NORTHWEST & ALASKA FISHERIES CENTER PROCESSED REPORT

This report does not constitute a publication and is for information only. All data herein are to be considered provisional.

HAWAIIAN MONK SEAL (MONACHUS SCHAUINSLANDI) HABITAT AND POPULATION SURVEY IN THE NORTHWESTERN (LEEWARD) HAWAIIAN ISLANDS, APRIL 1977.

by
Robert L. DeLong
and
Robert L. Brownell, Jr.

AUGUST 1977

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest and Alaska Fisheries Center
2725 Montlake Boulevard East
Seattle, Washington 98112

HAWAIIAN MONK SEAL (*Monachus schauinslandi*) HABITAT AND POPULATION SURVEY IN THE NORTHWESTERN (LEEWARD) HAWAIIAN ISLANDS, APRIL 1977.

by

Robert L. DeLong *
and
Robert L. Brownell, Jr. **

Funded jointly by the U.S. Department of Interior, Fish and Wildlife Service, Division of Cooperative Research and the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Marine Mammal Division.

* Marine Mammal Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, 7600 Sand Point Way, Seattle, Washington 98115

** National Fish and Wildlife Laboratory, National Museum of Natural History Smithsonian Institution, Washington, D.C. 20560

CONTENTS

Hawaiian monk seal (Monachus schauinslandi) habitat and population survey in the Northwestern (Leeward) Hawaiian Islands, April 1977.

INTRODUCTION

The vessel Easy Rider was chartered for the survey conducted between 6 and 26 April 1977. The survey itinerary is detailed in Table 1. The objectives of the survey were to: 1) obtain current census information, 2) begin a study of causes behind the population decline at Pearl and Hermes Reef, 3) resupply the study team at Laysan Island. The Island of Nihoa was not visited. A landing was made on Necker Island which was not surveyed in 1976. Six days (2 at each location) were devoted to surveying monk seals at French Frigate Shoals, Laysan, and Lisianski Islands (Figure 1). It was our intention to spend 10 days at Pearl and Hermes Reef, but we lost 3 days (stormbound) when we first arrived and had only six days to carry out the study.

The survey activities were carried out under Marine Mammal Protection Act Permit No. 71 and MMPA/Endangered Species Act Permit No. 180.

Special Use Permit number HWN-11-76 to visit the Hawaiian Islands National Wildlife Refuge was granted by Refuge Manager Palmer Sekora.

In addition to this survey, researchers Brian W. and Patricia A. Johnson established a camp on Laysan Island on 27 February. Clifford H. Fiscus, NMFS, accompanied the Johnsons to Laysan Island to help them establish camp and begin their studies. The report of that trip is included here as Appendix 1. The Johnsons will remain at Laysan Island until about 1 September studying Hawaiian monk seal population biology. Karl W. Kenyon and Mark Rauzon, both of the Fish and Wildlife Service

Table 1. Monk seal survey itinerary, R/V Easy Rider, 6-26 April 1977.

Date	Vessel or personnel	Location
31 March-6 April	Robert L. DeLong	Honolulu, Hawaii
3-6 April	Robert L. Brownell	Honolulu, Hawaii
6 April 1210 hrs.	R/V Easy Rider, departs Kewalo Basin	Honolulu
8 April 1100 hrs.	Anchored	Necker Island
9 April 0030 hrs.	Anchored in lagoon	French Frigate Shoals
10 April 1730 hrs.	Depart	French Frigate Shoals
12 April 0515 hrs.	Anchored	Laysan Island
13 April 2400 hrs.	Depart	Laysan Island
14 April 1515 hrs.	Anchored	Lisianski Island
15 April 1645 hrs.	Depart	Lisianski Island
16 April 1200 hrs.	Anchored in Lagoon	Pearl and Hermes Reef
16-18 April	Stormbound	Pearl and Hermes Reef
19 April	Establish tent camp	Southeast Island, P & H Reef
21-22 April	Survey other islands in Atoll	
24 April	Depart	Pearl and Hermes Reef
25 April 0800 hrs.	Arrive	Midway Atoll
26 April 1230 hrs.	Depart, via MAC, Log Flight	Midway Atoll

