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THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND, 1990

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

NOAA Technical Memorandum NMFS

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ABSTRACT

The endangered Hawaiian monk seal, *Monachus schauinslandi*, was studied on Laysan Island in the Northwestern Hawaiian Islands during 10 April-9 August and 14 October-4 November 1990. Data were collected on haul-out, behavior, and reproductive patterns; population structure; and factors affecting survival (primarily male aggression towards adult female and immature seals). Mean (\pm SD) beach counts during the spring and summer were 80.9 seals (\pm 12.8) including pups and 72.2 (\pm 11.6) excluding pups. The total spring-summer population was 233 seals. The sex ratio of adult males to adult females was 1.54:1. Seventeen pups were born, and 29% of the adult-sized females gave birth. The mean nursing period was 39.0 days (\pm 4.6) for 10 pups, and the mean girth, straight dorsal length, and weight measurements for weaned pups were 103.6 cm (\pm 9.3, $n = 16$), 126.0 cm (\pm 6.2, $n = 16$), and 72.5 kg (\pm 12.6, $n = 7$), respectively. A total of 17 weaned pups, 5 subadults, 57 adult males, and 19 adult females were tagged. Interatoll movement was documented for 12 seals, which moved between Laysan Island and either Lisianski Island, French Frigate Shoals, or Pearl and Hermes Reef. At least 29 potentially life-threatening conditions were found in all age groups of monk seals, resulting in the death or probable death of 6 animals. Of these 6 animals, 1 death and 1 probable death were related to injuries from male mounting. Though no seals were seen entangled, 781 pieces of debris capable of entangling seals were inventoried and destroyed. Tissue plugs were collected from 97 animals for DNA analysis, two necropsies were performed, and four spewings were collected for diet analysis.

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INTRODUCTION

Laysan Island (lat. 25°42'N, long. 171°44'W), located in the Northwestern Hawaiian Islands and 709 miles northwest of Honolulu, is within the Hawaiian Islands National Wildlife Refuge. It is one of the major breeding and haul-out areas for the endangered Hawaiian monk seal, *Monachus schauinslandi*. Intensive research to monitor and enhance the recovery of the Laysan population has been conducted annually since 1977 in 3- to 9-month field camps; research by the National Marine Fisheries Service (NMFS) on Laysan Island began in 1981. Results have been presented in Johnson and Johnson (1978, 1981a, 1981b, 1984) for 1977-80, Knudtson (1981 and 1983) for 1981, Alcorn (1984) for 1982, Alcorn and Buelna (1989) for 1983, Johanos et al. (1987) for 1984, Johanos and Austin (1988) and Becker et al. (1989) for 1985, Alcorn and Westlake (1993) for 1986, and Johanos et al. (1990) for 1988. For information on other past research efforts and on the history, geology, flora, and fauna of Laysan Island, consult Ely and Clapp (1973). Additional historical counts are listed in Hiruki and Ragen (1992).

The data collected during two field camps established on Laysan Island in 1990 are summarized in this report. The primary objective of the spring-summer field season was to monitor the breeding behavior of Hawaiian monk seals by collecting data on haul-out and behavior patterns and male aggression towards adult female and immature seals. Other objectives included conducting beach counts; identifying the entire population and maintaining identification of individual seals by recording natural markings, applying and maintaining bleach marks on adults and subadults, tagging weaned pups and untagged immature seals, and retagging animals with lost or damaged tags; monitoring survival, reproduction, interatoll movement, injuries, entanglements, disappearances, and deaths; measuring weaned pups and yearlings for a growth and condition study; performing necropsies; inventorying and destroying debris capable of entangling seals and turtles; and collecting tissue samples for DNA analysis and spew samples for food habit analysis. The fall field camp focused on tagging adult-sized male and female seals to aid in future identification.

