

**HAWAIIAN ISLANDS
NATIONAL WILDLIFE REFUGE**

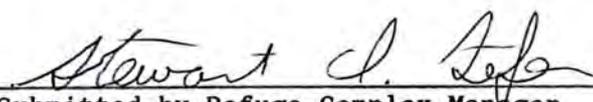
ANNUAL NARRATIVE REPORT
Calendar Year 1987

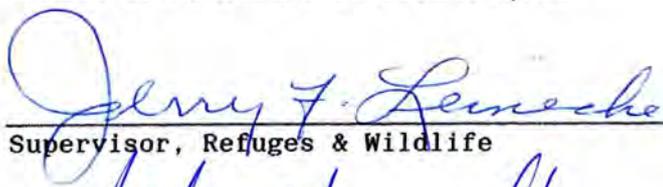
U.S. Department of the Interior
Fish and Wildlife Service
NATIONAL WILDLIFE REFUGE SYSTEM

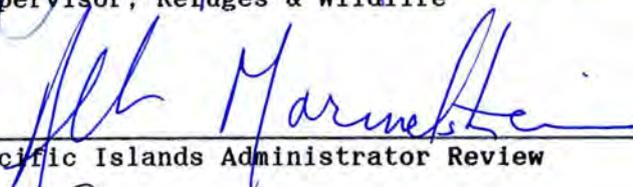
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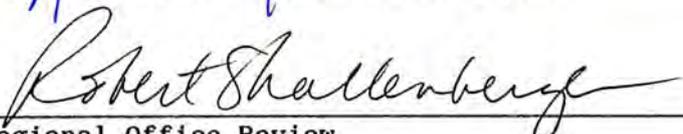
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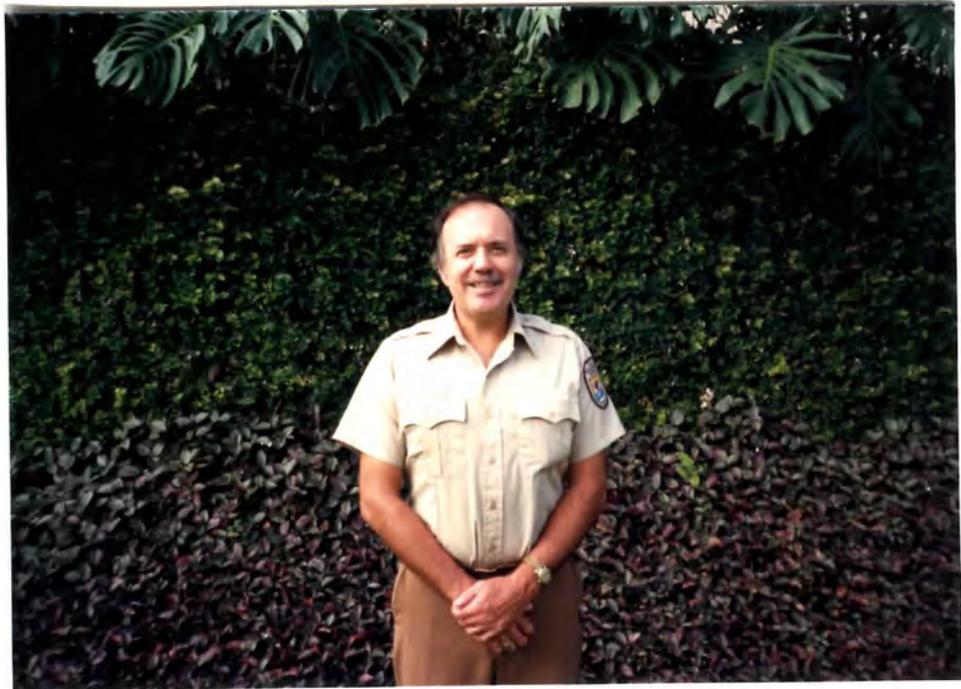
REVIEW AND APPROVALS


Submitted by Refuge Complex Manager 8/1/89
Date


Supervisor, Refuges & Wildlife 8/2/89
Date


Pacific Islands Administrator Review 2 Aug 89
Date


Regional Office Review 7/25/90
Date



J. Leinecke



L-R: K. Niethammer, K. McDermond, S. Fefer, J. Holm



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E. Bean (standing) and R. Vetter

INTRODUCTION

The Hawaiian Islands National Wildlife Refuge consists of a chain of eight islands, reefs, and atolls extending about 800 miles in a northwesterly direction from the main Hawaiian Islands. Emergent lands total approximately 1,740 acres. The Fish and Wildlife Service (Service) considers another 242,700 acres of submerged land to be within the Refuge, though jurisdiction is contested by the State of Hawaii. Nihoa and Necker Islands, Gardner Pinnacles, and La Perouse Pinnacle at French Frigate Shoals are the cores of old volcanic cones. Sheer cliffs of basalt and the absence of beaches are typical of these islands. Laysan and Lisianski Islands are low, flat sand islands surrounded by submerged coral reefs. French Frigate Shoals and Pearl and Hermes Reef are typical coral atolls. Maro Reef has only a couple of small coral heads protruding a few feet above the surface of the ocean. Only one of the islands in the Refuge is presently inhabited. The FWS maintains a field station at Tern Island, French Frigate Shoals, manned year-round by two permanent employees and a handful of volunteers during the spring and summer.

Theodore Roosevelt established the Refuge in 1909 by Executive Order as a "preserve and breeding ground for native birds." Four endangered bird species (Laysan duck, Laysan finch, Nihoa finch and Nihoa millerbird) presently breed on the islands along with 18 species of seabirds totaling about 14 million individuals. The Refuge also supports almost the entire population of endangered Hawaiian monk seals, provides nesting beaches for virtually the entire Hawaiian population of threatened green sea turtles, and furnishes habitat for 13 candidate endangered plants, 32 candidate terrestrial invertebrates and a diverse array of marine fishes and invertebrates.

HAWAIIAN ISLANDS NATIONAL WILDLIFE REFUGE

	Page
INTRODUCTION	1
TABLE OF CONTENTS	i
A. HIGHLIGHTS	2
B. CLIMATIC CONDITIONS	2
C. LAND ACQUISITION	
1. Fee Title	NTR
2. Easements	NTR
3. Other	5
D. PLANNING	
1. Master Plan	5
2. Management Plan	5
3. Public Participation	NTR
4. Compliance with Environmental and Cultural Resource Mandates.	8
5. Research and Investigations	8
6. Other	NTR
E. ADMINISTRATION	
1. Personnel	33
2. Youth Program	34
3. Other Manpower Programs	NTR
4. Volunteer Programs	34
5. Funding	35
6. Safety	35
7. Technical Assistance	36
8. Other	38

F. HABITAT MANAGEMENT

1. General	NTR
2. Wetlands	38
3. Forests	NTR
4. Croplands	NTR
5. Grassland	NTR
6. Other Habitats	38
7. Grazing	NTR
8. Haying	NTR
9. Fire Management	NTR
10. Pest Control	41
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	42
3. Waterfowl	44
4. Marsh and Waterbirds	NTR
5. Shorebirds, Gulls, Terns, and Allied Species	44
6. Raptors	49
7. Other Migratory Birds	NTR
8. Game Mammals	NTR
9. Marine Mammals	50
10. Other Resident Wildlife	NTR
11. Fisheries Resources	NTR
12. Wildlife Propagation and Stocking	NTR
13. Surplus Animal Disposal	NTR
14. Scientific Collections	50
15. Animal Control	51
16. Marking and Banding	51
17. Disease Prevention and Control	NTR

H. PUBLIC USE

1. General	51
2. Outdoor Classrooms - Students	NTR
3. Outdoor Classrooms - Teachers	NTR
4. Interpretive Foot Trails	NTR
5. Interpretive Tour Routes	NTR
6. Interpretive Exhibits/Demonstrations	52
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.	52
18.	Cooperating Associations	NTR
19.	Concessions.	NTR

I. EQUIPMENT AND FACILITIES

1.	New Construction	52
2.	Rehabilitation	53
3.	Major Maintenance.	58
4.	Equipment Utilization and Replacement.	59
5.	Communications Systems	59
6.	Computer Systems	NTR
7.	Energy Conservation.	60
8.	Other.	60

J. OTHER ITEMS

1.	Cooperative Programs	NTR
2.	Other Economic Uses.	NTR
3.	Items of Interest.	NTR
4.	Credits.	62

K. FEEDBACK

A. HIGHLIGHTS

The Refuge undergoes major staffing reorganization and personnel changes.

The Regional Director and Congressional aide to the House Interior Appropriations Committee visit Tern Island.

Funding for the operation and maintenance of Tern Island is received through special Congressional appropriation.

The Tern Island field station receives major rehabilitation including the installation of a photo-voltaic power system and purchase of a new tractor.

Rehabilitation of the Refuge warehouse facility begins.

Refuge staff visited each of the islands in the Refuge during a month-long expedition in May and June.

Eight research projects were initiated, continued or completed on refuge lands. Refuge staff either participated or facilitated these projects.

The blowout on Laysan Island shows initial signs of revegetation.

B. CLIMATIC CONDITIONS

The portion of the Hawaiian Archipelago included in the refuge extends from Nihoa Island ($23^{\circ}03'N$, $161^{\circ}55'W$) to Pearl and Hermes Reef ($27^{\circ}47'N$, $175^{\circ}49'W$). Weather conditions vary within these latitudes, but, generally, conditions are tropical to subtropical with a fairly constant northeast trade wind.

Tern Island, French Frigate Shoals, weather information is collected two ways, for different purposes. A remote weather station transmits data to a satellite on an hourly basis for use by the National Weather Service. These data are used only for marine weather forecasting, so no long-term records are maintained. Tern Island refuge staff operate a weather station for long-term records. Minimum and maximum temperatures, wind velocity and direction, and precipitation and cloud cover are measured and recorded on a daily basis.

The following data are from the 1987 station logs:

1987 WEATHER SUMMARY

Month	Mean Max. (F)	Mean Min.	Daily Mean	Wind Vel. (kt.)	Precip. (in.)
Jan.	75.0	66.0	70.5	13.4	0.48
Feb.	74.2	65.3	69.8	11.2	1.44
Mar.	74.6	66.7	70.7	11.3	0.28
Apr.	76.5	67.2	71.7	12.5	1.34
May	76.5	67.5	71.8	13.9	0.51
June	80.0	72.0	76.0	13.4	1.20
July	83.0	71.0	79.0	12.2	1.20
Aug.	85.2	75.9	80.6	11.0	2.83
Sep.	87.0	75.4	80.1	13.0	0.73
Oct.	82.6	73.3	78.0	11.6	2.24
Nov.	80.2	70.7	75.5	14.0	0.93
Dec.	78.4	69.7	74.1	13.7	3.76
Monthly Mean	79.4	70.0	74.8	12.6	1.40

The mean temperature for 1987 was 74.8°F, the mean maximum was 79.4 and the mean minimum was 70.0. February was the coolest month--the average minimum was 65.3 and the coolest temperature was 62.0°F on 24 February. September was the warmest month with a mean maximum of 87.0.

Average wind velocity was 12.6 kt. Mild to moderate trade winds (from the northeast) prevailed throughout the year. Winds during winter months were more variable, influenced by major storm systems. Wind velocities of 47 kt were recorded on 15 March.

Precipitation for 1987 was 16.9 inches. The highest rainfall occurred in December with 3.76 inches recorded. January had the least precipitation, with 0.48 inches recorded for the month.

Throughout the Northwestern Hawaiian Islands 1987 was a dry year. Tern Island went into emergency water rationing procedures because of low rainfall. Rainfall there was half of what fell in 1986. On Laysan Island extremely low water levels were recorded in the hypersaline lake during the field camp season from April to September. Vegetation on Laysan, as well as on other islands visited during the yearly charter, was noticeably drier than in recent years.



Laysan lake in **wet** year of 1986 ...



...and **dry** year of 1987. (DKM)

C. LAND ACQUISITION

3. Other

The Midway Overlay Refuge proposal, submitted by the Service to the Navy in 1984, was under consideration by the Navy throughout the year. A meeting of Refuge staff and the Pacific Islands Administrator with Captain Walt West, Commander of the Naval Air Station at Barber's Point Hawaii and the Naval Air Facility at Midway Islands, concluded with assurances from Captain West that the Midway Overlay Refuge proposal would be considered favorably and would be signed after Navy legal representatives approved of the wording of the Overlay Refuge agreement. Changes to the agreement suggested by the Navy were subsequently completed, reviewed by Service staff and resubmitted to the Navy for signature. Despite assurances that the Overlay Refuge Proposal would be approved by the Navy, no definitive response was received by year's end.

D. PLANNING

1. Master Plan

Formal Master Planning for the refuge began in 1983. The Draft Master Plan/Environmental Impact Statement for the Hawaiian Islands National Wildlife Refuge was released for public review and comment August 31, 1984. The Final Master Plan/Environmental Impact Statement for the Hawaiian Islands National Wildlife Refuge was dated May 1986. The Record of Decision (ROD) to adopt the Hawaiian Islands National Wildlife Refuge Master Plan/Environmental Impact Statement was signed by Regional Director Rolf L. Wallenstrom on September 10, 1986 and published in the Federal Register October 9, 1986. The ROD notes that the Preferred Alternative, a hybrid of about 50 management strategies derived from the "No Action", "Baseline", "Resource Preservation" and "Resource Utilization" Alternatives, has been selected for implementation as the best course of action to manage the HINWR for the next 10-20 years.

