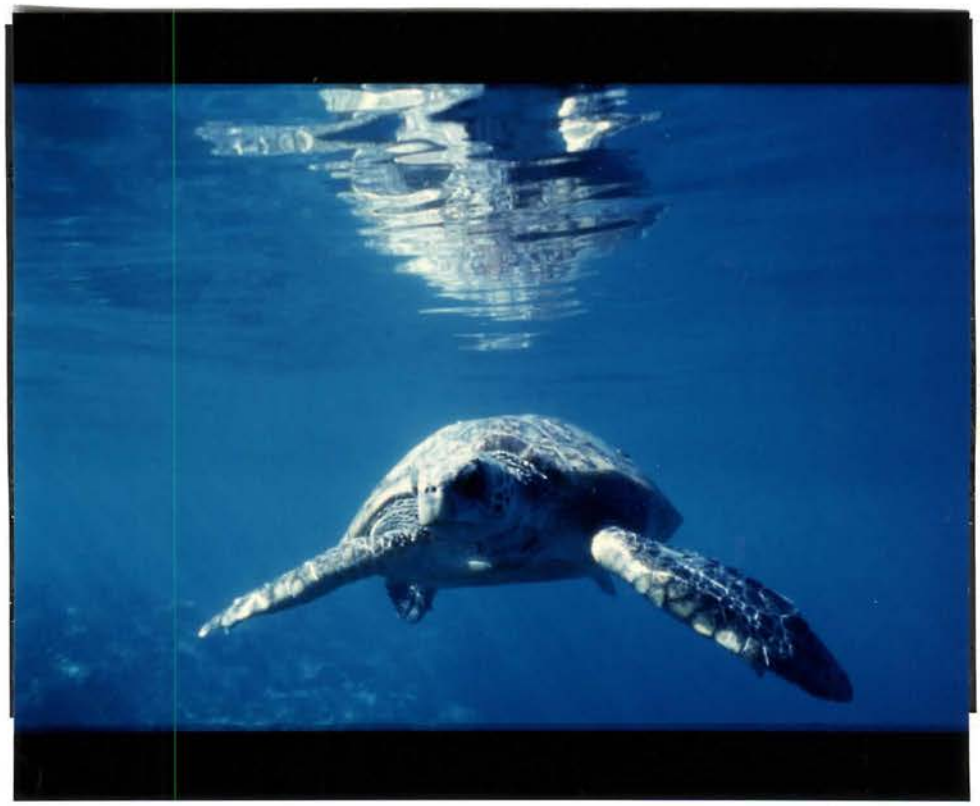
HAWAIIAN ISLANDS
NATIONAL WILDLIFE REFUGE
HONOLULU, HAWAII

ANNUAL NARRATIVE REPORT

Calendar Year 1989



Green Sea Turtle

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

HAWAIIAN ISLANDS NATIONAL WILDLIFE REFUGE
PERSONNEL - 1989

Jerry F. LEINECKE, Supervisor, Refuges & Wildlife, GS-13, PFT
Stewart I. FEFER, Refuge Complex Mgr., GS-12, PFT
Duane K. (Ken) MCDERMOND, Asst. Refuge Mgr. GS-9, PFT
Darcy HU, Wildlife Biologist, GS-7, PFT
Craig ROWLAND, Bio-tech., GS-5, TFT
Kennneth, R. NIETHAMMER, Asst. Refuge Mgr. (Tern Island), GS-9, PFT
Lynn M. DENLINGER, Asst. Refuge Mgr. (Tern Island), GS-7, PFT
William, B. TYLER, Wildlife Biologist, (Midway Atoll) GS-7, INT
Thomas, M. MOSER, Biological Aid, GS-3, INT
Glynnis, L. NAKAI, Biological Aid, (Tern Island), GS-4, TFT
Richard A. BAUER, Biological Technician, GS-5, INT
Katherine J. CASTELO, Admin. Support Assistant, GS-7, PFT
Lynn, HONDONERO, Clerk Typist, GS-3, TFT
Wendy, TASHIRO, Purchasing Agent, GS-4, PFT
Dolores, HU, Clerk Typist, GS-4, PFT

Review and Approvals

3-6-91

Submitted by: Refuge Manager **Date**

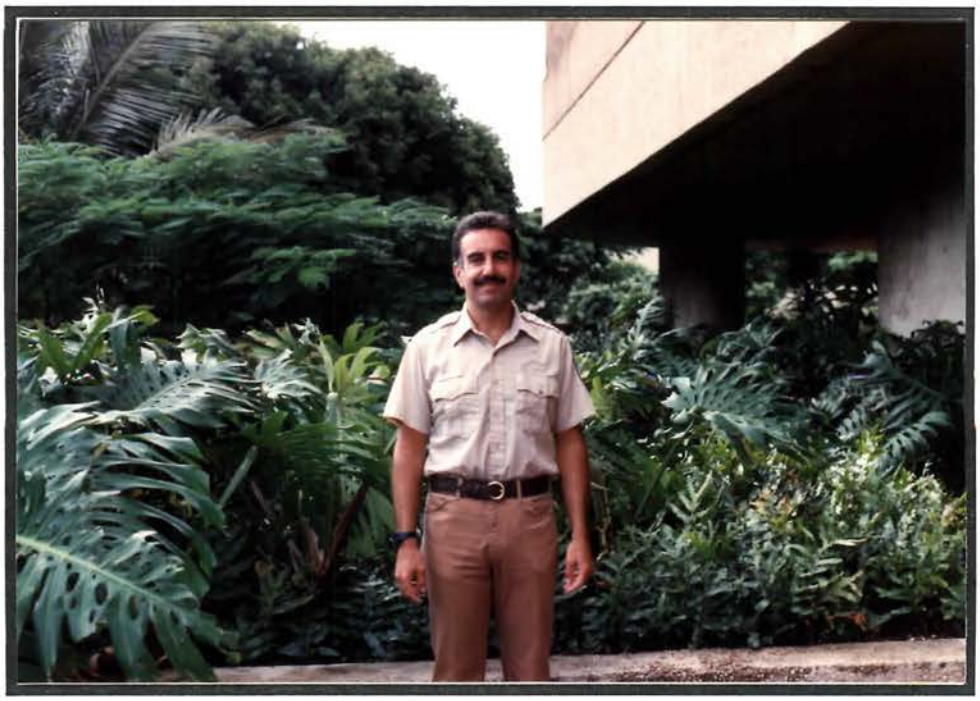
3/7/91

Complex Manager **Date**

4/8/91

Regional Office Review **Date**

Complex Staff: Wendy Tashiro, Jerry Leinecke, Kathy Castelo



Stewart Fefer

Ken McDermond, Ken Niethammer, Lynn Denlinger, Craig Rowland

Michael Moser

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 considers another 242,700 acres of submerged land to be within the Refuge. 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 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 Service 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

TABLE OF CONTENTS i

A. HIGHLIGHTS 1

B.CLIMATIC CONDITIONS 1

C. LAND ACQUISITION

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

D. PLANNING

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

E. ADMINISTRATION

1. Personnel.....24
2. Youth Programs.....24
3. Other Manpower Programs.....NTR
4. Volunteer Programs.....24
5. Funding.....25
6. Safety.....25
7. Technical Assistance.....26
8. Other Items.....27

F. HABITAT MANAGEMENT

1. General.....NTR
2. Wetlands.....29
3. Forests.....NTR
4. Croplands.....NTR
5. Grasslands.....NTR
6. Other Habitats.....30
7. Grazing.....NTR
8. Haying.....NTR
9. Fire Management.....NTR
10. Pest Control.....33
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.....35
3. Waterfowl.....36
4. Marsh and Waterbirds.....NTR
5. Shorebirds, Gulls, Terns, and Allied Species.....37
6. Raptors.....40
7. Other Migratory Birds.....NTR
8. Game Mammals.....NTR
9. Marine Mammals.....40
10. Other Resident Wildlife.....NTR
11. Fisheries Resources.....NTR
12. Wildlife Propagation and Stocking.....NTR
13. Surplus Animal Disposal.....NTR
14. Scientific Collections.....45
15. Animal Control.....45
16. Marking and Banding.....45
17. Disease Prevention and Control.....NTR

H. PUBLIC USE

1. General.....49
2. Outdoor Classrooms - Students.....NTR
3. Outdoor Classrooms - Teachers.....NTR
4. Interpretive Foot Trails.....NTR
5. Interpretive Tour Routes.....NTR
6. Interpretive Exhibits/Demonstrations.....51
7. Other Interpretive Programs.....NTR
8. Hunting.....NTR
9. Fishing.....NTR
10. Trapping.....NTR
11. Wildlife Observation.....NTR
12. Other Wildlife Oriented Recreation.....NTR

H. PUBLIC USE (Cont.)

13. Camping.....NTR
14. Picknicking.....NTR
15. Off-Road Vehicling.....NTR
16. Other Non-Wildlife Oriented Recreation.....NTR
17. Law Enforcement.....51
18. Cooperating Associations.....NTR
19. Concessions.....NTR

I. EQUIPMENT AND FACILITIES

1. New Construction.....NTR
2. Rehabilitation.....52
3. Major Maintenance.....53
4. Equipment Utilization and Replacement.....53
5. Communications Systems.....53
6. Computer Systems.....NTR
7. Energy Conservation.....54
8. Other.....54

J. OTHER ITEMS

1. Cooperative Programs.....56
2. Other Economic Uses.....NTR
3. Items of Interest.....NTR
4. Credits.....57

K. FEEDBACK

A. HIGHLIGHTS

U.S. Congressman from Hawaii,Daniel Akaka and aide Mike Kitamura, visit French Frigate Shoals on 27 May.

Refuge receives Federal Energy Efficiency Award for significant energy savings as a result of the Tern Island Photovoltaic system.

