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THE HAWAIIAN MONK SEAL IN THE NORTHWESTERN HAWAIIAN ISLANDS, 1995

Compiled and Edited by

Thea C. Johanos
Timothy J. Ragen

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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 1995, 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, provides 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 population. In 1995, 176 pups were counted at these sites, 73 of which were born at French Frigate Shoals (the lowest number recorded at this site since monitoring began in the early 1980s). Increased pupping at other sites compensated, at least partially, for the decline at French Frigate Shoals.

Mean beach counts from the main reproductive sites (again, excluding Midway Atoll), totaled 384 seals excluding pups, slightly greater than in 1993 (counts were not conducted at all locations in 1994). Here, too, counts at French Frigate Shoals declined considerably, but the decline at this site was compensated for by increases at Pearl and Hermes Reef and Kure Atoll.

Finally, the composition of the counts remained largely skewed toward adults. Since the mid 1980s, adults have comprised a growing portion of the animals counted. 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.

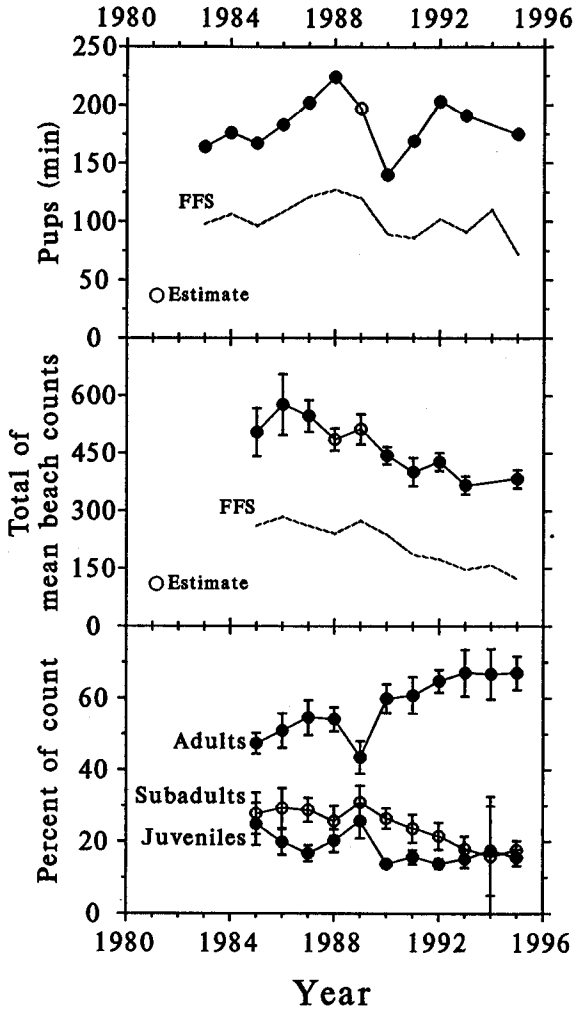

Fig. 1. Demographic trends of the Hawaiian monk seal, based on the main reproductive sites (excluding Midway Atoll). a) Number of pups born. b) Total of mean beach counts excluding pups. c) Portion of the counts comprised of adults, subadults, and juveniles.

First, 12 weaned female pups were collected from French Frigate Shoals and trasnported to Oahu for rehabilitation to salvage reproductive potential otherwise lost with the high mortality of immature seals. Second, 7 rehabilitated yearling females, collected from French Frigate Shoals in 1994, were released at Kure Atoll to enhance the recovery of its long-depleted population. Third, debris capable of entangling seals was removed from all study sites and 10 entangled seals were disentangled by field biologists.

This document describes these and other field studies conducted during 1995. 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

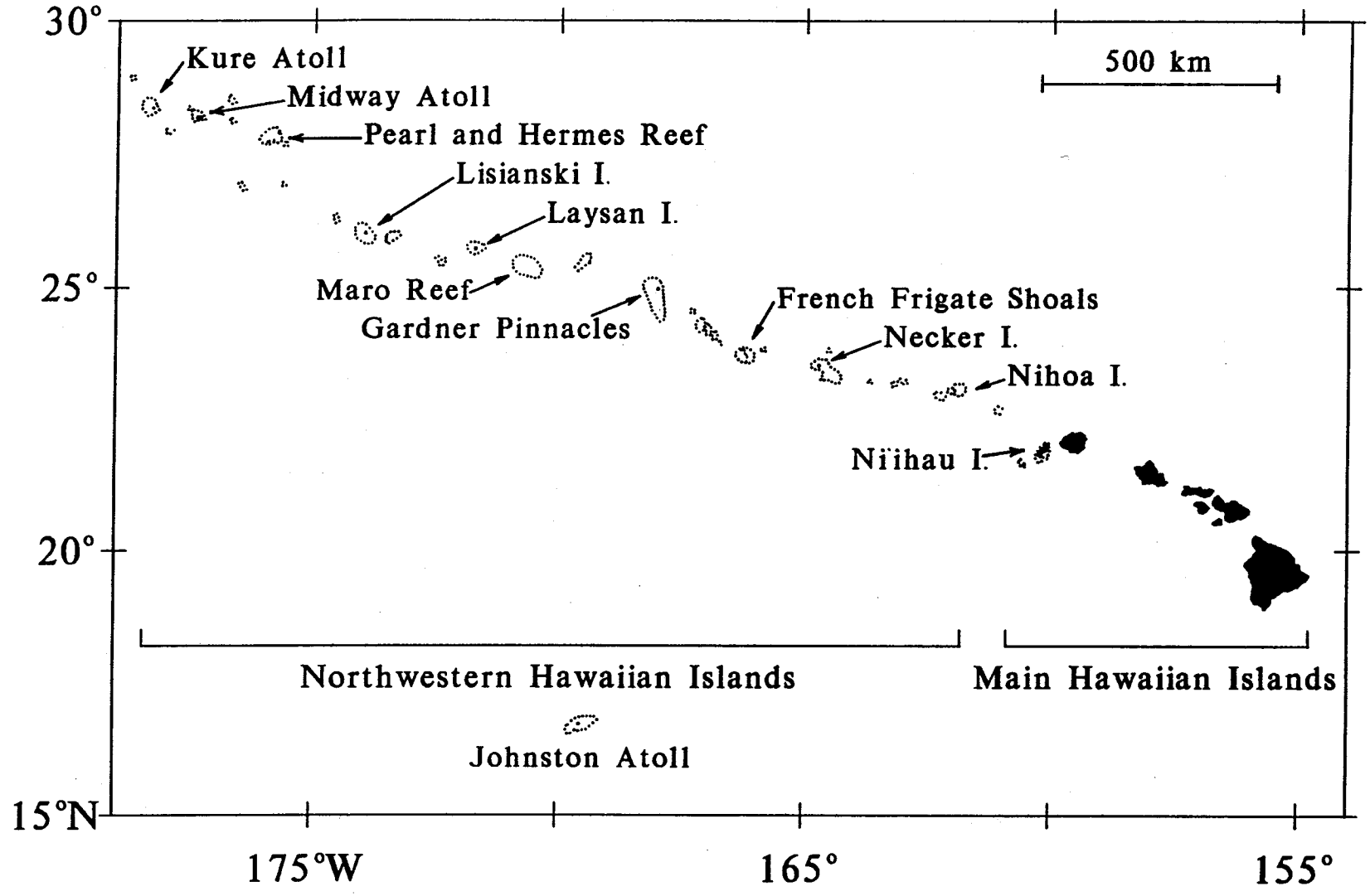

Fig. 1.1. The Hawaiian Archipelago.

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 Reseach 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) and 1982 (French Frigate Shoals (FFS) and Pearl and Hermes Reef). Nearly every year thereafter, field camps of several days to 9 months were established to monitor and enhance the recovery of this species. Limited population monitoring has also been conducted at Midway Atoll, where current pup production is well below historical levels, and at Nihoa and Necker Islands, where pup production is spacially limited by availability of haulout area. Reports summarizing past NMFS research are listed in Appendix A.

In 1995, the objectives of Hawaiian monk seal research were to (1) conduct beach counts (censuses), (2) tag weaned pups and immature seals for permanent identification, (3) identify other seals by previously applied tags and by natural or applied markings, (4) monitor reproduction, survival, injuries, entanglements, interatoll movements, disappearances, and deaths, (5) perform necropsies, (6) collect scat and spew samples for food habit analysis, (7) collect tissue samples for DNA analysis of paternity patterns and genetic variation within and among populations, and (8) inventory, sample, and destroy debris capable of entangling seals. Location-specific objectives and summaries of data collected during the 1995 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 every 3 to 8 days, 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 toward 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 was 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 calculation of 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 had 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 if they simultaneously involved more than one male aggressor or resulted in at least one puncture or gaping wound (missing skin or extending into the fat layer) or $\geq$ 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, 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, two passive integrated transponder (PIT) tags were implanted subcutaneously in the dorsum of each weaned pup (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, and 1984 at French Frigate Shoals. 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.

In 1995, 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 Atoll, and Kure Atoll), adult, subadult, and untagged immature seals were bleach-marked for individual

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

identification (Stone, 1984), using the solution described in Johanos et al. (1987). Molting seals were re-marked to maintain their identities. At Laysan Island, 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 first seen unless it pupped at another location. A parturient female was always included in the population where it pupped, if it was seen there anytime during March-August.

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 one 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 as soon after weaning as possible, their 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. 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, external measurements and observations were recorded. The skull was collected from all seals except pups. For a recent death, an internal examination was made, and samples of tissue, organs, parasites, and stomach contents were collected. Detailed descriptions of necropsy procedures and sample collection methods are in Winchell (1990).