MATERIALS AND METHODS

Data collection by NMFS occurred from 10 April-9 August and 14 October-4 November in 1990. In addition, incidental observations on Laysan Island (e.g., the weaning date, tagging, and measuring of a pup) were documented by U.S. Fish and Wildlife Service (USFWS) personnel during 13 August-12 October and 9-30 November 1990. The USFWS personnel at French Frigate Shoals (FFS) also recorded interatoll movement of a seal from Laysan Island to FFS by December.

Individual Identification

Natural markings, scars, applied bleach marks, and tags were used to identify individual seals. Seals were also classified by size and sex. Procedures for seal identification and size classification are detailed in Stone (1984). Scar cards have been developed annually, and photographs were taken to supplement the scar card drawings. Both the scar cards and photographs were added to the individual identification files initiated in 1982. A total of 177 non-pups sighted in 1990 were bleach-marked either post-molt 1989 or during 1990 using the methods in Stone (1984) and the bleach solution described by Johanos et al. (1987). When possible, these seals were followed through their molt and were remarked to maintain their identities.

The population total included all unique individuals seen alive on Laysan Island during March to August and all pups born during the year. If a seal was seen at more than one island during this period, it was included in the population where it was first seen unless it pupped. A parturient female was always included in the population where it pupped if it was seen there anytime from March to August.

Tagging

Temple Tags and Passive Integrated Transponders (PIT; described in Thomas et al. 1987) were applied to animals on Laysan Island in 1990. Two different series were used for the Temple Tags. Tan "cohort" tags, uniquely coded to indicate location (by color), year of birth (by letter prefix), and individual identification (by numerical sequence), were applied to all weaned pups. A second tan series was applied to immature and adult-sized seals whose birth years and locations were unknown. These tags indicate the island where the animal was tagged (by color) and individual identification (by numerical sequence). A single tag was placed at the trailing edge of each hind flipper in the webbing, usually between the fourth and fifth digits (Gilmartin et al., 1986).

All pups were tagged as soon as possible after weaning. Seals identified with broken or lost Temple Tags were opportunistically retagged with one or two tags during the spring-summer and fall camps. To avoid potential disturbance or behavioral alteration effects during the breeding season, unknown-aged, adult-sized males and up to one-half of the adult-sized female population were Temple-tagged during the fall.

Adult-sized, unknown-aged males were tagged with one (in the left hind flipper) or two (one in each hind flipper) PIT tags at the same time they received Temple Tags. The tags were inserted about 1 cm below the skin and underlying blubber, on the dorsal side of the hind flipper approximately 3.5 cm posterior of the ankle joint. The area of implantation was cleansed with an

iodine scrub prior to injection. Tags were implanted with a sterile syringe and 12-gauge needle. Antibiotic ointment was used to hold the PIT tag in the needle until insertion. Each PIT tag was read immediately before and after application with a portable reader held less than 8 cm from the tag to verify the tag number and that implantation was successful.

For tagging, lone seals were captured and restrained with either a stretcher or hoop net with a head covering. Restraint and recovery times were recorded for each tagging event. A seal was considered "recovered" when it had regained a normal breathing pattern, and for adults, recovery also included when the animal entered the water. To minimize heat stress, tagging of immature and adult-sized seals was done in the morning or evening. When possible, adult-sized seals were dragged in the net to the waterline after tagging and then released. All seals handled for tagging were cooled with sea water prior to release.

Censuses and Patrols

The primary methods of data collection were censuses and patrols which were scheduled to ensure that the entire 11 km perimeter, divided into 20 approximately equal-sized sectors (Alcorn, 1984), was monitored at least once each day during 13 April to 9 August 1990. Areas where marked male aggression had been observed, sectors 1-8 and 18-20 (Johnson and Johnson, 1981b; Alcorn, 1984; Johanos et al., 1987; Johanos and Austin, 1988; Alcorn and Buelna, 1989; Johanos et al., 1990; and Alcorn and Westlake, 1993), were monitored twice daily on 65% (76/116) of the data collection days. No censuses or formal patrols were conducted during the fall field camp. Census and patrol data were recorded on the standard census form (Forsyth et al., 1988), following the 1990 coding instructions (Lee et al., 1993).

