NOAA Technical Memorandum NMFS

JUNE 1999

THE HAWAIIAN MONK SEAL IN THE NORTHWESTERN HAWAIIAN ISLANDS, 1997

Compiled and Edited by

Thea C. Johanos
Timothy J. Ragen

NOAA-TM-NMFS-SWFSC-262

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

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EXECUTIVE SUMMARY

In 1997, field studies of the endangered Hawaiian monk seal (*Monachus schauinslandi*) were conducted at all of its main reproductive sites in the Northwestern Hawaiian Islands. These studies provide information necessary to evaluate (1) the status and trends of monk seal populations, (2) natural history traits such as survival, reproduction, growth, behavior, and feeding habits, and (3) the success of various activities designed to facilitate population growth.

Results of these studies are best described on a site-by-site basis, and the information presented in this document is organized accordingly. Pooled site-specific data, however, provide useful indices of the status and trends of the whole species, including the total number of pups at the main reproductive sites, the total of the site-specific mean beach counts, and the size composition of the seals observed during the counts (Fig. 1).

Since 1983, the number of pups born at the main reproductive sites (excluding Midway Atoll) has been highly variable, and the variability has been largely determined by the number born at French Frigate Shoals (Fig. 1a), the largest subpopulation. In 1997, 201 pups were counted at these sites, 97 of which were born at French Frigate Shoals. Mean beach counts, excluding pups, from the main reproductive sites (again, excluding Midway Atoll) totaled 373 seals and have remained essentially unchanged since 1993 (Fig. 1b).

Since the mid 1980s, adults have comprised a growing portion of the animals counted (Fig. 1c) and, in 1997, the composition of the counts remained largely skewed towards adults. This shift in composition bodes poorly for reproduction in the near future if older adult females are not replaced by young females reaching reproductive age. The overall impact from this shift in composition will be determined by the magnitude of its change and the length of time that the resulting skewed distribution persists, neither of which can be reliably predicted at this time. High mortality of immature seals appears to be a major factor leading to the shift in composition, particularly at French Frigate Shoals and Laysan Island.

In 1997, three management activities were conducted by the Marine Mammal Research Program (Honolulu Laboratory, National Marine Fisheries Service) to enhance recovery of the species. First, debris capable of entangling seals was removed from all

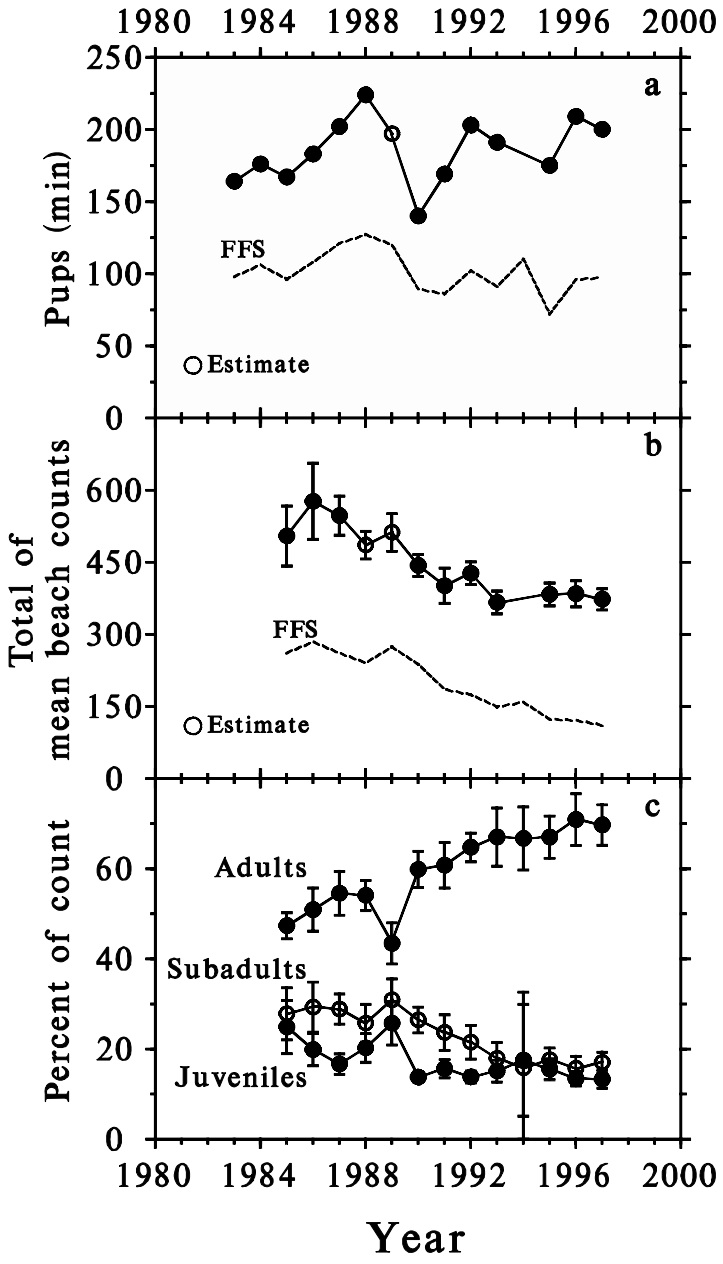

Fig. 1. Demographic trends of the Hawaiian monk seal, based on the main reproductive sites (excluding Midway Atoll). a) Number of pups born. b) Total of mean beach counts, excluding pups. c) Portion of the counts comprised of adults, subadults, and juveniles.

study sites and 13 entangled seals were disentangled by field biologists. Second, debris was removed from sections of fringing reef at French Frigate Shoals and Pearl and Hermes Reef to reduce hazards to the seals, assess the extent of reef fouling, and determine the feasibility of large scale debris removal. Third, weaned pups were translocated within French Frigate Shoals to increase their probability of survival.

This document describes these and other field studies conducted during 1997. The format followed is intended to provide complete, standardized, and timely summaries of the research activities and findings at each study site. The ready availability of such information is essential for ongoing efforts to stop the decline of this species and enhance its recovery.

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CHAPTER 1. GENERAL INTRODUCTION

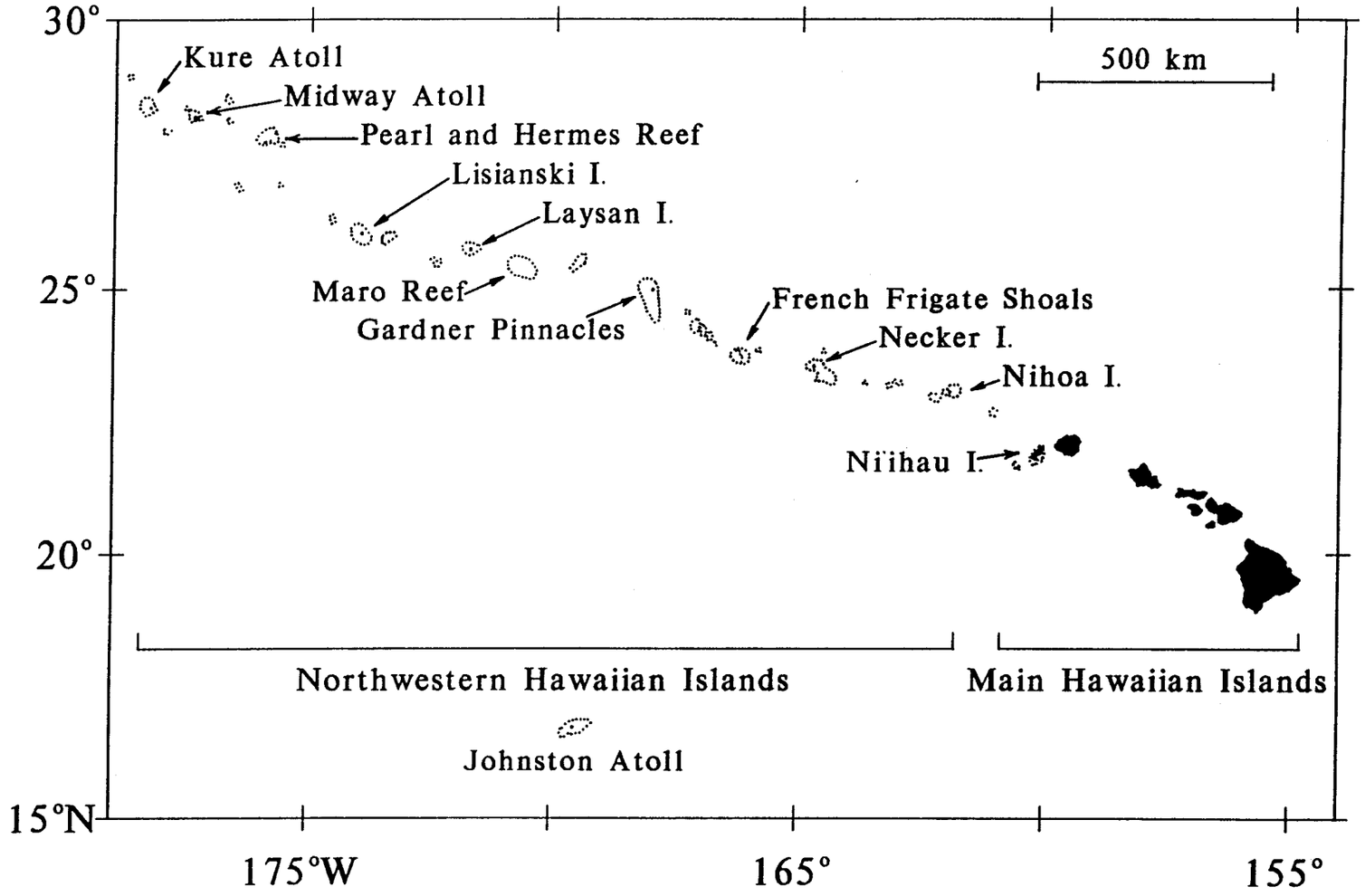

Fig. 1.1. The Hawaiian Archipelago.

The endangered Hawaiian monk seal (*Monachus schauinslandi*) hauls out and breeds in the Northwestern Hawaiian Islands, (NWHI, Fig. 1.1). The National Marine Fisheries Service (NMFS) is the lead agency responsible for the recovery of the Hawaiian monk seal. Each year the Southwest Fisheries Science Center, Honolulu Laboratory, NMFS Marine Mammal Research Program conducts studies at the main breeding sites to provide information necessary to evaluate (1) the status and trends of the monk seal populations, (2) natural history traits such as survival, reproduction, growth, behavior, and feeding habits, and (3) the success of various activities designed to facilitate population growth.

The Marine Mammal Research Program began research on Hawaiian monk seals at most major reproductive sites in the NWHI during 1981 (Kure Atoll, Laysan Island, and Lisianski Island), 1982 (French Frigate Shoals (FFS) and Pearl and Hermes Reef), and 1983 (Midway Atoll). 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 Nihoa and Necker Islands, where pup production is spatially limited by availability of haulout area. Reports summarizing past NMFS research are listed in Appendix A.

In 1997, the Hawaiian monk seal research activities 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 and summaries of data collected during the 1997 field season are described in the following chapters. Much of the information presented in this memorandum is incorporated into larger data sets for additional analysis and publication elsewhere.

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. Although data were collected on all seals, those that were in the water, captive, or dead were excluded from the beach count totals. Identified individuals were counted only once if they were resighted during the survey. The resulting counts did not reflect total population size but provided an index of population

size for comparison among years and locations. Data collected on each seal observed during censuses included size class (ranging from pup to juvenile, subadult, and adult size as described in Stone, 1984); sex; location on the island; beach position (indicating whether the seal was in the water or on land); body condition (a subjective estimate; e.g., fat or thin); identification information (permanent or temporary identification numbers and tag numbers); molting status (an estimate of the percentage an animal had molted); and disturbance index (the extent that the observer disturbed the seal). Further data were collected if any of the following events occurred: (1) factors affecting survival (e.g., entanglements or mobbings), (2) animal handling, (3) photography, and (4) documentation of tag condition (e.g., good or broken). In addition, behavior data (seal associations and interactions) were collected on Laysan and Lisianski Islands. A sample census form and guidelines for its completion are included in Appendix B. Censuses were conducted once at Necker Island or every 3-8 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 Atoll, and Kure Atoll) were completed within a 2-day period. The perimeter of each study area was divided into sectors to facilitate the analysis of data and detection of demographic trends in different geographic areas. Census methods specific to each location are detailed in the following chapters.

Patrols consisted of untimed surveys of an entire 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 as a visual barrier. 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 towards the documentation of (1) births, pup exchanges, and weanings, (2) mating activities, adult male aggression, and post-mobbing aggregations (defined below), (3) entanglements in marine debris, (4) injuries, and (5) deaths.

Reproduction

Parturient females were identified, and birth and weaning information were recorded. Because parturient females will nurse

pups other than their own (Boness, 1990), efforts were made to identify pups and document changes in nursing relationships from birth to weaning. A pup exchange occurred when the pups of two lactating females were switched. Most frequently, such exchanges occurred during an aggressive interaction between the two females. On other occasions, a mother and pup became separated, and one or both seals then actively sought and obtained another nursing relationship.

The average nursing period was calculated for the pups at each location. The average lactation period of parturient females was also calculated for seals at FFS because higher population density and frequent pup exchanges (Boness, 1990) made it difficult to track individual pups and determine their nursing period. Nursing or lactation periods were defined as the number of days from birth until the end of the last nursing relationship. Temporary breaks in nursing relationships were not subtracted from the total. When the exact birth or weaning date was not known, but occurred within a range of 4 days or less, then the midpoint of that range was used as the start or end date for the calculation of the average nursing or lactation period. Nursing or lactation data were not used if the range exceeded 4 days or if the pup died or disappeared before weaning.

Factors Affecting Survival

A wide range of injuries was observed. The origins of these injuries were distinguished based upon characteristic wound patterns described in Hiruki et al. (1993). Injuries were documented if they were related to mounting or entanglement or if they were considered severe enough to possibly affect survival. Injuries were considered severe, and were summarized, if they consisted of (1) three or more abscesses, each <5 cm in diameter, or one abscess with a diameter ≥5 cm; (2) an amputation of more than one digit (either foreflipper or hindflipper); (3) at least three punctures or gaping wounds, 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 healed when first observed.

A seal was listed as dead if its death or carcass was 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 listed as probably dead if it sustained severe injuries or was emaciated (with skeletal structure clearly evident) and subsequently disappeared. In addition, one of the following conditions must have been satisfied to place a seal in the "probably dead" category:

(1) the seal was lethargic, had difficulty 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 listed as probably dead if they disappeared within 3 weeks of birth.

Mobbing and other mating-related male aggressions were observed and recorded. By definition, mobbing occurred when multiple males attempted to mate with a single seal, usually an adult female or immature seal of either sex, causing injury or death of that seal (e.g., Alcorn, 1984). Mating-related aggression was defined as any incident where an adult or subadult male repeatedly bit the dorsum, attempted to mount, and tried to prevent the escape of another seal. These incidents were summarized in this report 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 blubber layer) or $\geq$15 scratches to the dorsum or flanks. 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.

