

# NOAA Technical Memorandum NMFS



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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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# THE HAWAIIAN MONK SEAL ON LAYSAN ISLAND, 1986

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### U.S. DEPARTMENT OF COMMERCE

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### National Marine Fisheries Service

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## ABSTRACT

The Hawaiian monk seal, *Monachus schauinslandi*, was studied on Laysan Island, Northwestern Hawaiian Islands, from 4 May to 4 August 1986. Beach counts ( $N = 20$ ) ranged from 102 to 147 seals ( $\bar{x} = 122.2$ ) excluding pups and from 122 to 174 ( $\bar{x} = 144.4$ ) including pups. Twenty-three of the 30 pups tagged in 1985 were resighted. Six seals moved to or from Laysan Island. A total of 110 seals were tagged: 32 of the 34 pups born in 1986 were tagged, a yearling that had lost a tag was retagged, 73 males (adult, subadult, and juvenile) were newly tagged, and 4 males were retagged. Adult male aggression appeared to be involved in five of the six known deaths and in 15 of the 27 known nonfatal injuries; the death of a weaned (male) pup is described in detail. Four necropsies were performed, and the entire skeleton of one adult female was transported to Honolulu for the Bishop Museum. One seal was entangled in debris, and 137 pieces of marine debris were inventoried and sampled.

## INTRODUCTION

Extensive research to monitor and aid the recovery of the endangered Hawaiian monk seal, *Monachus schauinslandi*, has been conducted yearly since 1977 at Laysan Island (lat. 25°42'N, long. 171°44'W), Northwestern Hawaiian Islands. Beginning in 1981, this monitoring has been conducted by the Honolulu Laboratory of the Southwest Fisheries Science Center, National Marine Fisheries Service (NMFS), NOAA. This report presents the 1986 findings; it is not intended to present and review other monk seal research. Findings from Laysan Island for other years since 1977 are reported in Johnson and Johnson (1978, 1981a, 1981b, 1984); Alcorn (1984); Johanos et al. (1987); Johanos and Austin (1988); Alcorn and Buelna (1989); Becker et al. (1989); and Johanos et al. (1990).

## METHODS

A 3-month-long seal research camp was established on Laysan Island from 4 May to 4 August 1986. Objectives were to (1) census seals, (2) document reproduction and tag all weaned pups, (3) tag male seals, (4) document injuries and deaths, (5) collect scats, spews, and necropsy samples, (6) document entanglements, and inventory and sample debris capable of entangling seals.

We were both present on Laysan Island during the entire research period, along with U.S. Fish and Wildlife Service (USFWS) personnel conducting bird research, and brief visits were made by a film crew and others (Appendix A). The 7-mile perimeter of Laysan Island was divided into the same 20 sectors used since 1982 to define seal locations during data collection (Fig. 1).

Individual seals were recognized by bleach markings, tags, natural markings, and scars. Bleach was not applied on Laysan Island seals in 1986, but some seals still bore bleach marks from 1985. Two (tan) plastic Temple Tags<sup>3</sup> were put on each weaned pup, one tag in each hind flipper. A new tag was also put on a yearling which had lost one tag. Seals were restrained when they were tagged with Temple Tags; for a description of the pup tagging procedure, see Gilmartin et al. (1986). Metal (Monel) tags were applied to one or both hind flippers of adult and subadult males and one juvenile male; tagging priority was given to adults with temporary (1985 postmolt) bleach marks, so identity would not be lost with the 1986 molt. Seals were not restrained for tagging with Monel tags; for a description of this tagging procedure see Alcorn and Buelna (1989). We were not able to ascertain at the time of tagging whether the metal tag was on securely because the seals were not restrained. We, therefore, attempted to resight newly tagged seals and

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<sup>3</sup>Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

apply a second tag if the first one trailed the web by more than one-half the tag length or if the tag did not appear to have locked.