Censuses consisted of timed, standardized beach counts of seals conducted at 1300 h every third day during which the entire island was surveyed (Johanos et al., 1987). To avoid disturbing seals and affecting census counts, handling of animals and bleaching activities were typically conducted after the completion of the census.

Patrols consisted of untimed surveys of all or a portion of the island perimeter. Information collected during patrols was similar to that collected during censuses. Standardized patrols focused on activity patterns of adults and large subadults to document male aggression and detect mobbing incidents in which multiple males attempted to mate with a single seal, usually an adult female, causing injury or death of that seal (e.g., Alcorn, 1984). During these patrols, attention was directed out to sea as much as possible, as mobbings have been documented most frequently in the water.

During all observation periods (i.e., censuses, patrols, and incidental sightings), observers attempted to minimize seal disturbance by walking above the beach crest and using vegetation for cover. Additionally, special efforts were directed toward observation and documentation of (1) births, pup exchanges, weanings, (2) injuries, (3) entanglements in marine debris, (4) mating activities and male aggression, and (5) deaths.

The pup nursing period was the length of time (days) from the birth of a pup until it weaned. Weaning was defined as the end of the pup's nursing from any female. Temporary breaks in the suckling period were not subtracted from the total length. Nursing periods which were terminated by the death of a pup were excluded from analysis. When the exact date was not known for either a birth or weaning event, but the event was known to have occurred within an interval of ≤ 4 days, the event date was estimated as the midpoint of the interval. If the interval was > 4 days, then the data were not used in this analysis.

Injury types and their probable causes were classified according to descriptions in Hiruki et al. (1993). Injuries considered potentially life-threatening had at least one of the following conditions: (1) three abscesses less than 5 cm or one abscess with a minimum diameter of 5 cm, (2) an amputation of greater than one digit of a flipper (either foreflipper or hind flipper), (3) densely spaced (overlapping) scratches, abrasions, or lacerations (through the skin layer) covering an area equivalent to at least 1/2 of the dorsum, or evidence of extensive underlying tissue damage (including uneven or darkened surface of the injured area, leaching fluids, or impaired seal movement), or (4) three punctures or gaping wounds (missing skin or extending into the fat) less than 5 cm diameter (or largest dimension), or one gaping wound at least 5 cm diameter (or largest dimension).

Male aggression was defined as incidents where adult or subadult males repeatedly bite the dorsum of a subject seal, attempt to mount the subject, and try to prevent its escape. These incidents must either simultaneously involve more than one male aggressor or result in injury to the subject of at least one puncture or gaping wound (missing skin or extending into the fat) or 15 scratches on the dorsum or laterals. Post-mobbing aggregation were defined as groups of males on the beach attending a seal with a new mounting injury, severity described above.

A seal was considered to have probably died if it had an injury with a severity considered potentially life-threatening (described earlier) or was severely emaciated (with extreme loss of weight so that its skeleton was clearly evident) and subsequently disappeared. In addition, one of the following conditions must have been satisfied: (1) the seal must have been lethargic, have trouble moving, or float listlessly in the water,

and it must have disappeared more than 1 week before the end of data collection; or (2) the seal must have been in deteriorating condition (loss of weight, enlargement of abscesses, sloughing of skin), and must not have been seen for at least 10 counts or patrols, or one month, whichever was longer. Nursing pups were considered to have probably died if they disappeared within 3 weeks of birth.

Measurements of Seals

Weaned pups and yearlings were measured as part of a growth study. The axillary girth (American Society of Mammalogists 1967), straight dorsal length (Winchell 1990), and weight were measured. To weigh a seal, three researchers restrained and strapped the animal in a hooded stretcher net which was then manually lifted off the ground and attached to a Detecto 400-lb scale. When possible, weaned pups were measured in conjunction with their tagging. Weighings took place during early morning or evening hours to minimize heat stress. Restraint time did not exceed 15 minutes, and seals were cooled with water and monitored after their release. Since pups lose weight after weaning, only those measurements taken within 2 weeks after weaning were considered comparable and averaged. Additional information on procedures and results will be reported elsewhere.

