. Therefore, a Section 404 permit was required from the U.S. Army Corps of Engineers. An Environmental Assessment was prepared detailing the project and possible effects. Applications were prepared for the State of Hawaii, 401 Water Quality Certification from the Department of Health; Coastal Zone Management Compliance from the Department of Business and Economic Development; and Hawaii State Clearinghouse Review and compliance through the Office of State Planning. The Environmental Assessment and permit compliance process began in April when applications were filed. All environmental permits and required coordination was completed promptly except for the required water quality certification. The Water Quality Certification Process is permitted through State regulation to take one year. Due to continual coordination with the Department of Health of the State of Hawaii, the permit was issued in mid-August. We had requested that the permit be issued earlier so that the impoundments could be constructed during the dry period in the Hanalei Valley but were pleased, that the full year process was expedited. Once the Water Quality Certification was received, the Army Corps of Engineers promptly issued the required Section 404 permit.

The State of Hawai'i has determined that the Hanalei Valley is eligible for inclusion on the National Register of Historic Places. Facility and habitat improvements must be performed mindful of historic and archaeological preservation. Coordination with and concurrence from the State Historic Preservation Office is required for projects on the Refuge.

The Refuge advised the State Historic Preservation Officer of our intent to construct impoundments in Hanalei Valley on May 2, 1988. Included in this notification was a plan developed by U.S. Army Corps of Engineers Archeologist Charles Streck, in order to comply with Section 106 responsibilities. The State Historic Preservation Office responded indicating that not enough information was known concerning the sites of the proposed impoundments and that additional information was required. We consulted with the Advisory Council on Historic Preservation and determined that a Research Design which included an inventory of the site would be sufficient to meet the requirements of Section 106 for this project. A determination of "no adverse effect" was agreed upon by the State Historic Preservation Office and the Advisory Council on Historic Preservation. Charles Streck prepared a "Scope of Work and Research Design for Archeological Subsurface Survey, Construction Monitoring and Sampling During Construction of Impoundments at Hanalei Valley" which was submitted

to the State Historic Preservation Office in mid-June. On July 11, the State Historic Preservation Office responded with some minor comments but agreement with the Plan. Concurrence from the President's Advisory Council on Historic Preservation was received on 11 August, 1988.

Archeological monitoring during construction occurred on site during the development of the impoundments. Completion of the monitoring would not occur until the impoundments were completed. At year's end, development of a headwall for the water delivery system remained and this would require archeological subsurface monitoring.



Due to eligibility of the Hanalei Valley for inclusion on the National Register of Historic Places, close coordination with the State Historic Preservation Office and the federal Advisory Council are required under National Historic Preservation Law. This remnant of a Hawaiian aqueduct is typical of significant historical structures on the Refuge.
(JB)

E. ADMINISTRATION

1. Personnel

Stewart I. Fefer remained the Refuge Complex Manager for the Hawaiian Wetlands Refuge Complex. In March Stephen Berendzen transferred to the Refuge Manager position at Colusa National Wildlife Refuge in the Sacramento Refuge Complex. Thomas E. Harvey was assigned as Acting Assistant Manager for Wetlands in March and acted in this position until May when he was permanently assigned. Tom transferred from a wildlife biologist position within the Pacific Islands Refuge Office to assume this position. Jeffrey Holm was hired as the Wildlife Biologist for the Wetland Refuges during May. Jeff transferred to this position from the Assistant Refuge Manager's position on Tern Island, Hawaiian Islands National Wildlife Refuge.

During June, Timothy Cramer was hired as a temporary, full-time maintenance worker for the Hanalei Refuge. Due to "culture shock" Tim resigned within a few weeks of working at the site. Anthony Texeira was hired during August for this same position.

Plans were developed for staffing the Hanalei Refuge with a permanent full-time Assistant Refuge Manager. However, long-term base funding was not available to commit to this permanent position.

5. Funding

The Fiscal Year 88 budget for the wetland refuges was split between the five Refuges on O'ahu, Kaua'i and Moloka'i. The total management, operations and maintenance budget for the wetland Refuges was \$300,000.00. Additional funding was provided by the Challenge Grant Program (\$12,000 from the Challenge Grant Program matched by \$12,000 from the James Campbell Estate, Ducks Unlimited, the State of Hawaii and the Hawaii Audubon Society), and Special Projects including contaminants monitoring, and impoundment development at the Refuge (\$65,000). Part of the base budget funding was allocated from the Special Appropriation received from Congress for Hawaii Refuges which totalled \$500,000.00.

Fiscal Year 88 was a year of significant capital expenditures at the Hanalei Refuge. In addition to the \$65,000 spent on developing the wetland impoundments, approximately \$20,000 was spent on improving the Hanalei quarters to bring it to good condition and an additional \$5000 was spent on tools and equipment for maintenance of this area.

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 Ecological Services 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. Projects on Kauai that required Refuge technical assistance included planning for mitigation activities involving Pua Poa Marsh and review of activities proposed in the Hanalei River. The Refuge staff also provided technical assistance to The Hanalei Project through the review of documents.

8. Other Items

A Refuge revenue sharing check for \$14,219.00 was presented to Kaua'i Mayor Kunimura on April 29. This amount was based on 75% of the appraised land value of Hanalei and Hule'ia National Wildlife Refuges; however, only 59% of the full amount was appropriated, resulting in the payment.

The Complex Manager and Assistant Manager attended a public hearing on the State of Hawaii Water Commission's water registration process and requirements for registering surfacewater diversions and wells. All diversions and well use will need to be registered with the Commission on Water Resource Management in May 1989.

F. HABITAT MANAGEMENT

1. General

This 917-acre refuge consists of wooded slopes, river bottom land supporting taro farms, pasture and wetland impoundments in the northern end of Hanalei Valley. The primary wetland habitats are taro fields (120 acres), located on both sides of the Hanalei River and impoundments (64 acres) on the west side of the river. The 4- to 6-inch water depth maintained by taro farmers provides habitat for the four endangered Hawaiian waterbirds: stilt, coot, moorhen, and duck. Following planned completion of repairs and a water-delivery system in 1989, the impoundments built this year, will greatly increase the availability of both maintenance and production habitat on the Refuge. With additional funding new wetland impoundments eventually may be constructed in for remaining pasture lands. The river that flows north through the middle of the Refuge also provides wetland habitat.

2. Wetlands

Taro fields are generally considered to provide good maintenance habitat for endangered waterbirds. However, due to their high level of human disturbance, their production value is limited. The additional wetland impoundments which were constructed this year in former pasture land will provide good habitat for all four waterbird species throughout the year and for wintering migrant waterfowl and shorebirds.



Fallow taro field providing excellent feeding opportunities for Hawaiian stilt and coot. Human disturbance and predation reduce the value of these agricultural wetlands for nesting waterbirds.



Newly constructed impoundments which were completed should provide excellent waterbird maintenance and production habitat with much less water use than in taro fields. (SIF)

California grass which has been choking pond A soon after it was constructed in 1983, was considerably opened up through the aerial application of the herbicide Rodeo. The proposed dike-raising planned for this pond in 1989, will improve our ability to inundate the vegetation and maintain open water/mudflat habitats.

The Hanalei River, drainage and delivery ditches, and taro fields also provide wetland habitat for the endangered waterbirds; but most of this habitat is used for maintenance. The Hawaiian coot, stilt and duck are uncommon nesters at Hanalei, but the additional Service-managed wetland impoundments should provide good production habitat.

3. Forest

The forested slopes (458 acres) along most of the Refuge perimeter provide an excellent buffer zone for the wetland. Hau (Hibiscus tiliaceus), a tree up to 15m tall grows in dense thickets along ditches and lowland areas on the Refuge. It will invade wetlands, impede ditches, aggravate flooding threats and requires frequent removal by permittees and Refuge maintenance staff. Significant stands were removed on part of new impoundment construction this year. (See Section I.1).

4. Croplands

A total of 11 taro farming permittees presently lease areas ranging from 7 to 27 acres in size. Nine of them maintain residences or equipment storage sheds on the Refuge. They pay a fee for the land they farm and reside on, but based on a 1986 Regional Solicitor's opinion, the permittees own the houses, and the Service charges no rent.

In April, the Refuge received a request from Sen. Daniel Inouye, on behalf of one of the taro permittees who wished to expand his farm. We informed Sen. Inouye that we did not expect to have additional land available for expansion of taro farming. We also stated our intention to first see all of the 150 acres presently permitted for farming under cultivation and then only if funding is not available for additional impoundment construction, consider expanding or issuing new taro leases. Results of recent studies have underscored that optimal waterbird habitat is best provided in wetland impoundments and less so in taro fields.

Some damage from coots occurs to young taro plants during the winter and farmers may put up chicken wire fencing to exclude the birds from recently started fields where damage is typically greatest. Some farmers suffer the loss and accept the damage as one of the costs of farming on the Refuge. Lease fees are set at an appropriate rate to compensate farmers for losses incurred as a result of the need to favor birds in bird-taro conflicts. Despite the loss to coots, most farmers feel the farming is profitable and they appear tolerant of the waterbirds.

Several times during the year, Refuge staff met with taro farmers to discuss concerns regarding ditch and road maintenance, water allocation and to answer questions regarding Refuge policy or impoundment construction plans. Farmers are required to cooperatively maintain irrigation and drainage ditches, however, conflicts frequently arise.

7. Grazing

Approximately 97 acres of grazing land exist on the Refuge. Currently, three grazing permits are used on the Refuge: Mahuiki (26.14), Tai Hook (17.5), Princeville Ranch (45.0) and Haraguchi (8.4). The total Animal Unit Months grazed on Hanalei during 1988 was approximately 828 at \$1.25 per Animal Unit Month.

The main benefit of grazing to refuge management is providing close-cropped pasture as seasonal habitat for waterbirds. Grazing also converts nutrients currently tied up in dense grass into a more accessible media. Problems caused by grazing include damage to crops, dikes, irrigation structures, or endangered waterbird nests from cattle that escape fenced areas.

In 1988, Princeville Ranch continued to cooperate with the Service by grazing the 16-acre impoundment (pond A) as an experimental method of vegetation control. This method was helpful at reducing choking coverage of the pond by noxious California grass, however, some significant trampling/compacting of the pond dikes also occurred. With the construction of two additional impoundments adjacent to pond A this year, we have excluded pond A and the former lower pasture site of Princeville Ranch from their lease. In the future, we intend to control California grass through herbicides, mowing, discing and flooding.

10. Pest Control

Dogs and cats appear to be the worst predators of endangered waterbirds on Kaua'i. Wild chickens or "jungle fowl" cause problems to taro by pecking holes in taro corms, thus allowing invasion of bacteria and fungus that rot the corm. Wild chickens are controlled by Refuge staff throughout the year.

G. WILDLIFE

1. Wildlife Diversity

The Hanalei National Wildlife Refuge provides a wide variety of habitats for endangered waterbirds as well as for other wetland inhabitants. Habitat diversity and, subsequently, wildlife diversity will be increased with the completion and management of the new wetland impoundments (see section, Habitat Management).

2. Endangered and/or Threatened Species

Four endangered species of waterbirds use the Refuge: Hawaiian stilt, coot, moorhen, and duck. Waterbird censuses are conducted from two overlook locations above the valley with a high powered telescope. Taro provides a dense cover that frequently obscures viewing of waterbirds; however, systematic refuge counts are designed to provide an index to population variation. Due to limited manpower and funding and a several month waiting period for repair of the telescope, monthly counts of the Hanalei National Wildlife Refuge were not conducted during most of 1988. Several incidental counts were conducted during the year.

The endangered Hawaiian bat ('Ope'ape'a) often feeds over open water areas on the refuge in the evenings.

Hawaiian Duck

Count data for the Hawaiian duck show considerable variation. There is a great deal of crepuscular movement throughout the valley, perhaps to mountain streams off the Refuge during days, but back to safe roosting areas (such as the Refuge) during the night. Also, birds tend to be solitary or in pairs, so scattered individuals near dense cover are difficult to detect. As a result, Refuge counts are of questionable accuracy.

Hawaiian Coot

The coot population is variable and ranges from 20 to 150 with no obvious seasonal trends. The average population is approximately 50 birds. No nesting has been reported on the Refuge, but coot broods have been observed on Hanalei River adjacent to the Refuge. New refuge impoundments will provide coot production habitat that has been lacking in this area.



The Hawaiian coot is a common resident of Hanalei Valley, but resting habitat is limited. New impoundments scheduled for completion in 1989 should provide much needed production habitat. (GH)

Hawaiian Moorhen

Moorhens are relatively secretive and, therefore, it is difficult to assess the population in a given area. Count accuracy increases proportionately with increased observation time and Refuge counts are designed to allow for this factor. At present, most nesting attempts by this species occur in taro ponds. The conditions of the Special Use Permits issued to taro farmers require reporting any waterbird nests found in their allotments, and provision of a buffer area around all located nests. It is felt that many taro farmers do not report all nests that they find, and that some nests are destroyed during their operations. In addition, nest success is very low in nests that are reported, possibly due to a combination of inadequate buffer size and continued disturbance during the nesting period.

The new impoundments should draw some of the nesting population out of the taro ponds and overall production should increase with increased use of this relatively safe habitat.

The new impoundments should draw some of the nesting population out of the taro ponds and overall production should increase with increased use of this relatively safe habitat.



The Hawaiian moorhen is the most common waterbird in taro patches on the Refuge. Taro ponds provide excellent maintenance habitat but are marginal for production. (GH)



Several moorhen broods were successfully raised on the Refuge in 1988, however, the majority of nesting attempts failed due to disturbance. (FWS file photo)

Hawaiian Stilt

Stilt numbers are also quite variable at Hanalei Refuge. During dry periods, stilts congregate in refuge wetlands. During rainy periods this species exhibits large scale movements to ephemeral wetland areas, some located on the island of Ni`ihau.

Nesting at Hanalei is generally restricted to narrow dikes between taro fields, however, the new impoundments will provide considerable mudflat area for nesting and brood rearing and production should increase when impoundment construction is completed.



Hawaiian stilt nesting at the Refuge is primarily restricted to taro pond dikes. More secure nesting habitat will be provided by the new impoundments currently under construction. (JH)

3. Waterfowl

Small numbers (10-50) of northern shoveler, northern pintail, green-winged teal and American wigeon were observed utilizing the 20-acre impoundment and taro fields on the Refuge during the months of November through February. Waterfowl use of the Refuge is expected to increase substantially with the development of additional impoundments which will provide the required feeding habitat during the winter season.

4. Marsh and Waterbirds

Black-crowned night herons occurred regularly on the Refuge, and counts averaged 5-10 birds. The heron is known to take chicks and eggs of endangered waterbirds. The overall impact on waterbird production on the Refuge is unknown, but may be significant in light of the low level of nesting activity.

Cattle egrets often feed in shallow water areas such as fallow fields and impoundments. Refuge counts show an average of 40 birds using refuge wetlands during the year. A roost of as many as 1500 individuals presently exists in a grove.

5. Shorebirds, Gulls, Terns, and Allied Species

Lesser golden plovers winter at the Refuge, with numbers averaging 7 birds. Wandering tattlers are sometimes seen in open taro ponds. Additional shorebird species that frequent refuge wetlands during migration include ruddy turnstones, sanderlings and long-billed dowitchers. Infrequent staff visits result in a lack of opportunity to accurately survey these species.

11. Fisheries Resources

The aquatic fauna in Hanalei National Wildlife Refuge is found in the taro fields, adjacent wetlands, and the Hanalei River. Many of these species are food sources for the endangered waterbirds. The waterbirds are attracted to chironomids (midges) and tubificids (worms), that exist in the taro fields. Chironomids are abundant in shallow water, while tubificids can flourish in wet and dry environments. Bird feeding is most intensive during the wet fallow period of the taro agricultural cycle, between harvesting and replanting of the taro fields. Endemic and exotic gastropod mollusks (snails, slugs, etc.), as well as toads and bullfrogs, inhabit some of the taro fields and ponds.

The Hanalei River contains substantial populations of several native aquatic species. The Hanalei River not only yielded the greatest number of endemic species in the streams surveyed (based on the number of mountain shrimp per sampling station), but also had the highest percentage of endemic species sampled (74%).

Four species of native 'o'opu (gobies) are known to inhabit the streams and ponds of Hanalei Valley. These are 'o'opu nakea (Awaous stamineus), 'o'opu nopili (Sicydium stimpsoni), 'o'opu naniha (Awaous geniuttatus), and 'o'opu okuhe (Eleotris sandwicensis).

'O'opu nakea is the largest goby, and is commercially valuable. The young gobys grow to maturity in mountain streams and pools. During the high water season (starting in July), mature gobys come downstream to spawn, riding on the runoff produced by intermittent heavy rains. At this time many local residents crowd the banks of the Hanalei River and fish for the prized gobys. The 'o'opu nakea is relatively scarce, and state regulations prohibit catching them with traps or weirs. The other species of 'o'opu are believed to spawn year-round at various locations in the river.

The 'opae kala'ole (Atya bisulcata), fresh water mountain shrimp, is endemic to the Hawaiian Islands. It is described as a detritivore, consuming suspended organic particles, and it generally inhabits the middle and upper portions of streams. 'Opae have a diadromous life cycle, requiring access to seawater to spawn. Spawning takes place year-round, suggesting a multivoltine life cycle known for many other tropical species.

Other aquatic fish inhabiting the Refuge include tilapia (Tilapia spp.), mosquito fish (Gambusia affinis), and swordtails (Xiphophorus spp). Fish species inhabiting or spawning in the estuary and brackish waters of the Hanalei river include papio (Caranx sp.), mullet (Mugilcephalus), barracuda (Sphyraena barracuda), milkfish (Chanos chanos), and aholehole (Kuhlia sandwicensis). The brackish waters also provide habitat for a number of species of crabs.