2. Management Plan

Implementation of the Master Plan would be costly, requiring double the present annual expenditure of about \$300,000 for management of the HINWR. Because it appeared that a decrease in funding was a more likely scenario for FY 87 than an increase in funding, the Refuge Complex staff began to develop options for reducing expenditures at the Tern Island field station. The options centered around reducing the cost and time spent for facilities maintenance and reducing the FWS

presence on the island from permanent to intermittent. In July 1986, the FWS Endangered Species Office was requested to provide a Section 7 Consultation on an option calling for abandonment and destruction of the facility left by the Coast Guard and an intermittent FWS presence (field camps of one to six months duration) at French Frigate Shoals.

In August 1986, a planning document was written which discussed four options for operating/abandoning the Tern Island Field Station and estimated the cost of each. The options were: 1) normal, ongoing operation of Tern Island Field Station; 2) immediate closure of field station (October 7, 1986) at minimal expense; 3) orderly withdrawal from Tern Island (October 31, 1986); and 4) orderly withdrawal from Tern Island (March 31, 1987). Estimated FY 87 costs for implementing these options ranged from \$24,000 to \$267,000. For a number of reasons which included negative reactions to the proposed reductions from concerned agencies and individuals (including many within the FWS), the apparent need for a Section 7 Biological Consultation from the National Marine Fisheries Service, and continued funding uncertainties, the Service was reluctant to make a hasty decision regarding a reduced mode of operation at Tern Island. The new fiscal year began while various options were studied.

By December, the preferred option had evolved to include the following key elements: 1) Maintenance would cease on the bulk of the Coast Guard structures and facilities and they would be abandoned by March 31, 1987; 2) Equipment required by field camp personnel would remain on the island but most items would be shipped to Honolulu or destroyed to prevent the material from attracting salvors and "treasure hunters;" 3) No immediate attempt would be made to demolish the main buildings; and 4) Biologists from the Service and NMFS would establish long term field camps on Tern or another of the islands at French Frigate Shoals for 3-7 months each year to continue research and population monitoring efforts on endangered species and seabirds. A Section 7 Consultation on this plan was requested from NMFS and preparations were underway to announce the plan in a Planning Update.

Calendar year 1987 began with no sign of a return to the previous levels of funding required to maintain the Tern Island field station.

During February 1987 Planning Update (No. 7) which outlined the Service's preferred option was mailed to the same people contacted during the Master Planning process. Substantive adverse comments were subsequently received by the Service and considerable controversy resulted. In addition, NMFS endangered species staff informally notified Refuge staff that the newly proposed action would be considered to jeopardize the Hawaiian monk seal population. Several monk seals had in the recent past become stranded behind the eroding seawall at Tern Island and Refuge staff have assisted in the release of these entrapped animals. NMFS biologists felt that without the

permanent presence of Service personnel, animals would continue to become entrapped but would not be released. This possible loss of animals to the population was felt to jeopardize the endangered population of Hawaiian monk seals by NMFS biologists commenting informally. However, no formal Section 7 consultation had been issued by NMFS by the end of the year.



Hawaiian monk seal trapped behind section of seawall at Tern Island (RTV).

During April, Neal Sigmon, Principal Staff Member for the House Subcommittee on Appropriations for the Department of Interior traveled to Tern Island with Rolf Wallenstrom, Regional Director, FWS, Region 1; PIA Marmelstein; District Supervisor, Leinecke; Refuge Complex Manager Fefer, and Assistant Refuge Manager McDermond in order to view first-hand the facilities at Tern Island and discuss alternatives for operation of Tern Island in future years.

Perhaps at least partially as a result of this trip, in May, Refuge staff learned that the House appropriated \$200,000 for maintenance of facilities at Tern Island during 1987 (Section I.1). This funding enabled the Service to modify the operation on Tern Island to provide a less maintenance intensive facility and maintain a full-time presence through the calendar year.

4. Compliance with Environmental and Cultural Resource Mandates

A Cooperative Agreement between the FWS and the Bernice P. Bishop Museum, Honolulu, was signed in June of 1984 for the purpose of gathering data to facilitate management of prehistoric cultural resources of the HINWR. Under this agreement, archaeological research was conducted on the islands of Nihoa and Necker in 1984 by Dr. Paul Cleghorn and Mr. Eric Komori. Late in 1984, Dr. Cleghorn submitted the first draft of his report describing the archaeological sites and their significance, discussing the prehistory of the islands and recommending management strategies for study and preservation of the resources. He also drafted nomination forms to place Nihoa and Necker Islands on the National Register of Historic Places.

The final drafts of the National Register Nomination Forms were reviewed by the Service and forwarded to the Hawaii State Historic Preservation Officer early in 1987 for concurrence as the final step preceding submission to the Keeper of the National Register for formal listing. Because of the boundary dispute between the State and the Service over jurisdiction and ownership of the Refuge, the State Historic Preservation Officer who is also the Director of the Board of Lands and Natural Resources refused to concur with the nomination during 1987. The final report describing the cultural resources and listing recommendations for their management was received during November from Dr. Cleghorn.

5. Research and Investigation

Refuge staff coordinated and participated in numerous research projects in the Hawaiian Islands NWR. Projects were conducted by a variety of agencies and personnel. Tern Island, FFS, continued to be a year-round focal point for wildlife studies. A temporary field camp was established on East Island, FFS by NMFS and Smithsonian researchers from early April through 22 July.

Research efforts were also concentrated on Laysan Island where NMFS and FWS conducted a joint field camp. The field camp was operational on Laysan Island from 6 April to 12 September. Volunteer Biologist Marie Morin lead the field camp during her presence in the field camp from establishment through 22 July. Volunteer Biologist Annie Marshall traveled to Laysan Island aboard the F/V FERESA arriving on Laysan Island on 23 May. She departed Laysan along with Volunteer Biologist Mark Scheffel on 12 September aboard the F/V FERESA.



Combined NMFS/FWS field camp on west beach of Laysan Island (SIP).

An expedition to all of the islands in the Refuge for the general purpose of wildlife surveys including surveys for presence of alien plants and animals was conducted during May and June. The FWS chartered the F/V FERESA and traveled to the HINWR. Refuge Biologist Darcy Hu, Tern Island Refuge Manager Rick Vetter, National Wildlife Health Center Research Biologist Louis Sileo, Volunteer and University of Hawaii Professor Sheila Conant and NMFS biologist Gerrodette visited Nihoa Island on 13-18 May and conducted seabird, finch, millerbird and monk seal population surveys. These biologists spent 20 May surveying Necker Island seabirds and seals. Hu, Vetter and Conant departed the expedition at Tern Island on 21 May and Refuge Managers Fefer and McDermond joined Biologists Sileo and Gerrodette. The FERESA arrived at Laysan Island on 23 May and departed 31 May. Seabird, duck and finch population surveys were conducted and chick growth measurements at a 7 day interval were taken for red-footed and masked boobies, red-tailed tropicbirds and black noddies. Lisianski Island was visited from 1-4 June and Pearl and Hermes Reef from 5-7 June. Seabird surveys were conducted during these visits.

NMFS also had field camps on Lisianski Island (5-29 August) and on Pearl and Hermes Reef (14-28 August). On Pearl and Hermes Reef field camps were located on Southeast Island and North Island.

Numerous volunteers also participated in biological studies on Tern Island. FWS efforts focused on seabird monitoring, studies of the prevalence of plastic in Hawaiian seabirds, surveys of endangered landbirds (Nihoa finch, Nihoa millerbird, Laysan finch and Laysan

duck), monitoring the reproductive effort of threatened green sea turtles on Tern Island, and surveying the population of Hawaiian monk seals on Tern Island. NMFS research efforts continued on endangered Hawaiian monk seals and threatened green sea turtles. Cooperating scientists were involved in a variety of studies on the Refuge including studies of monk seal mother-pup interactions (Dr. Daryl Boness and Mitchell Craig on East Island, French Frigate Shoals), Laysan finch life history (Marie Morin on Laysan Island), Laysan duck populations and behavior (Annie Marshall, Laysan Island), and Laysan finch morphometry and genetic variation (Sheila Conant and Robert Fleischer, Pearl and Hermes Reef).

A significant amount of effort was spent by Refuge staff in Honolulu and on Tern Island in providing logistical and other support for investigations having significant potential benefit to Refuge resources. The following research projects were conducted or continued in 1987:

HWN-1-87 Seabird Monitoring Studies

Seabird monitoring studies are conducted by Refuge personnel annually in order to determine the status and health of the seabird populations in the HINWR. These data have been collected since 1979 on indicator species and are compared annually to determine if there are major differences in measured reproductive parameters which may indicate a change in environmental conditions due to natural or man-made causes. These data are useful for measuring affects of commercial fisheries and environmental conditions such as El Niño southern oscillations in the vicinity of the Refuge.



Fish and Wildlife Service volunteers Diane Campbell and Craig Rowland participating in red-footed booby chick growth study at Tern Island. (DKM)

During 1987, on Tern Island, population and chronology data were collected for each species at intervals equal to the mean incubation period of the species. Thus, at the end of the year, the total number of nests for each species could be added to obtain the total breeding population on the island. Semiannual-annual counts of breeding populations and determination of chronology were conducted on the islets of FFS. Egg size, reproductive success and chick growth studies were conducted on Tern Island involving red-footed boobies, black noddies and red-tailed tropicbirds. The year-round presence of personnel on Tern Island continues to be instrumental to the seabird monitoring studies.

On Laysan Island, population surveys were conducted for masked booby, brown booby, red-footed booby, great frigatebird, and black noddy. Chick growth studies were also conducted for masked boobies, red-footed boobies, red-tailed tropicbirds, and black noddies. Chick growth was measured using a different technique than has been used in prior years. In an attempt to develop techniques for monitoring health of indicator species on islands throughout the refuge, a short term growth measuring methodology was implemented. This in theory should allow us to measure growth of indicator species on short visits (1 week-10 days) to islands. This is desirable due to the cost of establishing long-term field camps to measure reproductive success and estimate populations. If the new method proves to be a reliable measure of growth and if growth can be shown to be related to health by analyzing data collected on Tern Island, we should be able to begin use of the short term growth methodology to monitor health throughout the refuge. Analysis of these data is not yet available.

On other islands visited during the May/June expedition, surveys of conspicuous nesting seabirds were conducted. Trip reports detail biological observations and populations, and breeding chronology information for Nihoa Island, Necker Island, Laysan Island, Lisianski Island and Pearl and Hermes Reef, and Midway Atoll. The following reports completed in 1987 are available in Refuge files:

Hu, D. 1987. Trip report to Nihoa, Necker, and French Frigate Shoals 11-23 May, 1987. U.S. Fish and Wildlife Service Administrative Report, Honolulu, Hawaii

Hu, Darcy. 1987. Trip report: Laysan Island, 6 April to 1 May 1987. Administrative Report, U.S. Fish and Wildlife Service, Honolulu, Hawaii.

McDermond, D.K. 1987. Trip report: French Frigate Shoals, Laysan, Lisianski, Pearl and Hermes Reef, and Midway Atoll, 21 May-11 June 1987. Administrative Report, U.S. Fish and Wildlife Service, Honolulu, Hawaii.

During trips to Midway Atoll to advise the Navy on wildlife matters, refuge staff conducted population censuses, collected nesting phenology data and conducted a banding program (see section G.16). The following reports completed in 1987 are available in Refuge files:

McDermond, Duane K. 1987. Trip Report: Midway Atoll, 22-31 January 1987. Administrative Report, U.S. Fish and Wildlife Service, Honolulu, Hawaii.

Woodby, D. 1987. Trip Report: Midway Atoll, 2-16 April 1987. Administrative Report, U.S. Fish and Wildlife Service, Honolulu, Hawaii.

McDermond, Duane K. 1987. Trip Report: Midway Atoll, 1-11 December 1987. Administrative Report, U.S. Fish and Wildlife Service, Honolulu, Hawaii.

HWN-2-87 Hawaiian Monk Seal Study

The Refuge staff at Tern Island have been counting Hawaiian monk seals hauling out on Tern Island beaches since 1979 when FWS began occupying the station there. In 1987, weekly surveys of monk seals were conducted. Table 1 summarizes counts up to 1987. Populations throughout the atoll have increased only slightly between 1983 and 1987. Weaned pups are significantly smaller at FFS than at other locations, perhaps indicating that the population is near its carrying capacity.

The data show a continuing increase in the number of seals using Tern Island since the FWS began regular surveys. The slight decline in the average number of seals using beaches on Tern Island during 1987 is not considered significant. Mean monthly numbers have increased from 5.7 seals in July 1979 to a peak of 127.6 seals in March 1985.

Most of the research on monk seals in the Hawaiian Islands NWR is conducted by personnel from the National Marine Fisheries Service (NMFS). The research is conducted under Refuge Special Use Permit. Refuge staff have assisted in many aspects of this research including tagging and resighting individual seals. In 1987, researchers from the Smithsonian Institute also conducted monk seal research involving studies of mother-pup interactions. This study is reported separately under HWN-5-87 below. The NMFS research activities conducted in 1987 are summarized below for each island of the Refuge:

Nihoa Island: NMFS and FWS personnel were present on Nihoa Island on 13 to 18 May. During the visit seal patrols and censuses were conducted. A single male nursing pup was observed. One seal tagged at FFS was also observed.