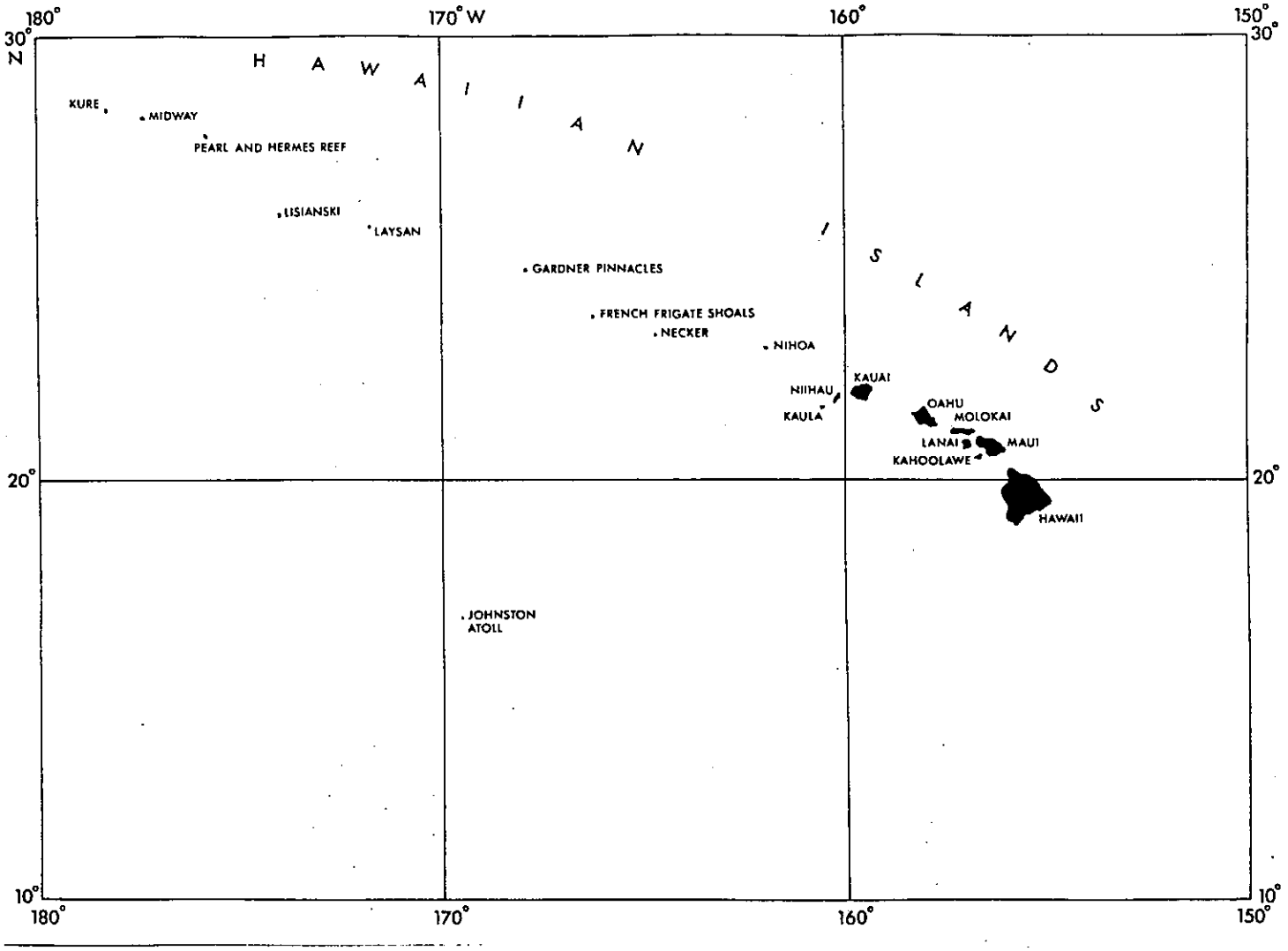

Figure 1.--Hawaiian Archepelago.

began a study of monk seals at French Frigate Shoals on 17 February. Karl Kenyon departed French Frigate on 31 March and Mark Rauzon will continue the studies until late May. Ancel Johnson and Jerry Ruehle began studies at Kure Atoll on 9 February and those studies will be continued by Ruehle until late May. Each of these parties will prepare reports upon the completion of their respective studies.

Personnel who participated in the survey cruise follow:

Monk seal survey team

Robert L. DeLong	Marine Mammal Division, NWAFC, NMFS
John Naughton	Southwest Region, NMFS, Honolulu
Robert L. Brownell, Jr.	Division of Cooperative Research, FWS
J. Brent Giezentanner	Hawaiian Islands National Wildlife Refuge, FWS

R/V Easy Rider Crew

Capt. Gary L. Naftel

Mate Leslie Dunman

Eng. James Grimshaw

Cook Robert Grimshaw

Deck Hand Gene Platino

Deck Hand George Evering

The monk seal research team left the R/V Easy Rider at Midway Atoll and returned to Honolulu on a Military Air Command (MAC) scheduled flight. Research personnel from the NMFS Hawaii Area Fishery Research Center were to join the R/V Easy Rider at Midway to conduct tuna and lobster fishing experiments in the waters of the Northwestern Hawaiian Islands on the return voyage of the vessel to Honolulu.

CENSUSES

Censuses were conducted by walking the shoreline and observing and classifying all monk seals to age (judged from size) and sex. The censuses for each island appear in Tables 2 through 5. On islands where more than one census was conducted only the census resulting in the largest number of animals is presented. During this survey animals were observed from a distance. This results in loss of some sex and tag recovery information but avoids disturbance to the animals which is of greater importance. As our studies of this endangered species become more intense every effort will be made to minimize disturbance (the animals recognition of human presence or anything more intense) in order to keep to an absolute minimum the deleterious effects of our presence. A few tag numbers were obtained (table 6) from sleeping animals generally with the aid of binoculars. However in several cases when tagged animals were approached they awakened and were disturbed, departing the beach and entering the water. Recording of scar patterns on adult animals has proven valuable in the studies at Laysan Island, and a conserted effort was made to photograph all scarred animals on each island. These photos will be printed and catalogued by island for use in future studies of adult animals.

This years census of monk seals at Pearl and Hermes Reef yielded some encouraging information. In 1976 no juvenile animals were seen, but this year we observed small numbers of juveniles in the population. There was also one more pup born at Pearl and Hermes Reef this year than last year, and the total number of animals recorded this year was 43, representing a considerable improvement over the count obtained in 1976.

Table 2.--Summary of Censuses of Hawaiian monk seals 8-25 April 1977, in the Northwest Hawaiian Islands.

Date	Island or Atoll	Adult			Subadult			Juvenile			Pups		Total
		Male	Female	Not sexed	Male	Female	Not sexed	Male	Female	Not sexed	Weaned	Nursing	
8 April													
	Necker Island	10	5	17	1	2	9	1	0	1	0	0	46
9-10 April													
	French Frigate Shoals	49	55	28	5	8	18	6	8	18	1	27	223
13 April													
	Lisianski	48	30	20	9	8	17	5	3	16	5	17	178
21-22 April													
	Pearl and Hermes	37	24	18	2	0	5	1	2	2	7	8	106
25 April													
	Midway	15	11	2	2	2	1	0	2	2	1	4	43
25 April													
	Kure Atoll	1	1	1	0	0	0	0	0	1	0	1	5
	Green Island	4	4	0	0	0	0	0	1	0	0	2	11
	Sand Spits	8	2	1	0	0	0	0	0	0	0	2	13
												Total	625

1/ Census conducted by Jerry O. Ruehle, FWS.

Table 3.--Census of Hawaiian monk seals at French Frigate Shoals, Northwest Hawaiian Islands, 9-10 April 1977.

Date, (hour)	Island	Adult			Subadult			Juvenile			Pups	
		Male	Female	Not sexed	Male	Female	Not sexed	Male	Female	Not Sexed	Weaned	Nursing
9 April (1010-1800)												
	Shark	13	4	8	3	1	6	0	0	2	0	0
	Tern	0	0	0	0	0	2	0	0	0	0	0
	Trig*	12	8	1	1	0	0	3	0	2	0	1
	Whale-Skate	9	12	5	0	1	1	2	0	6	0	7
	Round	0	7	0	0	0	1	0	0	1	0	7
	Mullet	2	4	2	0	1	0	0	0	0	0	2
	East	1	9	2	0	0	2	0	1	2	1	6
	Bare	0	2	1	0	1	1	0	1	0	0	0
10 April (1000-1300)												
	Gin	2	2	2	0	0	2	0	0	2	0	3
	Little Gin	1	1	2	0	0	0	0	1	0	0	0
	Disappearing	9	6	5	1	4	3	1	5	3	0	1
		49	55	28	5	8	18	6	8	18	1	27
	Total 223											

* Including animals on 2 small islets off Trig Island.

Table 4.--Census of Hawaiian monk seals at Laysan and Lisianski Islands, Northwest Hawaiian Islands, April 1977.

Island, Date and (hour)	Adult			Subadult			Juvenile			Pups	
	Male	Female	Not sexed	Male	Female	Not sexed	Male	Female	Not sexed	Weaned	Nursing
Laysan Island, 13 April (1230-1800)											
North Point to Refuge sign	6	12	6	0	2	6	1	0	3	2	7
North Point to Northeast Pt.	5	2	1	1	2	4	2	1	0	0	0
Northeast Pt. to South Point	19	6	9	1	1	6	1	2	12	1	2
South Point to Refuge sign	18	10	4	7	3	1	1	0	1	2	8
Total 178	48	30	20	9	8	17	5	3	16	5	17
Lisianski Island 15 April (1310-1630)											
Refuge sign to North Point	5	2	1	1	0	2	0	0	0	0	0
North Pt. along east side to South Point	18	14	13	0	0	1	0	1	2	7	5
South Point to Refuge sign (west side)	14	8	4	1	0	2	1	1	0	0	3
	37	24	18	2	0	5	1	2	2	7	8
Total 106											

Table 5.--Census of Hawaiian monk seals at Pearl and Hermes Reef, Northwest Hawaiian Islands, 21,22 April 1977.