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 on each hind flipper with a colored plastic Temple Tag,®[1] uniquely coded to indicate island or atoll population, year of birth, and individual ID (Gilmartin et al., 1986). In addition, passive integrated transponder (PIT) tags were implanted subcutaneously in the dorsum of each weaned pup (two each at FFS and one each at other locations) (see Lombard et al., 1994, for detailed tagging procedures).

Colored plastic Temple Tags have been applied to nearly all weaned pups since 1981 at Kure Atoll, 1982 at Lisianski Island, 1983 at Laysan Island and Pearl and Hermes Reef, 1984 at French Frigate Shoals, and 1995 at Midway Atoll. Pups at Midway Atoll, Necker and Nihoa Islands, and the main Hawaiian Islands have been tagged opportunistically since 1983. Since 1991, PIT tags have also been implanted subcutaneously in the dorsum of most weaned pups.

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[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

In 1997, untagged immature seals were tagged with Temple Tags uniquely coded to indicate that their ages and birth locations were unknown. Immature seals with lost or broken tags were retagged to maintain their identities.

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

Tags, scars, natural markings, and any applied bleach marks were sketched on an individual 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.

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 during the interval from March through August and all pups born during the year. Captive seals were included if they were released in the current year. If a seal was seen at more than one location during March-August, it was included in the population where it was sighted closest to May 15 unless it pupped or molted at another location. A parturient female was always included in the population where it pupped, and a non-parturient seal was included in the population where it molted. Pups were always included in the population where they were born.

The movement of seals between island or atoll populations confounds the estimation of population size and composition when the study period is short (i.e., less than 1 month). This is particularly true at Midway Atoll, where a number of the observed seals were tagged at other locations (primarily Kure Atoll and Pearl and Hermes Reef). These seals may be transient visitors, and additional study is needed to distinguish them from seals that reside at Midway Atoll.

Measurements of Seals

Pups were measured to determine their condition, growth patterns, and the relation between size and survival. Measurements were taken as soon after weaning as possible and included straight dorsal length (Winchell, 1990) and axillary girth (American Society of Mammalogists, 1967).

Collection of Samples

Samples were collected for DNA analysis, pathology 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 at Laysan Island on an opportunistic basis for DNA analysis. The primary objectives of genetic 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, and external measurements and observations were recorded. 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 were collected (Alcorn, 1984) for analysis of food habits. Emphasis was placed on collecting these 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 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, 1997

Mitchell P. Craig and Melissa A. Shaw

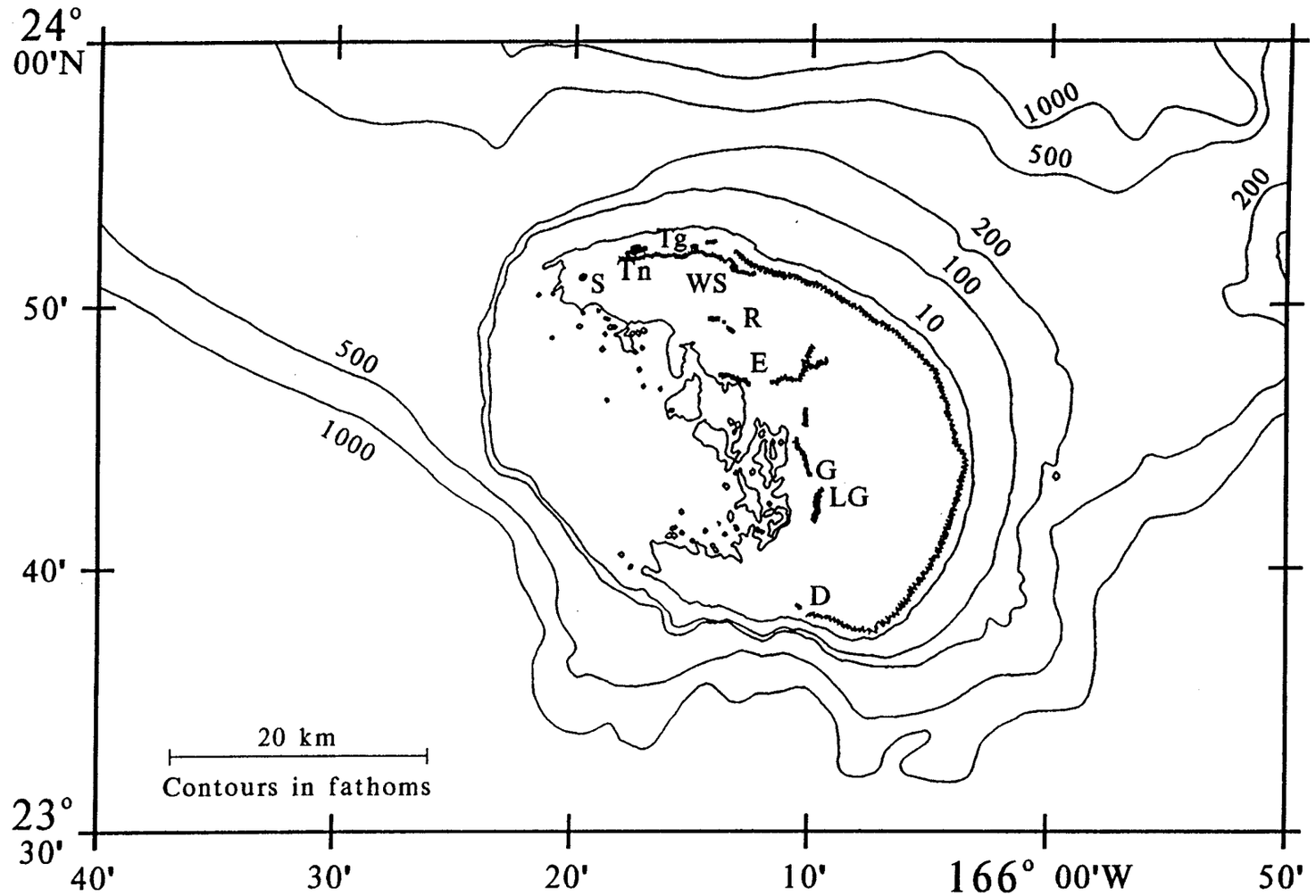

Fig. 2.1. French Frigate Shoals in the Northwestern Hawaiian Islands. Islands are: Disappearing (D), East (E), Gin (G), Little Gin (LG), Round (R), Shark (S), Tern (Tn), Trig (Tr), and Whaleskate (WS).

The largest island 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. This atoll is part of the Hawaiian Islands National Wildlife Refuge (Fig. 1.1) and consists of 10 permanent islands and 7 semipermanent sand spits (Fig. 2.1).

RESEARCH

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at FFS in 1982. In 1997, research was conducted by NMFS during January 8-23 and March 8-September 13. Incidental observations were recorded by U.S. Fish and Wildlife Service (USFWS) personnel during the rest of the year. The perimeters of the six larger islands were divided into sectors using artificial or natural landmarks. Research activities specific to this population in 1997 included (1) investigation of habitat use patterns using satellite-linked telemetry and seal-mounted video cameras, (2) assessment of nearshore prey availability and habitat structure, (3) collection of blood samples for health and disease studies, (4) translocation of weaned pups within the atoll to increase survival, and (5) debris removal from the fringing reef.

Censuses and Patrols

Atoll censuses (n = 10) were conducted every 8 days, on average, from May 20 to August 5. Each atoll census began between 0955 and 1113 Hawaii standard time and ended between 1550 and 1800. All islands were usually censused on foot by one or two persons. Patrols were conducted on noncensus days to monitor pupping activity and factors affecting survival.

Individual Identification

A total of 443 individuals (346 excluding pups) were identified by existing or applied tags, scars, or natural markings. Most weaned pups (n = 51) were tagged with Temple Tags; 46 of these same pups were tagged with passive integrated transponder (PIT) tags. Two juvenile seals (one male and one female) born in 1996 were tagged with Temple Tags in January 1997. One subadult male and one adult male were retagged with Temple Tags.

Collection of Samples

Fifty scat samples were collected and processed. Tissue samples were collected from 38 seals during tagging. Necropsies were performed on nine dead seals and two fetuses found at the study site, and tissue samples were collected.

Special Studies

Habitat Use Study

In January 1997, four satellite-linked time-depth recorders were retrieved from two adult males and two adult females that were instrumented in October 1996 as part of a foraging study conducted in collaboration with the University of Minnesota. Although another instrumented adult female was located, the unit was not retrieved because this seal was determined to be pregnant. In March, eight additional seals (three adult males and five adult females) were instrumented with satellite-linked time-depth recorders. Four of these recorders were retrieved in July (from three adult males and one adult female). Two of the adult females instrumented in October 1996 pupped successfully in 1997. None of the adult females instrumented in March pupped in 1997. Only females not considered to be pregnant were instrumented with satellite-linked time-depth recorders. In July and August, 10 adult male seals were instrumented with video cameras which were retrieved in 4 to 31 days. Nineteen seals were measured (axillary girth and dorsal straight length) during instrument applications and removals.

Reef Fish and Habitat Assessment

In July and August, the Ecosystem and Environment Investigation of the Honolulu Laboratory, NMFS, continued ongoing habitat assessment. This included a reef fish survey and video camera transects around and within the atoll and at Brooks Banks.

Health and Disease Study

Blood samples were collected from 31 seals as part of a health survey of the wild population; samples were collected during all satellite tag applications and retrievals and all video camera applications and retrievals but one.

Translocation of Weaned Pups

In response to unusually high mortality of pups at Trig Islet and Whale-Skate, intensive monitoring of mother-pup pairs and newly weaned pups was initiated. Circumstantial and direct evidence implicated both sharks and adult males in the loss of pups at these locations. Fourteen weaned pups (seven males and seven females) were translocated from Trig and Whale-Skate to the Gins to increase their probability of survival.

Debris Removal from Fringing Reef

Personnel aboard the NOAA ship *Townsend Cromwell* removed debris from a section of fringing reef to reduce these hazards to monk seals and other marine life, assess the extent of reef

fouling, and determine the feasibility of a large scale debris removal effort. During this effort, a partially submerged net was found near Whaleskate with two immature seals entangled in it; one seal had recently drowned and the other was released alive.

RESULTS

Population Abundance and Composition

The means (±SD) for 10 atoll censuses were 144.7 seals (±13.2) including pups, and 111.3 seals (±12.1) excluding pups (Table 2.1). The total spring-summer population included 161 immature individuals (subadults, juveniles, and pups), of which 64 were subadults or juveniles (Table 2.2). Although the total numbers of adult males and females were not obtained due to our inability to identify all individuals, it is estimated that less than 5 adult females and 10 adult males remained unidentified at the end of the field season. The numbers of tagged known-age seals born at FFS during the period from 1984 to 1996 and resighted there in 1997 are summarized in Table 2.3.

Reproduction

At least 97 pups were born: 59 were weaned, 36 died or disappeared prior to weaning, and the weaning status of 2 pups was unknown (Table 2.4a). Two fetuses were found, but not counted in the total number of pups born. Nursing periods and measurements of weaned pups are summarized in Table 2.4b. A total of 166 adult-sized females were identified and 92 (55.4%) of those were parturient. The birth rate was 57.6% (57/99) for older (>13 years old) and unknown-age adult females and 52.2% (35/67) for younger females of adult size ($\leq$13 years old). Parturient females were more likely to be identified during lactation, which probably biased the estimates of birth rate upward. As noted above, our best estimate is that less than five adult-sized females remained unidentified at FFS. The mean (±SD) lactation period for 23 females was 37.0 d (±5.8 d). At least 17 pups were fostered by mothers other than their own.

Interatoll Movement

Interatoll movement was documented for seven seals that made a total of seven movements between FFS and either Necker Island, Gardner Pinnacles, or Laysan Island (Tables 2.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by males, entanglement, and other/unknown factors resulted in 74 life-threatening conditions, which led to the confirmed deaths of 16 animals and the probable deaths of 28 seals (Table 2.6). A

nursing pup was eaten by a shark during an observed attack. At least three seals were entangled; in addition to the two seals found entangled in the same partially submerged net, a third seal, entangled in a net on shore, was released by USFWS personnel. In addition to the deaths presented in Table 2.6, two aborted fetuses were found on Tern Island in January, 1997.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge staff. 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 = 10) of Hawaiian monk seals at French Frigate Shoals from May 20 to August 5, 1997.

Size/Sex	Mean number of individuals	Standard deviation
Adults	94.7	11.0
Male	33.2	5.1
Female	58.0	8.3
Unknown	3.5	1.6
Subadults	7.8	2.1
Male	2.4	2.0
Female	4.4	1.5
Unknown	1.0	1.3
Juveniles	8.8	3.6
Male	4.9	3.0
Female	3.2	0.6
Unknown	0.7	0.8
Pups	33.4	3.2
Male	11.2	2.3
Female	7.0	1.9
Unknown	15.2	3.3
Nonpup Total	111.3	12.1
Grand Total	144.7	13.2

Table 2.2.--Composition of the Hawaiian monk seal population at French Frigate Shoals during the spring and summer of 1997. Includes all pups born during the calendar year.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	116[a]	166[a]	0	282[a]	0.7:1
Subadults	11	18	0	29	0.6:1
Juveniles	18[b]	17[b]	0	35[b]	1.1:1
Pups	54	31	12	97	1.7:1
Nonpup Total	145[a]	201[a]	0	346[a]	0.7:1
Grand Total	199[a]	232[a]	12	443[a]	0.9:1

[a]Although the adult population was not totally identified, it is estimated that less than 5 adult females and 10 adult males remained unidentified at the end of the field season.
[b]Numbers exclude six males and six females that were seen in January, but not resighted subsequently. Numbers include 2 males and 3 females that were last observed in March.

Table 2.3.--Summary of tagged known-age seals born at French Frigate Shoals and resighted there in 1997.

Age (years)	Sex	Number originally tagged	Number resighted in 1997
13	Male	49	10
	Female	43	15
12	Male	48	5
	Female	38	15
11	Male	52	9
	Female	48	15
10	Male	55	13
	Female	51	15
9	Male	52	5
	Female	62	8
8	Male	51	7
	Female	50	5
7	Male	39	1
	Female	40	2
6	Male	24	1
	Female	44	3
5	Male	36	2
	Female	55	7
4	Male	40	6
	Female	39	2
3	Male	47	1
	Female	48	4
2	Male	29	6
	Female	26	5
1	Male	39	17
	Female	30	15

Table 2.4a.--Summary of Hawaiian monk seals born at French Frigate Shoals in 1997.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	54	31	12	97[a]
Died/probably died prior to weaning	19	6	11	36
Weaning status unknown	0	1	1	2[b]
Weaned	35	24[b]	0	59[c]
Tagged	32	19	0	51

[a]Two fetuses (1 male and 1 female) were also found but are not included in the total number of pups born.
[b]Three nursing pups were observed in October and November; 1 pup weaned and the fate of the other two pups was unknown.
[c]Two female weaned pups died prior to tagging, and six weaned pups (3 males and 3 females) remained untagged.

