JAMES CAMPBELL NATIONAL WILDLIFE REFUGE

Island of Oahu, Hawaii

ANNUAL NARRATIVE REPORT

Calendar Year 1989

Donna Stovall	4/30/98	Rich D. Poetker	5/13/98
Refuge Manager	Date	Refuge Supervisor Review	Date

Robert P. Smith 5-14-98
Pacific Islands Ecoregion Manager Date

5/15/98
Regional Office Approval Date

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 Punamanō Pond Unit (37.5 acres) is a naturally occurring, spring-fed marsh, while the Ki'i Unit (107.5 acres) consists of artificial ponds established in 1977 to provide habitat for Hawai'i's four endemic, endangered waterbirds (stilt, coot, moorhen, and koloa) 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 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 (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 U.S. Fish and Wildlife Service (Service) under a 55-year lease from James Campbell Estate (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 landowners, the Estate. The water levels desired by the Estate may be lower than the levels required for maintenance of habitat for the endangered waterbirds. Frequent coordination with land managers from the Estate and with adjacent land users is required to minimize conflicts arising from water management practices.

Koloa

JMC-1

The Ki'i Unit of the James Campbell National Wildlife Refuge consists of seven 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. (THE)

JMC-2

The Punamanō Unit is a low-lying, spring-fed wetland subject to steady encroachment by emergent vegetation. Prescribed burns are planned for next year to expand open water habitat. Unfortunately, planned prescribed burns to impede encroachment of emergent vegetation were not done due to the lack of personnel. (ARY)

INTRODUCTION

TABLE OF CONTENTS

A. HIGHLIGHTS 1

B. CLIMATIC CONDITIONS 1

C. LAND ACQUISITION 2

D. PLANNING 3
- 1. Master Planning 3
- 2. Management Plan 3
- 4. Compliance with Environmental and Cultural Resource Mandates 4
- 5. Research and Investigations 4

E. ADMINISTRATION 11
- 1. Personnel 11
- 5. Funding 12
- 7. Technical Assistance 12
- 8. Other Items 12

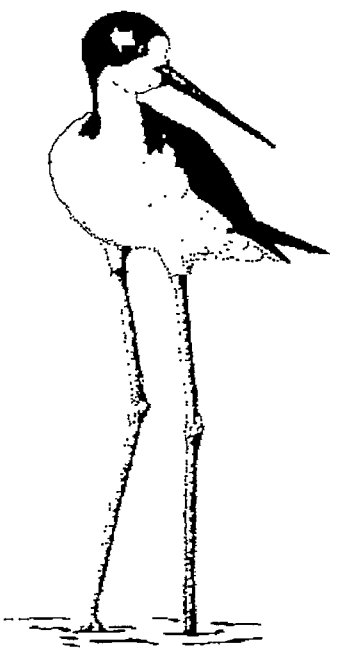
F. HABITAT MANAGEMENT 13
- 1. General 13
- 2. Wetlands 13
- 3. Forests 15
- 9. Fire Management 15
- 10. Pest Control 15

G. WILDLIFE 16
- 1. Wildlife Diversity 16
- 2. Endangered and/or Threatened Species 16
- 3. Waterfowl 21
- 4. Marsh and Waterbirds 23
- 5. Shorebirds, Gulls, Terns, and Allied Species 24
- 6. Raptors 25
- 7. Other Migratory Birds 26
- 10. Other Resident Wildlife 26
- 15. Animal Control 27

H. PUBLIC USE 27
1. General 27
2. Outdoor Classrooms 28
6. Interpretive Exhibits/Demonstrations 28
11. Wildlife Observation 29
17. Law Enforcement 29

I. EQUIPMENT AND FACILITIES 30
1. New Construction 30
3. Major Maintenance 30

J. OTHER ITEMS 30
1. Cooperative Programs 30
4. Credits 30



Hawaiian Stilt

A. HIGHLIGHTS

Thomas E. Harvey transferred from the Assistant Refuge Manager position and Jeff Holm transferred from the Wildlife Biologist position in November.

A Challenge Grant project was developed on the Refuge for the construction of an interpretive kiosk and trails on the Ki'i Unit. James Campbell Estate, Ducks Unlimited, Hawai'i Audubon Society, U.S. Army Western Command, and the Hawai'i Division of Forestry and Wildlife contributed funds and/or assistance toward the development of this visitor facility. During 1989, the U.S. Army Western Command constructed this kiosk.

Partial analysis for 1988 contaminant sampling on the Ki'i Unit was completed. DDE was detected in all samples (n=26) and one stilt egg contained PCBs. However, additional effort is needed to determine whether these levels were significantly high.

B. CLIMATIC CONDITIONS

The nearest weather station, Amorient Aquafarm, is adjacent to the Refuge. The station summary for January-December, 1989 generally reflects the climatic conditions at the Refuge.