Necker Island: NMFS and FWS personnel were present at Necker Island on 19 May. A census was conducted and no pups were sighted. Tagged seals resighted included the single seal tagged as a pup on Necker in 1983 and several seals tagged as pups at FFS in 1984 and 1985.

TABLE 1. Average Monthly Numbers of Hawaiian Monk Seals
Using Beaches on Tern Island, French Frigate Shoals

Month	1979	1980	1981	1982	1983	1984	1985	1986	1987
Jan		10.8	29.6	33.9	60.2	49.8	96.9	92.8	83.0
Feb		14.2	28.8	31.6	72.5	56.9	107.8	98.3	54.0
Mar		24.5	25.9	39.3	59.4	77.3	127.6	103.2	90.2
Apr		13.9	28.0	36.9	47.3	49.6	81.4	78.0	65.6
May		14.9	22.9	28.4	41.0	34.1	56.1	55.0	68.6
Jun		16.7	19.6	30.5	36.0	48.6	45.9	66.6	57.0
Jul	5.7	17.7	20.7	43.0	41.4	50.9	83.6	76.0	69.6
Aug	5.3	21.9	27.3	46.6	53.3	69.4	80.5	92.0	84.0
Sep	4.3	19.5	28.3	44.3	46.4	56.9	62.7	68.8	77.4
Oct	2.5	23.4	43.4	49.9	61.3	72.1	81.5	74.8	92.0
Nov	9.0	22.9	43.5	56.1	68.7	94.5	113.3	102.8	118.3
Dec	13.7	33.5	37.5	48.6	67.0	90.6	89.7	92.2	95.6
Annual Mean		19.5	29.6	40.8	54.5	62.6	85.6	83.4	79.6

French Frigate Shoals: NMFS personnel were present at FFS from 30 March to 24 July, and again on 1 September. A temporary field camp was erected on East Island in early April and was disbanded on 22 July. NMFS research activities on monk seals during these periods included identifying parturient female seals, monitoring pupping activity, tagging weaned pups, regularly censusing all islets within the shoals, and resighting previously tagged seals to determine survivorship. Nets, lines and other hazardous debris were also removed from all beaches and burned.

At least 121 pups were born at FFS in 1987. Live pups were born on all islands except Shark, Bare and Tern. Two premature pups were born stillborn on Tern Island in March. A total of 106 weaned pups were double tagged with yellow plastic tags in their hind flippers.

Tissue samples were collected from three seals which died during the field season. A skull and mandibles were collected from a mummified carcass of a juvenile seal found dead on Little Gin Island. Tissue plugs for subsequent genetic analysis were collected from seven weaned pups during tagging.

Four seals were observed entangled in debris. A juvenile female was found dead on Shark Island on 19 April tangled in a large mass of webbing and line ashore on the island. The pile of webbing had been seen on Shark Island approximately one week earlier. A subadult male was found on East Island on 21 April with a line encircling its chest. The animal was freed by NMFS and Smithsonian staff. NMFS and Smithsonian personnel also freed a subadult female seal which was encircled by a loop of line on 17 June on East Island. On 1 September NMFS personnel saw a subadult of unknown sex encircled about the neck by net or line on Whale-skate Island. They were unable to free the animal.

Approximately 200 debris items, primarily webbing and lines were catalogued, measured, and burned. Total weight of the items has not been determined at this time.

Several incidents of adult male aggression were observed at FFS during the field season, including two mass mobbings/matings which occurred off the south side of Tern Island. Extensive injuries to the female seals involved were not noted. A subadult male seal was observed on Whale-skate Island with extensive dorsal injuries likely inflicted by adult males.

Census and tag resighting information remains to be compiled for the 1987 field season.

Laysan Island: NMFS personnel were present on Laysan Island from 6 April to 22 July. Activity on Laysan included capturing for maintenance in captivity five adult male seals for captive research, tagging weaned pups, tagging adult and subadult males, regularly censusing seals, collecting data on male behavior, patrolling for mobbing activity of adult males, monitoring injuries to seals, necropsy of dead seals and resighting previously tagged seals.

Censuses of seals were conducted every three days. Total counts are still being summarized. Pup production totaled 34 animals born on Laysan in 1987. Three of these pups died at birth or shortly thereafter. Twenty-eight weaned pups were tagged on each rear flipper with a brown plastic temple tag. The color of tag used on Laysan in 1987 was changed from the "tan" of previous years to a darker, chocolate brown because of confusion arising from the color of faded tan tags.

Mortalities of two animals, an adult female and a subadult male, resulted from adult male aggression.

Metal Monel tags were applied to the rear flippers of adult male seals without restraining the animals. A maximum of 69 previously untagged adult male seals were tagged. The number is a maximum because difficulties with tagging apparatus caused some tags to not "take", and it is unknown in some instances if a certain tag was applied to an animal which had shed a tag previously applied in 1987. Metal tags were also applied to approximately 14 adult male seals which had been tagged in previous years but which had either lost a tag or had only been originally tagged with a single tag.

Tissue samples and skulls/mandibles were collected from necropsies of dead seals. Tissue plugs were collected from seven seals during tagging.

Five seals, comprising two juveniles, one subadult, and two adults, were observed entangled in ropes or webbing. None of the animals were restricted in their movements. Entangling materials were removed from two of the seals, and the remaining three escaped entangling without human intervention.

Webbing and lines were routinely collected, measured, and burned and totaled 378 different pieces. Total weight of all the items has not been calculated.

Seven seals moved to Laysan Island from Lisianski Island.

Lisianski Island: NMFS personnel were present on Lisianski Island with Service personnel from 1-4 June and in a short NMFS field camp from 5-29 August. Activity during the visits to Lisianski was limited to tagging weaned pups, resighting previously tagged seals, conducting censuses, and collecting and destroying nets and other hazardous debris.

Censuses were conducted every other day during the visits to the island. The average of 11 censuses conducted in August was 98.6 seals, including pups of the year.

Nineteen pups were born on Lisianski Island in 1987.

Five seal mortalities were documented, with tissue samples being collected during necropsies of these seals. Skull and mandibles were collected from three of the dead seals.

Eighteen weaned pups were tagged in both hind flippers with green plastic tags.

One entanglement was documented; a pup of the year, sex unknown, was found dead in August, having become entangled and almost completely buried in sand prior to the field party's arrival. The entanglement was in a pile of line which was probably already present on the island. Two seals, an adult female and a weaned female pup, bore new scars as a result of having become entangled.

Webbing and lines totaling 278 items were catalogued, measured and burned. Total weight of these items has not been calculated at this time.



Typical netting debris found on Refuge beaches. This net was burned on Lisianski Island by Refuge staff during the yearly charter (DKM).

Pearl and Hermes Reef: NMFS and FWS personnel were present at Pearl and Hermes Reef from 5 to 7 June. NMFS personnel had a temporary field camp on Southeast Island and North Island of Pearl and Hermes Reef from 14 to 28 August. Activities during the first visit were limited to censusing seals and tagging weaned pups. During the August visit

considerable effort went toward tagging, censusing, resighting tagged seals and cataloging/removing hazardous debris. Twenty-two pups were born at Pearl and Hermes Reef in 1987; all were tagged with blue plastic tags in both hind flippers. This represents the highest known pup production there during the past decade. Atoll-wide counts were conducted daily through the August visit; numbers have not been tallied.

There were no entanglements observed during the visits. Webbing and line totaling 331 pieces were catalogued, measured and burned. Total weight of the debris has not been calculated at this time.

Publications/reports resulting from Hawaiian monk seal research conducted on the Refuge that were published during 1987 include:

Banish, Linda D. and William G. Gilmartin. 1987. Preliminary investigation: hematology and serum chemistry of the young Hawaiian monk seal, Monachus schauinslandi. NMFS SWFC Admin. Report H-87-13. 10pp.

Gerrodette, Tim, Barry K. Choy, and Lisa M. Hiruki. 1987. An experimental study of derelict gill nets in the central Pacific ocean. NMFS SWFC Admin. Report H-87-18. 14pp.

Gilmartin, William G. 1987. Hawaiian monk seal die-off response plan, a workshop report. NMFS SWFC Admin. Report H-87-19. 7pp.

Gilmartin, William G., Thea C. Johanos, and Tim Gerrodette. 1987. Preliminary assessment of juvenile Hawaiian monk seal survival. NMFS SWFC Admin. Report H-87-16. 11pp.

Henderson, John R., Susan L. Austin and Miriam B. Pillos. 1987. Summary of webbing and net fragments found on Northwestern Hawaiian Islands beaches, 1982-86. NMFS SWFC Admin Report H-87-11. 15pp.

Johanos, Thea C. and Susan L. Austin. 1987. The Hawaiian monk seal on Laysan Island: 1984. U.S. Dep. Commer., NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFC-64. 7pp.

HWN-3-87 French Frigate Shoals Hawaiian Monk Seal Pup Rehabilitation Project And Kure Atoll Pup Headstart Project

The Hawaiian monk seal female pup headstart project was initiated in 1981 at Kure Atoll. Female pups born at Kure were placed in an enclosure and fed until they were in good condition and self-feeding. In 1984, underdeveloped female pups from French Frigate Shoals were flown to Honolulu and rehabilitated. After being screened for disease and genetic problems, they were flown to Kure for eventual release. Three female pups were collected at French Frigate Shoals in 1984, two in 1985 and five in 1986. In 1986, one male pup was also collected and this animal was converted to a research animal. No pups were collected at FFS in 1987.

At least two candidate pups, i.e. prematurely weaned, were observed on East Island but these pups disappeared before personnel were able to capture them. The pups were in the vicinity of several lactating females, and because biologists on East Island had documented extensive pup exchange, they thought the pups had an excellent chance of being adopted by another female. Also, because of their proximity to mother pup pairs, these pups could not be captured without risk of disturbance to these pairs. The pups disappeared after approximately 2 days.

Three of the female pups collected in 1986 that were in excellent condition and self-feeding were transported to Kure Atoll on 14 April and were placed in a headstart pen there. The transfer was documented by a film crew from the Public Broadcasting Service production "Discover: The World of Science", and formed the basis of a segment which later appeared on the nationally broadcast show. The yearling seals were released from the headstart pen on 22 and 23 June 1987.

One female seal collected in 1986 was in good condition but slow learning to feed. This seal remains in captivity at Sea Life Park, Oahu. The slow rehabilitation of this seal dictates a poor prognosis for her survival in the wild.

One of the seals collected in 1986 died due to renal failure with attendant uremic poisoning shortly after it arrived at the NMFS Kewalo Research Facility in Honolulu.

HWN-4-87 Capture for Maintenance in Captivity Adult Male Monk Seals

Large numbers (up to 30) of adult male monk seals have been documented to participate in mass attacks, or "mobbings" on adult female seals and immature seals of both sexes. These attacks may result in death of the attacked individuals either due to the male-inflicted wounds or from attack by sharks attracted to the area. Although attacks or animals displaying wounds characteristic of such attacks have been documented from most locations within the Hawaiian Islands NWR, they are most numerous at Laysan Island, where aggression by adult male seals (including apparent individual attacks) has caused the deaths of at least 10 seals in the past 3 years.

On 17-20 February, a workshop was convened by NMFS in Honolulu to address the problem of adult male aggression and mobbings. This workshop included recovery team members (including Refuge Manager Fefer) and other individuals with expertise in animal behavior, genetics, endocrinology and general physiology. The charge of the group was to review available data on mobbings and the social structure of male monk seals, to propose further data which should be collected, and to recommend any actions which could be taken to eliminate or reduce the incidence of mobbings.

The action proposed by the workshop was a 2 year program with the objective of reducing aggressive behavior in adult male seals by chemically lowering testosterone levels. The program would entail research on captive male monk seals to (1) determine normal testosterone levels and their seasonal fluctuations, (2) ascertain an appropriate drug and dosage which would lower testosterone levels, and (3) develop an appropriate drug delivery system. Once these three objectives were met, the technique would be applied to animals in the wild.

A collection team of 5 NMFS and 1 FWS biologist traveled to Laysan Island aboard the NOAA ship TOWNSEND CROMWELL arriving on Laysan Island 6 April. From 6 April - 1 May, five male seals were collected for permanent captivity. A seal retaining pen (40 ft x 90 ft) was constructed near the west cove landing site situated at the water's edge, enclosing both water and beach haulout area. Seals collected were individuals (1) who were identified as having participated in mobbing incidents and (2) who, based on NMFS analysis of 1985 data on male behavior, were not considered to be "high ranking" or dominant individuals. Capture was effected using a hoop net, cargo net and large stretcher to retain the seal, which were then transported to the holding pen via an inflatable raft. The five captured for permanent captivity were transported to the NMFS Kewalo research Facility in Honolulu aboard the NOAA ship TOWNSEND CROMWELL arriving in Honolulu on 6 May. One of the seals died in captivity approximately one month after arrival in Honolulu. The cause of death was determined to be probable renal failure due to captive stress. The four remaining seals were subsequently moved to the Hubbs Marine Research Center in San Diego California arriving at the Center in August 1987.