Table 2.4b.--Summary of nursing periods and measurements of weaned pups at French Frigate Shoals in 1997. Nursing periods were calculated where both birth and weaning date ranges were ≤4 days. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	39.6	101.8	126.4
St. Dev.	2.5	10.8	7.2
n	4	42	34

Table 2.5a.--Known movement of Hawaiian monk seals to French Frigate Shoals from other locations in 1997, summarized by movements between two locations. No seals made more than one trip.

Original location	Number, size, and sex class
Gardner Pinnacles	1 adult male
Laysan Island	1 adult male, 2 adult females, 1 subadult male

Table 2.5b.--Known movement of Hawaiian monk seals from French Frigate Shoals to other locations in 1997, summarized by movements between two locations. No seals made more than one trip.

Destination	Number, size, and sex class
Necker Island	1 adult female
Laysan Island	1 adult female

Table 2.6.--Factors affecting Hawaiian monk seal survival at French Frigate Shoals in 1997.

			Outcome		
Size	Sex	Total	Injured	Died	Probably died
Attack by Large Shark					
Adult	Male	5	5	0	0
	Female	8	8	0	0
Subadult	Male	2	2	0	0
Juvenile	Male	1	1	0	0
Weaned pup	Female	1	0	1	0
Nursing pup	Unknown	2	1[a]	1[b]	0
Mounting by Males					
Adult	Female	3	3	0	0
Weaned pup	Male	5	4[c]	1	0
	Female	4	2	2	0
Nursing pup	Male	3	0	3	0
	Female	2	0	2	0
Entanglement					
Adult	Female	1[d]	0	0	0
Subadult	Male	1[e]	0	1	0
Juvenile	Male	1[e]	0	0	0
Other/Unknown					
Adult	Male	2	2	0	0
Weaned pup	Male	3	0	2	1
Nursing pup	Male	16	0	1	15
	Female	4	0	2	2
	Unknown	10	0	0	10

[a]Disappeared later of unknown causes.
[b]Pup was eaten by a shark during an observed attack.
[c]One seal was mounted on two different occasions.
[d]Seal released by observers (net partially removed, came off as seal entered water).
[e]Two seals were found entangled in the same net; one had drowned, and the other was released by observers.

CHAPTER 3. THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND, 1997

Brenda L. Becker and Amber D. Pairis

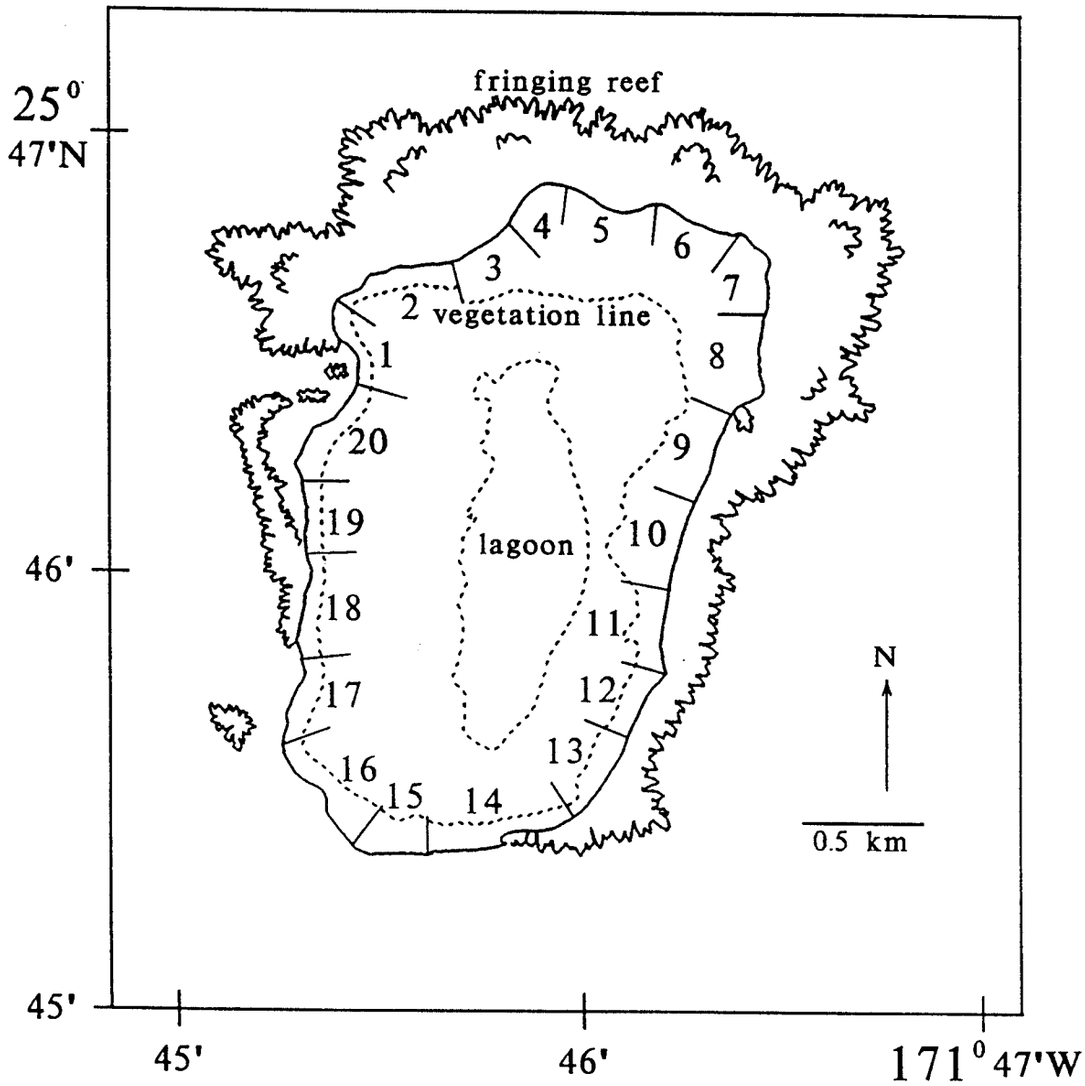

Fig. 3.1. Laysan Island in the Northwestern Hawaiian Islands.

Laysan Island (lat. 25°42'N, long. 171°44'W) is located ca. 1,300 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.

RESEARCH

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Laysan Island in 1981. In 1997, research was conducted by NMFS during March 12-July 24, and incidental observations were recorded by U.S. Fish and Wildlife Service (USFWS) personnel during the rest of the year. The perimeter of the island (ca. 11 km) was divided into 20 sectors using artificial or natural landmarks (Fig. 3.1). Research objectives specific to this population in 1997 included identification of all seals, assessment of maternity and pup exchanges, comparison of three methods to measure length of weaned pups, assessment of the prevalence of eye ailments in the wild population, description of male behavioral patterns and aggression to determine if the removal of 22 adult males from Laysan Island in 1994 reduced the incidence of mobbing, and identification of any of those males that may have returned to Laysan after translocation to the main Hawaiian Islands.

Censuses and Patrols

Censuses and patrols were scheduled to ensure that the entire island perimeter was monitored at least once each day during March 24-July 21. Censuses (n = 20) were conducted by two observers every fourth day from April 7 to June 25. Each census began at 1300 Hawaii standard time and continued for 3.0 to 4.1 hours.

Standardized behavior patrols were conducted on 43 noncensus days from March 24 to June 21 to assess activity patterns of adults and large subadults, document male aggression, and detect mobbing incidents. During behavior patrols, attention was directed out to sea as much as possible because mobbings have been observed most frequently in the water. Forty-two full-island incidental patrols to record noteworthy events were conducted on noncensus and nonbehavior patrol days.

Individual Identification

A total of 270 individuals (233 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. Bleach marks were applied to 231 seals, including 36 nursing pups. All weaned pups (n = 35) were tagged with Temple Tags and passive integrated transponder (PIT) tags. One pup, which weaned after the NMFS camp ended, was bleach-marked for identification in 1997 and tagged in 1998.

Collection of Samples

Ninety-nine scat and 48 spew samples were collected. Tissue samples were collected from 34 weaned pups during tagging. One necropsy was performed, and tissue samples and skull were collected. A lower jaw and os penis were collected from a seal that died during a previous year. Molt samples from 47 seals and sloughed fur from an injured seal were collected. Eleven placentas were also collected. In total, 713 pieces of potentially entangling debris were inventoried and destroyed, with the exception of 7 items: 4 were removed and collected from an entangled animal (2 from a seal and 2 from a seabird); 1 was left in place (where it would not pose a hazard); and 2 were collected for further analysis.

Noteworthy Events

Translocated Adult Males

Twenty-two adult male seals were collected from Laysan Island in 1994; 1 male died shortly after capture and the remaining 21 males were translocated to the main Hawaiian Islands. None of the translocated males had migrated back to Laysan Island, nor were they seen elsewhere in the Northwestern Hawaiian Islands in 1997, though one was sighted at Nihoa Island in 1996.

Oiled Seals

Eleven of seventeen seals observed with oiled pelage on Laysan Island in the spring of 1993 were sighted there in 1997. These seals appeared to be in good health, but sublethal or long-term effects could not be evaluated. Of the six not sighted in 1997, one seal was last seen in 1995, four were last seen in 1994 (one of these, an adult male, was translocated to the main Hawaiian Islands in 1994), and one was last seen in 1993.

RESULTS

Population Abundance and Composition

The means (±SD) for 20 censuses were 101.9 seals (±15.7) including pups, and 84.8 seals (±9.0) excluding pups (Table 3.1). The total spring-summer population was 263 individuals, 226 excluding pups (Table 3.2). The sex ratios of nonpup immature seals and adults were ca. 1.0:1 (43 males:45 females) and 0.9:1 (65 males:73 females), respectively. The sex ratio for older (>14 years of age) and unknown aged adults was slightly skewed toward males at ca. 1.2:1 (38 males: 32 females), whereas the ratio for younger adults (≤14 years of age) was ca. 0.6:1 (27 males:41 females). The numbers of tagged known-age seals born at

Laysan Island during the period from 1983 to 1996 and resighted there in 1997 are summarized in Table 3.3.

Reproduction

At least 37 pups were born: 35 were weaned, 1 died prior to weaning, and 1 was still nursing at the end of the NMFS camp (Table 3.4a). Nursing periods and measurements of weaned pups are summarized in Table 3.4b. Thirty-seven of seventy-three (51%) adult-sized females were parturient. At least 14 pup exchanges occurred between 12 nursing females; none of these incidents were observed. Two births and one weaning event were observed. One unusual temporary weaning (i.e., a nursing female abandoned her pup and then returned) was documented. One female had started to molt at the time of parturition and one parturient female had an unusually enlarged nipple for several months postweaning.

Interatoll Movement

Interatoll movement was documented for 14 seals that made a total of 18 movements between Laysan Island and either French Frigate Shoals or Lisianski Island (Tables 3.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by males, entanglement, and other factors led to 19 life-threatening conditions, which resulted in the confirmed death of 1 animal (Table 3.6). No incidents of adult male aggression were observed, and no seals were known to have died or disappeared following male-mounting incidents. Five entanglements were documented: in two incidents the seal escaped independently, and in the other three the seal was released by observers. In addition to the factors affecting survival presented in Table 3.6, the placenta was severed from two newborn pups whose movement (and thus survival) was severely restricted by the trailing tissue; two pups that nursed only 25 and 26 days each, as a result of pup exchanges, were emaciated at the end of the field camp and are not expected to survive the year; and a male seal had a cyst or tumor, first observed in 1996, still evident in 1997.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge staff and thank the captain and crew members of the NOAA ship *Townsend Cromwell*. Special thanks are extended to Rebecca Bernard, Monette Boswell, Chris Depkin, Catherine McMahon, Elizabeth Mitchell, Hadie Muller, Vanessa Pepi, Mari von Hoffman, and Peter Winch for their data collection and seal bleaching assistance.

TABLES

Table 3.1.--Summary statistics for censuses (n = 20) of Hawaiian monk seals at Laysan Island from April 7 to June 25, 1997.

Size/Sex	Mean number of individuals	Standard deviation
Adults	47.0	6.9
Male	19.5	5.2
Female	27.2	7.9
Unknown	0.3	0.7
Subadults	17.0	5.6
Male	7.9	3.1
Female	8.9	3.7
Unknown	0.1	0.3
Juveniles	20.9	4.6
Male	10.4	2.9
Female	10.2	3.0
Unknown	0.3	0.4
Pups	17.1	9.1
Male	10.0	5.8
Female	7.2	3.5
Unknown	0.0	0.0
Nonpup Total	84.8	9.0
Grand Total	101.9	15.7

Table 3.2.--Composition of the Hawaiian monk seal population at Laysan Island during the spring and summer of 1997. Includes all pups born during the calendar year.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	65	73	0	138	0.9:1
Subadults	19	21	0	40	0.9:1
Juveniles	24	24	0	48	1.0:1
Pups	19	17[a]	1	37	1.1:1
Nonpup Total	108	118	0	226	0.9:1
Grand Total	127	135	1	263	0.9:1

[a]One neonatal pup death.

Table 3.3.--Summary of tagged known-age seals born at Laysan Island and resighted there in 1997.

Age (years)	Sex	Number originally tagged	Number resighted in 1997
14	Male	10	1
	Female	10	6
13	Male	16	2
	Female	13	5
12	Male	16	1
	Female	14	5
11	Male	15	2
	Female	17	2
10	Male	13	3
	Female	15	5
9	Male	23	4
	Female	17	3
8	Male	16	2
	Female	13	2
7	Male	7	2
	Female	9	3
6	Male	18	8
	Female	13	8
5	Male	18	2
	Female	14	3
4	Male	23	4
	Female	14	4
3	Male	18	8
	Female	29	10
2	Male	16	8
	Female	21	11
1	Male	23	16
	Female	21	14

Table 3.4a.--Summary of Hawaiian monk seals born at Laysan Island in 1997.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	19	17	1	37
Died prior to weaning	0	1	0	1
Still nursing	0	0	1	1
Weaned	19	16	0	35
Tagged	19	16[a]	0	35

[a]Includes one pup weaned and bleached after the NMFS camp ended in 1997, and tagged in 1998.

Table 3.4b.--Summary of nursing periods and measurements of weaned pups at Laysan Island in 1997. Nursing periods were calculated where both birth and weaning date ranges were ≤4 days. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	37.0	103.7	125.8
St. Dev.	6.7	10.6	7.0
n	35	34	34

Table 3.5a.--Known movement of Hawaiian monk seals to Laysan Island from other locations in 1997, summarized by movements between two locations. No seals made more than one trip.

Original location	Number, size, and sex class
French Frigate Shoals	1 adult female
Lisianski Island	1 adult male, 6 adult females, 2 subadult females

Table 3.5b.--Known movement of Hawaiian monk seals from Laysan Island to other locations in 1997, summarized by movements between two locations. No seals made more than one trip.

Destination	Number, size, and sex class
French Frigate Shoals	1 adult male, 2 adult females, 1 subadult male
Lisianski Island	3 adult females, 1 subadult female

Table 3.6.--Factors affecting Hawaiian monk seal survival at Laysan Island in 1997.