Date and hour	Islet	Adult			Subadult			Juvenile			Pups	
		Male	Female	Not sexed	Male	Female	Not sexed	Male	Female	Not sexed	Weaned	Nursing
21 April (100-1400)												
	Southeast	3	2	0	1	0	1	0	0	1	0	0
	Sand	0	0	0	0	0	0	0	1	0	0	0
	Bird	0	0	0	0	0	0	0	0	0	0	0
	Grass	4	2	0	0	1	0	0	1	0	0	0
	Seal-Kittery	5	3	2	0	0	0	0	0	0	0	1
22 April (1140-1300)												
	Little North	1	1	0	0	1	0	0	0	0	0	1
	North	2	3	0	1	0	0	0	0	1	1	2
		15	11	2	2	2	1	0	2	2	1	4
	Total 43											

Table 6.--Monel Tags recorded from Hawaiian monk seals, during the April 1977 survey of Northwestern Hawaiian Islands.

Tag no.	Age, sex, and remarks	Atoll	Island	Date
A 757	Subadult female, small, and no scars.	FFS1/	Mullet	9 April
775	Adult, small, no scars	FFS1/	Little Gin	10 April
A 774	Adult, female with newborn pup	FFS1/	Disappearing	10 April
529	Adult, male with adult female		Lisianski	15 April
938	Small adult male, no scars		Lisianski	14 April
A 1011	Subadult female green algae on pelage, no scars		Lisianski	14 April

1/ French Frigate Shoals

The 1977 census occurred approximately 3 weeks later than the census in 1976. This resulted in recording more pups at French Frigate Shoals, where the onset of pupping occurs later than at either Laysan or Lisianski.

Hawaiian green turtles were recorded during the censuses and those observations are reported in Table 8. Cetacean observations were made from the vessel and are included in Table 7. No dead monk seals were encountered during the survey. Three spewing samples from monk seals were collected.

Necker Island

The census at Necker Island produced a total count of 46 animals. Three of the adult females appeared to be pregnant, although no pups were present at the time of the census. A single pup has been reported at Necker Island during each of the two preceeding pupping seasons (Naftel pers. comm. for 1975 observations and R. Shomura's memo of 11 August 1976 regarding Monachus observations on Townsend Cromwell Cruise 76-04-71).

The amount of available habitat at Necker Island is restricted to a shelf rock flat (Figure 2.) and several large boulder beaches in Shark Bay. There are no sand beaches which, judging from the other breeding rookery islands, are the preferred habitat. Since large numbers of monk seals are using the island, and pups are being born there, Necker Island and some water surrounding it should be included in any listing of critical habitat for Hawaiian monk seals.

Table 7.

Cetacean Observations, 6-25 April, 1977, from Oahu to Midway, Hawaiian Isalnds.

Date/ time	Location Latitude	Longitude	Species	Number seen	Remarks
7 April/1135	22 23'N	162 32'W	Balaeboptera edeni	1	Observed three rostral ridges. Total length ca 25 ft.
8 April/1335	Necker Island		Tursiops Truncatus	1	Off shore Necker Isl.
8 April/1620	23 42'N	165 14'W	Unknown	2	12-15 feet long, dark backs, beak pronounced but no detail, and dorsal fin pronounced, recurved. and located aft of bend in body while surfacing.
8 April/1930	23 51'N	165 41'W	Tursiops truncatus	ca 10	On edge of bank, 200 fathoms.
10 April	French Frigate Shoals		Tursiops truncatus	4	In lagoon at French Frigate Shoals.
11 April/1815	En route to Laysan Island		Unidentified	2	
15 April/1745	Offshore of Lisianski Island		Unidentified	2	Started to approach Easy Rider but turned off
17 April/ ca 1300	Inside Pearl and Hermes Reef		Stenella longirostris	10-15	Moving around Easy Rider
17 April/1545	Inside Pearl and Hermes Reef		Stenella longirostris	12-15	Spinning and jumping around Easy Rider at anchor
17 April/ ca 1800	Inside Pearl and Hermes Reef		Stenella longirostris	-	-

Table 7. (continued)

Cetacean Observations, 6-25 April, 1966, from Oahu to Midway, Hawaiian Islands.

Date/ time	Location		Species	Number Seen	Remarks
	Latitude	Longitude			
21 April/1350	entrance to Pearl and Hermes Reef		Stenella longirostris	ca 10-15	Moving slowly with only dorsal fins coming up out of the water
22 April/0930	Just inside entrance at Pearl and Hermes Reef		Stenella longirostris	ca 50	About eight sub groups approached Easy Rider
22 April/1605	Inside Pearl and Hermes Reef		Stenella longirostris	-	School noted again
24 April/1015	Inside Pearl and Hermes Reef 3/4 mile from entrance		Stenella longirostris	ca 50-60	Dolphins were milling around in a very dispersed school. Approximately 20 animals approached bow of Easy Rider. Some were spinning.
24 April/1645	Pearl and Hermes Reef		Stenella longirostris	-	School in entrance of the small boat channel - spinning in shallow green water
24 April/1915	Pearl and Hermes Reef		Stenella longirostris	ca 20	Dolphins on bow of Easy Rider along the SW end of the reef.
25 April/0800	Channel coming into Midway Harbor		Stenella longirostris	ca 20	Riding bow of Easy Rider for a few minutes.

Table 8. Green Sea Turtle Observations in the Northwestern Hawaiian Islands. 8-25 April, 1977.

Date	Location	Number	Remarks 1/
8 April	Necker Isl.	2	1>25"; 1<25"
	French Frigate Shoals		
9 April	Trig	1	Ad F, w/Rt. rear flipper and part of shell bitten off by shark.
9 April	Trig	4	(3 Ad M's, 1 Ad F) in HoH copulating
9 April	Whale - Skate	2	2 M's,tag #'s 948, 74
	Whale - Skate	3	Sex undetermined, all>25"
9 April	Mullet	3	2 Ad M's, 1 Ad F.
9 April	East	1	Ad F.
10 April	Little Gin	1	Ad M.
13 April	Laysan	6	1 F>25", 4 n.s.<25"; 1 n.s.> 25"
14 April	Lisianski	8	5 n.s.>25", 1 F<25"; 2 n.s.<25"
14 April	Lisianski	30 - 40	All small - offshore.
	Pearl and Hermes		
21 April	Southeast Isl.	13	(Several depressions, probably nests) 5 F's >25", 4 M's>25"; 4 n.s. >25"
22 April	North	3	1 M 25", 1 F 25", 1 n.s. 25".

