

# NOAA Technical Memorandum NMFS



MARCH 1999

## THE HAWAIIAN MONK SEAL IN THE NORTHWESTERN HAWAIIAN ISLANDS, 1996

Thea C. Johanos  
Timothy J. Ragen

NOAA-TM-NMFS-SWFSC-259

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

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## NOAA Technical Memorandum NMFS

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NOAA-TM-NMFS-SWFSC-259

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## EXECUTIVE SUMMARY

In 1996, field studies of the endangered Hawaiian monk seal (*Monachus schauinslandi*) were conducted at all of its main reproductive sites in the Northwestern Hawaiian Islands. These studies provide information necessary to evaluate (1) the status and trends of monk seal populations, (2) natural history traits such as survival, reproduction, growth, behavior, and feeding habits, and (3) the success of various activities designed to facilitate population growth.

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

Since 1983, the total number of pups born annually 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 1996, 207 pups were counted at these sites, 94 of which were born at French Frigate Shoals. Mean beach counts from the main reproductive sites (again, excluding Midway Atoll), totaled 381 seals excluding pups, and have remained essentially unchanged since 1993 (Fig. 1b).

Since the mid 1980s, adults have comprised a growing portion of the animals counted (Fig. 1c) and, in 1996, the composition of the counts remained skewed toward adults. This shift in composition bodes poorly for reproduction in the near future if older adult females are not replaced by young females reaching reproductive age. The overall impact from this shift in composition will be determined by the magnitude of its change and the length of time that the resulting skewed distribution persists, neither of which can be reliably predicted at this time. High mortality of immature seals appears to be a major factor leading to the shift in composition, particularly at French Frigate Shoals and Laysan Island.

In 1996, two management activities were conducted by the Marine Mammal Research Program (Honolulu Laboratory, National Marine Fisheries Service) to enhance recovery of the species. First, debris capable of entangling seals was removed from all study sites and nineteen entangled seals were disentangled by field biologists. Second, debris was removed from a section of fringing reef at French Frigate Shoals to reduce hazards to the seal population, assess the extent of reef fouling, and determine the feasibility of a large scale debris removal effort.

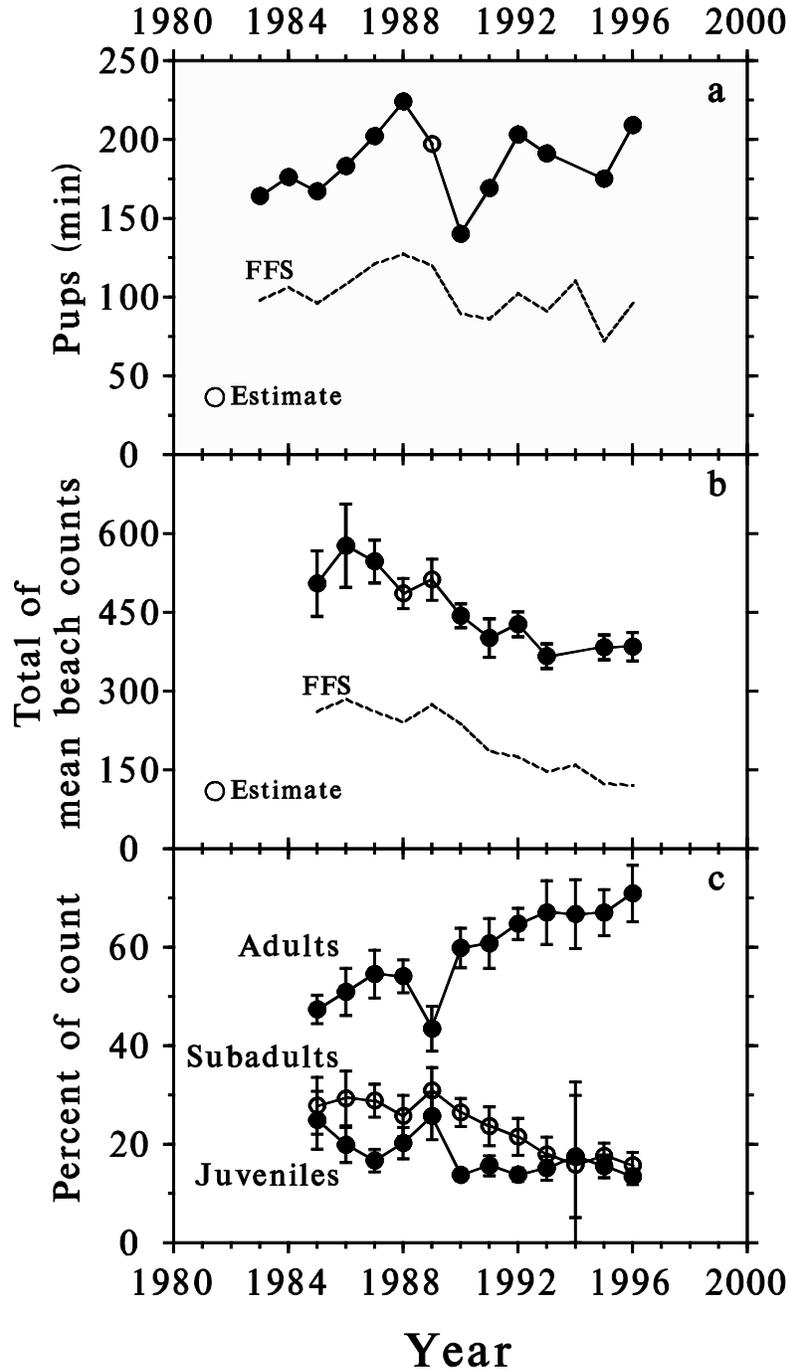


Fig. 1. Demographic trends of the Hawaiian monk seal, based on the main reproductive sites (excluding Midway Atoll). a) Number of pups born. b) Total of mean beach counts, excluding pups. c) Portion of the counts comprised of adults, subadults, and juveniles.

This document describes these and other field studies conducted during 1996. The format followed is intended to provide complete, standardized, and timely summaries of the research activities and findings at each study site. The ready availability of such information is essential for ongoing efforts to stop the decline of this species and enhance its recovery.



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## CHAPTER 1. GENERAL INTRODUCTION

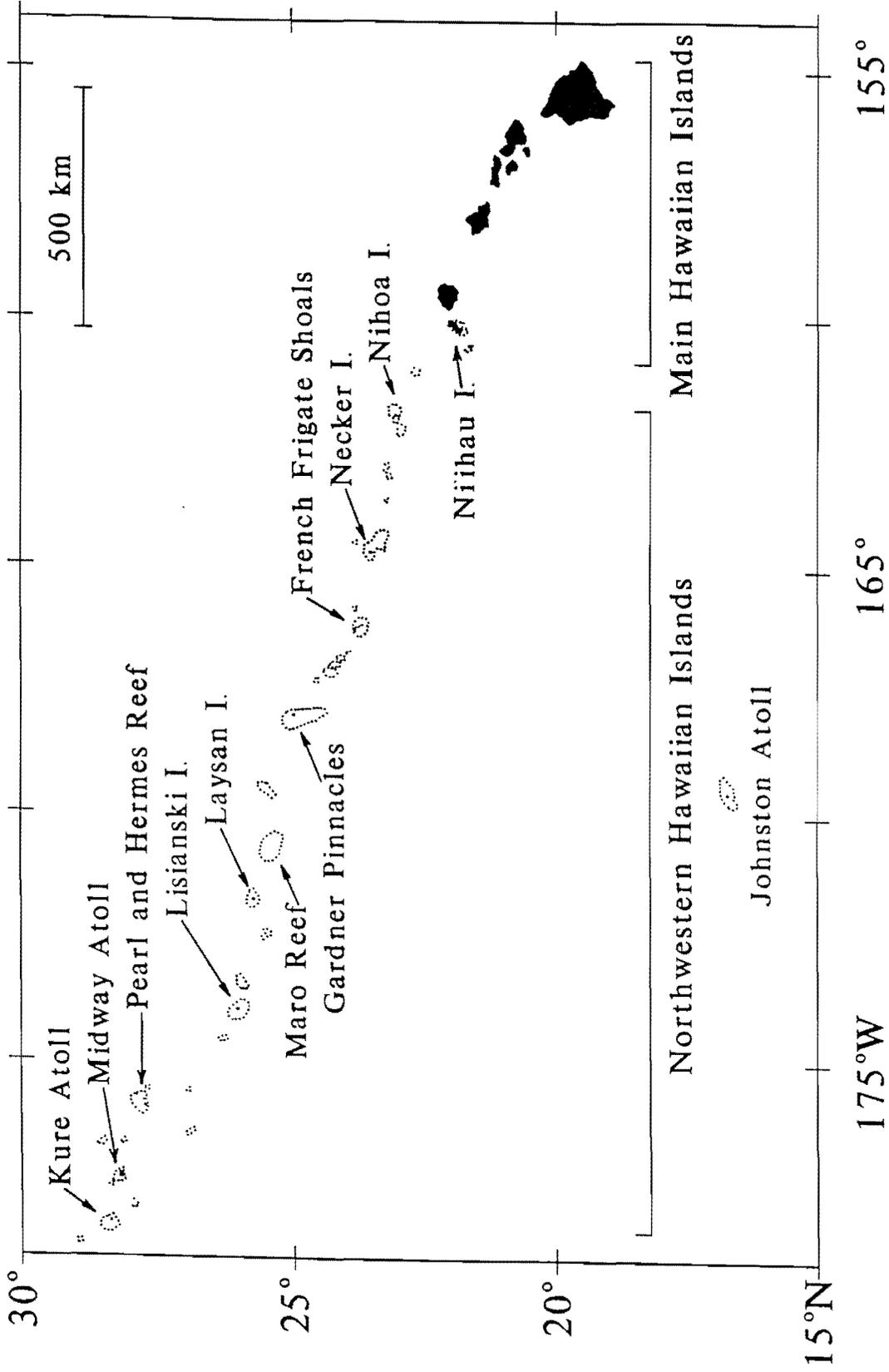


Fig. 1.1. The Hawaiian Archipelago.

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

The Marine Mammal Research Program began research on Hawaiian monk seals at most major reproductive sites in the NWHI during 1981 (Kure Atoll, Laysan Island, and Lisianski Island), 1982 (French Frigate Shoals (FFS) and Pearl and Hermes Reef), and 1983 (Midway Atoll). Nearly every year thereafter, field camps of several days to 9 months were established to monitor and enhance the recovery of this species. Limited population monitoring has also been conducted at Nihoa and Necker Islands, where pup production is spatially limited by availability of haulout area. Reports summarizing past NMFS research are listed in Appendix A.

In 1996, 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 1996 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 three times at Nihoa Island, once each at Necker Island and Gardner Pinnacles, or every 2 to 7 days (at all other locations), starting at 1300 Hawaii standard time when possible, using census methods and criteria outlined in Johanos et al. (1987). Atoll-wide counts for locations with more than a single island (French Frigate Shoals, Pearl and Hermes Reef, Midway 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 were recorded. Because parturient females will nurse pups other than their own (Boness, 1990), efforts were made to identify pups and document changes in nursing relationships from birth to weaning. A pup exchange occurred when the pups of two lactating females were switched. Most frequently, such exchanges occurred during an aggressive interaction between the two females. On other occasions, a mother and pup became separated, and one or both seals then actively sought and obtained another nursing relationship.

The average nursing period was calculated for the pups at each location. The average lactation period of parturient females was also calculated for seals at FFS because higher population density and frequent pup exchanges (Boness, 1990) made it difficult to track individual pups and determine their nursing period. Nursing or lactation periods were defined as the number of days from birth until the end of the last nursing relationship. Temporary breaks in nursing relationships were not subtracted from the total. When the exact birth or weaning date was not known, but occurred within a range of 4 days or less, then the midpoint of that range was used as the start or end date for 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 were 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  $\geq$ 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  $\geq$ 5 cm; or (4) densely spaced (overlapping) scratches, abrasions, or lacerations covering an area equivalent to half the dorsum, or evidence of extensive underlying tissue damage (e.g., an uneven or darkened surface of the injured area, leaching fluids, or impaired seal movement). We did not include injuries that were healed when first observed.

A seal was listed as dead if its death or carcass was observed. Deaths summarized here include carcasses found at the beginning of the field season if the seal had clearly died during the calendar year. A seal was listed as probably dead if it

sustained severe injuries or was emaciated (with skeletal structure clearly evident) and subsequently disappeared. In addition, one of the following conditions must have been satisfied to place a seal in the "probably dead" category: (1) the seal was lethargic, had difficulty moving, or floated listlessly in the water, and disappeared more than a week before the end of data collection, or (2) the seal was in deteriorating condition (loss of weight, enlargement of abscesses, sloughing of skin) and disappeared at least 10 surveys or 1 month before the end of data collection (whichever was longer). Nursing pups were listed as probably dead if they disappeared within 3 weeks of birth.

Mobbing and other mating-related male aggressions were observed and recorded. By definition, mobbing occurred when multiple males attempted to mate with a single seal, usually an adult female or immature seal of either sex, causing injury or death of that seal (e.g., Alcorn, 1984). Mating-related aggression was defined as any incident where an adult or subadult male repeatedly bit the dorsum, attempted to mount, and tried to prevent the escape of another seal. These incidents were summarized if they simultaneously involved more than one male aggressor or resulted in at least one puncture or gaping wound (missing skin or extending into the blubber layer) or  $\geq 15$  scratches to the dorsum or flanks. Post-mobbing aggregations were also summarized: these were groups of males congregated on the beach, attending a seal with new mounting injuries as described above.