AVERAGE DAILY TEMPERATURE

Month	Low (°F)	High (°F)	Rainfall (Inches)
January	69.8	79.0	5.61
February	66.1	79.9	8.47
March	*	80.7	11.96
April	96.1	79.2	4.77
May	73.5	82.0	1.65
June	75.0	83.8	1.62
July	76.0	84.0	5.07
August	*	*	*
September	76.5	85.5	1.33
October	73.8	85.3	5.32
November	71.2	83.6	3.16
December	63.7	78.4	3.49

* data not available

Typical weather patterns occurred in 1989; northeasterly trade winds averaging 12-13 mph blew throughout 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 Estate produced a map of sites to be leased by the Estate for aquiculture development. One such development was proposed for an area immediately adjacent to the Ki'i Unit of the Refuge. A permit application for this proposed aquiculture facility was reviewed by Refuge staff in coordination with our Ecological Services office. Refuge staff felt that this aquiculture facility would conflict with Refuge operations through encroachment of salt water 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 aquiculture and other leases of the 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 discussion with Estate land managers, we learned which parcels would be available for sale willingly by them. It was suggested the Estate would prefer to sell whole parcels to avoid subdivision. Refuge staff, using the aquiculture development map, identified which parcels the Service would be interested in. The Estate informed us that only part of the one lot adjacent to the west side of the Punamanō Unit would be available, and we identified on the map the portion that we felt was required for the Refuge. In later meetings with the Estate, we learned that an additional lot adjacent to the east side of Punamanō Unit would be available, and we added that lot to the map of the proposed acquisition boundary. Approximately 80 percent of the lands desired by the Service in fee are within boundaries of the approved ascertainment report.

The purpose of the maps provided up to this point (August 1988) was to identify areas that the Refuge would like to acquire and that the Estate was willing to sell. In October 1988, Realty, Region 1 requested acreage and an actual boundary for an acquisition proposal for the Washington D.C. 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 the 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 Punamanō Unit. The Estate had preliminary plans to construct a tramway to transport visitors between the Turtle Bay Hilton 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 the negotiations for the acquisition. The concern is that present water levels, which are maintained for wetland values, are reducing the flood water storage capacity of the area, and in the event of severe flooding, may result in flooding of commercially valuable properties upstream. In 1989, the Estate contracted with a private company to conduct a flood control study and to provide recommendations. The Service awaits results of this study.

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

D. PLANNING

1. Master Plan

The draft Master Plan for wetland refuges within the Complex raised concern from the State of Hawai'i-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, during 1987 we entered into a Memorandum of Understanding with the Environment Section of U.S. Army Corps of Engineers (Corps). According to this Memorandum, 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' archaeologist's efforts to an archaeological study of Hanalei Valley where the Service proposed development of waterbird impoundments. The archaeological work relating to the Master Plan was not completed as scheduled during 1989.

2. Management Plan

During 1989, significant progress was made on the development of management plans for the wetland refuges. Management plans have been developed generally for wetlands refuges with specific sections on operational considerations for individual refuges. In 1989, management plans drafted included predator control,

habitat monitoring, and fire management plans. In addition, the waterbird population monitoring plan was completed.

4. Compliance With Environmental and Cultural Resource Mandates

Refuge staff, with coordination from the Regional Office hydrologist and Office of the Solicitor, completed forms for the State of Hawai'i-Commission on Water Resource Management's water registration process and requirement of registering surface water diversions and wells. All diversions and wells used on the Refuge were submitted to be registered with the Commission in May 1989.

5. Research and Investigations

Strategies for Managing Endangered Waterbirds on Hawaiian National Wildlife Refuges

Investigator: Paul R. Chang (Co-operative Education Student)
Advisor: Dr. Curtice R. Griffin, University of Massachusetts, Amherst
Collaborators: Stewart I. Fefer, Refuge Complex Manager
Objectives:
- A. Evaluate the accuracy of waterbird survey methods;
- B. Assess the response of waterbirds to vegetation manipulation;
- C. Monitor nesting, productivity, and mortality factors of waterbirds;
- D. Determine the relation between invertebrate numbers, fish populations and water salinities;
- E. Determine the degree of hybridization of koloa and mallards at James Campbell NWR - Ki'i Unit.

A. Statewide waterbird counts were initiated in the 1960s to monitor population trends of Hawai'i's four endangered waterbirds: the black-necked (Hawaiian) stilt, *Himantopus mexicanus knudseni*; the American (Hawaiian) coot, *Fulica americana alai*; the common moorhen (Hawaiian gallinule), *Gallinula chloropus sandvicensis*; and the Hawaiian duck (koloa), *Anas wyvilliana*. Results from these counts have been used to monitor waterbird population trends and to assess recovery plan objectives. However, these data are highly variable between years and the accuracy of survey methods is not known. Timing of counts, level of rainfall, inter-island movements and recruitment success during the years are thought to account for fluctuations in waterbird count data (Engilis, 1988). Additionally, observability of waterbirds on a wetland may vary because of differences in waterbird behavior and vegetative structure.