Four additional seals were captured and placed in the holding pen on Laysan Island at various times during the April visit. One of these seals was subsequently released as it was a very old individual. Three seals were released when it was determined that they were dominant individuals.

The following report was prepared concerning this subject:

Gilmartin, William G. and Doris J. Alcorn. 1987. A Plan to address the Hawaiian monk seal adult male "mobbing" problem. Administrative Report H-87-12. Southwest Fisheries Center, Honolulu Laboratory, National Marine Fisheries Service, NOAA, Honolulu HI. 24pp.

HWN-5-87 Maternal Care and Pup Behavior in Hawaiian Monk Seals

This study was conducted by Dr. Daryl J. Boness, Department of Zoological Research, National Zoological Park, Smithsonian Institution. The primary objective of the study was to quantitatively describe the behavioral aspects of the maternal care system of the monk seal. The major emphasis was on documenting the occurrence of fostering behavior, its potential causes and its impact on the duration of lactation and pup growth during the suckling period. Data collected included: (1)

movements around the breeding ground by individuals, (2) spatial dispersion of the breeding colony, (3) activity budgets of mothers and pups, (4) an index of responsibility for maintenance of proximity, (5) frequency of fostering behavior, temporal parameters of suckling and (6) the duration of the period of maternal care and pup dependence.

A field camp was established on East Island, French Frigate Shoals on 5 April and occupied until 20 July. Between 12 April and 1 May, data were collected by three researchers; thereafter, two researchers collected the data.

The analyses completed to date indicate that fostering behavior is widespread in Hawaiian monk seals on East Island, French Frigate Shoals. The preliminary results suggest that exchange of pups between mothers may be as high as 80%. Females that foster pups usually cared for their pups for a period of time before developing a foster relationship. A mother-pup pair may reunite for short periods between foster episodes or in some cases reunite and remain together until the end of lactation. Once a pup has become separated from its mother, the female may have several foster pups sequentially and the pup may have several foster females. The predominant cause of separations and fostering is aggressive interactions between two females with pups in close proximity to one another. Females and pups rarely end up without a partner for more than a few minutes following separations, although on occasion one or the other will not have a partner for several days.

The net effect of fostering on pup development for the population of females may not be negative. Only twelve pups appeared to be negatively affected and 19 either benefited or at least were not negatively affected. Those pups that benefited suckled for longer than they would have if they remained with their mothers and consequently were larger at weaning than those pups that did not have extended suckling periods. Of those pups affected negatively, 7 had their suckling periods shortened and were smaller at weaning than the other pups and 5 pups appeared to have died in relation to fostering activity. It will be important to determine survivorship at a year of age of all those pups that survived to the end of suckling to determine if the different patterns of development had a longer lasting effect, either to enhance or to decrease survival.

The end of suckling for pups does not appear to be totally passive on the part of the pup. The fact that there was a threshold age of pups below which pups were always observed to have another foster relationship if abandoned (i.e. separated or weaned) suggests that pups can choose to place themselves in situations that result in foster care or remove themselves from such a situation.

HWN-6-87 Green Sea Turtle Study

During 1987, FWS and NMFS personnel continued cooperative turtle research efforts concentrated on French Frigate Shoals, the major Hawaiian green sea turtle nesting area. FWS personnel conducted studies primarily at Tern Island and NMFS efforts were conducted primarily at East Island during May and June. Objectives of studies included collecting census data on turtles, tagging basking turtles and monitoring turtle nesting.

Comprehensive censusing and tagging of all nesting green sea turtles was conducted on East Island for 26 nights during May and June. During this time 124 females were found nesting, of which 54 (43.5%) were found to have been tagged previously. Of the remaining 70, 63 were tagged with one or two metal Monel tags in the front flippers or axillae.

On Tern Island, Refuge biologists monitored turtle nesting activity from 20 May - 15 November by patrolling the beaches twice daily, about one hour after sunset and at sunrise. Locations of nests were recorded on maps and data forms. Nest sites were physically marked with a stake placed 150 cm inland of the nest. Tags were applied or tags read for all turtles.

Hatchling emergence was monitored by observing each nest site starting about 54 days after eggs were laid. If a nest did not hatch within 90 days, the nest was excavated and the contents analyzed (throughout several years of study, mean incubation length for French Frigate Shoals nests has been between 63 and 68 days; extremes have been 54 to 88 days).

After hatching, nests were excavated to determine clutch size and hatching success. Hatching success parameters included the number of eggs that did not hatch (infertile and/or rotten), dead embryos (1/4, 1/2 and 3/4 developed), dead fully developed hatchlings, live hatchlings trapped in nest, and hatchlings that successfully emerged on their own (based on the number of hatched egg shells in the nest).



Assistant Managers Holm and Niethammer excavate a post hatch turtle nest as part of a nest success study on Tern Island (DKM).

Green sea turtles nested on Tern Island between 25 May and 20 October 1987. Eighty two percent of the nesting occurred during the months of June, July and August. All nests were located on the south facing shoreline of Tern Island. Nine different turtles were observed nesting on Tern Island; one individual was observed nesting 4 times while three others were observed nesting twice. No adult turtles were observed entrapped on Tern Island.

Forty eight of the 50 nests located produced hatchlings; the first hatchling emerged on 29 July and the last on 26 December. Eighty one percent of the nests hatched during August, September and October.

The mean incubation period for the 34 nests with lay and hatch dates known was 63.0 days with a range of 54 to 85 days.

The mean clutch size was 86.7 eggs, with a range of 36 to 115 eggs. Individual nest success ranged from 0 to 100% hatch. Two of the 50 nests failed to produce any hatchlings. When excavated, the eggs from these two nests showed no signs of embryo development. Of the 4,161 eggs found in 1987, 75.5% (3,137) produced viable hatchlings that succeeded in reaching the sea. Of these, 482 hatchlings required assistance, as they were trapped in their nests or were not fully developed (yolk sac still extended). Most obstructions were large pieces of coral; however, 6 hatchlings in one nest were trapped under a piece of copper wire. A total of 1024 eggs (24.6% of the eggs) failed to produce viable hatchlings.

During the field camp on Laysan Island, a single turtle was tagged while basking. The humerus of a dead turtle was collected for subsequent age determination of the turtle.

During the field camp on Lisianski Island, at least 10 series of turtle pits were documented in August, all of which were located on the west side of the island. One tagged turtle was resighted while basking.

On Pearl and Hermes Reef, during the field camp effort, 3 basking turtles were tagged with metal Monel bands.

Several significant tag resights summarized below were reported during 1987.

Twenty-two turtles were resighted for the first time after initial tagging, one for the second time, five for the third time, one for the fourth time, and one for the fifth. The longest period between original tagging and any of this year's recoveries was 10 years.

Significant movements revealed by resightings this year included: four moved from Whale-Skate, French Frigate Shoals to East Is., FFS; one moved from Johnston Atoll, Central Pacific to East Is. FFS; one moved from Kawela, Molokai to East Is. FFS; one moved from East Is. FFS to Tern Is. FFS; and one moved from Whale-Skate Is. FFS to Moloaa, Kauai.

HWN-7-87 Mitochondrial DNA Studies of Hawaiian Green Sea Turtles

The objective of this study is to determine the phylogenetic relationships within the *Chelonia mydas* complex, an important matter that needs to be resolved if turtles are to be managed effectively. Researchers will test the possibility that green sea turtles nesting on different beaches are genetically distinct evolutionary units. Dr. John G. Avise working in cooperation with the NMFS, Honolulu Lab, conducted the mitochondrial DNA analysis. Personnel from NMFS collected 48 partially developed green sea turtle eggs and 24 hatchlings from East Island, French Frigate Shoals and these were transported to Honolulu and then to Athens, Georgia. Eggs were collected in June. A maximum of four eggs were collected from 12 nests. The eggs were incubated artificially at French Frigate Shoals prior to shipment.

Dr. Avise received eggs of green sea turtles from Costa Rica, Venezuela, Oman, Hawaii, Florida and Ascension Island. On the basis of about 500 nucleotides per specimen, the following conclusions were reached:

1. The Atlantic and Pacific turtles constitute two distinct phylogenetic groups. Additional phylogenetic groups may be revealed by future analyses.

2. Within the Atlantic Ocean, evidence of a restriction in gene flow was observed between eastern Caribbean and other Atlantic rookeries. Stocks of turtles may be defined on a regional basis. Further analysis may reveal more extensive geographic subdivision within this species.
3. The rate of molecular evolution in marine turtles appears to be slower than in other vertebrates. This conclusion is based on a comparison of Hawaiian and Caribbean groups, and on the assumption that these demes have been isolated by the isthmus of Panama for three million years.

HWN-8-87 Endangered Passerines Study--Nihoa Island, Pearl and Hermes Reef and Laysan Island

This research project was conducted by Dr. Sheila Conant and graduate student Marie Morin in the field and by Dr. Rob Fleischer. The objectives of the research on the three endangered passerines (Nihoa finch, Nihoa millerbird, Laysan finch) follow:

- 1) determine basic breeding biology parameters
- 2) conduct morphometric studies of all three species including comparative studies between the two species of finches between the two populations of Laysan finches, including studies of growth rates, survival, and inheritance of morphological characters.
- 3) studies of feeding behavior of all three species
- 4) identification of habitat requirements
- 5) examination of genetic variation within and between Laysan and Pearl and Hermes populations of the Laysan finch via analyses of blood proteins and mitochondrial DNA.
- 6) study of molt and plumage sequence and behavior in a small population of captive Laysan finches to aid in aging and sexing populations during censuses, allowing identification of age structure of wild populations.

Nihoa Island: Dr. Sheila Conant traveled to Nihoa Island and was present on this island from 13-18 May. On 13, 15, 16 and 17 May, Dr. Conant set mist nets and banded finches and millerbirds, banding a total of 14 finches and 7 millerbirds. One of the female finches had an oviducal egg indicating that the species was in breeding condition during the trip. One of the millerbirds banded had been banded previously by Dr. Conant in April 1983 as an adult male. This bird was at least 5 years old in May 1987 and that is a new age record for this species.



Dr. Sheila Conant of the University of Hawaii attempting to catch Nihoa finches on the steep terrain of Nihoa Island. (FWS file photo)

Pearl and Hermes Reef: Dr. Conant was present on Pearl and Hermes Reef from 14-27 August. She continued studies on the comparative ecology of Laysan finches in the Hawaiian Islands NWR. In 1967, 110 Laysan finches were introduced from Laysan Island to Pearl and Hermes Reef. Presently, there are Laysan finches nesting on the four vegetated islets of Pearl and Hermes Reef (North, Southeast, Grass and Seal-Kittery). The principle activities here involved capturing, banding and measuring Laysan finches. Blood samples were taken from some of the banded birds and three birds were collected.

Two hundred fifty Laysan finches were captured, measured and banded, of which 71 were recaptures of birds banded in 1984, 1985 or 1986. On Grass Island, 15 birds were captured on Seal-Kittery, 4 were captured and on North Island 31 were captured. The remaining 200 birds were captured on Southeast Island.

Blood samples were taken from 10 birds at Southeast Island, 14 from Grass Island, and 7 from North Island. Three of the 10 Southeast Island birds were also sacrificed and preserved in liquid nitrogen for mitochondrial DNA studies. Three additional birds were salvaged.

Data collection continued on the feeding behavior of finches and on breeding activity studies. Nest were under construction (1 on North), with eggs (1 on Grass and 2 on North) and with nestlings (1 on North and 1 on Grass). The number of hatch year birds appeared quite low this year, and the number of nests found was also low as compared to previous years. The islands and vegetation appeared to have been very dry, which may explain the apparent low reproductive success.

Laysan Island: Marie Morin was present on Laysan Island from 7 April to 22 July. A total of 301 Laysan finches were banded. Of these 102 were "local" birds and one was a hatch year bird. Four of the total were previously banded which were rebanded with a new band. All second year finches were weighed and measured.

Feeding observations indicated that the fuzzy fruits of Sicyos were preferred during the breeding season. It seems to be an important source of invertebrates. Finches also searched for invertebrates in Nama clumps as well as under Sesuvium leaves. Finches were observed to be truly omnivorous; in addition to leaves, seeds, flowers and stems, invertebrates and carrion are a significant portion of their diet.

Twenty wooden nest boxes were erected in 1987; ten in Eragrostis plant association and ten in the Ipomoea-Boerhavia-Tribulus-Eragrostis association. None of the boxes were used as nest sites.

The first active finch nest was located on May 7, a month later than last year. The delay in breeding may be tied to the very dry year on Laysan Island in 1987. July 11 was the last date in which eggs were observed which later hatched. From May 2 to July 13, 106 nests or nest-like formations were located. Of these 87 were included in the nesting study. Seventy of these 87 nests contained at least two eggs. A total of 216 eggs were laid in these nests. The mean clutch size was 3.09.

Fifty nests were included in the reproductive success study. In these 50 nests, 51 out of 152 eggs made it to "banding age". This is an overall success rate of 33.6%.

