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THE HAWAIIAN MONK SEAL IN THE NORTHWESTERN HAWAIIAN ISLANDS, 1992

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NOAA-TM-NMFS-SWFSC-216

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

NOAA Technical Memorandum NMFS

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EXECUTIVE SUMMARY

During 1992, field studies of the endangered Hawaiian monk seal (*Monachus schauinslandi*) were conducted at all of its main reproductive sites in the Northwestern Hawaiian Islands, although studies were intermittent at Midway Islands and brief at Pearl and Hermes Reef. In addition, Nihoa Island was visited by a collaborating scientist. Such studies provide information necessary to (1) assess the status and trends of monk seal populations, (2) characterize natural history traits such as survival, reproduction, growth, behavior, and food habits, and (3) evaluate the success of various recovery activities. The availability of up-to-date information is essential for ongoing efforts to mitigate the decline of this species and enhance its recovery.

Studies conducted during 1992 indicated that significant problems continued to impede recovery. The total number of births at the main reproductive sites increased to 204, well above the marked low of 142 in 1990. However, mortality of immature seals remained extremely high at French Frigate Shoals, the largest population, and the total of mean beach counts remained well below counts in the mid 1980s. Mobbing continued to be a significant problem; at Laysan Island, 10 animals either died or disappeared after receiving mobbing wounds. Only one animal was known to have died from mobbing at Lisianski Island, but at least 11 others were moderately or severely injured.

In 1992, three management activities or events occurred which have significant implications for the recovery and management of this species. First, the Kure Atoll LORAN station was closed and vacated by the U.S. Coast Guard, leaving the atoll uninhabited. Thus, human disturbance on land should not continue to impede the recovery of the seal population at this site. Second, collection of seals from French Frigate Shoals was increased significantly (approximately threefold) to salvage the reproductive potential lost because of the high mortality of juvenile seals. These seals were released at Midway to enhance the recovery of its long-depleted population. Third, field trials were conducted at Laysan Island to determine if drug treatment could be used to lower testosterone levels in adult males and if the treatment had any severe, unpredicted effects on those males. This document describes these and other field studies conducted in 1992. The reporting format has been changed from that in previous years. First, all field studies are reported in a single document to minimize duplication of effort and to facilitate comparison of status and trends among the different reproductive populations. Second, the data are summarized in tables rather than reported in detail. The summaries are intended to provide readily interpreted information to the agencies and organizations involved in the management of the species. These changes in format should hasten the dissemination of field camp results which is essential for responsive, timely management of the species.

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CHAPTER 1. GENERAL INTRODUCTION

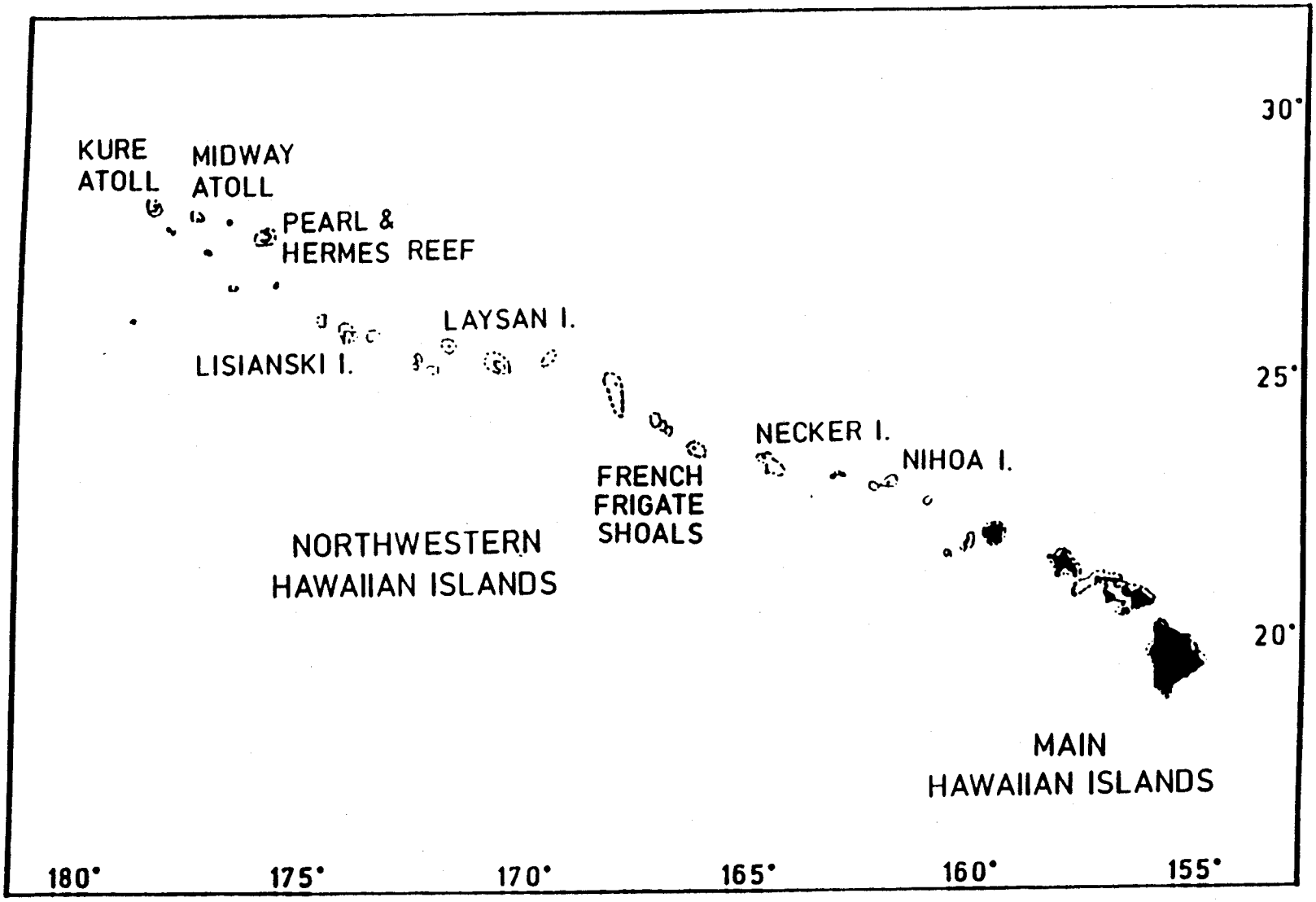

Fig. 1.1 Map of the Hawaiian Islands

The endangered Hawaiian monk seal (*Monachus schauinslandi*) hauls out and breeds in the Northwestern Hawaiian Islands, (NWHI, Fig. 1.1). The Southwest Fisheries Science Center, Honolulu Laboratory, National Marine Fisheries Service (NMFS), began research on Hawaiian monk seals at most major reproductive sites in the NWHI in 1981 (Kure Atoll and Lisianski Island) and 1982 (French Frigate Shoals (FFS), Laysan Island, and Pearl and Hermes Reef). Nearly every year thereafter, field camps of several days to 9 months were established to monitor and enhance the recovery of this species. Limited population monitoring has also been conducted at Midway Islands, where current pup production is well below historical levels, and at Nihoa and Necker Islands, where pup production is limited by haulout area. Reports summarizing past NMFS research are listed in Appendix A.

In 1992, the objectives of Hawaiian monk seal research were to (1) conduct beach counts (censuses), (2) tag weaned pups and immature seals for permanent identification, (3) identify other seals by previously applied tags and by natural or applied markings, (4) monitor reproduction, survival, injuries, entanglements, interatoll movements, disappearances, and deaths, (5) perform necropsies, (6) collect scat and spew samples for food habit analysis, (7) collect tissue samples for DNA analysis of paternity patterns and genetic variation within and among populations, and (8) inventory, sample, and destroy debris capable of entangling seals. Location-specific objectives are described in the following chapters. This report summarizes data collected during the 1992 field season.

MATERIALS AND METHODS

Censuses and Patrols

The primary means of data collection were censuses and patrols. Censuses consisted of timed, standardized beach counts during which an entire island or atoll was surveyed for seals. The resulting counts provided an index of population size for comparison among years and locations. Data collected on each seal observed during censuses included size class (as described in Stone, 1984), sex, location on the island, beach position (indicating distance from the water), identification information (permanent or temporary identification numbers and tag numbers), molting status (an estimate of the percentage an animal has molted), and disturbance index (the extent that the observer disturbed the seal). In addition, subjective estimates of the body condition of seals (e.g., fat, thin, or emaciated) were collected at Laysan Island and FFS, and behavior data (focusing on associations and interactions between seals) were collected on Laysan and Lisianski Islands. A sample census form and guidelines for its completion are included in Appendix B. Censuses were conducted daily (at Pearl and Hermes Reef), or every 4 to 7 days (at all other locations), starting at 1300 Hawaii standard time when possible, using census methods and criteria outlined in Johanos et al. (1987). Atoll-wide counts for locations with more than a single island (French Frigate

Shoals, Pearl and Hermes Reef, Midway Islands, and Kure Atoll) were completed within a 2-day period. Census methods specific to each location are detailed in the following chapters.

Patrols consisted of untimed surveys of all or a portion of an island perimeter. Information collected during patrols was similar to that collected during censuses. Because patrols were not timed, observers concentrated on documenting adult and subadult behavior, identifying and marking individuals, and collecting scat samples. Island-specific standardized patrols were conducted at some locations and are described in the following chapters.

During all observation periods (i.e., censuses, patrols, and incidental sightings), observers attempted to minimize seal disturbance by walking above the beach crest and using vegetation for cover. On census days, activities which could disturb the animals and bias the count were not conducted until after the count was completed. Additionally, special efforts were directed toward documentation of (1) births, pup exchanges, and weanings, (2) mating activities, adult male aggression, and post-mobbing aggregations, (3) entanglements in marine debris, (4) injuries, and (5) deaths.

The average nursing period was calculated for the pups at each location. In addition, the average lactation period of parturient females was calculated for the population at FFS because of difficulties in tracking pups (and obtaining nursing periods) at that site. Nursing or lactation periods were defined as the length of time (days) from birth (or pupping) until the end of the last nursing relationship for the pup (or parturient female). Temporary breaks in nursing relationships were not subtracted from the total. When a birth or weaning date was not known exactly, but must have occurred within a range of four days or less, then the midpoint of that range was used in the calculation of the average nursing or lactation period. Nursing or lactation data were not used if the known range exceeded four days, or if the pup died or disappeared before weaning.

Male aggression was observed and recorded. Aggression was defined as incidents where adult or subadult males repeatedly bit the dorsum, attempted to mount, and tried to prevent the escape of the subject. These incidents were summarized here if they simultaneously involved more than one male aggressor or resulted in at least one puncture or gaping wound (missing skin or extending into the fat layer) or 15 scratches to the dorsum or laterals. Post-mobbing aggregations were also summarized: these were groups of males congregated on the beach, attending a seal with new mounting injuries as described above.

A wide range of injury types (Hiruki et al. 1993) were observed. In general, however, injuries were documented if they were related to mounting or entanglement or if they were considered severe enough to affect survival. Injuries summarized here were at least as severe as follows: 1) three or more abscesses, each <5 cm in diameter, or one abscess with a diameter $\geq$5 cm, (2) an amputation of more than one digit (either foreflipper or hindflipper), (3) at least three punctures or gaping wounds (skin missing or wound extending into the fat layer), if largest dimension was <5 cm, or one gaping wound with

a maximum diameter-largest dimension ≥5 cm, or (4) densely spaced (overlapping) scratches, abrasions, or lacerations covering an area equivalent to half the dorsum, or evidence of extensive underlying tissue damage (e.g., an uneven or darkened surface of the injured area, leaching fluids, or impaired seal movement). We did not include injuries that were already healed when they were first observed.

A seal was considered dead only if its death or carcass were observed. Deaths summarized here include carcasses found at the beginning of the field season if the seal had clearly died during the calendar year. A seal was assumed to have died if it sustained injuries (at least as severe as described above) or was severely emaciated (with extreme loss of weight so that its skeleton was clearly evident) and subsequently disappeared. In addition, one of the following conditions must have been satisfied (1) the seal was lethargic, had trouble moving, or floated listlessly in the water, and disappeared more than a week before the end of data collection, or (2) the seal was in deteriorating condition (loss of weight, enlargement of abscesses, sloughing of skin) and disappeared at least 10 surveys or 1 month before the end of data collection (whichever was longer). Nursing pups were assumed dead if they disappeared within 3 weeks of birth.

Individual Identification

During censuses and patrols, individual seals were identified by tags, applied bleach marks, scars, or natural markings. After weaning, all pups were tagged as soon as possible on each hind flipper with a colored plastic Temple Tag®, uniquely coded to indicate island or atoll population (by color), year of birth (by letter prefix), and individual ID (by numerical sequence; Gilmartin et al., 1986). In addition, two passive integrated transponder (PIT) tags were implanted subcutaneously in the dorsum of each weaned pup, approximately 10 cm anterior to the base of the tail and 7.5 cm on either side of the spine (see Lombard et al., 1994, for detailed tagging procedures). Untagged immature seals were tagged only with Temple Tags which were uniquely coded to indicate that their age and birth location were unknown. Immature seals with lost or broken tags were retagged to maintain their identities. Tags, scars, natural markings, and any applied bleach marks of each seal were sketched on a scar card, which was revised throughout the field season to maintain a current description of the identifying marks of each seal. Photographs of scars and natural markings were added to individual identification files begun during 1981 or 1982.

At four locations (Laysan and Lisianski Islands, and Kure and Midway Atolls), adult and subadult seals were bleach-marked for individual identification (Stone, 1984), using the solution described in Johanos et al. (1987). Molting adults and subadults were re-marked to maintain their identities. At Laysan Island, nursing pups were also bleached prior to molt.

Population size and composition were determined at locations where all seals were identified; partial composition was determined where all seals within certain size and sex classes

were identified. These statistics included all individuals seen alive at the location from March through August and all pups born during the year. If a seal were seen at more than one location during this period, it was included in the population where it was first seen unless it pupped. A parturient female was always included in the population where it pupped, if it were seen there anytime during March-August.

Measurements of Seals

Measurements of seals were taken to determine monk seal growth patterns and to assess the effects of size on survival. Straight dorsal length (Winchell, 1990) and axillary girth (American Society of Mammalogists, 1967) were measured on weaned pups at the time of tagging. At two locations (FFS and Laysan Island), weights of weaned pups, yearlings, and juveniles were measured by suspending the seal in a net from a spring scale. In addition to the straight dorsal length and axillary girth, standard length (measured along the ventral side; American Society of Mammalogists, 1967) was measured on seals weighed at FFS.

Collection of Samples

Samples were collected for DNA analysis, pathological analysis, investigation of food habits, and documentation of marine debris. Tissue samples for DNA analysis were collected during tagging efforts for all newly tagged or retagged seals, and during necropsies on recently dead seals. Samples of sloughed epidermis and fur from molting seals were also collected on an opportunistic basis for DNA analysis. The primary objectives of these analyses are to investigate paternity patterns and determine genetic variability within and among populations.

For each dead seal recovered, an external examination was made, photographs were taken, external measurements and observations were recorded, and the skull was collected (for all seals except pups). For a recent death, an internal examination was made, and samples of tissue, organs, parasites, and stomach contents were collected. Detailed descriptions of necropsy procedures and sample collection methods are in Winchell (1990).

Scat and spew samples from seals were collected for analysis of food habits, following the methods in Alcorn (1984). Emphasis was placed on collecting scat and spew samples from seals of known size and sex class, but samples from seals of unknown size and sex class were also collected.