The study was conducted on the Ki'i Unit to evaluate the accuracy of waterbird survey methods; assess the response of waterbirds to vegetation manipulation; monitor nesting, productivity and mortality factors of waterbirds; determine the relationship between invertebrate numbers, fish populations and water salinities; and to determine the degree of hybridization of koloa and mallards.

Standardized, cumulative 2-hour counts were conducted on the Ki'i Unit at established stations on four impoundments. Each of the four impoundments had different levels of vegetative cover ranging from 91 percent to 22 percent. We determined the average time in minutes required to account for 80 percent of the total number seen of each species during a count. There was much variation in observability of waterbirds depending on species and impoundment.

For all impoundments combined, moorhens were least observable with only 12 percent of the total seen during the first 5-minute interval, where 69 percent and 58 percent of the coots and stilts, respectively, were observed during the first 5-minute interval. Koloa could not be counted accurately because they often flew from impoundments upon our arrival.

For all impoundments combined, observing 80 percent of the total number of coots and stilts took 20 to 30 minutes for each species; for moorhens, it took 70 to 80 minutes. There was no significant difference in time needed to observe 80 percent of stilts and 80 percent of coots. However, significantly more time was needed to observe 80 percent of moorhens than was needed for either coots and stilts. Waterbird detectability also varied among impoundments. Less time was required to observe 80 percent of waterbirds on impoundments with less vegetation cover.

Variation in Hawaiian waterbird detectability according to species and vegetative cover in a wetland indicates that current semi-annual waterbird surveys provide large underestimates of waterbird numbers.

While current state-wide semi-annual counts show general trends in waterbird populations, they do not provide accurate population estimates. However, it is probably not logistically practical for personnel to spend the time required to obtain accurate estimates. Information on population trends may be sufficient for monitoring general year-to-year population changes; however, accurate estimates of endangered waterbird population numbers are needed periodically to assess management needs and to guide recovery plan efforts.

B. The long history of modifications to Hawai'i's wetlands by Hawaiian and European cultures has left only remnants of former natural wetlands. These wetlands are critical to the survival of Hawai'i's four endangered waterbirds. Continued urbanization of lowland areas, particularly on O'ahu, is accelerating the conversion or alteration of remaining wetlands. Further, most of these wetlands are degraded by introduced plants. Approximately 55 percent of the plants found in Hawaiian wetlands are exotic (Stemmermann 1981). Exposed to Hawai'i's year-round growing conditions and lack of frost at lower elevations, these exotics often replace native species and form monotypic stands. Introduced plants such as California grass (*Brachiaria mutica*), cattail *(Typha angustata*), pickle-weed (*Batis maritima*), Indian marsh fleabane (*Pluchea indica*), and American mangrove (*Rhizophora mangle*) present serious problems in many Hawaiian wetlands by reducing the interspersion of open water and vegetated areas (Stemmermann, 1981). Reduced interspersion adversely affects the suitability of these wetland habitats for Hawaiian waterbirds.

Continental studies indicate that maximum levels of avian use and production occur when emergent macrophytes and open water cover roughly equal areas in an interspersed pattern (Weller and Spatcher 1965, Weller and Fredrickson 1974). Highest densities of dabbling duck pairs were associated with 50:50 cover:water ratios (Kaminski and Prince 1981, Murkin et al. 1982). The study objective was to determine Hawaiian waterbird responses to vegetation manipulations in order to optimize waterbird use of an artificial wetland.

The study was conducted in three phases. Phase 1 (April-July 1987) consisted of pre-manipulation observations of waterbird use on a section of an impoundment covered by approximately 75 percent pickle-weed. Phase 2 (August 1987 - March 1988) entailed de-watering the impoundment, manipulation of vegetation, and re-flooding. Phase 3 (April-July 1988) involved post-manipulation observations of waterbird use.

Criteria for measuring use consisted of biweekly waterbird counts and systematic waterbird nest searches every three weeks. Status of nests was checked at least weekly. Surveys of waterbird numbers were conducted for 30 minutes using binoculars from a vehicle parked at a single observation station.

There were differences in waterbird use of the study area between Phases 1 and 3. Only two nests were found in the study area prior to vegetation manipulation, while 18 nests were found during post-manipulation. Additionally, all four waterbird species nested on the study area post-

manipulation, whereas only Hawaiian stilt nested in the area prior to vegetation manipulation. Stilt nests also increased substantially post-manipulation in response to increased mudflat habitats created by mowing.

Numbers of waterbirds using the study section of impoundment A also increased between Phases 1 and 3. Hawaiian coot and stilt numbers were significantly higher during the post-manipulation phase. Although the mean number of moorhens increased over 60 percent in Phase 3, this difference was not significant.