Eight member film crew shoots footage for three different films at French Frigate Shoals from 23 May until 13 July.

Honolulu, Star Bulletin reporter visits French Frigate shoals between 14 July and 6 August to gather information for a five installment article on life at FFS.

Representatives from the Marine Mammal Fund and Oceanic Society visit French Frigate Shoals from 1 to 4 September.

The first major break in Tern Island's deteriorated seawall occurs in October.

A second successful season of green sea turtle saturation tagging was completed at East Island, French Frigate Shoals.

An impartial assessment of the future of the Tern Island field station was conducted by a Service "Upper Level Management Trainee".

Sailing vessel MIMI runs aground at Pearl and Hermes Reef.

The first known successful monk seal pupping occurred at Tern Island.

B. CLIMATIC CONDITIONS

The portion of the Hawaiian Archipelago included in the refuge extends from Nihoa Islands (23° 03'N, 161° 55'W) to Pearl and Hermes Reef (27° 47'N, 175° 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 1989 Tern Island weather logs:

1989 WEATHER SUMMARY

Month	Mean Max. (F)	Mean Min.	Daily Mean	Wind Vel. (kt.)	Precip. (in.)
Jan	78.0	71.0	74.5	10.3	2.68
Feb	75.0	68.0	71.5	11.3	6.46
Mar	77.1	69.9	73.5	12.7	4.14
Apr	76.0	67.4	71.7	17.1	1.06
May	79.0	70.7	74.8	14.0	1.02
Jun	83.0	73.6	78.3	12.7	2.26
Jul	82.3	73.7	78.0	16.0	6.14
Aug	84.4	75.6	80.0	11.4	2.02
Sep	84.1	75.6	79.8	12.4	1.07
Oct	82.7	73.2	77.9	12.2	3.20
Nov	78.5	69.6	74.0	11.7	4.20
Dec	76.6	66.9	71.7	9.7	1.77
Monthly Mean	79.7	71.3	75.5	12.6	3.00

The hottest temperature recorded was 86.0 F. This temperature was recorded on 3 days in each August and September and on one day in October. The coolest temperature recorded was 63.0 F on 3 March and 5 and 6 April.

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 30 to 40 kt. were recorded in January and February.

Precipitation for 1989 was 36.02 inches. The highest rainfall occurred in February with 6.46 inches recorded. May had the least precipitation, with 1.02 inches recorded for the month. The highest daily rainfall total was 2.78 inches on 7 November. We recorded more than an inch of rain 10 times in 1989.

A review of annual precipitation figures for Tern Island since 1981 indicates a mean annual precipitation of 29.5 inches.

ANNUAL PRECIPITATION FOR TERN ISLAND,
FRENCH FRIGATE SHOALS 1981-1989

YEAR	TOTAL PRECIP.
1981	32.1
1982	37.4
1983	19.6
1984	32.7
1985	33.0
1986	33.0
1987	17.0
1988	25.1
1989	36.0
Mean Annual	29.5

Historical data collected during military occupation from 1954 to 1962 recorded a mean of 45.29 inches per year. These data indicate a 35% decrease for mean annual precipitation for the area. The noting of these drastic annual perturbations in rainfall and other climatic factors is of great significance to the management of the refuge.

Because managers are only able to make short visits to most of the Refuge islands, they often return with a snapshot view of habitat conditions. For managers who make trips to the islands over the course of several years, these climatic perturbations are realized to be an integral part of these insular ecosystems. Rainfall and severe storms events which cause over-washing of some *small* islets can significantly alter the appearance of an island. The lesson for managers is to be cautious with hands on management and with interpretations of short-term biological data.

D. PLANNING

1. Master Plan

The Master Plan for the Hawaiian Islands National Wildlife Refuge has been used as a guiding document for the management program on the Refuge. Many of the preferred alternatives have been implemented as funding and manpower becomes available.

2. Management Plans

Several management plans were scheduled for completion this year, but were not completed due to unexpected staff shortages.

5. Research and Investigations

Refuge staff coordinated and participated in numerous research projects in the Hawaiian Islands National Wildlife Refuge. Projects were conducted by a variety of agencies and personnel, including Refuge Staff. Tern Island, French Frigate Shoals, continued to be a year-round focal point for wildlife studies. A field camp was established on East Island, French Frigate Shoals by Service staff from 1 May to 3 September for the purpose of green turtle population monitoring Smithsonian Institution personnel established a field camp on East Island, French Frigate Shoals from 29 April to 27 June for the purpose of Hawaiian Monk Seal research.

Other islands within the Refuge were visited for varying lengths of time by researchers as described below.

Refuge personnel were unable to visit all islands because of limited funding. Expensive vessel charters or cooperation from other agencies are required to accomplish visits to all islands and neither of these methods were available this year. Important endangered species surveys were performed by other researchers through special conditions in Special Use Permits.

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 1989:

HWN-1-89-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 Hawaiian Islands National Wildlife Refuge.

Populations, phenology, reproductive success, and chick growth monitoring were conducted on a variety of species.

During 1989, on Tern Island, French Frigate Shoals, population and phenology data were collected for each above-ground nesting species at intervals equal to the mean incubation length. Previously, the total number of nests island-wide was used to calculate the number of breeding pairs. However, studies of three indicator species (black noddy, red-tailed tropicbird, and red-footed booby) revealed that the total number of nests is an inaccurate estimate of breeding pairs for some species. It is most difficult to assess populations of birds that are asynchronous nesters; have naturally high egg loss rates; are affected by severe weather; encounter interspecific and intraspecific competition for nesting sites; or are highly susceptible to predation or disturbance. The mean incubation length censuses are useful in collecting phenological data and the reproductive effort of each species. However, the total number of nests per year should not be used to estimate the number of breeding pairs for those species which are not determinate layers. Management studies are needed to determine the basic breeding biology of each species, i.e. the number of eggs laid per pair each breeding season.

Reproductive success and egg count studies of the three indicator species are based on study plots that are closely monitored for the entire season. These studies are used to accurately estimate reproductive, hatching and fledgling success. Along with the mean incubation length census totals, the reproductive success and egg count studies are used to arrive at a more accurate number of total eggs laid. An estimate of the minimum number of breeding pairs island-wide is made using the highest number of active nests at one time recorded on the mean incubation length censuses.

New methods were employed to test the feasibility of measuring chick growth of indicator species. These methods are less intensive and require fewer measurements than have been used in past growth monitoring. The hope is that these methods could be used on short visits to other islands within the Refuge. Data have not been analyzed to date.

In order to refine population census methods, incubation period data were collected on a sub-sample of each species breeding on Tern Island. This data will be used to insure that incubation period counts are as accurate as possible.

General natural history information is also collected on Tern Island. This information is systematically recorded for each species and reported at the end of the year in Species Account Summary Reports.

With the exception of red-footed booby and great frigatebird counts on Laysan Island, no other seabird monitoring was conducted on the Refuge this year.

HWN-4-89 Green Turtle Studies

During 1989, Service and NMFS personnel continued cooperative turtle monitoring efforts concentrated on French Frigate Shoals, the major Hawaiian green turtle nesting area. Censusing and tagging were also conducted on other islands and atolls in the NWHI by NMFS.

French Frigate Shoals: The general objectives of this multi-year study are to monitor nesting populations, nesting and hatching phenologies, hatching success, and avian predation of turtle hatchlings. In addition full season data collected from 1988 to 1990 will be used to refine parameters of the population estimating model developed by NMFS.

Tern Island: A major consideration in conducting turtle research on Tern Island is related to the condition of the seawall. The Tern Island seawall will need to be replaced, removed, or left to continue rusting away. Information on green turtle use of Tern Island (nesting and hatching phenologies, location of nests, numbers of turtles nesting on Tern Island, numbers of hatchlings produced, etc.) will be an important consideration in making a decision on the fate of the seawall.

On Tern Island, Refuge personnel monitored turtle nesting activity from 28 April through 27 December. Each morning Tern Island beaches were patrolled and any nesting activity (new nests or hatchling emergences) recorded. While females were coming ashore to nest, an additional beach patrol was conducted at about 2100 hrs. The objective of this patrol was to identify any nesting females encountered.

Hatchling emergence was monitored by observing each nest site starting about 50 days after the 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, extremes in incubation length have been 54 and 88 days.)

Five days after hatching, nests were excavated to determine clutch size and hatching success. Hatching success parameters were the number of addled/infertile eggs, dead embryos (1/4, 1/2, and 3/4 developed), dead fully developed hatchlings, live hatchlings trapped in the nest, and hatchlings that successfully emerged on their own (based upon the number of hatched egg shells in the nest).

At Tern Island, green turtles nested between 28 April and 28 September and hatchlings emerged between 19 July and 27 December. Visits to other islets showed that the nesting activity on Tern Island was representative of atoll-wide nesting activity. In 1989, 103 nest were located on Tern Island. All but eight of these nests were located on the south-facing shoreline. The exceptions were seven nests on Shell Beach and one nest on Crab Beach. Forty-two female turtles were identified attempting to nest on Tern Island.

During 1989, 101 of the 103 nests produced hatchlings. The mean incubation period for 99 nests with known lay and hatchling emergence dates was 70.5 days with a range of 59 to 97 days.

The mean clutch size was 89 eggs with a range of 44 to 127 eggs. Individual nest success ranged from 0 to 100%. Of the 9,170 eggs, 81.9% produced viable hatchlings (defined as the number of eggs that produced hatchlings that made it out of the nest alive). Of these, 224 or 2.4% of the total number of eggs were found trapped (still in the nest upon excavation). The percentage of bad eggs (rotten or infertile) was 12.5%.

The diet of 50 nestling great frigatebirds was checked during peak turtle hatchling emergence to augment 1989 data. The purpose of this investigation was to determine whether or not frigatebirds are a major predator of hatchlings at French Frigate Shoals. As in 1988 no evidence of turtle hatchlings appeared in any of the samples.

