

# NOAA Technical Memorandum NMFS



**FEBRUARY 1995**

## **THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND, 1991**

Brenda L. Becker  
Kristen E. O'Brien  
Karen B. Lombard  
Leona P. Laniawe

NOAA-TM-NMFS-SWFSC-214

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

## **NOAA Technical Memorandum NMFS**

The National Oceanic and Atmospheric Administration (NOAA), organized in 1970, has evolved into an agency which establishes national policies and manages and conserves our oceanic, coastal, and atmospheric resources. An organizational element within NOAA, the Office of Fisheries is responsible for fisheries policy and the direction of the National Marine Fisheries Service (NMFS).

In addition to its formal publications, the NMFS uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series, however, reflect sound professional work and may be referenced in the formal scientific and technical literature.



## **NOAA Technical Memorandum NMFS**

This TM series is used for documentation and timely communication of preliminary results, interim reports, or special purpose information. The TMs have not received complete formal review, editorial control, or detailed editing.

**FEBRUARY 1995**

# **THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND, 1991**

Brenda L. Becker  
Kristen E. O'Brien  
Karen B. Lombard  
Leona P. Laniawe

Honolulu Laboratory, SWFSC  
National Marine Fisheries Service, NOAA  
2570 Dole Street  
Honolulu, Hawaii 96822-2396

NOAA-TM-NMFS-SWFSC-214

## **U.S. DEPARTMENT OF COMMERCE**

Ronald H. Brown, Secretary

## **National Oceanic and Atmospheric Administration**

D. James Baker, Under Secretary for Oceans and Atmosphere

## **National Marine Fisheries Service**

Rolland A. Schmitten, Assistant Administrator for Fisheries

**ABSTRACT**

The endangered Hawaiian monk seal, *Monachus schauinslandi*, was studied on Laysan Island in the Northwestern Hawaiian Islands during 31 March-22 July 1991. Data were collected on haul-out, behavior, and reproductive patterns; population structure; and factors affecting survival (primarily male aggression toward adult female and immature seals). The means ( $\pm$  SD) for 37 beach counts were 85.9 seals ( $\pm$  9.2) including pups, and 69.1 ( $\pm$  8.0) excluding pups. The total spring-summer population was 248 seals. The sex ratio of adult males to adult females was 1.25:1. Thirty-three pups were born, and 46% of the adult-sized females gave birth. The mean nursing period was 36.3 days ( $\pm$  4.2) for 27 pups, and the mean axillary girth, straight dorsal length, and weight measurements for weaned pups were 103.9 cm ( $\pm$  9.0,  $n = 29$ ), 122.4 cm ( $\pm$  6.5,  $n = 28$ ), and 62.5 kg ( $\pm$  12.8,  $n = 28$ ), respectively. At least 15 seals moved between Laysan Island and either Lisianski Island, French Frigate Shoals, or Pearl and Hermes Reef. Thirty life-threatening conditions were observed, resulting in the confirmed or probable death of six animals. Three of these deaths were attributed to male mounting inflicted injuries. One seal was seen entangled and freed itself, and 1,423 pieces of debris capable of entangling seals were inventoried and destroyed.

## CONTENTS

|  |    |
|--|----|
| Introduction . . . . .                         | 1  |
| Materials and Methods . . . . .                | 1  |
| Individual Identification . . . . .            | 1  |
| Censuses and Patrols . . . . .                 | 2  |
| Natural History Information . . . . .          | 3  |
| Measurements of Seals . . . . .                | 4  |
| Collection of Samples . . . . .                | 4  |
| Results and Discussion . . . . .               | 5  |
| Population Abundance and Composition . . . . . | 5  |
| Reproduction . . . . .                         | 5  |
| Interatoll Movement . . . . .                  | 5  |
| Factors Affecting Survival . . . . .           | 5  |
| Collection of Samples . . . . .                | 6  |
| Acknowledgments . . . . .                      | 6  |
| Citations . . . . .                            | 7  |
| Tables . . . . .                               | 10 |