### **Individual Identification**

During censuses and patrols, individual seals were identified by tags, bleach marks, scars, or natural markings. After weaning, all pups were tagged on each hind flipper with a colored plastic Temple Tag,<sup>1</sup> 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, 1984 at French Frigate Shoals, and 1995 at Midway Atoll. Pups at Midway Atoll, Necker and Nihoa Islands, and the main Hawaiian Islands have been tagged opportunistically since 1983. Since 1991, PIT tags have

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<sup>1</sup>Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

also been implanted subcutaneously in the dorsum of most weaned pups.

In 1996, 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 and Lisianski Islands, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll), seals were bleach-marked for individual identification (Stone, 1984), using the solution described in Johanos et al. (1987). Molting seals were re-marked to maintain their identities. At Laysan and Lisianski Islands, nursing pups were also bleached prior to molt.

Tags, scars, natural markings, and any applied bleach marks were sketched on an individual scar card, which was revised throughout the field season to maintain a current description of the identifying marks of each seal. Photographs of scars and natural markings were added to individual identification files begun during 1981 or 1982.

Population size and composition were determined at locations where all seals were identified; partial composition was determined where all seals within certain size and sex classes were identified. These statistics included all individuals seen alive at the location during the interval from March through August and all pups born during the year. Captive seals were included if they were released in the current year. If a seal was seen at more than one location during March-August, it was included in the population where it was 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 1 month). This is particularly true at Midway Atoll, where a number of the observed seals were tagged at other locations (primarily Kure Atoll and Pearl and Hermes Reef). These seals may be transient visitors, and additional study is needed to distinguish them from seals that reside at Midway Atoll.

### **Measurements of Seals**

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

### Collection of Samples

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

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

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

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

**CHAPTER 2. THE HAWAIIAN MONK SEAL ON  
FRENCH FRIGATE SHOALS, 1996**

Mitchell P. Craig, Nicole M. Adimey, Kimberly Raum-Suryan, and  
Allison Veit

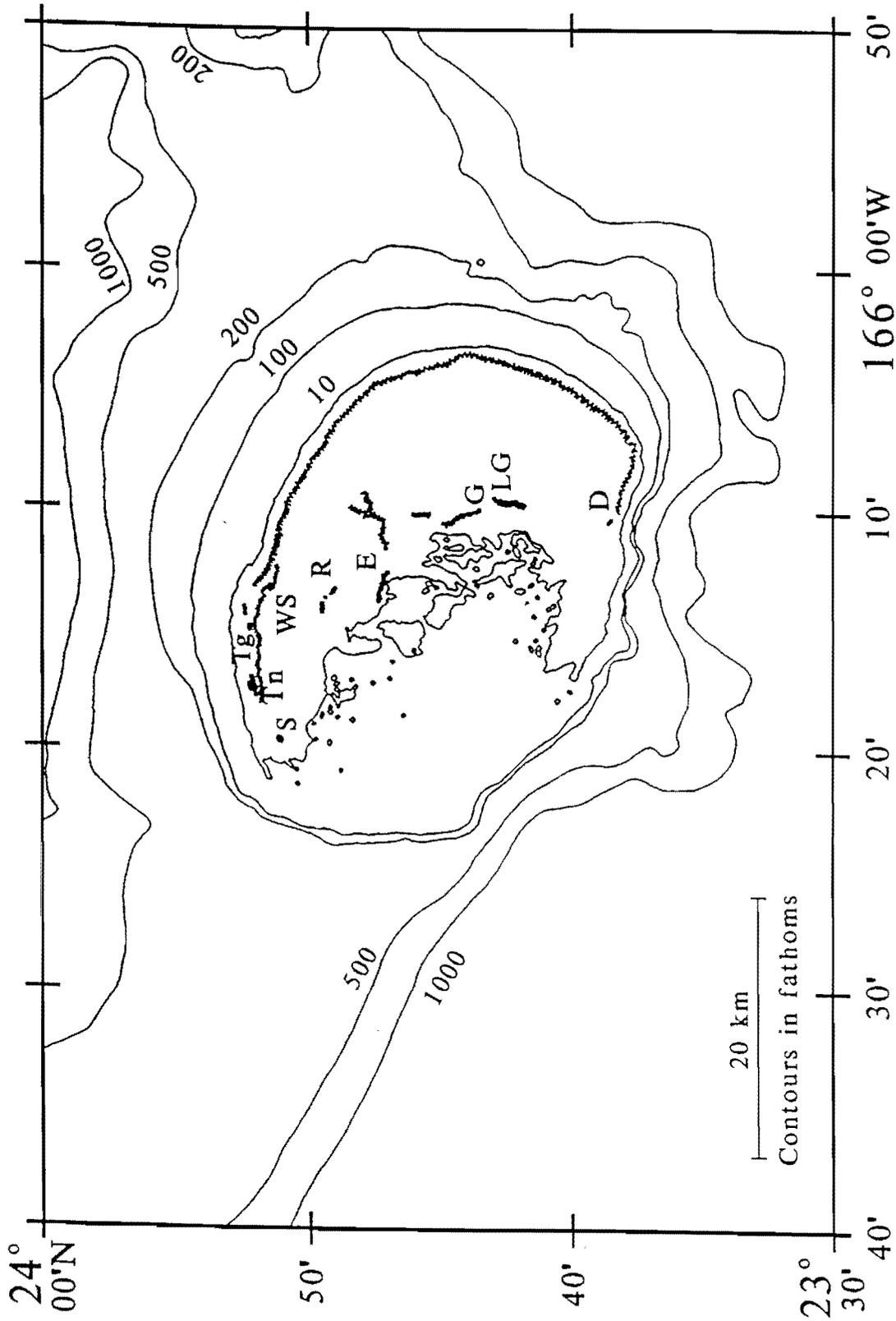


Fig. 2.1. French Frigate Shoals in the Northwestern Hawaiian Islands. Islands are: Disappearing (D), East (E), Gin (G), Little Gin (LG), Round (R), Shark (S), Tern (Tn), Trig (Tr), and Whaleskate (WS).

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

## **RESEARCH**

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at FFS in 1982. In 1996, research was conducted by NMFS during April 20-September 1. Incidental observations were recorded by U.S. Fish and Wildlife Service (USFWS) personnel during the rest of the year. The perimeters of six of the larger islands were divided into sectors using artificial or natural landmarks. Research objectives specific to this population in 1996 included (1) investigation of habitat use patterns using satellite-linked telemetry, seal-mounted video cameras, and GPS telemetry, (2) assessment of nearshore prey availability and habitat structure, and (3) visual examination of wild monk seal eyes for evidence of corneal opacities or symptoms consistent with those observed in captive seals.

### **Censuses and Patrols**

Atoll censuses ( $n = 10$ ) were conducted every 7 days, on average, from May 16 to July 18. Each atoll census began between 1000 and 1100 Hawaii standard time and ended between 1600 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 days to monitor pupping activity. Patrols of Tern Island were conducted every 3 days.

### **Individual Identification**

A total of 447 individuals (353 excluding pups) were identified by existing or applied tags, scars, or natural markings. Most weaned pups ( $n = 67$ ) were tagged with Temple Tags; 49 of these same pups were tagged with passive integrated transponder (PIT) tags. One immature seal was retagged with Temple Tags. Four adult males were tagged during instrumentation. One juvenile male born in December 1995 was tagged.

### **Collection of Samples**

Seventy-five scat and spew samples were collected. Tissue samples were collected from 52 seals during tagging. Blood samples were collected from five males and one female. Necropsies were performed on three dead seals found at the study site. Tissue samples were collected from all necropsied seals. In total, twelve pieces of potentially entangling debris were inventoried and destroyed.

### **Special Studies**

#### **Seals Collected for Rehabilitation**

No seals were collected for rehabilitation.

#### **Habitat Use Study**

In April and May, 10 adult males were instrumented with satellite-linked time-depth recorders as part of a habitat use study. One of these 10 instruments was lost and 7 instruments were retrieved in July and August. The remaining 2 instruments were still attached and functioning as of September 1 but were seen lost in October. During April and May three adult males were instrumented with experimental GPS (Global Positioning System) units. These GPS units were retrieved in 4 to 18 days. During August seven adult males were instrumented with video cameras and two adult males were instrumented with GPS units. The seven cameras were retrieved in 3 to 19 days. One GPS unit was lost within 4 days and the other was retrieved 92 days later. During October, five adult females and four adult males were instrumented with satellite-linked time-depth recorders. One satellite tag was lost from an adult female within a week after application, and the remaining tags were retrieved in January 1997.

#### **Reef Fish and Habitat Assessment**

In August the Ecosystem and Environmental Investigation of the Honolulu Laboratory, NMFS, continued ongoing habitat assessment. They repeated a reef fish survey, continued testing octopus trapping methods, and continued video camera transects around and within the atoll.

#### **Monk Seal Eye Assessment**

In August, the eyes of 120 wild seals were assessed from a distance by a veterinarian investigating an eye disease occurring in captive Hawaiian monk seals.

## **Debris Removal from Fringing Reef**

Personnel aboard the NOAA ship *Townsend Cromwell* removed debris from a section of fringing reef between Whale-Skate and Tern Islands to reduce these hazards to monk seals and other marine life, assess the extent of reef fouling, and determine the feasibility of a large-scale debris removal effort.

## **RESULTS**

### **Population Abundance and Composition**

The means ( $\pm$ SD) for 10 atoll censuses were 160.3 seals ( $\pm$ 26.9) including pups, and 120.5 seals ( $\pm$ 17.5) excluding pups (Table 2.1). The total spring-summer population included 159 immature individuals (subadults, juveniles, and pups), of which 64 were subadults or juveniles (Table 2.2). Although the total numbers of adult males and females were not obtained due to our inability to identify all individuals, it is estimated that less than seven individuals of each sex remained unidentified at the end of the field season. The numbers of tagged known-age seals born at FFS during the period from 1984 to 1995 and resighted there in 1996 are summarized in Table 2.3.

### **Reproduction**

At least 95 pups were born: 76 were weaned, 17 died or disappeared prior to weaning, and 2 were nursing at the end of this study (Table 2.4a). No fetuses were found. Nursing periods and measurements of weaned pups are summarized in Table 2.4b. A total of 166 adult-sized females were identified and 89 (54%) of those were parturient. The birth rate was 57% (56/98) for untagged adult females (>12 years old) and 49% (33/68) for tagged females of adult size ( $\leq$ 12 years old). Parturient females were more likely to be identified during lactation, which probably biased the estimates of birth rate upward. As noted above, our best estimate is that less than seven adult-sized females remained unidentified at FFS. The mean ( $\pm$ SD) lactation period was 38.3 d ( $\pm$ 4.2 d). At least seven pups were fostered by mothers other than their own.

### **Interatoll Movement**

Interatoll movement was documented for 22 seals that made a total of 33 movements between FFS and either Nihoa Island, Necker Island, Brooks Banks, Gardner Pinnacles, Laysan Island, or Lisianski Island (Tables 2.5a and b).

### **Factors Affecting Survival**

Attacks by large sharks, mounting attempts by males, entanglement, emaciation, and other/unknown factors resulted in 58 life-threatening conditions, which led to the confirmed deaths of 11 animals and the probable death of 22 seals (Table 2.6). One incident of adult male aggression was observed and one seal was known to have died following male-mounting incident. Two emaciated seals died. One seal was entangled and released by observers.

### **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 16 to July 18, 1996.

Size/Sex	Mean number of individuals	Standard deviation
Adults	102.3	16.4
Male	30.5	4.9
Female	62.5	15.4
Unknown	9.3	3.7
Subadults	7.7	2.5
Male	2.5	0.7
Female	4.6	2.1
Unknown	0.6	1.0
Juveniles	10.5	2.3
Male	4.0	1.6
Female	6.0	2.0
Unknown	0.5	1.0
Pups	39.8	10.6
Male	12.0	6.5
Female	7.7	3.7
Unknown	20.1	4.8
Nonpup Total	120.5	17.5
Grand Total	160.3	26.9

Table 2.2.--Composition of the Hawaiian monk seal population at French Frigate Shoals during the spring and summer of 1996. Includes all pups born during the calendar year.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	121 <sup>a</sup>	166 <sup>a</sup>	0	287 <sup>a</sup>	0.7:1
Subadults	10	20	0	30	0.5:1
Juveniles	15	19	0	34	0.8:1
Pups	47	37	11	95	1.3:1
Nonpup Total	146 <sup>a</sup>	205 <sup>a</sup>	0	351 <sup>a</sup>	0.7:1
Grand Total	193 <sup>a</sup>	242 <sup>a</sup>	11	446 <sup>a</sup>	0.8:1

<sup>a</sup>The adult population was not totally enumerated. It is estimated that less than 7 adult individuals of each sex remained unidentified at the end of the field season.

Table 2.3.--Summary of tagged known-age seals born at French Frigate Shoals Island and resighted there in 1996.

Age (years)	Sex	Number originally tagged	Number resighted in 1996
12	Male	49	11
	Female	43	16
11	Male	48	4
	Female	38	10
10	Male	52	11
	Female	48	19
9	Male	55	12
	Female	51	16
8	Male	52	5
	Female	62	8
7	Male	51	7
	Female	50	5
6	Male	39	1
	Female	40	2
5	Male	24	1
	Female	44	4
4	Male	36	2
	Female	55	8
3	Male	40	7
	Female	39	3
2	Male	47	2
	Female	48	6
1	Male	29	8
	Female	26	8

Table 2.4a.--Summary of Hawaiian monk seals born at French Frigate Shoals in 1996.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	47	37	11	95
Died/probably died prior to weaning	2	5	10	17
Still nursing	2 <sup>a</sup>	0	0	2
Weaned	43	32	1	76 <sup>b</sup>
Tagged	39	30	0	69 <sup>c</sup>

<sup>a</sup>Three male pups were nursing in October 1996; one is known to have weaned and was tagged in January 1997.