1/ Sexes: M and F denote male and female; n.s. is animal not sexed. Sizes <25" is immature and 25"> is mature.

Figure 2.--Hawaiian monk seal rookery and hauling area, Necker Island, 8 April 1977.

French Frigate Shoals

Mark Rauzon a member of the FWS French Frigate Shoals study team joined us for the survey of the islands at French Frigate Shoals. We landed on all islets and censused monk seals on 9 and 10 April. Round island is a very small islet but was occupied by 7 females with pups. This density of females with nursing pups was greater than was seen elsewhere during the survey. This small islet is protected by reef structure very close to shore and is encircled by shallow, protected water. It is noteworthy that most of the pups at French Frigate Shoals were very young. Pupping appears to occur later here than on the islands and atolls to the northwest.

Laysan Island

We delivered 200 gallons (20, ten gallon drums) of fresh water, mail, and a copy of MMPA/ES Permit No. 180 to Brian and Patricia Johnson on 12 April. During the two days at Laysan we looked at the study areas and discussed their findings to date and plans for the remainder of the season. On 13 April, we censused monk seals with the Johnsons (results in Table 3).

We observed 3 animals with large eroded lesions on their backs. This type of lesion was observed last year and when healed forms large gathered scars on the dorsal surface of the affected seal. Causes of these lesions are unknown but are thought to result from scrapes on coral or from pathogenic bacteria or fungi. The lesions have since been observed (Brian and Patricia Johnson, pers. comm.) to begin with puncture wounds, probably bites from other seals, and grow continually.

This observation suggests that the condition is the result of a pathogen.

Laysan Island had the unpleasant distinction of having received heavy oil pollution during March. More oil was present on Laysan than on any other island during this survey.

The Scaeola fringe on Laysan Islands west shore was defoliated by storm waves last winter. During our survey it showed little sign of recovery. A year ago this growth formed a hip to chest-high, dense stand; it is now represented by dead branches. There is an occassional green shoot from low on the stock of otherwise leafless plants. We did not check to see if the dead stocks had viable root systems. It may take several years for the Scaevola to recover and until it does it will provide no cover or protection from storm winds for monk seals.

All of the procellarid burrows within the Scaevola fringe were destroyed, but few birds were probably lost as the storm occurred before many of even the earliest burro nester, the Bonin Petrel, were present on the island in significant numbers.

Lisianski

The pupping season was more advanced at Lisianski than at any other island. Weaned pups constututed 47% of the pups censused at Lisianski as compared to 23% weaned pups at Laysan. Two of the weaned pups at Lisianski were very small and had not begun the post natal molt, indicating that they were weaned early or that pups in poor physical condition do not molt on schedule at 5 weeks of age.

Very large numbers of Vellela sp., a Siphonophore, and the pelagic purple snail, Janthina, sp. were washed ashore while we were at Lisianski. There were windrows of both organisms present on the windward beaches

when we arrived on 14 April and during the night of 14-15 April large numbers came ashore creating a continuous carpet of purple along the windward shore. The carpet was so dense and the concentration so heavy in the splash zone that it would have had the appearance of an oil slick from the air. Adult and pup monk seals were loafing in tide pools covered with Vellela. However, the seals appeared to experience no discomfort or irritation. Vellela have nematocysts, but we don't know if these nematocysts in dead and dying specimens could cause discomfort to the seals.

Pearl and Hermes Reef

We arrived at Pearl and Hermes Reef on 16 April but were unable to beg
begin our work until 19 April due to storm conditions. Our principal objective at Pearl and Hermes Reef was to gather data that might explain the apparent decline of the Monachus population; however, our scheduled 10 day visit was reduced to six days because of foul weather. Particular attention was given to observing and recording the numbers of adult, subadult and juvenile animals in the population.

During our stay ashore, Capt. Naftel and his crew carried out a shark fishing project to attempt to determine the species and numbers of large sharks utilizing the waters inside the Pearl and Hermes Reef lagoon and along the outer reef slope. This project was funded by the Marine Mammal Commission, with Capt. Gary Naftel and Dr. Leighton Taylor as principal investigators.

The presence of subadult and juvenile animals at Pearl and Hermes Reef is viewed with guarded optimism. These animals could either be from Pearl and Hermes Reef, or new immigrants (or simply visitants) from one of the other Northwestern Island populations. If they are animals born

at Pearl and Hermes Reef, then the population is not in as grave a condition as was thought after the 1976 survey (when no young animals were found). The number of subadult and juvenile animals found at neighboring Lisianski island was very small. The percentage of the Lisianski population composed of subadult and juveniles is much lower this year than that at French Frigate Shoals, Laysan Island, or Pearl and Hermes Reef, thus it is suggested that a large portion of the subadult and juvenile animals were away from Lisianski Island at the time of this survey and could have been visiting Pearl and Hermes Reef.

We attempted to collect moray eels to examine for the presence of ciguatera toxin. Ciguatera is a disease restricted to tropical coral reefs. The toxin is contained in a benthic dynaflagellate and is incorporated in herbiverous fishes and many inner reef carnivores. The toxin is cumulative in fishes. Ciguatera has been considered as a possible cause of the decline of the monk seal population at Pearl and Hermes Reef. DeLong discussed this possibility with Dr. Albert H. Banner, of the University of Hawaii. Banner has been studying ciguatera in the tropical Pacific for many years. He suggested that the collection of and analysis of tissue from a series of large moray eels (Gymnothorax flavimarginatus) from Pearl and Hermes Reef might be the logical first step in determining if a ciguatera outbreak had occurred within the past 10 or possibly 20 years. Large morays are the most consistantly toxic of any animals inhabiting the reefs and are long lived; therefore they could be expected to maintain a record of a outbreak of ciguatera if it occurred within the last decade.

We made an attempt to trap large moray eels at Pearl and Hermes Reef using wire lobster traps baited with both mackrel and local fishes. We fished two traps for three nights with no success, catching only lobsters, several species of reef fishes and small spotted eels; all were returned

to the water. We will try to capture moray eel again in 1978 or obtain specimens taken here during other NMFS fishing operations in the area.

It is our feeling that it is improbable that monk seals would react adversly to ciguatoxin. Albert Banner (pers. comm.) finds that marine crustacea from a reef are not sensitive to the toxin whereas closely related freshwater crustacea are killed by the toxin. The implication being that animals such as monk seals who evolved in the coral reef system along with the toxic dynaflagellates probably have evolved storage mechanisms as have the fish or metabolic pathways of eliminating the toxin from their systems.

From 21 through 24, April the R/V Easy Rider was off our charter and conducted the Marine Mammal Commission contract study on sharks at Pearl and Hermes Reef. A report of those studies will be available sometime after July 1977 from the Marine Mammal Commission. Briefly, sharks were found both within and outside the lagoon at Pearl and Hermes Reef. Large species were captured both during the day and at night within the reef, indicating that they are resident in the lagoon and represent potential monk seal predators even when the animals are very close to the rookery islands.