Bio-Aide Nakai and Volunteer Marshall pump the stomach of a sub-adult great frigatebird(KRN).

East Island:

East Island is the major turtle nesting site in French Frigate Shoals. It is estimated that 50% of the nesting in the shoals occurs here. East Island has been the main focus of research and population monitoring activities for at least the past decade. Data collected here are used in a model to estimate populations of nesting females for the entire atoll. This was the second season of a planned three season project to accomplish saturation tagging on the island. The results of this work will be used to refine the four parameters used in the population estimating model.

Basking female Hawaiian green turtles with temporary I.D. numbers on the beach at East Island, French Frigate Shoals (SIF).

Monitoring of green turtle nesting parameters began on East Island on 3 May. Tern Island staff accomplished the monitoring until 24 May when temporary bio-aides Nakai and Moser arrived. Monitoring continued throughout the season until 3 September for a coverage of 122 nights.

Data for the 1989 season have yet to be compiled.

HWN-6-89 Hawaiian Monk Seal Studies in the NWHI

Most of the research on monk seals in the Hawaiian Islands Refuge is conducted by personnel from the National Marine Fisheries Service (NMFS). Refuge staff have assisted in many aspects of this research including tagging, censusing, and resighting individual seals. During 1989, researchers from the Smithsonian Institute also conducted monk seal research involving studies of mother-pup interactions. This study is reported separately under HWN-8-89. The NMFS research activities conducted in 1989 are summarized below for each island of the refuge.

French Frigate Shoals: NMFS personnel and/or volunteers were present on French Frigate Shoals from 25 March to 4 September. Censuses were conducted regularly on all islets, and a total of 15 atoll-wide censuses were conducted. A preliminary summary of 7 atoll-wide censuses conducted in May and June gives a mean beach count of 317 seals.

Approximately 83 injuries were noted on seals in 1989. This total is preliminary because the data have not been examined to determine if some of the incidents are resightings of the same seal. Noteworthy were injuries which appeared to have been inflicted by boat propellers. Deaths of 31 seals were documented, including 7 pups which disappeared while nursing.

A minimum of 123 pups were born on eight different islets. Noteworthy was the first confirmed successful birth (survival to weaning) on Tern Island, as well as two births on Shark Island.

Female Hawaiian monk seal with pup. (RJS)

Five seals were known to have traveled from Laysan Island to French Frigate Shoals and two seals from French Frigate Shoals were sighted on Laysan.

Tissue plugs for DNA analysis were collected during tagging from 78 weaned pups. Organ samples and/or skulls were retained from 13 seals that died.

A total of 101 weaned pups were tagged with yellow temple tags in each rear flipper. An additional 48 older seals were retagged as necessary to replace lost or broken tags.

Five seals and one turtle were found tangled in wire, rope, net, and packing bands (each animal with a different type). Four of the seals and the turtle were released, and the remaining seal escaped unaided. One other seal was found on the Tern Island runway and was guided to the water, and one turtle was carried from the runway.

A total of 232 debris items from islets were inventoried, measured, and destroyed.

The Refuge staff at Tern Island have been counting Hawaiian monk seals hauling out on Tern Island beaches since 1979 when the Service began occupying the station there. In 1989 weekly surveys of monk seals were conducted. Table 1 summarizes counts up to 1989.

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	1988	1989
Jan	--	10.8	29.6	33.9	60.2	49.8	96.9	92.8	83.0	77.5	83.7
Feb	--	14.2	28.8	31.6	72.5	56.9	107.8	98.3	54.0	71.0	74.8
Mar	--	24.5	25.9	39.3	59.4	77.3	127.6	103.2	90.2	64.6	67.0
Apr	--	13.9	28.0	36.9	47.3	49.6	81.4	78.0	65.6	56.3	74.3
May	--	14.9	22.9	28.4	41.0	34.1	56.1	55.0	68.6	52.4	68.0
Jun	--	16.7	19.6	30.5	36.0	48.6	45.9	66.6	57.0	50.8	56.0
Jul	5.7	17.7	20.7	43.0	41.4	50.9	83.6	76.0	69.6	78.0	76.0
Aug	5.3	21.9	27.3	46.6	53.3	69.4	80.5	92.0	84.0	76.6	95.6
Sep	4.3	19.5	28.3	44.3	46.4	56.9	62.7	68.8	77.4	66.5	84.7
Oct	2.5	23.4	43.4	49.9	61.3	72.1	81.5	74.8	92.0	102.8	91.3
Nov	9.0	22.9	43.5	56.1	68.7	94.5	113.3	102.8	118.3	100.8	116.8
Dec	13.7	33.5	37.5	48.6	67.0	90.6	89.7	92.2	95.6	98.6	119.0
Annual Mean	--	19.5	29.6	40.8	54.5	62.6	85.6	83.4	79.6	74.7	83.9

The data shows a continuing increase in the number of seals using Tern Island since the Service began regular surveys until a peak in 1985. Mean monthly numbers have increased from 5.7 seals in July 1979 to a peak of 127.6 seals in March 1985. The annual mean number of seals using beaches at Tern dropped from 1986-1988, but was back near the 1985 high this year.

Populations throughout the atoll have increased only slightly between 1983 and 1988. Weaned pups are significantly smaller at French Frigate Shoals than at other locations, perhaps indicating the population is near its carrying capacity.

Laysan Island: NMFS personnel or volunteers were present on Laysan from 28 March to 17 July. Seal censuses were conducted regularly throughout the field season. Personnel also regularly patrolled the island perimeter to monitor injuries of seals, to document and photograph scarred seals, to identify parturient females, and to witness any mass attacks which may have occurred.

Deaths of 13 seals were documented. Causes included premature abortion (1), shark attack (1), adult male mobbing (4), adult male harassment (4), and unknown (3). Approximately 135 injuries were documented.

At least 33 pups were born, 32 of which survived to weaning.

Basking turtles were regularly counted during seal censuses, and tags were resighted opportunistically. At least nine turtle pits were documented between May and July. Tags were applied to two basking adult female turtles.

Twenty-nine weaned pups were tagged in the rear flippers with two each brown temple tags. Broken or missing tags were replaced on 11 immature seals. A total of 176 adult seals were bleach marked while sleeping.

Three adult female seals became entangled during the field season: one in a line w/fishing floats, one in a mass of net and ropes, and one in a small rubber tire. All seals were released without injury.

A total of 650 separate debris items from at least 465 different piles were inventoried, measured, and burned on the beach.

Lisianski Island: NMFS did not visit Lisianski Island in 1989.

Pearl and Hermes Reef: NMFS personnel or volunteers were on Pearl and Hermes Reef from 18 July to 1 August. Camps were established on Southeast and North Islands. Seal censuses of the entire atoll were performed as often as weather allowed small boat travel from Southeast to the southern islets within the lagoon. Eight atoll-wide censuses were completed. A preliminary tally reveals a mean count of 61 seals including pups.

No mortalities were observed, and only a single injury was documented to a juvenile male.

A minimum of 15 pups were born. Fourteen of these were tagged with blue plastic temple tags in both rear flippers.

No animals were observed entangled.

A total of 234 hazardous debris items were inventoried, measured, and burned.

Publications/reports resulting from Hawaiian monk seal research conducted on the Refuge that were published during 1989 include:

Alcorn, Doris J., and Elizabeth K. Buelna. 1989. The Hawaiian monk seal on Laysan Island, 1983. U.S. Dep. Commer., NOAA Tech. Memo. NMFS,NOAA-TM-NMFS-SWFC-124, 46p.

Becker, B.L. Morrow, R.J. 1989. Censuses and inter-atoll movements of the Hawaiian monk seal on Laysan Island in 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFC-124, 46p.

Reddy, M.C. 1989. Population monitoring of the Hawaiian monk seal (Monachus schauinslandi) and captive maintenance project for female pups at Kure Atoll 1987. NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFC-123.

HWN-7-89 Black Noddy Reproductive Biology, Tern Island, French Frigate Shoals

This study was conducted by Vanessa Gauger, Master's Degree Candidate, from the University of Hawaii-Honolulu. Research was conducted during 1987 and 1988 and concluded in 1989. Service personnel conducted research for Venice from October 1989 to March 1990, when Vanessa resumed research from March through August 1990.

Black noddy on nest. (SIF)

Primary objectives of the study were: (1) to study mate and nest-site fidelity, both throughout the season and from season to season, (2) to determine the maximum number of nesting attempts by a pair per season, and the percentage of successful attempts, (3) to find out how many pairs successfully raised two chicks per year, and (4) to determine aspects of the species' reproductive life history, including length of incubation and brood shifts, frequency of parental feeding of the chick, and post-fledgling feeding duration.

Methodologies used to accomplish the objectives were color banding and marking adults and color banding hatch-year chicks, interval nest checks, and band reading island-wide.

Of the 74 study pairs which could be accounted for in 1989, 64 pairs retained the same mate from 1988. Of those that retained the same mate, 42 pairs remained at the same nest site as last year, and 22 pairs moved as a pair to a new nest site.

This demonstrates that black noddies maintain fairly strong nest site and mate fidelity.

One study adult was found dead, leaving one known "widowed" bird. Of the 9 remaining pairs, which "split" (did not retain the same mate), there were 3 pairs in which only one of the adults of the pair was spotted this year. These 3 may thus have been either widowed or abandoned.

In four of the six split pairs, in which both adults had been seen this year, both partners had acquired a new mate. Only one of the mates of each of the remaining 2 pairs had re-mated.

Preliminary results indicate that in the period from November 1988 through August 1989, one pair fledged three chicks. An additional two pairs fledged two chicks each pair, and had begun their third clutches. Another adult was recorded as fledging three chicks in this period; however, its mate was not identified for the first clutch.