Nets, lines, ropes, and other debris items capable of entangling seals and turtles were inventoried and destroyed, following the methods in Johanos and Kam (1986).

CHAPTER 2. THE HAWAIIAN MONK SEAL ON FRENCH FRIGATE SHOALS, 1992

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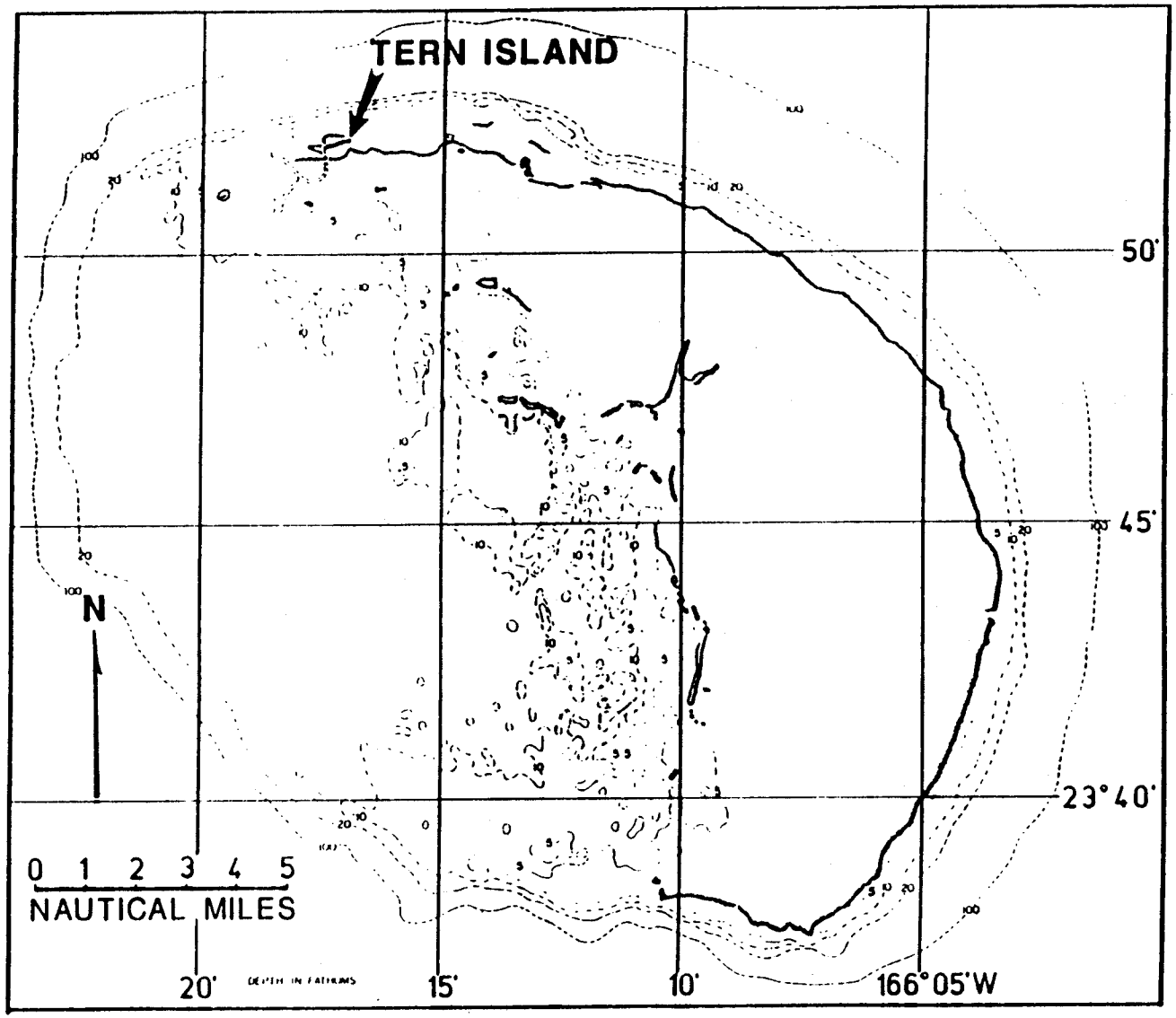


Fig. 2.1 Map of French Frigate Shoals, Northwestern Hawaiian Islands

The largest population of Hawaiian monk seals is located at French Frigate Shoals (FFS, lat. 23°45'N, long. 166°10'W), ca. 830 km northwest of Oahu in the Northwestern Hawaiian Islands (NWHI). This atoll is part of the Hawaiian Islands National Wildlife Refuge (Fig. 1.1), and consists of 10 permanent islands and 7 semi-permanent sand spits (Fig. 2.1).

ACTIVITIES

Research was conducted by the National Marine Fisheries Service (NMFS) during March 27 - December 19. In addition, Tern Island censuses and incidental observations were recorded by U.S. Fish and Wildlife Service (FWS) personnel during those portions of the year when NMFS personnel were not present. For the purpose of seal data collection, the perimeters of six of the larger islands were divided into sectors using artificial or natural landmarks. In 1992, research objectives specific to this population included (1) collection of blood samples from emaciated and healthy seals for assessment of potential disease problems, (2) capture of undersized weaned pups and emaciated juveniles for rehabilitation and translocation, (3) measurement of weaned pups and juvenile seals for a growth and condition study, (4) assessment of nearshore prey availability, and (5) investigation of habitat use patterns using satellite-linked telemetry.

Censuses and Patrols

Atoll censuses (n = 11) were conducted by two to four observers every 13 d, on average, from 4 April to 22 August. Each atoll census began between 0900 and 1100 Hawaii standard time and ended between 1500 and 1800. Round Island and Mullet Island were censused from a boat, while the remaining islands were censused on foot by one or two persons. From 5 January to 25 December, 1992, FWS and NMFS personnel conducted 34 censuses of seals on Tern Island.

Patrols were conducted on non-census days. Emphasis was placed on monitoring islets where females gave birth; these were visited every 3-6 d to monitor pupping activity. Patrols of Tern Island were conducted every 2-5 d.

Individual Identification

A total of 545 individuals (443 excluding pups) were identified by existing or newly applied tags, scars, or natural markings. Most weaned pups were tagged (n = 91) with Temple Tags; 78 pups were tagged with passive integrated transponder (PIT) tags. Twenty-three immature seals (13 male, 10 female) were retagged.

Collection of Samples

One hundred and sixty-six scat and spew samples were collected. Ninety-five tissue samples were collected from weaned pups and other seals during tagging. Thirty-three blood samples were collected from 1 subadult, 23 juveniles, and 4 weaned pups. Seven urine samples (in sand) were also collected. Necropsies were performed on seven wild seals, a seal collected for rehabilitation, and a fetus; tissue samples and skulls were collected from six of these dead seals. In total, 221 pieces of potentially dangerous debris were inventoried and destroyed before the end of the field season. Analysis of these samples will be presented elsewhere.

Special Studies

Blood Sampling

During autumn 1991 and winter 1992, FWS personnel at FFS notified NMFS of an unusual number of emaciated and dying weaned pups and juveniles. As a result, in April, 19 emaciated and healthy juvenile seals were weighed and measured and samples were taken of blood, feces, and nasal mucous to test for signs of disease, viruses, and severe parasite problems. The results of this study are reported in Gilmartin and Ragen (1992).

Seals Collected for Rehabilitation

Since 1984, NMFS has collected female pups whose size at weaning indicated their chance of survival to age 1 was relatively low compared to survival of larger seals (Gilmartin and Gerrodette, 1986). Pups, with axillary girths <90 cm at weaning, were transported by airplane or ship from FFS to captive care facilities on Oahu for rehabilitation. After reaching a minimum weight and consistently maintaining good health (8-12 mo after capture), they were reintroduced at Kure Atoll or Midway Islands. In 1992, this rehabilitation program was expanded to include weaned female pups with axillary girths $\leq$95 cm because evaluation of recent survival data (NMFS unpublished data) revealed that pups with girths of 90-95 cm also had substantially lower survival rates than larger seals. Eleven recently weaned female pups with axillary girths $\leq$95 cm were collected and, beginning in May, 10 1-year-olds (8 female, 2 male), 3 2-year-olds (2 female, 1 male), and 4 3-year-olds (3 female, 1 male) were also collected.

These seals were held on Tern Island for up to 29 d before transport to Oahu or Midway Islands. During the holding period, they were treated for infections and dehydration and were tube-fed fluids, including a milk replacer formula. Of the 28 seals collected, 1 weaned female pup died, 4 seals (1-year-old female, 1-year-old male, 3-year-old female, and 3-year-old male) were released at FFS to avoid their exposure to seals already in captivity (and that may have been infected with leptospira), and the remaining 23 seals were transported to Oahu or Midway

Islands. Of the 23 seals transported from FFS, 3 seals (1 weaned female pup, a 1-year-old male, and a 2-year-old male) died on Oahu, 6 weaned female pups remained in rehabilitation on Oahu for the remainder of 1992, and the remaining 14 seals were transported either directly to Midway or to Midway after rehabilitation on Oahu. Results of rehabilitation efforts will be presented elsewhere.

Growth Study

As part of a study comparing growth between the weaned pups and juveniles at Laysan Island and FFS, 71 weaned pups were weighed and measured within 2 weeks of weaning. In addition, 26 1-year-olds and 11 2-year-olds were weighed and measured in 1992. Results of this study will be presented elsewhere.

Prey Availability

The Insular Resources Investigation (IRI) of the Honolulu Laboratory, NMFS, conducted a study at FFS to determine if a decline has occurred in fish stocks that are potential prey for seals (DeMartini et al., 1993). A significant decline in prey availability might explain the observed changes in condition and survival of immature seals. In July, the IRI conducted transect surveys at nine stations around FFS, to sample and estimate densities of reef fishes; these surveys replicated surveys conducted at FFS during 1980-83. The results of this research are reported in DeMartini et al. (1993).

Habitat Use Study

In September, three molted subadult males were satellite-tagged as part of a habitat use pilot study. The results of this study will be presented elsewhere.

FINDINGS

Population Abundance and Composition

The means (±SD) for 11 atoll censuses conducted in 1992 were 224 seals (±33.1) including pups, and 175 seals (±18.1) excluding pups (Table 2.1). The total spring-summer population included 311 immature individuals (subadults, juveniles, and pups), of which 209 were subadults or juveniles (Table 2.2). The numbers of tagged known-age seals born at FFS during 1984-91 and resighted there in 1992 are summarized in Table 2.3.

Reproduction

At least 102 pups were born: 91 weaned, 5 died or disappeared prior to weaning, 2 pups were still nursing at the end of the field season, and the fate of 4 pups was unknown (Table 2.4a). A summary of nursing periods and measurements of weaned pups is in Table 2.4b.

An unknown number of adult-sized females were not identified, but 168 were identified and 76 (45%) of those gave birth. For untagged adult females (>8 years old) the birth rate was 54% (64/119) and for tagged females ($\leq$8 years old) the birth rate was 24% (12/49). Note that parturient females were more likely to be identified, which would bias estimates of birth rate upward. The mean (±SD) lactation period was 38.4 d (±6.0 d).

Interatoll Movement

In 1992, interatoll movement was documented for seven seals that made a total of 11 trips between FFS and Laysan (Tables 2.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by males, entanglement, emaciation, and other unknown factors resulted in 42 life-threatening conditions, which led to the confirmed deaths of 12 animals and the probable death of another seal (Table 2.6). Two incidents of adult male aggression were observed, and two seals died following unobserved male mounting incidents. Five emaciated seals died. Two seals were entangled and subsequently released by observers. In addition to the deaths presented in Table 2.6, a small weaned female pup, captured for rehabilitation, died at FFS while awaiting transportation to Oahu, and an aborted fetus was found on Tern Island in December 1992.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service and Hawaiian Islands National Wildlife Refuge Staffs. We thank the captain, officers, and crew of the NOAA ship *Townsend Cromwell* for logistical assistance.

TABLES

Table 2.1.--Summary statistics for atoll censuses (n = 11) of Hawaiian monk seals at French Frigate Shoals from April 4 to August 22, 1992.

Size/Sex	Mean number of individuals	Standard deviation
Adults	118.0	10.7
Male	26.4	5.2
Female	57.9	7.9
Unknown	33.7	8.6
Subadults	43.8	14.5
Male	20.5	7.3
Female	16.1	5.8
Unknown	7.2	5.1
Juveniles	11.7	2.5
Male	4.1	2.3
Female	6.5	2.3
Unknown	1.1	0.9
Pups	48.9	18.3
Male	11.2	7.5
Female	14.5	8.8
Unknown	23.2	11.3
Non-pup Total	175.2	18.1
Grand Total	224.1	33.1

Table 2.2.--Composition of the Hawaiian monk seal population at French Frigate Shoals during the spring and summer of 1992. Includes all pups born during the calendar year. Dashed lines indicate that the number of seals in a size-sex class was undetermined.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	--	--	--	--	--
Subadults	81	65	0	146	1.2:1
Juveniles	17	46	0	63	0.4:1
Pups	38[a]	56[b]	8[b]	102	0.7:1
Non-pup Total	--	--	--	--	--
Grand Total	--	--	--	--	--

[a]Two neonatal pup deaths.
[b]One neonatal pup death.

Table 2.3.--Summary of tagged known-age seals born at French Frigate Shoals and resighted there in 1992.

Age (years)	Sex	Number originally tagged	Number resighted in 1992
8	Male	49	18
	Female	43	27
7	Male	48	17
	Female	38	19
6	Male	52	17
	Female	48	24
5	Male	55	25
	Female	51	21
4	Male	52	15
	Female	62	14
3	Male	51	17
	Female	50	16
2	Male	41	12
	Female	38	3
1	Male	24	6
	Female	44	30

Table 2.4a.--Summary of Hawaiian monk seals born at French Frigate Shoals in 1992.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	38	56	8	102
Died/probably died prior to weaning	2	1	2	5
Fate unknown	0	0	4	4
Still nursing	0	0	2	2
Weaned	36	55	0	91
Tagged	36	55	0	91[a]

[a]At the end of the field season, one weaned pup had not been tagged and two pups were still nursing (neither had been tagged). One of these three pups was tagged in January 1993.

Table 2.4b.--Summary of nursing periods and measurements of weaned pups at French Frigate Shoals in 1992. Nursing periods were calculated where both birth and weaning date ranges were ≤4 d. All measurements were taken within two weeks after weaning. Measurements include 16 pups with an axillary girth of ≤95 cm.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)	Weight (kg)
Mean	36.1	103.1	125.2	63.1
St. Dev.	3.1	9.6	6.5	15.1
n	5	71	71	70

Table 2.5a.--Known movement of Hawaiian monk seals to French Frigate Shoals from other locations in 1992, summarized by number of trips. Some seals made more than one trip.

Original location	Number, size, and sex class
Laysan Island	5 adult females

Table 2.5b.--Known movement of Hawaiian monk seals from French Frigate Shoals to other locations in 1992, summarized by number of trips. Some seals made more than one trip.