H. PUBLIC USE

1. General

Kauai's North Shore is a major tourist destination and most of the visitors to Kauai rent a car and drive through the area. These visitors generally stop at the Hanalei Valley overlook which was developed by the State of Hawaii, Department of Transportation. The Refuge has maintained interpretive exhibits at this site. The overlook site provides a scenic view of the Hanalei Valley and an excellent vantage point from which to view the Refuge.



Over 500,000 visitors to the island of Kauai viewed the Refuge and the scenic Hanalei Valley from the overlook site. (TEH)



Southwestern view from the overlook of portions at the Refuge and Hanalei Valley. (TEH)

2. Outdoor classrooms - Students

Refuge permittees occasionally provide tours to local school groups upon request. These tours generally involve the history of taro farming and methods of cultivation.

6. Interpretive Exhibits/Demonstrations

This year the Regional Office awarded a contract to a private design firm to replace the interpretive panels on the Hanalei Valley overlook which were originally constructed in 1980. The panels describe the Refuge, the natural history of the endangered waterbirds and the history and significance of taro farming. Due to deterioration of the exhibits, they were removed towards the end of the year. The new panels which will provide additional information on wetland management for waterbirds are expected to be in place by mid-July 1989. Approximately 522,000 people viewed the Refuge and had access to the interpretive panels in 1988.



Heavy precipitation and sun exposure damaged the exhibit supports and discolored the exhibits, making them nearly unreadable. The panels were first installed in 1980 and have needed replacement since 1984. (TEH)

Following destruction by Hurricane Iwa in 1982, the Haraguchi Rice Mill, which is a site on the State and Federal Register of Historic Places, was restored in 1987 with funds from the Department of the Interior matched by local donations. Prior to becoming re-established as a taro growing area, the Hanalei Valley was primarily used for cultivation of rice by Asian immigrants. As a condition for receiving federal funding, the rice mill must play host to a specified number of educational student tour groups each year. The rice-milling equipment, machinery and exhibits provide an excellent setting for school children about the role that taro and rice cultivation have played in island history. The purpose of the Hanalei Refuge is also discussed during the tours.

9. Fishing

Hanalei River attracts recreational and part-time commercial fishermen who fish mainly for several species of gobies. Fall or early winter storms that create heavy stream flows induce one goby, the o'opu nakea, to go downstream to spawn in estuaries. Commercial fishermen set nets across Hanalei River to harvest tons of these fish annually. Nets frequently break loose and are washed downstream and out to sea, thus causing

potential problems for other fish and marine life. Unfortunately, the recreational fishermen who do the bulk of the fishing in Hanalei River catch only a small portion of the fish harvested. Commercial fishermen take a disproportionate amount of fish in only a few days each year. Recreational fishermen have indicated a decrease in fishing success over the past few years.

The Sport Fishing Plan for the Refuge incorporated the state fishing regulations to be applied to Refuge fishing, but the plan also expressed concern over some of the commercial fisheries uses of Hanalei River.

11. Wildlife Observation

Frequent use is made by tourists of a county road, which passes through the Refuge, for wildlife observation. The single-lane lower 1/4 mile portion of the road is the most attractive area for this activity. However, frequent obstruction of traffic and trespassing onto taro farms for photographic opportunities occurs.

16. Other Non-Wildlife Oriented Recreation

Hanalei River has two small boat harbors in the estuary. Many of these boats give tours of Na Pali coast or whale-watching. Upon returning to Hanalei River, many boats run upstream to flush saltwater from their engines. This increase in boat traffic could have adverse impacts on waterbird usage of the river as well as on the fisheries resource.

Kayak rental has been an increasing tourist-related venture in the Hanalei area. An estimated 40-50 kayaks per week are rented by tourists and paddled up the Hanalei River through the Refuge. This type of boating is not expected to negatively affect waterbird use of the riverine habitats of the Refuge.

I. EQUIPMENT AND FACILITIES

1. New Construction

As reported last year, a construction contract to build a second refuge impoundment was awarded in 1987 to Kobayashi Trucking and Equipment, Inc., however, no construction had occurred. During the winter of 1988, we were informed that an ARMM project for additional impoundment construction on the Refuge had received funding. Following solicitation for bids by the Regional Office, a contract for hourly rental of equipment and operators to construct a third impoundment, clear approximately 2,200 linear feet of drainage ditches and install a water delivery system was awarded in August to Kobayashi. This brought the total to 48 acres of new waterbird impoundments to be created in former pasture land in addition to our existing 16 acre management unit (pond A).

Construction was begun in late August and part-time engineering oversight and surveying on the project were provided by two Regional Office engineers, one of whom was also overseeing construction of the new visitor center at Kilauea Point. All work was performed by a track excavator, crawler-dozer or rubber tired backhoe. Even though the project was begun late in the season, rapid progress was made due to dry fall weather and highly-experienced heavy-equipment operators. Most of the drainage ditches were cleared, hau (*H. tiliaceus*) trees removed, 2,300 linear feet of dikes and moats constructed and five water control structures in place by mid-October. In addition, 1,000 linear feet of water delivery ditch and dirt access road were cleared of debris and vegetation. Remaining tasks for next year in the Kobayashi work order include constructing a water delivery pipeline system with headwall and graveling the dirt access road.



Two construction and equipment rental contracts awarded during 1987 and 1988 to Kobayashi Trucking and Equipment, Inc., resulted in the creation of 48 additional acres of wetland management impoundments. Previously-constructed pond A is at extreme left while ponds B and C (under construction) are to the right. Hanalei River is shown in upper right. (SIF)



Even though the project began late in the summer, generally dry soil conditions and an unseasonably dry fall made completion of the dikes and moats, and placement of water control structures possible. (TEH)

On October 17, the original 16-acre pond (pond A) as well as the two newly-constructed impoundments were aerially sprayed with Rodeo by a Murray Air Co. helicopter. Nearly complete die-off of the California grass in the ponds was in evidence by three weeks. Following the spraying, we had hoped to disk the pond bottoms to further break down the grass and knock down high areas prior to flooding. However, this was derailed due to difficulty in locating a suitable disk and occasional wet periods. Burning of dead grass was also delayed by rain and rapid growth of "honohono" Commelina diffusa.



Aerial application of Rodeo by a Murray Air Co. helicopter was utilized to open up pond bottoms choked with california grass. (TEH)

During mid-October, while attempting to flood all three impoundments, insufficient compaction caused significant leaks to develop around three water control structures. This necessitated draining of all three impoundments on December 21. Attempts to block a leak around one structure were nearly successful until high water levels in an adjacent drainage ditch blew out the plug. Re-sealing of all leaky structures is currently planned for next summer. Since we were unable to adequately inundate California grass in the ponds and this species so rapidly re-establishes, follow-up aerial spraying or discing will be needed next year.

Even though we were unable to inundate the newly-built ponds to their desired depths due to leakage, high water levels were maintained in pond A and in portions of the additional ponds. This resulted in significant use of these areas by Hawaiian ducks, moorhen and stilts and some

production of moorhen. The aerial herbicide treatment of pond A increased the extent of open water in the impoundment and set back the domination of California grass.

In mid November, approximately 5 acres of the impoundment dike surfaces were hydroseeded by Kauai Hydroseeding and Landscaping with annual rye and Bermuda grass. This was done to arrest "gullying" by heavy Hanalei Valley rains and discourage re-invasion by California grass.

In anticipation of the installation of the water delivery pipeline for the impoundments, 1,460 feet of 12-inch PVC pipe was delivered to the Refuge late in the year. Laying of the pipe and construction of a headwall in Little China Ditch should begin in the summer of 1989.



Hydroseeding with annual rye and Bermuda grass of newly-constructed dikes reduced erosion and discouraged re-establishment of California grass. Impoundment moat at right of photo was excavated to limit access by predators. Note water from recent rainfall. (SIF)

3. Major Maintenance

In June, we initiated the renovation of a former taro farmer's house as a bunkhouse for our newly-hired maintenance worker and any visiting Refuge staff. This structure was originally purchased in 1985, however renovation had been delayed due to funding shortages. All structural, electrical and plumbing repairs were completed, new appliances installed and staff began using the bunkhouse by early September. Grounds adjacent to the house were also cleared of invasive hau trees and other vegetation.

In addition, approximately 1/3 of an acre across the China Ditch was opened up and graded as a future equipment storage shed and work yard site for the house. Two culverts were placed in the ditch to provide vehicle access to the work area.



Renovation of an abandoned taro farmer's house, purchased in 1985, allowed a newly-hired maintenance worker to take up residence on the Refuge and oversee impoundment construction. (TEH)

The John Deere 302 tractor which was stored at the James Campbell National Wildlife Refuge on Oahu was to be shipped to Hanalei for use by maintenance staff. Prior to shipping this tractor, major maintenance was conducted including a hydraulics overhaul, steam cleaning, painting and basic parts replacement and adjustment.

A total of approximately 50 tons of quarry rock was provided to farmers on the Kuna ditch side of the Refuge for maintenance of a rut-filled road which providing access to their farms.

Maintenance worker Woodside constructed an adjustable screw gate for regulating water flows from the Little China ditch into the waterbird impoundments. The structure will be installed onto an existing concrete headwall during the summer of 1989.

At the suggestion of Refuge staff, taro farmers relying on the China ditch water delivery system removed a considerable amount of silt and vegetation from a silt trap on the China ditch pipeline. The trap had become overgrown with California grass and may have been impeding water flow. Some improvement to water flow was observed following the cleaning.

4. Equipment Utilization and Replacement

The Dodge four-wheel drive pickup truck was transferred to the Refuge from the Kakahaia on Molokai where it was used during intermittent visits. In addition, many hand tools were transferred from James Campbell to Hanalei. Other major equipment purchased through the year included a four-wheel drive ATV, an agricultural sprayer and various shop tools. Several useful items were acquired from Defense Re-utilization for outfitting the newly restored bunkhouse including tables and chairs, bunkbeds, a metal locker and overhead light fixtures.

5. Communications Systems

A telephone was installed at the Hanalei bunkhouse and a Post Office box was established for the Refuge at the Hanalei Post Office.

J. OTHER ITEMS

4. Credits

Stewart Fefer wrote Sections A, C, D, E, J, and K. Tom Harvey wrote Sections B, F, H, and I. Jeff Holm wrote Section G.

K. FEEDBACK

The Hawaiian/Pacific Complex National Wildlife Refuge received additional funding in FY88 provided through a Congressional add-on. Significant maintenance and facility improvements described here were completed. A Refuge infrastructure was developed to support the significant on-going maintenance requirements of the facilities. The dependency of this Refuge on the one-year funds is of serious concern. If these funds are discontinued, the Refuge will not be able to support local staff, the facilities developed will not be maintained, the endangered species

resource dependent on these facilities will decline locally and the Service will lose credibility with the local community for allowing expensive facilities to fall to disrepair. The solution is for the Service to attempt to incorporate the Congressional add-on, or a portion thereof, into the base operating budget of the Refuge to allow for the maintenance of facilities that Refuge and Regional Office staff felt were worthy of improvement.

The Environmental and Cultural Resources compliance process that Refuge staff completed during 1988 in order to obtain necessary permits and compliances from local, State and Federal agencies was a frustrating and tedious process. Many of the permits were interrelated so that one would not be issued until another was issued. Some of the State permitting agencies had one year to review the application and planned on spending one year reviewing the application except for some carefully applied persuasion. State agencies that are involved in waterbird management were silent while their related departments listed concerns that required detailed responses to reconcile. There was an underlying feeling that the Refuge permit process was being held hostage by agencies that had disagreed with the Service positions on permitting issues our Ecological Services Office had been involved with through the years. Despite applying for permits six months in advance of the proposed commencement of activities permits were delayed beyond our planned deadlines. Had it not been for cooperative dry fall weather the project would have been delayed for a full year.

**HULEIA
NATIONAL WILDLIFE REFUGE
HONOLULU, HAWAII**

**ANNUAL NARRATIVE REPORT
Calendar Year 1988**

*U. S. Department of the Interior
Fish and Wildlife Service
NATIONAL WILDLIFE REFUGE SYSTEM*

INTRODUCTION

TABLE OF CONTENTS

A. HIGHLIGHTS

B. CLIMATIC CONDITIONS

C. LAND AQUISITION

1. Fee Title	NTR
2. Easements	NTR
3. Other	NTR

D. PLANNING

1. Master Plan	1
2. Management Plan	2
3. Public Participation	NTR
4. Compliance with Environmental and Cultural Resource Mandates	NTR
5. Research and Investigations	NTR
6. Other	NTR

E. ADMINISTRATION

1. Personnel	2
2. Youth Program	NTR
3. Other Manpower Programs	NTR
4. Volunteer Programs	NTR
5. Funding	2
6. Safety	NTR
7. Technical Assistance	3
8. Other	3

F. HABITAT MANAGEMENT

1. General	NTR
2. Wetlands	3
3. Forests	NTR
4. Croplands	NTR
5. Grassland	NTR
6. Other Habitats	NTR
7. Grazing	4
8. Haying	NTR
9. Fire Management	NTR
10. Pest Control	NTR
11. Water Rights	NTR
12. Wilderness and Special Areas	NTR
13. WPA Easement Monitoring	NTR

G. WILDLIFE

1. Wildlife Diversity	NTR
2. Endangered and/or Threatened Species	4
3. Waterfowl	NTR
4. Marsh and Waterbirds	6
5. Shorebirds, Gulls, Terns, and Allied Species	6
6. Raptors	NTR
7. Other Migratory Birds	NTR
8. Game Mammals	NTR
9. Marine Mammals	NTR
10. Other Resident Wildlife	NTR
11. Fisheries Resources	NTR
12. Wildlife Propagation and Stocking	NTR
13. Surplus Animal Disposal	NTR
14. Scientific Collections	NTR
15. Animal Control	NTR
16. Marking and Banding	NTR
17. Disease Prevention and Control	NTR

H. PUBLIC USE

1. General	6
2. Outdoor Classrooms - Students	NTR
3. Outdoor Classrooms - Teachers	NTR
4. Interpretive Foot Trails	NTR
5. Interpretive Tour Routes	NTR
6. Interpretive Exhibits/Demonstrations	NTR
7. Other Interpretive Programs	6
8. Hunting	NTR
9. Fishing	6

H. PUBLIC USE (Cont.)

10. Trapping.	NTR
11. Wildlife Observation.	NTR
12. Other Wildlife Oriented Recreation.	NTR
13. Camping	NTR
14. Picnicking.	NTR
15. Off-Road Vehicling.	NTR
16. Other Non-Wildlife Oriented Recreation.	7
17. Law Enforcement	NTR
18. Cooperating Associations.	NTR
19. Concessions	NTR

I. EQUIPMENT AND FACILITIES

1. New Construction.	NTR
2. Rehabilitation.	NTR
3. Major Maintenance	NTR
4. Equipment Utilization and Replacement	NTR
5. Communications Systems.	NTR
6. Computer Systems.	NTR
7. Energy Conservation	NTR
8. Other	NTR

J. OTHER ITEMS

1. Cooperative Programs.	NTR
2. Other Economic Uses	7
3. Items of Interest	NTR
4. Credits	7

K. FEEDBACK

INTRODUCTION

The Hule'ia National Wildlife Refuge (Service) consists of 238 acres of river bottom land and wooded slopes in Hule'ia Valley near the Menehune (Alakoko) Fish Pond, west of Nawiliwili Harbor on the east shore of the island of Kaua'i. The Refuge was established in 1973 to provide habitat for Hawaii's four species of endangered waterbirds. This is an unmanned station that is administered by staff from the Honolulu Complex office. Waterbird use is minimal due to limited wetland area on the Refuge. However, existing wetland development plans could dramatically increase waterbird use and production if development were implemented.



View of Hule'ia National Wildlife Refuge looking east up Hule'ia River shows river bottom areas which historically supported taro farming and would be suitable for impoundment development. (EK)

B. CLIMATIC CONDITIONS

Weather data recorded at Lihu'e Airport is most representative of Hule'ia National Wildlife Refuge.

AVERAGE DAILY TEMPERATURE

	Low	High	Rainfall (inches)
January	66.4	76.9	9.81
February	68.4	79.2	1.46
March	67.8	79.4	2.63
April	70.3	80.4	1.60
May	71.7	81.1	3.79
June	74.3	83.4	0.53
July	73.7	83.7	1.95
August	74.2	84.2	3.28
September	74.8	84.9	1.09
October	70.9	83.3	1.88
November	72.8	81.6	8.18
December	68.7	79.7	6.86
TOTAL ANNUAL RAINFALL			43.06
AVERAGE MONTHLY RAINFALL			3.59

D. PLANNING

1. Master Plan

The Draft of the Master Plan for the wetland Refuges within the Complex raised concern from the State of Hawaii, Department of Land and Natural Resources regarding potential adverse effects on several archaeological and historic sites. In response to these comments and in order to comply with Section 106 of the National Historic Preservation Act, we entered into a Memorandum of Understanding with the Environmental Section of the U.S. Army Corps of Engineers (Corps) during 1987. According to this agreement, a Corps staff archaeologist will prepare an addendum to the Master Plan, addressing possible effects on historic sites and measures to mitigate these effects, if necessary. During 1988, the Service redirected the Corps of Engineers Archeologist's efforts to an archeological study of Hanalei Valley where the Service proposed development of waterbird impoundments. The archeological work relating to the Master Plan was not completed as scheduled during 1988. The Corps archeologist is still planning to conduct this work and Refuge staff awaited completion at year's end.

2. Management Plan

A management plan development schedule for the wetland refuges was agreed upon by Refuge and Regional Office staff. By year's end, a draft of the Waterbird Population Monitoring Plan and the Waterbird Nesting and Production Monitoring Plan were prepared for review. Prescribed Burn Plans were completed and fire permits received from the County of Kauai.

An Advance Project Planning document for construction of shallow impoundments at the Refuge was completed in 1988 by contractors Wilson Okamoto and Associates, Inc. The plan involved diversion of the Papakolea and Hule'ia Stream waters and the development of 6 impoundments totalling 67 acres. The project is planned to be constructed in phases with half of the impoundments to be constructed in Phase I at an estimated cost of \$572,500 and half in Phase II for an estimated cost of \$501,500.00. The impoundments would create important nesting and feeding habitat for endangered waterbirds.