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

[a]Seal has an opacity in one eye from 1996, uncertain if vision is affected.
[b]Seal was released by observer.
[c]Seal escaped by itself.
[d]One seal became entangled twice and was released by observers each time.
[e]Entangling debris was dragged by a seal from beach berm down towards waterline, but animal was not observed (only tracks); unknown if animal was injured.
[f]Pup was blind and small, and mother of pup was severely injured during a mobbing event several days prior to parturition.

CHAPTER 4. THE HAWAIIAN MONK SEAL ON LISIANSKI ISLAND, 1997

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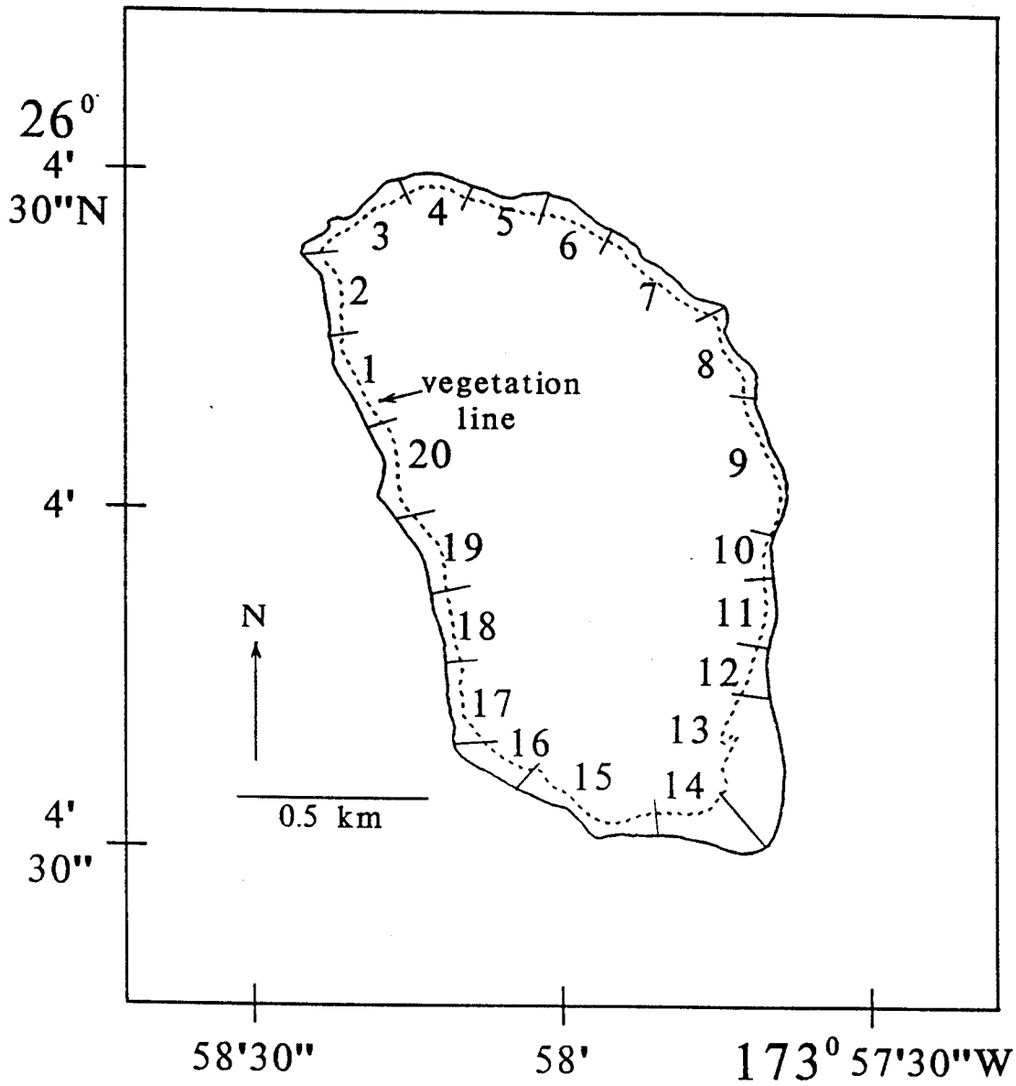

Fig. 4.1. Lisianski Island in the Northwestern Hawaiian Islands.

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. 1,760 km northwest of Oahu (Fig. 1.1) and is part of Neva Shoals, a shallow reef bank within the Hawaiian Islands National Wildlife Refuge.

RESEARCH

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Lisianski Island in 1981. In 1997, research was conducted by NMFS during March 10-July 1. The perimeter of the island (ca. 5.2 km) was divided into 20 sectors using artificial or natural landmarks (Fig. 4.1). Research objectives specific to this population in 1997 included identification of all seals, assessment of maternity and pup exchanges, and documentation of adult male behavioral patterns and aggression.

Censuses and Patrols

Censuses and patrols were scheduled to ensure that the entire island was monitored at least once each day during March 15-July 1. Censuses (n = 18) were conducted by two observers every fifth day from March 31 to June 24, beginning at 1300 Hawaii standard time and continuing for 1.4-2.6 hours.

Standardized behavior patrols were conducted on noncensus days to assess activity patterns of adults and large subadults, document male aggression, and detect mobbing incidents. During these patrols (n = 73), attention was directed out to sea as much as possible because mobbing has been observed most frequently in the water.

Individual Identification

A total of 189 individuals (167 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. All weaned pups (n = 19) were tagged with Temple Tags and passive integrated transponder (PIT) tags. One Temple Tag was reapplied on a weaned pup that had broken its original tag. Two adult male seals were retagged with Temple Tags.

Collection of Samples

One hundred and four scat and 22 spew samples were collected. Tissue samples were collected from 21 seals during tagging. Necropsies were performed and tissue samples were collected from three dead seals, including two adult males and one female neonate pup. Skeletal samples were collected from four seals: two skulls from previous mortalities and two skulls

from adult males necropsied this season. In total, 417 pieces of potentially entangling debris were inventoried and destroyed.

Noteworthy Events

Mating Behavior

Two adults were observed possibly mating in shallow water. The male clasped the female with his left foreflipper while holding onto her back with his teeth. The male's posterior was flexed and curved under the female's posterior end. They maintained this position, slowly rolling in the shallows for approximately 1 minute. In a separate incident, an adult male was observed offshore over the reef, harassing an adult female who had recently (<24 hours) weaned her pup. The male pursued the female to the outer reef where they disappeared.

Oiled Wildlife

Beginning May 8 we observed oiled seabirds with as much as 50% of their plumage fouled. Approximately 20 birds, mostly Masked and Red-Footed Boobies, were affected. A few Black Noodies were also oiled. Six weaned pups and one adult male seal were documented with oil spots on their pelage. The oiling appeared superficial and did not seem to affect the seals' health. No seabird mortality related to oiling was observed during the study period.

RESULTS

Population Abundance and Composition

The means (±SD) for 18 censuses were 71.2 seals (±10.5) including pups, and 57.3 seals (±10.3) excluding pups (Table 4.1). The total spring-summer population was 188 individuals, 166 excluding pups (Table 4.2). The sex ratios of nonpup immatures and adults were ca. 1.0:1 (26 males:26 females) and 1.5:1 (69 males:45 females), respectively. The sex ratio for older (>15 years of age) and unknown aged adults was skewed toward males at ca. 2.6:1 (41 males:16 females), whereas the ratio for younger adults (≤15 years of age) was ca. 1.0:1 (28 males:29 females). The numbers of tagged known-age seals born at Lisianski Island during the period from 1982 to 1996 and resighted there in 1997 are summarized in Table 4.3.

Reproduction

At least 22 pups were born: 19 were weaned, 1 died prior to weaning, and 2 were nursing at the end of this study (Table 4.4a). Nursing periods and measurements of weaned pups are summarized in Table 4.4b. Twenty-two of forty-five (49%) adult-sized females were parturient. At least 31 pup exchanges occurred between 9 nursing females; researchers observed 4 of these incidents. One female nursed two pups at one time and a second female fostered three pups simultaneously.

Interatoll Movement

Interatoll movement was documented for 12 seals that made a total of 17 movements between Lisianski Island and either Laysan Island or Pearl and Hermes Reef (Tables 4.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by males, entanglement, emaciation, and other/unknown factors led to 18 life-threatening conditions, which resulted in the confirmed deaths of 3 animals and the probable death of 1 seal (Table 4.6). Six adult males were observed attempting to mount each other and an adult female who sustained no apparent external injuries. One adult male seal sustained a dorsal injury possibly associated with male mounting. No seals were known to have died or disappeared following male-mounting injuries. Three entanglements were documented; in all incidents the seal was released uninjured by observers. Two emaciated adult males died during this study. In addition to the deaths presented in Table 4.6, the mummified carcass of a juvenile female was found at the beginning of the field season; this seal died of unknown causes after the 1996 field season.

ACKNOWLEDGMENTS

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

TABLES

Table 4.1.--Summary statistics for censuses (n = 18) of Hawaiian monk seals at Lisianski Island from March 31 to June 24, 1997.

Size/Sex	Mean number of individuals	Standard deviation
Adults	42.0	7.3
Male	24.4	6.2
Female	17.3	2.8
Unknown	0.3	0.6
Subadults	11.1	4.4
Male	6.3	3.3
Female	4.8	2.2
Unknown	0.0	0.0
Juveniles	4.2	1.6
Male	2.4	1.0
Female	1.7	1.1
Unknown	0.0	0.0
Pups	13.9	2.8
Male	6.8	1.8
Female	6.8	1.5
Unknown	0.3	0.6
Nonpup Total	57.3	10.3
Grand Total	71.2	10.5

Table 4.2.--Composition of the Hawaiian monk seal population at Lisianski Island during the spring and summer of 1997. Includes all pups born during the calendar year.

	Number of seals			
Size	Male	Female	Total	Sex ratio male:female
Adults	69	45	114	1.5:1
Subadults	19	16	35	1.2:1
Juveniles	7	10	17	0.7:1
Pups	10	12	22	0.8:1
Nonpup Total	95	71	166	1.3:1
Grand Total	105	83	188	1.3:1

Table 4.3.--Summary of tagged known-age seals born at Lisianski Island and resighted there in 1997.

Age (years)	Sex	Number originally tagged	Number resighted in 1997
15	Male	7	2
	Female	6	2
14	Male	6	2
	Female	18	7
13	Male	10	4
	Female	5	2
12	Male	5	2
	Female	9	2
11	Male	11	5
	Female	9	3
10	Male	12	1
	Female	6	0
9	Male	10	5
	Female	8	5
8	Male	--	--
	Female	--	--
7	Male	8	4
	Female	9	3
6	Male	9	5
	Female	6	2
5	Male	13	6
	Female	8	4
4	Male	4	2
	Female	9	3
3	Male	4	2
	Female	5	2
2	Male	7	2
	Female	10	3
1	Male	9	3
	Female	13	6

Table 4.4 a.--Summary of Hawaiian monk seals born at Lisianski Island in 1997.

Event	Number of pups		
	Male	Female	Total
Born	10	12	22
Died prior to weaning	0	1	1
Still nursing	0	2	2
Weaned	10	9	19
Tagged	10	9	19

Table 4.4b.--Summary of nursing periods and measurements of weaned pups at Lisianski Island in 1997. Nursing periods were calculated where both birth and weaning date ranges were ≤4 days. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	35.1	99.7	121.1
St. Dev.	3.4	8.5	6.2
n	15	19	19

Table 4.5a.--Known movement of Hawaiian monk seals to Lisianski Island from other locations in 1997. Some seals made more than one trip.

Original location	Number, size, and sex class
Laysan Island	3 adult females, 1 subadult female
Pearl and Hermes Reef	1 adult male, 1 subadult male

Table 4.5b.--Known movement of Hawaiian monk seals from Lisianski Island to other locations in 1997. Some seals made more than one trip.

Destination	Number, size, and sex class
Laysan Island	1 adult male, 6 adult females, 2 subadult females
Pearl and Hermes Reef	1 adult female, 1 subadult male

Table 4.6.--Factors affecting Hawaiian monk seal survival at Lisianski Island in 1997.

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

[a]Six males were observed mounting an adult female who sustained no apparent injuries.
[b]Seal released by researchers.
[c]Same seal became entangled twice and was released each time by observers.
[d]Poor condition resulted in shark injury and finally, death.
[e]Seal not resighted during last 2 months of field season.
[f]Neonate, <24 hours old, cause of death undetermined but may have been crushed by mother or suffocated by the amniotic sac.

CHAPTER 5. THE HAWAIIAN MONK SEAL ON PEARL AND HERMES REEF, 1997

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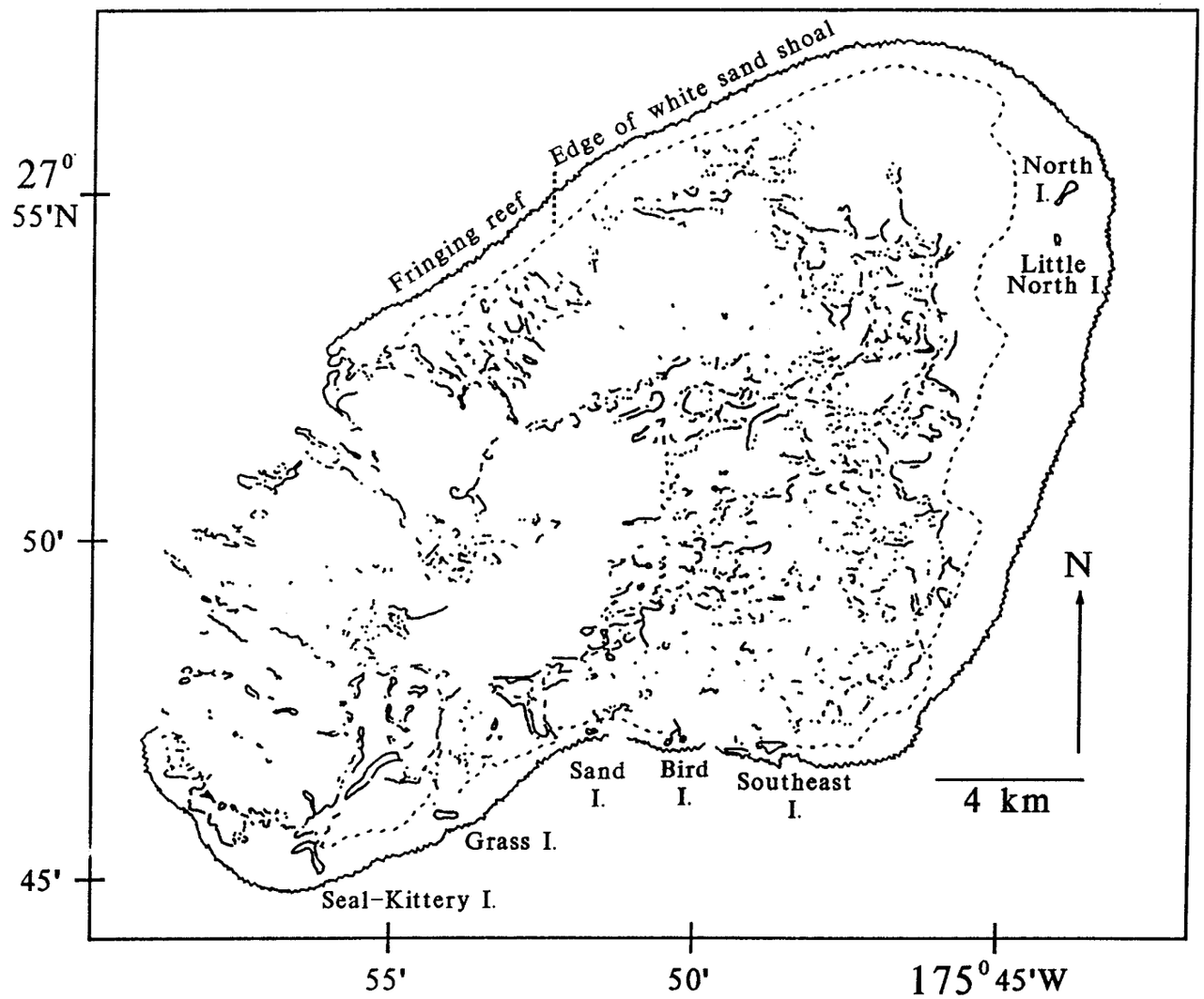

Fig. 5.1. Pearl and Hermes Reef in the Northwestern Hawaiian Islands.