A pilot cross-fostering study was conducted as a necessary first step for future genetic studies. This study was to investigate mortality and behavioral changes which could result from cross-fostering. This study used 10 control nests and 5 pairs of experimental nests. In the experimental nests, pairs were matched according to clutch size and to egg age. In the control nests, eggs numbered 1 and 3 were taken approximately 10 meters away from the nest and kept in clean glass jars with a loose lid for 5 minutes, after which time they were returned to the nest. Jostling of the eggs was kept to a minimum. In the experimental nests, eggs numbered 1 and 3 were removed from the nest and carried to the other experimental nest in a clean glass jar. These eggs were placed in the nest after eggs 1 and 3 were removed. Eggs 1 and 3 from the second nest were then placed in the first nest. This procedure took less than five minutes.

Out of the 32 eggs from the 10 control nests, 11 (34%) produced chicks which lived to banding age. Of the 32 eggs in the 10 experimental nests, 18 (56%) produced chicks which lived to banding age. These results are puzzling.



Fish and Wildlife Service volunteer biologist Marie Morin checks a typical Laysan finch nest site in Eragrostis variabilis clump (DKM).

Thirty-one birds were taken from Laysan Island. One died on the return trip to Honolulu, three were sacrificed for mitochondrial DNA studies, and two died of unknown causes (being examined at the National Wildlife Health Center). Twenty-four birds remain in captivity. Birds are captured, measured and photographed at regular intervals for studies of plumage development.

A trip report detailing the methods and preliminary results of this investigation is available in Refuge files.

HWN-9-87 Laysan Duck Study

Annie Marshall, Refuge volunteer and Ph.D. candidate at Ohio State University, spent April thru September on Laysan Island to complete studies of the Laysan duck. The field study was a continuation of a

study on reproductive behavior begun at the Smithsonian-Conservation and Research Center in 1984 and 1985 and continued on Laysan in 1986. The research objectives for the 1987 field season included the following:

- 1) to continue banding efforts and increase the color marked population allowing more accurate censusing and effective behavioral observations;
- 2) to continue monitoring pair behavior, five ducks were to be radio collared to closely determine their movements, and possibly to find nests;
- 3) to continue monitoring hen-duckling interactions, specifically concentrating on groupings of females and young which may be creches. In relation to this 5-10 broods were planned to be marked with color patagial tags so that movements of ducklings could be monitored;
- 4) to continue to monitor the use of fresh water by the ducks, and to obtain measurements of salinity of various areas around the lake;
- 5) to sample brine flies at specified areas around the lake; and
- 6) to continue weekly duck censuses around the lake.

Adult Laysan ducks were captured on dark nights with long-handled nets using head lamps to locate the ducks. All birds captured were banded with FWS bands (males on right legs and females on left) and color banded. Plastic color bands that were used in 1986 were discontinued following the discovery of a female who had lost a leg, and 3 other females with swollen legs due to constriction by the plastic bands. Subsequently, color marking proceeded by using painted metal bands.

During the first period of the field season when the ducks were paired and courting, pair observations of marked individuals were obtained in the morning and early evening hours using scan sampling techniques.

Five ducks were fitted with radio collars and their locations obtained approximately once per day. All but one duck were recaptured and the collars removed before departing from Laysan.



Fish and Wildlife Service volunteer biologist Annie Marshall tracks a radio collared female Laysan duck along the edge of the hypersaline lake. (DKM)

Once a week salinity measures were taken of the lake and possible seep areas at 5 locations around the lake. Twice a month, at the same locations, brine fly samples were taken by 3, 1-meter long sweeps with an insect net.

Censuses were carried out once a week by walking around the lake from dusk to dark and noting all ducks seen. One hundred twenty eight ducks were captured and banded or rebanded. Fifty one of these were previously banded birds; 47 were originally banded in 1986 and 4 of these previously banded birds were banded prior to 1986.

Salinity measurements indicate lower salinity in the seep areas around the central lake perimeter (8-34 0/00) than in the lake water. In general, salinity of the smaller north lake (122-150 0/00) was higher than the larger south lake (80-108 0/00). The southwest pool seeps tended to have a lower salinity than the southwest pool itself, which was separated from the main lake. The salinity of the south end of the southwest pool declined throughout the summer and the drying seeps showed slightly higher salinities in some places. The decreasing salinity of the southwest pool may have been the result of fresh water seeping into the pool which was shrinking throughout the summer.



Laysan duck alongside typical freshwater seep. (SIF)

There was a trend for the north and south lakes to increase in salinity through the summer. There was little rain through the 1987 field season and the lake levels were very low throughout the period. There was a land bridge through the lake in April and the lake level decreased throughout the summer until the lake level was below the water level gauge bottom.

Brine fly samples have not been analysed to date. It appeared obvious that there were many fewer flies in 1987 than in 1986. Few ducks were observed fly foraging in 1987. Undoubtedly, the decline in flies relates to the lack of precipitation.

The Lincoln-Peterson index was used to estimate the population of ducks. The average estimate of 22 censuses conducted yielded a mean of 466 ducks. Means were also calculated after grouping 3 sets of censuses based on date, yielding means of 538 (4/9-6/1), 360 (6/8-8/3) and 543 (8/10-9/8). These groupings related to when the numbers of ducks seen on census began to decline, and when the numbers increased again. It is likely that the means of 538 and 543 are most accurate. As in 1986, there was an observable decrease in the population estimate of ducks as changes in visibility of ducks occurred (and therefore less accurate population estimates obtained). The decrease indicates the time of males molting, females laying and incubating and females molting.

Although many females were noted apparently egg-heavy, and there was a drop in the observed number of females in the usual loafing areas indicating that females were nesting, there were few ducklings observed and those observed were few in number and were lost during early stages. It seems likely that ducklings died of starvation due to a lack of brine flies. Though many tried to catch the larger house flies, they were not proficient in this behavior. It is possible that females were stressed under these poor feeding conditions and therefore they may have laid infertile eggs or were not incubating sufficiently.

A trip report detailing the methods and preliminary results of this research project is available in Refuge files.

HWN-10-87 Prevalence and Effects of Plastic Ingestion In Hawaiian Seabirds

This study was funded by the National Marine Fisheries Service (NMFS) through the Fish and Wildlife Service, National Wildlife Health Center. A proposal written by Refuge staff was accepted for funding by NMFS Entanglement Study Branch at the Seattle Laboratory. The approved funding was directed to the National Wildlife Health Center by FWS Research Division staff in the Washington Office. The study was conducted in 1986 and field efforts were continued and completed in 1987.

Dr. Louis Sileo is the principal investigator at the Health Center. Mr. Paul Sievert was hired to assist in this study and Paul conducted the field sampling on Midway Atoll from April through August of 1986 and February through August 1987.

During 1987, Dr. Sileo traveled to Nihoa, French Frigate Shoals, Laysan and Pearl and Hermes reef to collect regurgitate samples from seabirds as part of this study. Refuge staff were involved in the prevalence portion of this investigation. Refuge staff sampled birds for plastic occurrence on Tern Island, Laysan Island and Kilauea Point, Kauai. NMFS personnel recorded entanglements of seals and turtles during field camps on Refuge islands and also recorded and burned hazardous debris (including nets). Paul Sievert conducted studies of prevalence and effects on Midway Islands.



Dr. Lou Sileo (NWHL) stomach pumps a masked booby chick on Laysan Island to determine frequency of occurrence of plastic in the species. (SIF)

Prevalence of plastic in the digestive tract of 18 species of Hawaiian seabirds, representing three orders (Procellariiformes, Pelecaniformes, Charadriiformes), was examined. Birds were sampled by stomach pumping or necropsy techniques on Maui, Kauai, Nihoa, Tern, Laysan, Pearl and Hermes Reef and Midway Islands.

The types of plastic eaten varied in size from 2-5 mm diameter spherical polyethylene pellets to large plastic items such as bottle caps, cigarette lighters and children's toys. Typically, chicks had a higher prevalence of plastic than adults. Plastic was found in 16 species of Hawaiian seabirds located in the proventriculus, ventriculus and intestines. Charadriiformes ingested the least plastic and has the only two species that were not found to ingest plastic (gray-backed and white terns). Pelecaniformes had a moderate prevalence and Procellariiformes had the highest prevalence with 94% of Laysan albatross chicks containing plastic.

Survival rates were calculated for Laysan albatross chicks artificially fed plastic (0, 100 and 200 cc) and chicks naturally fed plastic by adults during the period 15 May-31 July 1986. Plastic quantities in naturally fed chicks were determined by endoscopic examination of the proventriculus. Chicks ingesting high volumes of plastic had low survival rates. In 1987, the same pattern was found. Plastic did not affect survival rate as determined by the survival rate sample. In

1987, we determined that the main cause of mortality was dehydration. Based on these preliminary results, we believe that plastic ingestion as a direct cause of mortality in Laysan albatross is not significant. Further study is needed on the effects of plastic on foraging efficiency and other indirect physiological effects.

Information concerning this study was presented at the annual meeting of the Pacific Seabird Group by Paul Sievert. The citation for this paper follows:

Sievert, Paul R., Sileo, L. and Fefer, S. I. 1987. Prevalence and effect of plastic ingestion in Hawaiian seabirds. Pac. Seabird Group Bull. 15(1).

Additional reports on this study are in preparation.

E. ADMINISTRATION

1. Personnel

	<u>CS</u>	<u>Full-time</u>	<u>Part-time</u>	<u>Temp.</u>	<u>Total</u>
CY-86	1	6	---	2	9
CY-87	1	6	---	4	11

Larry Martin transferred from the secondary Assistant Manager position at Tern Island to Assistant Refuge Manager, Ash Meadows NWR, Las Vegas, Nevada effective 4 January.

Joan Suther was hired as a temporary Biological Technician on Tern Island starting on January 5 to temporarily fill the secondary Assistant's position vacated by Larry Martin. She remained until 23 May when she accepted a promotion to a position with BLM in Salem, Oregon.

Ed Bean, Biological Technician (Honolulu), temporarily filled the second Assistant Manager's position after Joan departed until 28 August. Bean resigned his position effective 10 September.

Rick Vetter, primary Assistant Refuge Manager at Tern Island, accepted a position at Columbia White Tailed Deer Refuge in Washington State, departing on July 15. He filled the Assistant Refuge Manager position at the receiving station.

Ken Niethammer was hired as the new primary Assistant Manager at Tern Island on 7 June.

Jeff Holm was hired to fill the secondary Assistant Manager position at Tern Island on 2 August. Jeff transferred from National Elk Refuge.

Career - Seasonal Biologist, Maura Naughton, remained on leave without pay status throughout the year while she attended graduate school in Oregon State University in the Department of Fisheries and Wildlife.

A major reorganization of Hawaiian/Pacific Islands NWR Complex took place throughout the year. Richard Wass previously manager of the Hawaiian Islands NWR, Remote Islands NWR, and Johnston Atoll NWR, transferred to the newly created Hakalau Forest NWR on the island of Hawaii. Stewart Fefer previously the Supervisory Wildlife Biologist for the Complex became the Complex Refuge Manager for the Hawaiian Islands NWR, Remote Islands NWR, Johnston Atoll NWR, and Hawaiian Wetlands NWR. Duane McDermond previously the Biological Technician for Hawaiian Islands NWR was hired to fill the newly created Assistant Refuge Manager position for this refuge.

Craig Rowland was hired in November to fill the Biological Technician position vacated by McDermond.

Darcy Hu, Refuge Biologist, went on leave without pay status to attend graduate school at U.C. Davis in September.

2. Youth Programs

Lack of funding and personnel to offer continuous supervision to the work crew precluded a YCC program at Tern Island during 1987.

4. Volunteer Program

A record number of volunteers continued to play an important role in daily operation and research activities conducted on Tern Island, particularly when the refuge was short-handed while refuge staff were on leave. An ongoing effort has been made to fully utilize the experience, training, talents, and interests of those people during their stays.

Volunteers also played an important role in our field camp efforts on Laysan Island and Lisianski Island. Marie Morin and Annie Marshall were instrumental in the endangered finch and duck work accomplished on Laysan Island in 1987.

Volunteers Tony Berto, Ken Niethammer, Diane Campbell, Craig Rowland, Dick Bauer, Vanessa Gauger, and Patrick Ching conducted seabird monitoring studies, Hawaiian monk seal and green sea turtle surveys, banded seabirds, maintained data files, and provided assistance to the staff and visiting researchers. Additionally, volunteers entered biological data into computer files at the Honolulu office. Volunteers also assisted with maintenance and biological tasks.



Fish and Wildlife Service volunteer Dick Bauer censuses sooty terns on Tern Island. (KRN)

5. Funding

The Hawaiian Islands NWR is part of the Hawaiian and Pacific Islands NWR Complex. During 1987, 1,071.5K was received for management (operations, maintenance and special projects) of the Refuge Complex. This amount includes the 200K Congressional add-on received late in the year for maintenance of the Tern Island facility. In 1987, 50k was received from Endangered Species for management at Tern Island FFS. Resource Problem related projects on the Hawaiian Islands NWR included a wildlife habitat survey (25K) and an alien rodent survey (10K).

An additional 60K was received from the Regional Office for a large Accelerated Refuge Management and Maintenance project to rehabilitate our Kapahulu Storage Facility in Honolulu.

6. Safety

Because of Tern Island's remote location, safety is of paramount concern both during work and free time. Any serious injuries or illnesses requiring Medivac face a delay of 7-10 hours before the patient can obtain treatment in Honolulu. For this reason, safety precautions are taken seriously.