## INTRODUCTION

Laysan Island (lat. 25°42'N, long. 171°44'W) is located in the Northwestern Hawaiian Islands approximately 709 miles northwest of Honolulu, and is within the Hawaiian Islands National Wildlife Refuge. This island 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 monk seal population has been conducted annually since 1977 in 3- to 9-month field camps; 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, Becker et al. (1994) for 1987 and 1989, Johanos et al. (1990) for 1988, and Lombard et al. (1994) for 1990. Additional historical monk seal counts are listed in Hiruki and Ragen (1992). The data collected on the Hawaiian monk seal on Laysan Island in 1991 are summarized in this report.

The primary objective of the field season was to monitor breeding activity by collecting data on haul-out and behavior patterns, particularly male aggression toward adult female and immature seals. Other objectives included: (1) conducting beach counts; (2) identifying all individuals in the population; (3) tagging weaned pups and untagged immature seals, and retagging animals with lost or damaged tags; (4) monitoring survival, reproduction, movement between populations, injuries, and entanglements; (5) measuring weaned pups, yearlings, and two-year-olds for a growth and condition study; (6) performing necropsies, primarily to determine cause of death; (7) inventorying and destroying debris capable of entangling seals and turtles; and (8) collecting tissue samples for DNA analysis of paternity patterns and genetic variation within and among populations, and scat and spew samples for food habit analysis.

## MATERIALS AND METHODS

Data were collected by NMFS personnel during 31 March-22 July in 1991. Additional data (e.g., 10 birth dates, four weaning dates, tagging of two pups, two injuries, one death, and debris inventory) were collected by U.S. Fish and Wildlife Service (USFWS) personnel on Laysan Island during 2 February-30 March and 31 July-31 December 1991.

### Individual Identification

Seals were classified by size and sex (Stone 1984). Individual animals were identified on the basis of natural markings, scars, applied bleach marks, and tags; scar cards drawings and photographs were added to the individual identification files initiated in 1982. A total of 182

individuals (primarily adults and subadults) sighted in 1991 were bleach-marked (Stone 1984, Johanos et al., 1987) either post-molt in 1990 or during 1991. In addition, ten nursing pups were bleach-marked in 1991. When possible, adults and subadults were monitored through their molt and re-marked to maintain their identities.

The population total included all individuals seen alive on Laysan Island during March through July and all pups born during the year. If a seal were 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 she pupped if she were seen there anytime from March to August.

All weaned pups were tagged with tan "cohort" (Lombard et al., 1994) Temple tags and Passive Integrated Transponders (PIT; described in Thomas et al., 1987). A single Temple tag was placed in each hind flipper at the trailing edge of the webbing, usually between the fourth and fifth digits (Gilmartin et al., 1986). A single PIT tag was inserted on the dorsal side of each hind flipper (Lombard et al., 1994). One adult seal was retagged with two additional Temple tags.

### **Censuses and Patrols**

The primary methods of data collection were censuses and patrols, which were scheduled to ensure that the 11-km island perimeter (divided into 20 approximately equal-sized sectors; Alcorn, 1984) was monitored at least once each day during 5 April to 22 July 1991. Special attention was directed toward documentation of (1) births, pup exchanges, weanings, (2) injuries, (3) entanglements in marine debris, (4) mating activities and male aggression, and (5) deaths. 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 43% (44/102) of the data collection days. Census and patrol data were recorded on the standard monk seal census form (Forsyth et al., 1988), following the 1991 coding instructions (NMFS, unpublished). Observers attempted to minimize seal disturbance by walking above the beach crest and using vegetation for cover.

Censuses consisted of timed, standardized beach counts of seals during which the entire island was surveyed (Johanos et al., 1987). As seals spend approximately one-third of their lives on land, the census counts only provide an index of the total population. Census counts began at 1300 and were conducted

every third day. On census days, activities which might disturb seals were 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. By definition, a mobbing incident occurred when 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.