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. 1,900 km northwest of Oahu in the Northwestern Hawaiian Islands and is part of the Hawaiian Islands National Wildlife Refuge (Fig. 1.1). Pearl and Hermes Reef is composed of four vegetated and three non-vegetated sand islands enclosed in a fringing reef (Fig. 5.1).

RESEARCH

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Pearl and Hermes Reef in 1982. In 1997, research was conducted by NMFS during May 29-July 22 and October 24-November 3. The perimeters of the four larger vegetated islands were divided into sectors using natural landmarks. The smaller sand islands were counted as a single sector. Research objectives specific to this population in 1997 included (1) investigation of habitat use patterns using satellite-linked telemetry, and (2) debris removal from the fringing reef. In addition, seabird counts were conducted on all islands for the U.S. Fish and Wildlife Service, and recording and banding of Laysan finches were done on Southeast and North Islands for Dr. Sheila Conant.

Censuses and Patrols

Atoll censuses (n = 9) were conducted approximately every 3 days, on average, from June 14 to July 20, beginning at 1030 Hawaii standard time and continuing for approximately 5 hours. All islands were censused on foot by one or two persons. In addition, incidental patrols were conducted opportunistically to resight seals tagged in previous years, bleach untagged seals, and record scars that could be used to identify untagged seals.

Individual Identification

A total of 246 individuals (219 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. All weaned pups (n = 27) were tagged with Temple Tags; 22 of these same pups were tagged with passive integrated transponder (PIT) tags. Two of these pups were tagged in October, and three others were tagged in February 1998. Ten seals (three adult males, six adult females, and one juvenile female) were also tagged with Temple Tags. In addition, seven adult seals were retagged with Temple Tags.

Collection of Samples

Sixty-six scat and spew samples were collected. Tissue samples were collected from 19 seals during tagging. One skull sample was collected. In total, 346 pieces of potentially entangling debris were inventoried and destroyed.

Special Studies

Habitat Use Study

In October, 24 seals (9 adult males, 9 adult females, and 6 juvenile males) were instrumented with satellite-linked time-depth recorders as part of a foraging ecology study conducted in collaboration with the U.S. Fish and Wildlife Service and Hubbs Sea World Research Institute. Blood samples and measurements (axillary girth and dorsal straight length) were collected from all seals during instrumentation.

Debris Removal from Fringing Reef

In October, personnel aboard the NOAA ship *Townsend Cromwell* removed debris from a section of fringing reef to reduce hazards to monk seals and other marine life, assess the extent of reef fouling, and determine the feasibilility of a large scale debris removal effort.

RESULTS

Population Abundance and Composition

The means (±SD) for nine atoll censuses were 91.6 seals (±12.4) including pups, and 77.1 seals (±10.8) excluding pups (Table 5.1). The total spring-summer population was 240 individuals, 213 excluding pups (Table 5.2). The sex ratios of nonpup immature seals and adults were 0.8:1 (31 males:39 females) and 1.2:1 (72 males:60 females), respectively. The numbers of tagged known-age seals born at Pearl and Hermes Reef during the period from 1983 to 1996 and resighted there in 1997 are summarized in Table 5.3.

Reproduction

At least 27 pups were born, and all 27 were weaned (Table 5.4a). Measurements of weaned pups are summarized in Table 5.4b. Twenty-seven of sixty (45%) adult-sized females were parturient.

Interatoll Movement

Interatoll movement was documented for 20 seals that made a total of 24 movements between Pearl and Hermes Reef and either Kure Atoll, Midway Atoll, or Lisianski Island (Tables 5.5a and b).

Factors Affecting Survival

Entanglements resulted in two life-threatening conditions (Table 5.6). Both incidents involved weaned pups entangled in marine debris. The pups were disentangled and no deaths were observed during the season. In addition to the incidents presented in Table 5.6, a mummified skeleton of a juvenile seal was found buried on Seal Kittery.

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 Islands National Wildlife Refuge staff.

TABLES

Table 5.1.--Summary statistics for atoll censuses (n = 9) of Hawaiian monk seals at Pearl and Hermes Reef from June 14 to July 20, 1997.

Size/Sex	Mean number of individuals	Standard deviation
Adults	50.8	7.5
Male	21.0	4.9
Female	19.7	5.4
Unknown	10.1	2.6
Subadults	17.6	3.6
Male	6.4	2.0
Female	9.4	1.9
Unknown	1.7	1.8
Juveniles	8.7	4.1
Male	4.8	2.0
Female	3.0	1.6
Unknown	0.9	1.2
Pups	14.4	4.2
Male	7.0	2.2
Female	5.2	1.8
Unknown	2.2	1.9
Nonpup Total	77.1	10.8
Grand Total	91.6	12.4

Table 5.2.--Composition of the Hawaiian monk seal population at Pearl and Hermes Reef during the spring and summer of 1997. Includes all pups born during the calendar year.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	72	60	10	142	1.2:1
Subadults	15	23	0	38	0.7:1
Juveniles	16	16	1	33	1.0:1
Pups	16	11	0	27	1.5:1
Nonpup Total	103	99	11	213	1.0:1
Grand Total	119	110	11	240	1.1:1

Table 5.3.--Summary of tagged known-age seals born at Pearl and Hermes Reef and resighted there in 1997.

Age (years)	Sex	Number originally tagged	Number resighted in 1997
14	Male	8	4
	Female	2	1
13	Male	5	1
	Female	8	2
12	Male	9	1
	Female	6	3
11	Male	10	1
	Female	7	2
	Unknown	1	0
10	Male	14	7
	Female	7	2
9	Male	12	9
	Female	6	2
8	Male	8	5
	Female	6	2
7	Male	5	2
	Female	1	0
6	Male	10	7
	Female	11	2
5	Male	13	7
	Female	10	6
4	Male	14	5
	Female	7	4
3	Male	--	--
	Female	--	--
2	Male	16	9
	Female	11	5
1	Male	11	5
	Female	12	7

Table 5.4a.--Summary of Hawaiian monk seals born at Pearl and Hermes Reef in 1997.

Event	Number of pups		
	Male	Female	Total
Born	16	11	27
Died prior to weaning	0	0	0
Weaned	16	11	27
Tagged	16	11	27[a]

[a] Two male pups were tagged in October, and three pups (2 male, 1 female) were tagged as yearlings in February 1998.

Table 5.4b.--Summary of nursing periods and measurements of weaned pups at Pearl and Hermes Reef in 1997. All measurements were taken within 2 weeks after weaning.

	Axillary girth (cm)	Straight dorsal length (cm)
Mean	106.5	124.9
St. Dev.	6.2	4.4
n	6	6

Table 5.5a.--Known movement of Hawaiian monk seals to Pearl and Hermes Reef from other locations in 1997, summarized by movements between two locations. Some seals made more than one trip.

Original location	Number, size, and sex class
Lisianski Island	1 adult female, 1 subadult male
Midway Atoll	1 adult male, 4 adult females

Table 5.5b.--Known movement of Hawaiian monk seals from Pearl and Hermes Reef to other locations in 1997, summarized by movements between two locations. Some seals made more than one trip.

Destination	Number, size, and sex class
Lisianski Island	1 adult male, 1 subadult male
Midway Atoll	2 adult males, 9 adult females, 2 subadult males
Kure Atoll	1 adult female, 1 subadult male

Table 5.6.--Factors affecting Hawaiian monk seal survival at Pearl and Hermes Reef in 1997.

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

[a]Seal released by observers.

CHAPTER 6. THE HAWAIIAN MONK SEAL ON MIDWAY ATOLL, 1997

Lucy W. Keith, Heather R. Smith, Heidi J. Auman,
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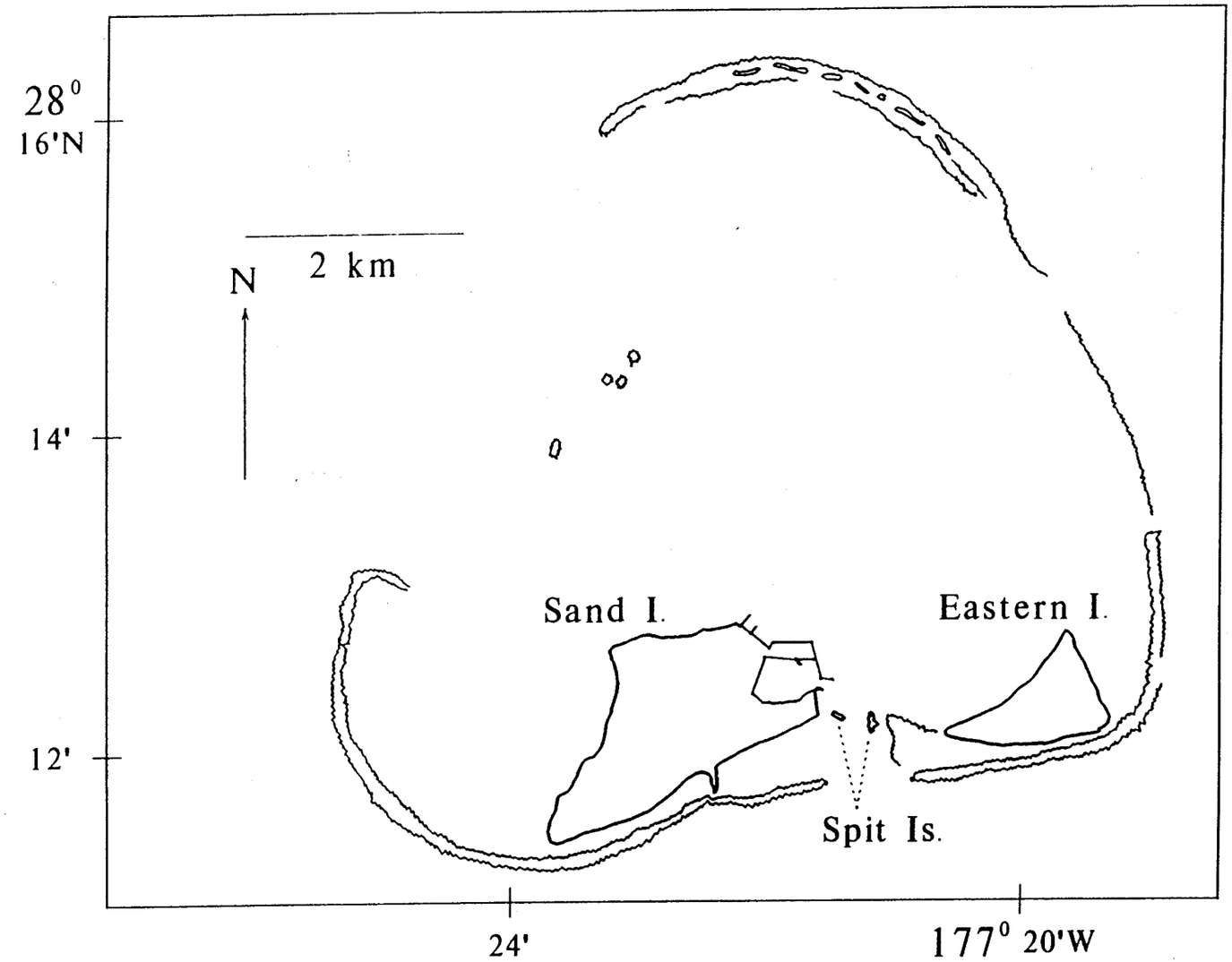


Fig. 6.1. Midway Islands in the Northwestern Hawaiian Islands.

Midway Atoll (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 2,100 km northwest of Oahu in the Northwestern Hawaiian Islands (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). Eastern and Spit Islands are uninhabited. Sand Island was the site of a U.S. Naval Air Facility until 1993 when the facility was closed. On June 30, 1997, the Navy transferred primary management authority to the U.S. Fish and Wildlife Service (USFWS), which has maintained a refuge (Midway Atoll National Wildlife Refuge) at the site since 1988.

Beach counts of the Hawaiian monk seal at Midway Atoll averaged 56 animals in the late 1950s (Kenyon, 1972) but declined severely by the late 1960s; a single seal was observed during an aerial survey in 1968 (Kenyon, 1972). From the late 1960s to the late 1980s the population failed to recover, but recent assessments suggest that recovery may be beginning because of an influx of immigrants from Kure Atoll and Pearl and Hermes Reef and an increasing number of seals born on Midway Atoll. The earlier counts indicate that the Midway population has significant potential for growth, and recovery of this population is an important management goal.

RESEARCH

The National Marine Fisheries Service (NMFS) began limited population monitoring of Hawaiian monk seals at Midway Atoll in 1983. In 1997, research was conducted by NMFS during April 28-October 17. Collaborating researchers from the Oceanic Society and Hawaii Wildlife Fund began data collection on February 20 and continued through the rest of the year. Incidental observations were also recorded by USFWS personnel. The perimeters of the three permanent islands were divided into sectors using artificial or natural landmarks. In 1997, research objectives specific to Midway Island included the identification of all seals in the resident population, tagging pups and other untagged seals, and radio telemetry tracking of all resident juvenile seals.

Censuses and Patrols

Atoll censuses (n = 28) were conducted every 7 days, on average, from June 5 to December 14. All islands were censused on foot by one or two persons. Each atoll census began between 0830 and 1400 Hawaii standard time and ended between 1454 and 1918. Beach counts of Sand Island (n = 40), Eastern Island (n = 38), or Spit Island (n = 29) were conducted on non-atoll census days to identify and resight seals.

Individual Identification

A total of 65 individuals (52 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. Most weaned pups (n = 9) were tagged with Temple Tags and passive integrated transponder (PIT) tags. One juvenile seal (female) was also tagged with Temple Tags and a PIT tag. In addition, Temple Tags with radio transmitters epoxied to their dorsal sides were applied to 9 weaned pups and 3 juvenile seals.

Collection of Samples

Eighty-two scat samples and three spew samples were collected. Tissue samples were collected from eight weaned pups and two juvenile seals during tagging. Necropsy samples were collected from two seals that were found dead (one female pup and one subadult male). In total, 540 pieces of potentially entangling debris were inventoried and destroyed.