E. ADMINISTRATION

1. Personnel

Stewart I. Fefer remained the Refuge Complex Manager for the Hawaiian Wetlands Refuge Complex. In March Stephen Berendzen transferred to the Refuge Manager position at Colusa National Wildlife Refuge in the Sacramento Refuge Complex. Thomas E. Harvey was assigned as Acting Assistant Manager for Wetlands in March and acted in this position until May when he was permanently assigned. Tom transferred from a wildlife biologist position within the Pacific Islands Refuge Office to assume this position. Jeffrey Holm was hired as the Wildlife Biologist for the Wetland Refuges during May. Jeff transferred to this position from the Assistant Refuge Manager's position on Tern Island, Hawaiian Islands National Wildlife Refuge.

During June, Timothy Cramer was hired as a temporary full time maintenance worker for the Hanalei Refuge. Due to "culture shock" Tim resigned within a few weeks of working at the site. Anthony Texeira was hired during August for this same position. This position would also participate in maintenance and surveys at Huleia Refuge.

Plans were developed for staffing the Hanalei and Huleia Refuges with a permanent full time Assistant Refuge Manager. However, long term base funding was not available to commit to this permanent position.

5. Funding

The Fiscal Year 88 budget for the wetland refuges was split between the five Refuges on O'ahu, Kaua'i and Moloka'i. The total management, operations and maintenance budget for the wetland Refuges was \$300,000.00.

Additional funding was provided by the Challenge Grant Program (\$12,000 from the Challenge Grant Program matched by \$12,000 from the James Campbell Estate, Ducks Unlimited, State of Hawaii and the Hawaii Audubon Society), and Special Projects including contaminants monitoring, and impoundment development at the Hanalei Refuge (\$65,000). Part of the base budget funding was allocated from the Special Appropriation received from Congress for Hawaii Refuges which totalled \$500,000.00.

No projects were conducted at the Huleia Refuge. The only funds expended involved staff time for monitoring permittee uses and wildlife.

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 Ecological Services 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. Projects on Kauai that required Refuge technical assistance included planning for mitigation activities involving Pua Poa Marsh and review of activities proposed in the Hanalei River. The Refuge staff also provided technical assistance to The Hanalei Project through the review of documents.

8. Other Items

A Refuge revenue sharing check for \$14,219.00 was presented to Kaua'i Mayor Kunimura on April 29. This amount was based on 75% of the appraised land value of Hanalei and Hule'ia Refuges; however, only 59% of the full amount was appropriated, resulting in the payment.

The Complex Manager and Assistant Manager attended a public hearing on the State of Hawaii Water Commission's water registration process and requirements for registering surface water diversions and wells. All diversions and well use will need to be registered with the Water Commission in May 1989.

F. HABITAT MANAGEMENT

2. Wetlands

The Refuge was acquired in 1973 to serve as a wetland refuge for four species of endangered Hawaiian waterbirds: Hawaiian moorhen, Hawaiian stilt, Hawaiian coot and Hawaiian duck (koloa). Land use patterns in the area included various forms of agriculture including rice, taro, starch and more recently, grazing.

Drainage ditches were previously constructed to reclaim portions of this former wetland. At present, the ditches and seasonally flooded lowlands provide only marginal wetland habitat.

No operational or new construction funds were available to develop wetland impoundments, so little wetland management has been done.



Portion of wetlands adjacent to Hule'ia River being invaded by upland vegetation. (FZ)

7. Grazing

Grazing permittee Lara had a total of 340 AUMs for the 158-acre grazing area. He was charged \$1.25 per AUM. Lara has been battling noxious vegetation in the grazing permit area, but cats claw (Caesalpinia sepiaria), an exotic legume with double rows of thorns on each branch, appears to be overtaking some areas.

6. WILDLIFE

2. Endangered and/or Threatened Species

The Refuge was purchased to provide habitat for the endangered Hawaiian moorhen, Hawaiian coot, Hawaiian stilt, and Hawaiian duck. Hule'ia Refuge provided limited habitat for an average of six Hawaiian ducks, and an occasional coot or moorhen was observed during censuses conducted along

Papakolea Stream. The Hawaiian duck is the principal endangered species that utilizes wetland habitat at the Refuge.

Mountain streams on Kaua'i apparently provide the best nesting and brood habitat. Considerable potential exists for providing optimum waterbird maintenance and breeding habitat with the construction of shallow water impoundments at this site.

Waterbird counts were conducted intermittently during staff visits to the site.



Occasional Hawaiian moorhen were observed during censuses and some production occurs on the Refuge. (GH)

4. Marsh and Waterbirds

A population of cattle egrets ranging from 20-40 individuals is commonly observed on the Refuge. Cattle egrets typically use upland pasture areas and have expanded their range throughout Hawai'i due to little competition and few predators. Generally fewer (<10) black-crowned night herons are seen.

5. Shorebirds, Gulls, Terns and Allied Species

Lesser golden plover (<10) are occasionally sighted on Hule'ia.

H. PUBLIC USE

Due to the undeveloped status of the Refuge, isolation from main roads and poor access roads, the public is not encouraged to visit Hule'ia Refuge.

1. General

Visitors view historic Menehune Fishpond from a roadside overlook on the nearby public highway. The lower reaches of the Refuge can also be observed from this location. It was estimated that approximately 47,000 people stopped at this overlook to view the fishpond and Refuge in 1988, and nearly 600 people photographed the area.

7. Other Interpretive Programs

Special Use Permittee, Kaua'i River Adventures, led kayak tours along Hule'ia River. Information on the National Wildlife Refuge system and the purpose of Hule'ia Refuge are included in the tour narrative. A total of 7,384 kayakers passed through the Refuge in 1988 representing a slight decrease in use from 1987.

9. Fishing

Recreational fishing and crabbing is restricted to access by boat on Hule'ia River. The amount of pressure on fisheries resources in this stream is unknown, but small boat traffic on the river has apparently increased in recent years according to the state fishery biologist.

16. Other Non-Wildlife Oriented Recreation

The Hule'ia River Valley has been designated as a noise sensitive area by the Federal Aviation Administration. However, there has been a noticeable increase in helicopter use of this area. Helicopter tours are popular with Kaua'i visitors, and much air traffic passes through Hule'ia Valley over the Refuge.

J. OTHER ITEMS

2. Other Economic Uses

Special Use Permittee, Kaua'i River Adventures, was issued a revised permit and charged a \$500.00 fee to cover the cost of administering their permit and to pay part of the travel expenses to monitor use of the area by their commercial operation.



Kauai River Adventures conducts tours on the Hule'ia River for several thousand tourists annually. (FWS file photo)

4. Credits

Stewart Fefer wrote Sections A, C, D, E, and J. Tom Harvey wrote Sections B, F, H, and I. Jeff Holm wrote Section G.

**JAMES CAMPBELL
NATIONAL WILDLIFE REFUGE
HONOLULU, HAWAII**

**ANNUAL NARRATIVE REPORT
Calendar Year 1988**

*U. S. Department of the Interior
Fish and Wildlife Service
NATIONAL WILDLIFE REFUGE SYSTEM*

INTRODUCTION

The James Campbell National Wildlife Refuge consists of 145 acres of wetland habitat in two units near the community of Kahuku on the northeastern shore of O'ahu, Hawai'i. The Punamano Pond Unit (37.5 acres) is a naturally occurring, spring-fed marsh, while the Ki'i Unit (107.5 acres) consists of man-made ponds established in 1977 to provide habitat for Hawai'i's four endemic, endangered waterbirds (stilt, coot, moorhen, Hawaiian duck) and other native wildlife, as well as migratory waterfowl and shorebirds. Both units are located in a coastal area that was an extensive freshwater wetland. This large wetland was drained by a series of ditches designed to create terrestrial areas to be used for growing sugar cane. The Ki'i pond area was used as a settling basin for water used to wash the sugar cane at the Kahuku Sugar Mill. Prior to Refuge establishment, closure of the Kahuku Sugar Mill resulted in drying of Ki'i settling ponds which had been used extensively by waterbirds. The James Campbell National Wildlife Refuge was established in an attempt to enhance this wetland area and to provide maximum production and survival of endangered Hawaiian waterbird populations. The Refuge is managed by the Fish and Wildlife Service under a 55-year lease from the James Campbell Estate. There are a number of special conditions in the lease agreement that are undesirable for optimum waterbird management. For example, one special condition of the lease states that the Refuge must maintain major drainage ditches at water levels desired by the landowner, the James Campbell Estate. The water levels desired by the Estate may be lower than levels required for maintenance of habitat for the endangered waterbirds. Frequent coordination with land managers from the Estate and with adjacent landusers is required to minimize conflicts arising from water management practices.

INTRODUCTION

TABLE OF CONTENTS

A. HIGHLIGHTS

B. CLIMATIC CONDITIONS

C. LAND AQUISITION

1. Fee Title	2
2. Easements	NTR
3. Other	3

D. PLANNING

1. Master Plan	4
2. Management Plan	4
3. Public Participation	NTR
4. Compliance with Environmental and Cultural Resource Mandates	4
5. Research and Investigations	5
6. Other	NTR

E. ADMINISTRATION

1. Personnel	11
2. Youth Program	NTR
3. Other Manpower Programs	NTR
4. Volunteer Programs	12
5. Funding	12
6. Safety	NTR
7. Technical Assistance	12
8. Other	13

F. HABITAT MANAGEMENT

1. General	13
2. Wetlands	13
3. Forests	16
4. Croplands	NTR
5. Grassland	NTR
6. Other Habitats	NTR
7. Grazing	NTR
8. Haying	NTR
9. Fire Management	16
10. Pest Control	17
11. Water Rights	NTR
12. Wilderness and Special Areas	NTR
13. WPA Easement Monitoring	NTR

G. WILDLIFE

1. Wildlife Diversity	19
2. Endangered and/or Threatened Species	19
3. Waterfowl	28
4. Marsh and Waterbirds	30
5. Shorebirds, Gulls, Terns, and Allied Species	31
6. Raptors	34
7. Other Migratory Birds	34
8. Game Mammals	NTR
9. Marine Mammals	NTR
10. Other Resident Wildlife	35
11. Fisheries Resources	NTR
12. Wildlife Propagation and Stocking	NTR
13. Surplus Animal Disposal	NTR
14. Scientific Collections	35
15. Animal Control	35
16. Marking and Banding	NTR
17. Disease Prevention and Control	NTR

H. PUBLIC USE

1. General	36
2. Outdoor Classrooms - Students	37
3. Outdoor Classrooms - Teachers	NTR
4. Interpretive Foot Trails	NTR
5. Interpretive Tour Routes	NTR
6. Interpretive Exhibits/Demonstrations	37
7. Other Interpretive Programs	NTR
8. Hunting	NTR
9. Fishing	NTR

H. PUBLIC USE (Cont.)

10. Trapping	NTR
11. Wildlife Observation	38
12. Other Wildlife Oriented Recreation	NTR
13. Camping	NTR
14. Picnicking	NTR
15. Off-Road Vehicling	NTR
16. Other Non-Wildlife Oriented Recreation	NTR
17. Law Enforcement	38
18. Cooperating Associations	NTR
19. Concessions	NTR

I. EQUIPMENT AND FACILITIES

1. New Construction	38
2. Rehabilitation	NTR
3. Major Maintenance	38
4. Equipment Utilization and Replacement	39
5. Communications Systems	NTR
6. Computer Systems	NTR
7. Energy Conservation	NTR
8. Other	NTR

J. OTHER ITEMS

1. Cooperative Programs	39
2. Other Economic Uses	NTR
3. Items of Interest	NTR
4. Credits	39

K. FEEDBACK



The Ki'i Unit of the James Campbell National Wildlife Refuge consists of nine wetland management impoundments converted from settling ponds previously used by the Kahuku sugar mill. They straddle three ditches which were excavated to lower water levels for sugar cane cultivation. (TEH)



The Punamano Unit is a low-lying, spring-fed wetland subject to steady encroachment by emergent vegetation. Prescribed burns planned for next year expand open water habitat. (ARY)

A. HIGHLIGHTS

The Refuge staff proposed fee acquisition of the existing leased lands and adjacent areas surrounding the existing Refuge. Congress appropriated \$1.5 million for this acquisition for FY89.

Results of contaminant samples collected in 1986 and 1987 showed evidence of heavy metal and organochlorine contamination. During 1988, samples were collected to determine if contaminant levels at the James Campbell Refuge pose a threat to the four endangered waterbirds.

High numbers of nests of the four waterbird species were recorded during 1988. We believe the increase is a result of birds responding to water and vegetation manipulations.

Feed trials were conducted to determine the efficiency of diphacinone, and anticoagulant, in bait stations for the control of mongooses. Mongoose control is needed in wetlands to improve production of the Hawaiian waterbirds.

Stephen Berendzen transferred from the Assistant Refuge Manager position and Thomas E. Harvey was selected for this position. Jeffrey Holm was hired as the wildlife biologist.

A Challenge Grant Project was developed on the Refuge for the construction of an interpretive kiosk and trails on the Ki'i Unit. The James Campbell Estate, Ducks Unlimited, Hawaii Audubon Society, and U.S. Army Western Command Hawaii State Division of Forestry and Wildlife, contributed funds and/or assistance toward the development of this visitor facility. By the end of the year, all materials were purchased and the site graded. The Army agreed to construct this facility in the summer of '85.

B. CLIMATIC CONDITIONS

The nearest weather recording station, Amorient Aquafarm, is adjacent to the Refuge. The station summary for January-December, 1988 generally reflects the climatic conditions at the Refuge; however, complete data was unavailable.

AVERAGE DAILY TEMPERATURE

	Low	High	Rainfall (inches)
January			
February	68.7	78.6	1.80
March	79.0	69.6	3.34
April	70.3	79.3	1.85
May	68.2	80.1	2.58
June	72.0	81.2	0.76
July		82.0	5.06
August	74.0	82.7	2.55
September	74.7	82.9	4.41
October	72.6	81.9	2.59
November	73.4	80.9	
December	68.6	80.1	8.13

Typical weather patterns occurred in 1988: 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.

C. LAND ACQUISITION

1. Fee Title

During 1987, the James Campbell Estate produced a map of sites to be leased by the Estate for aquaculture development. One aquaculture development was proposed for an area immediately adjacent to the Ki'i Unit of the Refuge. A permit application for this proposed aquaculture facility was reviewed by Refuge staff in coordination with our Ecological Services Office. Refuge staff felt that this aquaculture facility would conflict with Refuge operations through encroachment of saltwater from the proposed facility into the Refuge. Acting on the Service's recommendation, the City and County of Honolulu subsequently denied this permit.

In order to avoid future conflict with aquaculture and other lessees of the Campbell Estate and to provide for protection of wetland habitats and other adjacent wildlife habitat the Refuge proposed fee acquisition of areas adjacent to the Refuge. The Refuge staff also proposed fee acquisition of the existing leased Refuge.

In discussions with Campbell Estate Land Managers, we learned which parcels would be available for sale willingly by Campbell Estate. It was suggested that Campbell Estate would prefer to sell whole parcels to avoid subdivision. The Refuge staff, using the aquaculture development map, identified which parcels the Service would be interested in. The Estate informed us that only part of one lot adjacent to the west side of the Punamano Unit would be available and we identified the part of the lot we

felt was required for the Refuge on their map. In later meetings with the Campbell Estate, we learned that an additional lot adjacent to the east side of Punamano Unit would be available and added that lot to the map of the proposed acquisition boundary. Approximately 80% of the lands desired by the Service in fee are within boundaries of the approved ascertainment report.

The purpose of the maps provided to this point (August 1988) was to identify areas that the Refuge would like to acquire and that Campbell Estate was willing to sell. In October 1988, Realty, Region 1, requested acreage and an actual boundary for an acquisition proposal for the Washington Office. In order to provide a map of a preferred refuge boundary, we identified all wetland areas contiguous with the existing Refuge Units. At the desired water levels, all known contiguous wetland areas were included in this boundary along with buffer areas around these wetlands.

In further discussions with Campbell Estate concerning the Refuge acquisition, we learned of the Estate's interest in maintaining a railroad right of way through the existing Ki'i Unit and adjacent to the Punamano Unit. The Campbell Estate had preliminary plans to construct a tramway to transport visitors between the Hotel at Turtle Bay and the developing shopping center at the Sugar Mill site in Kahuku. We also learned that the Estate was concerned with flood control in the area and that these concerns would need to be part of negotiations for the acquisition. The concern is that the present water levels which are maintained for wetland values are reducing the flood water storage capacity of the area and in the event of a severe flood, may result in flooding of commercially valuable properties upstream. The Service contacted the Army Corps of Engineers and the Soil Conservation Service to inquire as to whether these agencies would conduct a flood control study in this area.

During FY88 we learned that Congress had appropriated \$1.5 million for FY89 for the acquisition of the James Campbell Refuge. Environmental Services Biologist John Ford has been assigned as the coordinator of planning for this acquisition.

3. Other

The lease agreement with James Campbell Estate for a 12-acre addition to the existing Ki'i Unit lease progressed to a formal request for recording the transfer in the land court office. However, this 12-acre addition required approval from the City and County of Honolulu as it involved a subdivision of Campbell Estate Property. James Campbell Estate was advised that a Declaration of Restrictive Covenant as it related to the continued use of the land for agricultural activity was required to be executed by them as owners of the parcel. Campbell Estate had not gone through this process at year's end. However, given the acquisition project proposed for this area, any future real estate activity may wait until the outcome of the acquisition efforts.