Destination	Number, size, and sex class
Laysan Island	1 adult male, 4 adult females, 1 subadult male

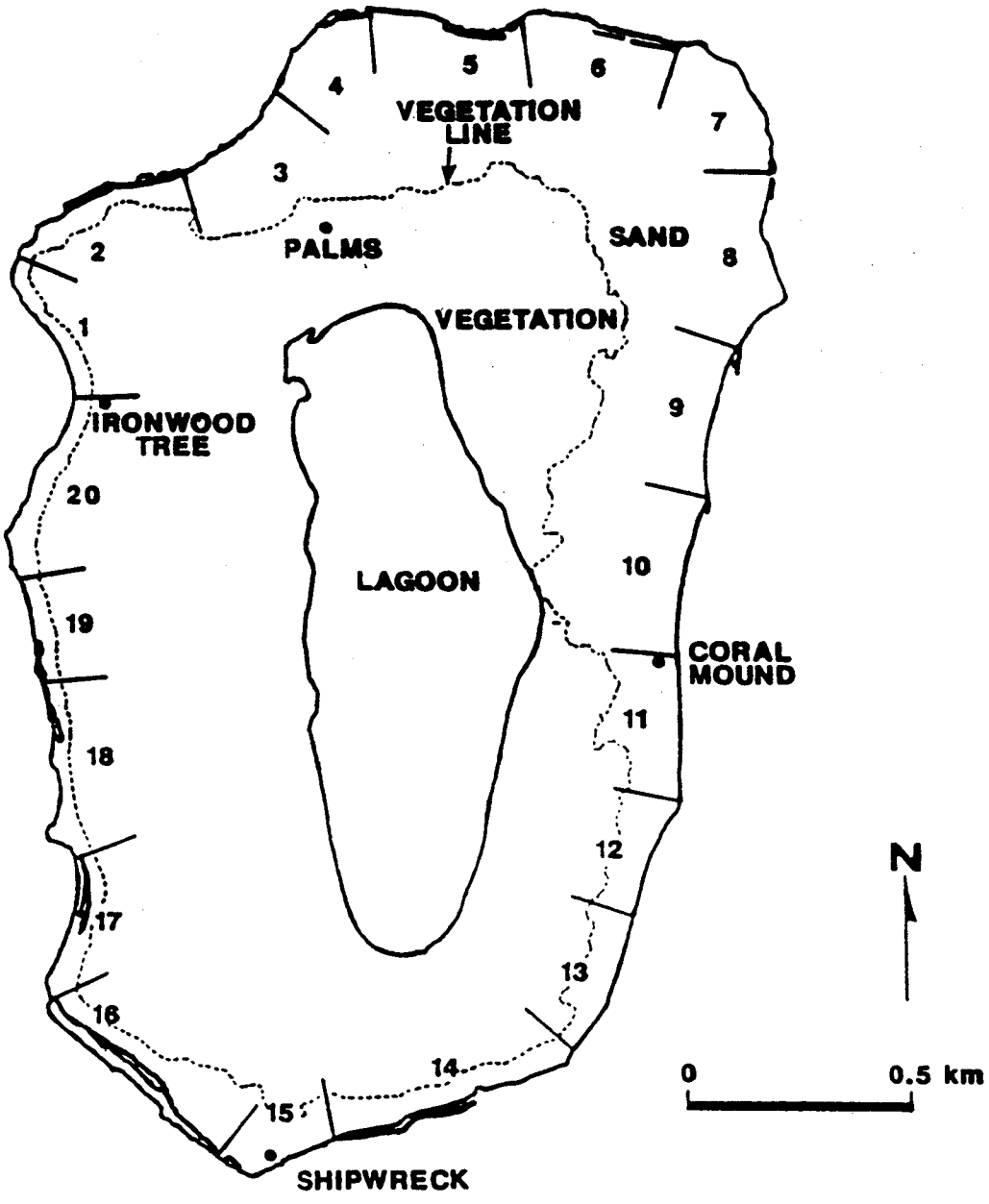
Table 2.6.--Factors affecting Hawaiian monk seal survival at French Frigate Shoals in 1992. Does not include captive seals.

Size	Sex	Outcome			
		Total	Injured	Died	Probably died
Attack by Large Shark					
Adult	Male	4	4	0	0
	Female	1	1	0	0
Subadult	Male	3	3	0	0
	Female	1	1	0	0
Juvenile	Male	1	1	0	0
	Female	2	2	0	0
Weaned pup	Female	1	1	0	0
Mounting by Males					
Adult	Female	7[a]	4[b]	1	0
Subadult	Male	1	1	0	0
	Female	1	1	0	0
Nursing pup	Male	1	0	1	0
Entanglement					
Adult	Female	1[c]	0	0	0
Subadult	Female	1[c]	0	0	0
Emaciation					
Subadult	Male	1	0	1	0
Juvenile	Male	1	0	1	0
	Female	3	0	3	0
Other/Unknown					
Adult	Male	2	2	0	0
	Female	4	3	1	0
Subadult	Female	1	1	0	0
Juvenile	Female	1	0	1	0
Nursing	Male	1	0	1	0
pup	Female	1	0	1	0
	Unknown	2	0	1	1

[a]Two incidents were observed involving 5 and 7 males, respectively. These did not result in serious injury.
[b]A seal with male mounting injuries was also attacked by a shark.
[c]Seal was released by observers.

CHAPTER 3. THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND, 1992

Brenda L. Becker, John R. Klavitter, Leona P. Laniawe, Walter A. Machado, Timothy J. Ragen, and Molly B. Tarleton



LAYSAN ISLAND

Fig. 3.1 Map of Laysan Island, Northwestern Hawaiian Islands

Laysan Island (lat. 25°42'N, long. 171°44'W) is located ca. 1300 km northwest of Oahu in the Northwestern Hawaiian Islands (Fig. 1.1). This island lies within the Hawaiian Islands National Wildlife Refuge, and is one of the major haulout and pupping locations of the Hawaiian monk seal.

ACTIVITIES

Research was conducted by the National Marine Fisheries Service (NMFS) during March 23-July 25, and incidental observations were recorded by Fish and Wildlife Service personnel during those portions of the year when NMFS personnel were not present. For the purpose of seal data collection, the perimeter of the island (ca. 11 km) was divided into 20 sectors using artificial or natural landmarks (Fig. 3.1). In 1992, research objectives specific to this population included identification of all seals, documentation of male behavioral patterns and aggression, assessment of maternity and pup switches, and measurement of weaned pups and juveniles for a growth and condition study. Additionally, a sample of adult male seals were injected with a gonadotropin-releasing hormone (GnRH)-agonist to evaluate its effectiveness in reducing blood levels of testosterone and determine if it might have severe unanticipated side effects on these seals or their behavior.

Censuses and Patrols

Censuses and patrols were scheduled to ensure that the entire island perimeter was monitored at least once each day during March 27-July 24. Twenty-seven censuses were conducted by two observers every 4th day from 30 March to 12 July. Each census began at 1300 Hawaii standard time and continued for 2.4 to 3.7 h.

Standardized behavior patrols, conducted on non-census days, focused on activity patterns of adults and large subadults to document male aggression and detect mobbing incidents in which multiple males attempted to mate with a single seal, usually an adult female, causing injury or death of that seal (e.g., Alcorn 1984). During these patrols (n = 135), attention was directed out to sea as much as possible, as mobbings have been documented most frequently in the water.

Individual Identification

A total of 264 individuals (226 excluding pups) were identified by existing or newly applied tags, bleach marks, scars, or natural markings. Bleach marks were applied to 195 seals, including 22 nursing pups. Most weaned pups were tagged (n = 32) with Temple Tags and passive integrated transponder (PIT) tags. Eight immature seals (6 male, 2 female) and 23 adult males were retagged.

Collection of Samples

Thirty-four scat and spew samples were collected. Molt samples were collected from 57 different individuals. Sixty-two tissue plugs were collected from weaned pups and other seals during tagging. Necropsies were performed and tissue samples were collected from 11 dead seals. Eight skulls and seven complete skeletons were collected. In total, 626 pieces of potentially dangerous debris were inventoried; one entanglement item was removed from a seal and collected, the remainder were destroyed before the end of the field season. Analysis of these samples will be presented elsewhere.

Special Studies

Growth Study

As part of a study comparing growth between the weaned pups and juveniles at Laysan Island and French Frigate Shoals (FFS), 32 weaned pups were measured within two weeks of weaning. In addition, 23 one-year-olds and 10 two-year-olds were measured in 1992. Results of this study will be presented elsewhere.

Testosterone-suppressant Drug Study

As part of management efforts to minimize seal deaths resulting from severe mobbing attacks, a testosterone suppressing drug was administered to 11 adult males as a pilot field trial. The study animals were divided into three groups: treated, control for treatment, and control for handling. Each captured animal initially received a 20.0 mg dose of valium, after which a blood sample was drawn. Animals in the treatment group received a 7.5 mg dose of Decapeptyl® and were fitted with an instrument pack (time-depth recorder and a very-high-frequency (VHF) radio transmitter). Animals in the treatment control group also were fitted with an instrument pack. These two groups were re-captured at a later date to recover the time-depth recorders and collect a second blood sample. The last group, control for handling, was captured near the end of the season for collection of a blood sample. The blood samples were used to assess plasma levels of testosterone prior to and after treatment. The time-depth recorders and VHF radio transmitters were used to assess haulout and diving patterns.

Thirty-three adult males were captured for the drug study: 11 in the treatment group (one died during capture), 9 in the treatment control group, 10 in the handling control group, and 3 additional animals that were captured, determined unfit for the study, and then released. Results of this study will be presented elsewhere.

FINDINGS

Population Abundance and Composition

The means (±SD) for 27 census counts conducted in 1992 were 92 seals (±12.5) including pups, and 74 seals (±9.5) excluding pups (Table 3.1). The total spring-summer population was 260 individuals, 222 excluding pups (Table 3.2). The sex ratios of non-pup immature seals and adults were 1.2:1 (35 males: 29 females) and 1.5:1 (94 males: 64 females), respectively. Within the adult class, the male skewed sex ratio was due to older, unknown-aged seals, where the male to female ratio was 1.8:1 (64 males: 36 females); in the seals of adult size, but for animals ≤9 years of age, the sex ratio was 1.1:1 (30 males: 28 females). Table 3.3 summarizes the number of tagged known-age seals born at Laysan Island during 1983-91 and resighted there in 1992.

Reproduction

At least 38 pups were born: 35 weaned and 3 died prior to weaning (Table 3.4a). A summary of nursing periods and measurements of weaned pups is in Table 3.4b. Thirty-eight of 64 (59%) adult-sized females gave birth. At least 18 pup exchanges occurred between 15 nursing females; researchers observed two of these incidents.

Interatoll Movement

In 1992, interatoll movement was documented for 15 seals that made a total of 25 trips between Laysan Island and either FFS, Lisianski Island, or Pearl and Hermes Reef (Tables 3.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by males, entanglement, and other-unknown factors led to 24 life-threatening conditions, which resulted in the confirmed deaths of 11 animals and the probable deaths of 3 other seals (Table 3.6). Two post-mobbing aggregations were observed; in one aggregation, the mobbed seal died. Six seals died following unobserved male mounting incidents, including a seal with fresh mobbing wounds that was attacked and killed by a shark. Two seals were entangled: one escaped by itself, and the other was released by observers.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge staff and thank the captains and crew members of the NOAA ship *Townsend Cromwell*. Special thanks are extended to Jim Applegate, Donna Ball, Pam Bruce, Tony Chappelle, Jennifer Gervais, Randy Hertzel, A. Kay Kepler, Cindy Newton, Willie Joe Rogers, and Rick Schauffer for their data collection and tagging assistance.

TABLES

Table 3.1.--Summary statistics for atoll censuses (n = 11) of Hawaiian monk seals at Laysan Island from March 30 to July 12, 1992.

Size/Sex	Mean number of individuals	Standard deviation
Adults	51.1	7.1
Male	25.7	5.2
Female	22.9	5.3
Unknown	2.5	3.0
Subadults	8.6	4.1
Male	5.5	2.8
Female	2.7	2.0
Unknown	0.3	0.6
Juveniles	14.6	3.9
Male	7.4	2.5
Female	6.4	1.9
Unknown	0.8	1.6
Pups	17.6	6.0
Male	8.5	4.3
Female	6.7	2.9
Unknown	2.4	2.0
Non-pup Total	74.3	9.5
Grand Total	91.9	12.5

Table 3.2.--Composition of the Hawaiian monk seal population at Laysan Island during the spring and summer of 1992. Includes all pups born during the calendar year.

Size	Number of seals			Sex ratio male:female
	Male	Female	Total	
Adults	94	64	158	1.5:1
Subadults	17	10	27	1.7:1
Juveniles	18	19	37	0.9:1
Pups	22[a]	16[a]	38	1.4:1
Non-pup Total	129	93	222	1.4:1
Grand Total	151	109	260	1.4:1

[a]One neonatal pup death.

Table 3.3.--Summary of tagged known-age seals born at Laysan Island and resighted there in 1992.

Age (years)	Sex	Number originally tagged	Number resighted in 1992
9	Male	10	1
	Female	10	6
8	Male	16	6
	Female	13	5
7	Male	16	5
	Female	14	5
6	Male	15	6
	Female	17	5
5	Male	13	4
	Female	15	6
4	Male	23	7
	Female	17	4
3	Male	16	7
	Female	13	5
2	Male	7	4
	Female	9	7
1	Male	18	14
	Female	13	12

Table 3.4a.--Summary of Hawaiian monk seals born at Laysan Island in 1992.

Event	Number of pups		
	Male	Female	Total
Born	22	16	38
Died/probably died prior to weaning	2	1	3
Weaned	20	15	35
Tagged	18	14	32

Table 3.4b.--Summary of nursing periods and measurements of weaned pups at Laysan Island in 1992. Nursing periods were calculated where both birth and weaning date ranges were ≤4 d. All measurements were taken within two weeks after weaning. Measurements include one pup with an axillary girth of ≤95 cm.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)	Weight (kg)
Mean	38.1	107.2	124.6	69.2
St. Dev.	4.2	6.7	5.7	10.0
n	22	32	32	32

Table 3.5a.--Known movement of Hawaiian monk seals to Laysan Island from other locations in 1992, summarized by number of trips. Some seals made more than one trip.

Original location	Number, size, and sex class
French Frigate Shoals	1 adult male 4 adult females, 1 subadult male
Lisianski Island	2 adult females, 1 adult male, 1 subadult female
Pearl and Hermes Reef	1 subadult female

Table 3.5b.--Known movement of Hawaiian monk seals from Laysan Island to other locations in 1992, summarized by number of trips. Some seals made more than one trip.

Destination	Number, size, and sex class
French Frigate Shoals	5 adult females
Lisianski Island	2 adult males, 4 adult females 2 subadult females 1 juvenile male

Table 3.6.--Factors affecting Hawaiian monk seal survival at Laysan Island in 1992.

Size	Sex	Outcome			
		Total	Injured	Died	Probably died
Attack by Large Shark					
Adult	Male	2	2	0	0
Subadult	Female	1	1	0	0
Juvenile	Female	1	1	0	0
Mounting by Males					
Adult	Male	1	0	1	0
	Female	6[a]	2	2[b]	1
Subadult	Male	3	1	2[c]	0
	Female	3	0	1	2
Juvenile	Male	1	0	1	0
Entanglement					
Adult	Male	1[d]	0	0	0
	Female	1[e]	0	0	0
Other/Unknown					
Adult	Male	1	0	1	0
Nursing	Male	2	0	2	0
pup	Female	1	0	1	0

[a]A post-mobbing aggregation of 3-5 males was observed, the seal did not appear to be seriously injured.
[b]A post-mobbing aggregation of 3-4 males was observed for one of the seals.
[c]A seal with male mounting injuries was subsequently attacked by a shark.
[d]Seal was released by observers.
[e]Seal escaped by itself.