Special Studies

Radio Telemetry of Immature Seals

Radio transmitters were applied to 12 seals (9 weaned pups and 3 juveniles) between May 15 and September 14. Four seals were recaptured and a second transmitter was applied after the first one was lost. Five automatically recording receiver stations were set up to cover all possible haulout locations on the three islands within the atoll. The results of this study will be discussed elsewhere.

RESULTS

Population Abundance and Composition

The means ($\pm$SD) for 28 atoll censuses were 16.0 seals ($\pm$5.3) including pups and 12.2 seals ($\pm$4.1) excluding pups (Table 6.1). The total spring-summer population was 50 seals, 39 excluding pups (Table 6.2).

The estimation of population abundance is confounded by movement of seals among Midway Atoll, Kure Atoll, and Pearl and Hermes Reef. Because of this, it is difficult to distinguish transient visitors from resident seals. Further study of this population is needed to identify resident seals and thereby provide a more reliable measure of abundance at Midway.

The numbers of tagged known-age seals born at Midway Atoll during the period from 1988 to 1996 and resighted there in 1997 are summarized in Table 6.3.

Reproduction

At least 11 pups were born: 10 were weaned and 1 died prior to weaning (Table 6.4a). One pup was born on the closed beach on Sand Island; this pup weaned successfully and is the first recorded birth on Sand, the largest and only populated island at Midway Atoll. Measurements of weaned pups are summarized in Table 6.4b. Eleven of twenty (55%) adult-sized females were parturient.

Interatoll Movement

Interatoll movement was documented for 32 seals that made a total of 40 movements between Midway Atoll and either Pearl and Hermes Reef or Kure Atoll (Tables 6.5a and b). Interatoll movement of weaned pups was detected for the first time; 2 pups (1 male and 1 female) moved from Kure Atoll to Midway Atoll in August 1997.

Factors Affecting Survival

Attacks by large sharks, entanglements, and unknown factors led to five life-threatening conditions, which resulted in the confirmed deaths of two animals (Table 6.6). One entanglement was documented; a female weaned pup was found entangled and was released by observers.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service, Midway Atoll National Wildlife Refuge. Special thanks are extended to Nanette Seto, Robert Shallenberger, Bob Dieli, Bart McDermott, James Aliberti, and Jim Nestler for assistance with radio telemetry research; and to Kenneth Niethammer, Jon Hale, Pat Whitebear, and R. Sudarshan for logistical assistance. 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 = 28) of Hawaiian monk seals at Midway Atoll from June 5 to December 14, 1997.

Size/Sex	Mean number of individuals	Standard deviation
Adults	9.1	2.9
Male	3.0	1.5
Female	5.3	2.7
Unknown	0.8	1.0
Subadults	2.2	1.8
Male	1.0	0.9
Female	0.9	1.0
Unknown	0.3	0.5
Juveniles	0.8	0.9
Male	0.1	0.3
Female	0.7	0.8
Unknown	0.1	0.3
Pups	3.9	2.3
Male	1.0	1.0
Female	2.6	1.6
Unknown	0.3	0.5
Nonpup Total	12.2	4.1
Grand Total	16.0	5.3

Table 6.2.--Composition of the Hawaiian monk seal population at Midway Atoll during the spring and summer of 1997; includes all pups born during the calendar year.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	10	20	0	30	0.5:1
Subadults	2	4	0	6	0.5:1
Juveniles	1	2	0	3	0.5:1
Pups	3	7	1	11	0.4:1
Nonpup Total	13	26	0	39	0.5:1
Grand Total	16	33	1	50	0.5:1

Table 6.3.--Summary of tagged known-age seals born at Midway Atoll and resighted there in 1997.

Age (years)	Sex	Number originally tagged	Number resighted in 1997
9	Male	0	--
	Female	1	1
8	Male	0	--
	Female	0	--
7	Male	0	--
	Female	0	--
6	Male	1	1
	Female	1	1
5	Male	0	--
	Female	1	1
4	Male	1	0
	Female	0	--
3	Male	0	--
	Female	0	--
2	Male	1	1
	Female	6	1
	Unknown	1	0
1	Male	1	0
	Female	4	1

Table 6.4a.--Summary of Hawaiian monk seals born at Midway Atoll in 1997.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	3	7	1	11
Died prior to weaning	0	1	0	1
Weaned	3	6	1	10
Tagged	3	6	0	9

Table 6.4b.--Summary of nursing periods and measurements of weaned pups at Midway Atoll in 1997. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	39.5	110.2	131.0
St. Dev.	4.4	3.8	2.7
n	3	4	4

Table 6.5a.--Known movement of Hawaiian monk seals to Midway Atoll from other locations in 1997, summarized by movements between two locations. Some seals made more than one trip.

Original location	Number, size, and sex class
Pearl and Hermes Reef	2 adult males, 9 adult females, 2 subadult males
Kure Atoll	4 adult males, 6 adult females, 2 subadult male, 1 subadult female, 2 juvenile males, 1 weaned pup male, 1 weaned pup female

Table 6.5b.--Known movement of Hawaiian monk seals from Midway Atoll to other locations in 1997, summarized by movements between two locations. Some seals made more than one trip.

Destination	Number, size, and sex class
Pearl and Hermes Reef	1 adult male, 4 adult females
Kure Atoll	1 adult male, 2 adult females, 1 juvenile male, 1 juvenile female

Table 6.6.--Factors affecting Hawaiian monk seal survival at Midway Atoll in 1997.

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

[a]Seal released by observers.

CHAPTER 7. THE HAWAIIAN MONK SEAL ON KURE ATOLL, 1997

Katherine W. McFadden and Bradley C. Ryon

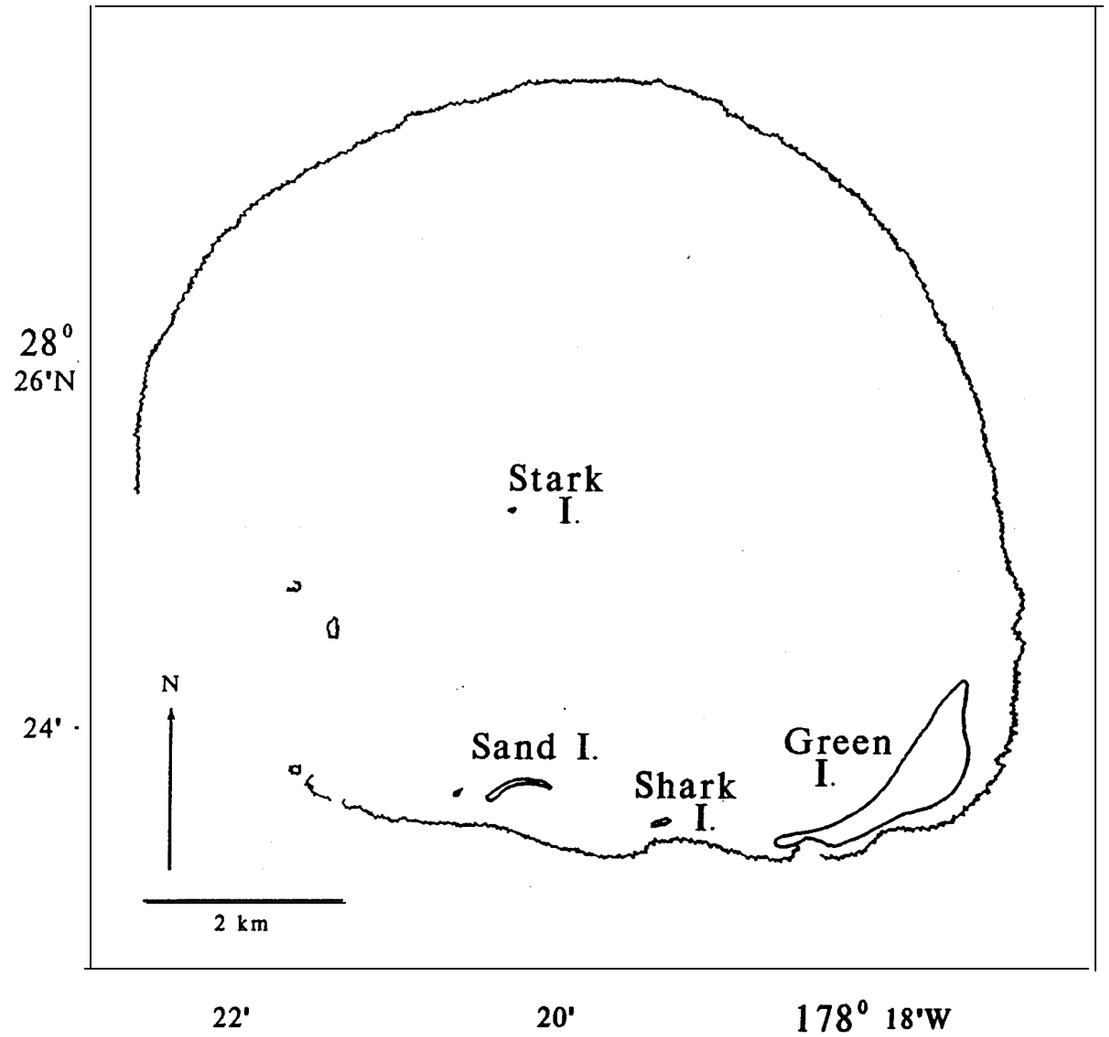


Fig. 7.1. Kure Atoll in the Northwestern Hawaiian Islands.

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. 2,300 km northwest of Oahu in the Northwestern Hawaiian Islands (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, the enclosed 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. In 1993, the USCG completed the removal of buildings and other structures on Green Island.

The Kure Atoll population of Hawaiian monk seals has been growing in recent years due, in part, to a reduction of human disturbance and to two capture-and-release programs designed to increase recruitment of females. The Head Start Project (1981-91) involved the capture and protection of weaned female pups from Kure Atoll during the transition phase from weaning to independent feeding. The Rehabilitation Project (1984-91 and 1993-95) involved the capture of undersized weaned female pups from French Frigate Shoals, conditioning on Oahu, and then transport to Kure Atoll for release. Continued monitoring of seals involved in these projects is considered imperative to evaluate the projects' long-term success.

RESEARCH

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Kure Atoll in 1981. In 1997, research was conducted by NMFS during May 30-July 20. The perimeter of Green Island was divided into eight sectors, using artificial or natural landmarks. Research objectives for the Kure Atoll monk seal population in 1997 included the identification of all seals, evaluation of the success of past seal introductions, and the use of photogrammetry as a means to assess body size.

Censuses and Patrols

Atoll censuses (n = 9) were conducted approximately every 3-4 days, weather permitting, from June 16 to July 19. Each census began at approximately 1300 Hawaii standard time and ended between 1517 and 1632. All islands were censused on foot by one or two persons. Stark Reef was not emergent during the 1997 field season. Patrols were conducted to identify seals and monitor locations used by parturient females.

Individual Identification

A total of 114 individuals (96 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. Most weaned pups (n = 16) were tagged with Temple Tags and passive integrated transponder (PIT) tags. One juvenile seal (female) was also tagged with Temple Tags.

Collection of Samples

Twenty-nine scat and spew samples were collected. Tissue samples were collected from 11 weaned pups and 1 other seal during tagging. In total, 320 pieces of potentially entangling debris were inventoried; 2 entanglement items were removed from seals and collected. The remainder was destroyed before the end of the field season.

Special Studies

Assessment of Photogrammetry as a Tool to Estimate Body Size

During the 1997 field season, weaned pups were photographed, measured, and weighed in order to assess whether photographs could be used as a noninvasive means to assess size and condition. A rigid measuring pole was positioned over the seals while sleeping and photographs of two views (either anterior/posterior or viewed from the side) were taken at various camera heights and distances. The goal of this project was to determine if a predictive relationship could be established between photographically measured variables (digitized side, anterior/posterior area, length, width), which may aid researchers in more accurately predicting size and condition.

RESULTS

Population Abundance and Composition

The means (±SD) for nine atoll censuses were 50.1 seals (±7.9) including pups and 42.7 seals (±6.3) excluding pups (Table 7.1). The total spring-summer population was 112 individuals, 94 seals excluding pups (Table 7.2). The numbers of tagged known-age seals born at Kure Atoll during the period from 1981 to 1996 and resighted there in 1997 are summarized in Table 7.3.

Reproduction

At least 18 pups were born: 17 were weaned and 1 died prior to weaning (Table 7.4a). Nursing periods and measurements of weaned pups are summarized in Table 7.4b. Of the 39 adult-sized females identified, a minimum of 18 were parturient (46%). At least 3 of these 18 parturient females had been temporarily maintained as pups in the Kure Atoll Head Start enclosure (2 in

1985 and 1 in 1984), and none were rehabilitated seals from FFS introduced to Kure as yearlings.

Interatoll Movement

Interatoll movement was documented for 20 seals that made a total of 24 movements between Kure Atoll and either Midway Atoll or Pearl and Hermes Reef (Table 7.5a and b).

Factors Affecting Survival

Mounting attempts by male seals, entanglement in debris, and unknown factors resulted in four life-threatening conditions, which led to the death of one seal (Table 7.6). In the mounting incident, two seals were seen repeatedly attempting to mount a weaned pup. The same pup was later resighted with no visible injuries. Two entanglements were documented; in both incidents the weaned pup was released by observers. One pup was found dead by Department of Forestry and Wildlife researchers prior to the NMFS 1997 field season.

ACKNOWLEDGMENTS

We acknowledge the support of the State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife, and the Coast Guard ship *Kiska*. We thank the captains and crew of the NOAA ship *Townsend Cromwell* for logistical support and for transport to and from Kure Atoll.

TABLES

Table 7.1.--Summary statistics for atoll censuses (n = 9) of Hawaiian monk seals at Kure Atoll from June 16 to July 19, 1997.

Size/Sex	Mean number of individuals	Standard deviation
Adults	26.0	4.0
Male	8.2	1.9
Female	17.3	3.9
Unknown	0.4	0.7
Subadults	10.0	2.5
Male	6.2	1.4
Female	3.6	1.4
Unknown	0.2	0.4
Juveniles	6.7	1.6
Male	5.0	1.6
Female	1.6	0.5
Unknown	0.1	0.3
Pups	7.4	3.1
Male	4.6	2.3
Female	2.8	0.8
Unknown	0.1	0.3
Nonpup Total	42.7	6.3
Grand Total	50.1	7.9

Table 7.2.--Composition of the Hawaiian monk seal population at Kure Atoll during the spring and summer of 1997. Includes all pups born during the calendar year.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	23	39	0	62	0.6:1
Subadults	12	8	0	20	1.5:1
Juveniles	9	3	0	12	3.0:1
Pups	10	7	1	18	1.4:1
Nonpup Total	44	50	0	94	0.9:1
Grand Total	54	57	1	112	0.9:1

Table 7.3.--Summary of tagged known-age seals born at Kure Atoll and resighted there in 1997.