Censuses were conducted every 2 to 7 days; the goal was to conduct 20 censuses within the 3-month research period. Censusing commenced at 1300 hours (Hawaii standard time) as we simultaneously departed camp in opposite directions and proceeded around the island perimeter until we met. Consult Stone (1984) for a description of age (size) classification, Johanos et al. (1987) for the census protocol, and Forsyth et al. (1988) for a copy of the preprinted census form and 1986 coding instructions. We restricted our movements and did not tag seals on census days prior to the census to minimize potential disturbance that could affect seal haul-out patterns.

In addition to formal censuses, we made informal patrols along portions of the island perimeter. Time, direction, area covered, purpose, and the number of persons conducting the patrol varied; however, we attempted to circuit the entire island at least every other day, either on a census or patrol. During patrols, we tagged seals, photographed and sketched seal physical characteristics for identification, collected spews, and inventoried and sampled entanglement debris. We also recorded tag resightings, births, injuries and deaths, using the same forms used during censuses.

## RESULTS AND DISCUSSION

### Censuses

We conducted 20 censuses from 9 May through 2 August 1986 (Appendix B). Counts ranged from 102 to 147 seals ( $\bar{x}$  = 122.2) excluding pups, and from 122 to 174 ( $\bar{x}$  = 144.4) including pups. Average number of seals present during the 1986 censuses was considerably higher than in the previous year; during a comparable time period (11 May through 3 August 1985;  $n$  = 30 censuses), the average was 98.9 excluding pups and 118.1 including pups (Becker et al. 1989). Twenty-three (13 males and 10 females) of the 30 pups (16 males and 14 females) tagged in 1985 were seen in 1986 on Laysan Island.

### Interisland Movement

Six seals (two males and four females) moved to or from Laysan Island in 1986: one made a round trip to French Frigate Shoals; one moved from Laysan Island to French Frigate Shoals; one moved from Lisianski Island to Laysan Island; and three moved from Laysan Island to Lisianski Island (Table 1).

### Reproduction

Thirty-four pups were born: 17 females, 16 males, and 1 of unknown sex (Table 2). This is slightly higher than the 32 (Johanos and Austin 1988) born in 1985. No females were obviously preparturient when data collection ended in August.

### Tagging

A total of 110 seals were tagged during 1986. Thirty-two of the 1986 pups were tagged with Temple Tags after weaning, one was still nursing when research ended, and one newborn pup was found dead. In addition, a juvenile (TT29) that had lost one tag received a new Temple Tag. Seventy-three males (adult, subadult, and juvenile) were newly tagged with metal tags, and four adult males that had lost metal tags applied during 1985 received new tags (Appendix C). Despite seals not being restrained when metal tags were applied, at least 56 of the 77 seals had tags which extended <10 mm beyond the hind flipper edge.

### Deaths and Injuries

There were six known deaths: five appeared to be related to injuries inflicted by one or more adult males and the cause of the remaining death was unknown (Table 3). We performed only four necropsies (Appendix D), because two carcasses were not recovered: one was consumed by sharks, and the decomposing carcass of the newborn pup seen during the initial circuit of the island could not be relocated following a storm. A pancreatic cyst, a condition not previously reported in Hawaiian monk seals, was found in adult female T23F. The carcass of this female was flensed, buried in the sand, and, at the end of the research camp, taken to Honolulu where the skeleton was permanently loaned to the Bishop Museum in 1988.

We documented 27 nonfatal injuries: 15 appeared to have been inflicted by adult male monk seals, 3 by cookie cutter sharks, *Isistius brasiliensis*, 2 by larger sharks, and 7 by unknown causes (Table 4).

Adult male aggression appeared to be related to 84% of the observed deaths and 55.6% of the nonfatal injuries. We witnessed the incident leading to the death of a weaned male pup (TL36) caused by an adult male. In this incident, detailed in Appendixes E and F, the pup appeared weakened from earlier adult male-inflicted injuries; immediate cause of death was probably drowning because the pup had breathing difficulties and was frequently submerged when the adult male seal T475 mounted it. The aggressive behavior of the seal T475 did not appear to change after the pup died; seal T475 continued to bite and mount the pup and attempted to defend the carcass from another adult male. Seal T475 repeatedly pushed its nose into the pup's dorsal wound, a behavior repeated by the adult male T723 that subsequently displaced him at the carcass.