D. PLANNING

1. Master Plan

The Draft of the Master Plan for the wetland Refuges within the Complex raised concern from the State of Hawaii, Department of Land and Natural Resources regarding potential adverse effects on several archaeological and historic sites. In response to these comments and in order to comply with Section 106 of the National Historic Preservation Act, we entered into a Memorandum of Understanding with the Environmental Section of the U.S. Army Corps of Engineers (Corps) during 1987. According to this agreement, a Corps staff archaeologist will prepare an addendum to the Master Plan, addressing possible effects on historic sites and measures to mitigate these effects, if necessary. During 1988, the Service redirected the Corps of Engineers Archeologist's efforts to an archeological study of Hanalei Valley where the Service proposed development of waterbird impoundments. The archeological work relating to the Master Plan was not completed as scheduled during 1988. The Corps Archeologist is still planning to conduct this work and Refuge staff awaited completion at year's end.

2. Management Plan

A management plan development schedule for the wetland Refuges was agreed upon by Refuge and Regional Office staff. By year's end, a draft of the Waterbird Population Monitoring Plan and the Waterbird Nesting and Production Monitoring Plan were prepared for review. Prescribed Burn Plans were completed and fire permits received from the City and County of Honolulu.

4. Compliance with Environmental and Cultural Resource Mandates

During March 1988, Refuge Managers Fefer and Harvey attended a training session conducted by the Advisory Council on Historic Preservation on Federal Projects and Historic Preservation Law.

See number D.1. above.

5. Research and Investigations

Strategies for Managing Endangered Waterbirds on Hawaiian National Wildlife Refuges

Investigator: Mr. Paul R. Chang (Co-operative Education Student)

Advisor: Dr. Curtice R. Griffin, University of Massachusetts,
Amherst, MA.

Collaborators: Mr. Stewart I. Fefer, Refuge Complex Manager

Objectives:

- A. Monitor nesting phenologies, productivity, and mortality factors of endangered waterbirds on National Wildlife Refuge wetlands on O'ahu.
- B. Determine the degree of hybridization of koloa and mallards at James Campbell National Wildlife Refuge - Ki'i Unit.
- C. Monitor aquatic invertebrate populations and responses to changes in water quality.

The following is a progress report on the results of this study during 1988.

A. Systematic searching for waterbird nest sites on the Ki'i Unit was conducted every three weeks. From January through July, 224 nests of four waterbird species were found in the Ki'i Unit (Table 1). During 1988, nest surveys were conducted during fewer months than in previous years, yet the highest numbers of nests were found in 1988. We believe this increase in 1988 is a result of birds responding to water and vegetation manipulation conducted since 1985. The number of nests (Table 2) were highest in ponds G(38) and C(31) though these were closely followed by ponds A(29) and F(29). Located nests were checked weekly to determine their fate. In 1988 Hawaiian ducks and stilts had the lowest hatching success, while hatching success of moorhens and coots was relatively high (Table 3). Low success rates for ducks and stilts was due primarily to predation associated with low water levels and vegetative changes in pond C.

TABLE 1. Numbers of Waterbird Nests, Ki'i Unit, 1985-88.

Species	1985 (n=11)	1986 (n=12)	1987 (n=8)	1988 (n=7)
Hawaiian coot	23	32	28	59
Hawaiian duck	46	60	22	51
Hawaiian gallinule	23	20	13	35
Hawaiian stilt	52	50	64	79
Totals	144	162	127	224

n = number of months nest surveys conducted.

TABLE 2. Numbers of Waterbird Nests in Manipulated Ponds, Ki'i Unit, 1985-88.

Pond	1985	1986	1987	1988
A	2	1	3	29*
C	24	22	24	31*
F	4	1*	0	29
G	9	7*	5	38

* - indicates when vegetative treatment was made in pond.

TABLE 3. Hatching Success of Waterbirds, Ki'i Unit, 1985-88.

Species	1985	1986	1987	1988	Mean
Hawaiian coot	83%	77%	30%	71%	66%
Hawaiian duck	53%	49%	45%	63%	54%
Hawaiian gallinule	73%	80%	63%	69%	74%
Hawaiian stilt	47%	67%	63%	51%	53%

Mean = weighted average

B. Concern has been raised over the threat to the genetic integrity of the Hawaiian duck from hybridization with wild and feral mallards. One hundred twenty single eggs were collected from koloa nests at the Ki'i Unit during 1988 and 12 from captive koloa at the State breeding facility. In addition, 11 mallards and mallard x koloa hybrids were collected at the Ki'i Unit and 8 Laysan duck eggs were collected at the State breeding facility. Collection of eggs from wild koloa at Ki'i is not expected to adversely affect the species considering that over 58% of all koloa eggs at Ki'i do not successfully hatch. Collected eggs and carcasses were frozen at Refuge facilities and then shipped to the mainland for mitochondrial DNA analyses conducted by the Savannah River Ecology Laboratory in cooperation with the University of Massachusetts.

C. Due to primary use of well water for maintaining water levels in the Ki'i Unit, water quality and resulting aquatic invertebrate species diversity were significantly improved over 1987. This was particularly true for chironomids, damsel fly, and dragon fly larvae. As expected, water boatmen (*Corixid* spp.) densities were relatively higher in ponds treated for fish control with rotenone (ponds F&G), until expanding algae blooms hampered invertebrate sampling technique. Snail population were significantly lower than 1987, reflecting improved water quality conditions.



Nearly exclusive use of artesian fresh well water for re-flooding impoundments as apposed to saline Punamano ditch water, resulted in improved water quality and higher densities of invertebrates such as dragonfly larvae. (SLB)

Control of Mongoose Predation on Endangered Hawaiian Birds

Project Leader: James O, Keith, Denver Wildlife Research Center, USDA, APHIS/ADC

- Objectives:
- A. Develop methods for assessing mongoose numbers
 - B. Determine the movements of mongooses in selected habitats.
 - C. Describe the population biology of mongooses in Hawaii.
 - D. Develop and test registration for methods that can be used to control mongooses in Hawaii.

Mongoose (Herpestes auropunctatus) were introduced into Hawai'i in 1883 and now occur on all main islands except Kaua'i. Their predation on eggs and young are limiting productivity and, thereby, restricting the recovery of at least eight species of endangered Hawaiian birds. These include the Hawaiian goose (Nesochen sandvicensis), the Hawaiian crow (Corvus hawaiiensis), the dark-rumped petrel (Pterodroma phaeopygia sandwichensis), the Newell's shearwater (Puffinus newelli), the Hawaiian duck (Anas wyvilliana), coot (Fulica americana alai), stilt (Himantopus mexicanus knudseni), and moorhen (Gallinula chloropus sandvicensis). A method is needed to remove mongooses from breeding areas

of these species during the nesting season. In programmatic meetings of the U.S. Fish and Wildlife Service during 1983, the development of a method for poisoning mongooses was given a high priority for future research on endangered species in Hawai'i. As a result, an agreement was reached with the Denver Wildlife Research Center for research on mongoose control over a 4-year period to begin in FY 1984.

In late 1987, data on mongooses were obtained from wetlands. Mongoose populations were found to be relatively more dense in wetlands than in uplands, perhaps because food was more abundant. Home ranges were smaller and individuals monitored by radiotelemetry returned each night to permanent dens shared with other mongooses. In upland areas, mongooses are nomadic, use different dens each night and den alone. Their reproductive success is poor. The pregnancy rate is low and few pregnant females produce viable young; young and subadults are scarce and the population consists largely of adults. Reproduction appeared more successful in wetlands; young and subadults occur in numbers that might be expected in a more healthy population.

During 1988, activities have been concerned with gathering and compiling data to support registration. To obtain a special local-need registration in the State of Hawaii, efficacy of the control method and safety to non target animals must be shown.

Field trials were conducted to determine the effectiveness of 2.5 parts per million diphacinone, an anticoagulant, in bait stations for the control of mongooses. Work was done on replicated plots in the Punamano Unit of the Refuge. Mongoose control is needed in wetlands to improve production nesting of the Hawaiian duck, coot stilt and moorhen.

To evaluate control efficacy, radio transmitters were attached to 34 mongooses on this area. These animals were located daily during the 21 day baiting periods or until they died. On the Refuge, the only mongooses surviving were two that did not frequent the control area after they were initially trapped. Results indicate that mongooses can be killed by using 2.5 parts per million diphacinone bait in bait stations spaced 100 to 250 meters apart. Mongooses were caught after poisoning which suggested movement of animals from adjacent areas. Control to protect nesting birds require continued baiting until reinvasion ceases.

By the end of 1988, EPA registration of this method had not been received.



Diphacinone bait station devised by James O. Kieth (APHIS/ADC) to determine effectiveness of the anticoagulant in control of mongoose. Design of the bait stations was intended to reduce possible threats to nontarget animals. (JH)

Refuge Contaminant Sampling

Results of the analysis of contaminant samples collected from the Refuge in 1986 and 1987 showed evidence of heavy metal and organochlorine contamination. During 1986 and 1987 Refuge staff collected black-crowned night herons (liver and body fat), fish (tilapia, mollies and other species) and invertebrates and submitted these samples for heavy metal and organochlorine analysis. The 1987 samples submitted for organochlorine analysis were handled improperly by the analytical lab and were not analyzed.

Although inconsistencies in sampling limited overall applicability of the results, significant levels of several contaminants were found in some of the collected samples. Significant levels of lead were found in 3 of 9 fish samples and in 1 of 22 heron livers. PCB's were present in 1 of 2 heron livers. The heron body fat sample also contained significant levels of DDE and heptachlor.

During 1988 we attempted to collect samples in a more systematic manner in order to determine if contaminant levels at the James Campbell Refuge pose a threat to the four endangered waterbirds. As in 1986 and 1987, we collected black-crowned night herons for analysis for metals. In addition, we collected 23 waterbird eggs from the Ki'i Unit and submitted them for organochlorine and metal analysis. We expect results of these analyses in mid-1989.

E. ADMINISTRATION

1. Personnel

Stewart I. Fefer remained the Refuge Complex Manager for the Hawaiian Wetlands Refuge Complex. In March Stephen Berendzen transferred to the Refuge Manager position at Collusa National Wildlife Refuge in the Sacramento Refuge Complex. Thomas E. Harvey was assigned as Acting Assistant Manager for Wetlands in March and acted in this position until May when he was permanently assigned. Tom transferred from a wildlife biologist position within the Pacific Islands Refuge Office to assume this position. Jeffrey Holm was hired as the Wildlife Biologist for the Wetland Refuges during May. Jeff transferred to this position from the Assistant Refuge Manager's position on Tern Island, Hawaiian Islands National Wildlife Refuge.

David Woodside, Maintenance Worker, continues to be responsible for the maintenance of windmills, pumps, equipment, roads, vegetation, and predators on James Campbell Refuge as well as Pearl Harbor and Kakahai'a National Wildlife Refuges.

Anthony Texeira was hired during August as a temporary full time Maintenance worker at the Hanalei National Wildlife Refuge on Kauai.

The co-operative education position occupied by Paul R. Chang continued through the entire year. Paul returned to the University of Massachusetts for course work in December.

Refuge staff attended the following training during the year:

Complex Manager Fefer: Federal Projects and Historic Preservation Law
Procurement Training
Land Acquisition Process Training
Contaminant Workshop
How to be a successful supervisor

Assistant Manager Harvey: Federal Projects and Historic Preservation Law
Introduction to Supervision
Heavy Equipment Operation
Procurement training
Land Acquisition Process training

Wildlife Biologist Holm: Fire Behavior; S-390
Contaminant Workshop

4. Volunteer Program

During the months of March through August, five volunteers donated a total of 504 hours to assist Cooperative Education Student, Paul Chang with waterbird censuses, nest searchers, broad observatories and predator control.

5. Funding

The FY 88 budget for the wetland refuges was split between the five Refuges on O'ahu, Kaua'i and Moloka'i. The total management, operations and maintenance budget for the wetland Refuges was \$300,000.00. Additional funding was provided by the Challenge Grant Program(\$12,000 from the Challenge Grant Program matched by \$12,000 from the James Campbell Estate, Ducks Unlimited, State of Hawaii and the Hawaii Audubon Society), and Special Projects including contaminants monitoring, and impoundment development at the Hanalei National Wildlife Refuge (\$65,000). Part of the base budget funding was allocated from the Special Appropriation received from Congress for Hawaii Refuges which totalled \$500,000.00.

7. Technical Assistance

Refuge staff participated in semi-annual, state-wide waterbird surveys, and assisted other various agencies with resource-related concerns or problems. Kane'ohe Marine Corps Air Station was given suggestions and assistance regarding development plans for Nu'upia Ponds wildlife area. 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 well drilling. Projects involving Heeia Marsh, Kawainui Marsh, fish ponds around the West Loch of Pearl Harbor, housing development at Pearl Harbor, public access in the Kahuku area adjacent to the Refuge, a plan to develop wetlands from wastewater at the Schofield Barracks military facility, and golf course development around the Punahoolapa wetland were reviewed. In addition, Refuge staff coordinated with Animal Damage Control and Amorient Aquafarms concerning black-crowned night heron depredation problems, and with the National Marine Fisheries Service concerning monitoring of green sea turtles nesting on the beach adjacent to the Refuge.

Refuge Complex Manager Fefer co-authored a publication with J. Michael Scott, Cameron B. Kepler and Charles van Riper III entitled "Conservation of Hawaii's Vanishing Avifauna" in *Bioscience*, Vol.38, No. 4 in April 1988. This paper included a discussion of the status of Hawaiian waterbird populations a description of recovery efforts implemented on the wetland Refuges in Hawaii.

8. Other Items

Complex Manager Fefer and Assistant Manager Harvey attended the Western Section of the Wildlife Society Annual Meeting held in Hilo, Hawaii during January.

F. HABITAT MANAGEMENT

1. General

This 155-acre refuge consists of two units supporting approximately 118 acres of wetlands, 10 acres of grasslands, and 27 acres of scrub forest areas. The Ki'i Unit (117.3 acres) consists of a series of eight diked impoundments. Water for the impoundments on the Ki'i Unit is provided by wind-driven and electrical pumping from three artesian wells and from the Punamano drainage ditch. Water control structures in the form of concrete or metal flash board risers connect the ponds. Which also support small nesting islands. Dominant vegetation includes: Batis maritima, Brachiaria mutica, Pluchea indica, Scirpus spp., Echinochloa crus-galli, and Bacopa monnieri.

The Punamano Unit (37.5 acres) is a natural system. It is a spring-fed pond with deeper water areas. This unit contains more emergent plant growth than the Ki'i Unit. Its wetland area is dominated by Scirpus spp. along with Typha sp., B. monnieri, and P. indica. The Ki'i Unit is surrounded by a livestock fence, while the Punamano Unit remains unfenced, except for a small portion completed in early 1986 by Refuge staff.

2. Wetlands

Ki'i Unit

Prior to 1987, water levels within ponds A through G were generally maintained by pumping water from the Punamano drainage ditch with electric or wind-generated pumps. However, conversion of the neighboring Amorient Aquafarm from fresh to saltwater aquaculture resulted in the Punamano ditch becoming too saline for refuge use.

Following a 1987 Chevron Oil Company fuel spill which affected the Pearl Harbor Refuge, Waiawa Unit, Chevron funded the construction of three wells and a freshwater delivery system for James Campbell. This system began delivering freshwater directly to ponds B, C, F and G and indirectly to ponds A and D via artesian flow in early December, 1987.

Unfortunately, the wind-generated pumping system for the new wells have not performed up to expectations. Don Avery, the manufacturer of the windmill and pump, spent most of 1988 performing repairs and modifications on the system. In addition to drawing from the three wells, the windmill was also designed to draw brackish water (5-10 ppt) from the adjacent Ki'i

drainage ditch. At the close of the year, refuge staff continued to raise serious concerns about the fundamental design of the windmill which has not operated successfully for more than six weeks at time. The lack of a dependable water supply has resulted in unplanned fluctuations of waterlevels and contributed to problems with predation, water quality and invertebrate populations.

Water levels in ponds A, B, C, D, F and G of the Ki'i Unit were maintained due to artesian flow from the wells, occasional pumping from the Punamano drainage ditch and rainfall. Pond E levels were maintained by allowing drain water to build up in the Punamano ditch, resulting in backflow into the pond though a flapgate in a control structure. Due to primary use of well water, water quality in the Ki'i Unit was significantly improved over previous years.



The 14-ft windmill was designed and constructed by Don Avery to draw water from three 290-ft wells and the Ki'i drainage ditch. Fortunately, artesian flow from the wells continued to provide water for impoundments during the windmill's prolonged periods of modification and repair. (JH)



Valve opening in two-stroke 1000 gpm capacity pump designed by Avery and powered by 14-ft windmill. Water enters pipeline to impoundments through a 12-inch opening at right. (JH)

Due to leakage through pond dikes, high ditch levels are typically helpful throughout the fall and winter months when full or nearly full pond levels are preferable. However, problems occur with high surf during spring months when stilts begin nesting. High surf will clog the evacuation ditch going out to sea and water remains at higher levels in the ditch, hampering drawdown of ponds for stilt nesting. Running the 40-hp evacuation pump overnight typically flushes the sand plug in the ditch, and allows pond drainage.

Ponds B, C, F and G were drawn down to expose mudflat areas at the onset of stilt nesting season. This resulted in synchronous nesting by the stilts, and slight manipulations in water levels throughout the summer provided mudflat and shallow water habitat resulting in dynamic food supplies for young stilt.

Following drawdown, blooms of green filamentous algae occurred in ponds C and F, nearly covering entire pond surfaces. In an attempt to slow this growth, we increased the exchange of water in the ponds and also pumped saline water into pond C from Punamano ditch. Since ponds C and F have traditionally supported high numbers of stilt nests, the adjacent pond G was also drawn down to provide additional nest sites thus offsetting the negative effects of algae coverage.

Small stilt nesting islands were constructed in pond C using a tractor and blade. Stilts appeared to prefer small earthen humps or mudflats for nesting in preference to large (greater than 20 square feet), elevated nesting islands.

Vegetation and water manipulations were made in ponds at the Ki'i Unit 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.