CHAPTER 4. THE HAWAIIAN MONK SEAL ON LISIANSKI ISLAND, 1992

Lisa M. Hiruki, Heather L. Johnston, and S. E. Roian Egnor

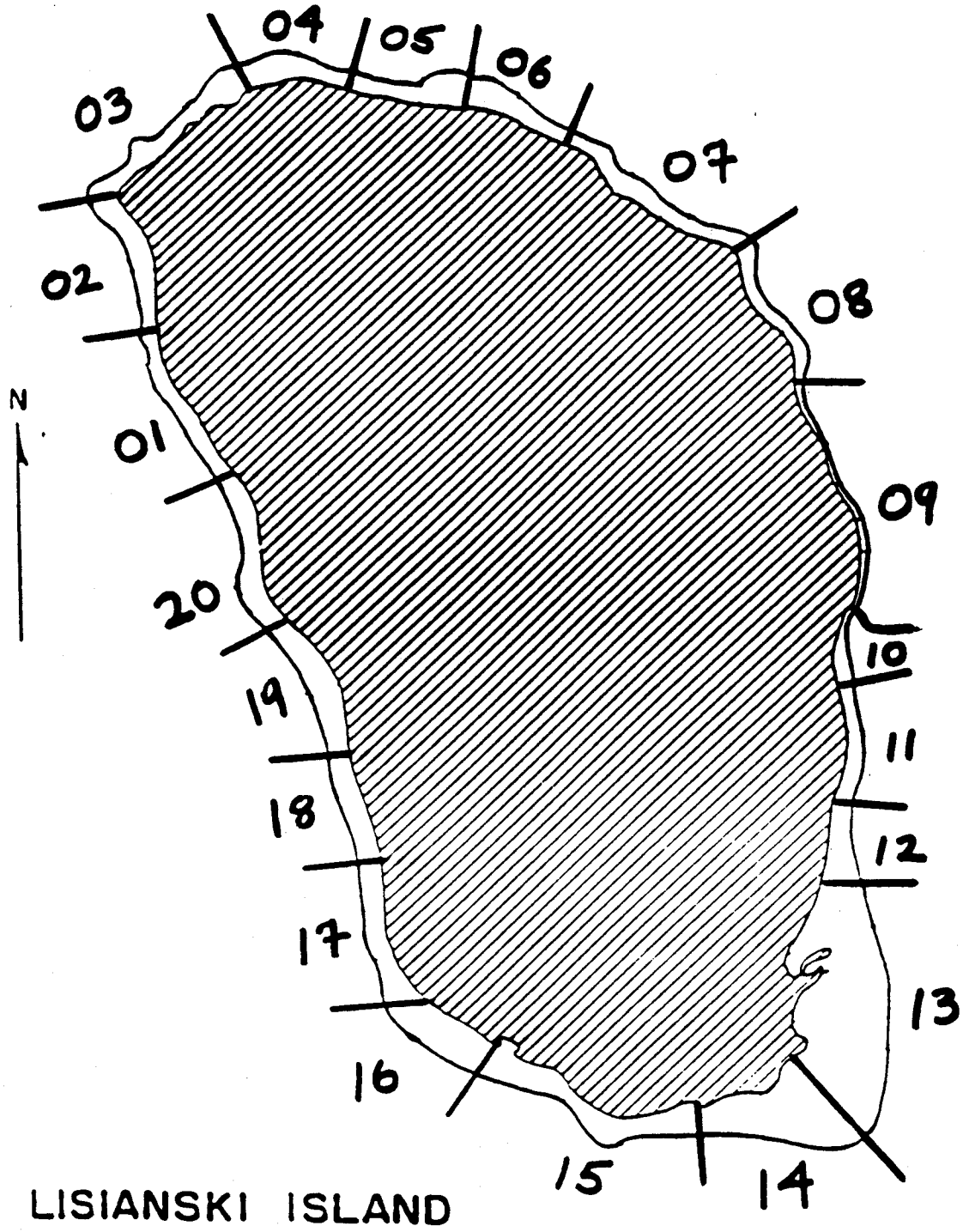


Fig. 4.1 Map of Lisianski Island, Northwestern Hawaiian Islands

Lisianski Island (lat. 26°02'N, long. 174°00'W) is one of the major haulout and pupping locations of the Hawaiian monk seal. The island is located ca. 1760 km northwest of Oahu (Fig. 1.1), and is part of Neva Shoal, a shallow reef bank within the Hawaiian Islands National Wildlife Refuge.

ACTIVITIES

Research was conducted by the National Marine Fisheries Service (NMFS) during March 23-July 15. For the purpose of seal data collection, the perimeter of the island was divided into 20 sectors using artificial or natural landmarks (Fig. 4.1). In 1992, research objectives specific to this population included identification of all seals, and documentation of adult male behavior.

Censuses and Patrols

Censuses and patrols were scheduled to ensure that the entire island was monitored at least once each day during March 28-July 12. Areas where intense adult male aggression had been observed, sectors 1-2 and 13-20 (Johanos and Kam 1986), were monitored 1-3 times daily on non-census days.

Censuses (n = 28) were conducted by two observers every 4th day, beginning at 1300 Hawaiian Standard Time and continuing for 1.3 to 2.2 h. Standardized patrols were conducted on non-census days, and focused on activity patterns of adults and large subadults to document male aggression and detect mobbing incidents. During these patrols (n = 76), attention was directed out to sea as much as possible, as mobbing has been documented most frequently in the water.

Individual Identification

A total of 216 individuals (193 excluding pups) were identified by existing or newly applied tags, bleach marks, scars, or natural markings. All weaned pups (n = 21) were tagged with Temple Tags and passive integrated transponder (PIT) tags. Five immature seals (three male, two female) were newly tagged, and one immature female was retagged with Temple Tags.

Collection of Samples

Seventy-four scat and spew samples were collected. Molt samples were collected from 70 different individuals. Twenty-six tissue plugs were collected from weaned pups and other seals during tagging. Necropsies were performed and tissue samples were collected from two dead seals. Two skulls and one complete skeleton were collected. In total, 543 pieces of potentially dangerous debris were inventoried and destroyed before the end of the field season. Results from analysis of these samples will be presented elsewhere.

FINDINGS

Population Abundance and Composition

The means (±SD) for 28 census counts were 83 seals (±11.7) including pups, and 71 seals (±9.3) excluding pups (Table 4.1). The total spring-summer population was 214 individuals, 191 excluding pups (Table 4.2). The sex ratios of non-pup immatures and adults were 1.8:1 (42 males: 23 females) and 2.0:1 (84 males: 42 females), respectively. Within the adult class, the male skewed sex ratio was due to older, unknown-aged seals, where the male to female ratio was 3.1:1 (66 males: 21 females); in the seals of adult size, but for animals ≤10 years of age, the sex ratio was 0.9:1 (18 males: 21 females). Table 4.3 summarizes the number of tagged known-age seals born at Lisianski Island during 1982-91 and resighted there in 1992.

Reproduction

At least 23 pups were born; 21 weaned and 2 were still nursing at the end of the field season (Table 4.4a). A summary of nursing periods and measurements of weaned pups is in Table 4.4b. Twenty-three of 42 (55%) adult-sized females gave birth. At least three pup exchanges occurred between four nursing females.

Interatoll Movement

In 1992, interatoll movement was documented for 7 seals that made a total of 13 trips between Lisianski Island and Laysan Island (Tables 4.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by males, entanglement, and unknown factors led to 27 life-threatening conditions, which resulted in the confirmed deaths of two animals and the probable death of one other seal (Table 4.6). Two incidents of adult male aggression and one post-mobbing aggregation were observed and resulted in the death of one seal. Eight seals were entangled: one escaped by itself and seven others were released by observers. In addition to the cases summarized in Table 4.6, the skeleton of a dead subadult was found; this seal had died of unknown causes since the 1991 field season.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service and Hawaiian Islands National Wildlife Refuge staffs. We thank the captain, officers and crew of the NOAA ship *Townsend Cromwell* for logistical assistance. Thanks are also extended to the U.S. Coast Guard, Barbers Point, for an airdrop.

TABLES

Table 4.1.--Summary statistics for censuses (n = 28) of Hawaiian monk seals at Lisianski Island from March 29 to July 15, 1992.

Size/Sex	Mean number of individuals	Standard deviation
Adults	47.9	7.8
Male	27.9	5.8
Female	16.1	5.1
Unknown	3.9	4.2
Subadults	15.1	5.8
Male	9.1	3.8
Female	5.1	2.7
Unknown	0.9	0.9
Juveniles	7.5	2.2
Male	4.5	1.9
Female	2.6	1.1
Unknown	0.4	0.6
Pups	12.3	4.0
Male	6.6	2.7
Female	3.4	2.6
Unknown	2.3	1.4
Non-pup Total	70.5	9.3
Grand Total	82.8	11.7

Table 4.2.--Composition of the Hawaiian monk seal population at Lisianski Island during the spring and summer of 1992. Includes all pups born during the calendar year.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	84	42	0	126	2.0:1
Subadults	26	14	0	40	1.9:1
Juveniles	16	9	0	25	1.8:1
Pups	13	8	2	23	1.6:1
Non-pup Total	126	65	0	191	1.9:1
Grand Total	139	73	2	214	1.9:1

Table 4.3.--Summary of tagged known-age seals born at Lisianski Island and resighted there in 1992.

Age (years)	Sex	Number originally tagged	Number resighted in 1992
10	Male	7	3
	Female	6	2
9	Male	6	3
	Female	18	7
8	Male	10	5
	Female	5	2
7	Male	5	2
	Female	9	2
6	Male	11	7
	Female	9	4
5	Male	12	3
	Female	6	2
4	Male	10	6
	Female	8	6
3	Male	--	--
	Female	--	--
2	Male	8	7
	Female	9	6
1	Male	9	8
	Female	6	4

Table 4.4a.--Summary of Hawaiian monk seals born at Lisianski Island in 1992.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	13	8	2	23
Died prior to weaning	0	0	0	0
Still nursing	0	0	2	2
Weaned	13	8	0	21
Tagged	13	8	0	21

Table 4.4b.--Summary of nursing periods and measurements of weaned pups at Lisianski Island in 1992. Nursing periods were calculated where both birth and weaning date ranges were ≤4 days. All measurements were taken within two weeks after weaning. Measurements include seven pups with an axillary girth of ≤95 cm.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)	Weight (kg)
Mean	34.8	100.0	124.9	--
St. Dev.	3.5	10.6	8.6	--
n	14	21	21	--

Table 4.5a.--Known movement of Hawaiian monk seals to Lisianski Island from other locations in 1992, summarized by number of trips. Some seals made more than one trip.

Original location	Number, size, and sex class
Laysan	2 adult males, 4 adult females, 2 subadult females, 1 juvenile male

Table 4.5b.--Known movement of Hawaiian monk seals from Lisianski Island to other locations in 1992, summarized by number of trips. Some seals made more than one trip.

Destination	Number, size, and sex class
Laysan Island	1 adult male, 2 adult females, 1 subadult female

Table 4.6.--Factors affecting Hawaiian monk seal survival at Lisianski Island in 1992.

Size	Sex	Outcome			
		Total	Injured	Died	Probably died
Attack by Large Shark					
Adult	Male	2	1	0	1
	Female	1	1[a]	0	0
Subadult	Female	1	1	0	0
Weaned pup	Male	1	1	0	0
Mounting by Males					
Adult	Female	12[b]	11[c]	0	0
Subadult	Female	1	0	1[d]	0
Entanglement					
Adult	Male	1[e]	0	0	0
	Female	1[f]	0	0	0
Subadult	Male	2[f]	0	0	0
Weaned pup	Male	4[f]	0	0	0
Unknown					
Subadult	Male	1	0	1	0

[a]A seal with minor male mounting injuries was also attacked by a shark.
[b]An incident was observed involving 4 males, the seal was not seriously injured.
[c]An incident was observed involving a single male.
[d]A post-mobbing aggregation was observed involving 5 males.
[e]Seal escaped by itself.
[f]Seal(s) released by observers.

CHAPTER 5. THE HAWAIIAN MONK SEAL ON PEARL AND HERMES REEF, 1992

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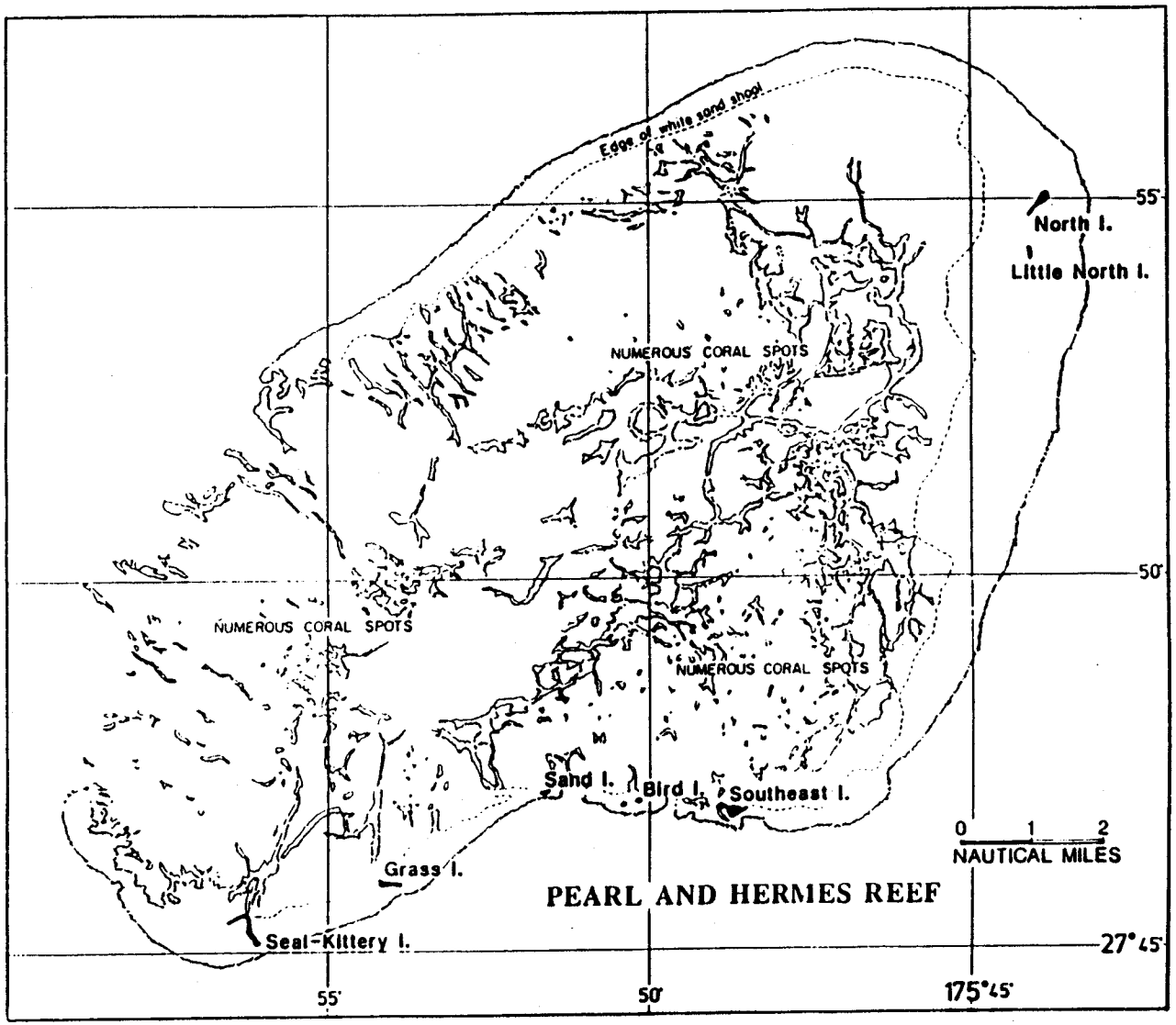


Fig. 5.1 Map of Pearl and Hermes Reef, Northwestern Hawaiian Islands

Pearl and Hermes Reef (lat. 27°55'N, long. 175°45'W) is one of the major haulout and pupping locations of the Hawaiian monk seal. This atoll is located ca. 1900 km northwest of Oahu in the Northwestern Hawaiian Islands (NWHI), and is part of the Hawaiian Islands National Wildlife Refuge (Fig. 1.1). Pearl and Hermes is composed of four vegetated and three nonvegetated sand islands surrounded by a fringing reef (Fig. 5.1).