The effect shark predation has on the survival of monk seal pups to age of recruitment at Pearl and Hermes Reef remains unknown. It is not known what changes may have occurred in the shark population of Pearl and Hermes Reef in the last 50 years. At various times from 1926 through 1930 fishery operations were carried out in the lagoon and adjacent reef areas for both fish and pearl oysters. The shark population may have been reduced or altered during these years. The effect of military operations at

at Pearl and Hermes Reef in the late 1930's and early 1940's on monk seals and sharks is also unknown.

The few records available on the numbers of monk seals comprising the Pearl and Hermes Reef population prior to 1957 indicate a gradual buildup in numbers from the early 1900's, coincident with an increase in numbers throughout its range. Large sharks have been fished in waters around the High (main) Hawaiian Islands in recent years. Large tiger sharks were fished out of areas quickly, but within two years they again repopulated the areas (Fujimoto and Sakuda, 1972). . If this generalization can be extended to Pearl and Hermes Reef we expect that tiger shark populations would have been back up within a few years after the 1931 termination of commercial fishing. The monk seal population continued to increase during the 1940's and 1950's probably in the presence of rather large shark populations. Thus if shark predation on monk seals has become significant only in the past 20 years, sharks at Pearl and Hermes may have only recently learned to prey on monk seals.

Thirty-four of the recorded adult, subadult and juvenile monk seals censused were carefully observed for presence of shark scars. Twelve or 35% of the animals had scars or bites that were inflicted by sharks. These bites showed the unmistakeable crescent shaped shark scar (11 animals), and a recent clean removal of a single digit of the rear flipper (1 animal). The digit removal was a clean bite and this type of scar was on animals with other shark scars on the body trunk. Two additional large straight line scars (up to 12") were recorded but are not included as shark scars as it is

probable they were caused by other monk seals. The 35% shark scarring on monk seals older than pups at Pearl and Hermes Reef is compared to 13% scarring at Lisianski (the population with next highest occurrance). The scars represent predation attempts and can not be translated into a rate of predation.

Wirtz (1968) observed dead monk seal pups with large shark wounds. Because we see few juveniles with shark scars we surmise that most predation attempts on monk seal pups are successful. Predation of pups at Pearl and Hermes Reef may have played a major role in the population reduction.

Human disturbance at uninhabited Pearl and Hermes Reef is difficult to document. Between 1949 and 1960 there were 5 visits by scientists totaling 9 days when people were probably ashore. Between 1960 and 1969 there were 12 visits totaling 43 days by FWS Refuge biologists and 12 visits totaling 52 days by Pacific Ocean Biological Survey Program biologists. Clearly there was a dramatic increase in human visitation during the 1960's. Southeast Island was the base camp of any survey of the atoll because of its accessability, and experienced the majority of visitation. From information contained Table 1 and Appendix Table 1 in Amerson et al. (1974), it appears there were 378 man-days or parts thereof, on Southeast Island compared to 54 man-days for Grass Island, 60 man-days for Seal Island, 65 man-days for Kittery, and 71 man-days for North Island. The man-days calculations are exaggerations, for generally several islets were surveyed in a single day, but probably most seals were aware of human presence during those surveys.

The meaning of a figure like 378 man-days of human presence to a population of monk seals is not clear. Monk seals were counted, photographed and tagged during those visits. Those legitimate scientific activities are potentially as disturbing to seals as other human presence.

on the island. Also four of the late 1960's visits were accomplished with Navy helicopter. The effect of noise from landing helicopter is unknown. The 378 man-days of scientific visitation is compared to 331 man-days of scientific visitation at Laysan Island (calculated from Appendix Table 1 Ely and Clapp, 1973), during the same period. Although the potential human disturbance appears great at Pearl and Hermes Reef, it was nearly the same at Laysan Island, where there has not been a drastic decrease in the seal population. A more complete analysis of human visitation for scientific investigation will be completed soon summerizing published information and drawing together refuge records of visitation from 1970 to 1977.

Pearl and Hermes Reef lies within helicopter range of Midway and there have been helicopters at Midway for at least 10 years. Since Pearl and Hermes Reef is within the Hawaiian Islands National Wildlife Refuge, the refuge manager exerts some control over aircraft visitation to Pearl and Hermes Reef. Helicopters in recent years have visited Pearl and Hermes once a year for combined refuge patrol and glass ball hunting trips; however, it seems unlikely that disturbance of this frequency could have caused sufficient disturbance to reduce the monk seal population to present levels. This assumes that the noise from the helicopters do not constitute high intensity disturbance which can not be tolerated by monk seals. It is the expressed opinion of the Navy Command at Midway that helicopter visitation has not been frequent, so unless there have been flagrant violations of both Refuge and Navy regulations and many unrecorded trips to Pearl and Hermes Reef had been made during the last decade it does not seem that helicopter disturbance would have been frequent enough to play a major role in the observed decline.

Another factor to be considered in relation to a declining monk seal population is that if the entire reef ecosystem were unhealthy the mammalian carnivores might show a marked population reduction. With this in mind it was hoped that considerable diving might be done at Pearl and Hermes to obtain an impression of the general health of the reef system. When shark fishing was started and the presence of large tigers inside the lagoon during the day became known there was a dampened enthusiasm to dive. Diving was limited to snorkeling in shallow water areas around Southeast Island, where John Naughton spent some time looking at the reef. He recorded octopus, some live coral on an otherwise dead coral substrate, and a single Acanthaster (Crown of thorns starfish), but did not notice any destruction of live coral by Acanthaster.
The second survey of the reef was carried out 2 miles east of North Island. In this area the reef fauna was generally luxuriant, with large amounts of live coral. These observations and observation of extensive live coral structures throughout the very large lagoon suggested that the atoll system is generally very healthy.

Studying monk seals at Pearl and Hermes Reef is difficult. The islands of Seal-Kittery and North where pups are still being born are widely spearated (Fig. 3).

Obtaining substantial amounts of information on this population would be very costly.