### **Natural History Information**

The nursing period for a pup was estimated as the length of time (days) from birth to weaning. Temporary breaks in the period were not subtracted from the total. When the exact date was not known for either birth or weaning, but the event was known to have occurred within an interval of  $\leq 4$  days, the event date was estimated as the mid-point of the interval. If the interval was  $> 4$  days, the data were not used for further analyses. Calculation of the mean nursing period was based on data from pups that survived the entire period.

Injury types and their probable causes were classified according to descriptions in Hiruki et al. (1993). Injuries considered life threatening satisfied at least one of the following conditions: (1) three abscesses  $< 5$  cm diameter or one abscess  $\geq 5$  cm in diameter; (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 mobility of the seal); or (4) three punctures or gaping wounds (missing skin or extending into the fat)  $< 5$  cm in diameter (or largest dimension), or one gaping wound  $\geq 5$  cm in diameter (or largest dimension).

Male aggression was defined to include incidents where adult or subadult males repeatedly bit the dorsum of a subject seal, attempted to mount the subject, and tried to prevent its escape. These incidents must have either simultaneously involved more than one male aggressor, or resulted in injury to the subject including at least one puncture or gaping wound (missing skin or extending into the fat) or 15 scratches on the dorsal or lateral surfaces. Post-mobbing aggregations were defined as groups of males on the beach attending a seal with a new mounting injury of severity described above.



A seal was considered to have died if it disappeared following an injury with a severity considered life threatening (described earlier) or had been severely emaciated (with extreme loss of weight, so that its skeleton was clearly evident), and one of the following conditions was observed: (1) the seal was lethargic, had trouble moving, or floated listlessly in the water, and disappeared more than 1 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 was not seen for at least 10 counts or patrols, or 1 month, whichever was longer. In addition to the above, nursing pups were considered to have died if they disappeared within 3 weeks of birth.

### **Measurements of Seals**

The axillary girth (American Society of Mammalogists, 1967), straight dorsal length (Winchell, 1990), and weight (Lombard et al., 1994) were measured for weaned pups, yearlings, and 2-year-olds. When possible, weaned pups were measured in conjunction with their tagging. Since pups lose weight after weaning, only those measurements taken within 2 weeks after weaning were used to determine mean weaning girth for the season. Additional information on procedures and results will be reported elsewhere.

### **Collection of Samples**

Tissue samples for DNA analysis were collected during Temple tag application (skin tissue plugs) and necropsies (heart and skin tissues). These samples were immediately placed on ice packs in coolers and frozen later. The results of DNA analyses will be reported elsewhere.

External examinations, including observations, photographs, and measurements, were made of each dead seal recovered to assess cause of death and age/size specific mortality rates. If the death was recent, a necropsy was performed (Winchell, 1990), which included an internal examination, and collection and fixation of samples of tissues, parasites, and stomach contents. Skulls from all animals except nursing pups were collected, flensed, and dried for evaluation of skull characteristics and of aging.

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, scats from animals of known size and sex and all spewings were

opportunistically collected following the methods in Alcorn (1984). Prey items from spewings were frozen for ciguatera analysis. Results of food habits and ciguatera analyses will be reported elsewhere.

## **RESULTS AND DISCUSSION**

### **Population Abundance and Composition**

The means ( $\pm$  SD) for 37 census counts were 85.9 seals ( $\pm$  9.2) including pups, and 69.1 ( $\pm$  8.0) excluding pups (Table 1). The total spring-summer population was 248 individuals, or 215 excluding pups (Table 2). Counts are reported both with and without pups; with pups for consistency with historical information; without pups as these counts are a less variable index of the total population. The sex ratios for non-pup immatures and for adults were 1.50:1 (33 males: 22 females) and 1.25:1 (89 males: 71 females), respectively (Table 2). Within the adult size class, the skewed sex ratio was due to older seals (> age 8), where the male to female ratio was 1.64:1 (69 males: 42 females). For the seals of adult-size but  $\leq$  age 8, the sex ratio was 0.69:1 (20 males: 29 females). The number of pups tagged on Laysan Island during 1983-90 and resighted at the island in 1991 is reported in Table 3.