<sup>b</sup>Seven weaned pups (4 male, 2 female, and 1 sex unknown) disappeared prior to tagging, lost hindflippers, or were too severely injured to tag.

<sup>c</sup>Two weaned pups (1 male, 1 female) were tagged in January 1997.

Table 2.4b.--Summary of nursing periods and measurements of weaned pups at French Frigate Shoals in 1996. Nursing periods were calculated where both birth and weaning date ranges were  $\leq 4$  days. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	39.8	105.4	126.2
St. Dev.	5.3	9.0	7.2
<i>n</i>	3	48	48

Table 2.5a.--Known movement of Hawaiian monk seals to French Frigate Shoals from other locations in 1996, summarized by movements between two locations. Some seals made more than one trip.

Original location	Number, size, and sex class
Nihoa Island	1 adult male, 1 adult female
Necker Island	1 adult male, 3 adult females
Brooks Bank	1 adult male, 1 adult female
Gardner Pinnacles	2 adult males
Laysan Island	2 adult females, 1 subadult female
Lisianski Island	1 subadult male

Table 2.5b.--Known movement of Hawaiian monk seals from French Frigate Shoals to other locations in 1996, summarized by movements between two locations. Some seals made more than one trip.

Destination	Number, size, and sex class
Necker Island	4 adult males, 3 adult females, 1 subadult female
Brooks Bank	1 adult male, 1 adult female
Gardner Pinnacles	4 adult males
Laysan Island	1 adult male, 4 adult females

Table 2.6.--Factors affecting Hawaiian monk seal survival at French Frigate Shoals in 1996.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
<b>Attack by Large Shark</b>					
Adult	Male	5	5	0	0
	Female	1	1	0	0
Juvenile	Female	1	1	0	0
Weaned pup	Male	2	2	0	0
	Female	4	4	0	2
Nursing pup	Female	1	1	1	0
	Unknown	1	1	0	1
<b>Mounting by Males</b>					
Adult	Female	1	1	0	0
Weaned pup	Male	7	7	1	3
	Female	3 <sup>a</sup>	3	0	1
<b>Entanglement</b>					
Adult	Female	1 <sup>b</sup>	0	0	0
<b>Emaciation</b>					
Adult	Male	1	0	1	0
	Female	2	0	0	1
Juvenile	Male	4	1	1	1
	Female	1	0	0	1
<b>Other/Unknown</b>					
Adult	Male	2	2	0	0
	Female	2	1	1	0
Weaned pup	Male	1	1	0	0
	Female	2	0	1	1
	Unknown	1	0	0	1
Nursing pup	Male	2	1	2	0
	Female	4	2	3	1
	Unknown	9	0	0	9

<sup>a</sup>A seal was observed being mounted on August 18 by one adult male, YN22.

<sup>b</sup>Seal was released by observers.

**CHAPTER 3. THE HAWAIIAN MONK SEAL ON  
LAYSAN ISLAND, 1996**

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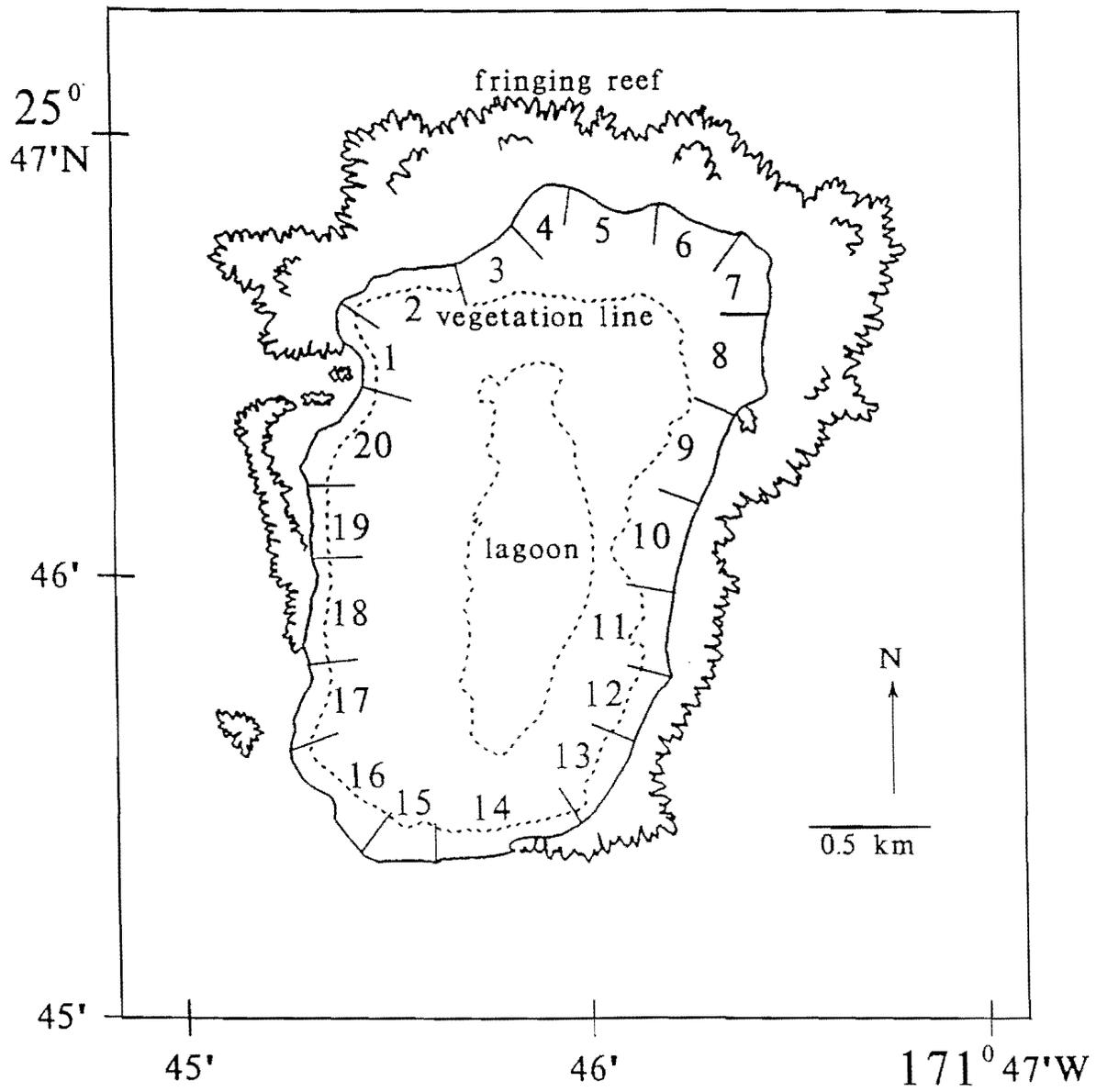


Fig. 3.1. Laysan Island in the Northwestern Hawaiian Islands.

Laysan Island (lat. 25°42'N, long. 171°44'W) is located ca. 1,300 km northwest of Oahu in the Northwestern Hawaiian Islands (Fig. 1.1). This island lies within the Hawaiian Islands National Wildlife Refuge and is one of the major haulout and pupping locations of the Hawaiian monk seal.

## **RESEARCH**

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Laysan Island in 1981. In 1996, research was conducted by NMFS during March 15-July 30, and incidental observations were recorded by U.S. Fish and Wildlife Service (USFWS) personnel during the rest of the year. The perimeter of the island (ca. 11 km) was divided into 20 sectors using artificial or natural landmarks (Fig. 3.1). Research objectives specific to this population in 1996 included identifying all seals, assessing maternity and pup exchanges, retagging seals whose tags were unreadable, monitoring the readability of PIT tags, describing 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 identifying any of those males that may have returned to Laysan after translocating to the main Hawaiian Islands.

### **Censuses and Patrols**

Censuses and patrols were scheduled to ensure that the entire island perimeter was monitored at least once each day during March 19-July 27. Censuses ( $n = 23$ ) were conducted by two observers every fifth day from April 5 to July 24. Each census began at 1300 Hawaii standard time and continued for 2.2 to 3.1 hours.

Standardized behavior patrols were conducted on noncensus days to assess activity patterns of adults and large subadults, document male aggression, and detect mobbing incidents. During these patrols ( $n = 98$ ), 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 262 individuals (215 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. Bleach marks were applied to 226 seals, including 44 nursing pups. All weaned pups ( $n = 44$ ) and 1 juvenile female seal were newly tagged with Temple Tags; all but 2 weaned pups also received passive integrated transponder (PIT) tags. One hundred seals (65 males, 35 females) were retagged with Temple Tags.

### **Collection of Samples**

One hundred twenty-seven scat and spew samples were collected. Tissue samples were collected from 141 seals during tagging. Two necropsies were performed and tissue samples were collected from one dead seal. Molt samples were collected from 29 seals. In total, 586 pieces of potentially entangling debris were inventoried and destroyed with the exception of one that was removed and collected from an entangled seal.

### **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, but one was observed at Nihoa Island in 1996.

#### **Oiled Seals**

Eleven of seventeen seals observed with oiled pelage on Laysan Island in the spring of 1993 were sighted there in 1996. These seals appeared to be in good health, but sublethal or long-term effects could not be evaluated. Of the six not sighted in 1996, one seal was last seen in 1995, four were last seen in 1994 (one of these, an adult male, was translocated to the main Hawaiian Island in 1994), and one was last seen in 1993.

#### **PIT Tag Readability**

Excluding pups of the year, 96 animals in the current Laysan Island population have one or two PIT tags for a total of 181 PIT tags. Only 3 (2%) of the 131 tags scanned in 1996 were unreadable.

## RESULTS

### Population Abundance and Composition

The means ( $\pm$ SD) for 23 censuses were 110.7 seals ( $\pm$ 15.6) including pups, and 86.5 seals ( $\pm$ 8.9) excluding pups (Table 3.1). The total spring-summer population was 261 individuals, 214 excluding pups (Table 3.2). The sex ratios of nonpup immature seals and adults were ca. 0.9:1 (35 males:37 females) and 0.9:1 (67 males:74 females), respectively. The sex ratio for older ( $>$ 13 years of age) and unknown aged adults was slightly skewed toward males at ca. 1.1:1 (38 males:36 females), whereas the ratio for younger adults ( $\leq$ 13 years of age) was ca. 0.8:1 (29 males:38 females). The numbers of tagged known-age seals born at Laysan Island during the period from 1983 to 1995 and resighted there in 1996 are summarized in Table 3.3.

### Reproduction

At least 47 pups were born: 44 were weaned, 2 died prior to weaning, and 1 disappeared prior to weaning (Table 3.4a). Nursing periods and measurements of weaned pups are summarized in Table 3.4b. Forty-seven of 74 (64%) adult-sized females were parturient. At least 9 pup exchanges occurred between 12 nursing females; none of these incidents were observed. No weaning events were observed. One unusual temporary weaning (i.e., a nursing female abandoned her pup, and then returned) was documented.

### Interatoll Movement

Interatoll movement was documented for 16 seals that made a total of 19 movements between Laysan Island and haulout sites at French Frigate Shoals or Lisianski Island, or probable foraging areas at Northampton Seamounts or Maro Reef (Tables 3.5a and b). Two seals sighted on Laysan Island in 1996 had not been sighted at any location for 1 (an adult female) or 4 (an adult male) years.

### Factors Affecting Survival

Attacks by large sharks, mounting attempts by males, entanglement, and other/unknown factors led to 35 life-threatening conditions, which resulted in the confirmed deaths of 3 animals and the probable deaths of 3 other seals (Table 3.6). One post-mobbing event was observed and involved 7 adult males with an adult female who sustained serious injuries. No seals were known to have died or disappeared following male-mounting incidents. Four seals were entangled: two escaped by themselves by 1997, and two were disentangled by researchers.

**ACKNOWLEDGMENTS**

We acknowledge the support of the U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge staff and thank the captains and crew members of the NOAA ship *Townsend Cromwell* and the U.S. Coast Guard Cutter *Washington*. Special thanks are extended to Brian Allen, Rebecca Bernard, Monette Boswell, Leslie Leroux, Amber Pairis, Mike Schultz, Drew Wettergreen, Peter Winch, and NOAA Corps officers Lt. Carolyn Sramek and Lt. (j.g.) Kurt Zegowitz for their data collection and tagging assistance. We also thank the captain of the F/V *Fortuna* for reporting the seal sighting at Northampton Seamounts.

## **TABLES**



Table 3.1.--Summary statistics for censuses ( $n = 23$ ) of Hawaiian monk seals at Laysan Island from April 5 to July 24, 1996.

Size/Sex	Mean number of individuals	Standard deviation
Adults	49.0	5.7
Male	20.2	4.6
Female	28.5	5.3
Unknown	0.3	0.8
Subadults	13.0	4.0
Male	7.3	2.3
Female	5.4	2.2
Unknown	0.4	0.6
Juveniles	24.3	4.2
Male	11.0	3.0
Female	12.9	2.1
Unknown	0.4	0.7
Pups	24.3	10.2
Male	13.3	5.8
Female	10.7	4.6
Unknown	0.3	0.8
Nonpup Total	86.5	8.9
Grand Total	110.7	15.6

Table 3.2.--Composition of the Hawaiian monk seal population at Laysan Island during the spring and summer of 1996.  
Includes all pups born during the calendar year.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	67	74	1	142	0.9:1
Subadults	15	12	0	27	1.3:1
Juveniles	20	25	0	45	0.8:1
Pups	24	22 <sup>a</sup>	1 <sup>a</sup>	47	1.1:1
Nonpup Total	102	111	1	214	0.9:1
Grand Total	126	133	2	261	1.0:1

<sup>a</sup>One neonatal pup death.

Table 3.3.--Summary of tagged known-age seals born at Laysan Island and resighted there in 1996.