Punamano Unit

During periods of low rainfall, saltwater effluent from Amoriant Aquafarm flows up the ditch to the Punamano Unit, resulting in saltwater contamination of the pond. In 1987, a flapgate was installed by refuge maintenance staff to reduce saltwater inflow to Punamano Pond. Encroachment by wetland emergents into the Punamano Unit continued during 1988, further reducing the extent of open water available to waterbird. De-watering of the area is not possible due to the low-lying, spring-fed nature of this permanent pond, however, we are hopeful prescribed burning of portions of the unit will help maintain its value.

3. Forests

The Ki'i Unit contains very little tree or shrub growth. The Punamano Unit contains some upland areas that are densely covered by koa-haole (Leucaena leucocephala), kiawe (Prosopis pallida), and Pluchea spp.

9. Fire Management

Encroachment into ponds of the Ki'i Unit by continuous stands of California grass (B. mutica) was discouraged through prescribed burning during October. The majority of wetland vegetation targeted for burning must first be killed with herbicides for ignition to occur. Some small patches of California grass (B. mutica) were removed from three sites on Ki'i Unit in January by prescribed burns. Some sprouting of root clumps occurs after burning but where possible, immediate flooding with coverage

of at least six weeks is adequate to kill the sprouted plants. This year, prescribed burns were concentrated along the south perimeters of ponds C and F where encroachment of vegetation and shallow pond bottoms create numerous land bridges to nesting islands.



Burning of dike slopes followed by re-flooding in a useful method to discourage encroachment by California grass into the moats and bottoms of impoundments. The proximity of Kamehameha Highway (1/4 mile away) necessitates precise ignition techniques and smoke management. (TEH)

10. Pest Control

Vegetation control of California grass on the Ki'i Unit is an annual maintenance task. Spraying Roundup or Dalapon on pond and ditch banks during summer when water levels are low produces the best results. California grass encroaches into ponds by rhizome growth, but this species can be controlled from the banks to prevent establishment within ponds or ditches. Moats circling the inside perimeters of impoundments also discourage the encroachment of California grass from dikes into ponds.



Burning and mowing followed by re-flooding opened up the perimeter moat of pond C, thereby reducing predator access providing additional waterbird foraging/nesting areas.

G. WILDLIFE

1. Wildlife Diversity

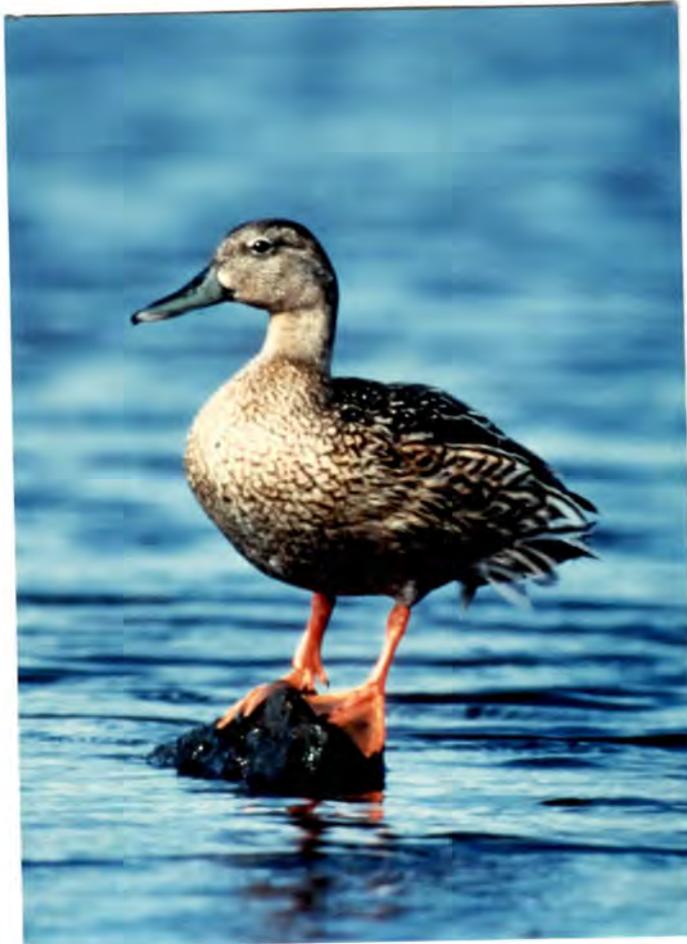
Habitat manipulations conducted on the Refuge are intended not only to provide optimal habitat for endangered waterbirds, but to maximize habitat diversity to the benefit of all native and migratory wildlife species that use Hawaiian wetlands. The four endangered waterbirds collectively require and use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

2. Endangered and/or Threatened Species

Both the Punamano and Ki'i units of the James Campbell National Wildlife Refuge provide year-round habitat for all four endangered Hawaiian waterbirds (Hawaiian duck, Hawaiian coot, Hawaiian moorhen, and Hawaiian stilt). Normally, the Ki'i Unit contains higher numbers of these birds because of greater habitat diversity.

Hawaiian Duck ("Koloa")

This species is very mobile and exhibits seasonal variation in use of James Campbell wetlands. Peak numbers occur during the winter months with nearly 80-90 koloa present on the Refuge at times. Populations build up in late fall and nesting usually begins in December. Reflooding of drained ponds is timed to coincide with the onset of koloa nesting. A small percentage of nesting ducks remain on the Refuge through mid-summer, with some hens laying up to 3 or 4 clutches per season if previous nesting attempts are interrupted early after initiation.



The Hawaiian duck or Koloa. A relative of the endangered Laysan duck; both species are distant relatives of the mallard. (GH)

A total of 51 koloa nests were found on the Ki'i unit this year, compared to 20 nests found in 1987. The difference is most likely due to a longer study period in 1988 (7 months, compared to 5 months in 1987).

Sixty-three percent of these study nests hatched, a marked improvement over 1987's 40% success. Both estimates of hatching success are calculated using traditional means (No. successful/total No. X 100). Mayfield estimates are expected in the final report provided by researchers (see section D.5).

The Refuge is used throughout the summer by small numbers of koloa (20-40), primarily at night and presumably for roosting. Many duck broods moved back and forth between Ki'i Unit and the adjacent Amorient Aquafarm. The Hawaiian duck uses montane stream habitat extensively on other islands it inhabits, and may depart for O'ahu streams during the summer months.

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

Hawaiian coot numbers on the Refuge fluctuate seasonally. During the winter of 1988 numbers peaked at over 560 birds, a dramatic increase over last years peak of 300+ birds. Coots readily move to other wetland areas in response to changes in food availability. During rainy periods a large portion of the coot population leaves permanent wetland areas to exploit food resources in ephemeral wetlands.

Summer counts peaked at over 200 birds, however the actual breeding population on the Refuge was about half the peak number. A portion of the local coot population appears to be simply maintaining itself and does not breed.

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. Coot territories are somewhat flexible, with some persisting throughout the year and others being more seasonal. With these somewhat restrictive habitat requirements, the Hawaiian coot may be approaching saturation levels at the refuge and increasing recruitment in the statewide or island-wide populations will require protection, development and management of additional wetland areas.

A total of 59 coot nests were found on the Ki'i unit in 1988, more than twice the number found in 1987. The increase is more a function of a longer study period rather than any real increase in nesting effort. Hatching success (traditional calculation) was 71% compared with 54% in 1987. This may be due in part to increased predator trapping efforts.



Hawaiian coots typically rest in dense vegetation on islands or pond embankments. Fifty-nine coot nests were located on the Ki'i unit in 1988. (GH)

Brood survival appears to be low; it is rare to see coot broods of more than 2 young. It is believed that predator activity is primarily responsible. It appears that young coots are particularly vulnerable to predators, and their habit of hiding in vegetation along pond banks while the parents feed them probably contributes to their overall vulnerability. It is estimated that 45 coots fledged from the Ki'i unit in 1988.



Nest success for the Hawaiian coot is apparently high on the Ki'i Unit, but low brood survival limits overall production.
(GH)

Hawaiian Moorhen ("`Alae`ula")

Unlike the Hawaiian coot, there does not appear to be a large "floating" population of nonbreeding moorhens. In addition, moorhens do not seem to move out of their permanent wetland habitat to exploit food resources in seasonally available wetlands. On both the Punamano and Ki'i units most areas of potential habitat appear to have a pair of moorhen occupying a territory.

Moorhens are generally intolerant of conspecifics during the breeding season. Usually adults will chase young birds off the territory shortly after fledging, however some family groups have been known to stay together for several months after fledging. Moorhen territories seem to be more elastic than those of breeding coots, and they fluctuate in size in reaction to changes in water levels and food availability. The number of territories on the refuge appears to be fairly stable with an estimated 40+ pairs on the Ki'i unit and 10+ pairs on the Punamano unit. Highly variable count results for this species reflect the secretive nature of the moorhen. High counts for 1988 were 30 in the Ki'i unit and 5 in the Punamano unit.



Hawaiian moorhen. Once common on all of the main islands with the exception of Lanai and Niihau, this species is now found only on Oahu and Kauai. (GH)

Nesting typically occurs from December through July, but in permanent water areas, some pairs nest throughout the year; very similar to paired coots. Thirty-five nests were found on the Ki'i unit in 1988, compared to 10 nests in 1987. Again, the increase is more a function of a longer study period rather than any real increase in nesting effort. Hatching success (traditional calculation) was 69%.

An estimated 43 moorhen fledged from the Ki'i unit in 1988. Moorhen nesting and fledging success appears to be higher than that of the koloa or coot, possibly due to their secretive nature and general wariness.



The Hawaiian moorhen is the most secretive of the Hawaiian waterbirds. This creates difficulty in census but is advantageous in that nest success is fairly high. (GH)

Hawaiian Stilt ("Ae`o")

The Hawaiian stilt is a mobile species that utilizes dynamic food sources as they become available. This is particularly evident on the adjacent aquafarm when ponds are dewatered for shrimp or prawn harvest and, as the case with the Hawaiian coot, when seasonal wetlands become available. Because of this ability to track food sources closely, the number of stilts using refuge lands fluctuates throughout the year, even during the breeding season (April-June). Counts for the Ki'i unit ranged between 163 (January) and 37 (December) birds. Counts for the Punamano unit ranged between 0 (several months) and 4 (February) birds.

The Ki'i unit provides some of the best breeding habitat in the state for Hawaiian stilts (see Section H. Habitat Management). 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.



The Hawaiian stilt. The Hawaiian name Ae`o means "one standing tall." It is one of the most conspicuous birds in Hawaiian wetlands. (GH)

A total of 79 stilt nests were found on the Ki'i unit during the 1988 field season, compared to 64 nests found in 1987. Both field seasons encompassed the entire breeding season so there was an apparent increase in the number of nesting attempts. Hatching success (traditional calculation) was lower (41% compared to 66%) but the estimated number fledged was higher (43 compared to 36) in 1988 than in 1987. Problems

maintaining stable water levels resulted in instances of nest flooding during rainy periods and exposure of nests to predators during dry periods. Heavy trapping pressure during the brood rearing season may have limited the loss of stilt chicks and increased chick survival.

The deep somewhat stable nature of the Punamano unit limits its value for Hawaiian stilt, although some stilt use occurs when low areas adjacent to the main pond are flooded during the rainy season. During the last few years a pair of stilts have nested along the southwest edge of the south pond. No young were observed in 1988.

Green Sea Turtle ("Honu")

One of the few remaining nesting areas for the threatened green sea turtle (Chelonia mydas) on the island of O'ahu is located on the beach just outside of the Refuge. One female nested in this area in 1986, resulting in the hatching of 70+ eggs. It is believed that this turtle is following a two-year nesting cycle, and we expected to find evidence of nesting activity in 1988. Weekly surveys of the area showed no sign of turtle activity during the nesting season. This area receives heavy public use throughout the summer months and evidence of turtle activity is subject to obliteration by extensive foot traffic. Monitoring will continue through the 1989 nesting season.



The Pacific green sea turtle is still occasionally seen around the main islands. Nesting is restricted primarily to the outer islands, with 90% occurring at French Frigate Shoals. The last recorded nesting on Oahu occurred on the beach near the Ki'i Unit in 1986. This area is proposed for acquisition & inclusion to the Refuge. (FWS file photo)

3. Waterfowl

Wintering migratory waterfowl use the Refuge from September through May, and the impoundments on the Ki'i unit are managed to provide critical habitat for the dwindling state population. Drawing down ponds in the summer promotes seed germination in the annual plant species that occur in these areas. This annual vegetation should be mature in late fall when ponds are reflooded and migrant waterfowl return to Hawai'i. The annuals provide a food source for these birds and provide substrata and nutrients for invertebrate hatches as the plants decompose throughout the winter.

The two most abundant waterfowl species that use Hawaiian wetlands are northern pintail and northern shoveler. Statewide surveys in the early 50's estimated wintering populations of up to 8,000 pintail and 2,000 shoveler. Surveys from the early 80's have averaged less than 900 pintail and fewer than 800 shoveler statewide.

Refuge counts conducted on the Ki'i unit during the winter of 1988 showed peak numbers similar to those recorded for the past few years, with high counts of 180 shoveler and 76 pintail in January. With continued habitat improvement at the Ki'i since the refuge was established, monthly counts indicate that migratory waterfowl are using this area more consistently during the winter months. The ducks are most often seen in ponds A and G. These two ponds are relatively large and are removed from the most travelled dikes and roadways.

Use of the Punamano unit by wintering waterfowl tends to be sporadic. Peak numbers for 1988 were 7 pintail and 44 shoveler, however there were several counts during the winter months in which we saw no waterfowl use in this area. The deep, somewhat sterile conditions of the pond limit overall production and availability of dabbling foods, and most use by the more common wintering dabblers occurs after rains have flooded low areas adjacent to the main pond. Most of the migratory diving ducks use the Punamano Unit where a larger, deep open water area provides secure habitat.

Other migrants include a mixed flock of lesser and greater scaup, ring-necked ducks and canvasbacks, mallard, occasional green-winged and blue-winged teal, and occasional Eurasian and American wigeon.



The fulvous whistling duck has become established at James Campbell and in surrounding wetlands. It was first seen in Hawaii in 1982 on the Ki'i Unit.

The resident population of fulvous whistling-ducks remained stable at approximately 30+ birds. This species first appeared in Hawaii in 1982 on Oahu, and has become established on the north shore in the vicinity of the Refuge. It is suspected that the birds were illegally introduced to the area, but it may have been a natural colonization. The first record of breeding by this species in Hawaii was in 1984 at the Refuge, Ki'i unit. Nests of this species have only been found on the Ki'i unit, however broods have been observed on the ponds in section D of the Amorient Aquafarm, and there is some indication that the population has started to spread westward into the vicinity of the Punamano unit. Six nests of this species were found on the refuge this year. Hatching success was very poor, but clutches that hatched were typically large and brood survival appeared to be high.

4. Marsh and Waterbirds

Combined counts of black-crowned night herons in the Ki'i and Punamano units revealed a variable population of 100-200 birds. Little is known about their feeding habits on the Refuge due to their crepuscular and nocturnal habits, however most observations of feeding activity have revealed a preference for fish, frogs and shrimp. Black-crowned night herons have been observed taking waterbird young on a few occasions, but it is not known to what extent they are influencing the populations of these birds.



The black-crowned night heron. This species is identical to the mainland form although it has been a Hawaiian resident since pre-Polynesian times. (GH)

A black-crowned night heron roost/rookery is located in a large clump of trees in the center of Punamano Unit. There are usually 10-15 birds using the roost and there are usually 3 or 4 active nests during the breeding season.

The refuge cattle egret population is also variable, but a local roost located near Kahuku Point harbors up to 3,000 birds at times. When ponds on the Ki'i unit are reflooded, up to 150 birds can be seen feeding in the flooded vegetation, picking up displaced terrestrial invertebrates. The cattle egret was introduced to Hawaii in 1959 in an effort to control arthropod pests in cattle and other livestock. The State Department of Agriculture introduced a total of 105 birds on the main Hawaiian islands; 40 on Oahu. The 28 year-old rookery near Kahuku Point is the oldest known rookery in the state.



The expansion of various agriculture industries on the north shore of Oahu has resulted in a dramatic increase in the local black-crowned night heron population. The Amorient Aquaculture prawn-rearing ponds provide abundant, easy food. (FWS file photo)

5. Shorebirds, Gulls, Terns, and Allied Species

The Ki'i unit provides some of the best shorebird habitat on the north shore of Oahu and numerous species may be seen during the fall, winter, and spring months. Habitat manipulations implemented to benefit stilt at the Ki'i Unit are equally attractive to most migratory shorebirds.

American golden plover and ruddy turnstones are the most abundant shorebird species using the Refuge. Individuals of both species may be seen during most months, but numbers peak during the fall migration. In 1988, the high count for plovers was 65 in August. The high count for turnstones was 56 in November.



The American golden plover is a common winter resident in Hawaiian wetlands. This species maintains "territories" during the winter months and are intolerant of conspecifics unless food is abundant. Flock activity is noticeable prior to migration. (FWS file photo)



The wandering tattler is a regular visitor during the winter months. Usually present in low numbers, they are solitary in habit and prefer the shallow pond areas for feeding. (RJS)

Sanderlings and wandering tattlers were also common, with peak numbers occurring during the fall migration. Usually each species numbers less than 10 during counts, however 43 sanderlings were counted in November.

Numerous other migrants were sighted on the Ki'i unit during 1988 including: long-billed dowitcher, western sandpiper, Wilson's phalarope, least sandpiper and bristle-thighed curlew.

The Punamano Unit provides habitat for shorebirds when adjacent low areas start drying after rainstorms, exposing mudflats. American golden plovers, ruddy turnstones, sanderlings and wandering tattlers are all seen in small numbers (usually less than 20) during migration.

Other sightings of note that occurred during 1988 include: least tern, laughing gull, ring-billed gull, and Thayer's gull.