Collection of Samples

Skin samples (tissue plugs) were collected for DNA analysis from weaned pups, immature seals, adult-sized males and females, and retagged animals during Temple Tag application. The samples were immediately placed on ice packs in coolers and taken back to camp to be frozen. The DNA analyses will be reported elsewhere.

External examinations, including observations, photographs, and measurements, were made of each dead seal recovered. If the death was recent, a necropsy was performed (Winchell 1990), which included an internal examination and collection of samples of tissues, parasites, and stomach contents. Skulls from all animals except nursing pups were collected, flensed, and dried.

Throughout the field season, all nets, lines, and other debris items capable of entangling seals and turtles were collected, inventoried, and destroyed using the methods described in Johanos and Kam (1986). To determine monk seal food habits, spewings were opportunistically collected from any seals (Alcorn 1984). Prey items were then frozen for ciguatera analysis, and these results will be reported elsewhere.

RESULTS AND DISCUSSION

Population Abundance and Composition

The means (\pm SD) for 39 census counts during the spring-summer camp were 80.9 seals (\pm 12.8) including pups, and 72.2 seals (\pm 11.6) excluding pups (Table 1). The total spring-summer population was 233 individuals, 215 excluding pups (Table 2). The sex ratios of non-pup immatures and adults were 1.10:1 (34 males: 31 females) and 1.54:1 (91 males: 59 females), respectively (Table 2). Within the adult class, the male-skewed sex ratio was due to older seals, where the male to female ratio was 1.72:1 (74 males: 43 females); in the seals of adult-size but \leq age 7, the sex ratio was 1.06:1 (17 males: 16 females).

Seventeen weaned pups, three subadults and one adult were tagged during the spring-summer, and a total of 75 adults (57 males and 18 females) were tagged in the fall. Table 3 reports the number of pups tagged on Laysan Island during 1983-89 and resighted there in 1990.

Reproduction

At least 17 pups were born; one pup died prior to weaning (Table 4a). One older (based on his thinner girth and lighter colored pelage) male weaned pup was first sighted on Laysan in July, 3 months after research began, and his birth island was unknown. Seventeen of 59 (29%) adult-sized females gave birth in 1990. Table 4b reports the average nursing period and body measurements of weaned pups in 1990. One birth was observed, and two unusual absences of a lactating female were documented.

Interatoll Movement

Interatoll movement was documented for at least 12 individuals who moved between Laysan Island and either Lisianski Island, French Frigate Shoals, or Pearl and Hermes Reef (Table 5).

Factors Affecting Survival

A total of 29 life-threatening conditions attributed to large shark and male mounting incidents, emaciation, and other/unknown factors were documented and resulted in the death of 4 animals and probable deaths of 2 seals (Table 6). Injuries from male mounting resulted in the death of 1 seal and probable death of another. No seal entanglements were documented.

Collection of Samples

Tissue plugs for DNA analysis were collected from 97 of 98 newly tagged or retagged animals. Necropsies were performed and tissue samples were collected from the two seals that died during

the spring-summer camp. In total, 781 (620 spring-summer camp, 161 fall camp) pieces of potentially dangerous debris that had accumulated since the previous year were inventoried and destroyed during the two field camps. Four spew samples were also collected.

ACKNOWLEDGMENTS

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Table 1.--Summary statistics for Hawaiian monk seal census counts ($n = 39$) on Laysan Island from 16 April to 9 August, 1990.