Age (years)	Sex	Number originally tagged	Number resighted in 1996
13	Male	10	1
	Female	10	6
12	Male	16	2
	Female	13	5
11	Male	16	1
	Female	14	5
10	Male	15	2
	Female	17	2
9	Male	13	3
	Female	15	5
8	Male	23	6
	Female	17	3
7	Male	16	3
	Female	13	3
6	Male	7	2
	Female	9	3
5	Male	18	8
	Female	13	8
4	Male	18	2
	Female	14	3
3	Male	23	5
	Female	14	3
2	Male	18	8
	Female	29	11
1	Male	16	12
	Female	21	13

Table 3.4a.--Summary of Hawaiian monk seals born at Laysan Island in 1996.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	24	22	1	47
Died prior to weaning	0	1	1	2
Disappeared prior to weaning	1	0	0	1
Weaned	23	21	0	44
Tagged	23	21	0	44

Table 3.4b.--Summary of nursing periods and measurements of weaned pups at Laysan Island in 1996. Nursing periods were calculated where both birth and weaning date ranges were  $\leq 4$  days. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	36.6	104.5	123.8
St. Dev.	3.8	6.9	5.4
<i>n</i>	42	42	42

Table 3.5a.--Known movement of Hawaiian monk seals to Laysan Island from other locations in 1996, 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, 4 adult females
Lisianski Island	4 adult females, 1 subadult female
Maro Reef	1 adult male

Table 3.5b.--Known movement of Hawaiian monk seals from Laysan Island to other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

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

Table 3.6.--Factors affecting Hawaiian monk seal survival at Laysan Island in 1996.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
<b>Attack by Large Shark</b>					
Adult	Male	3	3	0	0
	Female	2	2	0	0
	Unknown	1	0	0	1
Juvenile	Male	1	1	0	0
<b>Mounting by Males</b>					
Adult	Female	5 <sup>a</sup>	5	0	0
Subadult	Female	1	1	0	0
Weaned Pup	Male	2	2	0	0
<b>Entanglement</b>					
Subadult	Male	1 <sup>b</sup>	0	0	0
Juvenile	Male	1 <sup>c</sup>	1	0	0
Weaned Pup	Male	1 <sup>d</sup>	1	0	0
	Female	1 <sup>b</sup>	0	0	0
<b>Other/Unknown</b>					
Adult	Male	3 <sup>e</sup>	2	0	0
	Female	3	3	0	0
Subadult	Female	1	1	0	0
Juvenile	Male	2	2	0	0
	Female	2 <sup>f</sup>	1	0	0
Weaned Pup	Male	1 <sup>g</sup>	0	0	1
	Female	1 <sup>h</sup>	0	1	0
Nursing Pup	Male	1 <sup>i</sup>	0	0	1
	Female	1 <sup>j</sup>	0	1	0
	Unknown	1 <sup>k</sup>	0	1	0

<sup>a</sup>Post-mobbing event observed; seven adult males with a severely injured seal.

<sup>b</sup>Released by researchers; no injury resulted from entanglement.

<sup>c</sup>Seal disentangled itself by 1997, but was injured.

<sup>d</sup>Seal escaped by itself but was injured.

<sup>e</sup>Seal had seizure during capture for retagging, appeared to fully recover.

<sup>f</sup>One seal had an opaque, blind eye.

<sup>g</sup>Seal was prematurely weaned and not resighted after weaning date.

<sup>h</sup>Too decomposed to confirm cause of death, but mounting scratches present.

<sup>i</sup>Disappeared near weaning age; probably swept away in high tide during night.

<sup>j</sup>Mother wounded by large shark within 2 months prior to parturition.

<sup>k</sup>Mother had abnormal skin condition and molted early in relation to the end of nursing period (death of her pup).

**CHAPTER 4. THE HAWAIIAN MONK SEAL ON  
LISIANSKI ISLAND, 1996**

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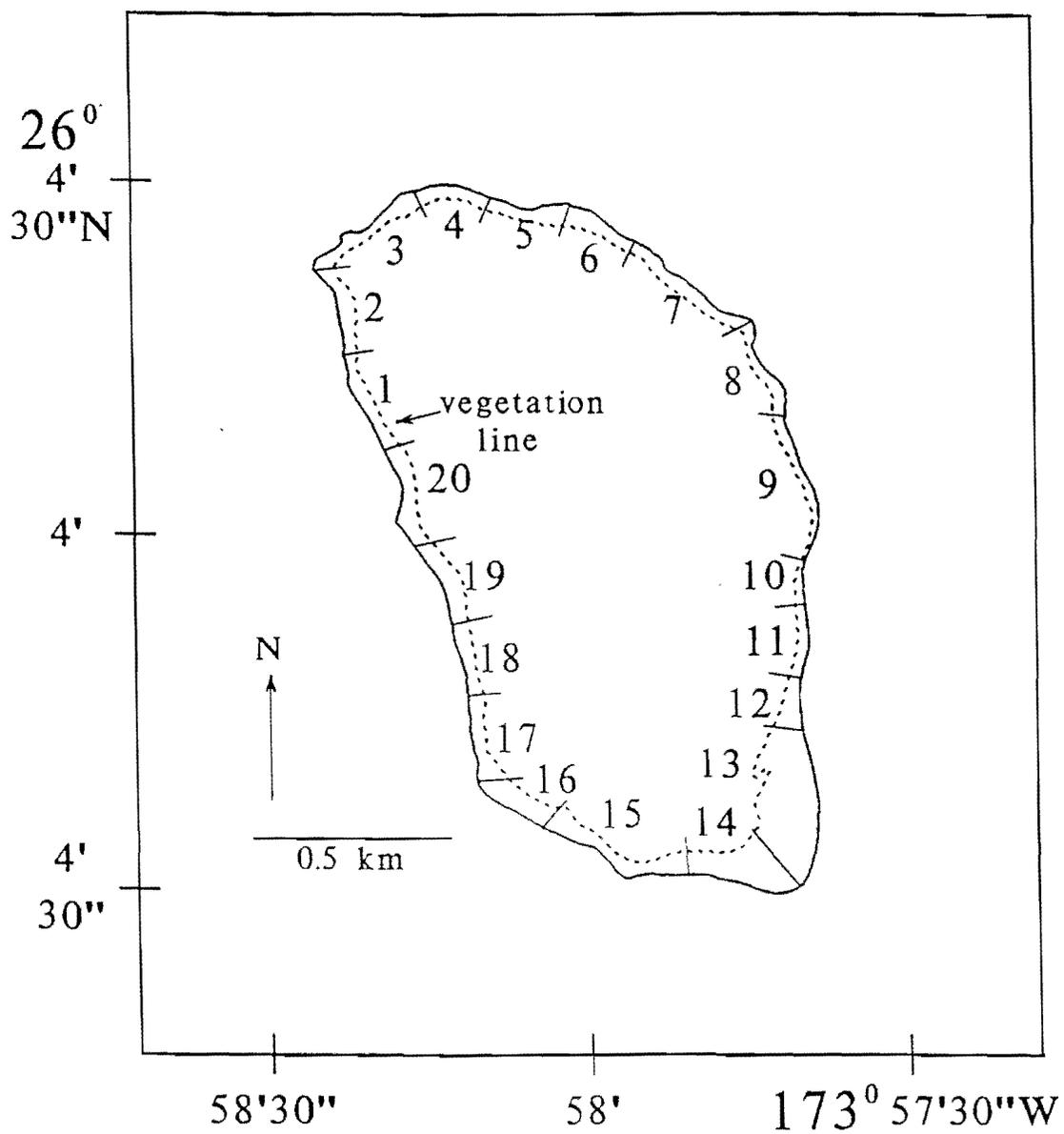


Fig. 4.1. Lisianski Island in the Northwestern Hawaiian Islands.

Lisianski Island (lat. 26°02'N, long. 174°00'W) is one of the major haulout and pupping locations of the Hawaiian monk seal. The island is located ca. 1,760 km northwest of Oahu (Fig. 1.1), and is part of Neva Shoal, a shallow reef bank within the Hawaiian Islands National Wildlife Refuge.

## **RESEARCH**

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Lisianski Island in 1981. In 1996, research was conducted by NMFS during March 14-July 28. The perimeter of the island (ca. 5.2 km) was divided into 20 sectors using artificial or natural landmarks (Fig. 4.1). Research objectives specific to this population in 1996 included identification of all seals, assessment of maternity and pup exchanges, and description of adult male behavioral patterns and aggression.

### **Censuses and Patrols**

Censuses and patrols were scheduled to ensure that the entire island was monitored at least once each day during March 27-July 24. Censuses ( $n = 22$ ) were conducted by two observers every fifth day from March 31 to July 24, beginning at 1300 Hawaii standard time and continuing for 1.2 to 2.1 hours.

Standardized behavior patrols were conducted on noncensus days to assess activity patterns of adults and large subadults, document male aggression, and detect mobbing incidents. During these patrols ( $n = 81$ ), 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 202 individuals (178 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. Bleach marks were applied to 136 seals, including 18 nursing pups. All weaned pups ( $n = 22$ ) were tagged with Temple Tags, and all but one also received passive integrated transponder (PIT) tags. One subadult and one juvenile female were retagged with Temple Tags.

### **Collection of Samples**

One hundred and seven scat and spew samples were collected. Tissue samples were collected from 17 seals during tagging. A necropsy was performed and tissue samples were collected from one dead seal. In total, 516 pieces of potentially entangling debris were inventoried and destroyed, with the exception of five pieces which were removed and collected from entangled seals.

## RESULTS

### Population Abundance and Composition

The means ( $\pm$ SD) for 22 censuses were 77.7 seals ( $\pm$ 10.0) including pups, and 63.4 seals ( $\pm$ 8.3) excluding pups (Table 4.1). The total spring-summer population was 201 individuals, 177 excluding pups (Table 4.2). The sex ratios of nonpup immature seals and adults were ca. 0.9:1 (23 males:26 females) and 1.6:1 (78 males:50 females), respectively. The sex ratio for older ( $>14$  years of age) and unknown aged adults was strongly skewed toward males at ca. 2.6:1 (52 males:20 females), whereas the ratio for younger adults ( $\leq 14$  years of age) was ca. 0.9:1 (26 males:30 females). The numbers of tagged known-age seals born at Lisianski Island during the period from 1982 to 1995 and resighted there in 1996 are summarized in Table 4.3.

### Reproduction

At least 24 pups were born: 22 were weaned, 1 died prior to weaning, and 1 was 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-four of fifty (48%) adult-sized females were parturient. At least 9 pup exchanges occurred between 11 nursing females; none of these incidents were observed.

### Interatoll Movement

Interatoll movement was documented for 12 seals that made a total of 13 movements between Lisianski Island and either French Frigate Shoals, 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 14 life-threatening conditions, which resulted in the confirmed death of 2 animals and probable death of 1 seal (Table 4.6). One mobbing event was observed and involved 5 adult males with an adult female who was uninjured. No seals were known to have died or disappeared following male-mounting injuries. Seven entanglements involving six seals were observed: in one event, the seal escaped by itself and in six incidents the seal was released by researchers. In addition to the cases summarized in Table 4.6, a pup was extremely undersized (63 cm axillary girth) after completing a full nursing period (43 days). The seal was observed through the end of this study, though it was not expected to survive the year.

**ACKNOWLEDGMENTS**

We acknowledge the support of the U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge staff. We thank the captains and crew of the NOAA ship *Townsend Cromwell* and the U.S. Coast Guard Cutter *Washington*, and the U.S. Coast Guard Barbers Point flight operations for logistical assistance.



## **TABLES**



Table 4.1.--Summary statistics for censuses ( $n = 22$ ) of Hawaiian monk seals at Lisianski Island from March 31 to July 24, 1996.

Size/Sex	Mean number of individuals	Standard deviation
Adults	47.4	6.8
Male	26.0	4.9
Female	20.3	4.2
Unknown	1.1	1.2
Subadults	12.0	4.2
Male	5.6	2.6
Female	5.8	2.5
Unknown	0.5	1.1
Juveniles	4.0	2.0
Male	1.5	1.0
Female	2.4	1.5
Unknown	0.2	0.5
Pups	14.3	3.5
Male	6.0	2.0
Female	7.9	2.7
Unknown	0.5	1.0
Nonpup Total	63.4	8.3
Grand Total	77.7	10.0

Table 4.2.--Composition of the Hawaiian monk seal population at Lisianski Island during the spring and summer of 1996. Includes all pups born during the calendar year.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	78	50	0	128	1.6:1
Subadults	17	16	0	33	1.1:1
Juveniles	6	10	0	16	0.6:1
Pups	10	13	1 <sup>a</sup>	24	0.8:1
Nonpup Total	101	76	0	177	1.3:1
Grand Total	111	89	1	201	1.2:1

<sup>a</sup>One neonatal pup death.

Table 4.3.--Summary of tagged known-age seals born at Lisianski Island and resighted there in 1996.