ACTIVITIES

Research was conducted by the National Marine Fisheries Service (NMFS) during July 20-25. For the purpose of seal data collection, the perimeters of the four larger vegetated islands were divided into sectors using natural landmarks. In 1992, research objectives for the Pearl and Hermes monk seal population were as outlined in Chapter 1.

Censuses and Patrols

Atoll censuses (n = 5) were conducted daily by four observers during July 20-24, beginning at 0830 Hawaiian Standard Time and continuing for approximately 9 h. In addition, 14 incidental patrols were conducted opportunistically to resight animals tagged in previous years.

Individual Identification

A total of 130 individuals (114 excluding pups) were identified by existing or newly applied tags, scars, or natural markings. Weaned pups were tagged with Temple Tags (n = 23) and passive integrated transponder (PIT) tags (n = 16). Two immature seals (one male, one female) were newly tagged.

Collection of Samples

Twenty-three tissue plugs were collected from weaned pups and other seals during tagging. A skull and a complete skeleton were collected. Potentially dangerous debris was inventoried; one entanglement item was removed from a seal and collected, the remaining items were destroyed.

FINDINGS

Population Abundance and Composition

The means (±SD) for five atoll censuses conducted in 1992 were 89 seals (±13.5) including pups, and 75 seals (±9.8) excluding pups (Table 5.1). Due to limited effort, the composition of the spring-summer population was not determined.

Reproduction

At least 26 pups were born: 23 weaned, one died prior to weaning, and 2 pups were still nursing at the end of the field season (Table 5.4a). Measurements from one recently weaned pup are in Table 5.4b.

Interatoll Movement

In 1992, interatoll movement was documented for four seals that made a total of four trips between Pearl and Hermes Reef and either Laysan Island or Kure Atoll (Tables 5.5a and b).

Factors Affecting Survival

Attacks by large sharks, entanglement, and unknown factors resulted in four life-threatening conditions, which led to the confirmed death of 1 seal (Table 5.6). One seal was found entangled and was released by observers. In addition to the cases summarized in Table 5.6, the skeleton of a dead juvenile female was found; this seal had died of unknown causes since the 1991 field season.

ACKNOWLEDGMENTS

We thank the captain, officers, and crew of the NOAA Ship *Townsend Cromwell* for their logistical support. We also acknowledge the support of the U.S. Fish and Wildlife Service Hawaiian Island National Wildlife Refuge Staff.

TABLES

Table 5.1.--Summary statistics for atoll censuses (n = 5) of the Hawaiian monk seals at Pearl and Hermes Reef from July 20 to July 24, 1992.

Size/Sex	Mean number of individuals	Standard deviation
Adults	35.6	4.4
Male	10.0	1.9
Female	13.8	3.7
Unknown	11.8	4.0
Subadults	24.6	5.4
Male	6.4	3.2
Female	4.8	2.4
Unknown	13.4	4.8
Juveniles	14.6	2.3
Male	3.4	1.8
Female	2.8	1.9
Unknown	8.4	4.0
Pups	13.8	5.3
Male	4.4	1.5
Female	3.0	2.0
Unknown	6.4	2.2
Non-pup Total	75.0	9.8
Grand Total	88.8	13.5

Table 5.2.--Composition of the Hawaiian monk seal population at Pearl and Hermes Reef during the spring and summer of 1992.

Size	Number of seals			Sex ratio male:female
	Male	Female	Total	
Adults	(Composition not determined as described on page 53.)			
Subadults				
Juveniles				
Pups				
Non-pup Total				
Grand Total				

Table 5.3.--Summary of tagged known-age seals born at Pearl and Hermes Reef and resighted there in 1992.

Age (years)	Sex	Number originally tagged	Number resighted in 1992
9	Male	8	5
	Female	2	1
8	Male	5	2
	Female	8	2
7	Male	9	3
	Female	6	2
6	Male	10	3
	Female	7	4
	Unknown	1	0
5	Male	14	7
	Female	7	4
4	Male	12	9
	Female	5	5
3	Male	8	5
	Female	6	3
2	Male	5	4
	Female	1	1
1	Male	9	8
	Female	12	8

Table 5.4a.--Summary of Hawaiian monk seals born at Pearl and Hermes Reef in 1992.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	14	9	3	26
Died prior to weaning	0	0	1	1
Still nursing	0	0	2	2
Weaned	14	9	0	23
Tagged	14	9	0	23

Table 5.4b.--Summary of nursing periods and measurements of weaned pups at Pearl and Hermes Reef in 1992. All measurements were taken within two weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)	Weight (kg)
Mean	--	105.0	127.0	--
St. Dev.	--	NA	NA	--
n	--	1	1	--

Table 5.5a.--Known movement of Hawaiian monk seals to Pearl and Hermes Reef from other locations in 1992, summarized by number of trips. No seals made more than one trip.

Original location	Number, size, and sex class
Kure Atoll	1 subadult female

Table 5.5b.--Known movement of Hawaiian monk seals from Pearl and Hermes Reef to other locations in 1992, summarized by number of trips. No seals made more than one trip.

Destination	Number, size, and sex class
Laysan Island	1 subadult female
Kure Atoll	1 subadult male, 1 subadult female

Table 5.6.--Factors affecting Hawaiian monk seal survival at Pearl and Hermes Reef in 1992.

Size	Sex	Outcome			
		Total	Injured	Died	Probably died
Attack by Large Shark					
Adult	Female	1	1	0	0
Weaned pup	Male	1	1	0	0
Mounting by Males					
(none observed)					
Entanglement					
Weaned pup	Male	1[a]	0	0	0
Unknown					
Nursing pup	Unknown	1	0	1	0

[a]Seal released by observers.

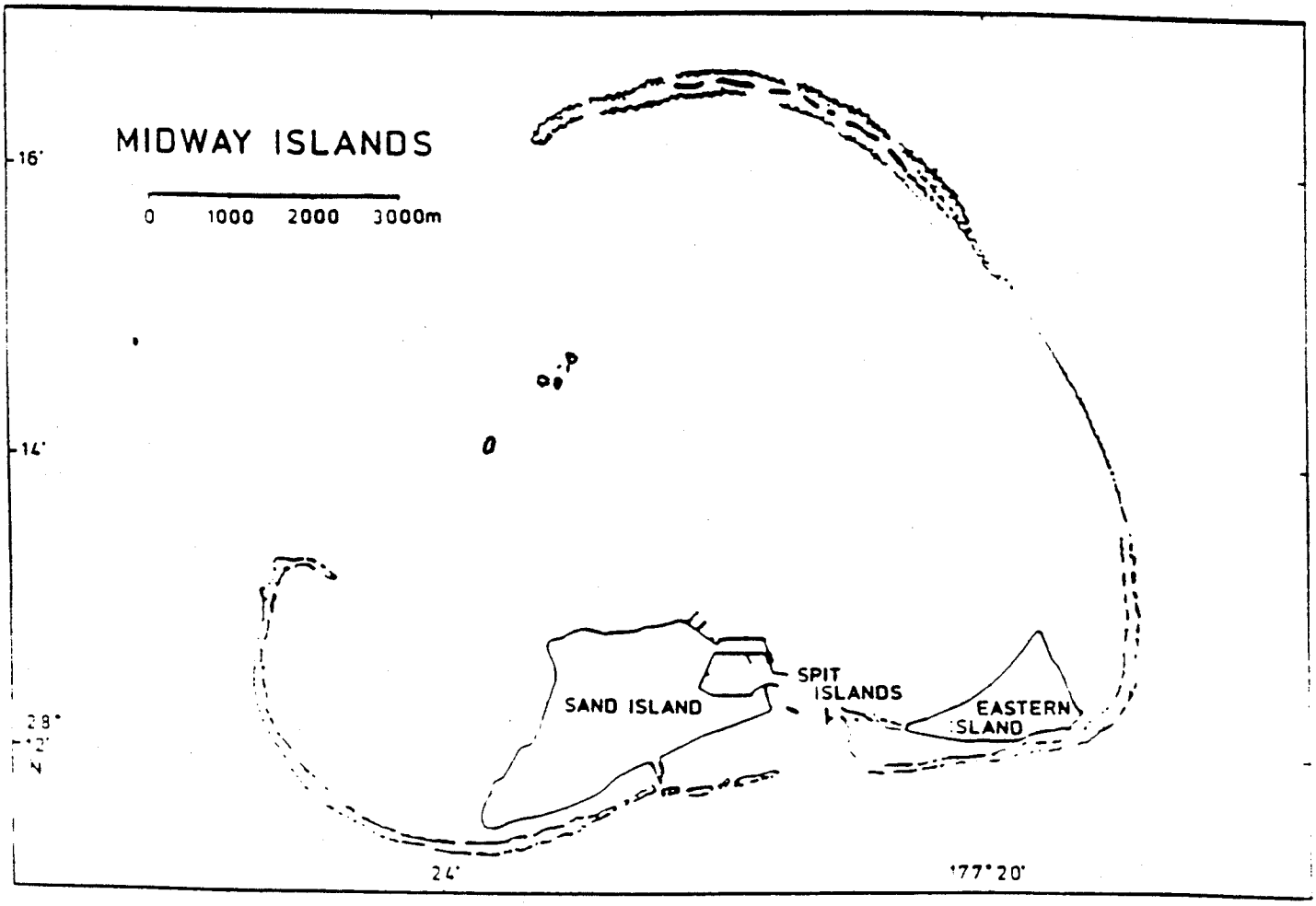


Fig. 6.1 Map of Midway Islands, Northwestern Hawaiian Islands

Midway Island (lat. 28°15'N, long. 177°35'W) has historically been one of the major haulout and pupping locations of the endangered Hawaiian monk seal, although current population levels and pup production are low. This atoll is located 2100 km northwest of Oahu in the Northwestern Hawaiian Islands (NWHI; Fig. 1.1) and comprises a circular fringing reef approximately 9 km in diameter, enclosing a lagoon and three permanent islands (Sand, Spit, and Eastern Islands) inside the southern part of the reef (Fig. 6.1). Sand Island is the site of a U.S. Naval Air Facility, staffed by approximately 250 people. Eastern and Spit Islands are uninhabited.

ACTIVITIES

Intermittent research was conducted by the National Marine Fisheries Service (NMFS) during April 28-December 3. In addition, censuses and patrols were recorded by Fish and Wildlife Service (FWS) personnel during those portions of the year when NMFS personnel were not present. For the purpose of seal data collection, the perimeters of the three permanent islands were divided into sectors using artificial or natural landmarks. Research objectives were as outlined in Chapter 1. In addition, an objective specific to this population included maintenance and release of seals translocated from French Frigate Shoals (FFS).

Censuses and Patrols

Atoll censuses (n = 12) were not regularly scheduled but were conducted by two to three observers as time and weather conditions permitted from January 8 to October 30. Additionally, separate censuses of Sand Island were conducted opportunistically, and patrols to resight tagged seals were made by FWS personnel during periods when NMFS personnel were absent.

Individual Identification

A total of 40 individuals (36 excluding pups) were identified by existing or newly applied tags, bleach marks, scars, or natural markings: 20 were from the resident population, and the remainder were seals translocated to Midway in 1992. One weaned pup was tagged with Temple Tags and passive integrated transponder (PIT) tags. One immature male was newly tagged. Midway (red) Temple Tags were added at Midway or Oahu to 10 rehabilitated seals which were later released.

Collection of Samples

Necropsies were performed, and tissue samples were collected from all dead seals (four wild and two captive). Sand Island was regularly cleaned by U.S. Navy contracting personnel. In total, 532 pieces of potentially dangerous debris were collected by NMFS personnel from the beaches of Spit Island, inventoried, and destroyed before the end of the field season. Analysis of these samples will be presented elsewhere.

Special Studies

Rehabilitation Program

Twenty immature female seals (three weaned pups, 13 yearlings, two 2-year olds, and two 3-year olds) were translocated to Midway Islands in 1992 in an effort to augment the Midway population. Five of the yearlings were collected from FFS in 1991 as recently weaned pups, and 1 was similarly collected at Kure Atoll in 1991. The remainder of the seals were collected from FFS in 1992. When collected, all of these seals were of a size or weight smaller than other seals in their age class; most were rehabilitated on Oahu, although some were rehabilitated for a short time at FFS and at Midway before their release.

At Midway, the seals were maintained in temporary enclosures of plastic and wire mesh suspended from vertical pipes embedded in the sand. Enclosures were located at two sites. The first enclosure was erected in sector 6 on the northwest side of Sand Island, 100 m south of a rock revetment bordering the north end of the abandoned north-south runway. This enclosure originally measured approximately 30 m x 30 m and included beach and water to a depth of approximately 1.5 m. It was subsequently reduced to approximately 30 m x 15 m, and included water to a depth of 1.0 m. Because of excessive wave surge and accumulation of drifting algae which fouled the fence, maintenance of the first enclosure became excessively difficult, and a second site was selected late in the year. The second enclosure was located in sector 13 on the south side of Sand Island, immediately adjacent to an abandoned Naval facility. The east side of the pen abutted a groin constructed of circular caissons filled with concrete. This enclosure measured approximately 30 m x 15 m, and required less maintenance than at the previous site. A temporary wooden corral to hold seals was also erected on land adjacent to an abandoned building.

Seals maintained in the enclosure were fed live reef fish caught daily by wire mesh traps set within the lagoon. The food supply was augmented by frozen herring.

All 20 seals were temporarily maintained in one of the mesh enclosures at Midway Islands prior to release. Two seals died in the enclosure prior to release and 15 were released during 1992. Three seals were returned to Oahu in early December for further rehabilitation and were ultimately released at Midway Islands in January, 1993. Three of the seals released at Midway in 1992 died in November of that year, and one died in January 1993. Additional results of this rehabilitation effort will be presented elsewhere.

FINDINGS

Population Abundance and Composition

The means (±SD) for 12 whole atoll census counts conducted in 1992 were 10 seals (±4.5) including pups, and 9 seals (±4.1) excluding pups (Table 6.1). The total spring-summer resident immature population was nine individuals, eight excluding pups (Table 6.2). Population totals exclude seals translocated to Midway Islands in 1992. Table 6.3 summarizes the number of tagged known-age seals born at Midway during 1988-91 and resighted there in 1992.

Reproduction

At least one female pup was born and successfully weaned (Table 6.4a). Measurements from this pup are in Table 6.4b.

Interatoll Movement

In 1992, interatoll movement was documented for one seal that made a total of one trip between Midway Islands and Kure Atoll (Table 6.5).

Factors Affecting Survival

Mounting attempts by males and unknown factors resulted in seven life-threatening conditions, which led to the death of four animals: one seal died following an unobserved male mounting incident, and the other three (all translocated and released at Midway in 1992) died of unknown causes (Table 6.6). In addition to the deaths presented in Table 6.6, two captive juvenile female seals, translocated to Midway Island in 1992, died prior to release from the temporary enclosure.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service, Midway Atoll National Wildlife Refuge. Special thanks are extended to Don Williamson, Biologist, and Mike Nishimoto, Refuge Manager. We also thank the officers and crew of the NOAA ship *Townsend Cromwell* for logistical assistance.