Twenty pairs were documented as fledging two chicks per pair in 1989, while six additional pairs had fledged one chick and had begun their second clutch, at the end of the data collection period. Forty-four pairs fledged just one chick, and the remainder of the pairs were unsuccessful at fledging any chicks.

If data collection had been continued throughout the late summer and fall of 1989, the number of pairs documented to fledge two or three chicks would have most likely been higher. This is because nesting continued throughout this period, at a much higher rate than during the June - September period in the previous two years of study.

HWN-08-89 Maternal Care Behavior of the Hawaiian Monk Seal (Monachus schauinslandi) on East Island, French Frigate Shoals.

This was the third year of a project to study the maternal behavior of Hawaiian monk seals. The project director was Dr. Daryl J. Boness of the Smithsonian Institution's National Zoological Park and conducted by Damon Job and John Francis.

The major objective of this year's work was to study the proximate causes of fostering behavior and particularly the role of individual vocal recognition. Summary of this work is not yet available. A summary of the overall project follows.

Fostering behavior was abundant at both East and Laysan Islands relative to its occurrence in most other mammals. The level at East Island, however, was nearly double that at Laysan. Concomitantly, the extent to which females fostered was also much greater at East Island. A major proximate factor contributing to fostering is probably the propensity for lactating females of this species to be

dispersed. Because of their movements in and out of the water, even at the low densities at which they occur, female-pup pairs are occasionally in close proximity to one another. These situations often lead to aggressive encounters that presumably lead to confusion and switching of pups. Where the density is higher (e.g. at East Island) females end up within a few meters of each other more often and hence exhibit a higher frequency of fostering.

Despite the expectation form theory that fostering behavior is likely to be detrimental to a female's offspring, this does not seem to be the case in this species. Estimates of reproductive success (suckling duration of pups, size at the end of weaning, and survival to one year of age) don not correlate with the extent to which females foster. Nevertheless, some individuals may be weaned prematurely as a result of not being cared for exclusively by their own mothers. On the other hand, other individual become "super pups" by virtue of extending suckling for more than a month over what they would have if they had been with their own mothers exclusively. It does not seem likely that the mean size differences in weanling pups a French Frigate Shoals can be attributed to fostering, nor more generally does fostering appear to reduce overall pup survival.

HWN-09-89 Assessment of Sexual Reproductive Condition in the Reef Coral Genus Acropora at French Frigate Shoals.

Jean Kenyon worked at French Frigate Shoals from 26 May to 27 July. She was supported by an assistantship with Moana Productions and by volunteering for the Refuge. Jean is working towards a Ph.D. in the Zoology department at the University of Hawaii.

The objective of this work was to test the hypothesis that three species of the reef coral genus Acropora (A. cytherea, A. valida, and A. humilis) occurring at French Frigate Shoals, sexually reproduce by the broadcasting of gametes during the late spring or summer. Limited previous investigations reached the conclusion that successful production of larvae by Hawaiian Acropora was unlikely.

The results of this study demonstrated that the three species in question are reproductively mature at French Frigate Shoals. Reef flat colonies of Acropora valida spawned between July 1 and July 9, most closely aligned with new moon. Colonies of Acropora valida at La Perouse Pinnacle spawned between July11 and July 27. A single colony of A. humilis found at La Perouse Pinnacle spawned between June 6 and June 14, most closely aligned with first quarter. Lunar period of spawning for reef flat A. valida and for A. humilis differs from other regions where these species have been studied. Clear patterns regarding time of spawning and degree of synchrony between colonies for A. cytherea do not emerge from the more limited data, yet strong evidence for sexual reproductive maturity exists from this species as well.

Results of the present study, based upon both larger sample size and a finer time regime of sampling, clearly refute previously published information, and therefore call into question further conclusions which derive from such a basis.

In Hawaiian waters, Acropora occurs exclusively within the boundaries of the Hawaiian Islands National Wildlife Refuge. From the standpoint of Refuge management, results of the present study ecologically support the present division of Hawaiian Islands NWR and Johnston Atoll NWR into two distinct management units, in regards to the unique occurrence of Acropora in the Hawaiian Archipelago.

HWN-11-89 Space Utilization Patterns of Gray Reef and Tiger Sharks

This study was conducted by Wesley R. Strong, a shark researcher from California State College, Long Beach. The work was conducted from 23 May to 13 July in conjunction with filming activities of Moana Productions at French Frigate Shoals.

The main objective of the study was to conduct a detailed investigation of the relationships and ecology of gray reef sharks, tiger sharks, and fledgling albatross near East Island. Work was conducted from boats, reef platforms, and underwater.

The following are results of this work:

Packs consisting usually of 12-24 female gray reef sharks inhabited the East Island enclosure for ca. two months until 9 June. The sharks averaged ca. 150 cm in length and appeared pregnant. One individual was captured and dissected on 31 May. She contained five early-term embryos. Concerning reports that pregnant sharks do no feed, it should be noted that these sharks responded appetitively to olfactory and auditory stimuli and fed vigorously. Within several days of the first albatross fledgling departures at East Island, the gray reef shark packs were no longer observed to enter the adjacent micro-lagoon. Shortly thereafter, on 15 June, the first tiger shark was observed in the area and it killed an albatross. the number of tiger sharks observed at East Island increased in the days that followed.

Tiger shark at French Frigate Shoals. (Rocky Strong)

Of 502 fledglings that entered the water adjacent to East Island, 101 (20.1%) were attacked by tiger sharks. Forty-seven (9.4%) of the birds were killed and 54 (10.8%) escaped, either by flying back to East Island or by continuing offshore. An additional 22 kills were observed, but are not included in calculations of fledging success rate because, on a number of days, other activities limited data taking mainly to birds that were attacked. A total of 138 attack episodes were observed. Exactly one-half were successful kills.

Shark presence in the semi-enclosed embayment was directly related to the number of fledging departures. Tiger shark sightings were rare on days when weather conditions did not facilitate fledgling take-offs.

Seven different tiger sharks were identified based on scars etc. Tiger sharks typically feed during crepuscular periods and nighttime. Tigers at East Island continued to feed into the afternoon hours. The sharks seemed to ignore turtles, seals, and divers, responding almost exclusively to birds.

Much more information is needed to determine whether tiger shark predation is a significant vehicle of natural selection in albatrosses. The fact that sharks killed ca. 10% of the fledglings observed leaving East Island warrants further investigation.

HWN-13-89 Endangered Passerine Research

The purpose of this research was to continue to conduct descriptive and comparative morphometric studies of endangered passerines. Other work included studies of growth rates, survival, and inheritance of morphological characters, completion of studies of feeding behavior including studies directed at comparing the two finch species, identification of habitat requirements, and examination of causes of morphological variation.

Sheila Conant from the University of Hawaii has been the principal investigator conducting this work for the past several years. She was on Laysan Island for a half day on 17 July. Most of her work was at Pearl & Hermes Reef where she worked on various islets from 18 July to 1 August. Base camp was at Southeast Island.

The only activity on Laysan was sample quadrats for density of Eragrostis variabilis.

Activities at Pearl and Hermes Reef included capturing, banding, measuring, and observing Laysan finches. Finch censuses were conducted on Southeast, North, Grass, and Seal-Kittery Islands. A total of 104 were captured. Twenty-six of these were recaptures from previous years.

HWN-14-89 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, fed until they were in good condition and self-feeding, and then they were released. 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 Atoll 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. 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 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.

No pups were collected from the Refuge for rehabilitation during 1987. At least two candidate pups, 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.

During 1988, NMFS removed 8 seal pups from French Frigate Shoals for rehabilitation purposes. Three of these pups died during rehabilitation efforts in 1988, and the remaining 5 pups were being maintained at the NMFS Kewalo Research Facility at the end of the year.

Early in 1989 two of the 5 remaining pups died in Honolulu. The remaining three were transported to Kure Atoll in May and released shortly thereafter. Two of these were resighted regularly during 1989.

Three undersized female pups were collected from French Frigate Shoals in 1989. All three are currently being held at Sea Life Park. They are in good condition and are self-feeding. The pups await transport to Kure Atoll in early 1990 where they will be maintained in an enclosure until they are observed catching and consuming live fish. The pups will then be released.

HWN-15-89 Ecology of Bristle-thighed Curlews

This was the second year of this study. The principle investigator was Roland Redmond from the University of Montana Cooperative Wildlife Research Unit. The primary field investigator, who also is using this research to complete Ph.D requirements at the University of Montana, was Jeff Marks.

The primary objectives of this study were to:

A) Estimate numbers of curlews (by age class) present on Laysan during the summer.

B) Estimate the minimum proportion of ASY curlews on Laysan that forego a northward migration to Alaska.

C) Monitor the timing of the fall migration of ASY and HY curlews from Alaska, and evaluate the duration of stopover by ASY migrants.

D) Complete the description of the second prebasic wing molt of SY curlews and determine if, and for how long, individuals of this age class become flightless.

E) Evaluate habitat use and local movement patterns of SY and ASY curlews during the study period.

F) Collect blood samples from two curlews of each sex for use in developing a non-invasive method of sex determination by DNA hybridization techniques.

Marks visited Tern Island from 13 June to 19 June. He was on Laysan from 28 June to 8 September. Redmond joined him on Laysan on 17 July and also remained until 8 September. There were complications when leaving Laysan involving the chartered vessel FORTUNA. It was not fully capable of off loading all the gear. It ran low on fuel and its landing craft was inadequate. For this reason most of the field gear was left on the island. Refuge staff insisted that the gear be removed as soon as possible. Marks returned via the vessel GOLDEN EAGLE on 9 November to retrieve the remaining equipment.

Dr.Redmond prepares to release a color banded bristle-thighed curlew. (Jeff Marks)

Significant preliminary results include the following:

Captures: Eighty-five different birds were captured on Laysan during 44 nights of trapping. Fifty-one of these were first time captures and 22 were recaptures of birds banded in 1988.