### **Reproduction**

Thirty-three pups were born; two of which died prior to weaning (Table 4). The birth rate for adult-sized females was 0.46 (33 births per 71 females). Of the 31 weaned pups, the average nursing period was measured for 27, and 29 were measured within 2 weeks after weaning (Table 5). Five pup exchanges, five unusual absences of lactating females, and one incident of a lactating female attending two nursing pups for a short period were documented.

### **Interatoll Movement**

Known interatoll movement was documented for 15 individuals which moved between Laysan Island and either Lisianski Island, French Frigate Shoals, or Pearl and Hermes Reef (Table 6).

### **Factors Affecting Survival**

A total of 30 life-threatening conditions, including attacks by large sharks, male mounting incidents causing severe injuries, entanglement, asphyxiation, and unknown factors, were documented and resulted in the confirmed deaths of four animals and probable

deaths of two others (Table 7). Although many animals had recent dorsal injuries indicating mounting by males (Table 7), none of these incidents were observed. Severe injuries from mounting by males accounted for 50% (3 of 6) of the deaths.

### Collection of Samples

Tissue samples for DNA analysis were collected from 32 tagged seals and two freshly dead animals. Necropsies were performed and tissue samples were collected from three seals that died during the season. In total, 1,423 pieces of potentially dangerous debris that had accumulated since the previous fall were inventoried and destroyed during the field camp. For diet analysis, 20 scat and seven spew samples were also collected.

### ACKNOWLEDGMENTS

We acknowledge the support of the USFWS, Hawaiian Islands National Wildlife Refuge staff and the captains and crew members of the Coast Guard cutter *Sassafras* and the NOAA ship *Townsend Cromwell*. Special thanks are extended to USFWS personnel Steve Barclay, Pam Bruce, Randall Hertzell, Shawne Leasure, Jeffrey Marks, and Robert Rydell for their data collection and assistance. We also thank Ancel Johnson and Marc Webber for their valuable comments on this manuscript. The work was authorized by the USFWS special use permit No. HWN-04-9152670 and MMPA/ESA No. 657 and 707.

## CITATIONS

- Alcorn, D. J.  
1984. The Hawaiian monk seal on Laysan Island: 1982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-42, 37 p.
- Alcorn, D. J., and E. K. Buelna.  
1989. The Hawaiian monk seal on Laysan Island, 1983. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-124, 46 p.
- Alcorn, D. J., and R. L. Westlake.  
1993. The Hawaiian monk seal on Laysan Island, 1986. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-191, 25 p.
- American Society of Mammalogists, Committee on Marine Mammals.  
1967. Standard Measurements of Seals. J. Mammal. 48:459-462.
- Becker, B. L., R. J. Morrow, and J. K. Leialoha.  
1989. Censuses and interatoll movements of the Hawaiian monk seal on Laysan Island, 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-135, 25 p.
- Becker, B. L., P. A. Ching, L. M. Hiruki, and S. A. Zur.  
1994. The Hawaiian monk seal on Laysan Island, 1987 and 1989. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-213, 20 p.
- Forsyth, R. G., D. J. Alcorn, T. Gerrodette, and W. G. Gilmartin.  
1988. The Hawaiian monk seal and green turtle on Pearl and Hermes Reef, 1986. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-107, 24 p.
- Gilmartin, W. G., R. J. Morrow, and A. M. Houtman.  
1986. Hawaiian monk seal observations and captive maintenance project at Kure Atoll, 1981. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-59, 9 p.
- Hiruki, L. M., W. G. Gilmartin, B. L. Becker, and I. Stirling.  
1993. Wounding in Hawaiian monk seals (*Monachus schauinslandi*). Can. J. Zool. 71:458-468.
- Hiruki, L. M. and T. J. Ragen.  
1992. A compilation of historical Hawaiian monk seal, *Monachus schauinslandi*, counts. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-172, 183 p.
- Johanos, T. C. and S. L. Austin.  
1988. Hawaiian monk seal population structure, reproduction, and survival on Laysan Island, 1985. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-118, 38 p.