Scat and spew samples 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, 1995

Mitchell P. Craig, Derek Kuda, Alison Veit, Kyler Abernathy, and Kate McFadden

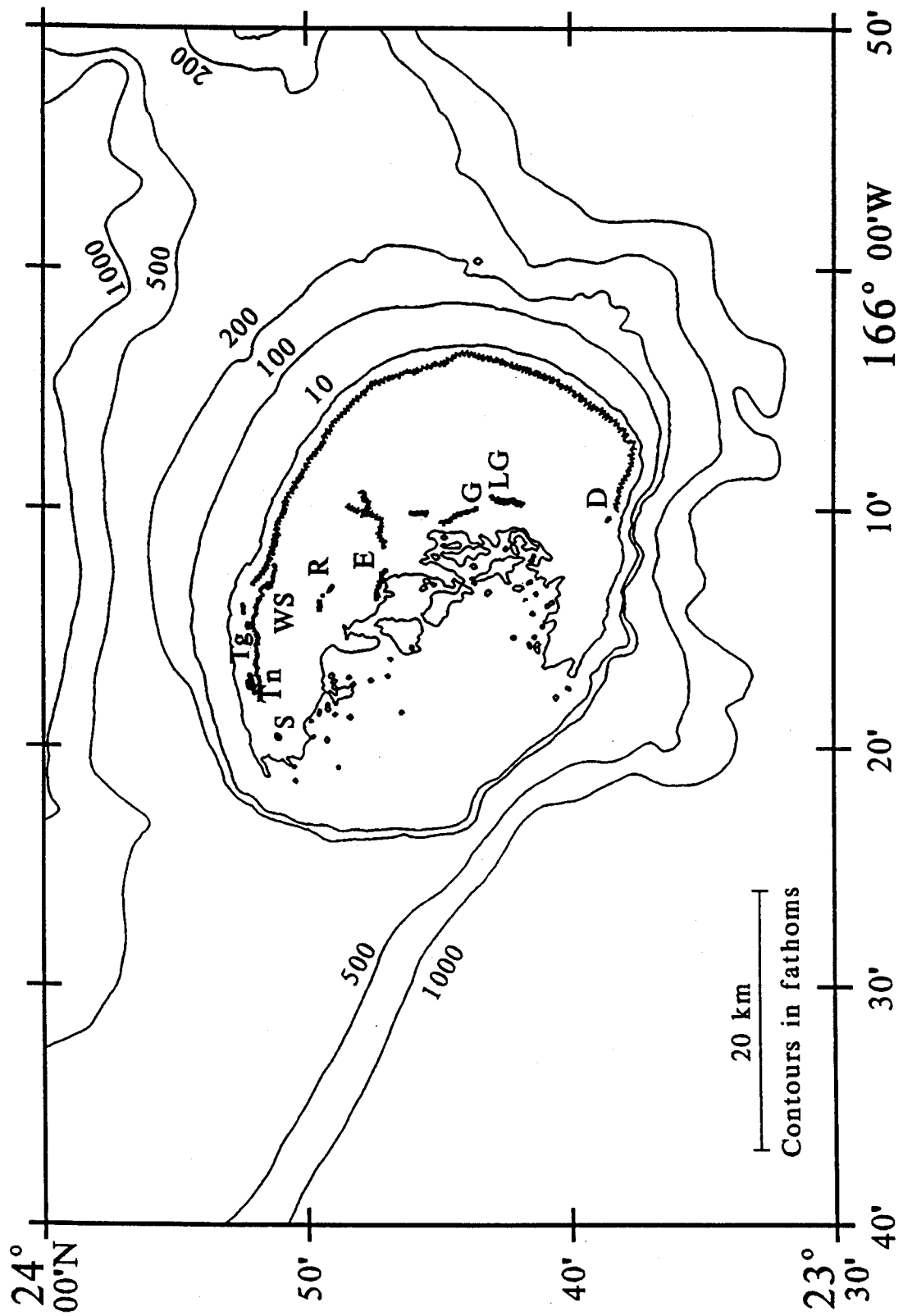

Fig. 2.1. French Frigate Shoals in the Northwestern Hawaiian Islands. Islands are: Disappearing (D), East (E), Gin (G), Little Gin (LG), Round (R), Shark (S), Tern (Tn), Trig (Tr), and Whaleskate (WS).

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

Research was conducted by the National Marine Fisheries Service (NMFS) during May 8-September 3 and during October 25-November 18. 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. In 1995, research objectives specific to this population included (1) capture of undersized weaned pups for rehabilitation, (2) investigation of habitat use patterns using satellite-linked telemetry and seal-mounted video cameras, (3) assessment of nearshore prey availability, and (4) collection of reef fish for an Hawaiian monk seal feeding study.

Censuses and Patrols

Atoll censuses (n = 10) were conducted every 8 d, on average, from May 20 to August 5. Each atoll census began between 0900 and 1100 Hawaii standard time and ended between 1500 and 1800. Round Island and Mullet Island were censused from a boat, while the remaining islands were censused on foot by one or two persons.

Patrols were conducted on noncensus days. East, Mullet, Round, and Whaleskate Islets were visited every 3-4 d to monitor pupping activity. Patrols of Tern Island were conducted every 3 d.

Individual Identification

A total of 426 individuals (353 excluding pups) were identified by existing or applied tags, scars, or natural markings. Most weaned pups were tagged (n = 55) with Temple Tags; 51 of these same pups were tagged with passive integrated transponder (PIT) tags. Two juvenile seals (1 male, 1 female) and 2 adult males were tagged, and 111 subadult or adult seals (46 male, 65 female) were retagged with Temple Tags.

Collection of Samples

Ninety-nine scat and spew samples were collected. Tissue samples were collected from 139 seals during tagging. Necropsies were performed on eight dead seals found at the study site. Tissue and skeletal samples were collected from all necropsied

seals. In total, 148 pieces of potentially entangling debris were inventoried and destroyed.

Special Studies

Seals Collected for Rehabilitation

Since 1984, NMFS has collected female pups whose size at weaning indicated that their chance of survival to age 1 was low relative to survival of larger seals (Gilmartin and Gerrodette, 1986). From 1984 to 1991, female pups with an axillary girth <90 cm at weaning were captured and transported by airplane or ship to rehabilitation facilities on Oahu. After 8-12 mo of rehabilitation, they were reintroduced at Kure or Midway Atolls. In 1992, the collection criteria (axillary girth at weaning) were raised to ≤95 cm, and in 1995 the collection criteria were again raised to ≤100 cm, because recent survival data (NMFS unpublished data) revealed that pups with girths of 90-100 cm also had substantially lower survival rates than larger seals.

Twelve female pups were collected for rehabilitation in 1995. These seals were held on Tern Island for up to 21 d before transport to Oahu. During the holding period, they were treated for bacterial infections and dehydration and were tube-fed fluids, including a milk replacer formula and a herring slurry, and force-fed herring. All collected pups were transported to Oahu and remained in rehabilitation there for the remainder of 1995.

Habitat Use Study

In October and November, eight molted adult males were instrumented with video cameras for 2 to 18 d. The seals were instrumented as part of a habitat use pilot study conducted in collaboration with the National Geographic Society. In November, three other molted adult males were instrumented with both satellite-linked time-depth recorders and radio transmitters and tracked for 3 weeks to determine the satellite tag position error.

Prey Availability

The Ecosystem and Environment Investigation (EEI) of the Honolulu Laboratory, NMFS, conducted a study at FFS to determine if a decline has occurred in fish stocks that are potential prey for seals (DeMartini et al., 1993). A significant decline in prey availability might explain the observed changes in condition and survival of immature seals. In September, the EEI conducted transects at nine stations around FFS to estimate densities of higher taxonomic categories of reef fishes. These surveys replicated surveys conducted at FFS during 1980-83 and 1992. The EEI also began to test octopus trap designs in order to assess

octopus abundance. The results of this ongoing research will be reported at the conclusion of these studies.

Feeding Study

In September, the EEI collected reef fish for a monk seal feeding study being conducted by researchers from the University of Hawaii.

RESULTS

Population Abundance and Composition

The means (± SD) for 10 atoll censuses were 150.5 seals (± 16.6) including pups, and 123.9 seals (± 14.3) excluding pups (Table 2.1). The total spring-summer population included 161 immature individuals (subadults, juveniles, and pups), of which 88 were subadults or juveniles (Table 2.2). The total numbers of adult males and females were not obtained due to our inability to identify all individuals. The numbers of tagged known-age seals born at FFS from 1984 to 1994 and resighted there in 1995, are summarized in Table 2.3.

Reproduction

At least 73 pups were born: 56 were weaned and 17 died or disappeared prior to weaning (Table 2.4a). Four 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 179 adult-sized females were identified and 63 (35%) of those were parturient. An unknown number of adult-sized females remained unidentified at FFS. The birth rate was 45% (45/101) for untagged adult females (>11 years old) and 23% (18/78) for tagged females of adult size (≤11 years old). Parturient females were more likely to be identified during lactation, which probably biased the estimates of birth rate upward. The mean (± SD) lactation period for 27 females was 35 d (± 4.3 d). At least four pups were fostered by mothers other than their own.

Interatoll Movement

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

Factors Affecting Survival

Attacks by large sharks, mounting attempts by males, emaciation, and other-unknown factors resulted in 55 life-threatening conditions, which led to the confirmed deaths of 21

animals and the probable death of 13 seals (Table 2.6). One incident of adult male aggression was observed; an adult male nearly drowned a weaned female pup. This same pup was later found drowned, probably by an adult male. Ten emaciated seals died. No seals were entangled. In addition to the deaths presented in Table 2.6, four aborted fetuses were found on Tern Island in January, February, March, and November 1995.

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, 1995.

Size/Sex	Mean number of individuals	Standard deviation
Adults	102.5	13.0
Male	29.1	4.4
Female	55.3	12.3
Unknown	18.1	6.6
Subadults	10.1	2.6
Male	2.5	1.5
Female	6.1	1.7
Unknown	1.5	1.8
Juveniles	11.3	4.7
Male	3.6	2.3
Female	6.8	3.0
Unknown	0.9	1.3
Pups	26.6	3.5
Male	11.4	3.9
Female	5.5	2.3
Unknown	9.7	2.5
Nonpup Total	123.9	14.3
Grand Total	150.5	16.6

Table 2.2.--Composition of the Hawaiian monk seal population at French Frigate Shoals during the spring and summer of 1995. Includes all pups born during the calendar year. Dashed lines indicate that the number of seals in a size-sex class was undetermined.

	Number of seals				
Size	Male	Female	Unknown	Total	Sex ratio male:female
Adults	--	--	--	--	--
Subadults	16	20	0	36	0.8:1
Juveniles	20	32	0	52	0.6:1
Pups	38[a]	27[b]	8[c]	73	1.4:1
Nonpup Total	--	--	--	--	--
Grand Total	--	--	--	--	--

[a]Three neonatal pup deaths.
[b]Number includes 12 weaned pups collected for rehabilitation in 1995.
[c]Two neonatal pup deaths.

Table 2.3.--Summary of tagged known-age seals born at French Frigate Shoals and resighted there in 1995.

Age (years)	Sex	Number originally tagged	Number resighted in 1995
11	Male	49	11
	Female	43	22
10	Male	48	9
	Female	38	16
9	Male	52	13
	Female	48	21
8	Male	55	16
	Female	51	17
7	Male	52	5
	Female	62	8
6	Male	51	8
	Female	50	6
5	Male	41	2
	Female	38	2
4	Male	24	1
	Female	44	5
3	Male	36	2
	Female	55	9
2	Male	40	8
	Female	39	7
1	Male	47	10
	Female	48	14

Table 2.4a.--Summary of Hawaiian monk seals born at French Frigate Shoals in 1995.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	38	27	8	73[a]
Died/probably died prior to weaning	8	1	8	17
Weaned	30[b]	26	0	56
Tagged	29[c]	26	0	55

[a]Four fetuses (two female, one male, and one unknown sex) were also found but are not included in the total number of pups born.
[b]One weaned male pup disappeared before tagging.
[c]Number includes one pup that was tagged as a yearling in 1996.