This increased use of the study area by these three waterbird species was not a function of increased waterbird use of Ki'i Unit as a whole. Monthly waterbird surveys conducted on similar dates in both years showed no significant increases in stilt and moorhen numbers. Further, coot numbers significantly decreased for Refuge-wide surveys between Phases 1 and 3. This decrease in coot use of the Refuge as a whole, combined with a significant increase in observed coots in the manipulated study section of impoundment A further illustrates the increased use of the manipulated section by waterbirds.

These findings support the hypothesis that monotypic stands of vegetation in Hawaiian wetlands discourage waterbird use. The results also support conclusions of other studies that maximum levels of avian use and production occur when emergent macrophytes and open water are in equal proportions in an interspersed pattern (Weller and Spatcher 1965, Weller and Fredrickson 1974, and Murkin et al. 1982). Average distances of Hawaiian stilt (120 cm), coot (143 cm), moorhen (212 cm), and duck (217 cm) nests to open water measured on Ki'i Unit from 1987 to 1988 indicate that Hawaiian waterbirds are unlikely to nest in interiors of large, monotypic vegetation stands.

C. While the need to secure, maintain and enhance suitable habitats are at the core of a long-term conservation program, proximate factors limiting waterbird productivity and survival need to be identified and managed. Habitat loss and predation are considered primary causes of declines in waterbird numbers (Shallenberger 1977). Diseases, such as salmonella and botulism, have also been identified as potential mortality factors (Coleman 1981). Although several studies have been conducted on Hawaiian waterbirds in recent years (Byrd and Zeillemaker 1981, Byrd et al. 1985, Coleman 1981, Nagata 1983), specific factors limiting waterbird recruitment and survival have not been well-quantified. Thus, the objectives of this study were to: 1) determine nesting chronology; 2) monitor nesting success and cause of nest failure; and 3) determine fledging success and cause of chick loss for Hawaiian waterbirds.

Complete nest searches of the study area were done every 3 weeks from January 1985 to December 1986, April to August 1987, and January to August 1988. The three weeks between nest searches was short enough so that eggs in nests initiated one day after a search would not hatch before the next search. Each nest was mapped and visited 1 to 2 times per week until all eggs hatched or nest fate was determined.

We summarized mean clutch sizes, mean number of young hatched per nest, hatching success, nest fates and egg loss codes by species to identify levels of production and to identify egg and chick mortality factors. Unidentified predators were responsible for most stilt, coot, and moorhen egg losses. Dogs accounted for the highest loss on koloa eggs in comparison to other species.

Stilt and coot chicks were most susceptible to mortality factors during the first two weeks of life. Hawaiian moorhen data were too few to categorize age of chick disappearance. Causes of chick and adult mortality were difficult to collect. However, dogs and mongooses accounted for high proportions of losses. The highest percentages of dead moorhen and coot chicks were found in nests with no evidence of injuries. A high percentage of chick and adult stilt deaths was also attributed to unknown causes. Of the known predators, dogs affected stilt chicks and adults, and adult coots most severely. However, owls caused a notable level of mortality on coots. A Hawaiian short-eared owl (*Asio flammeus sandwichensis*) was observed eating an adult coot. The proportion of fledged birds in the observed brood sample was 0.243, 0.276 and 0.418 for stilt, coots and moorhens, respectively.

In 1988, an attempt was made to observe selected broods twice a week for at least 30 minutes. Koloa left nests shortly after their eggs hatched so data on broods could not be collected for this species.

On the Ki'i Unit, 657 nests, of which 642 had eggs, were located for all species. Numbers of nests and placement on Ki'i differed between species and impoundments. Stilts and koloa accounted for 37.3 percent and 27.2 percent of total nests, respectively. Coots and moorhens nested at lower levels, 21.8 percent and 13.75 percent, respectively.

The stilt nesting season was short and intense compared to other Hawaiian waterbird nesting periods. For all years, nesting began in March, peaked in May, and ended in July.

Coot nesting was highest from February to May, and was lowest from June to October. Peak nesting for moorhens was in March and October with

low levels through August and September. Koloa initiated most of their nests in January, February and October. Lowest nesting levels for all species occurred in July and August.

Hatching success on an egg basis (number of eggs hatched/number of eggs laid) was highest for moorhens and coots and lowest for koloa.

Most nest failures for all species were attributed to predation, flooding and abandonment. Nests are easily flooded if water levels are allowed to rise unchecked, causing loss of nesting and feeding substrate. However, if water levels are too low, access to nests and chicks becomes easier for predators such as mongooses, cats and rodents. Further, drying mudflats become unsuitable habitat for invertebrate populations, which are believed to be an important food source for waterbirds.

It was difficult to find dead or missing chicks, and determine cause of death. However, relatively high portions of coot and moorhen chicks were found dead in nests. Most of these birds found in nests had no evidence of injury.