- Johanos, T. C. and A. K. H. Kam.  
1986. The Hawaiian monk seal on Lisianski Island: 1983. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-58, 37 p.
- Johanos, T. C., A. K. H. Kam, and R. G. Forsyth.  
1987. The Hawaiian monk seal on Laysan Island: 1984. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-70, 38 p.
- Johanos, T. C., B. L. Becker, M. A. Brown, B. K. Choy, L. M. Hiruki, R. E. Brainard, and R. L. Westlake.  
1990. The Hawaiian monk seal on Laysan Island, 1988. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-151, 44 p.
- Johnson, B. W., and P. A. Johnson.  
1978. The Hawaiian monk seal on Laysan Island: 1977. U.S. Dep. of Commer., NTIS PB-285-428, 38 p.
- 1981a. Estimating the Hawaiian monk seal population on Laysan Island. U.S. Dep. of Commer., NTIS PB-82-106113, 29 p.
- 1981b. The Hawaiian monk seal on Laysan Island: 1978. U.S. Dep. of Commer., NTIS PB-82-109661, 17 p.
1984. Observations of the Hawaiian monk seal on Laysan Island from 1977 through 1980. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-49, 65 p.
- Knudtson, E. P.  
1981. Hawaiian monk seal observations at Laysan Island, March-July 1981. Unpubl. manusc., 23 p. Southwest Fish. Cent. Honolulu Laboratory, Natl. Mar. Fish. Serv., NOAA, 2570 Dole St., Honolulu, HI 96822-2396.
1983. Survey of the Hawaiian monk seal, *Monachus schauinslandi*, at Laysan Island, 25-28 January 1981. Unpubl. manusc., 3 p. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, 2570 Dole St., Honolulu, HI 96822-2396.
- Lombard, K. B., B. L. Becker, M. C. Craig, G. C. Spencer, and K. Hague-Bechard.  
1994. The Hawaiian monk seal on Laysan Island, 1990. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-206, 16 p.
- Stone, H. S.  
1984. Hawaiian monk seal population research, Lisianski Island, 1982. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-47, 33 p.

Thomas, J. A., L. H. Cornell, B. E. Joseph, T. D. Williams, and S. Dreischman.

1987. A transponder chip used as a permanent tag for sea otters (*Enhydra lutris*). *Mar. Mammal Sci.* 3(3):271-274.

Winchell, J. M.

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

Table 1.--Summary statistics for Hawaiian monk seal census counts  
( $n = 37$ ) on Laysan Island from April 5 to July 22,  
1991.

| Size          | Mean No. of<br>individuals | Standard<br>deviation |
|---------------|----------------------------|-----------------------|
| Adults        | 48.5                       | 7.5                   |
| Male          | 23.9                       | 6.1                   |
| Female        | 23.4                       | 3.2                   |
| Unknown       | 1.2                        | 2.1                   |
| Subadults     | 10.9                       | 3.7                   |
| Male          | 7.3                        | 2.7                   |
| Female        | 3.3                        | 1.5                   |
| Unknown       | 0.3                        | 0.8                   |
| Juveniles     | 9.7                        | 3.2                   |
| Male          | 4.5                        | 2.0                   |
| Female        | 5.0                        | 1.6                   |
| Unknown       | 0.2                        | 0.4                   |
| Pups          | 16.7                       | 4.0                   |
| Male          | 8.8                        | 3.0                   |
| Female        | 7.1                        | 2.4                   |
| Unknown       | 0.8                        | 1.3                   |
| Non-pup total | 69.1                       | 8.0                   |
| Grand total   | 85.9                       | 9.2                   |

Table 2.--Composition of the Laysan Island Hawaiian monk seal population during the spring and summer of 1991.  
Total includes all pups born during the calendar year.