Table 2.4b.--Summary of nursing periods and measurements of weaned pups at French Frigate Shoals in 1995. Nursing periods were calculated where both birth and weaning date ranges were ≤4 d. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)	Weight (kg)
Mean	32.5	100.8	125.4	52.0
St. Dev.	4.4	11.2	8.2	8.1
n	4	53	53	11[a]

[a]Includes only weaned females collected for rehabilitation and measured within 2 weeks after weaning.

Table 2.5a.--Known movement of Hawaiian monk seals to French Frigate Shoals from other locations in 1995, summarized by movements between two locations. No seals made more than one trip.

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

Table 2.5b.--Known movement of Hawaiian monk seals from French Frigate Shoals to other locations in 1995, summarized by movements between two locations. No seals made more than one trip.

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

Table 2.6.--Factors affecting Hawaiian monk seal survival at French Frigate Shoals in 1995. Does not include captive seals.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
Attack by Large Shark					
Adult	Male	3	3	1	0
	Female	6	6	1	0
Subadult	Male	1	1	0	0
	Female	1	1	0	0
Juvenile	Female	1	1	0	0
Weaned pup	Female	1	1	0	0
Nursing pup	Male	1	1	1	0
Mounting by Males					
Adult	Female	1	1	0	0
Subadult		1	1	0	0
Weaned pup	Male	2	2	0	0
	Female	4[a]	3	1	0
Emaciation					
Adult	Male	1	0	1	0
	Female	1	0	1	0
Juvenile	Male	3	0	3	0
	Female	6	0	4	2
Other/Unknown					
Adult	Male	2	2	0	0
Juvenile	Male	2	0	2	0
Weaned pup	Male	2	1	0	1
Nursing pup	Male	6	1	4	2
	Female	1	0	0	1
	Unknown	9	0	2	7

[a]One adult male attempted to copulate with a weaned female pup in very shallow water, nearly drowning her in the process. She was drowned by an adult male in a later unobserved incident.

CHAPTER 3. THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND, 1995

Brenda L. Becker and Gina M. Reppucci

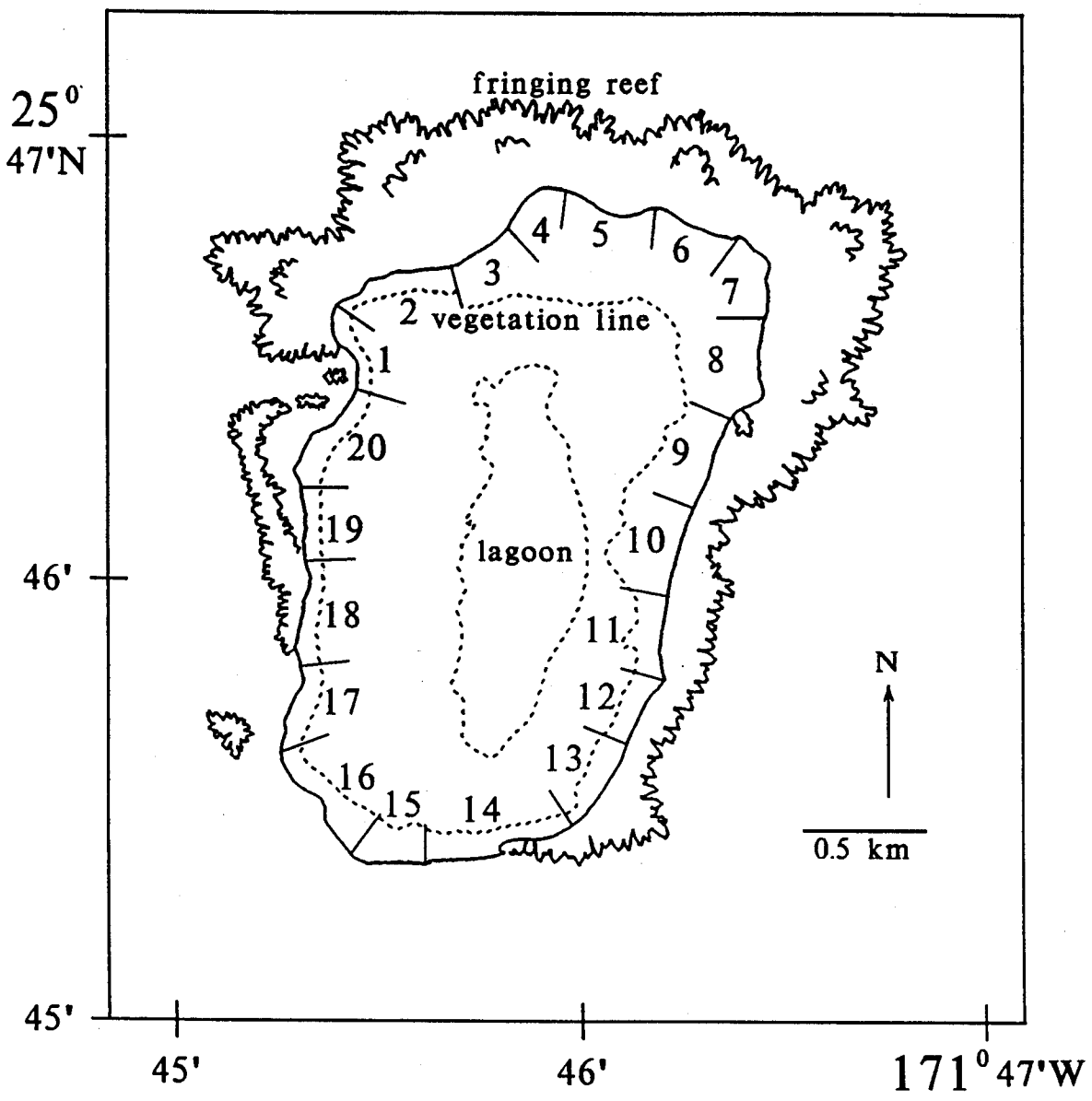

Fig. 3.1. Laysan Island in the Northwestern Hawaiian Islands.

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

Research was conducted by the National Marine Fisheries Service (NMFS) during April 21-July 18, 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). In 1995, research objectives specific to this population included identification of all seals, assessment of maternity and pup exchanges, 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 monitoring for the return of the adult males translocated to the main Hawaiian Islands.

Censuses and Patrols

Censuses and patrols were scheduled to ensure that the entire island perimeter was monitored 5-6 times per week during April 26-July 10. Thirteen censuses were conducted by two observers every 5th day from April 28 to June 12, and by one observer every 7th day from June 23 to July 7. Each census began at 1300 Hawaii standard time and continued for 2.4 to 3.0 h when conducted by two observers, and 5.4 to 5.6 h when conducted by one observer.

Standardized behavior patrols were conducted on 40 noncensus days 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.

Individual Identification

A total of 253 individuals (210 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. Bleach marks were applied to 198 seals, including 32 nursing pups. Most weaned pups (n = 37) were tagged with Temple Tags and passive integrated transponder (PIT) tags.

Collection of Samples

One hundred and eighteen scat and spew samples were collected. Tissue samples were collected from 37 weaned pups during tagging. Two necropsies were performed and tissue samples

were collected from both dead seals. In total, 581 pieces of potentially entangling debris were inventoried and destroyed.

Noteworthy Events

Translocated Adult Males

Twenty-two adult male seals were collected from Laysan Island in 1994; one male died shortly after capture and the remaining twenty-one 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 1995.

Oiled Seals

Twelve of 17 seals observed with oiled pelage on Laysan Island in the spring of 1993 were sighted there in 1995. These seals appeared to be in good health, but sublethal or long-term effects could not be evaluated. Of the five not sighted in 1995, one was also not seen in 1994, and one, an adult male, was translocated to the main Hawaiian Islands in 1994.

RESULTS

Population Abundance and Composition

The means (± SD) for 13 censuses were 92.0 seals (± 10.3) including pups, and 69.5 seals (± 10.0) excluding pups (Table 3.1). The total spring-summer population was 252 individuals, 209 excluding pups (Table 3.2). The sex ratios of nonpup immature seals and adults were ca. 0.8:1 (31 males:40 females) and 1.0:1 (68 males:70 females), respectively. The sex ratio for older adults (>12 years of age) was slightly skewed toward males at ca. 1.1:1 (41 males:37 females), whereas the ratio for younger adults (≤12 years of age) was ca. 0.8:1 (27 males:33 females). The numbers of tagged known-age seals born at Laysan Island during the period from 1983 to 1994 and resighted there in 1995 are summarized in Table 3.3.

Reproduction

At least 43 pups were born: 37 were weaned, 5 died prior to weaning, and 1 pup was still nursing at the end of the study (Table 3.4a). Nursing periods and measurements of weaned pups are summarized in Table 3.4b. Forty-three of 70 (61%) adult-sized females were parturient. At least nine pup exchanges occurred between fourteen nursing females; one exchange was observed. Three unusual temporary weanings (i.e., a nursing female abandoned her pup, and then returned) were documented.

Interatoll Movement

Interatoll movement was documented for 14 seals that made 15 movements between Laysan Island and either French Frigate Shoals, Lisianski Island, Pearl and Hermes Reef, or Maro Reef (Tables 3.5a and b).

Factors Affecting Survival

Attacks by large sharks, mounting attempts by males, entanglement, emaciation, and other- unknown factors led to 26 life-threatening conditions, which resulted in the confirmed deaths of 5 animals and the probable deaths of 2 other seals (Table 3.6). One incident of adult male aggression was observed, but the recipient of the aggression did not appear to be seriously injured. One seal disappeared after sustaining injuries characteristic of male mounting. Two seals were entangled: one escaped independently, and the other was released by an observer.

ACKNOWLEDGMENTS

We acknowledge the support of the U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge staff and thank the captains and crew members of the M/V *Glorita* and NOAA ship *Townsend Cromwell*. Special thanks are extended to Monette Boswell, Leah deForest, Amy Edmonds, Bradford Keitte, Leslie Leroux, Jeffrey Marks, Donna O'Daniel, Greg Spencer, and Drew Wettergreen for their data collection and tagging assistance.

TABLES

Table 3.1.--Summary statistics for censuses (n = 13) of Hawaiian monk seals at Laysan Island from April 28 to July 7, 1995.