TABLES

Table 6.1.--Summary statistics for atoll censuses (n = 12) of Hawaiian monk seals at Midway Islands from January 8 to October 30, 1992.

Size/Sex	Mean number of individuals	Standard deviation
Adults	3.4	2.0
Male	0.9	0.7
Female	2.1	1.4
Unknown	0.4	0.5
Subadults	2.5	1.0
Male	0.4	0.5
Female	1.7	1.0
Unknown	0.4	0.8
Juveniles	3.4	2.5
Male	0.5	0.7
Female	2.7	2.8
Unknown	0.3	0.5
Pups	0.8	0.9
Male	0.0	0.0
Female	0.6	0.9
Unknown	0.2	0.4
Non-pup Total	9.3	4.1
Grand Total	10.1	4.5

Table 6.2.--Composition of the Hawaiian monk seal population at Midway Islands during the spring and summer of 1992. Includes all pups born during the calendar year.

Size	Number of seals			Sex ratio male:female
	Male	Female	Total	
Adults	--	--	--	--
Subadults	1	5	6	0.2:1
Juveniles	1	1	2	1.0:1
Pups	0	1	1	NA
Non-pup Total	--	--	--	--
Grand Total	--	--	--	--

Table 6.3.--Summary of tagged known-age seals born at Midway Islands and resighted there in 1992.

Age (years)	Sex	Number originally tagged	Number resighted in 1992
4	Male	0	NA
	Female	1	1
3	Male	0	NA
	Female	0	NA
2	Male	0	NA
	Female	0	NA
1	Male	1	1
	Female	1	1

Table 6.4a.--Summary of Hawaiian monk seals born at Midway Islands in 1992.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	0	1	0	1
Died prior to weaning	0	0	0	0
Weaned	0	1	0	1
Tagged	0	1	0	1

Table 6.4b.--Summary of nursing periods and measurements of weaned pups at Midway Islands in 1992. All measurements were taken within two weeks after weaning[a].

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)	Weight (kg)
Mean	--	114.0	135.5	--
St. Dev.	--	NA	NA	--
n	--	1	1	--

[a]Weaning date for this pup is unknown. Taking into account the birth date and typical nursing period, it is estimated that measurements were taken within two weeks of weaning.

Table 6.5.--Known movement of Hawaiian monk seals to Midway Islands from other locations in 1992, summarized by number of trips.

Original location	Number, size, and sex class
Kure Atoll	1 subadult female

Table 6.6.--Factors affecting Hawaiian monk seal survival at Midway Islands in 1992. Does not include captive seals.

Size	Sex	Outcome			
		Total	Injured	Died	Probably died
Attack by Large Shark					
(none observed)					
Mounting by Males					
Adult	Male	1	0	1	0
Subadult	Unknown	1	1	0	0
Entanglement					
(none observed)					
Unknown					
Subadult	Female	1	0	1[a]	0
Juvenile	Female	2	0	2[b]	0

[a]Translocated seal released at Midway Islands in 1992.
[b]Two translocated seals released at Midway Islands in 1992.

CHAPTER 7. THE HAWAIIAN MONK SEAL AT KURE ATOLL, 1992

Michele A. Finn and Harry J. Swensen

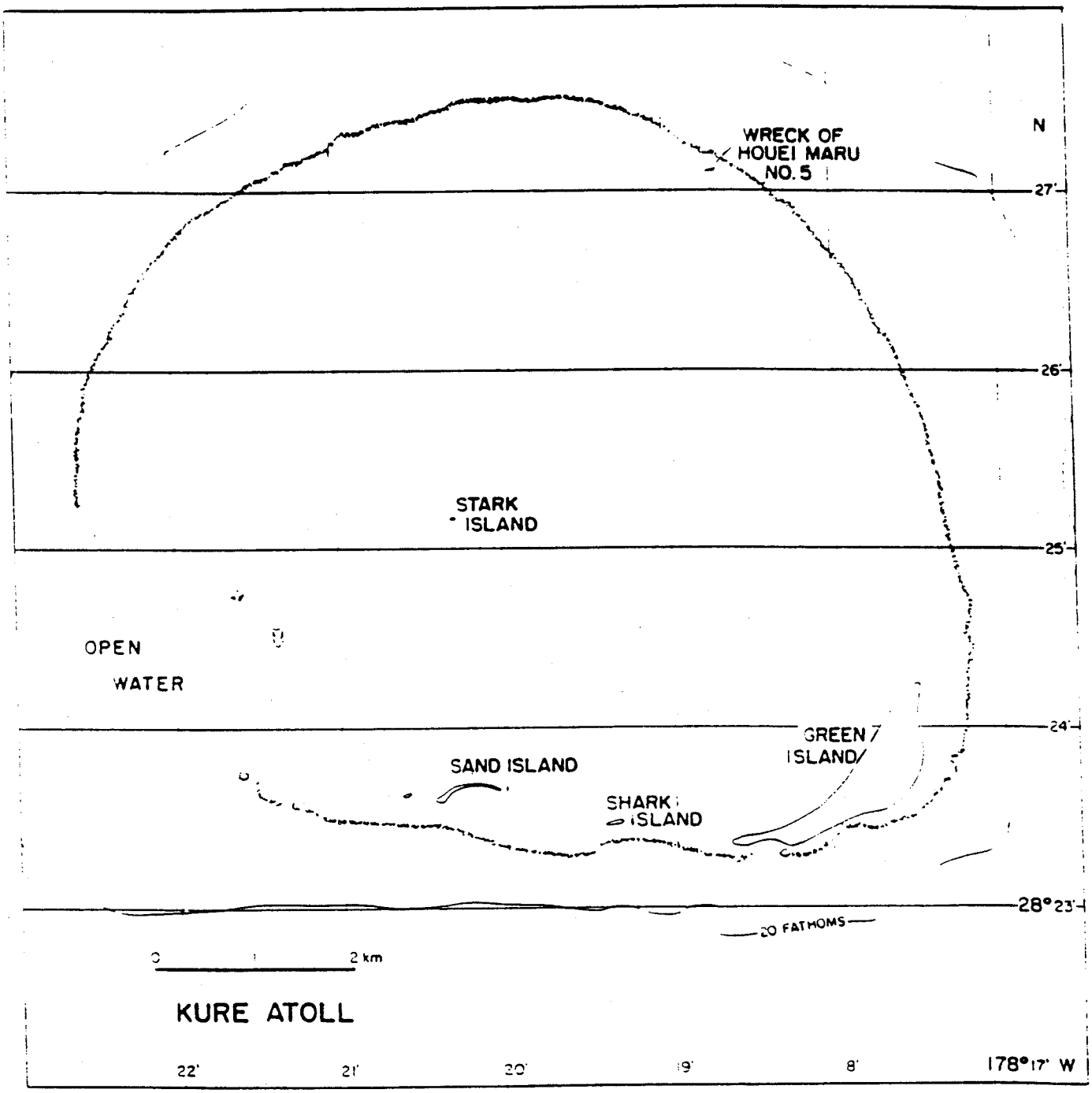


Fig. 7.1 Map of Kure Atoll, Northwestern Hawaiian Islands

Kure Atoll (lat. 28°25'N, long. 178°10'W) is one of the major haulout and pupping locations of the Hawaiian monk seal. The atoll is located ca. 2300 km northwest of Oahu in the Northwestern Hawaiian Islands (NWHI; Fig. 1.1), and is a Seabird Sanctuary of the State of Hawaii. The atoll consists of a circular fringing reef approximately 9 km in diameter, enclosing a lagoon, one permanent vegetated island (Green Island), two sand islets (Sand and Shark Islets), and a sometimes emergent area known locally as Stark Reef (Fig. 7.1). Until 1992, Green Island was the site of a U.S. Coast Guard (USCG) LORAN station, commissioned in 1961 and staffed by 20-30 USCG personnel. In July 1992 this station was closed and vacated by the USCG, leaving the atoll uninhabited.

ACTIVITIES

Research was conducted by the National Marine Fisheries Service (NMFS) during March 8-July 16. In addition, USCG personnel documented the neonatal death of a pup in early spring, before the arrival of NMFS field researchers. For the purpose of seal data collection, the perimeter of the largest vegetated island was divided into eight sectors, using artificial or natural landmarks. In 1992, a research objective specific to this population was monitoring the survival of weaned female pups in an effort to identify impacts from discontinuation of the Head Start Project.

Censuses and Patrols

Atoll censuses (n = 15) were conducted by two observers approximately twice a week, weather permitting, from March 21 to July 11. Each census began between 0900 and 1400 Hawaii standard time and ended between 1500 and 1900. Stark Reef was censused by boat when weather permitted and the reef was above water, while the remaining islands were censused on foot by one or two persons.

In addition, patrols were conducted to identify seals and monitor locations where females pupped.

Individual Identification

A total of 84 individuals (71 excluding pups) were identified by existing or newly applied tags, bleach marks, scars, or natural markings. All weaned pups (n = 13) were tagged with Temple Tags, and five pups also received passive integrated transponder (PIT) tags.

Collection of Samples

At least five tissue plugs were collected from weaned pups during tagging. In total, 15 pieces of potentially dangerous debris were inventoried; one entanglement item was removed from a seal and collected, the remainder was destroyed before the end of

the field season. Analysis of these samples will be presented elsewhere.

Special Studies

Monitoring Impacts of Past Management Efforts

The Head Start Project (1981-91) and the Rehabilitation Project (1984-91) utilized a temporary enclosure, stocked with locally trapped live reef fish, to enhance the first year survival of weaned female seal pups, and reintroduce rehabilitated yearlings from French Frigate Shoals (FFS) into the wild (Gilmartin and Gerrodette, 1986). Because of the logistical constraints imposed by the closure of the USCG LORAN Station on Kure in 1992, both projects were discontinued, and the enclosure was removed. In 1992, observers monitored the survival of weaned female pups and seals that had gone through the Head Start and Rehabilitation Projects in previous years, in order to assess the impacts of past management efforts and discontinuation of the Head Start Project. Results of this assessment will be reported elsewhere.

FINDINGS

Population Abundance and Composition

The means (±SD) for 15 census counts were 42 seals (±6.8) including pups, and 35 seals (±7.1) excluding pups (Table 7.1). The total spring-summer immature population was 49 individuals, 35 excluding pups (Table 7.2). Table 7.3 summarizes the number of tagged known-age seals born at Kure Atoll during 1981-91 and resighted there in 1992.

Reproduction

At least 14 pups were born: 13 weaned and 1 died prior to weaning (Table 7.4a). A summary of nursing periods and measurements of weaned pups is in Table 7.4b. Twenty-two adult-sized females were identified, of which 13 gave birth (59%). Eight parturient females had been temporarily maintained as pups in the Kure Atoll Head Start enclosure, and one was a rehabilitated seal from FFS--introduced to Kure as a yearling via the Head Start enclosure.

Interatoll Movement

In 1992, interatoll movement was documented for four seals that made a total of four trips between Kure Atoll and either Pearl and Hermes Reef or Midway Islands (Table 7.5a and b).

Factors Affecting Survival

Attacks by large sharks, entanglement, and unknown factors resulted in three life-threatening conditions and led to the confirmed death of one animal (Table 7.6). One seal was entangled and injured by plastic debris and was subsequently released by observers.

ACKNOWLEDGMENTS

We acknowledge the Aids to Navigation Branch of the 14th Coast Guard District, the Coast Guard Air Station Barbers Point, and the State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife.

TABLES

Table 7.1.--Summary statistics for atoll censuses (n = 15) of Hawaiian monk seals at Kure Atoll from March 21 to July 11, 1992.

Size/Sex	Mean number of individuals	Standard deviation
Adults	18.0	6.1
Male	6.7	3.0
Female	8.9	2.9
Unknown	2.4	1.8
Subadults	5.7	1.8
Male	3.1	1.2
Female	2.3	1.5
Unknown	0.3	0.6
Juveniles	11.1	2.3
Male	3.5	0.8
Female	7.3	1.9
Unknown	0.3	0.6
Pups	7.1	2.7
Male	2.9	1.5
Female	4.1	1.6
Unknown	0.1	0.3
Non-pup Total	34.7	7.1
Grand Total	41.8	6.8

Table 7.2.--Composition of the Hawaiian monk seal population at Kure Atoll during the spring and summer of 1992. Includes all pups born during the calendar year.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	--	--	--	--	--
Subadults	7	6	0	13	1.2:1
Juveniles	7	15	0	22	0.5:1
Pups	5	8	1[a]	14	0.6:1
Non-pup Total	--	--	--	--	--
Grand Total	--	--	--	--	--

[a]One neonatal pup death.

Table 7.3.--Summary of tagged known-age seals born at Kure Atoll and resighted there in 1992.

Age (years)	Sex	Number originally tagged	Number resighted in 1992
11	Male	4	2
	Female	5	2
10	Male	1	0
	Female	3	2
9	Male	4	1
	Female	0	NA
8	Male	4	2
	Female	2	2
7	Male	2	1
	Female	3	3
6	Male	1	0
	Female	0	NA
5	Male	1	1
	Female	3	2
4	Male	2	2
	Female	5	2
3	Male	5	4
	Female	4	1
2	Male	3	1
	Female	3	2
1	Male	7	6
	Female	6	4

Table 7.4a.--Summary of Hawaiian monk seals born at Kure Atoll in 1992.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	5	8	1	14
Died prior to weaning	0	0	1	1
Weaned	5	8	0	13
Tagged	5	8	0	13

Table 7.4b.--Summary of nursing periods and measurements of weaned pups at Kure Atoll in 1992. Nursing periods were calculated where both birth and weaning date ranges were ≤4 d. All measurements were taken within two weeks after weaning. Measurements include two pups with an axillary girth of ≤95 cm.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)	Weight (kg)
Mean	34.9	109.4	128.8	--
St. Dev.	3.7	9.0	6.7	--
n	9	11	11	--

Table 7.5a.--Known movement of Hawaiian monk seals to Kure Atoll from other locations in 1992, summarized by number of trips. No seals made more than one trip.

Original location	Number, size, and sex class
Pearl and Hermes Reef	1 subadult male, 1 subadult female

Table 7.5b.--Known movement of Hawaiian monk seals from Kure Atoll to other locations in 1992, summarized by number of trips. No seals made more than one trip.

Destination	Number, size, and sex class
Pearl and Hermes Reef	1 subadult female
Midway Islands	1 subadult female

Table 7.6.--Factors affecting Hawaiian monk seal survival at Kure Atoll in 1992.

Size	Sex	Outcome			
		Total	Injured	Died	Probably died
Attack by Large Shark					
Weaned pup	Female	1	1	0	0
Mounting by Males					
(none observed)					
Entanglement					
Adult	Male	1	1[a]	0	0
Unknown					
Nursing pup	Unknown	1	0	1	0

[a]Seal released by observers.

CHAPTER 8. THE HAWAIIAN MONK SEAL ON NIHOA AND NECKER ISLANDS, 1992

Thea C. Johanos

MAP OF NIHOA AND NECKER ISLANDS

Nihoa Island (lat. 23°15'N, long. 161°92'W) and Necker Island (lat. 23°60'N, long. 164°62'W) are located ca. 450 and 750 km northwest of Oahu in the Northwestern Hawaiian Islands (NWHI)(Fig. 1.1). These islands lie within the Hawaiian Islands National Wildlife Refuge (Fig. 1.1). Although endangered Hawaiian monk seals utilize these islands, pup production is limited by lack of haulout area.