Size	Mean	Standard deviation
Adults	45.8	6.9
Male	23.9	5.2
Female	19.6	5.8
Unknown	2.2	2.2
Subadults	17.7	7.2
Male	9.4	3.8
Female	7.7	3.9
Unknown	0.5	0.9
Juveniles	8.8	1.9
Male	4.6	1.4
Female	3.7	1.7
Unknown	0.5	0.6
Pups	8.7	2.2
Male	3.3	1.5
Female	4.0	2.2
Unknown	1.4	1.7
Non-pup Total	72.2	11.6
Grand Total	80.9	12.8

Table 2.--Composition of the Laysan Island Hawaiian monk seal population during the spring and summer of 1990. Total includes all pups born during the calendar year.

Size	Number of seals			Sex ratio Male:Female
	Male	Female	Total	
Adults	91	59	150	1.54:1
Subadults	24	21	45	1.14:1
Juveniles	10	10	20	1:1
Pups	9 ^a	9	18 ^a	1:1 ^a
Non-pup Total	125	90	215	1.39:1
Grand Total	134 ^a	99	233 ^a	1.35:1 ^a

^aIncludes one weaned pup who may not have been born on Laysan Island.

Table 3.--Summary of tagged known-age seals born on Laysan Island and resighted there in 1990.

Age (years)	Sex	No. originally tagged	No. resighted
7	Male	10	2
	Female	10	6
6	Male	16	8
	Female	13	6
5	Male	16	5
	Female	14	5
4	Male	15	8
	Female	17	7
3	Male	13	4
	Female	15	9
2	Male	23	6
	Female	17	5
1	Male	16	9
	Female	13	6

Table 4a.--Summary of Hawaiian monk seals born on Laysan Island in 1990.

Event	Number of pups		
	Male	Female	Total
Born	8 ^a	9	17 ^a
Died/probably died prior to weaning	1	0	1
Weaned	7 ^a	9	16 ^a
Tagged	7 ^a	9	16 ^a

^aExcluded older weaned pup whose birth island was not known.

Table 4b.--Summary of nursing period and measurements of weaned pups on Laysan Island in 1990. Nursing periods were calculated where both birth and weaning date ranges were ≤ 4 days. All measurements were taken within 2 weeks after weaning and include three weaned pups with axillary girths ≤ 95 cm.

	Nursing period (days)	Axillary girth (cm)	Straight dorsal length (cm)	Weight (kg)
Mean	39.0	103.6	126.0	72.5
St. Dev.	4.6	9.3	6.2	12.6
n	10.0	16.0	16.0	7.0

Table 5.--Known interatoll movement of Hawaiian monk seals
between Laysan Island and other locations in 1990.

Size	Sex	Number
Between Laysan and Lisianski		
Adult	Male	2
	Female	2
Subadult	Male	1
	Female	2
Between Laysan and French Frigate Shoals		
Adult	Male	1
	Female	3
Between Laysan and Pearl and Hermes Reef		
Adult	Male	1

Table 6.--Factors affecting survival of Hawaiian monk seals observed on Laysan Island in 1990.

Size	Sex	Total	Outcome		
			Injured	Died	Probably died
Attack by Large Shark					
Adult	Male	3	3	0	0
	Female	1	1	0	0
	Unknown	1	1	0	0
Subadult	Male	2	2	0	0
	Female	1	1	0	0
Juvenile	Female	1	1	0	0
Mounting by Males					
Adult	Male	2	2	0	0
	Female	3 ^a	1	1	1 ^a
Juvenile	Male	1	1	0	0
Weaned pup	Female	1 ^b	1	0	0
Entanglement					
None observed					
Emaciation					
Juvenile	Female	1	0	0	1 ^c
Other/Unknown					
Adult	Male	1	0	1	0
	Female	4	4	0	0
Juvenile	Male	1	0	1	0
Nursing pup	Male	1	0	1	0

^aOne seal was injured twice; the first injury of unknown severity occurred 6 days earlier and was not included in the table. This animal's condition deteriorated (pelage of injured area sloughed off, became lethargic, and lost weight), and she was last sighted 1.5 months prior to the end of the summer camp.

^bPup had an axillary girth <95 cm.

^cThis seal was seen regularly; her condition deteriorating (her skeleton evident), and was last sighted 2 months before the end of the summer camp.

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