Size/Sex	Mean number of individuals	Standard deviation
Adults	44.7	6.8
Male	17.9	6.0
Female	24.8	4.4
Unknown	1.9	2.9
Subadults	11.8	3.8
Male	5.2	1.9
Female	6.1	2.4
Unknown	0.5	0.8
Juveniles	13.0	3.3
Male	5.3	2.2
Female	7.4	2.8
Unknown	0.3	0.9
Pups	22.5	5.7
Male	10.4	1.8
Female	11.6	4.8
Unknown	0.5	0.9
Nonpup Total	69.5	10.0
Grand Total	92.0	10.3

Table 3.2.--Composition of the Hawaiian monk seal population at Laysan Island during the spring and summer of 1995. Includes all pups born during the calendar year.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	68	70	0	138	1.0:1
Subadults	19	17	0	36	1.1:1
Juveniles	12	23	0	35	0.5:1
Pups	18[a]	23[a]	2[b]	43	0.8:1
Nonpup Total	99	110	0	209	0.9:1
Grand Total	117	133	2	252	0.9:1

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

Table 3.3.--Summary of tagged known-age seals born at Laysan Island and resighted there in 1995.

Age (years)	Sex	Number originally tagged	Number resighted in 1995
12	Male	10	1
	Female	10	6
11	Male	16	2
	Female	13	5
10	Male	16	2
	Female	14	5
9	Male	15	2
	Female	17	2
8	Male	13	3
	Female	15	5
7	Male	23	5
	Female	17	3
6	Male	16	3
	Female	13	3
5	Male	7	3
	Female	9	3
4	Male	18	8
	Female	13	8
3	Male	18	3
	Female	14	5
2	Male	23	6
	Female	14	5
1	Male	18	9
	Female	29	20

Table 3.4a.--Summary of Hawaiian monk seals born at Laysan Island in 1995.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	18	23	2	43
Died prior to weaning	2	2[a]	1	5
Still nursing	0	0	1	1
Weaned	16[b]	21[b]	0	37
Tagged	16	21	0	37

[a]Includes one pup born after the field season.
[b]Includes one pup weaned and tagged after the NMFS camp.

Table 3.4b.--Summary of nursing periods and measurements of weaned pups at Laysan Island in 1995. Nursing periods were calculated where both birth and weaning date ranges were ≤4 d. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	35.3	102.8	124.4
St. Dev.	4.0	5.2	4.9
n	28	34	34

Table 3.5a.--Known movement of Hawaiian monk seals to Laysan Island from other locations in 1995, summarized by movements between two locations. One seal made more than one trip.

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

Table 3.5b.--Known movement of Hawaiian monk seals from Laysan Island to other locations in 1995, summarized by movements between two locations. One seal made more than one trip.

Destination	Number, size, and sex class
French Frigate Shoals	1 adult male, 3 adult females
Lisianski Island	3 adult females, 1 subadult female, 1 juvenile male
Pearl and Hermes Reef	1 adult female
Maro Reef	1 adult male

Table 3.6.--Factors affecting Hawaiian monk seal survival at Laysan Island in 1995.

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

[a]Event was observed and involved two males mounting a lactating female. The resulting injuries appeared to be minor.
[b]Seal escaped by itself.
[c]Seal was released by observers.
[d]Parturient female had a prolapsed uterus. This condition resolved itself.

CHAPTER 4. THE HAWAIIAN MONK SEAL ON LISIANSKI ISLAND, 1995

Heather L. Johnston, Joy A. Seymour, and W. Chad Leedy

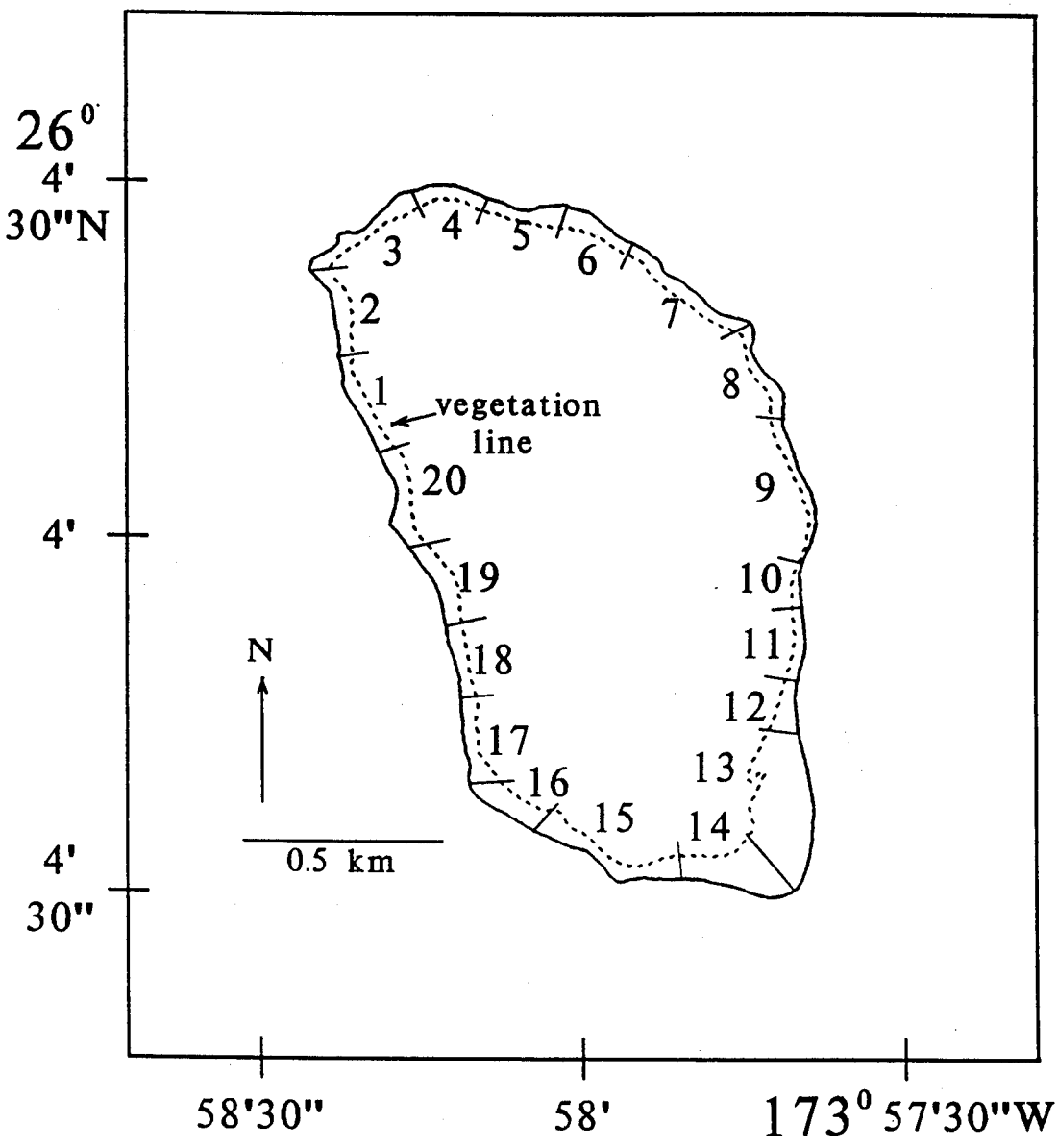

Fig. 4.1. Lisianski Island in the Northwestern Hawaiian Islands.

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 Shoal, a shallow reef bank within the Hawaiian Islands National Wildlife Refuge.

RESEARCH

Research was conducted by the National Marine Fisheries Service during April 19-July 14. The perimeter of the island was divided into 20 sectors using artificial or natural landmarks (Fig. 4.1). In 1995, research objectives specific to this population included identification of all seals, 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 April 19-July 10. Censuses (n = 14) were conducted by two observers every 6th day from April 21 to July 8, beginning at 1300 Hawaiian Standard Time and continuing for 1.0 to 1.7 h. Standardized behaviour 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 = 63), 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 220 individuals (198 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. All weaned pups (n = 17) were tagged with Temple Tags and passive integrated transponder (PIT) tags. Ten immature seals (4 male, 6 female) were also tagged with Temple Tags and PIT tags.

Collection of Samples

One hundred and seven scat and spew samples were collected. Tissue samples were collected from 23 seals during tagging. Necropsies were performed and tissue samples were collected from three dead seals. Skeletal samples were collected from two dead seals. In total, 1,201 pieces of potentially entangling debris were inventoried and destroyed.

RESULTS

Population Abundance and Composition

The means (± SD) for 14 censuses were 77.6 seals (± 9.1) including pups, and 66.7 seals (± 7.0) excluding pups (Table 4.1). The total spring-summer population was 219 individuals, 197 excluding pups (Table 4.2). The sex ratios of nonpup immature seals and adults were ca. 1:2:1 (37 males:32 females) and 1.6:1 (79 males:49 females), respectively. The sex ratio for older adults (>13 years of age) was strongly skewed toward males at ca. 2.6:1 (47 males:18 females), whereas the ratio for younger adults (≤13 years of age) was ca. 1.0:1 (32 males:31 females). The numbers of tagged known-age seals born at Lisianski Island during the period from 1982 to 1994 and resighted there in 1995, are summarized in Table 4.3.

Reproduction

At least 22 pups were born; 17 were weaned, 3 died prior to weaning, and 2 were still 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 49 (45%) adult-sized females were parturient. At least six pup exchanges occurred between eight nursing females; researchers observed none of these incidents.

Interatoll Movement

Interatoll movement was documented for eight seals that made eight 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 unknown factors led to 17 life-threatening conditions, which resulted in the confirmed deaths of 5 animals and the probable deaths of 2 other seals (Table 4.6). Incidents of adult male aggression were not observed, and no seals were known to have died following male mounting incidents. Five seals were entangled: one escaped independently and four were released by observers. In addition to the cases summarized in Table 4.6, a prematurely weaned male pup, in deteriorating condition at the end of the field season, probably did not

survive. The skeleton of a dead subadult was found; this seal had died of unknown causes since the 1994 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* and the M/V *Glorita* for logistical assistance.

TABLES

Table 4.1.--Summary statistics for censuses (n = 14) of Hawaiian monk seals at Lisianski Island from April 21 to July 8, 1995.

Size/Sex	Mean number of individuals	Standard deviation
Adults	45.5	5.6
Male	19.7	5.2
Female	16.6	5.7
Unknown	9.2	6.3
Subadults	13.7	5.1
Male	6.4	2.8
Female	4.5	2.7
Unknown	2.9	2.4
Juveniles	7.5	2.2
Male	3.1	1.4
Female	3.0	1.7
Unknown	1.4	1.9
Pups	10.9	2.8
Male	4.4	1.9
Female	5.2	2.1
Unknown	1.2	1.2
Nonpup Total	66.7	7.0
Grand Total	77.6	9.1

Table 4.2.--Composition of the Hawaiian monk seal population at Lisianski Island during the spring and summer of 1995. Includes all pups born during the calendar year.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	79	49	0	128	1.6:1
Subadults	24	17	0	41	1.4:1
Juveniles	13	15	0	28	0.9:1
Pups	10	10	2	22	1.0:1
Nonpup Total	116	81	0	197	1.4:1
Grand Total	126	91	2	219	1.4:1

Table 4.3.--Summary of tagged known-age seals born at Lisianski Island and resighted there in 1995.