We also witnessed an adult female (T11N) receive dorsal scratches and punctures from up to six adult males during a "mobbing" attack in sector 18 on 18 June 1986 from 1313 to 1451 hours. "Mobbing" is described as an attempt by several males to mate with a single adult female or immature seal of either sex. The incident originated and ended on the beach, but at one time the female with associated males moved 37 m offshore.

### Debris and Entanglement

A total of 137 items of debris capable of entangling seals were found and sampled. Analysis of debris type is ongoing and will be reported elsewhere.

A seal was entangled in one of the debris items. On 14 June, a subadult male with a thick rope looped around his neck and left foreflipper was seen resting on the damp sand (sector 8). The rope appeared to be tightly wrapped, but when removed (by DJA), it appeared that the seal probably could have extricated itself.

### ACKNOWLEDGMENTS

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Table 1.--Interisland movement of Hawaiian monk seals, to and from Laysan Island, 1986 (A = adult, S = subadult, and J = juvenile; M = male and F = female; FFS = French Frigate Shoals).

| Perm. ID | Tags |       |       | Size and sex | Movement from          |                | Movement to             |                 |
|----------|------|-------|-------|--------------|------------------------|----------------|-------------------------|-----------------|
|          | Left | Right | Color |              | Location               | Date last seen | Location                | Date first seen |
| TT14     | T14  | T12   | tan   | SM           | Laysan <sup>a</sup>    | 11/26/85       | Lisianski <sup>b</sup>  | 5/31/86         |
| G027     | 027  | 028   | green | SF           | Laysan <sup>a</sup>    | 7/7/85         | Lisianski <sup>b</sup>  | 8/10/86         |
| T25F     | --   | --    | --    | AF           | Laysan <sup>a</sup>    | 7/28/85        | Lisianski <sup>b</sup>  | 8/18/86         |
| TT36     | T35  | T36   | tan   | SM           | Laysan <sup>a</sup>    | 11/23/85       | FFS <sup>c</sup>        | 9/2/86          |
| Y156     | --   | --    | --    | AF           | Laysan <sup>a</sup>    | 7/26/85        | FFS <sup>d</sup> (East) | 4/19/86         |
| "        | "    | "     | "     | "            | FFS <sup>d</sup>       | 5/28/86        | Laysan                  | 6/23/86         |
| GK24     | K24  | K25   | green | JF           | Lisianski <sup>e</sup> | 7/13/85        | Laysan                  | 5/10/86         |

<sup>a</sup>Becker et al. 1989.

<sup>b</sup>Westlake and Siepmann 1988.

<sup>c</sup>J. Henderson, Honolulu Laboratory, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 2570 Dole St., Honolulu, HI 96822-2396, pers. commun., September 1986.

<sup>d</sup>T. Johanos, Honolulu Laboratory, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 2570 Dole St., Honolulu, HI 96822-2396, pers. commun., April 1986.

<sup>e</sup>Alcorn et al. 1988.

Table 2.--Birth summary of Hawaiian monk seal pups on Laysan Island, 1986 (M = male, F = female, U = unknown sex, AG = axillary girth, and DSL = dorsal straight length).