Age (years)	Sex	Number originally tagged	Number resighted in 1996
14	Male	7	2
	Female	6	3
13	Male	6	2
	Female	18	7
12	Male	10	3
	Female	5	2
11	Male	5	2
	Female	9	2
10	Male	11	5
	Female	9	4
9	Male	12	2
	Female	6	0
8	Male	10	5
	Female	8	6
7	Male	--	--
	Female	--	--
6	Male	8	4
	Female	9	3
5	Male	9	5
	Female	6	2
4	Male	13	6
	Female	8	4
3	Male	4	2
	Female	9	3
2	Male	4	2
	Female	5	2
1	Male	7	2
	Female	10	5

Table 4.4a.--Summary of Hawaiian monk seals born at Lisianski Island in 1996.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	10	13	1	24
Died prior to weaning	0	0	1	1
Still nursing	1	0	0	1
Weaned	9	13	0	22
Tagged	9	13	0	22

Table 4.4b.--Summary of nursing periods and measurements of weaned pups at Lisianski Island in 1996. Nursing periods were calculated where both birth and weaning date ranges were  $\leq 4$  days. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	37.2	102.8	124.8
St. Dev.	4.7	11.3	7.7
<i>n</i>	16	22	21

Table 4.5a.--Known movement of Hawaiian monk seals to Lisianski Island from other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

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

Table 4.5b.--Known movement of Hawaiian monk seals from Lisianski Island to other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Destination	Number, size, and sex class
French Frigate Shoals	1 subadult male
Laysan Island	4 adult females, 1 subadult female
Pearl and Hermes Reef	1 adult female, 1 subadult female

Table 4.6.--Factors affecting Hawaiian monk seal survival at Lisianski Island in 1996.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
<b>Attack by Large Shark</b>					
Adult	Male	1	1	0	0
Juvenile	Female	1	1	0	0
<b>Mounting by Male</b>					
Adult	Female	2 <sup>a</sup>	1	0	0
<b>Entanglement</b>					
Subadult	Female	1 <sup>b</sup>	0	0	0
Weaned Pup	Male	3 <sup>b</sup>	0	0	0
	Female	3 <sup>c</sup>	0	0	0
<b>Emaciation</b>					
Adult	Male	1	0	0	1
<b>Unknown</b>					
Adult	Male	1	0	1 <sup>d</sup>	0
Nursing Pup	Unknown	1 <sup>e</sup>	0	1	0

<sup>a</sup>A mobbing event was observed involving five adult males with an adult female who sustained no injuries.

<sup>b</sup>Seal(s) released uninjured by observers.

<sup>c</sup>One seal was entangled twice: once it disentangled itself and the other time it was released by observers. The other seal was released by observers. Both animals were uninjured.

<sup>d</sup>Seal was lethargic and later found dead with severe shark injuries.

<sup>e</sup>Decomposed carcass was found at the beginning of the season.

**CHAPTER 5. THE HAWAIIAN MONK SEAL ON  
PEARL AND HERMES REEF, 1996**

Chad H. Yoshinaga, Irene T. Kinan, Allison C. Veit, and Christine  
M. Vitulli

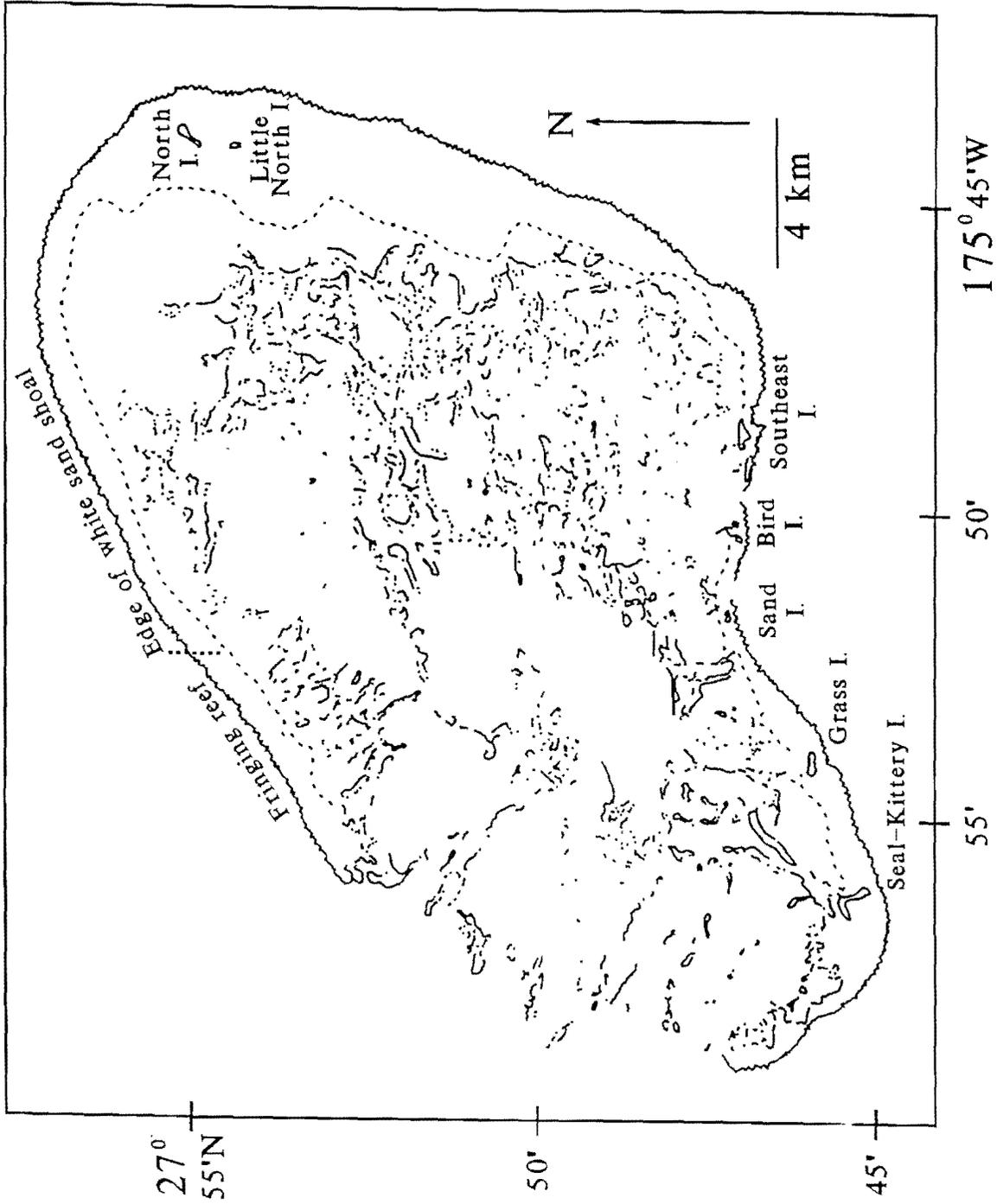


Fig. 5.1. Pearl and Hermes Reef in the Northwestern Hawaiian Islands.

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 non-vegetated sand islands enclosed in a fringing reef (Fig. 5.1).

## **RESEARCH**

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Pearl and Hermes Reef in 1982. In 1996, research was conducted by NMFS during April 26-July 27. The perimeters of the four larger vegetated islands were divided into sectors using natural landmarks. Research objectives for the Pearl and Hermes monk seal population in 1996 were to conduct basic population research as outlined in Chapter 1, document all births during the research period, and remove or destroy hazardous marine debris from all haulout areas.

### **Censuses and Patrols**

Atoll censuses ( $n = 8$ ) were conducted every 5 days, on average, during May 14-July 11, beginning at 1000 Hawaii standard time and continuing for approximately 7 hours. All islands were censused on foot by one or two persons. Patrols were conducted opportunistically on noncensus days to resight seals tagged in previous years.

### **Individual Identification**

A total of 232 individuals (207 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. All weaned pups ( $n = 23$ ) were tagged with Temple Tags and passive integrated transponder (PIT) tags. Two immature female seals were also tagged with Temple Tags.

### **Collection of Samples**

Forty-one scat and spew samples were collected. Tissue samples were collected from nine seals during tagging. In total, 241 pieces of potentially entangling debris were inventoried and destroyed, representing all of the potentially dangerous debris present on beaches and haulout sites in 1996. Large amounts of hazardous debris on offshore patch reefs and the outer barrier reef could not be removed safely and were left in place.

## RESULTS

### Population Abundance and Composition

The means ( $\pm$ SD) for eight atoll censuses were 86.5 seals ( $\pm$ 12.9) including pups, and 72.5 seals ( $\pm$ 13.4) excluding pups (Table 5.1). The total spring-summer population was 223 individuals, 198 excluding pups (Table 5.2). The sex ratios of nonpup immature seals and adults were 1.0:1 (37 males:37 females) and 1.1:1 (63 males:57 females), respectively. The numbers of tagged known-age seals born at Pearl and Hermes Reef during the period from 1983 to 1996 and resighted there in 1996 are summarized in Table 5.3.

### Reproduction

At least 25 pups were born: 23 were weaned and 2 pups were still nursing at the end of this study (Table 5.4a). Measurements of weaned pups are summarized in Table 5.4b. Twenty-five of fifty-seven (44%) adult-sized females were parturient.

### Interatoll Movement

Interatoll movement was documented for 19 seals that made a total of 27 movements between Pearl and Hermes Reef and either Lisianski, Midway, or Kure Atoll (Tables 5.5a and b).

### Factors Affecting Survival

Entanglement and unknown factors led to four life-threatening conditions (Table 5.6). Three weaned pups (two males, one female) were entangled in marine debris, released by observers, and resighted afterwards. No deaths were observed at Pearl and Hermes reef in 1996.

## ACKNOWLEDGMENTS

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

## **TABLES**



Table 5.1.--Summary statistics for atoll censuses ( $n = 8$ ) of the Hawaiian monk seals at Pearl and Hermes Reef, from May 14 to July 11, 1996.

Size/Sex	Mean number of individuals	Standard deviation
Adults	48.3	9.3
Male	17.5	2.9
Female	19.0	3.2
Unknown	11.8	5.6
Subadults	14.0	6.7
Male	7.0	4.3
Female	4.3	2.4
Unknown	2.8	1.2
Juveniles	10.1	2.9
Male	3.8	1.6
Female	4.6	2.4
Unknown	1.8	1.2
Pups	14.0	1.9
Male	5.6	1.9
Female	6.6	1.8
Unknown	1.8	1.2
Nonpup Total	72.5	13.4
Grand Total	86.5	12.9

Table 5.2.--Composition of the Hawaiian monk seal population at Pearl and Hermes Reef during the spring and summer of 1996. Includes all pups born during the calendar year.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	63	57	3	123	1.1:1
Subadults	25	16	0	41	1.6:1
Juveniles	12	21	1	34	0.6:1
Pups	11	12	2	25	0.9:1
Nonpup Total	100	94	4	198	1.1:1
Grand Total	111	106	6	223	1.0:1

Table 5.3.--Summary of tagged known-age seals born at Pearl and Hermes Reef and resighted there in 1996.

Age (years)	Sex	Number originally tagged	Number resighted in 1996
13	Male	8	4
	Female	2	1
12	Male	5	2
	Female	8	2
11	Male	9	1
	Female	6	4
10	Male	10	4
	Female	7	3
	Unknown	1	0
9	Male	14	7
	Female	7	2
8	Male	12	10
	Female	6	2
7	Male	8	5
	Female	6	3
6	Male	5	3
	Female	1	0
5	Male	10	8
	Female	11	5
4	Male	13	9
	Female	10	7
3	Male	14	6
	Female	7	5
2	Male	--	--
	Female	--	--
1	Male	16	12
	Female	11	7

Table 5.4a.--Summary of Hawaiian monk seals born at Pearl and Hermes Reef in 1996.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	11	12	2	25
Died prior to weaning	0	0	0	0
Still nursing	0	0	2	2
Weaned	11	12	0	23
Tagged	11	12	0	23

Table 5.4b.--Summary of measurements of weaned pups at Pearl and Hermes Reef in 1996. All measurements were taken within 2 weeks after weaning.

	Axillary girth (cm)	Straight dorsal length (cm)
Mean	107.6	129.6
St. Dev.	7.3	4.8
<i>n</i>	15	15

Table 5.5a.--Known movement of Hawaiian monk seals to Pearl and Hermes Reef from other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

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

Table 5.5b.--Known movement of Hawaiian monk seals from Pearl and Hermes Reef to other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Destination	Number, size, and sex class
Lisianski Island	1 subadult female
Midway Atoll	3 adult males, 4 adult females, 1 subadult male, 1 subadult female, 1 juvenile male
Kure Atoll	1 adult male, 1 adult female, 1 subadult male

Table 5.6.--Factors affecting Hawaiian monk seal survival at Pearl and Hermes Reef in 1996.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
<b>Attack by Large Shark</b>					
(none observed)					
<b>Mounting by Male</b>					
(none observed)					
<b>Entanglement</b>					
Weaned Pup	Male	2 <sup>a</sup>	0	0	0
Weaned Pup	Female	1 <sup>a</sup>	0	0	0
<b>Unknown</b>					
Adult	Male	1	1	0	0

<sup>a</sup>Seal(s) released uninjured by observers.