Longevity: Two birds captured in 1989 were banded by researchers in the 60's. The age of both of these birds was about 22 years 1 month. These two individuals are by far the oldest known scolopacids in North America and apparently the third and fourth oldest in the world.

Timing of southward migration: Curlews banded in 1988 began arriving on Laysan on 18 July. Fifteen color banded ATYs arrived between 18-24 July. By 15 August, 34 marked ATYs had been seen on the island, and 27 more were seen between 16-23 August. Based on flight speeds of 50-80 km/hour, it would take curlews 2-3 days to make the 3,800 km flight from the Yukon-Kuskokwim Delta to Laysan. Therefore, the first of the adult migrants probably left Alaska on 15 or 16 July and the first HYs on 26 or 27 August.

Duration of stopover: Preliminary observations indicate that there is little turnover of migrating adults that set down on Laysan during late summer.

Populations: Population estimates ranged from 127-449 birds overall. About 350 curlews were estimated to be on Laysan by early September.

The following was published as a result of additional work completed by the above permittee:

Marks, J.S. and P. Hendricks. 1989. On the flushing behavior of incubating white terns. Condor 91:997-998.

HWN-16-89 Age-Related Effects on the Reproductive Success of Red-footed Boobies, Tern Island, French Frigate Shoals.

This study was conducted by Darcy Hu, Service Wildlife Biologist and Master's Degree Candidate, from the University of California at Davis. Research was conducted from December 1988 through August 1989. No summary information is available to date.

Biologist Hu attempts to catch a red-footed booby at Tern Island. (DKM)

E. ADMINISTRATION

1. Personnel

	CS	Full-Time	Part-Time	Temp.	Total
CY-87	1	6	-	4	11
CY-88	1	4.3	-	5	10.3
CY-89	-	4.3	-	4	8.3

Ken McDermond, Assistant Refuge Manager received an upgrade from GS-9 to GS-11 in March.

Glynnis Nakai was hired as a temporary Biological Aide to assist with a cooperative (Service/NMFS) study of green sea turtle nesting at French Frigate Shoals. Michael Moser who was already on staff as a temporary Biological Aide in Honolulu was sent to French Frigate Shoals to assist with this project as well.

Tern Island Assistant Manager Denlinger transferred to Alaska on 7 June. The position was vacant for the remainder of the year.

Darcy Hu was on leave without pay status while attending the University of California at Davis from August to December. She was on Tern Island from January to July assisting with station operation and conducting research for her Masters Thesis.

Temporary Intermittent Biological Technician Dick Bauer assisted with operation of the Tern Island field station from March to May.

The reduction in total employees was a result of an administrative separation of Midway Atoll NWR from Hawaiian Islands NWR and one employee being covered by Midway. Maura Naughton who was a career seasonal on leave without pay status, completed her Masters Degree and was hired by William Finley NWR.

2. Youth Programs

Lack of funding and personnel to offer continuous supervision to the work crew precluded a YCC program at Tern Island during 1989.

4. Volunteer Program

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 staff were on leave. An ongoing effort has been made to fully utilize the experience, training, talents, and interests of volunteers during their stays.

Volunteers Jennifer Megyesi, Mike Fedorko, Jean Kenyon, Mark LaBarr, David Kuwahara, Venice Gauger, Robert Cummins, Alyce Reuter, Kris Moser, Annie Marshal, Sally Keefer, and Scott Hall conducted seabird and green turtle studies, banded seabirds, conducted Hawaiian monk seal censuses, maintained data files, and provided assistance to the staff and visiting researchers. Volunteers also assisted with maintenance and operational tasks.

Volunteer Megyesi measures the carapace of a young green turtle caught at Tern Island. Young turtles are captured, measured, and tagged to gain information on growth rates. (KRN)

5. Funding

The Hawaiian Islands National Wildlife Refuge is part of the Hawaiian/ Pacific Islands National Wildlife Refuge Complex. During 1989, the Refuge Complex in Hawaii received a $500,000 congressional add-on to the budget appropriated by the Service. The base budget is divided among the Refuges in the entire complex. The Hawaiian Islands National Wildlife Refuge received approximately $286,000 of funding in FY88.

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 to 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 for advice as needed over the radio. Dr. Nakasone provides medical advice to Tern Island staff when they have problems on Tern. He also provides assistance in evaluating Tern Island drug and first aid 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.

7. Technical Assistance

Refuge staff provided logistical support and technical advice on necessary mechanical repairs to NMFS 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 one trip to Tern 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 the University of Hawaii tide gauge and performed regular and emergency maintenance.

Technical assistance was provided to locally fishing vessels in the form of relay messages to Honolulu offices or to the U.S. Coast Guard.

8. Other

Congressman Daniel Akaka and Congressional Aide Mike Kitamura visited French Frigate Shoals in late May. They came to get first hand knowledge of our program and to view the deteriorating seawall. They were introduced to ongoing avian, seal, and turtle studies. They observed the film crews at work filming some of their shark footage. In addition to a thorough tour of Tern Island and the facilities there, the congressman and his Aide were shown several of the other islets within the atoll as well as the East Island turtle study/Smithsonian camp.

L to R Mike Kitamura (Congressional Aide), U.S. Congressman Dan Akaka, Complex Manager Fefer, and Dave Vogel on tour of Tern Island. (DKM)

Refuge Manager Fefer submitted an assignment proposal early in the year for potential completion by a participant in Upper Level Management Development Program. The assignment title was: Analysis of alternatives for U.S. Fish and Wildlife Service operation of Tern Island.

The project was chosen and in May Service employee Dave Vogel visited Honolulu and Tern Island to collect information for the assignment. As part of his training he was assigned the project of conducting a comprehensive review of the Tern Island field station. He was to develop options for shore stabilization, Service operation of the field station, analysis of the associated costs, and a recommendation for the appropriate course of action relating future operation of the station.

Although Dave was a Service employee (fisheries), he had not been intimately involved in Refuges and so was able to make a fairly unbiased review of the situation.

In September Dave submitted a report entitled: Evaluation of U.S. Fish and Wildlife Service operations on Tern Island in the Hawaiian Islands National Wildlife Refuge: Recommendations for a long-term course of action, and an accompanying video. Both products were of high quality and provided a good overview of the Tern Island operation. The report provided 3 Options or scenarios for the future of the station. These were 1)Abandonment or seasonal operation, 2)Status Quo, and 3)A 10-20 year plan which was the recommended course of action.

Important aspects of the Recommended Course of Action were:

1. Repair of the shore stabilization system.

2. Determine the extent of debris and contamination within the island.

3. Remove harmful debris and contaminants from the island.

4. If after 10-20 years the station is no longer required, and if debris has been cleaned up then the shore stabilization should be removed and allowed to revert to a natural state.

Vogel also had specific management recommendations for the future. These included:

1. Continue to conduct and support research and recovery actions for Hawaiian monk seals and green sea turtles.

2. Obtain radar equipment to monitor vessel traffic in nearby waters.

3. Locate, remove, and destroy marine debris endangering wildlife.

4. Utilize graduate students and volunteers to conduct seabird research.

5. Prioritize endangered species research efforts so that work requiring the use of Tern Island facilities is conducted over the next 10-20 years.

6. Conduct regularly scheduled inter-agency coordination meetings.

7. Allow limited controlled access to Tern Island by national conservation and environmental groups to develop public awareness and constituent support.

8. Rename the Hawaiian Islands National Wildlife Refuge to more accurately reflect the location and minimize confusion.

The Refuge staff greatly appreciated the efforts of Mr. Vogel. His appraisal of the Tern Island operation was fair and accurate and his recommendations were well thought out.

The Refuge is presently working towards solution of the shore stabilization problem.

F. HABITAT MANAGEMENT

2. Wetlands

The Hawaiian Islands National Wildlife Refuge 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 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 1989, studies of the lake were limited to Laysan duck surveys (Sec.G.2).

6. Other Habitats

Tern Island: Sooty terns continued to nest in great numbers on Tern Island, and measures to minimize bird strikes by aircraft were enforced prior to the nesting season. This included removal of vegetation from the east and west ends of the runway and removal of sooty tern nests on the runway.

Assistant Manager Niethammer scarifies west end of Tern Island runway to discourage nesting by sooty terns. (SIF)

Helene Takemoto and Tom Litke from the Army Corps of Engineers visited Tern Island in September 1988. The purpose of their visit was to survey French Frigate Shoals for presence of abandoned military debris. The Corps of Engineers (COE) manages the environmental restoration activities at closed or formally owned installations using funds from the Defense Environmental Restoration Account (DERA).

Of prime concern to the refuge is the steadily degrading seawall at Tern Island which was constructed by the Navy during World War II. In the course of the COE survey twenty 5,000-gallon underground storage tanks were discovered along the north side of the Island.

In June of 1989 Assistant Manager McDermond completed a draft report entitled Historic Ownership Patterns, Wildlife, and Related Resources of East and Tern Islands, French Frigate Shoals, Hawaii: The Effect of Military Debris and Alternatives for the Future. The Refuge received $18,400 from the Corps of

Engineers to prepare the document. The report was necessary to substantiate the fact that the Department of Defense had actually been responsible for the debris on Tern Island. The Corps plans to use the report and their own engineering assessment to request DERA funds to cleanup the island. The Corps had not completed its report at the end of 1989.