The potential for increased waterbird productivity can be realized through timing of management actions. Managers in Hawai'i need to control predators such as mongooses, dogs and cats on a year-round basis by trapping. Trapping levels should intensify during periods of waterbird nesting and whenever predator sign is discovered. Further, moats should be dug and maintained around impoundment perimeters to deter entry by predators and to provide refuge to invertebrates when impoundment water levels are drawn down during late summer months.

Water level management greatly affects waterbird nesting success. Managers must maintain water levels low enough to provide habitat for waterbird nesting and feeding, and high enough to deter predators. Water structures must be maintained in good condition to facilitate water level management. Further, managers need to be aware of nest locations to avoid inadvertently flooding nests when changing water levels.

D. Diverse macroinvertebrate populations regularly occur in moist-soil impoundments, and comprise the major or seasonal food source for many wetland birds. Although moist-soil management techniques were developed in temperate areas of the continental U.S., the ecological and management principles of moist-soil management are also of great value to the tropical wetlands of the Hawaiian islands.

Little is known about the response of invertebrates to changes in salinity. Further, fish in Refuge impoundments may be competing with waterbirds for invertebrates as a food source. Thus, the objective of this study was to investigate the relationship between invertebrate numbers, fish populations and water salinities before and after removing fish and implementing a new freshwater source to Refuge impoundments.

This study was originally planned as a complete study. However, logistical constraints and environmental changes prevented the compilation of a portion of the original goals. Rotenone, applied by Refuge staff in 1987 to eliminate fish, may have effected invertebrate declines for some taxa in 1988. Further, fish were not completely eliminated in the treated impoundment.

Analysis of invertebrate data showed that diversity of invertebrates decreased as salinity increased. However, the average number of invertebrates per sample increased with increasing salinity.

Tilapia were effectively removed from the treated impoundment and average number of invertebrates (37.0) in the water column of the treated impoundment was much higher than average numbers (1.1) contained in untreated impoundments.

E. Preliminary results from 30 koloa eggs and tissue from suspected hybrid adults collected on the Ki'i Unit indicated no difference from mallard stocks. Further tissues from pure koloa adults collected from the captive breeding facility at Pohakuloa differed from feral mallard tissue by 11 enzyme groups. Additionally, tissues from Laysan ducks also collected from Pohakuloa were compared to pure koloa tissue. These tests showed koloa and Laysan ducks to be closely related, differing by only 3 enzyme groups.

Hybridization of koloa with feral mallards in Hawai'i is a serious problem and it is questionable whether O'ahu still has a genetically pure koloa population. Managers and policy makers need to address this problem. Currently, importation of domestic mallard into Hawai'i is permitted, and migrating mallards are not thought to naturally frequent the islands.

E. ADMINISTRATION

1. Personnel

Stewart I. Fefer remained the Refuge Complex Manager, and Thomas E. Harvey the Assistant Refuge Manager for wetlands. In November, Thomas E. Harvey transferred to the position of Fish and Wildlife Biologist with the Habitat Enhancement Office in Sacramento, California. Jeffrey Holm was the Wildlife Biologist for the wetland refuges. Jeff transferred to Pierce National Wildlife Refuge in Stevenson, Washington in November.

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

The co-operative education position occupied by Paul R. Chang continued through the entire year. Paul remained at the University of Massachusetts for course work through December when he received his Master of Science degree in wildlife management.

JMC-3

(Left to Right) Wildlife Biologist Jeffrey Holm, Assistant Refuge Manager Thomas E. Harvey, Maintenance Worker David Woodside, and Refuge Manager Stewart I. Fefer.

5. Funding

The FY89 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 $250,000. Additional funding was provided by special projects including contaminants monitoring. Part of the base budget funding was allocated from the special appropriation received from Congress for Hawai'i refuges which totaled $500,000. Approximately $120,000 was spent in 1989 on staffing, operations, maintenance, and habitat and equipment improvements.

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 U.S. Fish and Wildlife Enhancement-Honolulu Field Office frequently asked advice regarding review of environmental impact statements and environmental assessments pertaining to wetlands, waterbirds or 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 other developments. Projects involving He'eia Marsh, Kawainui Marsh, fish ponds around West Loch of Pearl Harbor, housing development at Pearl Harbor, public access in the Kahuku area adjacent to the Refuge and golf course development around wetlands 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 green sea turtles nesting on the beach adjacent to the Refuge.

8. Other Items

Refuge staff coordinated with U.S. Army, Western Command, to gain their continued assistance with projects benefiting endangered species. This relationship resulted in many habitat and facility improvements in the past, and has proven to be very beneficial.

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 Punamanō and Ki'i drainage ditches. 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 pickle-weed (*Batis maritima*), California grass (*Brachiaria mutica*), Indian fleabane, *Scirpus* spp., millet (*Echinochloa crus-galli*) and *Bacopa monnieri*.

The Punamanō 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., *Bacopa monnieri* and *Pluchea indica*. The Ki'i Unit is surrounded by a livestock fence, while the Punamanō Unit remains unfenced, except for a small portion completed in early 1986 by Refuge staff.