ACTIVITIES

Research was not conducted by the National Marine Fisheries Service (NMFS) at either location in 1992, but censuses and incidental observations were recorded by a collaborating scientist on Nihoa Island during July 15-28. For the purpose of seal data collection, the perimeter of Nihoa Island was divided into three sectors using natural landmarks (Fig. 8.1). In 1992, research objectives for the Nihoa Island monk seal population were as outlined in Chapter 1.

Censuses and Patrols

Censuses (n = 8) were conducted opportunistically on Nihoa Island by one observer from July 15-28, beginning between 1255 and 1530 Hawaiian standard time and continuing for approximately 1 h. In addition, six incidental patrols were conducted.

Individual Identification

One adult female was identified by existing tags, which indicated that she had been born at French Frigate Shoals. No weaned pups were tagged.

Collection of Samples

No samples were collected.

FINDINGS

Population Abundance and Composition

The means (±SD) for eight census counts conducted on Nihoa Island in 1992 were 23 seals (±3.1) including pups, and 20 seals (±3.0) excluding pups (Table 8.1). Because of limited effort, the composition of the spring-summer population was not determined. The two tagged known-age seals born at Nihoa Island in 1991 were not resighted there in 1992 (Table 8.3).

Reproduction

At least five pups were born on Nihoa Island in 1992; all pups were still nursing at the end of the field season (Table 8.4).

Interatoll Movement

In 1992, interatoll movement was not documented for seals at Nihoa Island.

Factors Affecting Survival

Factors affecting survival were not observed on Nihoa Island in 1992.

ACKNOWLEDGMENTS

We thank Sheila Conant for collecting the data on Nihoa Island and also acknowledge the support of the U.S. Fish and Wildlife Service Hawaiian Island National Wildlife Refuge Staff.

TABLES

Table 8.1.--Summary statistics for censuses (n = 8) of Hawaiian monk seals at Nihoa Island from July 15 to July 28, 1992.

Size/Sex	Mean number of individuals	Standard deviation
Adults	17.6	2.4
Male	2.1	1.5
Female	6.9	2.9
Unknown	8.6	3.6
Subadults	1.8	1.6
Male	0.5	0.9
Female	0.1	0.4
Unknown	1.1	1.0
Juveniles	0.1	0.4
Male	0.0	0.0
Female	0.1	0.4
Unknown	0.0	0.0
Pups	3.4	1.3
Male	0.1	0.4
Female	0.0	0.0
Unknown	3.3	1.2
Non-pup Total	19.5	3.0
Grand Total	22.9	3.1

Table 8.2.--Composition of the Hawaiian monk seal population at Nihoa Island during the spring and summer of 1992.

Size	Number of seals			Sex ratio male:female
	Male	Female	Total	
Adults	(Composition not determined as described on page 93.)			
Subadults				
Juveniles				
Pups				
Non-pup Total				
Grand Total				

Table 8.3.--Summary of tagged known-age seals born at Nihoa Island and resighted there in 1992.

Age (years)	Sex	Number originally tagged	Number resighted in 1992
1	Male	2	0
	Female	0	0

Table 8.4.--Summary of Hawaiian monk seals born at Nihoa Island in 1992.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	1	0	4	5
Died prior to weaning	0	0	0	0
Still nursing	1	0	4	5
Weaned	0	0	0	0
Tagged	0	0	0	0

REFERENCES

Alcorn, D. J.
1984. The Hawaiian monk seal on Laysan Island: 1982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-42, 37 p.

American Society of Mammalogists, Committee on Marine Mammals.
1967. Standard Measurements of Seals. J. Mammal. 48:459-462.

DeMartini, E. E., F. A. Parrish, and J. D. Parrish.
1993. Temporal changes in reef prey populations at French Frigate Shoals, NWHI: Implications for juvenile monk seal (*M. schauinslandi*) predators. Honolulu Lab., Southwest Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Sci. Cent. Admin. Rep. H-93-06, 49 p.

Gilmartin, W. G. and T. Gerrodette.
1986. Hawaiian monk seal status and recovery potential at Kure Atoll. Honolulu Lab., Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396, Southwest Fish. Cent. Admin. Rep. H-86-16, 26 p.

Gilmartin, W. G. and T. J. Ragen.
1992. Collection of juvenile monk seals at French Frigate Shoals for rehabilitation and release at Midway Islands. Appendix A in: Gilmartin, W. G. 1993. Research and management plan for the Hawaiian monk seal at French Frigate Shoals, 1993-96. Honolulu Lab., Southwest Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396, Southwest Fish. Cent. Admin. Rep. H-93-08, 61 p.

Gilmartin, W. G., R. J. Morrow, and A. M. Houtman.
1986. Hawaiian monk seal observations and captive maintenance project at Kure Atoll, 1981. U.S. Dep. Commer., NOAA Tach. Memo. NMFS-SWFC-59, 9 p.

Hiruki, L. M., Gilmartin, W. G., Becker, B. L., and Stirling, I.
1993. Wounding in Hawaiian monk seals (*Monachus schauinslandi*). Can. J. Zool. 71:458-468.

Johanos, T. C. and Kam, A. K. H.
1986. The Hawaiian monk seal on Lisianski Island: 1983. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-58, 37 p.

Johanos, T. C., A. K. H. Kam, and R. G. Forsyth.
1987. The Hawaiian monk seal on Laysan Island: 1984. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-70, 38 p.

Stone, H. S.
1984. Hawaiian monk seal population research, Lisianski Island, 1982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-47, 33 p.

Winchell, J.
1990. Field manual for phocid necropsies (specifically *Monachus schauinslandi*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-146, 55 p.

APPENDIXES

(See following pages.)

Appendix A.--Reports summarizing past Hawaiian monk seal research.

French Frigate Shoals

Craig, Mitchell P., Jennifer L. Megyesi, C. Scott Hall, Jennifer L. Glueck, Leona P. Laniawe, Elizabeth A. Delaney, Sally S. Keefer, Mark A. McDermond, Martin Schulz, Glynnis L. Nakai, Brenda L. Becker, Lisa M. Hiruki, and Robert J. Morrow.
1994. The Hawaiian monk seal at French Frigate Shoals, 1999-91, U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NOAA-TM-NMFS-SWFSC-210, 70 p.

Craig, M. P., D. J. Alcorn, R. G. Forsyth, T. Gerrodette, M. A. Brown, B. K. Choy, L. Dean, L. M. Dennlinger, L. E. Gill, S. S. Keefer, M. M. Lee, J. S. Lennox, C. R. Lorence, G. L. Nakai, and K. R. Niethammer.
1992. The Hawaiian monk seal at French Frigate Shoals, 1988-89. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-178, 83 p.

Eliason, Julie J., John R. Henderson, and Marc A. Webber.
1993. Hawaiian monk seal observations at French Frigate Shoals, 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-187, 46 p.

Eliason, J. J., and J. R. Henderson.
1992. Hawaiian monk seal observations at French Frigate Shoals, 1984. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-177, 61 p.

Fairaizl, G. W.
1984. Intra-atoll resighting of the Hawaiian monk seal, *Monachus schauinslandi*, at French Frigate Shoals, 1 January 1983-31 August 1983. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-84-5C, 27 p.

Johnson, P. A., and B. W. Johnson.
1984. Hawaiian monk seal observations on French Frigate Shoals, 1980. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-50, 47 p.

Laysan Island

Alcorn, D.
1984. The Hawaiian monk seal on Laysan Island: 1982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-42, 37 p.

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

Becker, B. L., R. J. Morrow, and J. K. Leialoha.
1989. Censuses and interatoll movements of the Hawaiian monk seal on Laysan Island, 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-135, 25 p.

Johanos, T. C., and S. L. Austin.
1988. Hawaiian monk seal population structure, reproduction, and survival on Laysan Island, 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-118, 38 p.

Johanos, T. C., B. L. Becker, M. A. Brown, B. K. Choy, L. M. Hiruki, R. E. Brainard, and R. L. Westlake
1990. The Hawaiian monk seal on Laysan Island, 1988. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-151, 24 p.

Johanos, T. C., A. K. H. Kam, and R. G. Forsyth.
1987. The Hawaiian monk seal on Laysan Island: 1984. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-70, 38 p.

Johnson, B. W., and P. A. Johnson.
1984. Observations of the Hawaiian monk seal on Laysan Island from 1977 through 1980. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-49, 65 p.

Lisianski Island

Alcorn, D. J., R. G. Forsyth, and R. L. Westlake.
1988. Hawaiian monk seal research on Lisianski Island, 1984 and 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-120, 22 p.

Johanos, T. C., and J. R. Henderson.
1986. Hawaiian monk seal reproduction and injuries on Lisianski Island, l982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-64, 7 p.

Johanos, T. C., and A. K. H. Kam.
1986. The Hawaiian monk seal on Lisianski Island: 1983. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-58, 37 p.

Johanos, T. C., and R. P. Withrow.
1988. Hawaiian monk seal and green turtle research on Lisianski Island, 1987. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-121, 18 p.

Lee, M. M., L. K. Timme, R. Van Toorenburg, and B. L. Becker.
1993. The Hawaiian monk seal on Lisianski Island, 1988 and 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-179, 33 p.

Stone, H. S.
1984. Hawaiian monk seal population research, Lisianski Island, 1982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-47, 33 p.

Westlake, R. L., and P. J. Siepmann.
1988. Hawaiian monk seal and green turtle research on Lisianski Island, 1986. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-119, 18 p.

Pearl and Hermes Reef

Choy, B. K., and L. M. Hiruki.
1992. The Hawaiian monk seal and green turtle on Pearl and Hermes Reef, 1988. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-175, 18 p.

Finn, Michele A., John R. Henderson, Brenda L. Becker, and Timothy J. Ragen.
1993. The Hawaiian monk seal and green turtle at Pearl and Hermes Reef, 1990 and 1992. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-182, 29 p.

Forsyth, R. G., D. J. Alcorn, T. Gerrodette, and W. G. Gilmartin.
1988. The Hawaiian monk seal and green turtle on Pearl and Hermes Reef, 1986. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-107, 24 p.

Kure Atoll

Bowlby, C. E., P. Scoggins, R. Watson, and M. Reddy.
1991. The Hawaiian monk seal, *Monachus schauinslandi*, at Kure Atoll, 1982-83. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-155, 28 p.

Gilmartin, W. G., R. J. Morrow, and A. M. Houtman.
1986. Hawaiian monk seal observations and captive maintenance project at Kure Atoll, l981. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-59, 9 p.

Henderson, J. R., and M. R. Finnegan
1990. Population monitoring of the Hawaiian monk seal, *Monachus schauinslandi*, and captive maintenance project at Kure Atoll, 1988. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-150, 24 p.

Reddy, M. L.
1989. Population monitoring of the Hawaiian monk seal, *Monachus schauinslandi*, and captive maintenance project for female pups at Kure Atoll, 1987. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-123, 37 p.

Reddy, M. L., and C. A. Griffith.
1988. Hawaiian monk seal population monitoring, pup captive maintenance program, and incidental observations of the green turtle at Kure Atoll, 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-101, 35 p.

Van Toorenburg, R. A., W. G. Gilmartin, and J. R. Henderson.
1993. Composition of the Hawaiian monk seal population at Kure Atoll, 1990. Pac. Sci. 47(3):211-214.

Nihoa and Necker Islands

Morrow, R. J., and E. K. Buelna.
1985. The Hawaiian monk seal and green turtle on Necker Island, 1983. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-55, 1 p.

SEAL CENSUS FORM

SEAL CENSUS FORM, PAGE 2

1992
CENSUS FORM DIRECTIONS

Entry	Description
ISLAND	Name of island and atoll, *e.g.*, **East**, **FFS**.
OBSERVER	Three initials. If no middle initial, use the first and last block.
TIME BEGIN and **END**	On a 24-h clock, *e.g.*, 6 p.m. = 1800, for the group of pages.
DATA TYPE	**C** = Census: a complete count on an island begun around 1300 **A** = Atoll: atoll-wide census (must be completed within 2 days) **P** = Patrol: any other observation not on a timed census **I** = Incidental: incidental observations *Other letters may be used at your discretion to indicate specific kinds of noncensus data,* e.g., **M** *for male observations.*
NUMBER	Censuses and patrols may be assigned numbers at your discretion. (Atoll counts extending over more than 1 day *must* be numbered.)
PAGE	If census (or patrol) requires three pages, then mark first page as **page 1 of 3** and so on. If more than 1 person conducts the census, then combine page numbers; person A has pages 1 and 2, while person B has pages 3 and 4 of a four-page census day.
TEMP.	Temperature in degrees Celsius at beginning of census or patrol
WIND	Speed: **0** = no wind, calm (<5 knots) **1** = light breeze (5-15 knots) **2** = strong wind (>15 knots) Direction: **NW**, **NN**, **NE**, **EE**, **SW**, **SS**, **SE**, **WW** Thus: **2** N|N = strong wind from north
CLOUD	Cloud cover: **00** = no clouds **01**-**09** = 10 to 90% cover **10** = 100% cover
PREC.	Precipitation: **0** = no precipitation or trace **1** = mist/drizzle **2** = rain **3** = intermittent rain
SECTOR	Location on island (*e.g.*, **1**-**20** on Lisianski; **99** = no island)

Entry	Description
SIZE	**P** = Nursing pup: **P1** = wrinkles **P2** = no wrinkles **P3** = blimp, black **P4** = molting **P5** = molted **PW** = Prematurely weaned/undersized weaned pup (weaned ≤2 weeks ago and <90 cm girth) **W** = Weaned pup **J** = Juvenile and **I** = Immature: **J1** = Juvenile I **J2** = Juvenile II **S** = Subadult and **I** = Immature: **S3** = Subadult III **S4** = Subadult IV **A** = Adult **T** = Turtle: **T1** = Juvenile (<65 cm) **T2** = Subadult (65 - 80 cm) **T3** = Adult (>80 cm) **U** = Seal of unknown size
SEX	**M** = Male **F** = Female **U** = Unknown
ID	Record ID number of seal if known. If the ID number is "local", then code its last three digits here. If the number was assigned at a different location, then code all 4 digits (put both the island-specific prefix and second digit in the first box provided). **?** column: 1 = ID number is questionable. 0 = Seal is definitely not an IDed animal. ***<blank>*** = ID number is certain and complete if present.

Entry	Description
BLEACH	Bleach number (or temporary number) of seal if known; right justified; this column may be used for any temporary number assigned in the field. Use separate number series for bleach and various types of temporary numbers. **?** column: **1** = Bleach is present, but the number is questionable. **0** = Seal is definitely unmarked—can coexist with a bleach number if bleach hasn't taken yet or the number has molted off **4** = Partially read bleach number completed from other data. ***<blank>*** = Number is certain and complete if present.