| Size          | Number of seals |        |       | Sex ratio<br>Male:Female |
|---------------|-----------------|--------|-------|--------------------------|
|               | Male            | Female | Total |                          |
| Adults        | 89              | 71     | 160   | 1.25:1                   |
| Subadults     | 20              | 10     | 30    | 2.00:1                   |
| Juveniles     | 13              | 12     | 25    | 1.08:1                   |
| Pups          | 20              | 13     | 33    | 1.54:1                   |
| Non-pup total | 122             | 93     | 215   | 1.31:1                   |
| Grand total   | 142             | 106    | 248   | 1.34:1                   |



Table 3.--Summary of tagged known-age seals born on Laysan Island and resighted there in 1991.

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

Table 4.--Summary of Hawaiian monk seals born on Laysan Island in 1991.

| Event                                  | Number of pups |        | Total |
|--|----------------|--------|-------|
|  | Male           | Female |       |
| Born                                   | 20             | 13     | 33    |
| Died/probably died<br>prior to weaning | 2              | 0      | 2     |
| Weaned                                 | 18             | 13     | 31    |
| Tagged                                 | 18             | 13     | 31    |

Table 5.--Summary of nursing period and measurements of weaned pups on Laysan Island in 1991. Nursing periods were calculated where both birth and weaning date ranges were  $\leq 4$  days. All measurements were taken within 2 weeks after weaning and include 6 weaned pups with axillary girths less  $\leq 95$  cm.

|          | Nursing<br>period<br>(days) | Axillary<br>girth<br>(cm) | Straight<br>dorsal length<br>(cm) | Weight<br>(kg) |
|----------|-----------------------------|---------------------------|-----------------------------------|----------------|
| Mean     | 36.3                        | 103.9                     | 122.4                             | 62.5           |
| St. dev. | 4.2                         | 9.0                       | 6.5                               | 12.8           |
| <i>n</i> | 27                          | 29                        | 28                                | 28             |

Table 6A.--Known movement of Hawaiian monk seals to Laysan Island from other locations in 1991.

| Original location     | Number | Size     | Sex    |
|-----------------------|--------|----------|--------|
| French Frigate Shoals | 3      | adult    | female |
| Lisianski Island      | 2      | adult    | female |
|                       | 1      | subadult | male   |
|                       | 1      | juvenile | female |
| Pearl and Hermes Reef | 1      | adult    | female |

Table 6B.--Known movement of Hawaiian monk seals from Laysan Island to other locations in 1991.

| Destination           | Number | Size     | Sex    |
|-----------------------|--------|----------|--------|
| French Frigate Shoals | 3      | adult    | female |
| Lisianski Island      | 2      | adult    | male   |
|                       | 2      | adult    | female |
| Pearl and Hermes Reef | 1      | subadult | male   |

Table 7.--Factors affecting survival of Hawaiian monk seals observed on Laysan Island in 1991.

| Size                         | Sex    | Total          | Outcome |                |                |
|------------------------------|--------|----------------|---------|----------------|----------------|
|                              |        |                | Injured | Died           | Probably died  |
| <b>Attack by Large Shark</b> |        |                |         |                |                |
| Adult                        | Male   | 2              | 2       | 0              | 0              |
|                              | Female | 3              | 3       | 0              | 0              |
| Subadult                     | Female | 2              | 2       | 0              | 0              |
| Weaned pup                   | Male   | 1 <sup>a</sup> | 1       | 0              | 0              |
| <b>Mounting by Males</b>     |        |                |         |                |                |
| Adult                        | Male   | 2              | 2       | 0              | 0              |
|                              | Female | 8              | 6       | 1 <sup>b</sup> | 1              |
| Subadult                     | Male   | 1              | 1       | 0              | 0              |
|                              | Female | 1              | 0       | 0              | 1 <sup>c</sup> |
| Juvenile                     | Female | 1              | 1       | 0              | 0              |
| Weaned pup                   | Male   | 1              | 1       | 0              | 0              |
| <b>Entanglement</b>          |        |                |         |                |                |
| Adult                        | Female | 1 <sup>d</sup> | 0       | 0              | 0              |
| <b>Asphyxiation</b>          |        |                |         |                |                |
| Nursing pup                  | Male   | 1              | 0       | 1              | 0              |
| <b>Other/Unknown</b>         |        |                |         |                |                |
| Adult                        | Male   | 1              | 1       | 0              | 0              |
| Juvenile                     | Male   | 2              | 2       | 0              | 0              |
|                              | Female | 1              | 1       | 0              | 0              |
| Weaned pup                   | Male   | 1              | 0       | 1              | 0              |
| Nursing pup                  | Male   | 1              | 0       | 1              | 0              |