2. Wetlands

Ki'i Unit

Water levels in ponds A, B, C, D, F and G of the Ki'i Unit are maintained with artesian flow and pumping from the wells, occasional pumping from the Ki'i and Punamanō drainage ditches and rainfall. Pond E levels are maintained by allowing drain water to build up in the Punamanō ditch, resulting in backflow into the pond through a flapgate in a control structure.

The wind-generated pumping system designed by Don Avery for drawing water from three artesian wells and the brackish (5-10 ppt) Ki'i ditch continued to experience problems during the first seven months of the year. The fiberglass 1,000-gpm capacity pump required major repair in January that lasted three months; however, high rainfall reduced our dependency on the system. Several breakdowns/repairs during the summer caused impoundment water levels to recede, reducing protection afforded nesting waterbirds.

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.

Ponds B, C, F and G were drawn down to expose mud flat 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.

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 to release seed from clumped monotypic vegetation. Spraying followed by burning was used to prevent the spread of California grass into ponds and to 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.

JMC-4

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

Punamanō Unit

This spring-fed perennial wetland is situated one mile from the ocean and one mile east of the Ki'i Unit. The pond's water originates from a spring located inland just off the Refuge. The Punamanō drainage ditch connects this pond with the Ki'i Unit and the ocean.

Encroachment by wetland emergents into the Punamanō Unit continued during 1989, further reducing the extent of open water available to waterbirds. De-watering of the area is not possible due to the low-lying, spring-fed nature of this permanent pond; however, we are hopeful that 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 Punamanō Unit contains some upland areas that are densely covered by koa-haole (*Leucaena leucocephala*), kiawe (*Prosopis pallida*) and *Pluchea* spp.

9. Fire Management

The majority of wetland vegetation targeted for burning must first be killed with herbicides for ignition to occur. 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 perimeter of pond B where encroachment of vegetation and shallow pond bottoms create numerous land bridges to nesting islands.

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.

G. WILDLIFE

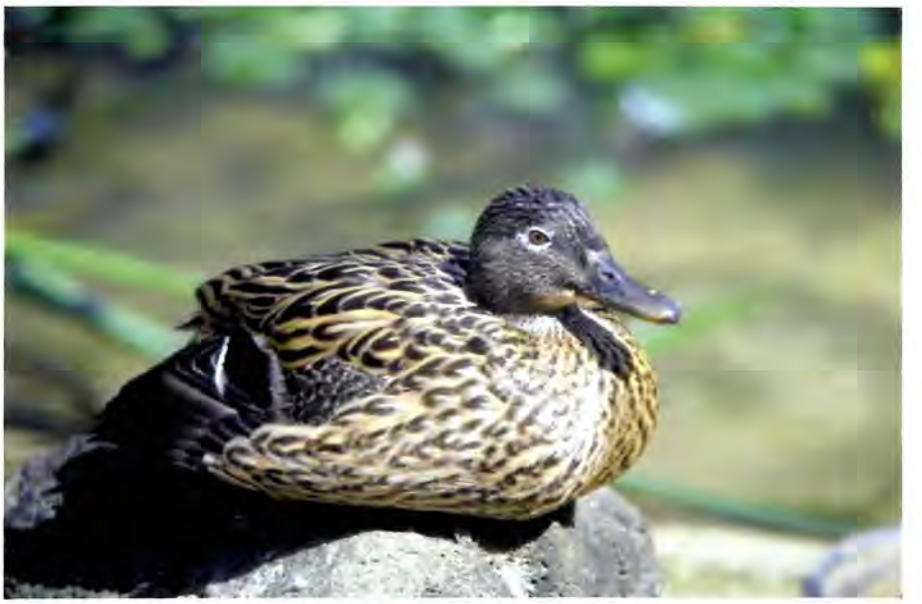
1. Wildlife Diversity

Habitat manipulations conducted on the Refuge are intended not only to provide optimal habitat for endangered water birds, 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 Punamanō and Ki'i Units of the Refuge provide year-round habitat for all four endangered Hawaiian waterbirds (koloa, coot, moorhen and stilt). Normally, the Ki'i Unit contains higher numbers of these birds because of greater habitat diversity.

Hawaiian Duck (koloa)



JMC-5

The Hawaiian duck, or koloa. A close relative of the endangered Laysan duck; both species are distant relatives of the mallard. (FWS file)

This species is very mobile and exhibits seasonal variation in use of Refuge wetlands. Peak numbers occur during the winter months when at times nearly 100 koloa are present on the Refuge. Populations build up in late fall and nesting usually begins in December. Re-flooding of drained ponds is timed to coincide

with the onset of koloa nesting. A small percentage of nesting birds remains on the Refuge through mid-summer, with some hens laying up to three or four clutches per season if previous nesting attempts are interrupted early after initiation.

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 koloa 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 1989, coot numbers peaked at over 269 birds, a dramatic decrease over last year's peak of over 560 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.