Midway Island

We were encouraged to find that Navy and civilian personnel at Midway were respecting the closure of Midway's Spit Islands. Equally encouraging was the presence of five monk seals on these islands; there

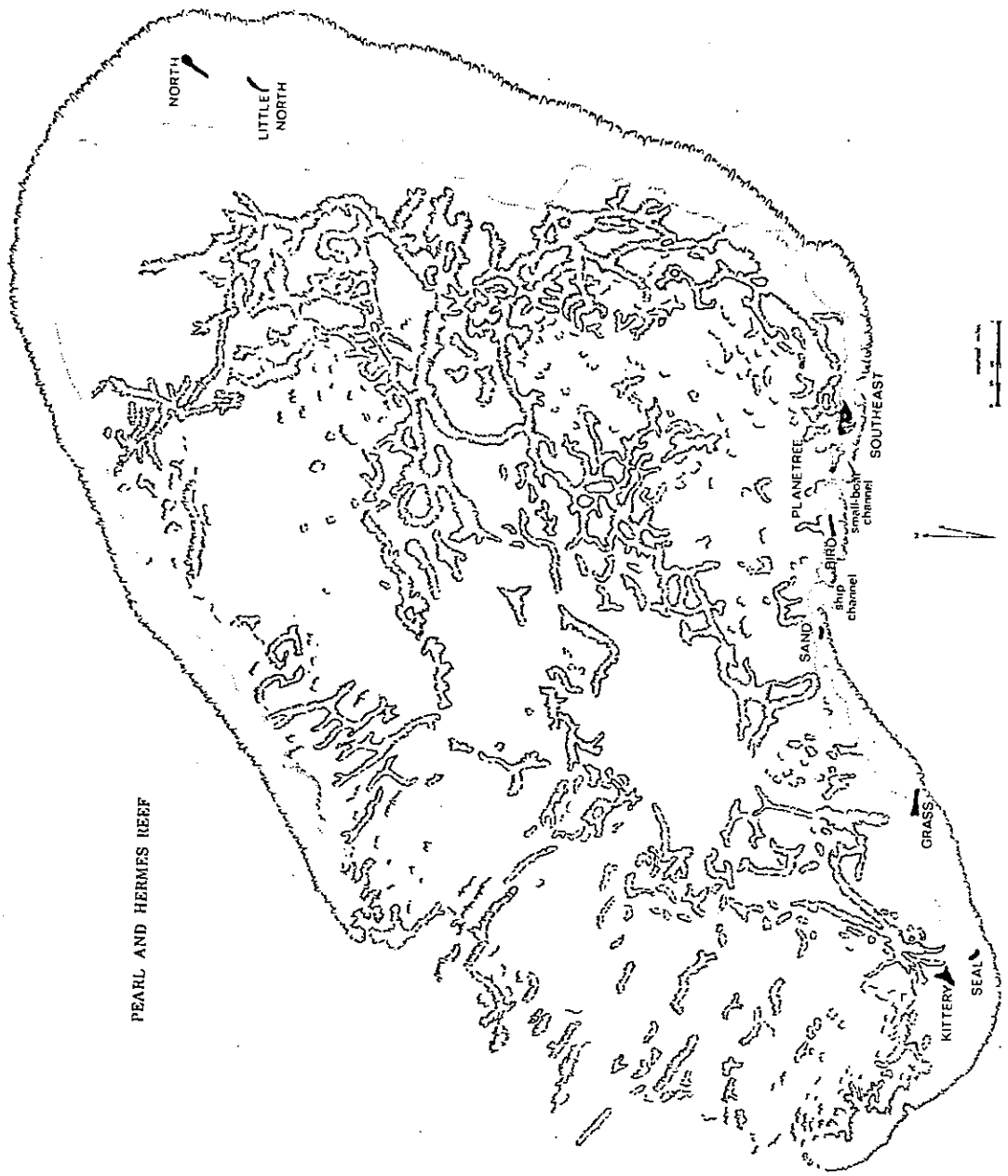

Figure 3. Map of Pearl and Hermes Reef.

was even an adult female with a pup on one of those small islets. This was an improvement over last year when apparently due to frequent human disturbance no pups were born there and few animals were utilizing the Spit Islands.

Kure Atoll

Although we did not visit Kure Atoll during this survey a single census conducted by Jerry O. Ruehle, FWS, on 25 April is included (Table 1.) to make the census information complete. Readers are referred to Ruehle's report for a total account of his census activity at Kure Atoll in 1977.

Monk Seal Pupping Habitat Requirements

We have previously considered preferred pupping habitat to be sand beaches which are backed by vegetation such as Scaevola or Eragrostis and which are adjacent to shallow, protected water. The presence of 7 females with nursing pups on Round Island at French Frigate Shoals forced us to reflect upon these requirements. Round island is a small, low, and unvegetated island. It does however have the requisite shallow, protected water ringing the island. This suggests that the shallow, protected water may be more important to pup survival on rookery islands than the presence of vegetation. The vegetation provides shelter during storms and this has been assumed necessary. Since in the western portion of the range from Lisianski to Kure, many of the pups are born in the stormy months of February and March if the vegetation offers critical protection it may confer survival advantages to seals. However if protection from wind were critical to pup rearing success, all pupping activity would be expected to occur on the leeward shores of rookery

islands. Most pups are born on the leeward shore of Laysan Island, but at Lisianski most pupping occurs on the windward shore. At French Frigate Shoals many of the small sand islets where pupping occurs are devoid of vegetation and offer no protection from the wind. But the single habitat component which all pupping areas at Laysan and Lisianski Islands, and French Frigate Shoals have in common is shallow offshore waters.

Literature Cited

Amerson, A.B., R.B. Clapp, and W.O. Wirtz. 1974. The Natural History of Pearl and Hermes Reef, Northwestern Hawaiian Islands. Atoll 174, 306 p.

Ely, C.A., and R.B. Clapp. 1973. The Natural History of Laysan Island, Northwestern Hawaiian Islands. Atoll 171, 361 p.

Fujimoto, M.M., and H.M. Sakuda. 1972. The 1971 shark control and research program final report. Division of Fish and Game, State of Hawaii, Honolulu, 37 p. (Processed.)

Wirtz, W.D., III. 1968. Reproduction, growth, and development and juvenile mortality in the Hawaiian monk seal. J. Mammal. 49:229-238.

APPENDIX I

Trip Report: Voyage to Laysan Island, February-March 1977. A part of the joint NMFS-FWS 1977 monk seal (Monachus schauinslandi) research program.

By

Clifford H. Fiscus

INTRODUCTION

Joint studies of the Hawaiian monk seal by biologists of the Marine Mammal Division, NWAFC, NMFS, and the Division of Cooperative Research, FWS, which began in 1976 are continuing in 1977.

One phase of the 1977 research plan was to establish an experienced research team on Laysan Island to study a relatively undisturbed population of seals throughout much of the pupping and breeding season. Objectives include: (1) regular censuses throughout the field season to obtain an accurate picture of the numbers of animals utilizing the island, (2) establishing figures for pup production, and (3) gathering over the six month period data on the biology and behavior of the species. These data are to be gathered with minimum disturbance of the animals.

Brian W. Johnson and Patricia A. Johnson, a man and wife team with three years' field experience studying harbor seals in isolated locations in Alaska, were selected as the Laysan research team. The Johnsons' research is supported in part through a contract with the Marine Mammal Commission, with direction and logistic support provided by NMFS and FWS.

Permission to establish the research study team at Laysan Island was granted by Palmer C. Sekora, Refuge Manager of the

Hawaiian National Wildlife Refuge, under Permit No. HWN-11-76 dated 17 December 1976. Sekora also provided assistance in Honolulu, and weather monitoring instruments, which were set up at Laysan Island by Assistant Refuge Manager J. Brent Giezentanner, who accompanied the party to acquaint the Johnsons with the qualifications described in the permit.