Age (years)	Sex	Number originally tagged	Number resighted in 1995
13	Male	7	3
	Female	6	2
12	Male	6	2
	Female	18	7
11	Male	10	4
	Female	5	2
10	Male	5	2
	Female	9	2
9	Male	11	5
	Female	9	4
8	Male	12	2
	Female	6	1
7	Male	10	5
	Female	8	6
6	Male	--	--
	Female	--	--
5	Male	8	4
	Female	9	4
4	Male	9	6
	Female	6	4
3	Male	13	7
	Female	8	6
2	Male	4	2
	Female	9	5
1	Male	4	3
	Female	5	4

Table 4.4a.--Summary of Hawaiian monk seals born at Lisianski Island in 1995.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	10	10	2	22
Died prior to weaning	1	0	2	3
Still nursing	2	0	0	2
Weaned	7	10	0	17
Tagged	7	10	0	17

Table 4.4b.--Summary of nursing periods and measurements of weaned pups at Lisianski Island in 1995. Nursing periods were calculated where both birth and weaning date ranges were ≤4 days. All measurements were taken within 2 weeks after weaning, and include two prematurely weaned male pups that nursed 17 and 24 d.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	33.9	101.4	121.6
St. Dev.	10.1	12.4	8.5
n	9	14	14

Table 4.5a.--Known movement of Hawaiian monk seals to Lisianski Island from other locations in 1995, summarized by movements between two locations. No seals made more than one trip.

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

Table 4.5b.--Known movement of Hawaiian monk seals from Lisianski Island to other locations in 1995, summarized by movements between two locations. No seals made more than one trip.

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

Table 4.6.--Factors affecting Hawaiian monk seal survival at Lisianski Island in 1995.

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

[a]A seal with a minor male mounting injury was also attacked by a shark.
[b]Seal was attacked on 1 and 9 May. This seal was thin when first attacked, and emaciated when last sighted.
[c]Seal escaped by itself.
[d]Seal(s) released by observers.
[e]Prematurely weaned pup.

CHAPTER 5. THE HAWAIIAN MONK SEAL ON PEARL AND HERMES REEF, 1995

John R. Henderson, Patience Browne, Kathleen M. O'Brien, and Chad A. Yoshinaga

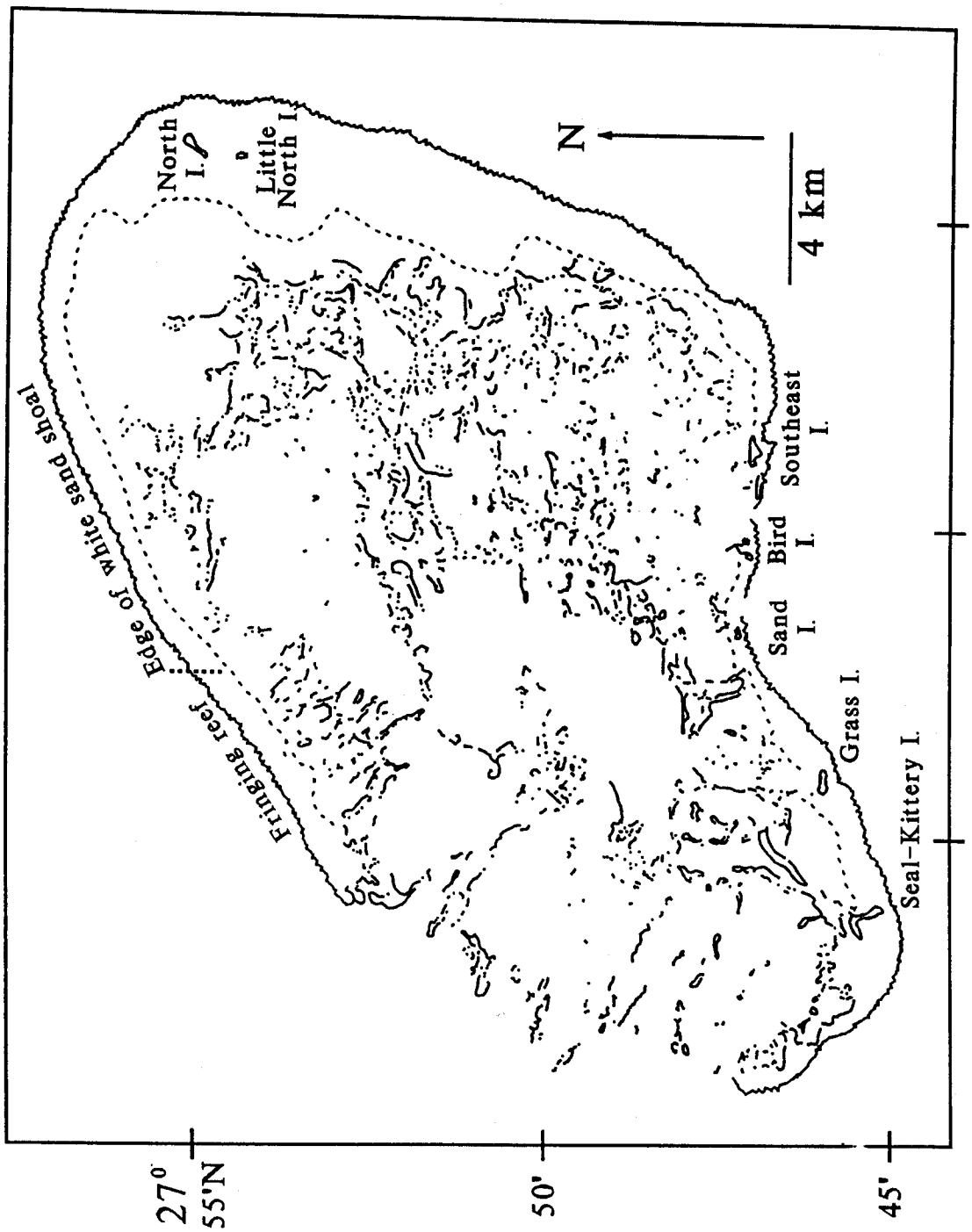

Fig. 5.1. Pearl and Hermes Reef in the Northwestern Hawaiian Islands.

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 is composed of four vegetated and three nonvegetated sand islands enclosed in a fringing reef (Fig. 5.1).

RESEARCH

Research was conducted by the National Marine Fisheries Service during July 16-August 31. Incidental data was also collected on a single day, May 15. The perimeters of the four larger vegetated islands were divided into sectors using natural landmarks. In 1995, the research objective for the Pearl and Hermes monk seal population was to conduct basic population research as outlined in Chapter 1.

Censuses and Patrols

Atoll censuses (n = 10) were conducted every 3 d, on average, during July 25-August 24, beginning at 1000 Hawaiian Standard Time and continuing for approximately 6 h. 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.

Individual Identification

A total of 230 individuals (203 excluding pups) were identified by existing or applied tags, scars, or natural markings. All weaned pups (n = 27) were tagged with Temple Tags and passive integrated transponder (PIT) tags. Twenty-five immature seals (10 male, 15 female) were also tagged with Temple Tags and PIT tags.

Collection of Samples

Sixty-five scat and spew samples were collected. Tissue samples were collected from 52 seals during tagging. Two skeletal samples were collected. In total, 678 pieces of potentially entangling debris were inventoried and destroyed.

RESULTS

Population Abundance and Composition

The means (± SD) for ten atoll censuses were 91.3 seals (± 15.0) including pups, and 80.8 seals (± 13.0) excluding pups (Table 5.1). The total summer population was 225 individuals, 198 excluding pups (Table 5.2). The sex ratios of nonpup immature seals and adults were 1.1:1 (47 males:41 females) and 1.0:1 (56 males:54 females), respectively.

The numbers of tagged known-age seals born at Pearl and Hermes Reef during the period from 1983 to 1994 and resighted there in 1995 are summarized in Table 5.3.

Reproduction

At least 27 pups were born, and all survived to weaning (Table 5.4). Measurements of weaned pups are summarized in Table 5.4.

Interatoll Movement

Interatoll movement was documented for 15 seals that made 19 movements between Pearl and Hermes Reef and either Kure Atoll, Laysan Island, Lisianski Island, or Midway Atoll (Tables 5.5a and b).

Factors Affecting Survival

Entanglement, mounting attempts by males, and unknown factors resulted in three life-threatening conditions (Table 5.6). In addition to the incidents presented in Table 5.6, a juvenile female seal was observed to have acquired an entanglement scar since 1993. The mummified skull of a subadult was found on Little North Island, and skeletal remains and pelage of an adult seal were found awash in association with a pile of debris at Southeast Island, but it is not known if these seals died in 1995.

ACKNOWLEDGMENTS

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

TABLES

Table 5.1.--Summary statistics for atoll censuses (n = 10) of the Hawaiian monk seal at Pearl and Hermes Reef, July 25-August 24, 1995.

Size/Sex	Mean number of individuals	Standard deviation
Adults	39.2	5.2
Male	17.7	4.5
Female	15.8	2.3
Unknown	5.7	3.8
Subadults	24.8	6.3
Male	12.3	3.3
Female	9.0	2.6
Unknown	3.5	1.8
Juveniles	16.7	5.0
Male	6.9	2.2
Female	7.4	3.3
Unknown	2.4	2.4
Pups	10.5	3.4
Male	6.7	1.7
Female	2.8	1.5
Unknown	1.0	1.4
Nonpup Total	80.8	13.0
Grand Total	91.3	15.0

Table 5.2.--Composition of the Hawaiian monk seal population at Pearl and Hermes Reef during the summer of 1995.

Size	Number of seals			Sex ratio male:female
	Male	Female	Total	
Adults	56	54	110	1.0:1
Subadults	29	20	49	1.5:1
Juveniles	18	21	39	0.9:1
Pups	16	11	27	1.5:1
Nonpup Total	103	95	198	1.1:1
Grand Total	119	106	225	1.1:1

Table 5.3.--Summary of tagged known-age seals born at Pearl and Hermes Reef and resighted there in 1995.

Age (years)	Sex	Number originally tagged	Number resighted in 1995
12	Male	8	4
	Female	2	1
11	Male	5	4
	Female	8	2
10	Male	9	4
	Female	6	3
9	Male	10	2
	Female	7	5
	Unknown	1	0
8	Male	14	9
	Female	7	3
7	Male	12	10
	Female	6	2
6	Male	8	6
	Female	6	4
5	Male	5	4
	Female	1	1
4	Male	10	9
	Female	11	7
3	Male	13	10
	Female	10	8
2	Male	14	7
	Female	7	5
1	Male	--	--
	Female	--	--

Table 5.4a.--Summary of Hawaiian monk seals born at Pearl and Hermes Reef in 1995.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	16	11	0	27
Died prior to weaning	0	0	0	0
Still nursing	0	0	0	0
Weaned	16	11	0	27
Tagged	16	11	0	27

Table 5.4b.--Summary of nursing periods and measurements of weaned pups at Midway Atoll in 1995. All measurements were taken within 2 weeks after weaning.