**CHAPTER 6. THE HAWAIIAN MONK SEAL ON  
MIDWAY ATOLL, 1996**

L. L. Eberhardt, K. V. Eberhardt, and R. Lance Jeffery

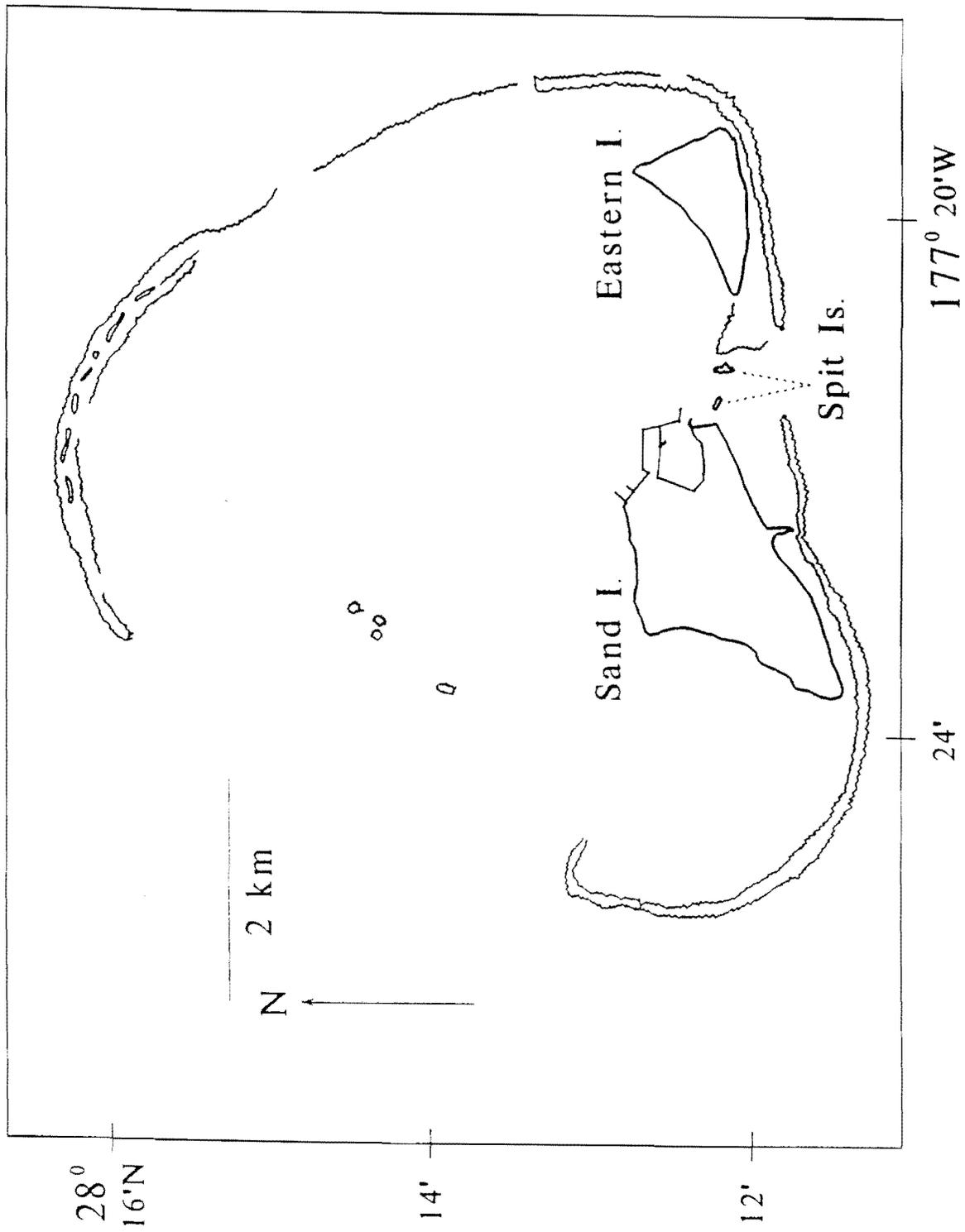


Fig. 6.1. Midway Islands in the Northwestern Hawaiian Islands.

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 has vacated the atoll and primary management authority has been 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 immigrants from Kure Atoll and Pearl and Hermes Reef and an increasing number of seals born on Midway Atoll. The earlier counts indicate that the Midway population has significant potential for growth, and recovery of this population is an important management goal.

## RESEARCH

Research was conducted by the National Marine Fisheries Service during March 29-May 1 and July 30-August 1, 1996. 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. Research objectives specific to this population in 1996 included the identification of all seals in the resident population, estimation of the proportion identified using sighting probability calculations, and tagging pups.

### Censuses and Patrols

Atoll censuses ( $n = 11$ ) were conducted every 2-3 days, on average, from March 31 to April 26. All islands were censused on foot by one or two persons. Each atoll census began between 0700 and 1400 Hawaii standard time, and ended between 0950 and 1650. Beach counts of Sand Island ( $n = 10$ ), Eastern Island ( $n = 1$ ), or Spit Island ( $n = 3$ ) were conducted on non-atoll census days during March 29-May 1 to identify and resight seals.

### **Individual Identification**

A total of 45 individuals (38 excluding pups) were identified by existing or applied tags, bleach marks, scars, or natural markings. One juvenile seal was identified in January by USFWS personnel, but was not subsequently resighted. Five weaned pups were tagged with Temple Tags, and one of these same pups was also tagged with passive integrated transponder (PIT) tags.

### **Collection of Samples**

Tissue samples were collected from two seals during tagging.

### **Special Studies**

#### **Sighting Probability Calculations**

Probability calculations suggested that the 43 seals identified during March 29-May 1 may have been virtually the entire "population" using Midway Island at that time, but there may have been one or two other seals undetected.

## **RESULTS**

### **Population Abundance and Composition**

The means ( $\pm$ SD) for eleven atoll censuses were 16.1 seals ( $\pm$ 3.5) including pups, and 12.7 seals ( $\pm$ 3.3) excluding pups (Table 6.1). The total spring-summer population was 42 seals, 35 excluding pups (Table 6.2). This total includes all seals observed at Midway Island during March 29-May 1 (43 seals) plus an additional nursing pup observed July 31, but minus two adult females that pupped at Pearl and Hermes Reef in 1996 and are thus included in the Pearl and Hermes population.

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 during the period from 1988 to 1995 and resighted there in 1996 are summarized in Table 6.3.

### **Reproduction**

At least seven pups were born: five weaned, the fate of one was unknown, and one was still nursing at the end of this study (Table 6.4). None of the weaned pups were measured within 2 weeks of weaning. Seven of sixteen (44%) adult-sized females were parturient.

### **Interatoll Movement**

Interatoll movement was documented for 21 seals that made a total of 29 movements between Midway Atoll and either Kure Atoll or Pearl and Hermes Reef (Tables 6.5a and b).

### **Factors Affecting Survival**

Attacks by large sharks, entanglement, and unknown factors led to five life-threatening conditions (Table 6.6). Three seals were entangled and were released by observers. No deaths were observed at Midway Atoll in 1996.

### **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 census ( $n = 11$ ) of  
Hawaiian monk seals at Midway Atoll from March 31 to  
April 26, 1996.

Size/Sex	Number of individuals	Standard deviation
Adults	9.0	3.0
Male	1.8	1.1
Female	7.2	2.6
Unknown	0.0	0.0
Subadults	1.0	1.0
Male	0.4	0.5
Female	0.6	0.7
Unknown	0.0	0.0
Juveniles	2.6	1.1
Male	1.7	0.6
Female	0.9	0.8
Unknown	0.0	0.0
Pups	3.4	1.3
Male	0.0	0.0
Female	0.8	0.4
Unknown	2.5	1.1
Nonpup Total	12.7	3.3
Grand Total	16.1	3.5

Table 6.2.--Composition of the Hawaiian monk seal population at Midway Atoll during the spring and summer of 1996.

Size	Number of seals			Total	Sex ratio male:female
	Male	Female	Unknown		
Adults	9	16	0	25	0.6:1
Subadults	1	4	0	5	0.2:1
Juveniles	3	2	0	5	1.5:1
Pups	2	4	1	7	1.0:1
Nonpup Total	13	22	0	35	0.6:1
Grand Total	16	25	1	42	0.6:1

Table 6.3.--Summary of tagged known-age seals born at Midway Atoll and resighted there in 1996.

Age (years)	Sex	Number originally tagged	Number resighted in 1996
8	Male	0	--
	Female	1	1
7	Male	0	--
	Female	0	--
6	Male	0	--
	Female	0	--
5	Male	1	1
	Female	1	0
4	Male	0	--
	Female	1	1
3	Male	1	0
	Female	0	--
2	Male	0	--
	Female	0	--
1	Male	1	1
	Female	6	2
	Unknown	1	1

Table 6.4.--Summary of Hawaiian monk seals born at Midway Atoll in 1996.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	2	4	1	7
Died prior to weaning	0	0	0	0
Still nursing	1	0	0	1
Weaning status unknown	0	0	1	1
Weaned	1	4	0	5
Tagged	1	4	0	5

Table 6.5a.--Known movement of Hawaiian monk seals to Midway Atoll from other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Original location	Number, size, and sex class
Pearl and Hermes Reef	3 adult males, 4 adult females, 1 subadult male, 1 subadult female, 1 juvenile male
Kure Atoll	1 adult male, 1 adult female

Table 6.5b.--Known movement of Hawaiian monk seals from Midway Atoll to other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Destination	Number, size, and sex class
Pearl and Hermes Reef	1 adult male, 4 adult females, 1 subadult male, 1 subadult female, 1 juvenile male
Kure	2 adult males, 6 adult females, 1 subadult male

Table 6.6.--Factors affecting Hawaiian monk seal survival at Midway Atoll in 1996.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
<b>Attack by Large Shark</b>					
Juvenile	Female	1	1	0	0
<b>Mounting by Males</b>					
(none observed)					
<b>Entanglement</b>					
Weaned pup	Unknown	1 <sup>a</sup>	0	0	0
Immature	Unknown	2 <sup>a</sup>	0	0	0
<b>Unknown</b>					
Adult	Female	1	1	0	0

<sup>a</sup>All entangled seals released by observers.

**CHAPTER 7. THE HAWAIIAN MONK SEAL ON  
KURE ATOLL, 1996**

Lucy W. Keith, R. Lance Jeffery, and Jill D. Pettinger

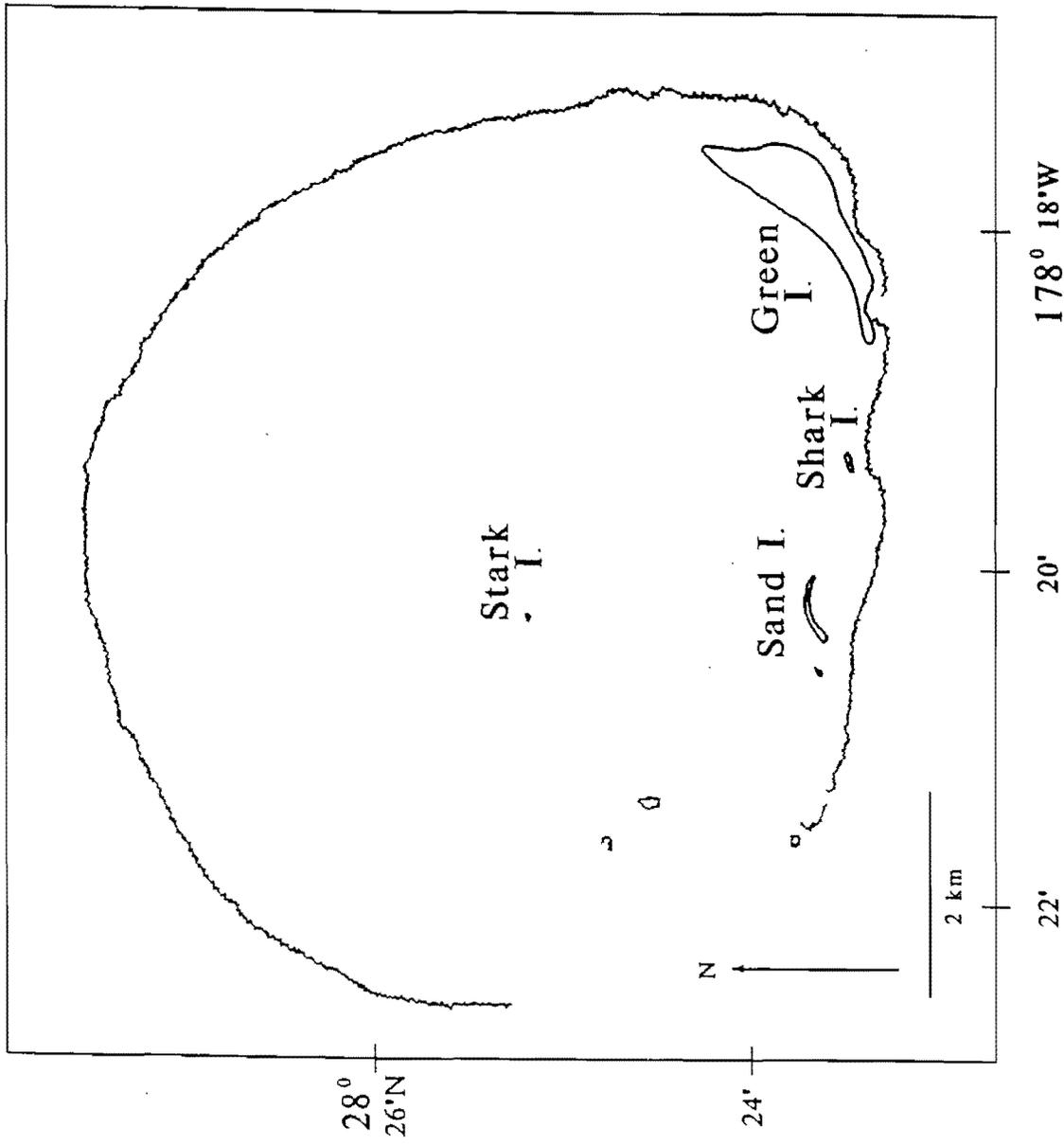


Fig. 7.1. Kure Atoll in the Northwestern Hawaiian Islands.

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.

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

## **RESEARCH**

The National Marine Fisheries Service (NMFS) began research on Hawaiian monk seals at Kure Atoll in 1981. In 1996, research was conducted by NMFS during April 28-July 25. The perimeter of Green Island was divided into eight sectors, using artificial or natural landmarks. Research objectives for the Kure Atoll monk seal population in 1996 are described in Chapter 1.

### **Censuses and Patrols**

Atoll censuses ( $n = 15$ ) were conducted approximately every 5 days, weather permitting, from May 11 to July 25. Each census began at 1300 Hawaii standard time and ended between 1400 and 1900. All islands were censused on foot by one or two persons. Stark Reef was not included in any atoll census or patrol. Patrols were conducted to identify seals and monitor locations used by parturient females.