JMC-6

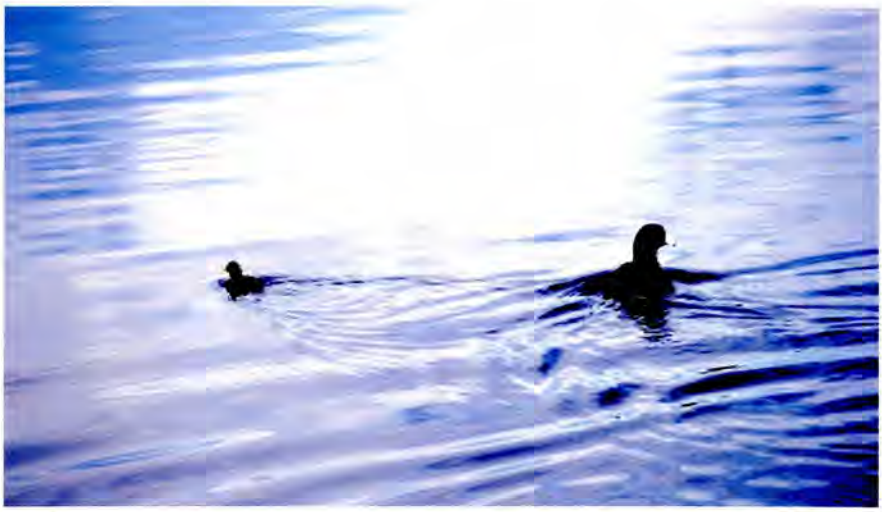
Hawaiian coots typically rest in dense vegetation on islands or pond embankments. (SB)

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 for 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 habit 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.

No intensive nest monitoring was conducted during 1989. Therefore, no nesting data are available. A program to monitor waterbird nesting on a less intensive basis will be developed for future use.

Brood survival appears to be low as young coots are particularly vulnerable to predators. Their habit of hiding in vegetation along pond banks while the parents feed them probably contributes to their overall vulnerability.



JMC-7

Nest success for the Hawaiian coot is apparently high on the Ki'i Unit, but low brood survival limits overall production. Intensive year-round predator trapping should improve brood survival. (RJS)

Hawaiian Moorhen ('alae 'ula)

Unlike the Hawaiian coot, there does not appear to be a large "floating" population of non-breeding 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 Punamanō 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. However, some family groups will stay together and older siblings have been to known to help raise young. Moorhen territories seem to be more elastic that those of breeding coots, and territories 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 Punamanō Unit. Highly variable count results for this species reflect the secretive nature of the moorhen. High counts for 1989 were 40 in the Ki'i Unit and 14 in the Punamanō Unit.

Nesting typically occurs from December to July, but in permanent water areas, some pairs nest throughout the year, as do paired coots. No nest monitoring was conducted in 1989.

JMC-8

Hawaiian moorhen. Once common on all of the main islands with the exception of Lana'i and Ni'ihau, this species is now found only on O'ahu and Kaua'i. (SLB)

JMC-9

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. (SLB)

Hawaiian Stilt (āe'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 de-watered for shrimp or prawn harvest and, as is 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 to June). Counts for the Ki'i Unit ranged between 35 (January) and 141 (May) birds. Counts for the Punamanō Unit ranged between 0 (several months) and 4 (January and April) birds.

The Ki'i Unit provides some of the best breeding habitat in the state for Hawaiian stilts (see Sec. 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 draw-down at the onset of the stilt breeding season provides small humps of mudflat or nesting islands. Additional draw-down 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 mud flats.

JMC-10

The Hawaiian stilt. The Hawaiian name āe'o means "one standing tall." It is one of the most conspicuous birds in the Hawaiian wetlands. (FWS file)

The deep, somewhat stable nature of the Punamanō 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 has nested along the southwest edge of the south pond.

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 annual plant species that occur in these areas. This annual vegetation matures in late fall when ponds are re-flooded and migrant waterfowl return to Hawai'i. The annuals are a food source for these birds and provide substrate and nutrients for invertebrates.

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

Refuge counts conducted on the Ki'i Unit during the winter of 1989 showed peak numbers of 159 shovelers and only seven pintails. With continued habitat improvement at Ki'i since the Refuge was established, monthly counts indicate the 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 traveled dikes and roadways.

Use of the Punamanō Unit by wintering waterfowl tends to be sporadic. Only two shovelers were seen on Punamanō during 1989, a marked decrease from 1988. The deep, somewhat sterile conditions of the pond limit overall production and availability of dabbler 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 Punamanō 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, mallards, occasional green-winged and blue-winged teals, and occasional Eurasian and American wigeons.

JMC-11

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

Fulvous whistling ducks first appeared in Hawai'i in 1982 on O'ahu, and have become established on the north shore in the vicinity of the Refuge. It is suspected 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 Hawai'i was in 1984 at the 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 Punamanō Unit.