6. Raptors

Short-eared owls (pueo) were frequently observed hunting over the grassy areas of the Ki'i Unit, and flying over portions of the Punamano Unit. Occasional observations of a barn owl were made on the Ki'i Unit in 1988. This species was introduced to prey on rats and mice in sugar cane to hopefully decrease the impacts of the rodents on cane production.

A single adult osprey is often observed during the winter months, catching fish from the ponds at the Ki'i Unit, and hunting over the Punamano Unit. This bird was first seen in the area a couple of years ago and was probably blown off course during migration. It has become a regular winter visitor to the area and roosts in the vicinity of Punaho'olapa marsh near the Punamano Unit. It is not known where this bird resides during the summer months.

7. Other Migratory Birds

Laysan albatrosses were regular visitors on the dunes outside of Ki'i Unit during the winter months. Great frigatebirds occasionally drink fresh water or take Tilapia and other fish from Ki'i ponds. Several other species of seabirds are often seen in the vicinity of both units including red-footed boobies, black noddies and brown noddies.



The great frigatebird often comes inland to the Ki'i and Punamano Units for a drink of fresh water or to catch fish in the impoundments. The frigatebird is known to eat the young of other seabirds, especially ground-nesting sooty terns, grey-backed terns and brown noddies. No instances of predation on waterbird young have been documented. (RJS)

10. Other Resident Wildlife

Approximately 20 to 30 ring-necked pheasants reside on the Refuge and use tree-rows and shrubby areas for nesting and brood rearing. In the past, local hunters crossed Refuge boundaries in search of these birds. There were no reported incidents of pheasant hunting on the refuge during 1988.

14. Scientific Collecting

A total of 120 Hawaiian duck eggs were collected from the Ki'i Unit for the Koloa/mallard hybridization study (Section D.5. Research and Investigations). In addition, 11 ducks of questionable ancestry (mallard x koloa or mallard) were collected from the Ki'i Unit for this study.

15. Animal Control

Live traps were set prior to the two nesting peaks of the endangered waterbirds during 1988 to catch mongooses, dogs, and cats. Over 500 mongooses were trapped in the Ki'i Unit alone, along with 8 cats and 2 dogs. The mongoose is a prolific animal that is quite an efficient predator of waterbird 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.



Feral cats are common on the Refuge. Proximity to housing areas exacerbates the problem and proposed development of the surrounding area will result in increased cat activity on the Refuge. (JH)

During 1988, the research project investigating effective chemical control of mongooses was completed (see section D.5 for interim results).



The small Indian mongoose is ubiquitous in lowland areas of most of the main Hawaiian islands. Trapping helps reduce local populations but recruitment is rapid, with populations returning to pre-trapping within 2 weeks. (JH)

H. PUBLIC USE

1. General

The Ki'i Unit of the Refuge has been designated by the Refuge Complex as the Refuge interpretation and education site for the island of O'ahu. It is the largest unit, and occasional public use of portion of the unit results in minimal disturbance to the waterbirds.

Public use of the Refuge during 1988 was limited to specific requests by school groups, scout clubs, local bird groups or individuals interested in visiting the Refuge for educational purposes such as photographic documentation or visual observation.

At present, public use of Ki'i Unit is limited, primarily due to the lack of restroom facilities and interpretive displays as well as the Refuge's distant location on the North Shore of O'ahu. Lack of part-time personnel or volunteer staff to monitor and maintain proposed public use facilities is also a factor. Eventual development of a proposed visitor's kiosk and trail system will hopefully improve our ability to educate the public.

2. Outdoor Classrooms

The Refuge was visited by seven groups, containing approximately 200 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. Ecological studies involving the animals, plants, invertebrates, water chemistry, etc., are promoted.

6. Interpretive Exhibits/Demonstrations

Significant progress was made on eventual construction of a visitor wildlife observation structure (kiosk) at the KI'i unit. The kiosk had been proposed in an Interpretative Development Prospectus completed in 1987 for the Refuge. Blueprints and a materials list for the kiosk were developed and finalized with the assistance of Engineering (RO). During 1987, a verbal commitment for financial assistance on the kiosk was received from the James Campbell Estate. Donations were obtained from James Campbell Estate and Ducks Unlimited for materials and exhibit panels for the kiosk. Additional funding also came from the Service Challenge Grant Program and the Hawaii Audubon Society. The Hawaii State Division of Forestry and Wildlife acted as recipient of the Ducks Unlimited funds, transferring them to the Service.

Towards the end of the year, the refuge received a verbal commitment from the U. S. Army Western Command regarding our request for assistance with construction of the kiosk. They agreed to enter into a Memorandum of Understanding in which their Engineering Division will build the facility as a "vertical exercise" while the Service agrees to reimburse the Army for any fuel used during the project. Building materials for the kiosk were purchased from Lee Haskin Co. in October. Text and blueprints for the kiosk interpretive panels are being prepared by SEE Design and Production, Inc under Service contract though EPIC (RO) and will be ready for review in early 1989.

Since refuge staff is currently inadequate for even partial opening of the kiosk and trail system, volunteer assistance will have to be relied upon. Towards this goal, we met with and received a positive response from the volunteer coordinator of The Nature Conservancy regarding their possible assistance with recruitment and staffing of the kiosk.

The Hawai'i chapter of the Audubon Society formally adopted the Refuge through the Adopt-A-Refuge program in 1985. They have provided active assistance through docent volunteers that lead tours of various groups on the Refuge throughout the year. This program has been a great asset to the Refuge, by reducing staff workload and increasing public

awareness of Refuge programs and endangered species. In addition, they have expressed a willingness to financially assist the Service with the implementation of a Public Use Plan including visitor facilities and interpretive materials.

11. Wildlife Observation

Approximately ten birding groups toured the Ki'i Unit of the Refuge during 1988. Leaders of these groups are issued Special Use Permits (Permits) and limited under the Special Conditions of their Permits from negatively affecting waterbird use of the Refuge.

17. Law Enforcement

An occasional weekend problem is the trespass of fishermen on to the Ki'i Unit. Most times they are attempting to catch baitfish at the outlet structure. Those apprehended were advised of the Refuge objectives and the rationale for not allowing trespass on the Refuge. No citations were issued.

During late January, several instances of private and military helicopters flying too low over the Ki'i Unit and disturbing waterbirds were observed by refuge staff. All observable identification was relayed to the Federal Aviation Administration (FAA) along with a description of the refuge and endangered species regulations. The FAA then provided us with information on the ownership of the aircraft. This was in turn relayed to our local Law Enforcement office who then forwarded letters to the owners further outlining the legal consequences of this activity. At least one request for a map of the refuge was received by one of these individuals and the occurrence of incidents dropped off immediately.

I. EQUIPMENT AND FACILITIES

1. New Construction

Use of the new entrance to the Ki'i Unit which was constructed in 1987 was completed through erection of an entrance gate with fencing. This will provide access to our parking area which was graded and graveled in 1987 and will serve as the starting point for visitors using our future trail system and kiosk.

3. Major Maintenance

A total of \$10,000 was spent this year on maintenance and repair of the Ford and John Deere farm tractors and Case backhoe used for maintenance and construction work on the Ki'i Unit.

4. Equipment Utilization and Replacement

A used and perfectly functional John Deere Flail Mower was obtained from Defense Re-utilization for maintenance of dikes and roads at the Ki'i Unit.

J. OTHER ITEMS

1. Cooperative Programs

As mentioned in Section D.1., the Refuge and the Army Corps of Engineers are cooperating on archeological investigations relating to the Master Plan for the wetland Refuges.

The James Campbell Estate, State of Hawaii, Ducks Unlimited and the Hawaii Audubon Society are participants in the Service' Challenge Grant Program for the purpose of developing an interpretive kiosk on the Ki'i Unit of this Refuge (see Section H.6). The Refuge has also developed an agreement with the U. S. Army, Western Command, Public Affairs Office for army assistance in a training exercise to build the kiosk on the Refuge.

4. Credits

Stewart Fefer wrote Sections A, C, D, E and J; Tom Harvey wrote Sections B, F, H and I and Jeff Holm wrote Section G.

**PEARL HARBOR
NATIONAL WILDLIFE REFUGE
HONOLULU, HAWAII**

**ANNUAL NARRATIVE REPORT
Calendar Year 1988**

U. S. Department of the Interior
Fish and Wildlife Service
NATIONAL WILDLIFE REFUGE SYSTEM

INTRODUCTION

TABLE OF CONTENTS

A. HIGHLIGHTS

B. CLIMATIC CONDITIONS

C. LAND AQUISITION

1. Fee Title	NTR
2. Easements	NTR
3. Other	NTR

D. PLANNING

1. Master Plan	2
2. Management Plan	2
3. Public Participation	NTR
4. Compliance with Environmental and Cultural Resource Mandates	2
5. Research and Investigations	2
6. Other	NTR

E. ADMINISTRATION

1. Personnel	4
2. Youth Program	NTR
3. Other Manpower Programs	NTR
4. Volunteer Programs	4
5. Funding	4
6. Safety	NTR
7. Technical Assistance	5
8. Other	NTR

F. HABITAT MANAGEMENT

1. General	5
2. Wetlands	5
3. Forests	8
4. Croplands	NTR
5. Grassland	NTR
6. Other Habitats	NTR
7. Grazing	NTR
8. Haying	NTR
9. Fire Management	NTR
10. Pest Control	9
11. Water Rights	NTR
12. Wilderness and Special Areas	NTR
13. WPA Easement Monitoring	NTR

G. WILDLIFE

1. Wildlife Diversity	9
2. Endangered and/or Threatened Species	9
3. Waterfowl	13
4. Marsh and Waterbirds	14
5. Shorebirds, Gulls, Terns, and Allied Species	15
6. Raptors	NTR
7. Other Migratory Birds	NTR
8. Game Mammals	NTR
9. Marine Mammals	NTR
10. Other Resident Wildlife	NTR
11. Fisheries Resources	NTR
12. Wildlife Propagation and Stocking	NTR
13. Surplus Animal Disposal	NTR
14. Scientific Collections	NTR
15. Animal Control	15
16. Marking and Banding	NTR
17. Disease Prevention and Control	NTR

H. PUBLIC USE

1. General	16
2. Outdoor Classrooms - Students	NTR
3. Outdoor Classrooms - Teachers	NTR
4. Interpretive Foot Trails	NTR
5. Interpretive Tour Routes	NTR
6. Interpretive Exhibits/Demonstrations	NTR
7. Other Interpretive Programs	NTR
8. Hunting	NTR
9. Fishing	NTR

H. PUBLIC USE (Cont.)

10. Trapping	NTR
11. Wildlife Observation	NTR
12. Other Wildlife Oriented Recreation	NTR
13. Camping	NTR
14. Picnicking	NTR
15. Off-Road Vehicling	NTR
16. Other Non-Wildlife Oriented Recreation	NTR
17. Law Enforcement	16
18. Cooperating Associations	NTR
19. Concessions	NTR

I. EQUIPMENT AND FACILITIES

1. New Construction	NTR
2. Rehabilitation	16
3. Major Maintenance	17
4. Equipment Utilization and Replacement	NTR
5. Communications Systems	NTR
6. Computer Systems	NTR
7. Energy Conservation	NTR
8. Other	NTR

J. OTHER ITEMS

1. Cooperative Programs	18
2. Other Economic Uses	NTR
3. Items of Interest	NTR
4. Credits	18

K. FEEDBACK

INTRODUCTION

The Pearl Harbor National Wildlife Refuge (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.



The Waiawa Unit of Pearl Harbor National Wildlife Refuge supports two impoundments manipulated for moist-soil management. Water for the unit, which originates from springs on nearby Bishop Estate land and from Pearl Harbor, is pumped into the ponds via a 250gpm electric pump. (SLB)

A. HIGHLIGHTS

A study of the landfill area adjacent to the Waiawa Unit conducted by the U.S. Navy found pthalate esters (an EPA designated carcinogen) in the groundwater and various unidentified "orange compounds" in sediment samples collected in Refuge ponds. In addition, pthalate esters were observed in fish tissue for Refuge ponds. The conclusions of this study recommended that more research be conducted.

A Refuge contaminant monitoring samples program was conducted during 1988. Results of 1986 and 1987 samples shown evidence of selenium, lead, arsenic and PCB's all at significant levels. During 1988, waterbird eggs and night herons were collected for analysis.

Intensive coordination between Refuge staff, Habitat Enhancement and the City and County of Honolulu involving the proposed West Loch housing and golf course development adjacent to the Honouliuli Unit resulted in agreement on required utilization measures.

Hawaiian moorhens were sighted on the Waiawa Unit during 1988 for the first time.

B. CLIMATIC CONDITIONS

The nearest weather reporting station, the Honolulu Observation Station, is located approximately 3 miles south of the Refuge. The following station summary for January-December, 1988 reflects the climatic conditions at the Refuge:

	AVERAGE DAILY TEMPERATURE		Rainfall (inches)
	Low	High	
January	63.2	80.8	3.03
February	63.7	82.9	0.68
March	65.2	84.1	1.14
April	67.2	83.8	0.51
May	69.7	85.1	1.13
June	70.1	87.6	0.10
July	70.9	88.8	0.15
August	71.5	88.8	0.81
September	71.2	88.9	0.45
October	68.6	88.3	0.44
November	70.3	86.2	1.99
December	65.3	83.2	6.58
TOTAL ANNUAL RAINFALL			17.01
MEAN MONTHLY RAINFALL			1.41

Temperatures are expressed in degrees Fahrenheit, and rainfall is expressed in inches. Total rainfall for 1988 was 17.01 inches.

D. PLANNING

1. Master Plan

The Draft of the Master Plan for the wetland Refuges within the Complex raised concern from the State of Hawaii, Department of Land and Natural Resources regarding potential adverse effects on several archaeological and historic sites. In response to these comments and in order to comply with Section 106 of the National Historic Preservation Act, we entered into a Memorandum of Understanding with the Environmental Section of the U.S. Army Corps of Engineers (Corps) during 1987. According to this agreement, a Corps staff archaeologist will prepare an addendum to the Master Plan, addressing possible effects on historic sites and measures to mitigate these effects, if necessary. During 1988, the Service redirected the Corps of Engineers Archeologist's efforts to an archeological study of Hanalei Valley where the Service proposed development of waterbird impoundments. The archeological work relating to the Master Plan was not completed as scheduled during 1988. The Corps archeologist is still planning to conduct this work and Refuge staff awaited completion at year's end.

Most of what is in the Master Plan relating to Refuge development in the Pearl Harbor Refuge has been accomplished.

2. Management Plan

A management plan development schedule for the wetland refuges was agreed upon by Refuge and Regional Office staff. By year's end, a draft of the Waterbird Population Monitoring Plan and the Waterbird Nesting and Production Monitoring Plan were prepared for review. Prescribed Burn Plans were completed and fire permits received from the City and County of Honolulu.

4. Compliance with Environmental and Cultural Resource Mandates

See number D.1. above.

5. Research and Investigations

Strategies for Managing Endangered Waterbirds on Hawaiian National Wildlife Refuges

Investigator: Mr. Paul R. Chang (Co-operative Education Student)

Advisor: Dr. Curtice R. Griffin

Collaborators: Mr. Stewart I. Fefer, Refuge Complex Manager
Mr. Tom Harvey, Assistant Refuge Manager (Wetlands)

Funding: Hawaiian and Pacific Islands NWR Complex

OBJECTIVES

A. Monitor nesting phenologies, productivity, and mortality factors of endangered waterbirds on National Wildlife Refuge wetlands on O'ahu.

Systematic searching for waterbird nest sites on both units of the Refuge was conducted every three weeks. Located nests were checked weekly to determine their fate. Ponds were drawn down to expose mudflat areas at the onset of stilt nesting season. This resulted in synchronous nesting by stilts, and slight manipulations in water levels throughout the summer provided mudflat and shallow-water habitat resulting in dynamic food supplies for young stilt.

Refuge Contaminant Sampling

The Waiawa Unit is adjacent to and lies below an abandoned Navy landfill site which may be a source of contaminants. According to Navy records, the landfill was in operation from March 1965 to October 1976. In addition to general household trash disposal from the Navy housing area, the landfill was used to dispose of polychlorinated biphenyls (PCB), asbestos, pesticides, photographic chemicals, oil, diesel fuel, kerosene, corrosives, paints, caustics, solvents and thinners. Results of a confirmation study conducted in 1986 were received this year. The basic conclusion of the study was that more research is needed. Pthalate esters (an EPA designated carcinogen) were found during the groundwater portion of the study, and various unidentified "organic compounds" were found in sediment samples collected in Refuge ponds. In addition, pthalate esters were observed in fish tissues collected from Refuge ponds. The concentrations of esters was "high", however no conclusion could be reached regarding the source of the contamination. The study noted that the flow of leachates from the landfill generally traveled in a southerly direction, towards the the Middle Loch of Pearl Harbor. The water pumping system for the Waiawa Unit does not totally preclude harbor water from the Refuge. Modifications designed to correct this problem should be completed in 1988. The summary of the study mentions concerns about bioaccumulation of contaminants, but does not address possible impacts on waterbirds using the refuge. No plans for further study have been brought to the attention of the Service. Given the 2-year waiting period between field studies and reporting of findings, it may be some time before we can determine the hazards associated with the close proximity of this landfill to the Waiawa Unit. Refuge personnel have been conducting a separate contaminants monitoring program since 1986.

The contaminants monitoring program was expanded to include the Honouliuli Unit. This area is adjacent to sugarcane fields and may be subject to pesticide contamination via run-off. Black-crowned night herons, fish and invertebrates were collected from both refuge units in 1986 and 1987 for contaminant sampling.

Results of sample analyses showed evidence of selenium, lead, arsenic, and PCB, all at significant levels. During 1988 refuge staff collected waterbird eggs and black-crowned night herons for analysis in order to determine if the contaminants were available to waterbirds and if ingestion was occurring at significant levels.