Richard S. Shomura, Director of the NMFS Hawaii Area Fishery Research Center, Honolulu, Hawaii, provided the assistance of his staff and facilities during the outfitting stage of the voyage. Personnel deserving special mention for their helpful assistance include: Robert Skillman, Don Alstead, Ted Kaiser, Mel Dutro, Mary Lynne Godfrey, Hazel Nishimura and Margaret Massie.

Doyle E. Gates, Administrator, Western Pacific Program Office, Honolulu, Hawaii, and his staff including Robert Iverson, Bill Streeter and John Naughton, provided assistance and liaison with the U. S. Coast Guard. Captain Skip Naftel (M/V Easy Rider) provided invaluable assistance in assembling supplies and building the radio mast in Honolulu.

Research is being carried out in part under authority of the Marine Mammal Protection Act and the Endangered Species Act Permit No. 180 issued to NWAFC, NMFS on 6 April 1977.

Personnel and Itinery

The Scientific Party consisted of:

Clifford H. Fiscus	Marine Mammal Division, NWAFC, NMFS
J. Brent Giezentanner	Asst. Refuge Manager, HPINWR, FWS
Brian W. Johnson	Laysan Island Research Team
Patricia A. Johnson	Laysan Island Research Team

The M/V Easy Rider[1/] crew consisted of:

Capt. Gary (Skip) Naftel

Eng. James Grimshaw

Cook Robert Grimshaw

Deck Hand Gene Platino

Deck Hand George Evering

The voyage itinerary was as follows:

14-18 February	Clifford H. Fiscus on duty in Honolulu, Hawaii, to finalize plans for field studies and to assist Brian and Patricia Johnson in completing outfitting for voyage and Laysan camp
18 February	M/V Easy Rider. Fiscus, B. Johnson and P. Johnson aboard, gear loaded, depart Kewalo Basin, Honolulu, 2300 hours
19 February	Humpback whale survey, Kauai Island, Hawaii, for MMD Cetacean Task (see Table 1)
20 February	Humpback whale survey, Niihau, Lehua and Kaula Islands, Hawaii, for MMD Cetacean Task (see Table 1)
22 February	Arrived French Frigate Shoals and anchored off Tern Island at 1010 hours
24 February	Depart French Frigate Shoals at 0925 hours. Assistant Refuge Manager HPINWR joined party.

[1/] See Survey of monk seal (Monachus schauinslandi) populations of the northwestern (Leeward) Hawaiian Islands, by DeLong et al., 1976, for description of vessel.

Table 1.--
Observations of cetaceans during voyage from Honolulu, Oahu, to Laysan Island and return, 19 February to 6 March 1977

Date & hour	Location		Species	Number seen	Remarks
	Latitude	Longitude			
19 Feb.[1]					
0740	21°49'N	159°06'W	Pseudorca crassidens false killer whale	15	Kauai Channel
0918	21°57'N	159°19.3'W	Unidentified dolphin	8	Kauai,E.side
0930	21°59.6'N	159°19'W	Unidentified dolphin	1	Kauai,E.side
1208	22°14.2'N	159°26.3'W	Stenella longirostris spinner dolphin	40+	Kauai,N.side
1330	22°13'N	159°39.5'W	Unidentified dolphin	15-20	Kauai,N.side
1450	22°06'N	159°48'W	Stenella longirostris spinner dolphin	50	Kauai,W.side w/ humpbacks 1 apparent albino in group
20 Feb.[2]					
0710	21°54.8'N	159°23'W	Stenella longirostris spinner dolphin	80-100	off Kipukai, Kauai
1218	21°53.3'N	160°04'W	Stenella longirostris spinner dolphin	20+	Niihau,E.side
1610	21°45.5'N	160°15.4'W	Tursiops truncatus bottlenosed dolphin	12	Niihau,SW side bowriding
21 Feb.					
1215	22°43'N	163°30'W	Unidentified dolphin	30	did not come to vessel; passed to starboard 200 yds. off
22 Feb.					
0830	23°40'N	166°16.1'W	Tursiops truncatus bottlenosed dolphin	6	10 min. after crossing reef into French Frigate Shoals
0920	23°47'N	166°16.3'W	Tursiops truncatus bottlenosed dolphin	2	French Frigate Shoals; female w/ 1/2 grown calf

Table 1, Cont.

Date & hour	Location		Species	Number seen	Remarks
	Latitude	Longitude			
24 Feb.					
0950	23°49.7'N	166°18.5'W	Tursiops truncatus bottlenosed dolphin	2	French Frigate Shoals;bowriding
1225	23°58'N	166°42.5'W	Tursiops truncatus bottlenosed dolphin	35	Photos;Brooks Banks
25 Feb.					
1310	25°15'N	170°35'W	Unidentified dolphin	2	Maro Reef
4 Mar.					
0720	23°59'N	165°55'W	Unidentified dolphin	20±	
1545	23°35'N	164°46'W	Unidentified dolphin	2	W. of Necker Is.
5 Mar.					
0700	23°11'N	162°56'W	Unidentified dolphin	1	
1225	22°58'N	162°16'W	Unidentified dolphin	2	

1/ Kauai circumnavigated 19 February, a continuation of the Rice and Wolman humpback whale survey of the Hawaiian Islands. Humpback observations included in their report.

2/ Niihau, Lehua, and Kaula circumnavigated 20 February, a continuation of the Rice and Wolman humpback whale survey of the Hawaiian Islands. Humpback observations included in their report.

25 February	Attempted to close in to Maro Reef for survey at 1200 hours, but turned back due to foul weather.
25 February	Anchored off Laysan Island 2045 hours
2 March	Departed Laysan Island 1735 hours. Study team remaining on Island.
4 March	Surveyed west and south sides of Necker Island 1600 to 1625 hours. Foul weather prevented observation of seal hauling area. No seals seen.
6 March	M/V Easy Rider tied up Kewalo Basin, Honolulu, at 2220 hours. End of voyage.
7 March	Fiscus departs Honolulu 1430 hours, bound for Seattle, Washington.

NARRATIVE REPORT

French Frigate Shoals

The M/V Easy Rider arrived off the south side of French Frigate Shoals at 0800, 22 February, ran up past La Perouse Pinnacle and anchored off the Coast Guard LORAN Station on Tern Island at 1010 hours. Stormbound 23 February. Sea conditions moderated on 24 February, and we were able to discharge two drums of gas for the Fish and Wildlife Service field party and to obtain a drum of lubricating oil (a break in the lube oil tank line caused the loss of most of the vessel's supply on 21 February before being detected) necessary to continue the voyage. The Hawaiian and Pacific Islands National Wildlife Refuge assistant manager, J. Brent Giezentanner, joined the vessel, and we departed Tern Island at 0925 hours, 24 February.

The Fish and Wildlife Service field party at French Frigate Shoals are: Karl W. Kenyon and Mark Rauzon, who flew out to the atoll from Honolulu 17 February to begin their field studies,

which will continue until mid-May. A report of this field party will be prepared at the conclusion of their studies; however, Kenyon gave us notes on some of their observations as follow.