Age (years)	Sex	Number originally tagged	Number resighted in 1997
16	Male	3	2
	Female	5	1
15	Male	1	0
	Female	3	2
14	Male	4	2
	Female	0	--
13	Male	4	1
	Female	2	2
12	Male	2	1
	Female	3	3
11	Male	1	0
	Female	0	--
10	Male	1	1
	Female	3	2
9	Male	2	2
	Female	5	2
8	Male	5	2
	Female	4	1
7	Male	3	0
	Female	3	2
6	Male	7	4
	Female	6	2
5	Male	5	3
	Female	8	5
4	Male	9	5
	Female	4	2
3	Male	3	0
	Female	0	--
2	Male	6	4
	Female	5	3
1	Male	10	7
	Female	6	2

Table 7.4a.--Summary of Hawaiian monk seals born at Kure Atoll in 1997.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	10	7	1	18
Died prior to weaning	0	0	1	1
Weaned	10	7	0	17
Tagged	9[a]	7[a]	0	16

[a]Three pups born in 1997 (one male and two females) were tagged in 1998.

Table 7.4b.--Summary of nursing periods and measurements of weaned pups at Kure Atoll in 1997. Nursing periods were calculated where both birth and weaning date ranges were ≤4 days. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)	Net Weight (kg)
Mean	32.5	111.5	130.0	66.4
St. Dev.	--	1.9	1.4	6.8
n	1	4	4	4

Table 7.5a.--Known movement of Hawaiian monk seals to Kure Atoll from other locations in 1997, summarized by movements between two locations. Some seals made more than one trip.

Original location	Number, size, and sex class
Pearl and Hermes Reef	1 adult female, 1 subadult male
Midway Atoll	1 adult male, 2 adult females, 1 juvenile male, 1 juvenile female

Table 7.5b.--Known movement of Hawaiian monk seals from Kure Atoll to other locations in 1997, summarized by movements between two locations. Some seals made more than one trip.

Destination	Number, size, and sex class
Midway Atoll	4 adult males, 6 adult females, 2 subadult males, 1 subadult female, 2 juvenile males, 1 weaned pup male, 1 weaned pup female

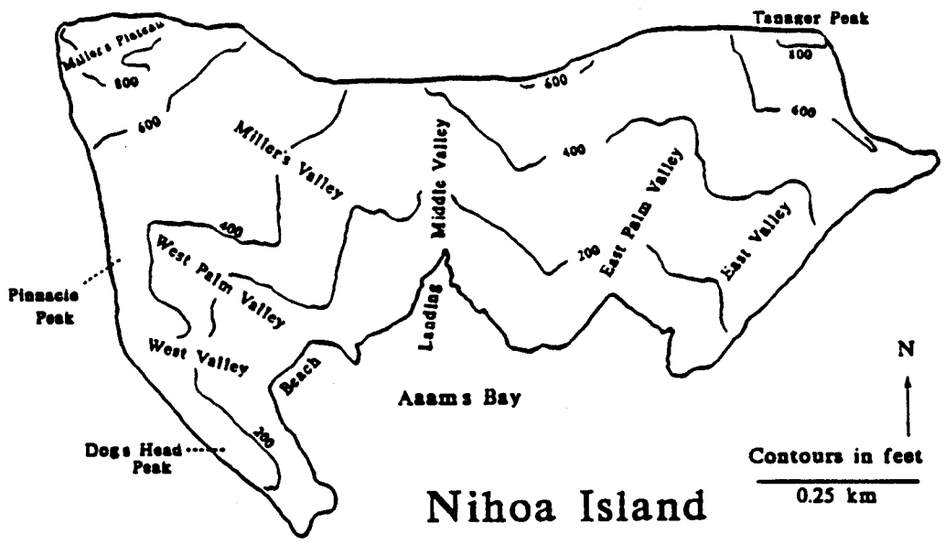
Table 7.6.--Factors affecting Hawaiian monk seal survival at Kure Atoll in 1997.

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

[a]Two males observed attempting to mount a weaned pup.
[b]Seals released by observers.
[c]Dead pup discovered by State researchers prior to NMFS field season.

CHAPTER 8. THE HAWAIIAN MONK SEAL ON NECKER ISLAND, 1997

Chad Yoshinaga and Kim Raum-Suryan



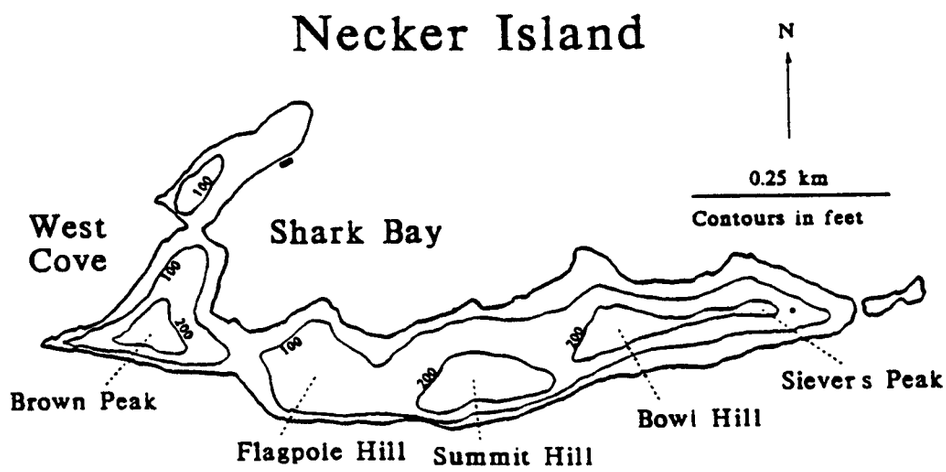


Fig. 8.1 Nihoa and Necker Islands in the Northwestern Hawaiian Islands.

Necker Island (lat. 23°36'N, long. 164°42'W) (Fig. 8.1) is located ca. 750 km northwest of Oahu in the Northwestern Hawaiian Islands (Fig. 1.1). This island lies within the Hawaiian Islands National Wildlife Refuge. Although endangered Hawaiian monk seals use this island, pup production is limited by lack of haulout area.

RESEARCH

Research was conducted by the National Marine Fisheries Service on July 27, 1997. The perimeter of the island was divided into 10 sectors using natural landmarks. Beginning in 1989, the monk seal population at French Frigate Shoals began to decline, largely from loss of juvenile seals. In 1997, research objectives specific to the Necker Island monk seal population included the assessment of the extent of monk seal migration from French Frigate Shoals to this location to determine if migration may have contributed to the decline observed at French Frigate Shoals.

Censuses and Patrols

One census was conducted beginning at 0800 Hawaii standard time and continuing for approximately 6 hours. The island was censused both on foot and by boat.

Individual Identification

One molting adult female was identified by tags applied at French Frigate Shoals.

Collection of Samples

No samples were collected during the census of the island.

RESULTS

Population Abundance and Composition

The census total was 11 seals (10 adults and 1 pup). The sex ratio of the adults was 1:1 (3 males:3 females) with 4 of unknown sex. In all, a total of 12 adult seals were observed on or around the island. Because of limited effort, the composition of the spring-summer population was not determined.

Reproduction

At least one pup was born. The only pup observed was female, and still nursing. The mother was untagged with no distinguishing marks or scars.

Interatoll Movement

Interatoll movement was documented for one seal that made a total of one movement between Necker Island and French Frigate Shoals (Tables 8.1a and b).

Factors Affecting Survival

No factors affecting survival were observed.

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 Islands National Wildlife Refuge staff.

TABLES

Table 8.1a.--Known movement of Hawaiian monk seals to Necker Island from other locations in 1997, summarized by movements between two locations.

Original location	Number, size, and sex class
French Frigate Shoals	1 adult female

Table 8.1b.--Known movement of Hawaiian monk seals from Necker Island to other locations in 1997, summarized by movements between two locations.

Destination	Number, size, and sex class
(None observed)	

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APPENDIXES

Appendix A.--Reports summarizing annual field research on the Hawaiian monk seal by the National Marine Fisheries Service and collaborating scientists.

All islands

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Appendix B.--Hawaiian monk seal census form and 1997 census form directions.

(See following pages.)

SEAL CENSUS FORM

ENTERED ☐

DATA TYPE _____ COMPUTER PAGE NO. ☐☐☐☐ PAGE _____ OF _____

ISLAND _____ OBSERVER ☐☐☐ TIME BEGIN ☐☐☐☐ END ☐☐☐☐

DATE _____ NUMBER _____ TEMP. ☐☐ WIND ☐☐☐ CLOUD ☐☐ Prec. ☐

Line No.	Continue	Time	Sector	Size	Sex	Beach Pos	Condition	ID			TAG				MOLT		Disturb	ASSOCIATION			Notes	Notes	EVENT	
								T/P	No.	?	No.	L/R	Col	?	%	?		Line No.	Dist	Behavior			Type	Codes
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2																								
3																								
4																								
5																								
6																								
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NOTES:

Line No.	Continue	Time	Sector	Size	Sex	Beach Pos	Condition	ID			TAG				MOLT		Disturb	ASSOCIATION			Notes	Notes	EVENT	
								U/P	No.	?	No.	L/R	Col	?	%	?		Line No.	Dist	Behavior			Type	Codes
15																								
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NOTES:

1997
CENSUS FORM DIRECTIONS
(Unabridged - Laysan and Lisianski Islands only)

This form is used to record all Hawaiian monk seal and green turtle sightings. Turtle sightings are recorded only during census activities (not during patrols).

All original 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 is editing before running the data entry and checking program. All field editing by the data collector should be in blue, and field editing by others should be in red. As soon as you begin the entry and checking program, the computer will assign the computer page number and display it on the screen. At this point, be sure to fill it in on your census form. All editing after this point should be in orange. After completing the entry and checking program, check off and initial the ENTERED box on the census form.

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. To save paper, you should use a census form with multiple headers if you only have a few seals to record (i.e., at some islands within an atoll, or when recording incidental sightings before or after census or patrol). In essence, on a census form with multiple headers, each header and its associated lines represents a separate data sheet.

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) and combine pages into one set. Patrols may be conducted by more than one observer, but page sets are not combined, and header information may differ. Patrol observers should attempt to start at roughly the same time. The sum of all observers' patrol activity for a day should result in one complete island count.

Always record disturbance. You must be honest about this! Fill out a census form to document disturbance if you disturb a seal when you are not otherwise collecting data. On a census or atoll count, it is also assumed that condition and molt data will be taken.

Do not make up additional codes. If the need for an additional code arises, contact Honolulu.

PAGE HEADER

DATA TYPE

C = Census: A complete, timed count on an island begun around 1300. Census is conducted as quickly as possible (while gathering all information).

A = Atoll-wide census (must be completed within 2 days).

B = Behavior patrol: A complete, untimed count where size, sex, ID, and disturbance are recorded. Associations are coded if

they involve adult or subadult seals (Laysan and Lisianski Islands only in 1997).

P = Patrol: A complete, untimed count where size, sex, ID, and disturbance are recorded. Behavior data is not taken.

I = Incidental observation.

T = Tag status entry for non-active tags (tags not currently on a seal). Record tag status (F or R) in notes columns.

COMPUTER PAGE NO. Leave this blank during data collection. It will be assigned and displayed on the screen when you enter the data. At that time, be sure to fill in the computer page number on your census form, as this number is needed for data retrieval.

PAGE Page number within a census or patrol. For example, if the census (or patrol) requires three pages, then mark the first page as "page 1 of 3" and so on. If more than one 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.

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-hour clock, e.g., 6 p.m. = 1800, for the group of pages.

DATE The date that data are collected (in YYMMDD format).

NUMBER Censuses, Atoll counts, Behavior patrols, and Patrols must be numbered. Each data type will have its own three-digit number series, starting with 001.

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.

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: NN,NE,EE,SE,SS,SW,WW,NW
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

LINES

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 from SECTOR through MOLT will be copied

from the original line if left blank on the continuation line. Several lines can have the same continuation line number.

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.

TIME The time should be recorded for each seal sighting, on a 24-hour clock.

SECTOR Location on island (e.g., 1-20 on Laysan)
Special codes as follows:
00 = unknown sector
77 = pen
88 = offshore spit
99 = island not present

SIZE Size is estimated using a classification scheme from Stone (1984), using the following terminology:

Pup — Seals born within the calendar year. Newborn pups are black and weigh ca. 11 to 15 kg. Pups molt to a silver-gray pelage near weaning. Weaning weight is ca. 50 to 80 kg.

Juvenile — Short, slight seals from the length of a weaned pup (about 138 cm) to 20-30 cm longer includes yearlings and other young seals up to 3 years. Distinguished from pups by thinness and pelage color.

Subadults — Seals perceptibly longer than juveniles up to breeding size; less robust than adults, generally with lighter pelage. Immature seals ca. 3 to 5 or 6 years old.

Adult — Reproductively active or breeding size seals at least as long as known breeders. Mature or probably mature seals. Adult females often have extensive back scars or wounds; adult males usually dark, including venter, and extensively scarred.

Code size as follows:
Nursing pups
- P = Nursing pup
  - P1 = Nursing pup, wrinkles
  - P2 = Nursing pup, no wrinkles
  - P3 = Nursing pup, blimp, black
  - P4 = Nursing pup, molting
  - P5 = Nursing pup, molted
- PW = Prematurely weaned/undersized weaned pup (weaned $\leq$2 weeks ago and <90 cm girth)
- W = Weaned pup

Immatures
- I = Immature
  - J = Juvenile
    - J1 = Juvenile I
    - J2 = Juvenile II
  - S = Subadult
    - S3 = Subadult III
    - S4 = Subadult IV

Adults
- A = Adult

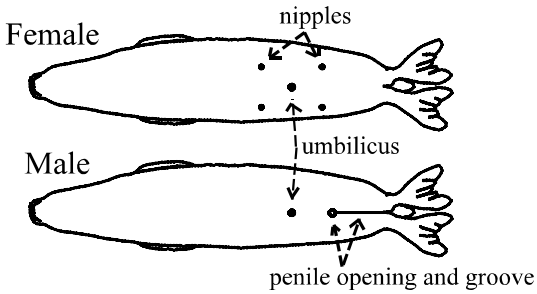
Unknowns
- U = Seal of unknown size

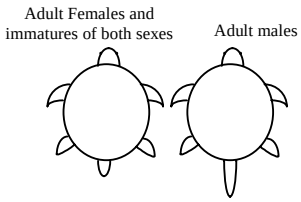
Turtles

T = Turtle
T1 = Turtle, juvenile (<65 cm)
T2 = Turtle, subadult (65-80 cm)
T3 = Turtle, adult (>80 cm)

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, scars, or behavior.

SEX M = Male
F = Female
U = Unknown





BEACH POS. Location of seal or turtle <u>when observer comes abreast of animal</u> (e.g., if seal is seen in the water from a distance and yet is on the beach when the observer comes abreast, the seal is recorded as being on the beach). When recording male-male interactions (at Laysan and Lisianski Islands in 1997), make a continuation line previous to the original line to indicate that the seal changed beach position before you come abreast of it.

0 = animal floating or swimming in water (not included in census tally but may be used for behavioral data or other analysis)
1 = on the beach
9 = on an offshore rock (not included in census tally)
X = data not taken

CONDITION It is assumed that condition is recorded for all seals (except nursing pups) on census or atoll count. **Always record** the condition of the mom and pup on their first sighting postpartum and postweaning, regardless of data type. Always note condition when recording a survival factor.