	Axillary girth (cm)	Straight dorsal length (cm)
Mean	109.7	131.5
St. Dev.	3.2	0.7
n	2	2

Table 5.5a.--Known movement of Hawaiian monk seals to Pearl and Hermes Reef from other locations in 1995, summarized by movements between two locations. Some seals made more than one trip.

Original location	Number, size, and sex class
Kure Atoll	1 adult male, 4 adult females, 1 juvenile male
Laysan Island	1 adult female
Midway Atoll	2 adult females, 1 subadult male, 1 juvenile male

Table 5.5b.--Known movement of Hawaiian monk seals from Pearl and Hermes Reef to other locations in 1995, summarized by movements between two locations. Some seals made more than one trip.

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

Table 5.6.--Factors affecting Hawaiian monk seal survival at Pearl and Hermes Reef in 1995.

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

[a]Seal released by observers.
[b]Seal unilaterally blinded by fresh injury of unknown cause.

CHAPTER 6. THE HAWAIIAN MONK SEAL AT MIDWAY ATOLL, 1995

L. L. Eberhardt, K. V. Eberhardt, W. G. Gilmartin,
Lucy W. Keith, and R. Lance Jeffery

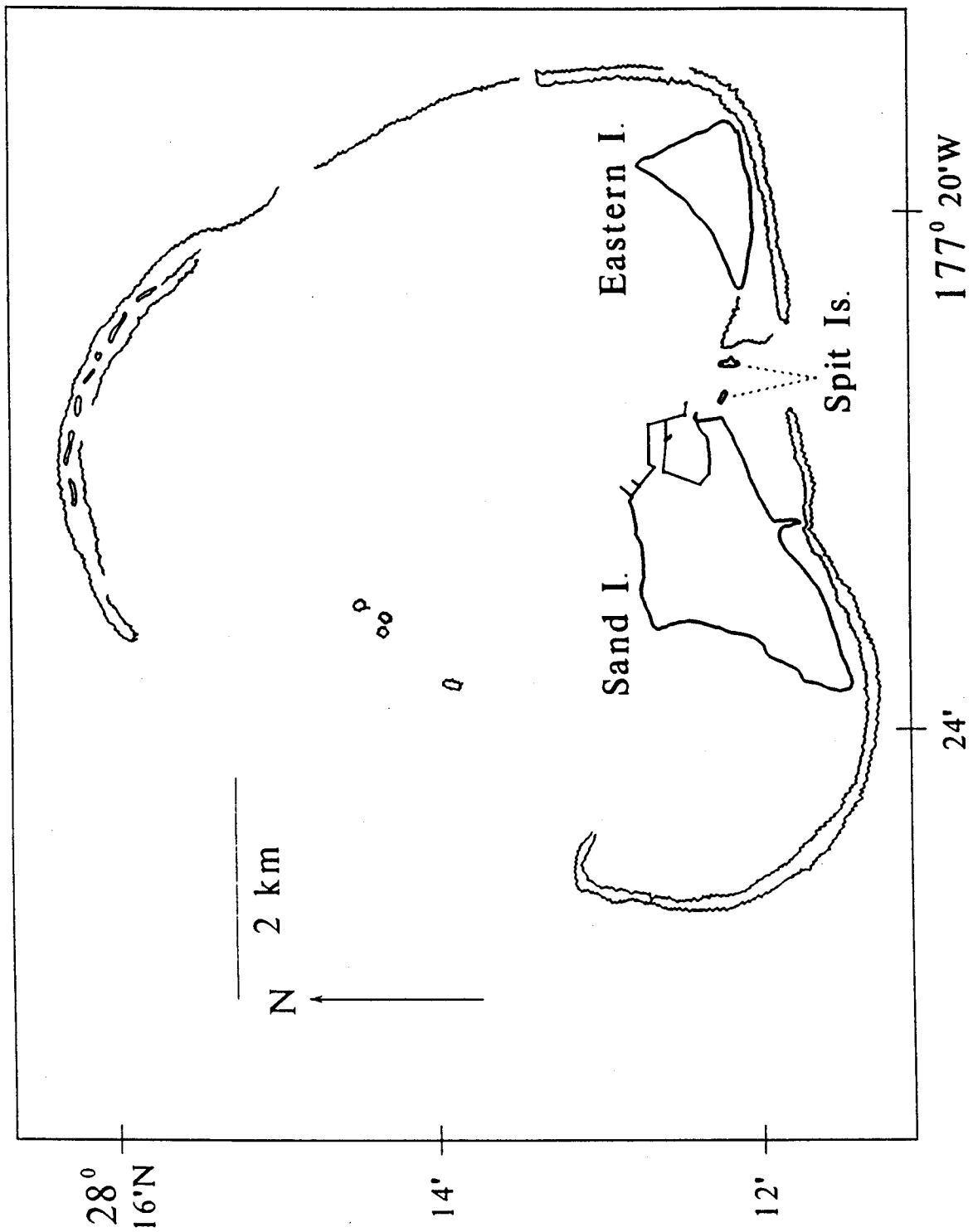

Fig. 6.1. Midway Islands in the Northwestern Hawaiian Islands.

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. The Navy is in the process of vacating the atoll, and primary management authority will be transferred 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 due to an influx of immigrants from nearby sites (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

Research was conducted by collaborating scientists during March 31-April 28, and by the National Marine Fisheries Service during August 4-18. Incidental observations were recorded by USFWS personnel during the rest of the year. The perimeters of the three permanent islands were divided into sectors using artificial or natural landmarks. In 1995, research objectives specific to Midway Atoll included the identification of all seals in the resident population, estimation of the proportion identified using sighting probability calculations, blood sampling for a disease survey of the wild population, and tagging pups and other untagged seals.

Censuses and Patrols

Atoll censuses (n = 9) were conducted every 3 d, on average, from April 3 to April 27. Each atoll census began between 1100 and 1310 Hawaii standard time, and ended between 1530 and 1700. All islands were censused on foot by one or two persons. Beach counts of Sand Island (n = 8), Eastern Island (n = 2), or Spit Island (n = 1) were conducted on non-atoll census days during April 1-April 28 to identify and resight seals.

Individual Identification

A total of 47 individuals (41 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings; 42 seals were identified during the period from March 31 to April 28, and an additional 5 seals were identified in August. Most weaned pups (n = 8) were tagged with Temple Tags; 2 of these same pups were tagged with passive integrated transponder (PIT) tags. Three juvenile seals (one male, two female) were tagged with Temple Tags. Five adult seals (two male, three female) were tagged, and one adult female was retagged with Temple Tags and PIT tags.

Collection of Samples

Tissue samples were collected from four weaned pups and three juvenile seals during tagging. Blood samples were collected from six adult seals during tagging or retagging.

Special Studies

Sighting Probability Calculations

Probability calculations suggested that the 42 seals identified during March 31-April 28 may have been virtually the entire "population" using Midway Atoll at that time, but there may have been 1 or 2 other seals undetected.

Disease Survey

Blood samples were collected from six adult seals during tagging or retagging as part of a disease survey of the wild population. All seals appeared healthy, although an adult male had a corneal opacity, and an adult female had an inflamed nictating membrane.

RESULTS

Population Abundance and Composition

The means ($\pm$ SD) for nine atoll censuses were 16.0 seals ($\pm$ 3.1) including pups, and 11.7 seals ($\pm$ 2.4) excluding pups (Table 6.1). The total spring-summer population was 47 seals, 38 excluding pups (Table 6.2). This total includes the population observed at Midway Atoll during March 31-April 28 (42 seals) and an additional 5 seals identified in August.

The estimation of population abundance is confounded by movement of seals among Midway Atoll, Kure Atoll, and Pearl and Hermes Reef. Because of the relatively short study period, 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 Atoll.

The numbers of tagged known-age seals born at Midway Atoll during the period from 1988 to 1994 and resighted there in 1995 are summarized in Table 6.3.

Reproduction

At least nine pups were born, and all survived to weaning (Table 6.4a). Measurements of weaned pups are summarized in Table 6.4b.

Interatoll Movement

Interatoll movement was documented for twelve seals that made 18 movements between Midway Atoll and either Pearl and Hermes Reef or Kure Atoll (Tables 6.5a and b).

Factors Affecting Survival

Entanglement led to three life-threatening conditions (Table 6.6). Two subadults (one male, one female) and one juvenile female were entangled and 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 W. H. Seto, Biologist, and Kenneth R. Niethammer, Refuge Manager. We also thank the officers and crew of the NOAA ship *Townsend Cromwell* for logistical assistance.

TABLES

Table 6.1.--Summary statistics for atoll censuses (n = 9) of Hawaiian monk seals at Midway Atoll from April 3 to April 27, 1995.

Size/Sex	Mean number of individuals	Standard deviation
Adults	5.1	2.4
Male	1.3	0.9
Female	3.8	1.9
Unknown	0.0	0.0
Subadults	3.8	1.1
Male	0.3	0.5
Female	3.4	1.1
Unknown	0.0	0.0
Juveniles	2.8	0.7
Male	1.1	0.3
Female	1.7	0.5
Unknown	0.0	0.0
Pups	4.3	1.1
Male	0.8	0.4
Female	1.7	0.5
Unknown	1.9	1.1
Nonpup Total	11.7	2.4
Grand Total	16.0	3.1

Table 6.2.--Composition of the Hawaiian monk seal population at Midway Atoll during the spring and summer of 1995.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	7	16	0	23	0.4:1
Subadults	2	8	0	10	0.3:1
Juveniles	3	2	0	5	1.5:1
Pups	1	7	1	9	0.1:1
Nonpup Total	12	26	0	38	0.5:1
Grand Total	13	33	1	47[a]	0.4:1

[a]A total of 42 seals were present in the Midway Atoll population during March 31-April 28. Five additional seals were observed August 4-18 (2 adult males, 1 adult females, and 2 female pups).

Table 6.3.--Summary of tagged known-age seals born at Midway Atoll and resighted there in 1995.

Age (years)	Sex	Number originally tagged	Number resighted in 1995
7	Male	0	NA
	Female	1	0
4	Male	1	1
	Female	1	1
3	Male	0	NA
	Female	1	1
2	Male	1	0
	Female	0	NA
1	Male	0	NA
	Female	0	NA

Table 6.4a.--Summary of Hawaiian monk seals born at Midway Atoll in 1995.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	1	7	1	9
Died prior to weaning	0	0	0	0
Weaned	1	7	1	9
Tagged	1	6	1	8

Table 6.4b.--Summary of nursing periods and measurements of weaned pups at Midway Atoll in 1995. All measurements were taken within 2 weeks after weaning.