### **Individual Identification**

A total of 117 individuals (100 excluding pups) were identified by existing or applied tags, bleach marks, scars, or

natural markings. All weaned pups ( $n = 16$ ) were tagged with Temple Tags, and passive integrated transponder (PIT) tags.

### **Collection of Samples**

Ninety-five scat and spew samples were collected. Tissue samples were collected from 16 weaned pups during tagging. In total, 844 pieces of potentially entangling debris were inventoried; 4 entanglement items were removed from seals and collected; the remainder was destroyed before the end of the field season.

## **RESULTS**

### **Population Abundance and Composition**

The means ( $\pm$ SD) for 15 atoll censuses were 46.7 seals ( $\pm$ 9.0) including pups, and 38.5 seals ( $\pm$ 7.7) excluding pups (Table 7.1). The total spring-summer population included 35 adult females and 56 immature individuals (subadults, juveniles, and pups), of which 39 were subadults or juveniles (Table 7.2). Although the total number of adult males was not obtained due to our inability to identify all individuals, it is estimated that only a small, but unknown, number was not identified. The numbers of tagged known-age seals born at Kure Atoll during the period from 1981 to 1995 and resighted there in 1996 are summarized in Table 7.3.

### **Reproduction**

At least 17 pups were born: 16 were weaned and 1 died prior to weaning (Table 7.4a). Seven pups were known to have weaned less than 2 weeks prior to being tagged, and their measurements are summarized in Table 7.4b. Of the 35 adult-sized females identified in the spring-summer population, a minimum of 17 were parturient (49%). Because eight pups weaned before field observations commenced in April, only nine parturient females were identified. Five of these nine females had been temporarily maintained as pups in the Kure Atoll Head Start enclosure (one in 1982, one in 1984, two in 1985, and one in 1988) and two others were rehabilitated seals from FFS introduced to Kure as yearlings via the Head Start enclosure.

### **Interatoll Movement**

Interatoll movement was documented for 16 seals that made a total of 17 movements between Kure Atoll and either Midway Atoll or Pearl and Hermes Reef (Table 7.5a and b).

### **Factors Affecting Survival**

Attacks by large sharks and entanglement in debris led to eight life-threatening conditions which resulted in the confirmed deaths of two animals and the probable death of another seal (Table 7.6). A subadult female from FFS, rehabilitated and released at Kure in 1995, died as a result of a shark bite wound to the ventrum. A male weaned pup was sighted with a large gaping shark bite wound covering most of his right side; the pup subsequently disappeared. Four entanglements were observed: an adult female from FFS, rehabilitated and released at Kure in 1991, and two male weaned pups were seen entangled, and subsequently released by observers. One of these pups was observed entangled, and then released on two separate occasions.

### **ACKNOWLEDGMENTS**

We acknowledge the officers and crew of the NOAA ship *Townsend Cromwell* for logistical support and for transport to and from Kure Atoll. We also thank the State of Hawaii Division of Forestry and Wildlife and the U.S. Coast Guard cutter *Washington* for logistical support.



## **TABLES**



Table 7.1.--Summary statistics for atoll censuses ( $n = 15$ ) of Hawaiian monk seals at Kure Atoll from May 11 to July 25, 1996.

Size/Sex	Mean number of individuals	Standard deviation
Adults	21.1	5.2
Male	6.3	2.1
Female	11.4	3.2
Unknown	3.4	1.6
Subadults	14.3	3.7
Male	6.1	2.8
Female	6.5	1.4
Unknown	1.7	1.2
Juveniles	2.9	1.2
Male	0.9	1.0
Female	1.3	0.7
Unknown	0.7	0.8
Pups	8.2	3.1
Male	5.3	1.5
Female	2.3	1.8
Unknown	0.7	0.9
Nonpup Total	38.5	7.7
Grand Total	46.7	9.0

Table 7.2.--Composition of the Hawaiian monk seal population at Kure Atoll during the spring and summer of 1996. Includes all pups born during the calendar year.

Size	Number of seals				Sex ratio male:female
	Male	Female	Unknown	Total	
Adults	24 <sup>a</sup>	35	0	59 <sup>a</sup>	0.7:1
Subadults	14	16	0	30	0.9:1
Juveniles	4	4	1	9	1.0:1
Pups	10	7	0	17	1.4:1
Nonpup Total	42 <sup>a</sup>	55	1	98 <sup>a</sup>	0.8:1
Grand Total	52 <sup>a</sup>	62	1	115 <sup>a</sup>	0.8:1

<sup>a</sup>A small, but unknown, number of adult males remained unidentified at the end of the field season.

Table 7.3.--Summary of tagged known-age seals born at Kure Atoll and resighted there in 1996.

Age (years)	Sex	Number originally tagged	Number resighted in 1996
15	Male	3	2
	Female	5	1
14	Male	1	0
	Female	3	2
13	Male	4	2
	Female	0	--
12	Male	4	1
	Female	2	2
11	Male	2	1
	Female	3	3
10	Male	1	1
	Female	0	--
9	Male	1	1
	Female	3	2
8	Male	2	2
	Female	5	2
7	Male	5	2
	Female	4	1
6	Male	3	0
	Female	3	2
5	Male	7	4
	Female	6	3
4	Male	5	3
	Female	8	5
3	Male	9	5
	Female	4	2
2	Male	3	0
	Female	0	--
1	Male	6	4
	Female	5	4

Table 7.4a.--Summary of Hawaiian monk seals born at Kure Atoll in 1996.

Event	Number of pups			
	Male	Female	Unknown	Total
Born	10	7	0	17
Died prior to weaning	0	1	0	1
Weaned	10	6	0	16
Tagged	10	6	0	16

Table 7.4b.--Summary of nursing periods and measurements of weaned pups at Kure Atoll in 1996. Nursing periods were calculated where both birth and weaning date ranges were  $\leq 4$  days. All measurements were taken within 2 weeks after weaning.

	Nursing period (d)	Axillary girth (cm)	Straight dorsal length (cm)
Mean	33.8	102.6	124.6
St. Dev.	3.5	9.0	8.0
<i>n</i>	3	7	7

Table 7.5a.--Known movement of Hawaiian monk seals to Kure Atoll from other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Original location	Number, size, and sex class
Pearl and Hermes Reef	1 adult male, 1 adult female, 1 subadult male
Midway Atoll	2 adult males, 6 adult females, 1 subadult male

Table 7.5b.--Known movement of Hawaiian monk seals from Kure Atoll to other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Destination	Number, size, and sex class
Pearl and Hermes Reef	2 adult males, 1 subadult male
Midway Atoll	1 adult male, 1 adult female

Table 7.6.--Factors affecting Hawaiian monk seal survival at Kure Atoll in 1996.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
<b>Attack by Large Shark</b>					
Subadult	Male	1	1	0	0
Subadult	Female	1	0	1	0
Weaned pup	Male	1	1	0	1
<b>Mounting by Males</b>					
(none observed)					
<b>Entanglement</b>					
Adult	Female	1 <sup>a</sup>	0	0	0
Weaned pup	Male	3 <sup>a</sup>	0	0	0
<b>Unknown</b>					
Nursing pup	Female	1	0	1	0

<sup>a</sup>All entangled seals released by observers.

**CHAPTER 8. THE HAWAIIAN MONK SEAL ON  
NIHOA AND NECKER ISLANDS AND GARDNER PINNACLES, 1996**

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Craig Rowland, Joy A. Seymour, and Suzanne Russell

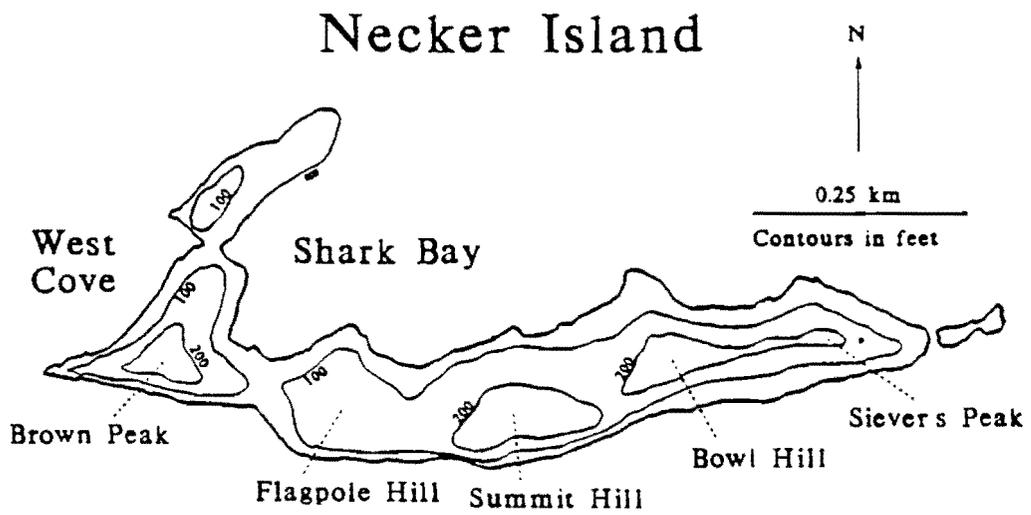
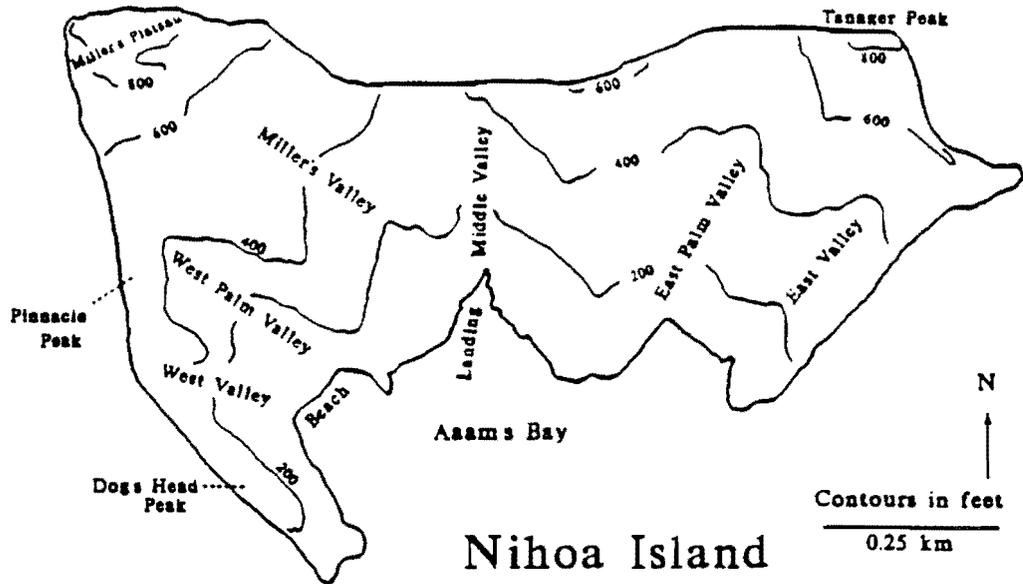


Fig. 8.1 Nihoa and Necker Islands in the Northwestern Hawaiian Islands.

Nihoa Island (lat. 23°04'N, long. 161°55'W), Necker Island (lat. 23°36'N, long. 164°42'W), and Gardner Pinnacles (lat. 25°00'N, long. 167°55'W) are located ca. 450, 750, and 850 km, respectively, northwest of Oahu in the Northwestern Hawaiian Islands (Fig. 1.1). These islands lie within the Hawaiian Islands National Wildlife Refuge. Although endangered Hawaiian monk seals use these islands, pup production is limited by lack of haulout area.

## **RESEARCH**

In 1996, data were collected by the U.S. Fish and Wildlife Service at Nihoa Island during July 9-26. The National Marine Fisheries Service collected data at Necker Island on April 19 and August 4 and at Gardner Pinnacles on August 2. The perimeters of Nihoa and Necker Islands were divided into 3 and 10 sectors, respectively, using natural landmarks (Fig. 8.1). Gardner Pinnacles was considered 1 sector. Beginning in 1989, the monk seal population at French Frigate Shoals began to decline, largely from poor survival of juvenile seals. In 1996, research objectives specific to the Nihoa and Necker Islands and Gardner Pinnacles monk seal populations included assessment of the extent of migration from French Frigate Shoals to these locations to determine if migration may have contributed to the decline observed at French Frigate Shoals.

### **Censuses and Patrols**

Three counts were conducted on Nihoa Island by one observer during different times of the day for approximately .2 to 1.4 hours. Incidental sightings were also conducted opportunistically to read tags previously applied to seals.

One census was conducted on Necker Island by one observer on April 19, beginning at 1000 Hawaii standard time and continuing for approximately 5 hours. One incidental patrol was conducted on August 4 to read tags previously applied to seals. Data from satellite-tagged seals also provided sighting data at Necker Island.

One census was conducted at Gardner Pinnacles by one observer on August 2, beginning at 1715 Hawaii standard time and continuing for .9 hour.

### **Individual Identification**

On Nihoa Island, two seals were identified by existing tags: one unknown-aged male seal tagged on Laysan Island that later translocated to the main Hawaiian Islands in 1994, and one female tagged at French Frigate Shoals.

On Necker Island, eight seals (four males, four females) were identified by existing tags applied at French Frigate Shoals, including a 2-year-old female, two 7-year-old males, a 9-year-old male, a 9-year-old female, a 12-year-old male, and two 12-year-old females. Four of these animals had been seen at French Frigate Shoals in 1995. It is unlikely that migration to Necker Island was the reason for the recent decline of juvenile seals at French Frigate Shoals as only one tagged seal was immature and 96% of the seals present during the census were adults.