The degradation of the refuge seawall continued during 1989, with a major break occurring in October 1989. The break is located on the north side, approximately 26 feet east of the western-most corner of the island. The break was approximately 18 feet in length in October and extended approximately 12 feet southward toward the runway. A buried diesel tank was exposed by sea water, and the tank was emptied of fuel by refuge staff. By December 1989, the break had widened to approximately 25 feet west to east and to 20 feet from north to south, exposing all four sides of the diesel tank and allowing sea water to rush in behind the wall and to the western corner. An attempt to block water from eroding away the western corner was made using pieces of broken cement. This has stopped the progression of water westward, but erosion continues southward and eastward. Furthermore, the integrity of the seawall on the entire north side continued to deteriorate during 1989. At high tide, water is able to pass through the crumbling seawall and form large pools on the other side. The weight of water against the inside of the wall causes it to bow out and collapse into the ocean, creating further risk of entrapment to seals, birds and turtles. During 1989, three seals and two turtles became trapped behind the dilapidated north seawall. All five animals were removed from behind the wall unharmed.

Degraded sheet pile sea wall at west end of Tern Island. (DKM)

Aerial photographs of Tern Island were taken by Service personnel from Service chartered aircraft in order to better monitor changes in vegetation and shoreline profile as well as to be used for producing base maps of the island.

Infra-red aerial photo of Tern Island. (KRN)

Laysan Island: Laysan Island had been modified extensively by human activity during the latter 19th and beginning of the 20th century. Guano mining and defloration 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 the 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 2,700 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 lake side 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.

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. A new section of fence was erected in 1988 to connect the S end of the innermost fence to the S end of the middle fence, in an attempt to stop the wave of sand that was encroaching here.

Aerial photos were taken of the blow-out area and the entire island in August. Photographs were also taken by the Curlew researchers from the photo points established in 1988. After viewing the photographs, the following conclusions were reached:

1. Dune formation around the 1988 drift fence was not significant.

2. Vegetation in the area leeward of the 1988 drift fence appeared to be recovering (mostly with Eragrostis).

3. Sand appears to be blowing around the South end of the 1988 drift fence causing devegetation of an area Southwest of the fence. The 1988 fence was erected to prevent sand from blowing around the South end of the inner fence which was causing devegetation. It appears that the problem has been moved Southward; the 1988 fence allowed the vegetation between it and the lake to begin to recover while at the same time, seemed to cause devegetation further down the lake shore.

4. Significant revegetation has occurred in the original blow-out area so that the entire gap along the lake shore is now becoming revegetated with Eragrostis, Ipomoea or Scaevola and hopefully will continue to do so.

10. Pest Control

Pest control in the Hawaiian Islands National Wildlife Refuge 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 1989, pest control primarily involved implementing procedures to prevent the introductions of exotic organisms. Also during visits to the refuge, the status of exotic organisms is monitored.

Bio-aide Moser developed field vegetation manuals to assist Refuge staff in monitoring status of native vegetation and possible presence of exotic species on island.

On Tern Island, efforts to eradicate sandbur (Cenchrus echinatus) began in November 1988. This exotic noxious weed was spreading rapidly and growing in large dense clumps that were choking out endemic vegetation. By June 1989, all existing sandbur plants had been pulled. Seed heads were disposed of through incineration to prevent germination. Since then, Tern Island has been patrolled every two weeks and sandbur sprouts pulled. These patrols will have to continue until the reservoir of seeds is used up.

Plans for the eradication of the weed on East Island (the only other island at French Frigate Shoals where sandbur is found) were discussed.

Sandbur was also reported as becoming extensive on the west side of Laysan Island by the researchers who visited the island during the year.

An increase in the ant population on Tern and Laysan Islands was observed during 1989. Many birds were found covered with ants, and Laysan finch, brown noddy and red-tailed tropicbird chicks were found dead or dying and covered with ants. Ground nesting species were observed deserting their nests in some cases where ants swarmed over the birds and the chicks or eggs. Two species of ants were identified, and plans to census the island for other species were discussed.

The islands of the Hawaiian Islands National Wildlife Refuge 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 Island chain serves to warn us about introduction of rat species on Refuge islands. Introductions of alien plants have caused problems on Southeast Island, Pearl and Hermes Reef and Sand Island and Midway Atoll where introduced plants 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 land birds. 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 the 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. 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.

G. WILDLIFE

2. Endangered and/or Threatened Species

The islands within the Hawaiian Islands National Wildlife Refuge 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 the Laysan finch 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 and degrading endangered species habitat.

3) Movement of all personnel on Tern Island is restricted to areas not frequented by seals and turtles.

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 Service and the National Marine Fisheries Service.

The Hawaiian Islands National Wildlife Refuge has only one resident waterfowl species, the Laysan duck. It is an endemic and endangered species, inhabiting a hypersaline lake on Laysan Island. During 1989, Laysan duck populations were surveyed from July to September by the curlew researchers. The largest count was 299 birds (including hatch-years) on 5 September. This count was lower than the 345 sighted on 18 October of 1988. It is possible that many females were still

going through molt and thus less likely to be seen. Observations of reproductive activity included a sighting of 11 broods on 2 July.

A Laysan finch survey was conducted on 28-29 July in 1989. A total of 310 birds were counted on the survey transects, resulting in an estimate of 10,536 finches +/- 1792. This count was higher than both of the 1988 surveys. This years count was conducted during the breeding season and likely includes some hatch year birds.

At Pearl and Hermes Reef transect censuses were conducted on each island where the Laysan Finch occurs. The censuses were carried out by Dr. Sheila Conant under conditions of her Special Use Permit on 21, 22, and 27 July 1989. The following are estimates derived from these censuses:

ISLAND	POPULATION ESTIMATE
Southeast	119
North	56
Grass	30
Seal-Kittery	29
Total Atoll Estimate	234

This count was only 1 bird higher than the 1988 count, but showed a different distribution. Fewer birds were on Southeast in 1989 with more birds on all the other islets. Observation by Dr. Conant revealed that nesting activity was in progress, and fledged chicks were present.

Budget shortfalls prevented a trip to Nihoa Island in 1989, so censuses of Nihoa finches and millerbirds were not obtained.

Assistant Manager McDermond was appointed to the Hawaiian monk seal animal care committee. This committee was established under requirements of the Department of Agriculture to review all aspects of the captive monk seal program.

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 Endangered and/or Threatened Species section (section G.2) above. Accounts of vagrant waterfowl are given in section G.5 below.

5. Shorebirds, Gulls, Terns and Allied Species

The Hawaiian Islands National Wildlife Refuge 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, and chick growth rates, are collected from black noddies, red-footed boobies, and red-tailed tropicbirds on Tern Island and at seasonal field camps when possible.

Masked booby. (CR)

In 1989, breeding birds (i.e. the number of nests) were censused on Tern Island based on two monitoring techniques. All above-ground nesters were censused on mean incubation length intervals. To test the accuracy of this census method in determining the total number of breeding pairs per year, three species were monitored every other day: black noddy, red-tailed tropicbird and red-footed booby, and nest totals were compared for these three with the totals obtained on the mean incubation length censuses. In addition, a management study was conducted by Fish and Wildlife personnel on Tern Island to gather base-line breeding biology data on the white tern. The management study and the every-other-day (reproductive success and egg count studies) census techniques showed that the mean incubation length counts greatly underestimated the number of eggs laid each breeding season for species with the ability to relay after failure and

with naturally high egg loss rates, or during times of severe weather. The management study on the white tern revealed that in totaling the number of eggs laid per year, an inaccurate number of breeding pairs may be obtained. A Master's thesis project conducted by Venice Gauger of the University of Hawaii on the black noddy also revealed an inaccurate estimate of the total breeding population using the total number of eggs laid annually. Table 2 shows an estimate of the number of nests or minimum number of breeding pairs on Tern Island at one time during 1988 and 1989, based on mean incubation length censuses. Table 3 shows the number of eggs laid island-wide for four species, calculated by extrapolating the total number of eggs laid within the reproductive success and egg count study plots, in comparison to the number of active nests at one time. As the table shows, the number of breeding pairs cannot be derived from the total number of eggs laid annually with accuracy for those species which are non-determinate layers. It is important for managers to take into consideration the basic breeding biology of the species being monitored, as well as other factors (i.e. weather, interspecific interactions, susceptibility to disturbance,etc.) which might affect the reproductive success of that species, to arrive at an accurate estimate of the number of breeding pairs.

TABLE 2. Estimate of the minimum number of breeding pairs, based on the highest umber of active nests at one time on Tern Island, F.F.S, 1988-89.

Species	Minimum # Breeding Pairs (month highest count occurred) Year 1988	1989
Black-footed albatross	451 (Dec)	516 (Dec)
Laysan albatross	990 (Dec)	1060 (Dec)
Red-tailed tropicbird	499 (May)	513 (May)
Red-footed booby	932 (May)	1133 (Feb)
Masked booby	0	0
Great frigatebird	395 (Jun)	573 (Jul)
Gray-backed tern	345 (May)	332 (May)
Sooty tern*	---	---
White tern	46 (Mar)	48 (Apr)
Brown noddy	1137 (Apr)	1384 (Apr)
Black noddy	1170 (Feb)	1600 (Dec)

* breeding pairs not estimated

Table 3. Comparison of the Total Number of Eggs Laid and the Highest Number of Nests Active at One Time on Tern Island, F.F.S During the 1989 Breeding Season, Based on Reproductive Success and Egg Count Studies.

Species	Number of Eggs	Number of Nests
White Tern	211	48
Red-tailed tropicbird	1685	513
Red-footed booby	1830	1133
Black Noddy	4313	1600

Table 4 shows an estimate of breeding birds atoll-wide, based on the highest number of nests encountered at one time (irregular visits were made to the outer islands throughout the year). Again, this table more accurately estimates the number of breeding pairs for those species which are determinate layers, such as the Procellarids.

An estimate of the current numbers of breeding pairs and their distribution for the entire Northwestern Hawaiian Islands is presented in Table 5. 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.

Island-wide shorebird counts were conducted throughout the year on Tern Island during 1989. A summary of the species and numbers are presented in Table 6.