	Straight dorsal length (cm)
Mean	139.5
St. Dev.	12.4
n	4

Table 6.5a.--Known movement of Hawaiian monk seals to Midway Atoll from other locations in 1995, 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 subadult male, 1 subadult female, 2 juvenile males
Kure Atoll	2 adult males, 2 adult females, 1 subadult female

Table 6.5b.--Known movement of Hawaiian monk seals from Midway Atoll to other locations in 1995, summarized by movements between two locations. Some seals made more than one trip.

Destination	Number, size, and sex class
Pearl and Hermes Reef	2 adult females, 1 subadult male, 1 juvenile male
Kure Atoll	3 adult males, 2 adult females

Table 6.6.--Factors affecting Hawaiian monk seal survival at Midway Atoll in 1995.

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

[a]Seal released by observers.

CHAPTER 7. THE HAWAIIAN MONK SEAL AT KURE ATOLL, 1995

Lucy W. Keith and R. Lance Jeffery

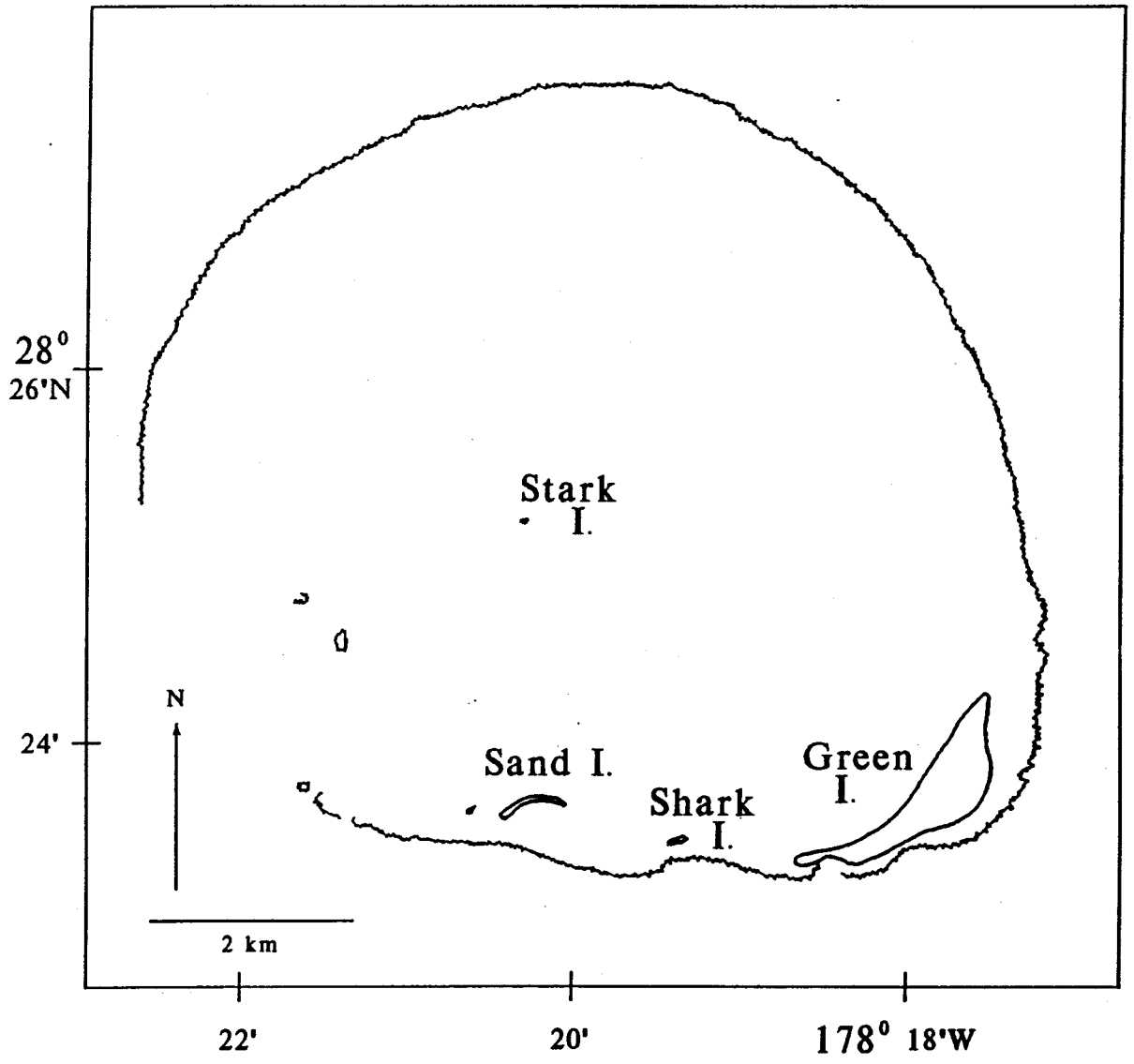

Fig. 7.1. Kure Atoll in the Northwestern Hawaiian Islands.

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 removal of buildings and other structures on Green Island.

RESEARCH

Research was conducted by the National Marine Fisheries Service during May 16-July 11. The perimeter of Green Island was divided into eight sectors, using artificial or natural landmarks. In 1995, research objectives for the Kure Atoll monk seal population included identification of all seals, evaluating the success of past management efforts (primarily seal introductions), and release of seals translocated from French Frigate Shoals (FFS).

Censuses and Patrols

Atoll censuses (n = 12) were conducted approximately every 4 d, weather permitting, from May 19 to July 6. Each census began between 1300 and 1400 Hawaii standard time and ended between 1445 and 1600. All islands were censused on foot by one or two persons. Stark Reef was not emergent during the 1995 field season. Patrols were conducted to identify seals and monitor locations used by parturient females.

Individual Identification

A total of 100 individuals (89 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. All weaned pups (n = 11) were tagged with Temple Tags, and passive integrated transponder (PIT) tags. Two juvenile seals (one male and one female) were also tagged with Temple Tags and PIT tags.

Collection of Samples

Fifty-seven scat and spew samples were collected. Tissue samples were collected from 11 weaned pups and 2 other seals during tagging. In total, 313 pieces of potentially entangling debris were inventoried; one entanglement item was removed from a seal and collected; the remainder were destroyed before the end of the field season.

Special Studies

Monitoring Impacts of Past Management Efforts

The Head Start Project (1981-91) and the Rehabilitation Project (1984-91) used a temporary enclosure, stocked with locally trapped live reef fish to enhance first-year survival of weaned female pups and to introduce rehabilitated yearlings from FFS (Gilmartin and Gerrodette, 1986). Due to logistical constraints imposed by closure of the USCG LORAN Station on Kure in 1992, both projects were discontinued and the enclosure was permanently removed. The Rehabilitation Project was resumed in 1993-94 with the introduction of yearling females from FFS. These animals were not maintained in a beach enclosure but were released directly from their cages onto the west beach of Green Island. In 1995, observers assessed the survival of weaned female pups and seals involved in the Head Start and Rehabilitation Projects in previous years to determine the effectiveness of these management efforts.

Introduction of Rehabilitated Seals

Seven weaned female pups were collected for rehabilitation in 1994 and released as yearlings in 1995. These animals were not maintained in any beach enclosure but were released directly from their cages onto the west beach of Green Island. All seven yearlings were released in May and resighted throughout the duration of the field effort.

RESULTS

Population Abundance and Composition

The means (± SD) for 12 atoll censuses were 48.8 seals (± 4.6) including pups, and 42.1 seals (± 4.1) excluding pups (Table 7.1). The total spring-summer population was 98 individuals, 87 excluding pups (Table 7.2). The numbers of tagged known-age seals born at Kure Atoll during the period from 1981 to 1994 and resighted there in 1995 are summarized in Table 7.3.

Reproduction

At least 11 pups were born and weaned (Table 7.4a). Nursing periods and measurements of weaned pups are summarized in Table 7.4b.) Of the 32 adult-sized females identified, a minimum of 11 were parturient (34%). Three of these 11 parturient females had been temporarily maintained as pups in the Kure Atoll Head Start enclosure (1 in 1982 and 2 in 1985), and none were rehabilitated seals from FFS introduced to Kure as yearlings via the Head Start enclosure.

Interatoll Movement

Interatoll movement was documented for 13 seals that made 17 movements between Kure Atoll and either Pearl and Hermes Reef or Midway Atoll (Table 7.5a and b).

Factors Affecting Survival

Mounting attempts by male seals and entanglement in debris resulted in three life-threatening conditions (Table 7.6). A post-mobbing aggregation of males was observed around an injured adult female. Two seals were entangled: a weaned pup was released by observers, and a nursing pup freed itself from net in the water.

ACKNOWLEDGMENTS

We acknowledge the support of the State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife, and the Aids to Navigation Branch of the 14th Coast Guard District, Coast Guard Air Station Barbers Point. We thank the captains and crew of the M/V *Glorita* and the NOAA ship *Townsend Cromwell* for logistical support and for transport to and from Kure Atoll. Special thanks are extended to Gordon Olayvar (State of Hawaii, Division of Forestry and Wildlife) for data collection; and to Steve Barclay (U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge), Dave Smith (State of Hawaii, Division of Forestry and Wildlife), and John Henderson for field assistance at Kure.

TABLES

Table 7.1.--Summary statistics for atoll censuses (n = 12) of Hawaiian monk seals at Kure Atoll from May 19 to July 6, 1995.

Size/Sex	Mean number of individuals	Standard deviation
Adults	23.3	1.9
Male	6.2	1.6
Female	12.1	1.8
Unknown	5.0	2.2
Subadults	9.5	3.2
Male	2.7	1.6
Female	4.4	2.1
Unknown	2.4	1.8
Juveniles	9.3	1.9
Male	1.9	1.1
Female	6.3	1.3
Unknown	1.2	1.4
Pups	6.7	1.7
Male	2.7	1.1
Female	3.7	1.4
Unknown	0.3	0.5
Nonpup Total	42.1	4.1
Grand Total	48.8	4.6

Table 7.2.--Composition of the Hawaiian monk seal population at Kure Atoll during the spring and summer of 1995. Includes all pups born during the calendar year.

Size	Number of seals			Sex ratio male:female
	Male	Female	Total	
Adults	20	32	52	0.6:1
Subadults	8	11	19	0.7:1
Juveniles	7	9[a]	16	0.8:1
Pups	6	5	11	1.2:1
Nonpup Total	35	52	87	0.7:1
Grand Total	41	57	98	0.7:1

[a]Number includes 7 rehabilitated yearlings released at Kure Atoll in May, 1995.

Table 7.3.--Summary of tagged known-age seals born at Kure Atoll and resighted there in 1995.