Dr. Ken Nakasone of the Honolulu Medical Group continued to act as medical advisor for Tern Island personnel and was called upon numerous times for medical advice over the radio. He also visited the island to discuss medical procedures with staff and evaluated the stock of prescription drugs, first aid and other medical supplies.

Volunteers and NMFS personnel were briefed on emergency procedures, including the use of radios in emergency situations. Practice sessions were also conducted.

Weekly radio checks were conducted with the U.S. Coast Guard. This routine procedure becomes a lifeline during emergencies. Information pertaining to flights, flight plans, weather and injured personnel was relayed through U.S. Coast Guard channels. The assistance in this regard has been greatly appreciated.

Emergency supplies were organized in waterproof buckets for each Boston Whaler. Buckets with tools, extra spark plugs, lubricants, wire and rags were also assembled for each boat.

Two new High Frequency Single-Sideband radios were installed at Tern Island to replace severely degraded systems.

Refuge staff completed courses in First Aid and CPR.

7. Technical Assistance

Refuge staff provided a variety of technical assistance to other government agencies, several institutions, and numerous fishing vessels.

Refuge staff provided logistical support and technical advice on necessary mechanical repairs to National Marine Fisheries Service field camps at French Frigate Shoals and other refuge islands. In addition, numerous radio checks were conducted for safety purposes and to relay messages between Honolulu and other camps. Tern Island personnel regularly monitored intra-atoll radios in support of NMFS research.

The Honolulu office assisted with transportation arrangements for 2 trips to Tern Island by the National Weather Service. Tern Island personnel also performed regular preventative maintenance and emergency repairs to the RAMOS weather station.

Tern Island personnel recorded information from a University of Hawaii tide gauge and performed regular and emergency maintenance.

The fishing vessel DATRO blew a head gasket and requested fresh water from Tern Island. Refuge personnel delivered two 55-gallon barrels of water to the vessel so they could return to Honolulu.

The fishing vessel ELLIE B requested fuel filters from Tern Island because of contaminated fuel. The filters were not available at the station. However they did assist by conducting radio checks as the vessel made its way back to Honolulu.

Twenty welding rods and a bag of cement were given to the fishing vessel DIAMOND HEAD for repairs in exchange for lobster.

The fishing vessel DATRO requested permission to tie up at the emergency buoy at French Frigate Shoals to fix a dirty fuel line. A scuba tank was shuttled from the FERESA to the DATRO by Bean and Bauer.

Four masked booby and 4 great frigatebird chicks were collected for the seabird display at Sea Life Park on Oahu.

Technical assistance was provided to the U.S. Navy Command at Midway regarding activities which may affect migratory birds and migratory bird permitting requirements and compliance.



This photo shows a former wedge-tailed shearwater and bonin petrel nesting area that was cleared of trees and bulldozed on Sand Island, Midway Atoll. Since Refuge staff make infrequent visits to the site, projects such as this are often completed without consultation as required by the Navy's Migratory Bird Permit issued by the Law Enforcement Division of the Service. (TEH)

8. Other

Refuge Managers Fefer and McDermond and Biologist Hu attended the Pacific Seabird Group Annual Meeting in Asilomar California.

Several papers involving work conducted by the Refuge staff on the Refuge were published or accepted for publication during the year. These papers are cited in specific sections of this report (Sec. D.5.).

F. HABITAT MANAGEMENT

2. Wetlands

The Hawaiian Islands NWR consists of extensive shoreline and coral reef habitats. However, studies in these areas are limited due to the remote nature of the area. These wetland areas are protected through the administration of Special Use Permits for entry. The State of Hawaii and the Fish and Wildlife Service dispute ownership of these areas.

The Laysan lagoon or lake is the most significant unique "inland" wetland on the Refuge. The lake supports the Laysan duck and substantial populations of migratory shorebirds. During 1987, studies of the lake were limited to measurements of salinity, water level and the use of fresh water seeps by ducks. In addition, Laysan duck behavior (Sec.D.5) was investigated and duck (Sec.G.2), waterfowl (Sec.G.3) and shorebird (Sec.G.5) surveys conducted.

6. Other Habitats

Tern Island

Sooty terns nest in great numbers on Tern Island and have a special affinity for the east and west ends of the runway. To discourage sooty tern use (thereby minimizing bird strikes by aircraft), large sheets of heavy black plastic have been laid on the ground in past years. This effort must be repeated each year as the plastic deteriorates. In 1987 the plastic was placed on the west end of the runway as usual, but on the east end only half of the area was covered and the other half was scraped clear of vegetation just prior to sooty tern nesting. The scraped ground proved to be just as effective as the plastic. It also required less maintenance, cost, and wastage.



Aerial view of Tern Island, French Frigate Shoals, Hawaiian Islands NWR. (DKM)

Laysan Island

Laysan Island had been modified extensively by human activity during the latter 19th and beginning of the 20th century. Guano mining and deforestation by feral herbivores caused extensive sand and soil shift, changing island topography and reducing the lake depth considerably. In 1980, Service personnel observed that an area of vegetation on the central eastern portion of Laysan Island had been covered by drifting sand. During this and subsequent trips, observers noted that sand was beginning to encroach on the boundary of Laysan's lake and that the freshwater seeps on the eastern portion of the lake were beginning to fill with sand. Also, due to the drifting sand, the dune height in this area had decreased. The decrease in dune height could increase the likelihood of flooding of the lake due to storm surge. If the ocean flooded the lake, major changes in the lake's ecology could occur. In an attempt to arrest the drifting sand and allow the vegetation to reestablish in the area in hopes of preserving the freshwater seeps for the Laysan duck, a drift fence was constructed in 1984 (two lines totaling 640 feet) and 1985 (two lines totaling 2700 feet). Observations made during the summer of 1986 revealed that the drift fences had caused the formation of dunes of varying heights and widths. Vegetation had not yet reestablished in this area in 1986. It was thought that the increase in dune height might result in the decrease in the westward drift of sand.

During the June 1987 visit to Laysan it did appear that vegetation was beginning to reestablish on the lakeside of the innermost fence. Ipomea pes-caprae was creeping inward from both sides of the blowout and Scaevola taccada seedlings were found growing on the lake side of the innermost fence. This new growth was not dramatic but encouraging.



Blowout area on the east shore of Laysan lake. Dunes have formed over the drift fence (left center) erected in 1984. (SIF).

An inspection of the fence did reveal some problems. The innermost fence had a breach which caused a severe cut through the innermost dune. This section of fence was repaired and sand was piled against the windward side in hopes that the dune would reform. It was also found that sand was continuing to encroach on the vegetation at the S end of the innermost fence. It appeared that there was enough room between this fence and the middle fence to allow the wind to reestablish and carry sand to the S of the inner fence. It was decided that a new section of fence should be erected to connect the S end of the innermost fence to the S end of the middle fence, hopefully stopping the wave of sand that is encroaching here. We estimated that this would require another 450 feet of fence.

Continued monitoring of sand movement, revegetation, the presence and location of freshwater seeps, and use of the seeps by Laysan ducks will be necessary to determine the ultimate effects of the drift fence. Photo plots should be established during the next visit to the site.

Audrey Newman, a graduate student in geography at the University of Hawaii continued the vegetation mapping project for Laysan Island which began in 1984 when aerial photographs of Laysan were taken. Interpretation and analyses of photographs continued with expected products to include a vegetation map of Laysan and methods development to allow the mapping of other low islands within the Refuge. A draft of this thesis project was reviewed by Refuge staff in November.

10. Pest Control

Pest control in the Hawaiian Islands NWR involves prevention of alien introductions, monitoring existing and potential new introductions, and planning and implementing control procedures for problem introductions on a case by case basis. During 1987, pest control primarily involved implementing procedures to prevent the introductions of exotic organisms. Also during visits to the refuge, the status of exotic organisms was monitored.

The islands of the Hawaiian Islands NWR are extremely sensitive to the introduction of alien species. The natural history of these islands is full of examples of problems when alien species are intentionally or unintentionally released on the islands. The introduction of rabbits on Laysan Island caused the extinction of the Laysan rail, Laysan millerbird and Laysan honeycreeper early in this century. The problem of rodents on Midway and Kure in the Northwestern Hawaiian Islands chain serves to warn us about the introduction of rat species on Refuge islands. Introductions of alien plants have caused problems on Southeast Island, Pearl and Hermes Reef and Sand Island, Midway Atoll where plant introductions compete with native plants important on these islands. The introduction of house flies on Laysan Island is another example of a major insect infestation resulting from an introduction. The introduction of mosquitoes on the Refuge islands could result in catastrophic consequences if malaria was transmitted to the native landbirds. The endemic finches are thought to be highly susceptible to malaria. On Midway Atoll where mosquitoes have been introduced, avian pox, which is carried by mosquitoes, has caused problems for the large Laysan albatross population which nests there. These are just a few of many specific examples of potential problems with exotic introductions. It is for these reasons that Refuge staff take great precautions when transporting equipment and visiting the remote islands.

Material transported to these islands must be packed in cleaned plastic or metal buckets that are sprayed with insecticide, not wood or cardboard boxes that may harbor insects, eggs, and/or plant seeds. Material that may carry seeds, insects, or eggs is fumigated before transport. For example, the fencing material which was transported to Laysan Island was professionally fumigated prior to transport. Many articles are frozen as an extra precaution to kill insects. Certain types of foodstuffs are not permitted on the islands. The Refuge stipulates transport procedures for all islands through the Special Use Permits issued to Refuge cooperators and monitors transport to ensure compliance with procedures required in the permits authorized.

Large numbers of great frigatebirds began nesting at the east end of Tern Island in 1985. Eight hundred fourteen nests were found in 1987 compared with 547 nests in 1986, 186 nests in 1985, one in 1983 and none in 1984. There is increased concern about bird air strike hazards because of the frigatebird's large size and behavior.

G. WILDLIFE

2. Endangered and/or Threatened Species

The islands within the Hawaiian Islands NWR harbor four endangered land birds (all endemic to single islands), the endangered Hawaiian monk seal, and the threatened green sea turtle. The endangered land birds are the Laysan duck, Laysan finch, Nihoa millerbird, and Nihoa finch. Research conducted on these species was described in a preceding research section (Sec. D.5). In addition to research, specific management practices directed toward the protection of endangered and threatened species on the refuge include strict control of all research and other activities. The following are among the measures taken: (1) Entry onto the refuge is prohibited to all but persons with Special Use Permits--permits are generally given only to activities which are likely to directly benefit the resources or improve management practices, so many requests are turned down; (2) all Special Use Permits include provisions to avoid disturbing endangered species; (3) movement of all personnel on Tern Island is restricted to areas not frequented by seals and turtles; and (4) fishermen are given information indicating the boundaries of the refuge and regulations pertaining to entry.

Activities conducted on the refuge that may impact endangered or threatened species are also submitted to Section 7 (Endangered Species Act) consultation with the FWS and National Marine Fisheries Service.

The Hawaiian Islands NWR has only one resident waterfowl species, the Laysan duck. It is an endemic and endangered species, inhabiting a hypersaline lake on Laysan Island. During 1987, Laysan duck populations were surveyed from April to September. Count methods and results are described in the research section (Sec. D.5).

Two Laysan finch surveys were conducted on Laysan Island during 1987. The 15 April survey, was considered a pre-breeding census since no active nests were seen until 7 May. The census counted 343 birds resulting in a population estimate of 11,659 +/- 1,817. The breeding census conducted on 28 May counted 321 birds resulting in an estimate of 10,911 finches +/- 1,769. Populations were lower than in 1986. This is possibly explained by the drier season in 1987.

At Pearl and Hermes Reef, Conant censused finches on North Island (23 August), on Southeast Island, Grass Island and Seal/Kittery Islands on 17 August. Results from 1987 indicate an estimated population for

the atoll of 317 birds. This is significantly different from estimates during recent years. Population estimates for each of the islets are as follows:

<u>Island</u>	<u>Population</u>
Southeast	181
Grass	29
North	53
Seal/Kittery	54

TOTAL	317

Dry conditions over the past 2 years have caused significant changes in vegetation on the islands. This has likely been the cause of the downward trend in finch numbers.

Two endemic endangered passerine birds inhabit Nihoa Island: the Nihoa millerbird and the Nihoa finch. Populations of these species were surveyed on 14 May. Transect surveys were conducted for this purpose. The population estimate for Nihoa millerbirds was 306 to 854 (580 +/- 274, 95% confidence interval). This was quite similar to last year's May estimate of 261 to 893 or 577 +/- 316.

Estimates of Nihoa finches indicated a population of 555 to 1337 individuals (946 +/- 391, 95% confidence interval). This is significantly lower than the May 1986 estimate of 1525 to 2929 finches. The extremely dry condition of the island may have decreased survival over the winter.



Nihoa finch. (CMR)

Information on populations of endangered Hawaiian monk seals and threatened green sea turtles is presented in Section D.5 of this report.

3. Waterfowl

The general lack of suitable habitat for waterfowl and the distance from major waterfowl migratory routes accounts for the rarity of this group within the Refuge. The only resident waterfowl is the endemic and endangered Laysan duck which inhabits the hypersaline lake on Laysan Island. Studies of this species are described in the Research and Investigations (Sec. D.5) and Endangered Species (Sec. G.2) above.