The following vagrant and overwintering species were observed at French Frigate Shoals in 1989:

Red-billed tropicbird	Cattle egret
Hawaiian coot	Blue-gray noddy
Lesser frigatebird (2)	Ruff
Northern pintail (3)	Glaucous-winged gull
Semi-palmated plover	Western sandpiper

The following vagrant and overwintering species were observed on Laysan Island in 1989:

Streaked shearwater	Lesser yellowlegs
Little tern	

6. Raptors

An immature female osprey was sighted on Tern Island, F.F.S during 1989. The bird was seen roosting on the island from October through November.

9. Marine Mammals

Spinner and Bottlenose dolphins are seen regularly at French Frigate Shoals.

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

Table 4. Estimate of the minimum number of nests atoll-wide 1988/1989, at F.F.S.

Species	Gins	Whaleskate	Trig	East
Black-footed albatross	190/146	2244/1735	31/1	3294/2009
Laysan albatross	0/0	376/234	4/0	1271/981
Great frigatebird	0/0	37/2	0/0	3/0
Red-tailed tropicbird	0/0	4/0	0/0	0/0
Red-footed booby	0/0	13/13	0/0	0/0
Brown booby	0/0	0/0	0/0	0/0
Masked booby	21/19	269/194	16/10	62/60
Brown noddy	9/5	575/539	0/0	176/362
Grey-backed tern	0/0	0/0	0/0	1/8
Tristram's storm-petrel	0/0	0/0	0/0	---/3

TABLE 5. 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 5. ESTIMATE OF BREEDING PAIRS OF SEABIRDS, NORTHWESTERN HAWAIIAN ISLANDS (continued)

	Location				
	Lisianski Island	Pearl and Hermes Reef	Midway Islands	Kure Atoll	Total
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	1,673,759

Table 6. Results of 1989 bi-weekly shorebird census on Tern Island, French Frigate Shoals.

	DATE OF COUNT																									
Species	1/6	1/21	2/6	2/20	3/4	3/17	3/31	4/14	4/28	5/12	5/31	6/9	6/25	7/7	7/25	8/4	8/21	9/5	9/15	9/29	10/13	10/27	11/12	11/24	12/08	12/22
Ruddy turnstone	369	454	470	451	526	449	423	461	371	225	52	55	52	66	95	120	422	614	540	698	605	565	647	586	574	620
Lesser golden plover	39	57	50	49	29	31	46	45	50	12	7	6	9	7	3	9	91	140	146	153	214	147	101	61	62	67
Sanderling	5	2	0	2	5	3	5	1	2	3	0	0	0	0	1	1	1	5	2	3	2	2	3	3	4	2
Wanderling tattler	1	3	0	3	2	0	0	2	3	2	2	3	0	1	1	2	5	4	1	2	3	5	1	2	1	4
Western sandpiper	1	1	0	1	1	1	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bristle-thighed curlew	10	7	12	10	12	9	6	9	6	5	4	5	2	6	2	6	12	16	11	10	12	12	9	11	9	9

14. Scientific Collection

Educational institutions such as universities, conservation organizations, and museums find the Hawaiian Islands National Wildlife Refuge a valuable resource for salvaged specimens of endemic and indigenous wildlife species. The refuge also makes fresh specimens available to the National Wildlife Health Center for diagnosis. Bird specimens salvaged in 1989 as skins, skeletons, frozen carcasses and eggs from the refuge (all from French Frigate Shoals) were the following : (numbers of specimens in parenthesis)

Laysan Albatross (1)	Brown Booby (2)
Sooty Tern egg (9)	White Tern egg (2)
Sooty Storm Petrel (1)	Red-footed Booby (1)
Great Frigatebird (2)	

The Refuge did not conduct any scientific collecting during 1989.

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 provided technical assistance to U.S. Department of Agriculture, Animal Damage Control personnel in their efforts to discourage nesting and roosting of Laysan albatross on and near airfields in Hawaii.

16. Marking and Banding

A variety of animals are marked, tagged, and/or banded annually on the Refuge Islands. Hawaiian monk seals are tagged as part of the monk seal research project conducted primarily by NMFS research program. Green turtles are tagged as part of a cooperative effort between the FWS and NMFS. Data on monk seal and green turtle tagging are presented in the discussion of these projects 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. At French Frigate Shoals, most of our seabird banding effort is directed towards banding chicks produced on Tern Island. The goals of our seabird banding program are : 1) to provide some fledging success data; 2) establish known age populations so that we can monitor productivity and survival of age classes, age of first breeding, and other factors that relate to interpretation of reproductive parameters being monitored; and 3) to provide a base of banded birds to get data on longevity, movements, etc. Staff of this refuge coordinate the banding program throughout the Hawaii/Pacific

Complex. French Frigate Shoals was the only location where the Refuge banded in 1989. Table 7 is a summary of this banding. Researchers also banded birds on the Refuge using their own permits and bands. The Refuge is able to keep track of recoveries of these bands by obtaining recovery reports for the entire Pacific Region (096) from the banding lab.

Because seabirds are long lived and move long distances, interesting recoveries are noted each year. Table 8 is a list of these recoveries made in 1989.

Table 7. Hawaiian Islands NWR banding totals for 1989.

Species	Number
Black-footed albatross	401
Laysan albatross	721
Bonin petrel	86
Bulwer's petrel	1
Wedge-tailed shearwater	175
Christmas shearwater	14
Red-tailed tropicbird	188
Masked booby	166
Red-footed booby	549
Great frigatebird	198
Gray-backed tern	92
Sooty tern	798
Blue-gray noddy	6
Brown noddy	565
Black noddy	965
White tern	131
Bristle-thighed curlew	1
Ruddy turnstone	1
Pacific golden plover	1
TOTAL	5059

Table 8. Significant recoveries of banded birds in 1989.

SPECIES CONDITION OF BIRD	DATE BANDED	LOCATION BANDED	AGE AT BANDING	DATE RECOVERED	LOCATION RECOVERED
Black-footed albatross Dead	06/06/87	Tern Is.	Local	05/06/89	Charleston, OR
Black-footed albatross Dead	02/03/79	Sand Is. Midway	AHY	07/27/89	Washington
Black-footed albatross Dead	03/16/67	Sand Is. Midway	Local	10/11/89	Long Beach, WA
Laysan albatross Alive	02/03/79	Sand Is. Midway	ATY	03/04/89	PMR, Kauai, Hawaii
Laysan albatross Dead	04/03/87	Sand Is. Midway	ATY	04/08/89	PMR, Kauai, Hawaii
Laysan albatross Alive	06/18/82	Tern Is. FFS	Local	04/09/89	PMR, Kauai, Hawaii
Laysan albatross Alive	06/30/83	Tern Is. FFS	Local	04/09/89	PMR, Kauai, Hawaii
Red-tailed tropicbird Alive	06/23/83	Sand Is. Johnston	Local	06/21/89	Sand Is., Midway
Black noddy Dead	01/28/88	Tern Is. FFS	Local	2/89	Nauru

H. PUBLIC USE

1. General

Public use of the Hawaiian Islands National Wildlife Refuge 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, researchers,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, French Frigate Shoals).

Special Use Permits for the following activities were issued in 1989:

HWN-05-89 Honolulu, Star-Bulletin Reporter, Information Gathering Visit.

Reporter Susan Scott and husband/photographer/doctor Craig Thomas visited Tern Island between 14 July and 6 August. The purpose of their visit was to gather photographs, interviews, and personal experience to write a series of newspaper articles on the Hawaiian Islands National Wildlife Refuge for the Honolulu, Star-Bulletin. The resulting 5-day series of articles appeared in the Honolulu, Star-Bulletin from 2 through 6 October, 1989.

HWN-10-89 Moana Productions, Natural History Documentary Filming at French Frigate Shoals

An eight-member film crew visited French Frigate Shoals between 23 May and 13 July to film scenes for three natural history documentaries. Members of the crew were Paul and Gracie Atkins, Mike deGruy, Mimi Armstrong, Rocky Strong, Keith Turner, Chip Matheson, and Jean Kenyon. The nature and objectives of each of these films is described below.

I. "Hawaii" - a one-hour documentary produced by Hawaii Public Television, the BBC, and Moana Productions. This film tells the story of man's impact on Hawaii's fragile natural resources, and the efforts of scientists and conservation agencies to protect native species and ecosystems. It will be broadcast on worldwide television in 1991, including the BBC in Britain and public television in the U. S. as a special (possibly a National Geographic Special). The objective of the FFS footage will be to show the work being done by the Fish and Wildlife Service and National Marine Fisheries Service to study and protect seabirds, green turtles, monk seals, and their island habitats.

II. "Trials of Life" - a series of one-hour programs hosted by David Attenborough and produced by the BBC. This series will explore the diversity of animal behavior all over the world, and will be broadcast in 1992 on worldwide television (on Ted Turner's network in the U.S.). The objective at French Frigate Shoals was to film tiger sharks preying on fledging albatrosses off East Island. The sequence will emphasize the albatrosses' point of view and will fit into a program in the series which concerns the trials and tribulations of "growing up" for young animals.

NMFS Biologist Mitch Craig assists film crew with shots of monk seals on Round Island, French Frigate Shoals. (DKM)

III. "Sharks" - a one-hour documentary produced by Hawaii Public Television, The BBC, and The Film Crew. This film will explore the diversity of sharks and other elasmobranchs in the world's oceans. It will be broadcast on worldwide television in 1992, including BBC in Britain and public television in the U.S. as a National Geographic Special. The objectives in FFS were twofold: 1) to film and study grey reef shark aggregations, with the hope of discovering the function of the behavior and possibly filming sharks giving birth; 2) to film tiger sharks preying on albatrosses as well as "behind the scenes" shots of the film being made.