Age (years)	Sex	Number originally tagged	Number resighted in 1995
14	Male	3	2
	Female	5	1
13	Male	1	0
	Female	3	2
12	Male	4	2
	Female	0	NA
11	Male	4	1
	Female	2	2
10	Male	2	1
	Female	3	2
9	Male	1	1
	Female	0	NA
8	Male	1	1
	Female	3	2
7	Male	2	2
	Female	5	2
6	Male	5	3
	Female	4	1
5	Male	3	0
	Female	3	2
4	Male	7	4
	Female	6	4
3	Male	5	4
	Female	8	4
2	Male	9	5
	Female	4	2
1	Male	3	0
	Female	0	NA

Table 7.4a.--Summary of Hawaiian monk seals born at Kure Atoll in 1995.

Event	Number of pups		
	Male	Female	Total
Born	6	5	11
Died prior to weaning	0	0	0
Weaned	6	5	11
Tagged	6	5	11

Table 7.4b.--Summary of nursing periods and measurements of weaned pups at Kure Atoll in 1995. Nursing periods were calculated where both birth and weaning date ranges were ≤4 d. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	40.5	98.8	143.9
St. Dev.	2.2	6.1	8.3
n	3	6	6

Table 7.5a.--Known movement of Hawaiian monk seals to Kure Atoll from other locations in 1995, 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 subadult male
Midway Atoll	3 adult males, 2 adult females

Table 7.5b.--Known movement of Hawaiian monk seals from Kure Atoll to other locations in 1995, 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, 1 juvenile male
Midway Atoll	2 adult males, 2 adult females, 1 subadult female

Table 7.6.--Factors affecting Hawaiian monk seal survival at Kure Atoll in 1995.

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

[a]A post-mobbing aggregation of 5 males was observed.
[b]Seal released by observers.
[c]Seal escaped by itself.

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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 1995 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	Cal	?	%	?		Line No.	Dist	Behavior			Type	Codes
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								

NOTES:

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
15																								
16																								
17																								
18																								
19																								
20																								
21																								
22																								
23																								
24																								
25																								
26																								
27																								
28																								
29																								
30																								

NOTES:

1995
CENSUS FORM DIRECTIONS

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 1995).
P = Patrol: A complete, untimed count where size, sex, ID and disturbance are recorded.
I = Incidental observations. (limit these).
T = Tag status entry for non-active tags (tags not currently on a seal). Record tag status 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 1 person conducts the census, then combine page numbers; person A has pages 1 and 2, while person B has pages 3 and 4 of a four-page census day.

ISLAND Name of island and atoll, e.g., East, FFS

OBSERVER Three initials. If no middle initial, use the first and last block.

TIME BEGIN and **END** On a 24-h clock, e.g., 6 p.m. = 1800, for the group of pages.

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

NUMBER Censuses and patrols may be assigned numbers at your discretion. (3 digits). Atoll counts must be numbered, starting with 001.

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

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.

TIME The time should be recorded for each seal sighting, on a 24-h 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:

Juvenile — Sort, slight seals from the length of a weaned pup (about 138 cm) to 20-30 cm longer, including yearlings, and perhaps younger seals, up to perhaps 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 likely from 3 or 4 to 5 or 6 years.

Adult — Repropductively 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 ≤ 2 wks ago and < 90cm girth)
W = Weaned pup

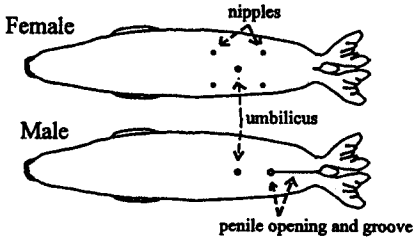
Immatures
I = Immature
J = Juvenile
J1 = Juvenile I
J2 = Juvenile II
S = Subadult
S3 = Subadult III
S4 = Subadult IV

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)

SEX
M = Male
F = Female
U = Unknown



BEACH POS. Location of seal or turtle <u>when observer comes abreast</u> <u>of animal</u> (e.g., if seal is seen in the water from a distance and yet is on the beach when the observer come abreast, the seal is recorded as being on the beach). When recording male-male interactions (at Laysan and Lisianski Islands in 1995), 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 post-partum and post-weaning, regardless of data type. Always note condition when recording a survival factor.

Condition codes:
M = medium
P = probably pregnant
F = fat
T = thin
X = data not taken
If the condition code is left **blank**, 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 temporary numbers.

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 #)
blank = number is certain and complete if present

PERMANENT ID NO. Record the 4 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. 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 the last 5 digits of a 10 digit PIT tag (put all 10 digits in the notes).

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)	P = plastic, Riese
G = green (Lisianski)	C = clear, PIT tag
B = blue (Pearl & Hermes)	
K = silver/gray (Kure)	
R = red (Midway, Necker, Nihoa, Main Islands)	

? column:

0 = seal is definitely not tagged
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 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 nursing pups

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.

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 ≤2 body lengths
2 = seal alerted to observer and moved >2 body lengths
3 = seal alerted to observer and fled into water

ASSOCIATION DATA Use continuation lines to record more than one association. Don't record associations involving turtles. Record detailed association data at Laysan and Lisianski Islands in 1996. At other locations, record mother-pup pairs and unusual events. At all locations except Laysan and Lisianski Islands, the X code will be filled in by computer to indicate that standard association data was not recorded on Census or Atoll Count.

Active associations
1) noted for all except behaviors between mother and nursing pup
2) must take place within 30 m of observer
3) subjects may be any distance apart

Spatial associations
1) noted as observer comes abreast of the subject
2) 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
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 N, X, and Q should not appear together with other behaviors. Behaviors B and M require distance = 0. With the exception of 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
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*
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

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) optional codes

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 2 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)
B = birth, 1st sighting post-partum (mom and pup)
G = seal is green with algae
H = handwritten notes
M = marked, bleach number 1st applied/re-applied post-molt
W = weaning, 1st sighting post-weaning (pup)
X = pup exchange, 1st sighting after exchange (mom and pup)
Y = disturbance is to "bystander" seal during non-survey activity such as tagging.

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 dead, always record factor type "D" on ORIGINAL LINE. For mobbings/ harassments, always code
TYPE	**CODES COLUMN**	**CONTENT**
		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

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 = capture
- F = free/release from captivity
- O = other

P = photo

RECORD IMPORTANT DESCRIPTIONS AND ANY NON-SEAL PHOTOS IN HAND- WRITTEN NOTES, AND TRANSFER TO THE PHOTO COMMENT FORM.

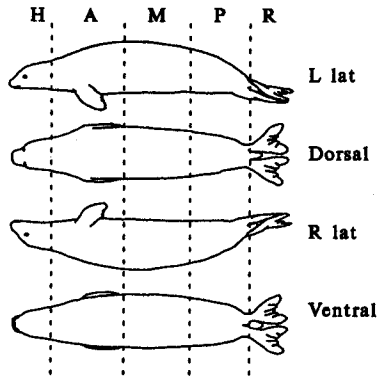
1 Type of photo
- S = slide
- P = print

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

TYPE	CODES COLUMN	CONTENT
		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 fore- flippers 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
T = tag condition		RECORD HERE FOR ACTIVE TAGS (TAGS ON SEALS) ONLY
	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 Riese and 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



TYPE	CODES COLUMN	CONTENT
	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

Additional notes:

1. All original monk seal data should be coded in pencil. Never erase data once you have left the recording site. Instead, cross errors out with a single line. Field editing 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 you 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.

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

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

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

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

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

7. Record all tag sightings explicitly (i.e., both left and right tag numbers) at least once during your stay. When a pup is tagged, record the 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.

8. Be sure to code the <u>original</u> 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

9. **Always record disturbance**. 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. At locations other than Laysan and Lisianski

Islands, it is not assumed that association data will be taken on census or atoll count in 1995. Thus, on a census or atoll count sheet from these other locations, no code in any of the association columns means that data was not taken, and an X code will be filled in by computer. If you wish to indicate that a seal was alone, use the O behavior code. At Laysan and Lisianski Islands in 1995, it is assumed that behavioral data will be taken on census (and during behavior patrol). Thus, on a census or behavior patrol data sheet from Laysan or Lisianski Island, no code in any of the association columns means that the seal was alone, whereas on a regular patrol data sheet from the same location, 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.

10. An association should either be all blank or have the O, Z, or X behavior only, with no line number or distance, or have a line number, a distance, and some behavior code (other than O or X) all present. Don't record behaviors of an animal after it has been disturbed by the observer.

11. 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).

12. 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.

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

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**

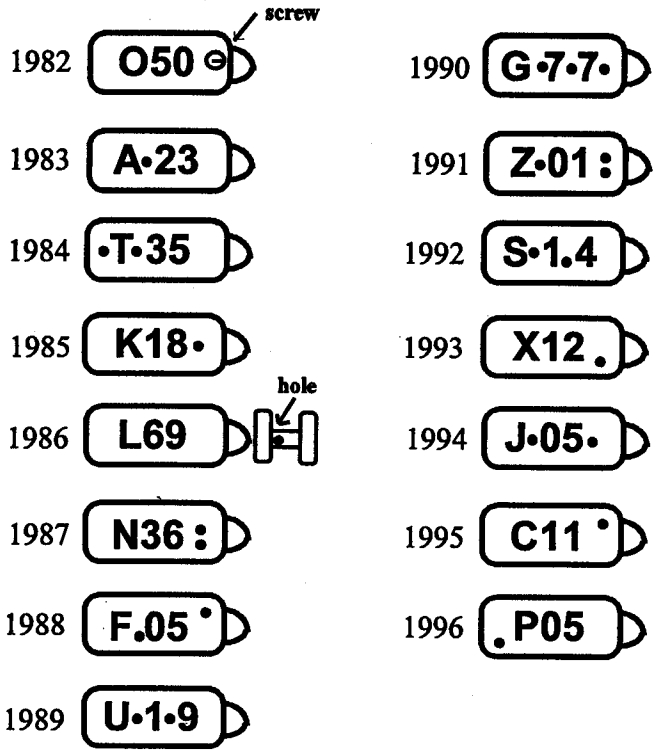
3. Definition of a male-male contest (must conform to at least one condition below):

   - 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:

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

HAWAIIAN MONK SEAL TEMPLE TAGS:
NUMBERING SCHEME AND HOLE DRILLING PATTERN FOR TAGS APPLIED TO WEANED PUPS



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 T/P	ID No.	ID ?	TAG No.	TAG L/R	TAG Col	TAG ?	MOLT %	MOLT ?	Disturb	ASSOCIATION Line No.	ASSOCIATION Dist	ASSOCIATION Behavior	Notes	Notes	EVENT Type	EVENT Codes
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2																								
3																								
4																								
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Line No.	Continue	Time	Sector	Size	Sex	Beach Pos	Condition	ID			TAG				MOLT		Disturb	ASSOCIATION			Notes	Notes	EVENT	
								T/B	No.	?	No.	L/R	Col	?	%	?		Line No.	Dist	Behavior			Type	Codes
15																								
16																								
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