On Gardner Pinnacles, four male seals were identified by tags or satellite tag transmissions, including an adult of unknown age, a 10-year-old, an 11-year-old, and a 12-year-old.

### **Collection of Samples**

No samples were collected.

## **RESULTS**

### **Population Abundance and Composition**

The means ( $\pm$ SD) for three counts conducted on Nihoa Island were 20 seals ( $\pm$ 4.4) including pups, and 18 seals ( $\pm$ 3.5) excluding pups. Because of limited effort, the composition of the spring-summer population was not determined.

The census total conducted on Necker Island was 28 seals; no pups were observed. Because of limited effort, the composition of the spring-summer population was not determined.

The Gardner Pinnacles census total was three seals; no pups were observed. Because of limited haulout space on sloping rocks at low tide, there may not be a resident population present.

### **Reproduction**

In 1996, at least three pups (all nursing) were born on Nihoa Island and at least two pups (one weaned male and one nursing female) were born on Necker Island. No pups were sighted at Gardner Pinnacles.

### **Interatoll Movement**

Interatoll movement was documented for three seals that made a total of three movements between Nihoa Island and the main Hawaiian Islands and French Frigate Shoals (Tables 8.1a and b). Interatoll movement was documented for eight seals that made a total of 12 movements between Necker Island and French Frigate Shoals (Tables 8.1c and d). In 1996, three of the adult females sighted at Necker Island subsequently moved to French Frigate

Shoals where they pupped. Four seals made a total of six trips between Gardner Pinnacles and French Frigate Shoals (Tables 8.1e and f).

### **Factors Affecting Survival**

One female on Nihoa Island received a potentially life-threatening injury, probably caused by a cookie cutter shark, and survived. Factors affecting survival were not observed on Necker Island or Gardner Pinnacles in 1996.

### **ACKNOWLEDGMENTS**

We acknowledge the support of the U.S. Fish and Wildlife Service, Hawaiian Islands National Wildlife Refuge staff, and the captain, officers, and crew of the NOAA ship *Townsend Cromwell*, R/V *Machias*, and the U.S. Coast Guard Vessel *Washington* for logistical assistance.



## **TABLES**



Table 8.1a.--Known movement of Hawaiian monk seals to Nihoa Island from other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Original location	Number, size, and sex class
Main Hawaiian Islands	1 adult male

Table 8.1b.--Known movement of Hawaiian monk seals from Nihoa Island to other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Destination	Number, size, and sex class
French Frigate Shoals	1 adult male, 1 adult female

Table 8.1c.--Known movement of Hawaiian monk seals to Necker Island from other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Original location	Number, size, and sex class
French Frigate Shoals	4 adult males, 3 adult females, 1 subadult female

Table 8.1d.--Known movement of Hawaiian monk seals from Necker Island to other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Destination	Number, size, and sex class
French Frigate Shoals	1 adult male, 3 adult females

Table 8.1e.--Known movement of Hawaiian monk seals to Gardner Pinnacles from other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Original location	Number, size, and sex class
French Frigate Shoals	4 adult males

Table 8.1f.--Known movement of Hawaiian monk seals from Necker Island to other locations in 1996, summarized by movements between two locations. No seals made more than one trip.

Destination	Number, size, and sex class
French Frigate Shoals	2 adult males



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## **APPENDIXES**



Appendix A.--Reports summarizing annual field research on the  
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Service and collaborating scientists.

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Appendix B.--Hawaiian monk seal census form and 1996 census form  
directions.

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(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				
							No.	?	No.	L/R	Col	?	%	?		Line No.	Dist	Behavior			Type	Codes			
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NOTES:

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**1996  
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 1996).

P = Patrol: A complete, untimed count where size, sex, ID, and disturbance are recorded.

I = Incidental observ. (limit these, FWS data, etc).

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 one person conducts the census, then combine page numbers; person A has pages 1 and 2, while person B has pages 3 and 4 of a four-page census day.

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

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

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

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

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

**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-hour clock

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

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

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

Code size as follows

Nursing pups

P = Nursing pup  
P1 = Nursing pup, wrinkles  
P2 = Nursing pup, no wrinkles  
P3 = Nursing pup, blimp, black  
P4 = Nursing pup, molting  
P5 = Nursing pup, molted  
PW = Prematurely weaned/undersized weaned pup (weaned  $\leq 2$  wks ago and  $< 90$  cm girth)  
W = Weaned pup

Immatures

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

Adults

A = Adult

Unknowns

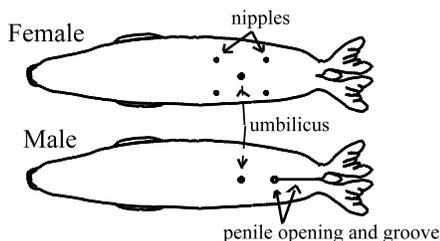
U = Seal of unknown size

Turtles

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

**SEX**

M = Male  
 F = Female  
 U = Unknown



**BEACH POS.**

Location of seal or turtle when observer comes abreast of animal (e.g., if seal is seen in the water from a distance and yet is on the beach when the observer comes abreast, the seal is recorded as being on the beach). When recording male-male interactions (at Laysan and Lisianski Islands in 1996), 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 #)  
 6 = temporary number valid for this survey only, use for data types C, A, B, or P (for unident. cruisers moving ahead of you on census, etc.).  
 blank = number is certain and complete if present

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

**? column:**

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

**TAG NO.** 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 five 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  $\leq 2$  body lengths  
 2 = seal alerted to observer and moved  $> 2$  body lengths  
 3 = seal alerted to observer and fled into water
- ASSOCIATION DATA** 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  $\leq 10$  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  $\leq$ 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,  $\leq$ 2 body lengths\*
    - C2 = chase,  $>$ 2 body lengths\*
  - D = seal displaces another (see CONTEST RULES)\*
  - F = flee
    - F1 = flee/move away,  $\leq$ 2 body lengths
    - F2 = flee/move away,  $>$ 2 body lengths move away
  - J = joust
    - J1 = joust  $\leq$ 30 s\*
    - J2 = joust  $>$ 30 s\* spar/fight\*
  - M = mount/attempted
    - M1 = mount/attempted mount  $\leq$ 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  $\leq$ 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.....Q  
 W.....W  
 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/reapplied post-molt  
 W = weaning, 1st sighting postweaning (pup)  
 X = pup exchange, 1st sighting after exchange (mom and pup)  
 Y = disturbance is to "bystander" seal during non-survey activity such as tagging.

FOR DATA TYPE "T", STATUS OF NON-ACTIVE TAGS:

F = found

R = recovered from seal in hand

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

TYPE	CODES COLUMN	CONTENT
F = survival factor		ONLY RECORD RESIGHT OF A SURVIVAL FACTOR AS AN EVENT IF THERE ARE IMPORTANT CHANGES TO DOCUMENT, SUCH AS A NEW WOUND, HEALING, DEATH, ETC.
	1-3	Survival Factor number
	4	Factor Type. If seal is dead, always record factor type "D" on ORIGINAL LINE. For mobbings/harassments, always code a census entry with factor type "M" for the victim at the beginning and end of the incident. Otherwise, you only need to record the most appropriate factor type if more than one applies. D = death W = wound E = entanglement V = very thin (emaciated) I = illness/abnormal M = mobbing/harassment O = other
	5	Participant type (for mobbings/

harassments only)  
 V = victim/subject  
 M = male aggressor

H = handling of wild seal

FOR SEAL CAPTURES OR RELEASES, RECORD DETAILS ON EITHER THE CAPTURE OR RELEASE FORM. OTHERWISE, RECORD DETAILS ON THE TAGGING/HANDLING CARD.

1 Handling type  
 T = tagging (w/ restraint)  
 M = measuring (includes weighing)  
 A = all (both tagging and measuring)  
 R = remote tagging  
 D = disentangle  
 I = instrument  
 B = bleeding  
 C = take into captivity  
 F = free from captivity  
 O = other

**TYPE**

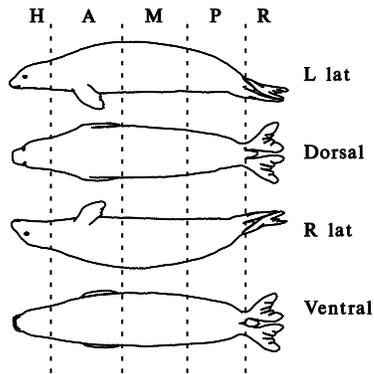
**CODES  
 COLUMN**

**CONTENT**

P = photo

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

1 Type of photo  
 S = slide  
 P = print  
 2-3 Roll number (pad with zeros)  
 4-5 Frame number (pad with zeros)  
 6 Side  
 L = left lateral or flipper  
 R = right lateral or flipper  
 D = dorsal side  
 V = ventral side  
 B = both (used for rear flippers only)  
 X = other, describe in handwritten NOTES  
 7 Part



- H = head
- A = anterior body (neck and shoulders)
- M = midbody (behind foreflippers and before posterior)
- P = posterior body (behind midbody and before rear flippers)
- F = foreflipper; write whether dorsal/ventral in comments
- R = rearflipper; write whether dorsal/ventral in comments
- O = overall view of a particular side
- X = other, describe in comments

8 Purpose

I = identification

- F = survival factor (link with survival factor EVENT using continuation lines)
- X = other, describe in comments

**TYPE**

**CODES COLUMN**

**CONTENT**

T = tag condition

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

- 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 your census form. All editing after this point should be in orange. After completing the entry and checking program, check off and initial the ENTERED box on the census form.
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 activities 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 during a survey (i.e., for a cruiser moving ahead of you), assign it a temporary number in a series reserved for unidentified seals, and code a 6 in the temp ? field.

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 original tag color, not the color that a tag has faded to. See the Tag Sample Kit in the Bible.

Original tag color: Faded tag may appear:

**Temple Tags:**

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

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

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

9. **Always record disturbance.** You must be honest about this! Fill out a census form to document disturbance if you disturb a seal when you are not otherwise collecting data. On a census or atoll count, it is also assumed that condition and molt data will be taken. At locations other than Laysan and Lisianski Islands, it is not assumed that association data will be taken on census or atoll count in 1996. 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 Q behavior code. At Laysan and Lisianski Islands in 1996, 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 Q 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 Q, Z, or X behavior only, with no line number or distance, or have a line number, a distance, and some behavior code (other than Q or X) all present. Don't record behaviors of an animal after it has been disturbed by the observer.

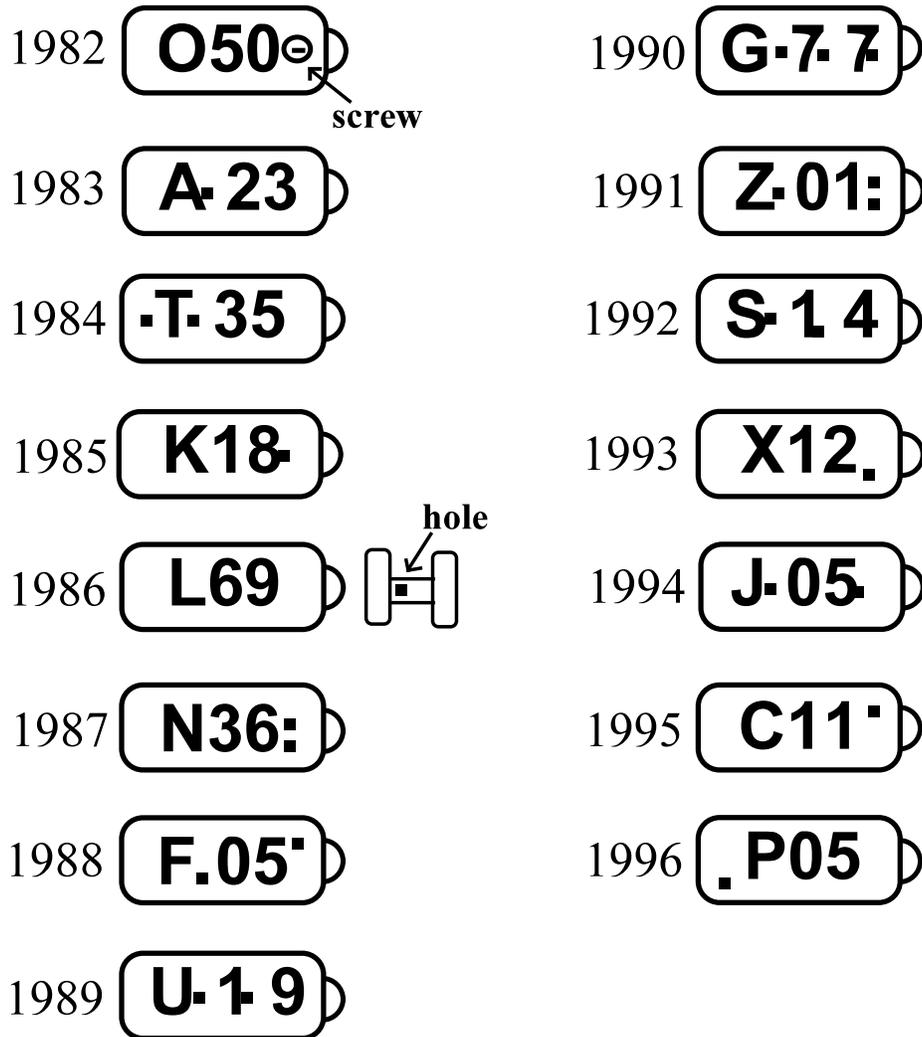
11. All associations should be in pairs, i.e., between animals on two different lines. If the behavior is active, you should fill in the line numbers, distances, and behavior codes for both animals involved in the association. If the behavior is N or L, however, you may record the association on only 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  $\geq 1$ , regardless of other behaviors
4. Definition of winner or loser adult male:

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

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



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