(*Next entry on following page)*

Entry	Description
TAG	Tag number if known, right justified, *e.g.*, tag #K23 = K23. Put the alpha prefix of the temple tag (combined with tag **?** column code = **5**) if you can determine the hole drilling pattern but can't decipher the number. Record the last 5 digits of a 10 digit Pit tag. **L/R** is the tag position: **L** = Tag on *left* flipper. **R** = Tag on *right* flipper. **B** = Tags on *both* flippers (enter one tag number). **COL** = Color: color code. See the Tag Sample Kit if unsure of the colors. **Temple Tags** **Y** = Yellow (FFS) **T** = Tan/brown (Laysan) **G** = Green (Lisianski) **B** = Blue (Pearl & Hermes) **K** = Silver/gray (Kure) **R** = Red (Midway, Necker, Nihoa, Main Islands) **Other tag types** **M** = Metal, Monel **P** = Plastic, Riese **C** = Clear, Pit tag **?** column: **1** = Seal is tagged, but the number is questionable. **0** = Seal is definitely not tagged. **4** = Partially read tag completed from other data. **5** = Incompletely read tag, but partial data are certain (if seal can't be identified by ID or Temporary #). ***<blank>*** = Tag information is certain if present. Partial data (in the form of some fields not filled) are OK and will be completed by computer if the seal is identified by ID, Temporary #, or Tag #. The computer will *only* fill blank fields, so a partial Tag # must be completed by hand (use a **4** in the tag **?** column).
BEACH POS.	Location of seal or turtle when observer comes abreast of animal (*e.g.*, if seal is seen midbeach from a distance and yet is at the waterline when the observer come abreast, then the seal is recorded as being at the waterline). **0** = Animal floating in water or on an offshore rock (not included in census tally but may be used for behavioral data). **1** = Along waterline, on wet sand. **2** = Midbeach, on dry sand. **3** = Vegetation zone or beach crest, on permanent beach.

Entry	Description
MOLT	Percentage of old pelage lost, optional for nursing pups. **0** or ***<blank>*** = No molting evident. **1** - **99** = 1 to 99% molted (right justified). **100** = 100% molted, freshly molted, up to 1 month after molt. **?** column: **1** = Seal is molting, but % molt estimate is questionable. May or may not include an estimate in the molt column. **0** = Seal is definitely not molting.
DISTURB	The degree to which the seal may have been disturbed by observer **0** or ***<blank>*** = No disturbance, or seal merely looked at observer. **1** = Seal vocalized, gestured, or moved ≤2 body lengths. **2** = Seal alerted to observer and moved >2 body lengths. **3** = Seal alerted to observer and fled into water.
TIME	The time of each observation, on a 24-h clock
ASSOCIATION DATA	There is room to describe two different seal associations (**A** and **B**). Always use the **A** block first. Don't record associations involving turtles. Record detailed association data at Laysan and Lisianski Islands in 1992. At other locations, record mother-pup pairs, entanglements, and unusual events, using the **X** code to indicate you are not recording standard association data on Census or Atoll Count. **Active** associations: 1) Noted for all except behaviors between mother and nursing pup. 2) Must take place within 30 m of observer. 3) Subjects may be any distance apart. **Spatial** associations: 1) Noted as observer comes abreast of the subject. 2) Entangling object: distances <2 m away. 3) Individual seals: . Mother-pup pair (**N**): any distance. . All others (**L**): distances ≤10 m away, record two nearest neighbors in straight line of sight.

Entry	Description
LINE NO.	Identity of the other party in the association 1) If a seal, put its line number here (note line number refers to within same census page only). 2) If an entangling object, put: **99** = net and/or rope; **98** = flotsam other than above.
DIST.	Closest distance during behavior. **0** = body contact **1** = <2 m **2** = 2-5 m **3** = >5 m (>5 m but ≤10 m in the case of L behavior code)

BEHAVIORUp to four behaviors may be recorded for each association, but **N**, **E**, **X**, and **O** should not appear together with other behaviors. Behaviors **B** and **M** require distance = **0**.

1) Individual seal (* = requires corresponding code—explained at end of this section)

a) Active behavior
A = approach/investigate/sniff/nudge

B = Bite:
B1 = nip
B2 = draws blood/breaks skin

C = Chase:*
C1 = ≤2 body lengths*
C2 = >2 body lengths*

D = Displace*

F = Flee/move away:
F1 = ≤2 body lengths
F2 = >2 body lengths

J = Joust/spar/fight:*
J1 = ≤30 s*
J2 = >30 s*

M = Mount/attempted mount
M1 = ≤30 s
M2 = >30 s

P = Play*
R = Submissive roll/present ventral
V = Vocalize
Z = Cruising A/S4 male only behavior (actual sex may be unknown). Does not require a line number reference to another seal, but may have one.

Entry	Description

(**BEHAVIOR** *continued on following page*)(**BEHAVIOR**, *continued*)(1) Individual seal, *continued)*

b)Spatial association

N =Mother-pup pair (any distance). Does not imply nursing. This is the only association recorded between mother-pup pairs.

L=Association by location only (distance ≤10 m apart, for all except mother-pup pairs)

c)Optional codes

L1=Pair association* A/S4 male paired with/defending an adult female or immature of either sex (actual sex may be unknown).

Q=Loser*
W=Winner*
Y=Tie*

* Requires a corresponding code on the line of the associated seal:

Code	*Corresponding code*
C, **C1**, **C2F**, **F1**, or **F2**	**J**, **J1**, **J2J**, **J1**, and **J2**, respectively
PP	Codes used for A/S4 male-male contest only (actual sexes may be unknown). See **CONTEST RULES.**
L1L1	
QW	
WQ	
YY	

2)Entangling object

L=Association by location only (distance <2 m).

E=Subject is entangled.

3)Nothing nearby

O=No behavior or association.

4) No data

X=No association data recorded on Census or Atoll Count.**CONTINUE**If the *same seal sighting* is recorded on several lines for any reason (*e.g.*, additional tag or association, behavior at a later time, change of beach position), put the *original* line number you are continuing *from* here. Lines may be continued only within the same page. All fields through **BEACH POSITION** will be copied from the original line if left blank on the continuation line.

NOTES

Code a **1** if you have handwritten notes on the observation. Put handwritten notes on the bottom of the census form, labeled by line number. The following note codes have specific meanings:

- **L** = Observation is purely incidental, *i.e.*, not on census or patrol.
- **R** = Seal is on rock offshore (combined with beach position **0**).
- **D** = Seal is dead.

Entry	Description

More **NOTES** codes (optional):

If several codes apply, you can use continuation lines (if it isn't an **L** sighting) or put the most important code down. Emphasize the condition codes (**P**, **E**, and **F**) because condition data isn't collected elsewhere.

P = Pregnant female
V = Vestibule checked/status noted
W = Initial wound sighting
E = Seal is emaciated/very thin
F = Seal is fat
A = Artwork (scars drawn)
G = Seal is green with algae
T = Tagged/tag condition noted
H = Harassment/mobbing
S = Snap shot/photo taken
B = Bleach number first applied/ re-applied post-molt

ADDITIONAL PROTOCOL

1. All original monk seal data should be coded in pencil. Never erase data once you have left the recording site. Instead, cross errors out with a single line. Field editing by the data collector should be in blue, and editing by others should be in red. Back in Honolulu, all post-entry editing should be in orange.

2. A separate data sheet should be filled out for each date, observer, data type, and island within an atoll. If no seals are present, you should still fill out the information at the top of the census form and write **No seals** in the data area (only enter the header information). If the island itself is not present, indicate this by using **99** for the sector code, leaving the rest of the (first) line blank.

3. If two people conduct the census, they should have the same weather and the same begin and end time (*i.e.*, both begin at the same time and place, and proceed in opposite directions until they meet on the other side of the island or islet).

4. Weather information (except temperature) should be a summary of the entire day up until the end of the census or patrol, not merely an instantaneous observation.

5. Make a new original line (*i.e.* do not use continuation lines) for a seal each time that you come abreast of it on census or patrol. If the seal is identified, it will not be counted twice on census. To link two sightings of an unidentified seal (*i.e.* a cruiser moving ahead of you on census), assign it a unique temporary number in a series reserved for unidentified seals.

6. Only code the sex as known if the ventral is seen or if the seal is the mother in a mother/pup pair, even if you "know" the sex because of the tag, bleach, or scars, or behavior.

7. Record all tag sightings explicitly (*i.e.*, both left and right tag numbers) at least once during your stay. When a pup is tagged, record the first occurrence of each tag on a census data sheet for that date as well as on a tagging card. If a seal is identified via a tag, it is not necessary to determine and enter its ID number on the census form. The ID number will be added by computer later.

8. Be sure to code the *original* tag color—*not* the color that a tag has faded to. See the Tag Sample Kit in the Bible.

(*Original/Faded color table on following page*)

Original Tag Color	Faded Tag May Appear As
Temple Tags	
Light Tan (**A**, **T**, **K**, **L** series @ Laysan)	Gray, Light Yellow, White
Dark Tan/Brown (later series @ Laysan)	Red
Gray (**600**-**900**, **O**, **Z** and later series @ Kure)	Light Tan
Silver Gray (**A**, **T**, **K**, **L**, **N**, **F**, **U**, **G** series @ Kure)	Metal
Red	—
Yellow	White, Light Yellow
Green (dark forest)	Dark Blue, Navy
Blue (light)	—
Riese Tags	
White	Yellow
Red	—
Orange	—
Yellow	White
Green	Blue
Blue	Green

9. On a census it is assumed that molt, disturbance, and behavioral data will be taken. Thus, on a census data sheet, no code in any of the A or B columns means that the seal was alone, whereas on a patrol data sheet, no code may simply mean that no data were taken. It is not necessary to put an **O** code for each unassociated animal on census. The computer will fill this in later. If you are not recording association data on Census or Atoll Count (all locations other than Laysan and Lisianski in 1992), or if you are unable to record association data on a Census at Laysan or Lisianski for any reason, indicate this with an **X** for the behavior code.

10. An association should *either* be all blank *or* have the **O**, **Z**, or **X** behavior only, with no line number or distance, *or* have a line number, a distance, and some behavior code (other than **O** or **X**) all present.

11. All associations (except with entangling objects) should be in pairs, *i.e.*, between animals on two different lines. If the behavior is active, you should fill in the line numbers, distances, and behavior codes for both animals involved in the association. If the behavior is **N** or **L**, however, you may record the association on only one of the lines, and the computer will fill in the other line.

12. Only use **L** in the **NOTES** column if you are *off* census or patrol (outside the time begin/time end bracket). **L** observations should stand alone (*i.e.* should not be a continue line for a seal on census, or associated with a seal on census). If an original line is an **L** sighting, be sure to put **L** on all its continuation lines (the computer will not fill in the **NOTES** column for you).

CONTEST RULES

1. Size class collapse for contests: all subadults = adults (both sexes)

2. Definition of pair type (depends on associate of adult male):

   - Pair type **#1**: adult male with adult female (**L1**)
   - Pair type **#2**: adult male with juvenile or pup of either sex (**L1**)
   - Pair type **#3**: "single" adult male not pair type **#1** or **#2**

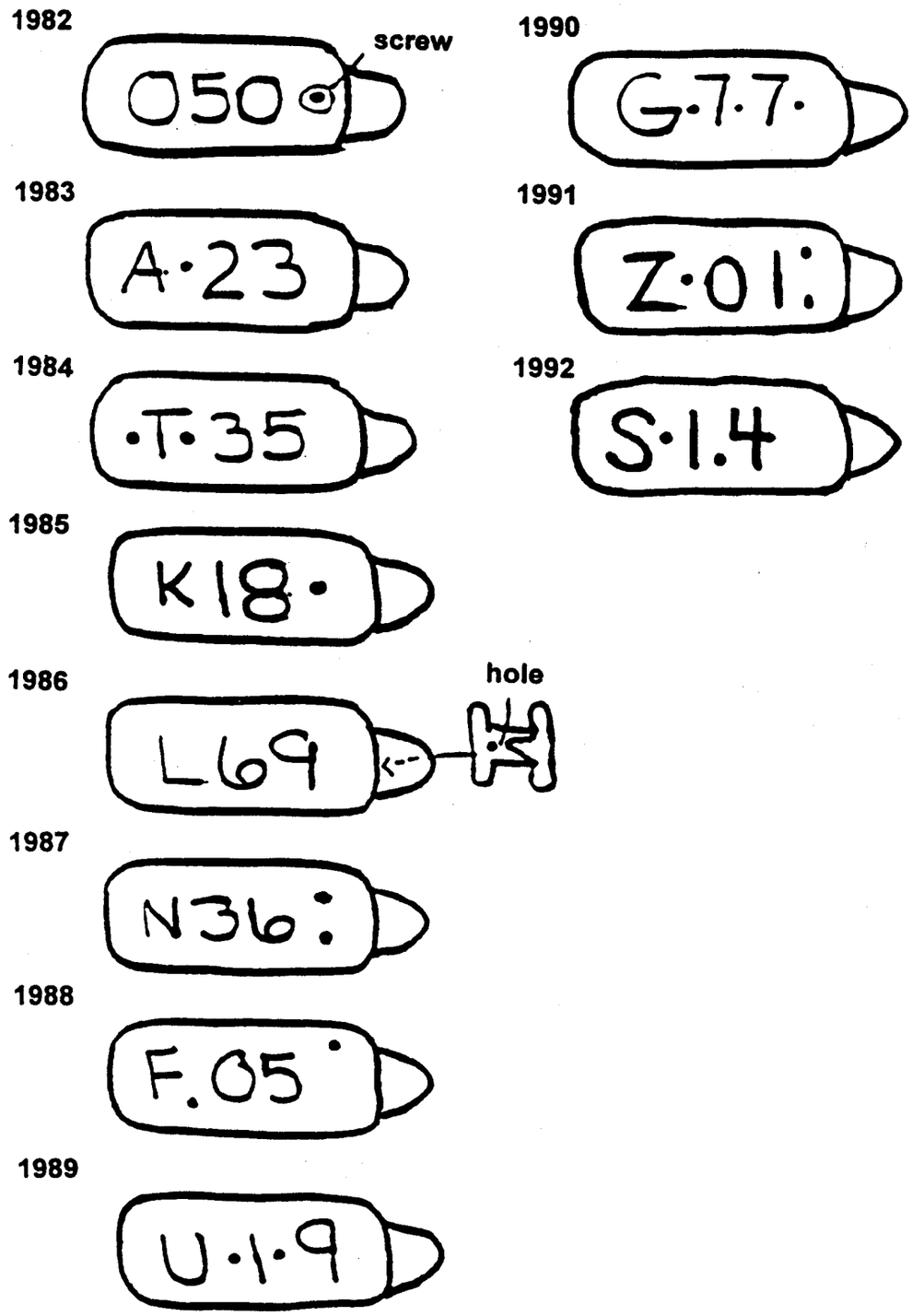
3. Definition of a male-male contest (must conform to at least one condition below):

   - Distance between males = 0
   - Either adult male vocalizes (**V**, **G**, **S**, **U**) or performs a **T**, **C**, **D**, or **J**
   - If cruiser approaches to beach position ≥ 1, regardless of other behaviors

4. Definition of winner or loser adult male:

Case	Winner (W)	Loser (Q)	Tie (Y)
Paired Male *vs*. Single Male: (**#1** or **#2** *vs*. **#3**)	i) Original Single Male if has **D**	Has **F**	No Ties
	ii) Original Paired Male otherwise		No Ties
Male Paired with Adult Female *vs*. Male Paired with Juvenile Seal: (**#1** *vs*. **#2**)	i) Original Male Paired with Juvenile if has **D**	Has **F**	No Ties
	ii) Original Male Paired with Adult Female otherwise		No Ties
Paired Male *vs*. Paired Male where both pairs are same type: (**#1** *vs*. **#1** or **#2** *vs*. **#2**)	Has **D**	Has **F**	Tie if no **D**
Single Male *vs*. Single Male: (**#3** *vs*. **#3**)	Has **D** or **C**	Has **F**	Tie if no **D** or **C**

HAWAIIAN MONK SEAL TEMPLE TAGS
NUMBERING SCHEME AND HOLE DRILLING SEQUENCE FOR WEANED PUPS



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