E. ADMINISTRATION

1. Personnel

Stewart I. Fefer remained the Refuge Complex Manager for the Hawaiian Wetlands Refuge Complex which include the Hawaiian/Pacific Islands Refuge Complex. In March Stephen Berendzen transferred to the Refuge Manager position at Colusa National Wildlife Refuge in the Sacramento Refuge Complex. Thomas E. Harvey was assigned as Acting Assistant Manager for Wetlands in March and acted in this position until May when he was permanently assigned. Tom transferred from a Wildlife biologist position within the Pacific Islands Refuge Office to assume this position. Jeffrey Holm was hired as the Wildlife Biologist for the Wetland Refuges during May. Jeff transferred to this position from the Assistant Refuge Manager's position on Tern Island, Hawaiian Islands National Wildlife Refuge.

David Woodside, Maintenance Worker, continues to be responsible for the maintenance of windmills, pumps, equipment, roads, vegetation, and predators on Pearl Harbor National Wildlife Refuge as well as the other wetland refuges in the complex.

The co-operative education position occupied by Paul R. Chang continued through the entire year. Paul returned to the University of Massachusetts for course work in December.

4. Volunteer Program

During the month of March through August, five volunteers donated a total of 504 hours assisting Cooperative Education Student, Paul Chang with waterbird censuses, nest searching, brood observations, predator control and contaminant sampling.

5. Funding

The Fiscal Year 88 budget for the wetland refuges was split between the five Refuges on O'ahu, Kaua'i and Moloka'i. The total management, operations and maintenance budget for the wetland Refuges was \$300,000.00. Additional funding was provided by the Challenge Grant Program \$12,000 from the Challenge Grant Program matched by \$12,000 from the James Campbell Estate, Ducks Unlimited, the State of Hawaii and the Hawaii Audubon Society), and Special Projects including contaminants monitoring, and impoundment development at the Hanalei (\$65,000).

Part of the base budget funding was allocated from the Special Appropriation received from Congress for Hawaii Refuges which totalled \$500,000.00.

7. Technical Assistance

Refuge staff participated in semi-annual, state-wide waterbird surveys, and assisted other various agencies with resource-related concerns or problems. Kane'ohe Marine Corps Air Station was given suggestions and assistance regarding development plans for Nu'upia Ponds wildlife area. The Ecological Services 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 well drilling. 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 had 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 the waterbirds; and a fence will be constructed around the Refuge to minimize animal entry within the Refuge.

F. HABITAT MANAGEMENT

1. General

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 30-50 feet wide. A 7-foot high chain link fence surrounds each Refuge unit. Water levels in the the individual impoundments are maintained artificially by electric pumps.

2. Wetlands

Islands and open water habitat were created within both units during the inception of the Refuge. Service investigations have indicated that these islands are too large in diameter and height. Large islands are less

productive than the small islands because stilts are very territorial and will defend the entire island on which they nest. However, stilts will tolerate other stilts nesting on nearby islands. Furthermore, the high islands at 1-1/2 feet or more above the water surface, provide a dry substrate for the establishment of undesirable upland vegetation. Lower islands preclude dry-land conditions and can be flooded to kill any unwanted vegetation that may become established.

Reconstruction of ponds occurred in 1985 at the Waiawa Unit, and in 1987 at the Honouliuli Unit, resulting in smaller islands with more water surface area available. Additional pond consolidation and island reconstruction is planned for Honouliuli in 1989.



Re-flooding of newly-combined ponds 3 and 4 at the Honouliuli Unit following reconstruction during 1987. Sizes of nesting islands were reduced and a dike separating two impoundments was lowered and broken into islands. (JH)

Salinity levels in the Waiawa Unit have historically been higher than optimal for management of waterbirds. Generally, levels greater than 6 ppt limit the presence and abundance of desirable invertebrates. The floating intake for the refuge pump is housed in a concrete weir located at the mouth of Waiawa Spring which receives brackish water from Pearl Harbor during high tides. Water from the spring enters the Refuge management ponds via a 5-hp submersible pump and 600 feet of 4-inch PVC pipe. The two ponds total 20 acres in size and management capabilities are limited by the restricted size and length of this pipe. Salinities within the management ponds increase as evaporation reduces the amount of fresh water thus, concentrating the salts. The deepest of the two ponds will attain salinities as high as 30 ppt due to this effect.



Waterbird impoundment at the Waiawa Unit with Pearl City skyline in background. Planned improvements in the delivery of fresh spring-water to the unit and drainage from the impoundments should create more ideal salinities for waterbird management. (JH)

A more direct connection between the upstream source of good quality spring water and the Waiawa Unit pump intake is obtained via a long-abandoned concrete sewer line originally constructed by the U.S. Navy. The spring water enters the sewer line outside of the refuge through an accidental opening made by a backhoe operator and exits the pipe at the mouth of Waiawa Spring. A plywood cover and six-inch PVC elbow were installed by maintenance worker Woodside in 1987 to allow a direct connection between the sewer line and our intake, however some inflow of brackish Pearl Harbor water into the weir still occurs, causing continued salinity problems in the refuge. Slightly brackish water (<5 ppt) for the Honouliuli Unit is obtained from a 12-foot deep well and delivered to the three impoundments with a 3-hp vertical shaft pump.



Site of break in abandoned concrete sewer line through which Waiawa spring water is conveyed to the pump for the Waiawa Unit. (JH)

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. Unfortunately, ponds 1 and 2 at Honouliuli were drawn down and kept dry from late June until mid-December in preparation for the U.S. Army conducting a similar pond reconstruction training exercise as they had last year. (See Section I.2).

3. Forests

Both units of the Refuge have introduced tree and shrub species that present management problems. On their upland areas is shrub zone dominated by kiawe (Prosopis pallida), a type of mesquite; koa-haole

(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.

10. Pest Control

Herbicide spraying is used to control exotic vegetation on the roads and fence lines of this Refuge. Roundup, Banvel, and Rodeo are used per manufacturers instructions.

G. WILDLIFE

1. Wildlife Diversity

This Refuge was established as mitigation for the loss of stilt feeding habitat when the Keehi Lagoon reef runway of the Honolulu International Airport was built in 1976. As a result, the man-made wetland habitats of this refuge were designed to provide feeding and nesting areas primarily for stilts. Other endangered waterbirds, migrant shorebirds and waterfowl have also benefited from these habitat modifications, and the overall diversity of these units has increased since acquisition.

2. Endangered and/or Threatened Species

The Pearl Harbor National Wildlife Refuge 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 in this complex 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.

Hawaiian Duck

Koloa nesting was documented on the Waiawa Unit for the first time. Two nests were found in the mauka pond, however both were destroyed by dogs.

Koloa use of the Honouliuli Unit was sporadic due to the early drawdown of refuge ponds in preparation for rehabilitation work. (see Section F2) In addition, pond 3 has not fully recovered from rehabilitation work completed in 1987. The high count for 1988 occurred in March when 5 koloa were observed on Pond 3. Past counts have documented up to 30 koloa on these ponds during winter months.



Koloa nesting on both units of the Pearl Harbor National Wildlife Refuge is sporadic. Attempts at establishing desirable plant species for nesting, coupled with continued freshening of impoundments has resulted in an overall increase in Koloa use of these units. (GH)

Hawaiian Coot

Waiawa coot numbers fluctuated widely throughout the year, with a low of 0 in April and June, and a peak of 57 birds in August. No nesting was noted in 1988.

Coots use Honouliuli impoundments and the protected area of the West Loch of Pearl Harbor adjacent to the Refuge. Even during the period in which all impoundments were dry for rehab work, there was a small flotilla of coots using the harbor and entering the Refuge after rains created small feeding areas. Prior to the drawdown, there were two active coot nests in pond one, and a total of 5 five coots fledged. Pond 3 usually provides excellent coot nesting habitat, however, the emergent vegetation had not recovered from the rehabilitation work conducted in 1987.



The Hawaiian coot is common on both units of the Pearl Harbor National Wildlife Refuge. The Honouliuli Unit provides excellent nesting/brooding-rearing habitat during the most years. Yearround coot use of the Waiawa Unit has increased dramatically over the last 5 years. (GH)

Hawaiian Moorhen

Hawaiian moorhens were documented on the Waiawa unit for the first time. The sighting of a single individual occurred on March 2, 1988. The bird was not seen after this initial sighting, but the presence of moorhens may indicate that efforts to lower the salinity of this unit are increasing it's suitability for this species.

No moorhens were seen on the Honouliuli Unit in 1988. Typically, 2 pairs of moorhen use this unit.



The Hawaiian moorhen is rarely seen in the Pearl Harbor area. Sightings on refuge units, although infrequent, have increased in the last 5 years. (GH)

Hawaiian Stilt

During 1988, populations of endangered Hawaiian stilt at the Waiawa Unit fluctuated with food availability. There were an estimated 7 breeding pairs of stilts on the Waiawa Unit. Total counts fluctuated between 8 and 18 birds. Production was minimal, primarily due to mongoose, cat and dog activity. It was estimated that 7 stilts fledged from the Waiawa Unit in 1988.

Stilt use of the Honouliuli Unit reflects changing availability of feeding habitat in this area. Numbers ranged from 10 birds in March to 41 in February. 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.



Both units of Pearl Harbor provide critical breeding habitat for the Pearl Harbor population of the Hawaiian stilt. The majority of the remaining wetlands in this area do not provide security from predator influence, human disturbance, encroachment of exotic vegetation, and uncontrolled water level fluctuation. (GH)

3. Waterfowl

Wintering and migrating waterfowl use both units of the refuge during the spring, fall, and winter months. The brackish, open-water habitat at Waiawa supports small numbers of scaup through most of the winter. Numbers of shoveler and pintail were considerably lower than in 1987, when as many as 30 shovelers and 40 pintails were observed. During 1988 the high counts for shoveler and pintail were 15 and 8, respectively.

The Honouliuli Unit usually provides habitat for a mixed group of shovelers, pintails, and a few green-winged teal through the fall and winter months, however all impoundments were dry during most of the fall and winter of 1988.

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. The high count for the Waiawa unit (15) occurred in August when both impoundments were at their lowest levels of the year. There are usually 3-5 heron nests in the mangroves west of the refuge. The high count for the Honouliuli unit was 10 birds in June.



The black-crowned night-heron is a common inhabitant of the Pearl Harbor area. Their ability to exploit saltwater, freshwater and brackish water habitats contributes to their continued well-being in this region of Oahu. (JH)

Cattle egret use of this area tends to be sporadic, again, relative to availability of food. The high count for the Waiawa Unit was 5 in May. The high count for the Honouliuli unit was 4 in March.

5. Shorebirds, Gulls, Terns, and Allied Species

Both units of the Refuge provide habitat 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 59 on the Waiawa unit in January and 106 on the Honouliuli unit in March.

A common tern was present on the Honouliuli unit in March and April.

15. Animal Control

Live traps were set by refuge staff during summer months to catch mongooses, cats and dogs. Mongooses are ubiquitous throughout the low-lying areas of Pearl Harbor. A total of approximately 35 mongoose were trapped on the taro units of the Refuge from April through August. In addition, the proximity of both units to housing areas results in a constant source of tame and feral cats and dogs. Six dogs and 5 cats were removed from these units. Efforts to trap dogs on the Waiawa unit proved futile as a few individuals developed trap smarts.



The small Indian mongoose is ubiquitous on both units of the Refuge. Proximity to cane fields and overgrown areas ensures constant recruitment to both areas. (JH)

H. PUBLIC USE

1. General

The urban, yet secluded location of this Refuge presents a great potential for environmental education. The small area of each unit would restrict the size of school groups and season of visits to minimize disturbance to the endangered waterbirds. Special teacher-training sessions could easily be accommodated with lesson plans designed to maximize the learning experience during subsequent brief visits by school groups. Budget and staff limitations thus far have limited such activity.

17. Law Enforcement

There has been a perennial problem with a few night fishermen from the Pearl City area who insist upon walking through the Waiawa Unit to fish off the Refuge in Pearl Harbor. They repeatedly cut holes in our boundary chain link fence, which we repeatedly repaired.

I. EQUIPMENT AND FACILITIES

2. Rehabilitation

Despite assurances we received in 1987, repeated communication with the U.S. Army during 1988, did not result in a hoped-for pond reconstruction exercise at the Honouliuli Unit. In 1987, a Memorandum of Understanding between the Service and the Army, resulted in equipment and operators being provided to reconstruct ponds 3 and 4. Similar work is still needed for the consolidation of ponds 1 and 2 into one larger pond and removing or reducing the elevations of large islands. In addition, the large pond resulting from the 1987 consolidation of ponds 3 and 4 should have a moat excavated around it's perimeter. After providing the Army with plans for the proposed work, a draft Memorandum of Understanding, and satisfying their concerns regarding permits, access and possible objections from local labor unions, we received an unofficial verbal commitment that the work will be done during 1989.



Prolonged discussion with the U.S. Army resulted in a verbal agreement to conduct a similar impoundment rehabilitation exercise as occurred in 1987. (SLB)

3. Major Maintenance

In December, the 5-hp submersible pump at Waiawa Unit, was repaired due to an electrical failure. Some lowering of impoundment water levels occurred from evaporation, however, since this was during the wet season and the repair was completed relatively quickly we were able to maintain deepwater habitat.

In early March, the 2-inch PVC pipeline for delivering well water to the Honouliuli Unit impoundments was replaced with a 4-inch line and new outflow valves were installed.

In mid-December, refuge staff cleaned up the break in the abandoned sewer line by which Waiawa Spring water is conveyed to the Waiawa Unit. Hollow tiles were placed around the opening and an expanded metal mesh screen was placed over the top of the pipe to filter out debris.

J. OTHER ITEM

1. Cooperative Programs

The Refuge is fortunate to be able to use a portion of the U.S. Navy motorpool area for storage. The area is located adjacent to the Waiawa Unit. A surplus four-wheel drive pickup and equipment trailer are stored at this secure location. The Navy also provide us with some additional enclosed storage for fencing and other hardware materials.

4. Credits

Stewart Fefer wrote Sections A, C, D, E and J; Tom Harvey wrote Sections B, F, H and I and Jeff Holm wrote Section G.

**KAKAHAI' A
NATIONAL WILDLIFE REFUGE
HONOLULU, HAWAII**

**ANNUAL NARRATIVE REPORT
Calendar Year 1988**

**U. S. Department of the Interior
Fish and Wildlife Service
NATIONAL WILDLIFE REFUGE SYSTEM**

INTRODUCTION

TABLE OF CONTENTS

A. HIGHLIGHTS

B. CLIMATIC CONDITIONS

C. LAND ACQUISITION

1. Fee Title	1
2. Easements	NTR
3. Other	NTR

D. PLANNING

1. Master Plan	2
2. Management Plan	2
3. Public Participation	NTR
4. Compliance with Environmental and Cultural Resource Mandates	NTR
5. Research and Investigations	NTR
6. Other	NTR

E. ADMINISTRATION

1. Personnel	2
2. Youth Program	NTR
3. Other Manpower Programs	NTR
4. Volunteer Programs	NTR
5. Funding	3
6. Safety	NTR
7. Technical Assistance	3
8. Other	3

F. HABITAT MANAGEMENT

1. General	4
2. Wetlands	4
3. Forests	7
4. Croplands	NTR
5. Grassland	NTR
6. Other Habitats	NTR
7. Grazing	NTR
8. Haying	NTR
9. Fire Management	NTR
10. Pest Control	NTR
11. Water Rights	7
12. Wilderness and Special Areas	NTR
13. WPA Easement Monitoring	NTR

G. WILDLIFE

1. Wildlife Diversity	NTR
2. Endangered and/or Threatened Species	7
3. Waterfowl	10
4. Marsh and Waterbirds	10
5. Shorebirds, Gulls, Terns, and Allied Species	11
6. Raptors	NTR
7. Other Migratory Birds	NTR
8. Game Mammals	NTR
9. Marine Mammals	NTR
10. Other Resident Wildlife	11
11. Fisheries Resources	NTR
12. Wildlife Propagation and Stocking	NTR
13. Surplus Animal Disposal	NTR
14. Scientific Collections	NTR
15. Animal Control	11
16. Marking and Banding	NTR
17. Disease Prevention and Control	NTR

H. PUBLIC USE

1. General	12
2. Outdoor Classrooms - Students	NTR
3. Outdoor Classrooms - Teachers	NTR
4. Interpretive Foot Trails	NTR
5. Interpretive Tour Routes	NTR
6. Interpretive Exhibits/Demonstrations	NTR
7. Other Interpretive Programs	NTR
8. Hunting	NTR
9. Fishing	12

H. PUBLIC USE (Cont.)

10. Trapping	NTR
11. Wildlife Observation	NTR
12. Other Wildlife Oriented Recreation	NTR
13. Camping	NTR
14. Picnicking	12
15. Off-Road Vehicling	NTR
16. Other Non-Wildlife Oriented Recreation	NTR
17. Law Enforcement	NTR
18. Cooperating Associations	NTR
19. Concessions	NTR

I. EQUIPMENT AND FACILITIES

1. New Construction	NTR
2. Rehabilitation	12
3. Major Maintenance	NTR
4. Equipment Utilization and Replacement	NTR
5. Communications Systems	NTR
6. Computer Systems	NTR
7. Energy Conservation	12
8. Other	NTR

J. OTHER ITEMS

1. Cooperative Programs	13
2. Other Economic Uses	NTR
3. Items of Interest	NTR
4. Credits	13

K. FEEDBACK

INTRODUCTION

Kakahai'a National Wildlife Refuge (Refuge) is a coastal freshwater pond, originally formed and used as a man-made fish pond. This 44.6-acre Refuge is situated along the south coast of the island of Moloka'i, Hawai'i, 5 miles east of the city of Kaunakakai. The Refuge was established in 1976 to provide habitat for the endangered coot. In 1983, an impoundment was constructed on the Refuge to provide additional shallow water habitat for the endangered stilt. The Refuge is surrounded by kiawe (Prosopis sp.), woodlands on the north, east and west. Hawai'i State Route 450 bisects the Refuge in its southern half. The two acres seaward of the highway are under Special Use Permit to the County of Maui for use as a County Park.