<sup>a</sup>Pup had an axillary girth < 95 cm.

<sup>b</sup>Four days prior to the death of this seal, an unidentified animal (but believed to be the same one) with a similar injury was seen in the vicinity. This seal had been attacked by a large shark after the male mounting incident.

<sup>c</sup>This seal was observed being attacked by a tiger shark which resulted in no detectable injury to the seal.

<sup>d</sup>The animal escaped by itself and was uninjured.

## RECENT TECHNICAL MEMORANDUMS

Copies of this and other NOAA Technical Memorandums are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22167. Paper copies vary in price. Microfiche copies cost \$9.00. Recent issues of NOAA Technical Memorandums from the NMFS Southwest Fisheries Science Center are listed below:

- NOAA-TM-NMFS-SWFSC-204 Development of an airborne LIDAR system to detect tunas in the eastern tropical Pacific purse-seine fishery.  
C.W. OLIVER, W.A. ARMSTRONG, and J.A. YOUNG  
(June 1994)
- 205 An assessment of the 1994 status of harbor porpoise in California.  
J. BARLOW and K. FORNEY  
(June 1994)
- 206 The Hawaiian monk seal on Laysan Island, 1990.  
K.B. LOMBARD, B.L. BECKER, M.P. CRAIG, G.C. SPENCER,  
and K. HAGUE-BECHARD  
(June 1994)
- 207 The estimation of perpendicular sighting distance on SWFSC  
research vessel surveys for cetaceans: 1974 to 1991.  
J. BARLOW and T. LEE  
(August 1994)
- 208 The physical oceanography off the central California coast during  
February-March and May-June 1992: a summary of CTD data from  
pelagic young-of-the-year rockfish surveys.  
K.M. SAKUMA, H.A. PARKER, S. RALSTON, F.B. SCHWING,  
D.M. HUSBY, and E.M. ARMSTRONG  
(September 1994)
- 209 The physical oceanography off the central California coast during March  
and May-June, 1993: a summary of CTD data from pelagic  
young-of-the-year rockfish surveys.  
K.M. SAKUMA, H.A. PARKER, S. RALSTON, F.B. SCHWING,  
D.M. HUSBY, and E.M. ARMSTRONG  
(September 1994)
- 210 The Hawaiian monk seal at French Frigate Shoals, 1990-91.  
M.P. CRAIG, J.L. MEGYESI, C.S. HALL, J.L. GLUECK, L.P. LANIAWE,  
E.A. DELANEY, S.S. KEEFER, M.A. McDERMOND, M. SCHULZ, G.L.  
NAKAI, B.L. BECKER, L.M. HIRUKI, and R.J. MORROW  
(September 1994)
- 211 Report of cetacean sightings during a marine mammal survey in the  
eastern Pacific ocean and the gulf of California aboard the NOAA  
ships *McArthur* and *David Starr Jordan* July 28-November 6, 1993.  
K.F. MANGELS, T. GERRODETTE  
(October 1994)
- 212 An evaluation of oocyte size in multiple regressions predicting gonad  
weight from body weight: A test using Hawaiian ehu, *Etelis carbunculus*.  
B.B. LAU and E.E. DeMARTINI  
(October 1994)
- 213 The Hawaiian monk seal on Laysan Island, 1987 and 1989.  
B.L. BECKER, P.A. CHING, L.M. HIRUKI, and S.A. ZUR  
(October 1994)