During 1987 waterfowl observed in the Northwestern Hawaiian Islands include mallard, American wigeon, green-winged teal and northern pintail.

5. Shorebirds, Gulls, Terns and Allied Species

The Hawaiian Islands NWR provides habitat for some of the largest and most important seabird colonies in the world. The islands harbor approximately 5.4 million breeding pairs of 18 species. The composition and number of breeding birds varies throughout the year. Because of the significance of the Hawaiian seabird population, indicator species of seabirds are emphasized in the monitoring program conducted on the islands. Baseline data on population size, phenology, egg size, reproductive success, chick growth rate, and food habits are collected from black noddies, red-footed boobies, and red-tailed tropicbirds on Tern Island and Laysan Island. These measurements are compared to those for prior years to detect changes due to natural or man-caused factors. Early detection of potential changes can avert significant population declines. Additional information on the seabird monitoring program is presented in Sec. D.5, HWN-1-86.

In 1987, breeding birds (i.e. number of nests) were censused at Tern Island at intervals of the mean incubation period for each species. In prior years, breeding birds were counted island wide once a month on Tern Island. In 1987, censuses of other islands in the atoll were too infrequent to develop a population estimate for the atoll as a whole. The total number of nests for the atoll have been estimated for prior years. The estimate for 1986 was based on opportunistic counts, whereas in previous years atoll-wide counts were conducted semi-annually on specific dates. Thus, neither Tern Island or atoll wide counts are directly comparable with previous years. The results of these censuses are summarized in Tables 2 and 3.

TABLE 2. TOTAL NUMBER OF NESTS ESTIMATED FOR TERN ISLAND 1983-1987

Species	1983	1984	1985	1986	1987
Black-footed albatross	193	221	292	304	448
Laysan albatross	852	854	720	588	1032
Red-tailed tropicbird	201	308	527	734	538
Red-footed booby	404	629	898	809	957
Great frigatebird	1	0	186	547	814
Gray-backed tern	56	48	121	272	78
Sooty tern	12,500	13,000	--	41,788	--
Brown noddy	921	927	890	1,861	2134
Black noddy	726	615	1,201	1,094	1333
White tern	34	34	34	54	73
TOTAL	15,888	16,636	4,869	52,551 10,763*	7407

*Does not include sooty tern nests

TABLE 3. FRENCH FRIGATE SHOALS ATOLL-WIDE NEST COUNTS 1984-1986

Species	1984		1985		1986 (results from multiple counts)
	3/84	6/84	4/85	8/85	
Black-footed albatross	2,490*	2,769	2,760	0	2,823
Laysan albatross	1,109*	901	1,380	0	1,339
Red-tailed tropicbird	163	327	352	365	754
Masked booby	380	337	127	226	493
Red-footed booby	540	611	618	510	818
Great frigatebird	470	308	368	375	693
Gray-backed tern	72	50	33	13	275
Sooty tern	9,879	0	8,300	--	41,788
Brown noddy	857	1,407	1,150	200	2,496
Black noddy	461	197	618	95	1,094
White tern	18	20	27	8	54
Sooty-storm petrel	--	--	--	--	13
TOTAL	16,439	6,749	15,733	1,792**	52,640

Includes: Tern, Trig, Whale-skate, East, Gin, and Little Gin Islands.

Includes: Tern, Trig, Whale-skate, East, and Little Gin Islands.

Includes: Tern, Trig, Whale-skate, and East Islands.

*Whale-skate not censused for albatross.

**Does not include sooty tern nests.



White tern chick. (DKM)

An estimate of the current numbers of breeding pairs and their distribution for the entire Northwestern Hawaiian Islands is presented in Table 4. These numbers are from population surveys conducted in recent years. Due to the magnitude of the seabird population on these islands, the diverse phenology of the species, and the remoteness of the island colonies, it is not possible to survey all of the populations on each island in every year. Thus, during visits to the islands, populations of indicator species are surveyed, and every five years detailed population surveys are scheduled to determine population trends.

The following vagrant and overwintering species were observed at French Frigate Shoals in 1986:

common ringed plover
lesser yellowlegs
ruff
whimbrel
Bonaparte's gull
western sandpiper
lesser frigatebird

cattle egret
bristle-thighed curlew
ruddy turnstone
American golden plover
sanderling
wandering tattler

TABLE 4. ESTIMATE OF BREEDING PAIRS OF SEABIRDS, NORTHWESTERN HAWAIIAN ISLANDS

	Location				
	Nihoa	Necker Island	French Frigate Shoals	Gardner Pinnacles	Laysan Island
Black-footed albatross	40 to 60	200 to 250	4,000 to 4,500	0	14,000 to 21,000
Laysan albatross	1 to 5	450 to 550	900 to 1,000	10 to 15	105,000 to 132,000
Bonin petrel	0	0	30 to 50	0	50,000 to 75,000
Bulwer's petrel	75,000 to 100,000	250 to 500	200 to 500	10 to 15	1,000 to 2,000
Wedge-tailed shearwater	30,000 to 40,000	1,500 to 2,500	1,500 to 1,750	25 to 50	125,000 to 175,000
Christmas shearwater	200 to 250	0	15 to 20	0	1,500 to 2,000
Sooty storm-petrel	2,000 to 3,000	+	+	0	500 to 2,500
Red-tailed tropicbird	250 to 300	100 to 150	550 to 600	20 to 25	1,500 to 2,500
Masked booby	250 to 300	250 to 300	500 to 600	125 to 150	400 to 425
Brown booby	150 to 200	20 to 25	40 to 60	5 to 10	34
Red-footed booby	1,500 to 2,000	650 to 750	550 to 600	0	250 to 300
Great frigatebird	3,500 to 4,500	700 to 900	350 to 375	0	2,000 to 2,500
Sooty tern	10,000 to 25,000	12,500 to 25,000	60,000 to 78,000	250 to 500	375,000 to 500,000
Gray-backed tern	9,000 to 12,000	3,500 to 4,500	750 to 1,000	1,500 to 2,500	5,000 to 10,000
Blue-gray noddy	2,000 to 2,500	1,000 to 1,500	+	+	0
Brown noddy	25,000 to 35,000	10,000 to 15,000	5,000 to 7,500	1,000 to 1,500	10,000 to 15,000
Black noddy	1,000 to 5,000	300 to 500	750 to 850	200 to 300	1,500 to 2,500
White tern	1,000 to 5,000	100 to 300	500 to 750	150 to 250	600 to 1,000
TOTAL	235,115	52,725	98,155	5,315	943,760

NOTE: + indicates breeding occurs but there was not significant data to make a quantitative statement;
 ? indicates breeding is suspected but no nests were found.

TABLE 4. ESTIMATE OF BREEDING PAIRS OF SEABIRDS, NORTHWESTERN HAWAIIAN ISLANDS
(continued)

	Location				Total
	Laysan Island	Pearl and Hermes Reef	Midway Islands	Kure Atoll	
Black-footed albatross	2,800 to 3,800	8,000 to 11,000	6,500 to 7,500	700 to 1,300	49,410
Laysan albatross	23,000 to 30,000	9,000 to 12,000	150,000 to 200,000	3,000 to 4,000	379,570
Bonin petrel	150,000 to 250,000	400 to 600	2,500 to 5,000	400 to 600	331,250
Bulwer's petrel	50 to 100	10	0	0	103,125
Wedge-tailed shearwater	10,000 to 30,000	5,000 to 10,000	500 to 1,000	900 to 1,100	261,400
Christmas shearwater	400 to 600	10	25 to 50	20 to 30	2,960
Sooty storm-petrel	?	1,000 to 2,000	0	?	7,500
Red-tailed tropicbird	900 to 1,300	40 to 60	4,000 to 5,000	1,000 to 1,300	11,235
Masked booby	300 to 350	140 to 160	5 to 10	65 to 75	2,370
Brown booby	15 to 25	50 to 60	0	50 to 60	474
Red-footed booby	350 to 450	40 to 60	450 to 500	400 to 450	5,110
Great frigatebird	750 to 850	300 to 400	60 to 75	200 to 250	9,850
Sooty tern	400,000 to 600,000	35,000 to 45,000	30,000 to 45,000	8,000 to 12,000	1,330,500
Gray-backed tern	15,000 to 20,000	650 to 750	100 to 200	30 to 50	51,000
Blue-gray noddy	0	0	0	0	4,000
Brown noddy	7,500 to 15,000	1,700 to 2,000	500 to 1,000	700 to 800	92,800
Black noddy	500 to 1,000	75 to 125	2,000 to 6,000	0	16,275
White tern	50 to 100	10 to 20	5,000 to 7,500	5 to 10	14,930
TOTAL	953,575	84,255	278,835	22,025	3,673,759

Several shorebird counts were conducted on Laysan Island from 6 April - 12 September. Two levels of counts were conducted depending on work load and number of participants. Only one census of the type that covers the majority of the habitat was conducted. This count was made in mid-April and reflects numbers present near the beginning of northward migration. This is most likely the closest to an overwintering count that has ever been conducted on the island. The results of this count are below.

Golden Plover	1090
Ruddy Turnstone	1188
Wandering Tattler	114
Bristle-thighed Curlew	28
Sanderling	27
<hr/>	
TOTAL	2447

The following vagrant species were seen on Laysan in 1987.

western sandpiper
bar-tailed godwit
red-necked phalarope

The following vagrant species were seen on Midway Atoll in 1987.

ring-billed gull
Leach's storm-petrel
sharp-tailed sandpiper
dunlin
cattle egret

A sub-adult short-tailed albatross was seen for the third year in a row at Midway this year. This endangered bird was banded as a local on Torishima island in 1978. Torishima an active volcanic island off the coast of Japan supports the only known breeding colony of this species. The most recent population estimate from the breeding grounds in 1987 was 60-80 pairs.

6. Raptors

An unidentified accipiter was seen on Laysan Island in April. On Midway Atoll Paul Sievert (NWHL) identified a hobby (Falco subbuteo) and a peregrine falcon.

9. Marine Mammals

Spinner and bottlenose porpoise are regularly seen at French Frigate Shoals and Pearl and Hermes Reef.

Two calves (or calf and yearling) and an adult humpbacked whale spent the afternoon of 6 February near Tern Island.

Monk seal observations and research are described above in Section D.5.

14. Scientific Collections

Because of the many endemic and unique wildlife species found in the Hawaiian Islands NWR, specimens are valuable to museums, educational institutions, and for research purposes. For specimens salvaged in fresh condition, the refuge attempts to make these available to the National Wildlife Health Center for diagnosis. Other specimens are provided to museums which make requests and have appropriate permits. During 1987, specimens were provided to the National Wildlife Health Center and the B.P. Bishop Museum.

Sea Life Park received 8 live birds collected at French Frigate Shoals for their permitted free-flying seabird exhibit. Four fledgling masked boobies and four fledgling great frigatebirds were collected at French Frigate Shoals and flown to Honolulu in cooperation with Sea Life Park for this educational exhibit.

Bird specimens salvaged in 1986 as skins, skeletons and frozen carcasses from the Hawaiian Islands NWR included (numbers of specimens in parentheses):

- Laysan albatross (3)
- Bonin petrel (1)
- wedge-tailed shearwater (1)
- sooty storm-petrel (1)
- masked booby (1)
- brown booby (1)
- red-footed booby (1)
- great frigatebird (1)
- brown noddy (1)
- parakeet auklet (1)

The National Marine Fisheries Service has been conducting research on "headstarting" underdeveloped pups from French Frigate Shoals by feeding these pups and transporting them and releasing them at Kure Atoll. This collecting and re-release program is described in the Research and Investigations section of this report (Sec. D.5).

15. Animal Control

Refuge staff monitor the potential introduction of exotic animals such as the various species of rats and feral cats during visits to the islands. No exotic mammals were noted within the refuge this year.

16. Marking and Banding

A variety of animals are marked and/or banded annually on the Refuge islands. Hawaiian monk seals are bleach marked and tagged as part of the monk seal research project conducted primarily by NMFS. Green sea turtles are also tagged as part of the NMFS research program. Data on green sea turtles and monk seals are presented in the discussion of this project in the Research and Investigations section (Sec. D.5).

Birds are banded as part of the refuge effort to monitor seabirds and migratory shorebirds which use refuge islands. Banding efforts focus on species which are studied as part of the seabird monitoring effort. Productivity of various age classes, age at first breeding and other factors relating to interpretation of the reproductive parameters are measured as part of the monitoring effort.

Seabird banding remains a priority at French Frigate Shoals. The emphasis in 1987 was on young birds produced at Tern Island, especially those species which are monitored each year.

Midway Atoll: In cooperation with Dr. Ralph Schreiber of the Los Angeles County National History Museum, Refuge staff rebanded 1078 Laysan and 91 black-footed albatross. These birds were first banded by Dr. H. Fisher and Chandler Robbins (FWS) in the mid 1960's. Information from these recoveries will be used to develop life tables for albatross.

H. PUBLIC USE

1. General

Public use of the Hawaiian Islands NWR is highly restricted because of the presence of endangered species and the high potential for introduction of exotic organisms to the fragile environment. In order to maintain public support for our programs, we attempt to keep the public informed by encouraging and assisting artists, journalists, and photographers in their effort to obtain information and photographs. This is done either at the Honolulu headquarters or by arranging for people to visit the refuge (usually Tern Island).