<u>Condition codes:</u>
M = medium
P = probably pregnant
F = fat
T = thin
X = data not taken
If the condition code is left **blank** during an atoll or census count, condition is assumed to be medium.

ID DATA These fields can be used to record either a temporary or permanent ID number. Use continuation lines to record both a temporary and permanent number, or two or more temporary numbers. If the seal is identified, it will not be counted twice on census. To link two sightings of an unidentified seal during a survey (i.e., for a cruiser moving ahead of you), assign it a temporary number in a series reserved for unidentified seals, and code a <u>6</u> in the temp ? field.

T/P Indicate whether the number in the subsequent field is a temporary or permanent ID number.

T = temporary ID number (or bleach number)
P = permanent ID number

TEMPORARY ID NO. Record the temporary ID number (or bleach number) of seal if known; right justified. This field may be used for any temporary number. Use separate number series for bleach and various types of temporary numbers. If a number is incompletely read, use dashes as place-holders within the number to indicate missing digits (e.g., incompletely read bleach 152 may be coded -52, 1-2, or 15-).

? column:

0 = seal is definitely unmarked; can coexist with a temporary number or with a bleach number if bleach hasn't taken yet or the number has molted off.
1 = bleach is present, but the number is questionable.
4 = partially read bleach number completed from other data
5 = incompletely read bleach number, but partial data are certain (if seal can't be identified by ID or Tag #).
6 = temporary number valid for this survey only, use for data types C, A, B, or P (for unident. cruisers moving ahead of you on census, etc.).
blank = number is certain and complete if present.

PERMANENT ID NO. Record the four-digit permanent ID number of seal if known (put both the island-specific prefix and next digit in the first box provided).

? column:

0 = seal is definitely not an IDed animal
1 = ID number is questionable
blank = ID number is certain and complete if present

TAG NO. The complete tag number if known; right justified. If a number is incompletely read, use dashes as place-holders within the number to indicate missing digits. 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 (e.g., A--RT5 for a right tan tag with a 1983 drill pattern).

Record all tag sightings explicitly (i.e., both left and right tag numbers) at least once during your stay. During the first weeks of the field camp, note tag condition each time that a tag is sighted. Once the majority of tags have been resighted, observers can carry a list of tags/individuals that haven't been seen, and only note tag condition if these tags/individuals are resighted. Also carry a list of broken or lost tags so that you will be aware, and can record, if a specific tag breaks or is lost during the field season. When a pup is tagged, record the animal handling event on the census data sheet, and record detailed information (such as all tag numbers) on a Tagging/Handling 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 can be determined by computer later.

L/R: Tag position

L = tag on left flipper
R = tag on right flipper
B = tags on both flippers (enter one tag number)

COL:

Color code--see the Tag Sample Kit if unsure of the colors.

Temple tags	Other tag types
Y = yellow (FFS)	M = metal, Monel
T = tan/brown (Laysan)	C = clear, PIT tag
G = green (Lisianski)	
B = blue (Pearl & Hermes)	
K = silver/gray (Kure)	
R = red (Midway, Necker, Nihoa, Main Islands)	

? column:

0 = seal is definitely not tagged on either flipper.
1 = seal is tagged, but the number is questionable.
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 #).
8 = Tag lost/unreadable. Fill out tag position (L/R) and the tag condition event with codes L or U. Complete the tag number and color from other data before entry.
blank = Tag information is certain if present. Partial data (either complete Tag #, position, or color 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 an incomplete Tag # must be completed by hand (use a "4" in the tag ? column).

MOLT Percentage of old pelage lost, optional for pups. However, for weaned pups, record the % molt at time of tagging.

blank = no molting evident.
0-9 = 1 to 99% molted:
0 = molting, but less than 10%; 1 = 10-19%; ... 9 = 90-99%. The first record of a $\geq$2 molt is considered the first day of true molt.
10 = 100% molted, freshly molted, required for the first month after molt. Put both digits of the 10 in the single box provided.

? column:

0 = seal is definitely not molting.
1 = seal is molting, but % molt estimate is questionable. May or may not include an estimate in the molt column.

DISTURB The degree to which the seal may have been disturbed by observer. Record disturbance every time a seal is disturbed, regardless of your activity. The only exception is that you do not need to record a disturbance for a seal that you are handling.

0 = no disturbance, or seal merely raised its head or looked at observer - If column **blank**, 0 is assumed
1 = seal vocalized, gestured, or moved $\leq$2 body lengths
2 = seal alerted to observer and moved >2 body lengths
3 = seal alerted to observer and fled into water

ASSOCIATION DATA Record detailed association data at Laysan and Lisianski Islands in 1997. Don't record associations involving turtles. If you wish to indicate that a seal was alone, use the O behavior code. On a census or behavior patrol data sheet no code in any of the association columns means that the seal was alone, whereas on a regular 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 or during behavior patrol at these locations because it will be filled in by computer. If you are unable to record association data on a census or behavior patrol at Laysan or Lisianski Island for any reason, indicate this with an X for the behavior code. Use continuation lines to record more than one association.

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. Don't record behaviors of an animal after it has been disturbed by the observer.

All associations 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 entry/checking program will fill in the other line. When recording an active behavior that requires a corresponding code, the association line number should refer directly to the line where the corresponding behavior is coded (i.e., if the corresponding code is on a continuation line, refer to that particular line, not to the original line or a different continuation line).

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) individual seals
   - mother-pup pair (N): any distance
   - all others (L): distances ≤10 m away; record two nearest neighbors in straight line of sight; can be on opposite sides of a log

LINE NO. Identity of the other seal in the association. Put its line number here (note line number refers to within same census page only).

DIST. Closest distance during behavior--both associated lines must have the same minimum distance.
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)

BEHAVIOR Up to four behaviors may be recorded for each association, but L, N, X, and O should not appear together with other behaviors. Behaviors B and M require distance = 0. Behavior J requires distance of 0 or 1. With the exception of Bites, Chases, Jousts, and Mounts, only record repetitive, sequential behaviors once (for example, if an animal approaches three times in a row, code one A). If vocalizations occur, only code V once (whether or not they are sequential).

1) individual seal
   a) active behavior
      A = approach/investigate/sniff/nudge

B = bite
B1 = bite, nip
B2 = bite, draws blood/breaks skin
C = chase
C1 = chase, ≤2 body lengths*
C2 = chase, >2 body lengths*
D = seal displaces another (see CONTEST RULES)*
F = flee/move away
F1 = flee/move away, ≤2 body lengths
F2 = flee/move away, >2 body lengths move away
J = joust
J1 = joust ≤30 s*
J2 = joust >30 s* spar/fight*
M = mount/attempted
M1 = mount/attempted mount ≤30 s
M2 = mount/attempted mount >30 s
P = play* (typically pup/immature behavior in the water)
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)

b) spatial association (reciprocal association filled by computer
N = mother-pup pair (any distance), does not imply actual nursing behavior. 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) additional codes (Laysan and Lisianski 1997)
L1 = pair assoc.* A/S4 male actively defends an adult female or immature of either sex (actual sex may be unknown) or establishes a pair relationship with a female or immature after displacing another male. Code the L1 relationship before and after contest if displacement occurs.
Q = loser*
W = winner*
Y = tie*

Note: codes Q, W, and Y are used for A/S4 male-male contests only, although the actual sexes may be unknown (in which case record as though they were known to be males); see the attached CONTEST RULES.

* requires a corresponding code on the line of the associated seal

Code	Corresponding code
C, C1, C2	F, F1, or F2
D	F, F1, or F2
J, J1, J2	J, J1, and J2 respectively
P	P
L1	L1
Q	W
W	Q
Y	Y

2) nothing nearby
O = no behavior or association

3) no data
X = no association data recorded on Census or Atoll Count

NOTES--There is room to code two different notes. Always use the first column first. Code an H if you have handwritten notes on the observation. Put handwritten notes on the bottom of the census form, labeled by line number. If more than two note codes apply, use continuation lines.

A = artwork (scars drawn) - attach drawing, labeled with date, computer page number, and line number
B = birth, 1st sighting postpartum (mom and pup)
G = seal is green with algae
H = handwritten notes
M = marked, bleach number 1st applied/reapplied post-molt
W = weaning, 1st sighting postweaning (pup)
X = pup exchange, 1st sighting after exchange (mom and pup)
Y = disturbance is to "bystander" seal during non-survey activity such as tagging, bleaching, instrumenting, etc. This includes all "hands on" research, even if the attempt was unsuccessful.

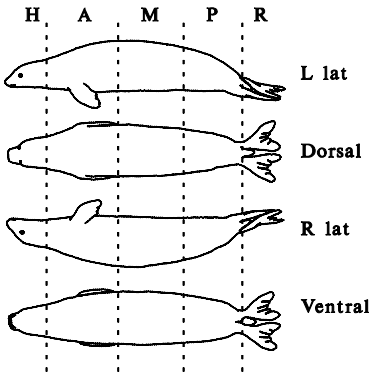
FOR DATA TYPE "T", STATUS OF NON-ACTIVE TAGS:
F = found
R = recovered from seal in hand

EVENT These columns are used to record a variety of data. The codes used will depend upon the type of event that you wish to record. Left justify your coding:

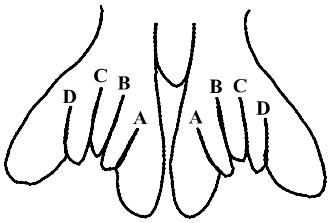
TYPE	**CODES COLUMN**	**CONTENT**
F = survival factor		ONLY RECORD RESIGHT OF A SURVIVAL FACTOR AS AN EVENT IF THERE ARE IMPORTANT CHANGES TO DOCUMENT, SUCH AS A NEW WOUND, HEALING, DEATH, ETC.
	1-3	Survival Factor number
	4	Factor Type. If seal is dead, always record factor type "D" on ORIGINAL LINE. For mobbings/harassments, always code a census entry with factor type "M" for the victim at the beginning and end of the incident. Otherwise, you only need to record the most appropriate factor type if more than one applies. D = death W = wound E = entanglement V = very thin (emaciated) I = illness/abnormal M = mobbing/harassment/post-mobbing aggregation O = other
	5	Participant type (for mobbings/ harassments only) V = victim/subject M = male aggressor
H = handling of wild seal		FOR SEAL CAPTURES OR RELEASES, RECORD DETAILS ON EITHER THE CAPTURE OR RELEASE FORM. OTHERWISE, RECORD DETAILS ON THE TAGGING/HANDLING CARD.
	1	Handling type T = tagging (w/ restraint) M = measuring (includes weighing)

A = all (both tagging and measuring)
R = remote tagging
D = disentangle
I = instrument
B = bleeding
C = take into captivity
F = free from captivity
O = other

TYPE	CODES COLUMN	CONTENT
P = photo		RECORD IMPORTANT DESCRIPTIONS AND ANY NON-SEAL PHOTOS IN HANDWRITTEN NOTES, AND TRANSFER TO THE PHOTO COMMENT FORM.
	1	Type of photo S = slide P = print
	2-3	Roll number (pad with zeros)
	4-5	Frame number (pad with zeros)
	6	Side L = left lateral or flipper R = right lateral or flipper D = dorsal side V = ventral side B = both (used for rear flippers only) X = other, describe in hand-written NOTES
	7	Part H = head A = anterior body (neck and shoulders) M = midbody (behind foreflippers and before posterior) P = posterior body (behind midbody and before rear flippers) F = foreflipper; write whether dorsal/ventral in comments R = rearflipper; write whether dorsal/ventral in comments O = overall view of a particular side X = other, describe in comments



	8	Purpose I = identification F = survival factor (link with survival factor EVENT using continuation lines) X = other, describe in comments

TYPE	CODES COLUMN	CONTENT
T = tag condition	1	Web A-D = from inner (medial) to outer web E = ankle P = posterior U = unknown
	2	Side of tag--the dorsal tag side is on the dorsal flipper surface unless the tag is reversed. For Temple Tags, the dorsal side is the bigger side; for Metal (Monel) tags, the dorsal side is the "male" side. For PIT tags, code the side as B (both). D = dorsal V = ventral B = both U = unknown
	3	Condition, code U (unreadable) if cannot use tag to ID seal (i.e., if broken so number gone). Also code U for a PIT tag if you completely scan for it but get no reading. Combine the L or U codes with the tag questionable code of 8. Code more than one condition using continuation lines. B = broken F = faded color G = good L = tag lost N = no/partial resin O = other P = pulling out U = unreadable V = tag side reversed W = no. worn/abraded

CONTEST RULES

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

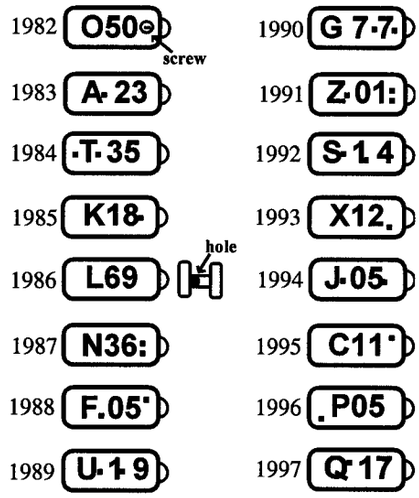
2. Definition of pair type (depends on associate of adult male):
   - Pair type **#1**: adult male with adult female (**L1**)
   - Pair type **#2**: adult male with juvenile or pup of either sex (**L1**)
   - Pair type **#3**: *single* adult male not pair type **#1** or **#2**

3. Definition of a male-male contest (must conform to at least one condition below):
   - Distance between males = 0
   - Either adult male vocalizes (**V**) or performs a **C**, **D**, or **J**
   - If cruiser approaches to beach position ≥1, regardless of other behaviors

4. Definition of winner or loser adult male (Even if the "winner" is not aware that the other seal flees, if that seal fled in response to a vocalization, then code the fleeing seal as the loser (Q) and the other seal as the winner (W)):

Case	**Winner (W)**	**Loser (Q)**	**Tie (Y)**
Paired Male *vs*. Single Male: (**#1** or **#2** *vs*. **#3**)	i) Original Single Male if has **D** ii) Original Paired Male otherwise	Has **F**	No Ties 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** ii) Original Male Paired with Adult Female otherwise	Has **F**	No Ties 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 PATTERN FOR TAGS APPLIED TO WEANED PUPS



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 tag color:	**Faded tag may appear:**
Temple Tags:	
Light Tan (A,T,K,L series @ Laysan)	Gray, Lt. Yellow, White
Dark Tan/Brown (later series @ Laysan)	Red
Gray (A,T,K,L,N,F,U,G series @ Kure)	Light Tan
Silver Gray (600-900,0,Z and later @ Kure)	Metal
Red	Orange
Yellow	White, Lt. Yellow
Green (dark forest)	Dark Blue, Navy
Blue (light)	--

Riese Tags (colors almost completely faded- just note presence if you can ID by other means):

White	Yellow
Red	Orange
Orange	Red
Yellow	White
Green	Blue
Blue	Green

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