Support of this major film making activity was a large drain on Refuge staff. The number of people on Tern Island during this work sometimes reached 15. In order to monitor this activity, a staff member was required to be with the crew during almost all of their activities. Honolulu staff were at Tern Island during the

entire production to assume responsibility for the extra work incurred. Although the stress level was high because of the extra work load and increased numbers of people on the island, it was felt that the benefit to the Refuge would be great. In addition the film crew transported a large amount of equipment and supplies to the island on their chartered vessel, which helped to make up for the inconvenience of their presence.

Complex Manager Fefer presents rules for film crew activities at French Frigate Shoals. (DKM)

6. Interpretive Exhibits/Demonstrations

Refuge staff routinely provided information, leaflets and brochures to various interested groups. Refuge Manager Denlinger presented a talk on the "Birds of the Northwestern Hawaiian Islands" to volunteers at Kilauea Point National Wildlife Refuge.

17. Law Enforcement

Since the Hawaiian Islands National Wildlife Refuge is comprised of isolated, inaccessible islands which are closed to the public, law enforcement is not a major activity. Law enforcement in the refuge 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, which they monitor by irregular aircraft and vessel patrols.

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 and are informed of refuge boundaries. This method has proven effective in establishing good working relationships with the captains. In addition all fishermen receiving permits to operate within the Northwestern Hawaiian Islands are required to receive a presentation from NMFS and FWS staff on wildlife resources of the area.

On 26 June a 35'sailing vessel MIMI ran hard aground in darkness on the outer reef of Pearl and Hermes Reef. The vessel was competing in the Honolulu to Hiroshima sail boat race. The 4 person crew was rescued by a helicopter crew embarked from the USS Kincaid on the following morning. The crew was transported to Midway and then to Honolulu via a Coast Guard C-130. All of the crew was in good condition.

A Special Use Permit was issued to F/V FORTUNA which was hired by the owner of the MIMI to salvage the vessel. When the salvage team arrived, sea conditions were bad. Despite warnings from the vessel captain, the salvage crew launched a Zodiac to attempt salvage operations. The Zodiac was quickly scuttled and the salvage team was without means of returning to the vessel for 12 hours. The vessel was finally able to deliver a line to the salvage team and haul them to safety.

The MIMI was in poor condition and determined to be unsalvageable at this point. The rigging was gone and the vessel was breaking up when the FORTUNA left the scene. A small amount (50-80 gallons) of diesel fuel remained on the vessel. No action was taken in relation to trespass in this case.

I. EQUIPMENT AND FACILITIES

2. Rehabilitation

At Tern Island, rehabilitation of equipment and structures is an ongoing effort where low elevation (6 feet above sea level), small area, and constant winds carrying salt spray result in much corrosion. All standing buildings were scraped and repainted during 1989.

3. Major Maintenance

Regular maintenance activities at Tern island included scheduled servicing of the photovoltaic system, diesel and gasoline generators, outboard engines, tractor, ATV, boat hoist, Boston Whalers, Zodiac, freshwater system, salt water system, sewage system, buildings, fuel supplying equipment, refrigeration systems and the runway. Also included were the servicing of freshwater cistern and saltwater pumps, water storage tanks, kitchen appliances, and shop tools.

In May, the front vertical wall of the boat dock was redesigned and replaced. This part of the boat dock takes a constant beating from the sea and seldom does a repair and replacement effort last more than three or four months. Hopefully, this new version, designed to interact with the ocean's forces, will last much longer.

4. Equipment Utilization and Replacement

Tern Island's photovoltaic power system performed faultlessly throughout 1989. Diesel generators were used for the boat hoist, cistern and saltwater pumps, and the washing machine. The system was designed to provide 3 days of electricity without input from the sun for a reduced Tern Island operation; however, the proposed reduction of the Tern Island operation did not take place. We have more appliances and higher energy requirements than what the photovoltaic system was designed to deliver. The photovoltaic storage batteries must be recharged with a diesel generator after only one day without adequate sun.

The 70 HP outboard on the red Boston Whaler at Tern Island ran irregularly throughout 1989. All other outboards ran smoothly.

By the year's end, the Tern Island boat hoist winch began faltering and was working sporadically. A back-up hand-winch was used occasionally, and a new boat hoist was ordered.

5. Communication 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. Scheduled radio contact is made with Honolulu Monday, Wednesday, and Friday and other times as needed. Tern Island also provides radio checks with seasonal field camps at Laysan and Lisianski Islands and Pearl and Hermes Reef. Information is then relayed to Honolulu. In addition to two, redundant high-frequency, single-side band radios, a VHF radio provides short-range communication between refuge staff and fishing vessels. The repeater system purchased in 1987 was fully functional by the summer of 1989 and facilitated intra-atoll communications. This system uses submergible VHF handheld radios for communications between personnel on small boats and throughout the atoll and a base station on Tern Island.

The U.S Coast Guard continued to provide infallible assistance to the refuge in reaching Service personnel in Honolulu 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.

7. Energy Conservation

Assistant Manager McDermond traveled to Washington D.C. in October of 1989 to receive a Federal Energy Efficiency Award on behalf of the Hawaiian Islands National Wildlife Refuge. These awards are presented to individuals and organizations in the federal sector for exceptional accomplishments in energy efficiency. The award presentation read as follows:

> "The Tern Island field station is located on a remote island in the French Frigate Shoals, part of the Hawaiian Archipelago. The U.S. Fish and Wildlife Service, located in Honolulu, oversaw the conversion of the Refuge power system from a diesel generator unit to the installation of a solar photovoltaic and solar domestic hot water system that has reduced fuel oil consumption from 6,000 gallons per year to zero in FY 1988. The system has been operational since December 1987 and since its installation the auxiliary fuel-powered generator has never been used. The solar system is fully capable of supplying the average 9 kWh needed for daily operation of the Refuge and has the ability to store power to last for three days if there is no sun. This project has removed all need for the fuel powered system and as a result will save the Service approximately $25,000 per year in fuel and maintenance costs, a saving that should continue over the 20 to 25 year life span of the system. The solar photovoltaic system, in addition to being efficient, is desirable environmentally since it does not produce air or noise pollution that can interfere with the wildlife patterns on the island."

Contrary to the above there continues to be a need for auxiliary diesel power, but at a much reduced amount (200-300 gallons per year).

8. Other

October of 1989 marked the one year anniversary of completion of the Kapahulu bunkhouse. Since that time the facility has been used regularly to house volunteers, TDY staff, and cooperating researchers.

There were a total of 404 person nights spent at the bunkhouse. If each of these nights would have required use of a hotel room, and $50.00 per night, the cost would have been $20,200 for FY-89. Supplies and utilities for the year were

approximately $2,000.00. this represents a saving of $18,200 if we would have had to use hotels.

For a couple of reasons the above gross analysis does not reflect reality. Some of the guests were couples and would have required only 1 room per night. Additionally we may not have allowed some people to stay as long, if we had to rent a room. A more realistic figure for savings made possible by this facility is about $10,000.

The cost to build the facility was $18,000. With the $10,000 we saved this past year, we have recouped our investment by more than half. There are additional benefits to this facility. Many hours of time are saved in making and confirming reservations with hotels. We also have more flexibility scheduling personnel and volunteers for duty in Honolulu. For example, in the past we would have volunteers here for no more than one or two days so as not to run up a big hotel bill. That caused problems because of trying to deal with Tern Island flight schedules. Now we can have people here for three or four days and they can get some experience in the office, help with chores here, and we don't run into problems if we have to delay Tern Island flights. Additionally, managers on Oahu are more likely to have outer-island staff come to Honolulu for various reasons, when the costs are cut.

In short the Kapahulu bunkhouse has been cost effective and otherwise beneficial to the Refuge Complex in its first year of operation.

Numerous hours are spent annually in the coordination of flights and boat trips which support Tern Island. During 1989, the logistics of 20 flights were handled, including developing orders for parts and equipment, coordinating volunteers, 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 Smithsonian Institute, two by the National Weather Service, two by the Marine Mammal Fund.

On February 29 the Office of Aircraft Services finally awarded a contract to Pearl Pacific Air for flight service to Tern Island. This operator is the same person, with a different company name, who provided air service from 1979 to 1987. The flights to Tern Island will now cost $3,500 (plus OAS overhead) for around 750 pounds of payload. The aircraft is a twin engine Aztec. The next lowest bid was $6,300 for 800 pounds of payload. The new contract provided excellent service throughout the year.

Pearl Pacific Air's twin engine Aztec departs Tern Island amid a cloud of sooty terns. (SIF)

J. OTHER ITEMS

1. Cooperative Programs

The NOAA vessel TOWNSEND CROMWELL continued to provide free transport of supplies, food, fuel, equipment, personnel and correspondence. Because of this important logistic support, which would cost the Refuge thousands of dollars to obtain otherwise, the National Marine Fisheries Service Monk Seal research program is not charged use fees for their stays at Tern Island.

HWN-3-89 R/V TOWNSEND CROMWELL

For the second year in a row the TOWNSEND CROMWELL was issued a special use permit for its operations in support of NMFS and FWS activities on the Refuge.

The CROMWELL routinely transports personnel and equipment to remote islands within the Refuge. This permit allows them entry into the Refuge and sets forth special conditions relating to this activity. Issuance of this permit has helped to educate vessel personnel to the sensitivity of the islands. It gives the vessel captain the responsibility of providing needed freezer space to field personnel for their equipment. In the past poor coordination between field and vessel personnel had allowed untreated field equipment to be landed on the island and thereby increased chances of introductions of exotic species.

Free transportation was also provided on two other vessels, these were the R/V KILA which was chartered by the visiting film crew and the F/V FORTUNA which was chartered by the University of Montana Wildlife Coop. Unit as part of their research on bristle-thighed curlews on Laysan Island.

4. Credits

This narrative was prepared by Jennifer Megyesi, Ken Niethammer, Craig Rowland and Ken McDermond.

K. FEEDBACK

Since we are a year behind getting this report completed this will be it for now. If we can manage to get next year's done some time near the year the work was completed, we may be able to remember items for this section.