6. Interpretive Exhibits/Demonstrations

During 1987, the mobile interpretive exhibit entitled "Wildlife of the Unseen Islands" was completed. This exhibit was developed in cooperation with the University of Hawaii Environmental Center and will be used at exhibits, fairs and conservation meetings to inform people about the Refuge and its natural resources.

Complex Manager Fefer presented a talk on the "Birds of the Northwestern Hawaiian Islands" to several environmental groups during the year including the Hawaii Audubon Society, the Moanalua Valley Foundation and the University of Hawaii.

Refuge staff routinely provided information, leaflets and brochures to various interested groups.

17. Law Enforcement

Since the Hawaiian Islands NWR is comprised of isolated, inaccessible islands which are closed to the public, law enforcement is not a major activity. Law enforcement in the Hawaiian Islands NWR consists primarily of monitoring Special Use Permits, Migratory Bird Permits, and Endangered Species Permits issued to cooperators conducting studies on the refuge. In addition, refuge staff coordinate with the Coast Guard concerning potential illegal entry inside refuge boundaries.

Nearly all law enforcement activities within the refuge occur at French Frigate Shoals and pertain to fishing vessels. With a permanent field station at Tern Island, the shoals can be closely monitored. Many vessels pass near the shoals, or rendezvous with other vessels in this area, as French Frigate Shoals is a half-way point for boats operating out of Honolulu.

All fishing boats observed from Tern Island are contacted by radio. They are informed of refuge boundaries and rules governing the use of the buoy before their approach in order to reduce conflicts. This method has proven effective in establishing good working relationships with the captains.

I. EQUIPMENT AND FACILITIES

1. New Construction

Two contracts were let at the end of FY-87 for work at the Refuge's warehouse facility in Honolulu. The facility is shared by the Refuge and the USEWS Cooperative Fisheries Unit of the University of Hawaii. This facility provides the only area where field equipment for the Refuge can be stored and prepared for expeditions. Conflicts for space between the two users and the need for a sterile environment for packing for expeditions to Refuge islands required improvements in the

existing facilities. The first contract was let to construct a block storage building to increase storage space. Part of the solicitation included the remodeling of an old caretakers cottage to provide berthing space for volunteers and Tern Island staff on rotation to Honolulu. The winning bid for the block storage building exceeded estimates of the Regional engineer by 100%. A 20- by 30-foot building with lights costs the government \$50,000.00 in Hawaii. Engineering is now convinced of the high cost of doing business in paradise. Unfortunately, the high bid eliminated the possibility of completing the bunkhouse. The second contract was let to pave 3/4 of the existing yard. Construction had begun on the block storage building but had not been completed by the end of CY-87. Paving did not begin until January of 1988.



Construction begins on 20- by 30-foot storage building at the Kapahulu compound. The old storage building stands in the background. (JFL)

2. Rehabilitation

Rehabilitation of equipment and structures is an ongoing effort at Tern Island, where low elevation (6 feet above sea level), small area (37 acres), and constant winds carrying salt spray result in much corrosion.

A \$200,000 congressional add-on for the operation and maintenance of Tern Island was received late in FY-87. This windfall appropriation provided the opportunity to make major changes in the facilities. Because of the tenuous nature of the station for the past year, funding

was either withheld or not available at the Refuge level for needed preventative maintenance and equipment replacement. Consequently Tern Island had fallen into a state of disrepair. On-site managers were constantly faced with the burden of maintaining equipment with few replacement parts. One of the two main electrical generators had exceeded its rebuild time twice and was questionable from day to day. A half complement of pumps required to operate the domestic water system had failed and were not replaced. This required personnel to move pumps from one location to the other during rainstorms to insure catchment water was not lost. The station was down to one semi-functional boat. This was due mainly to the failure of aged outboards. Again no replacements had been available. These were just a few of the situations the Tern Island staff had been facing during most of FY87.



Two 17.5 kw ONAN generators provided primary power to Tern Island prior to November. The old Coast Guard generators are in the background. (DKM)

After verification that the funds were forthcoming, Honolulu and Tern Island staff scrambled to put together a spending package for Tern Island before the end of the fiscal year. The following goals provided direction for the spending: 1) facilities should be simplified and upgraded to reduce maintenance time required by refuge staff; 2) systems should be redundant where possible; 3) spare parts, and

equipment should be on hand for all critical systems; 4) the electrical generation should be converted to a less fossil fuel intensive system; and 5) equipment should be of high quality. The following is a list of major upgrades effected at Tern Island:

- a. Primary electrical generation was converted from diesel powered to solar powered. A contract was let for procurement and installation of a photo-voltaic (PV) power system late in FY-87. In November the equipment was transported to Tern Island and installed. The system provides power to the barracks lighting, domestic water pump, refrigeration, radio communications equipment, computer, TV/VCR, copier, dehumidifier, tools, and small kitchen appliances. The system is designed to provide 3 days of electricity without input from the sun. Three days of clouds is a rarity on Tern Island. If excess power is consumed, exceeding the systems capabilities, the storage batteries can be recharged with a small diesel generator incorporated in the system. At the end of the year the PV system was operating as advertised. Generator recharging had not been necessary and the only maintenance required was to monitor battery state of charge and wash the solar panels. The only problem encountered was radio interference caused by the DC fluorescent lights installed with the system.

Major components of the new photo-voltaic power systems include:



Solar panels...(DKM)



Storage Batteries...(DKM)



...and Load Center. (DKM)

- b. Other electrical requirements including catchment system water pumping, boat winch, washing machine, and large power tools are provided by the remaining 17.5 kw diesel generator, and portable 3.8 kw diesel generators. The large generator is run 1 day per week to wash clothes and others are run only as needed.
- c. The water catchment and delivery system was modified to allow gravity flow of water where possible. New pumps were purchased and installed at the two required pumping stations. A generator was installed to provide power to both pumps during water transfers.
- d. A new boat winch was purchased to meet the change in available power. A generator was installed at the winch to provide power only when needed.
- e. A new tractor was purchased to replace a corrosion ridden machine that had become prohibitively expensive to maintain at a remote site. This tractor was returned to Honolulu to be repaired and used on Wetland Refuge units where anticipated future repair costs would be significantly lower.
- f. Two new redundant high frequency, single-sideband radio systems were purchased and installed. Prior to this only 1 ailing radio system was usable. These radios provide the only communications between the station and Honolulu. New VHF handheld radios and a VHF repeater were purchased. The handhelds were totally submersible units. Installation of this system allowed boat operators to have handhelds attached to their person. If their boat capsized at the far end of the atoll they could still contact Tern Island. If their engine failed and the boat drifted outside the range of the system they could still contact search aircraft on the Coast Guard frequency. The previous system incorporated handheld radios that had 3-foot antennas and were not waterproof. The radios had to be kept inside plastic bags making them difficult to use in a capsizing incident. The radios did not have the capability of operating on Coast Guard frequencies. The new repeater had not been installed at the end of 1987.
- g. A 17-foot Boston Whaler and outboards were purchased. A 16-foot heavy duty Zodiac was purchased. New outboards were purchased for an older whaler. This provided the station with a 3-boat contingent: two 17-foot Boston Whalers with 70hp outboards and 25hp auxiliaries, and a Zodiac with a 40hp outboard and 6hp auxiliary. Because of the remoteness of the station, there must always be 1 backup boat available before a boat can be launched. The Whalers are used primarily for transportation between islets of the atoll, and the Zodiac is used to transport supplies between delivery vessels and the island. Three boat trailers were purchased to replace ones that were barely movable.



This was the typical condition of equipment prior to November.
(DKM)

- h. Equipment purchased as backups included the following: pumps, dehumidifier, outboards, power inverter, generator, radio antennas, and washing machine. A major effort was made to obtain a good stock of replacement parts for all equipment.
- i. In addition to the refrigeration provided by the PV system, two propane powered refrigerators were purchased. These were used to store foods used regularly during the day. This lightened the load on the PV system by reducing the draw caused by frequent opening of doors on DC-powered refrigerators.

3. Major Maintenance

Regular maintenance activities at Tern Island included scheduled servicing of the electrical generators, outboard engines, backhoe, ATV, boat hoist, Boston Whalers, fresh water system, salt water system, sewage system, buildings, fuel supplies, refrigeration systems, and the runway. Also included were the servicing of electric and gasoline pumps, water storage tanks, kitchen appliances, and shop tools.

4. Equipment Utilization and Replacement

See section 3 above.

5. Communications System

Since Tern Island is a remote field station with the nearest assistance 500 miles away in Honolulu, radio communication is vital to the operation of the Refuge. Daily radio contact is made with the Honolulu headquarters (except on weekends and holidays). Because of its proximity to other remote island refuges, Tern Island provides radio checks with seasonal field camps at Laysan and Lisianski Islands and Pearl and Hermes Reef, and relays information to Honolulu. In addition to a single side band high frequency radio, a VHF radio provides short range communication between refuge staff and fishing vessels.



Tern Island communications center with VHF radio for intra-atoll communications and dual high frequency radios for long range communications. All are powered by PV system. (DKM)

Several incidents over the past few years required radio contact with the Honolulu Refuge staff outside of office hours. The U.S. Coast Guard provided assistance in reaching FWS personnel at home by phone patch. To insure this reliable means of communication, weekly radio checks with the Coast Guard were conducted on an assigned frequency. The Coast Guard is to be commended for its efforts in relaying information and establishing phone patches when needed.

Radio interference, caused by weather and other unidentifiable sources, produced high pitched squeals which made reception difficult and painful for listeners. Efforts were made to alter communication schedules with Honolulu to afternoons when reception is improved at the Tern Island station, though the reception is worse in Honolulu at that time.

The non-directional beacon (NDB) transmitter continued to be a source of repeated maintenance efforts in 1987. The unit aids aircraft in locating Tern Island, and is required by OAS for FWS flights. The system consists of a large transmitter, antenna coupler, and long wire antenna system. The main source of problems occurs at the antenna. Large seabirds find the wires perfect for roosting. They along with high winds have caused several breaks in the antenna. Each time this occurs several hours of work are required to repair the system. If the antenna takes a bird strike during operation of the system, the transmitter can be seriously damaged. This occurred during 1986 resulting in a 50% loss in power. This was enough power to put out a sufficient signal. The Refuge has lobbied OAS to either recommend a better system or eliminate the requirement for the NDB. Towards the end of the year they had provided the Refuge with a backup Loran receiver to take on flights, giving the aircraft the dual navigation systems required, and eliminating the need for an NDB.

7. Energy Conservation

With the change in power generation at Tern Island, fossil fuel consumption should be significantly reduced in future years. Because of Tern Island's location, logistical problems, safety hazards associated with fuel deliveries, and government regulations, procurement and consumption of fuel have been annual concerns. Annual consumption should now be reduced to about 500 gallons of diesel per year down from 6,000 gallons per year. With close to 2,000 gallons of diesel fuel on hand and consumption reduced, obtaining fuel should not be a problem. Once the current supply is depleted, the small amount of fuel required can be transported in 55 gallon drums on an opportunistic basis. This is currently how propane and gasoline are transported to the island.

8. Other

Numerous hours are spent annually in the coordination of flights and boat trips which support Tern Island. During 1987, the logistics of 15 flights were handled, including developing orders for parts and equipment, requests for volunteers with specific skills, facilitation

of transportation, and shopping lists to provide adequate, economic purchases of supplies for resident staff, visiting Honolulu staff, technicians and volunteers. Two of the flights were funded by the National Marine Fisheries Service and 2 were funded by the National Weather Service.

Repeated contacts with fishing and research vessels were necessary to arrange transport of personnel, nonperishable foods and heavy items to the island. Vessels which provided free transport of supplies, food, fuel, equipment, personnel and correspondence were: TOWNSEND CROMWELL (NOAA), MALLOW (USCG), SASSAFRAS (USCG) and the FERESA.



The fishing vessel FERESA made several stops at Tern Island to deliver mail and other supplies in 1987. (JS)

A vessel charter contract was awarded prior to the end of FY-87 to the R/V MCGAW. The purpose of the charter was to deliver supplies, personnel, and equipment associated with the rehabilitation of Tern Island. The contract posed stiff criteria associated with the shallow water at the Tern Island landing. The MCGAW proved the perfect vessel for the job. All the equipment including PV system, tractor, gasoline, diesel fuel, refrigerators, lumber, ATV, food, personnel, and etc. were offloaded in perfect fashion.



The R/V WM. A. MCGAW offloads supplies and equipment at the west end of Tern Island. (DKM)

In May the contractor who had been providing flight service to Tern Island, since the FWS took over the station, defaulted on the contract. The contractor and the FWS were able to convince another tour operator with a similar aircraft to takeover flights to Tern. In the process the gross weight available dropped from 1200 to 800 pounds. This resulted in a major decrease in our ability to transport people and supplies to the island. The charter is the main method of resupplying fresh food, delivering mail, and providing access to supervisors. In several cases people could not travel to the island due to weight constraints.

J. OTHER ITEMS

4. Credits

This narrative was prepared by Stewart I. Fefer and Ken McDermond.