17 February. Kenyon counted 12 monk seals hauled out on the beach in Shark Bay, Necker Island, when they flew over. Also seen were 2 humpback whales, presumably a cow and a calf, just outside the reef off the south-eastern end of French Frigate Shoals (NE of Disappearing Island).

19 February. On this date Kenyon and Rauzon were able to census Trig, Whale-skate, Round, Mullet and associated sandspits and East Islands of French Frigate Shoals as follows:

	Combined counts, all islands			
	Male	Female	Sex?	Total
Adult	26	10	8	44
Subadult	12	6	3	21
Juvenile	12	5	3	20
Pup			1	1
	50	21	15	86

In addition, two juvenile males hauled out on Tern Island.

In comparison, on 20-22 March 1976, censuses of these same islands revealed the following components of population:

	Male	Female	Sex?	Total
Adult	16	29	2	47
Subadult	11	12	8	31
Juvenile	4	13	4	21
Pup			12	12
	31	54	26	111

Laysan Island

The M/V Easy Rider arrived off Laysan Island and anchored at 2045 hours on 25 February. On 26 February we were stormbound with seas rough and surf breaking across entrance to landing area.

On 27 February the surf, although still high, had moderated enough by 0930 so that a landing could be attempted. It was found that a landing could be made, if care were exercised coming through the large swells, which occasionally broke in the entrance channel.

The Johnsons and Fiscus began a circuit of the island moving north (clockwise) from the landing area to carry out a census of seals at 1140 hours, and completing the circuit at 1720 hours. Giezentanner proceeded to the Lagoon at the same time to survey the tide gauge site and to census birds. Capt. Naftel and his crew began the difficult task of landing supplies and equipment. The deck cargo, consisting of lumber, and some cargo from the hold was unloaded. All hands returned to the Easy Rider at 1830 hours.

28 February. The weather had greatly improved and Capt. Naftel was able to move the Easy Rider in close to the entrance channel reducing the distance boats had to travel to and from the beach. All hands turned to, and using the Zodiak and Avon rubber boats, and the aluminum boat, all gear was landed by 1430 hours. The remainder of the day was spent in carrying gear from the beach up to the camp or cache sites, and in building the camp. Giezentanner and Platino moved materials for tide gauge to the lagoon site. A tent was pitched so the Johnsons could remain

ashore. All hands worked until 1900 hours.

1 March. All hands were ashore all day. Lunch was brought in from the vessel. Most weather instruments were in place, both tents up, radio mast up, water cache built by ironwood tree, gasoline cache set up at old fuel drum site, and a head was built about 50 yards distant from the gas cache. Grocery and supply cache was established near the tents. All caches and tents were located well above the storm tide line. The Johnsons, Fiscus and Giezentanner spent the night ashore.

2 March. Fiscus assisted Giezentanner on the early morning Laysan duck survey of the lagoon returning by way of the wreck and west beach. Crew went ashore to finish up camp work. Capt. Naftel checked out radio, making contact with Coast Guard Honolulu and a commercial vessel on the Kauai-Honolulu run. Fiscus reexamined sites for intensive studies with the Johnsons and discussed seal size categories. Shore work was completed and all hands left the beach by 1715. The Johnsons remained on Laysan to begin their studies. M/V Easy Rider departed Laysan at 1735 hours on 2 March bound for Honolulu.

It would have been impossible to lighter supplies and equipment ashore, pack them up to the camp site and set up the camp in the time allotted without the untiring efforts of the entire crew of the M/V Easy Rider and their assistance is gratefully acknowledged.

GENERAL NOTES

Monk Seal Observations

A complete circuit of the island was made on 27 February proceeding clockwise from the refuge sign. Census details are listed in Table 1 and counts are segregated by prominent landmarks or areas used during the 1976 surveys. Age categories are after criteria developed by DeLong and Kenyon in 1976. Extreme care was taken during the survey to avoid disturbing seals, hence the large numbers of unsexed animals appearing in the table.

Tags. Three tagged animals were seen: 1 adult female tagged on right hind flipper (tag number not obtained), 1 adult female tagged with number 931 on both hind flippers, and 1 large juvenile tagged on the right hind flipper (tag number not obtained).

Scars. A number of scarred animals was observed and photos were taken when possible. An album of photos of scarred animals obtained in 1976 on Laysan was left with the island study team as an aid in identification of animals, and photos taken during 1977 will be added to the collection.

Photos taken 27 February and 2 March are:

Juvenile female: 27 February	left front flipper distal 1/3 missing Fiscus, roll 2, frame 3
Subadult male: 2 March	right hind flipper scar Fiscus, roll 3, frame 3

Oil (tar)

Oil globules were noted windrowed along the high tide lines in about the same quantities as observed in 1976, and could not be considered a problem. Two seals were observed with tar on their pelage: one juvenile female with two spots on the ventral

Table 2. Laysan Island census, 27 February, 1140-1720 hours.

Locality (clockwise)	Adult			Subadult			Juvenile			Yearling			Pup	Remarks
	M	F	?	M	F	?	M	F	?	M	F	?		
Refuge sign to Grave Point	2	1	1	1	1	2		2	3		1	2		1 adult female molting
Grave Point to North Sand Beach	2	3	3	1		1	1		3	1			2	
North Sand Beach to Big Log	2		1	1					1			1		
Big Log to Red Line (S.side)	10	16	1	10	4	6	12	12	11	4		4	1	large black pup
Red Line to Wreck	2	1					1	1					1	small black pup juvenile female 1/3 of left flipper missing; photo roll 2, frame 3
Wreck to Puka Shell Beach	6	1	5				1	1	1	2		1		
Puka to DeLong	6					2	1	1	3			1		
DeLong Area	1		1			2								
Fiscus Area	4		1			3							1	pup very small
Kenyon Area	2	1	2											
Kenyon to Refuge Sign						1		1	1					
	37	23	15	13	5	17	16	18	23	7	1	9	5	189 total

surface and one juvenile male with tar about the throat. There was no evidence of major oiling of beaches at Laysan resulting from the sinking of the tanker Irene's Challenger in mid-January 1977.

Green Turtles (Chelonia mydas)

Two turtles were observed during the 27 February circuit of the island, both on the southern portion of the western beach, one a female, carapace length estimated at 20 inches, and one unsexed, carapace length estimated at 12-14 inches. On 2 March at Grave Point six turtles were observed. No attempt was made to approach them, they were not sexed, and they were described as 1 very large, 2 large, 2 medium (20"), and 1 very small.

Vegetation

The Scaevola growing along the beach crest and back inland up to 25 yards in some places, principally along the western shore of Laysan, had been washed by storm tides apparently in November (storm waves washed over islands of French Frigate Shoals during that month) and top growth had been killed. Some new growth was seen, but the lack of sheltering vegetation may alter monk seal behavior and haulout patterns in this area during the 1977 season.