4. Marsh and Waterbirds

Combined counts of black-crowned night herons at the Ki'i and Punamanō Units revealed a variable population of 100 to 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.

JMC-12

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

A black-crowned night heron roost/rookery is located in a large clump of trees in the center of Punamanō Unit. There are usually ten to 15 birds using the roost and there are usually three or four 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 Hawai'i 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 of these were released on O'ahu. The 31-year-old rookery near Kahuku is the oldest known rookery in the state.

5. Shorebirds, Gull, Terns and Allied Species

The Ki'i Unit provides some of the best shorebird habitat on the north shore of O'ahu 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.

Lesser golden-plovers 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 1989, the high count for plovers in November was 68. The high count for turnstones in November was 110.

JMC-13

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

JMC-14

The long-billed dowitcher is occasionally seen during winter months. Usually present in low numbers. (SLB)

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, 47 sanderlings were counted in September.

Numerous other migrants were sighted on the Ki'i Unit during 1989, including: long-billed dowitcher, Wilson's phalarope, semi-palmated plover and lesser yellowlegs.

The Punamanō Unit provides habitat for shorebirds when adjacent low areas start drying after rainstorms, exposing mudflats. Pacific 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 1989 include: Caspian tern, laughing gull, ring-billed gull and Bonaparte's gull.

6. Raptors

Hawaiian short-eared owls (pueo) were frequently observed hunting over the grassy areas of the Ki'i Unit, and flying over portions of the Punamanō Unit. Occasional observations of a barn owl were made on the Ki'i Unit in 1989. 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 Punamanō 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 Punamanō Unit. It is not known where this bird resides during the summer months.

7. Other Migratory Birds

Laysan albatrosses were regular visitors in the dunes outside of the Ki'i Unit during the winter months. Great frigatebirds occasionally drink freshwater 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.

JMC-15

The great frigatebird often comes inland to the Ki'i and Punamanō Units for a drink of freshwater 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 1989.

15. Animal Control

Live traps were set prior to the two nesting peaks of the endangered waterbirds during 1989 to catch mongoose, dogs, and cats. 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.

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 O'ahu. It is the largest unit, and occasional public use of a portion of the unit results in minimal disturbance to the waterbirds.

Public use of the Refuge during 1989 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. Refuge staff often lead groups interested in learning about the Refuge.

JMC-16

Refuge Complex Manager Fefer leading a Nature Conservancy tour of the Refuge. (SF)

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. Completion of a visitors' kiosk and trail system which was begun this year will greatly improve our ability to educate the public on the Ki'i Unit.

2. <u>Outdoor classroom</u>

During the year, the Refuge was visited by six groups, consisting of approximately 200 students. Refuge staff and local primary and secondary school teachers conducted the tours. Most school groups visit during late fall and winter months when many migrant birds are present to observe. Most ponds are full, and because stilt are not yet nesting, this is a period when they are least likely to be disturbed.

6. <u>Interpretive Exhibits/Demonstrations</u>

Following our receiving a commitment for assistance from the U.S. Army Western Command, construction was begun in July on a visitor wildlife observation structure (kiosk) at the Ki'i Unit. The kiosk and trail system had been proposed in an Interpretive Development Prospectus completed in 1987 for the Refuge. Donations were obtained from the Estate and Ducks Unlimited for materials and exhibit panels for the kiosk. Additional funding came from the Service Challenge Grant program. The interpretive panels are being prepared by a private design firm under contract through ARW-EPIC. Several reviews of the proposed panels were provided by Refuge staff.

Construction of the kiosk was conducted as a "vertical training exercise" during a two-week period in July by members of the 411th Engineering Battalion (Company C), a reserve unit station at Fort DeRussy in Honolulu. Additional work on the kiosk is being completed by temporary laborers and includes: a wooden railing to screen views of the visitors by wildlife, a concrete curb and graveling to improve the flooring in the kiosk, an elevated observation platform, a wooden footbridge and other trail improvements.

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 have 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.

JMC-17

The 411th Engineering Battalion of the U.S. Army Western Command constructing visitor wildlife observation structure as part of a "vertical training exercise." (JH)

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 1989. 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 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 prohibiting trespass thereon. No citations were issued.

I. EQUIPMENT AND FACILITIES

1. New Construction

A perforated and screened PVC pipe was attached to the intake pipe in the Ki'i Ditch for the Avery 12-foot windmill. This will insure that we are pumping the freshest water possible from the ditch to complement well water which is then delivered to the impoundments.

3. Major Maintenance

Approximately $300 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 of 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 archaeological investigations relating to the Master Plan for the wetland refuges.

James Campbell Estate, State of Hawai'i, Ducks Unlimited and the Hawai'i Audubon Society are participants in the Service's Challenge Grant program for the purpose of developing an interpretive kiosk on the Ki'i Unit of the Refuge (see Sec. 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. The Army constructed the kiosk during the summer of 1989.

4. Credits

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