The main pond on Kakahaia National Wildlife Refuge is a remnant of an ancient Hawaiian fishpond. Historically, the south shore of Molokai supported many of these man-made "fish farms". (FWS file photo)

B. CLIMATIC CONDITIONS

The nearest weather recording station, Moloka'i Airport, is located 10 miles west of the Refuge. Temperature and rainfall data from this station, which is at a higher elevation than the Refuge, does not accurately reflect the conditions at the Refuge. No wind speed data are available for the island of Moloka'i. General weather conditions are similar to that reported for the Honolulu Weather Observation Station.

The Refuge is located on the leeward side of the island of Moloka'i. The Refuge typically receives annual rainfall of 20-30 inches. Occasional storms will cause flooding in coastal areas near the Refuge. Winds are generally light and variable.

AVERAGE DAILY TEMPERATURE (Molokai Airport)

	Low	High	Rainfall (inches)
January	63.8	78.0	6.11
February	64.3	80.3	1.22
March	64.2	80.6	2.23
April	65.9	80.5	0.90
May	68.9	83.2	0.52
June	70.1	84.3	0.25
July	71.9	84.4	0.76
August	71.5	85.8	0.84
September	70.9	86.2	0.29
October	69.1	85.5	0.52
November	69.5	82.7	3.48
December	66.5	81.0	7.51

TOTAL ANNUAL RAINFALL	24.63
MEAN MONTHLY RAINFALL	2.05

C. LAND ACQUISITION

1. Fee Title

One parcel of private property on the north side of the Refuge is surrounded by Refuge land on three sides. This parcel belongs to the heirs of Sadakara. The property is located close to one of the Refuge's main water springs and less than 50 feet from the wetland. Presently it is unoccupied; however, this may not be the case for very long. Another parcel retains a right of way through the Refuge. If this land is developed, this right of way may not be compatible with the objectives of the Refuge. During April, Refuge staff recommended to the Region 1, Office of Realty, that several parcels adjacent to the Refuge be purchased in fee.

D. PLANNING

1. Master Plan

The Draft of the Master Plan for the wetland Refuges within the Complex raised concern from the State of Hawaii, Department of Land and Natural Resources regarding potential adverse effects on several archaeological and historic sites. In response to these comments and in order to comply with Section 106 of the National Historic Preservation Act, we entered into a Memorandum of Understanding with the Environmental Section of the U.S. Army Corps of Engineers (Corps) during 1987. According to this agreement, a Corps staff archaeologist will prepare an addendum to the Master Plan, addressing possible effects on historic sites and measures to mitigate these effects, if necessary. During 1988, the Service redirected the Corps of Engineers Archeologist's efforts to an archeological study of Hanalei Valley where the Service proposed development of waterbird impoundments. The archeological work relating to the Master Plan was not completed as scheduled during 1988. The Corps archeologist is still planning to conduct this work and Refuge staff awaited completion at year's end.

2. Management Plan

A management plan development schedule for the wetland refuges was agreed upon by Refuge and Regional Office staff. By year's end, a draft of the Waterbird Population Monitoring Plan and the Waterbird Nesting and Production Monitoring Plan were prepared for review. Prescribed Burn Plans were completed and fire permits received from the County of Maui.

E. ADMINISTRATION

1. Personnel

Kakahai'a National Wildlife Refuge is an unmanned station. The Refuge is typically visited once a month to census birds, perform light maintenance and to check water conditions. Intermittent visits occur to work on various projects or meet individuals with Refuge-related concerns or requests. Regular maintenance and bird counts are conducted during these visits if time allows.

Stewart I. Fefer remained the Refuge Complex Manager for the Hawaiian Wetlands Refuge Complex. In March Stephen Berendzen transferred to the Refuge Manager position at Colusa National Wildlife Refuge in the Sacramento Refuge Complex. Thomas E. Harvey was assigned as Acting Assistant Manager for Wetlands in March and acted in this position until May when he was permanently assigned.

Tom transferred from a wildlife biologist position within the Pacific Islands Refuge Office to assume this position. Jeffrey Holm was hired as the Wildlife Biologist for the Wetland Refuges during May. Jeff transferred to this position from the Assistant Refuge Manager's position on Tern Island, Hawaiian Islands National Wildlife Refuge.

David Woodside, Maintenance Worker, continues to be responsible for the maintenance of windmills, pumps, equipment, roads, vegetation and predators on wetland Refuges on Oahu and Moloka'i.

5. Funding

The Fiscal Year 88 budget for the wetland refuges was split between the five Refuges on O'ahu, Kaua'i and Moloka'i. The total management, operations and maintenance budget for the wetland Refuges was \$300,000.00. Additional funding was provided by the Challenge Grant Program (\$12,000 from the Challenge Grant Program matched by \$12,000 from the James Campbell Estate, Ducks Unlimited, State of Hawaii and the Hawaii Audubon Society), and Special Projects including contaminants monitoring, and impoundment development at the Hanalei National Wildlife Refuge (\$65,000). Part of the base budget funding was allocated from the Special Appropriation received from Congress for Hawaii Refuges which totalled \$500,000.00.

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 Service Ecological Services 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. Projects on Moloka'i that required Refuge technical assistance included aquafarm requests for control of black-crowned night herons.

8. Other

The Refuge revenue sharing check for Kakahai'a National Wildlife Refuge was mailed to Maui Mayor Tavares on April 18, 1988. Revenue sharing is based on 0.75% of the appraised value. However, the amount of \$4,334.00 is approximately 59% of this amount. Congress appropriated funds to make up the shortfall in the revenue sharing account, but apparently not enough to bring it to 100%.

F. HABITAT MANAGEMENT

1. General

This 44.6-acre Refuge consists of a centrally located 15-acre, spring-fed wetland area that at one time was an ancient Hawaiian fish pond. Later it was used for rice and taro cultivation. A 5.5 acre moist soil impoundment abuts this wetland to the west. This entire wetland area is bordered by a two-lane highway on the south, and scrub forest (22 acres) surrounds the remaining sides.

2. Wetlands

When this Refuge was first established in 1976, the central fish pond contained a total of 15 acres of open water habitat. This wetland now consists of 4 acres of open water surrounded by 11 acres of dense bulrush. A thick algal mat covers 50-80% of the open water area. Waterbird use of this spring-fed wetland was restricted, for the most part, to the open water pond (average depth ca. 50-70 cm.) and the bulrush border surrounding the open pond.



Gradual sedimentation and encroachment by bulrush has reduced the open water in the spring-fed central fish pond from 15 to 4 acres since 1976. (SLB)

During the summer of 1983, the 11-acre bulrush stand was partially opened by creating radiating channels from the central open water pond with a Menzi Muck backhoe. The channels were excavated to a depth of 4 feet and a width of 15 feet. A perimeter moat was also excavated around the entire wetland to the same dimensions. The moat serves as a barrier to the mongoose, which is the primary predator of nesting waterbirds.

During the last five years, the sedimentation and subsequent rate at which bulrush has re-invaded the channels and moat created by the Menzi Muck has been extremely rapid. At present, only 10-20% of the formerly-open water habitat has resisted becoming choked with vegetation. In addition, the dredge spoil berms and islands created by the Menzi Muck have served as sites for the establishment of upland vegetation such as Pluchea indica which are now invading the wetland. Since the fish pond is a low-lying, spring-fed wetland, drawing down the water level would be difficult without massive pumping. However, we are currently investigating the feasibility of conducting prescribed burns of the fish pond as a means of setting the bulrush back.

The 5.5-Acre Moist-Soil Impoundment

Since the main bulrush wetland contains no mudflat habitat, the area is used only by coots and waterfowl. In order to create habitat for the endangered stilt and to diversify wetland habitat on the Refuge, an additional wetland development project occurred during the summer of 1983. An open flat area along the west side of the Refuge was cleared of trees and converted into a 5.5 acre shallow impoundment. Small nesting islands were constructed in the center of this impoundment which was designed to be managed at depths ranging from 0 inches to 1-1/2 feet. A windmill for drawing water from the 15 acre fish pond into the newly created 5.5-acre shallow water impoundment, was also erected on the dike between the two wetlands.

Ideally, the Refuge would like to maintain high water levels from October through March in the new impoundment. This would increase habitat for wintering waterfowl and coots. In April the pond would be drawn down to provide stilt nesting habitat. Water levels would be manipulated through summer months to provide optimum mudflat and shallow water habitat for stilt broods. Dewatering would also allow germination and growth of moist-soil plant species for the upcoming fall and winter months. The entire month of September would be available for the slow build up of the pond to the desired high winter water level.

Since the original windmill water delivery system for the moist-soil impoundment does not adequately provide water to the pond, a supplementary system consisting of a 460-volt submersible pump was installed in 1987. Despite the exorbitant costs of electricity on Moloka'i, we believe installation of this pump will be critical in maintaining waterbird habitat, given the rapid succession occurring on other wetlands on the island and resulting losses in stilt and coot nesting areas.

Winds on the leeward side of Moloka'i are variable, and can be limited to the extent that the windmill will not pump an appreciable amount for up to 2 weeks. However, once the impoundment is re-flooded using the electric pump, we believe the windmill will be useful at helping maintain water levels. The windmill was rigged with 4 six-inch pumps for the first half of 1986, until the gearbox shattered from being overloaded. Presently, only two pumps are powered with the windmill.



Installation of a 460-volt submersible pump to supplement the windmill allows for a reliable water delivery system for the 5.5 acre impoundment. (SLB)

Despite frequent use of our submersible electric pump and staggering monthly electric bills of as high as \$1,000, water levels in the moist-soil impoundment were lower than desired throughout 1988. Full pond levels were never reached during the winter months, due to a possible combination of leakage through or under dikes, evapo-transpiration by dense stands of emergent vegetation and light winds. Lush stands of millet (Echinochloa crus-galli), makai (Scirpus maritimus) and sprangletop (Leptochloa uninervia) sprouted and matured as a result of reduced water levels and timely rains.

In an attempt to open up vegetation in the pond, a mowing contract was awarded to a local farmer who, despite numerous equipment failures, was able to clear some of the site. However, our attempts to re-flood were stymied by a series of electric pump failures which prevented covering the vegetation before it had grown back to it's full height.

Kakahai'a Bulrush Pond

The dredged channels in the old fish pond are being overtaken by exotic vegetation at a rapid rate. The spoil dikes are also getting more upland plant establishment on them; some kiawe trees are growing rapidly and need to be cut periodically. A culvert extends under the highway to the ocean beach for drainage of the main wetland. Typically, the county maintains this culvert by occasional removal of the sand plug in the culvert. High water levels exist in the old fish pond when the sand plug is in place. This inhibits further encroachment of bulrush into the pond, and high levels also assure a water source for the impoundment when needed. The old pond cannot be completely drained, but extended periods of low water levels permit more establishment of dry-site plant species into wetland vegetation. If a period of low water level could be maintained while a prescribed burn were attempted, it may be possible to improve habitat diversity in the fish pond. However, the pond is surrounded by dense, overhanging stands of kiawe, creating extremely hazardous burning conditions from possible spot fires.

3. Forests

Upland areas of the Refuge are covered by dense stands of koa-haole (Leucaena leucocephala), kiawe (Prosopis pallida) and Pluchea spp.

11. Water Rights

Development of an agricultural/residential subdivision, Kawela Plantations, which borders the Refuge to the north and west, began in 1980. This 6,000-acre subdivision contains 210 two-acre fee-simple lots. The first house was completed during the summer of 1983. Roads and utilities have been installed for the subdivision. Three wells were drilled within 1,600-2,000 feet of the Refuge boundary. This development and its water use may have detrimental impacts on the Refuge. A Stevens water level recorder, installed along the west side of the 15-acre open water area in 1980, continued to document baseline water data throughout the year.

G. WILDLIFE

2. Endangered Species

The Hawaiian coot and stilt are two endangered species normally encountered on the refuge. Management of wetland habitat on Kakahaia refuge is oriented toward these endangered species in addition to migrant shorebirds and waterfowl.

Due to the remote location of the refuge, and a lack of manpower and funds, monthly counts were not conducted on the refuge during 1988. Incidental counts were conducted during staff visits to the site.

Coot populations were variable, ranging from as few as 30 during the wet winter months to as many as 110 during the dry fall months. Apparently, coots move between different wetlands on Molokai, and to and from adjacent islands. Habitat availability varies seasonally, especially on this dry side of the island, and it is presumed that bird movements occur to take advantage of good wetland habitat as available. Coot nesting occurred throughout most of the year with 3 or 4 pairs consistently observed nesting, especially through the early summer months. It is not known if the same pairs are territorial and maintain these territories throughout the year. Apparently with higher coot densities there is a reduction in nesting, but the same resident breeders may persist until competition decreases allowing them to nest. Plans to open the large bulrush pond through spraying and burning should result in increasing the available nesting and brood rearing habitat for coots. In addition, when the water delivery system in the 5.5-acre impoundment is operational, there will be additional coot habitat in the deeper portion of this pond.



Mowing of vegetation in the 5.5 acre impoundment to improve stilt nesting conditions were unsuccessful due to electric pump problems. (DW)



The Refuge is the only major nesting area for Hawaiian coots on Molokai. Encroachment by bulrush has reduced the extent of suitable nesting habitat in the central fish pond portion at the Refuge. (SLB)

Hawaiian stilt use occurs in the 5.5-acre impoundment which provides nesting islands and shallow feeding areas. Stilt counts were variable throughout the year, depending on our ability to control water levels in this impoundment. Four stilts are known to have fledged from this pond in 1988. Typically 12 to 14 stilts are in the area and, presumably, production will increase with increased ability to control water levels and predator activity. The last reported sighting of a Hawaiian moorhen occurred in 1986. This bird was apparently a survivor of 6 birds that were transplanted to the refuge in 1983.



Improved management at the 5.5 acre impoundment will provide additional coot production habitat in the deeper portions at the pond. (GRH)

3. Waterfowl

Migrant waterfowl use of the refuge was noted during the winter months. Northern shoveler, pintail, and green-winged teal are commonly seen on the refuge from September through April.

One fulvous whistling duck was observed on the refuge intermittently during 1988. This bird is apparently an individual that dispersed from the population that has become established on Oahu.

4. Marsh and Waterbirds

Black-crowned night herons are regularly observed around the edge of the open water area or roosting in nearby trees. Numbers typically ranged from 3 - 13. No heron nesting was observed on the refuge during 1988.

Cattle egrets are common inhabitants at the Kakahaia refuge; typically 2 to 15 birds can be seen on the periphery of the wetlands.

A great blue heron was frequently seen on the refuge throughout the year. This mainland visitor apparently found its way here by accident after being lost in a storm and has taken up residency. Sightings of great blue herons have been reported on other islands; it is not known if these sightings are of other birds or this same individual.

5. Shorebirds, Gulls, Terns, and Allied Species

The 5.5-acre impoundment provides excellent shorebird habitat. These shorebirds are migrating and wintering birds that use the refuge during the fall, winter, and spring months. Common species include: lesser golden plover (2-4), ruddy turnstone (2-4), sanderling (1-2), and wandering tattler (1-2).

10. Other Resident Wildlife

Occasionally francolins (gray and black), an introduced game bird, can be heard calling as they use the upland areas of the refuge. Young gray francolins have been spotted near the 5.5-acre impoundment, and nesting may occur on the refuge. The island-wide populations of these birds have increased dramatically with the collapse of the island's pineapple growing industry as most of the former pineapple fields have reverted to grass and herbaceous cover.

Axis deer can be found in the thick kiawe forest on the refuge, and they drink water regularly at the bulrush pond and the 5.5-acre impoundment.

15. Animal Control

Mongoose depredation is a serious problem on the Kakahaia National Wildlife Refuge. Limited funding and staff time preclude conducting an effective trapping program and the limited trapping that occurs has little influence on the local mongoose population.

H. PUBLIC USE

1. General

Kakahai'a National Wildlife Refuge is located immediately adjacent to the southern coastal highway and only 5 miles east of Kaunakakai, the largest town on the island. Traffic on this road is very light and most travelers pass by the Refuge without seeing this important wetland. A tall, dense stand of bulrush shields any view of the open pond from the highway.

9. Fishing

Moloka'i residents fish from the beach along the Maui County Park, which is under Special Use Permit from the Refuge. Public use data are difficult to obtain due to night fishing and our infrequent visits to the Refuge. Estimates derived with the assistance of the state fishery biologist for Maui County suggest that approximately 25 fishermen use the area an average of 2 hours per month each.

14. Picnicking

A day-use picnic area was constructed in 1978 on the ocean side of the highway intersecting the Refuge and continues to be maintained by the County of Maui. The concrete tables, constructed by the YCC in 1978, and metal barbecue grills are used on a limited basis by local residents and tourists. No view of the wetland area is presently available from the picnic area.

I. EQUIPMENT AND FACILITIES

2. Rehabilitation

Three electrical repairs were necessary on the 460-volt, 5-hp submersible pump during the year, including an internal seal failure, a broken power supply wire and a burned out motor. These created numerous difficulties when we were attempting to reflood the 5.5-acre impoundment. Several blades on the 8-foot Dempster windmill required replacing, following their collapse due to corrosion from salt air.

7. Energy Conservation

The 8-foot Dempster windmill offers considerable savings in electric pumping costs. The spring through late-summer winds along the Moloka'i shoreline are fairly constant at 10-15 mph during the day, but die down at night. The greatest water needs occur in the fall when winds are not reliable.

J. OTHER ITEMS

1. Cooperative Programs

The Refuge is fortunate to have good relations with local personnel of the Forestry and Wildlife Division of the Department of Land and Natural Resources. They allow us to store our equipment and supplies in their secure maintenance yard. In addition, if we are in dire need of manpower assistance, they will lend a helping hand.

4. Credits

Stewart Fefer wrote Sections A, C, D, E, and J. Tom Harvey wrote Sections B, F, H, and I. Jeff Holm wrote Section G.