| ID No. | Sex | Birth |                  | Weaning |                  | Nursing period (days) | Measurements (cm) |       |       | Mother ID |
|--------|-----|-------|------------------|---------|------------------|-----------------------|-------------------|-------|-------|-----------|
|        |     | Date  | Islet/<br>Sector | Date    | Islet/<br>Sector |                       | Date              | AG    | DSL   |           |
|        |     |       |                  |         |                  |                       |                   |       |       |           |
| TL00   | F   | --    | --               | <5/11   | --               | --                    | 5/11              | 98.0  | 122.0 | --        |
| TL02   | M   | --    | --               | <5/11   | --               | --                    | --                | --    | --    | --        |
| TL04   | F   | --    | --               | <5/13   | --               | --                    | 5/13              | 113.0 | 128.0 | --        |
| TL06   | M   | --    | --               | <5/13   | --               | --                    | 5/13              | 92.0  | 124.0 | --        |
| TL08   | M   | --    | --               | <5/13   | --               | --                    | 5/13              | 88.5  | 115.0 | --        |
| TL10   | M   | --    | --               | <5/13   | --               | --                    | 5/13              | 100.0 | 122.0 | --        |
| TL12   | F   | --    | --               | <5/13   | --               | --                    | 5/13              | 102.5 | 130.0 | --        |
| TL14   | F   | --    | --               | <5/13   | --               | --                    | --                | --    | --    | --        |
| TL16   | F   | --    | --               | <5/13   | --               | --                    | 5/13              | 98.0  | 132.0 | --        |
| TL18   | F   | --    | --               | <5/13   | --               | --                    | 5/13              | 97.0  | 129.0 | --        |
| TL20   | F   | --    | --               | 5/13    | 4                | --                    | 5/13              | 112.0 | 131.0 | 005       |
| TL22   | F   | --    | --               | 5/13    | 3                | --                    | 5/13              | 105.0 | 132.0 | T08F      |
| TL24   | M   | --    | --               | 5/14    | 3                | --                    | 5/14              | 104.0 | 125.0 | 006       |
| TL26   | F   | --    | --               | <5/16   | --               | --                    | 5/16              | 97.0  | 126.0 | --        |
| TL28   | F   | --    | --               | <5/19   | --               | --                    | --                | --    | --    | --        |
| TL30   | F   | --    | --               | <5/21   | --               | --                    | --                | --    | --    | --        |
| TL32   | M   | --    | --               | <5/21   | --               | --                    | --                | --    | --    | --        |
| TL36   | M   | --    | --               | 5/17    | 18               | --                    | 5/24              | 96.0  | 121.0 | T04F      |
| TL34   | F   | --    | --               | --      | --               | --                    | --                | --    | --    | --        |
| TL38   | F   | --    | --               | 5/25-7  | 10               | --                    | 5/31              | 105.0 | 121.0 | T06F      |
| TL40   | M   | --    | --               | 5/25-7  | 12               | --                    | 5/31              | 97.0  | 118.0 | TY49      |
| TL42   | F   | --    | --               | 5/24    | 2                | --                    | 5/28              | 112.0 | 113.0 | T11N      |
| TL45   | M   | --    | --               | 6/04    | 20               | --                    | 6/05              | 115.0 | 131.0 | T17F      |
| TL46   | M   | --    | --               | 6/13    | 2                | --                    | 6/14              | 106.0 | 132.0 | T03F      |
| TL48   | M   | --    | --               | 6/15    | 20               | --                    | 6/15              | 106.0 | 128.0 | T11F      |
| TL50   | M   | --    | --               | 6/12    | 18               | --                    | 6/16              | 106.0 | 125.0 | T12F      |
| TL52   | M   | --    | --               | 6/15-6  | 11               | --                    | 6/18              | 110.0 | 129.0 | T14F      |
| TL54   | M   | --    | --               | 6/12    | 19               | --                    | 6/19              | 102.0 | 128.0 | T21F      |
| TL56   | F   | 5/06  | 3                | 6/20    | 3                | 45                    | 6/21              | 111.0 | 137.0 | T302      |
| TL58   | M   | 5/09  | 20               | 6/27    | 20               | 47-48                 | 6/25-6            | 98.0  | 123.0 | T22F      |
| TL60   | F   | 5/15  | 4                | 6/28    | 5                | --                    | 7/01              | 100.0 | 131.0 | T24F      |



Table 3.--1986 Hawaiian monk seal deaths on Laysan Island (A = adult, J = juvenile, W = weaned pup, N = nursing pup; F = female, M = male, U = sex unknown; cause of death, K = known, P = probable).

| Necropsy number | Date of death    | Size | Sex            | ID   | Cause of death  |
|-----------------|------------------|------|----------------|------|---|
| --              | <5/6             | N    | U              | --   | Unknown   |
| 01LA86          | 5/6 <sup>a</sup> | A    | F              | T23F | Adult male (dorsal wounds) (P)                                |
| --              | 6/2              | W    | M              | TL36 | Adult male (dorsal punctures, dorsal swelling; drowning?) (K) |
| 02LA86          | 6/5              | J    | M              | TK31 | Adult male (dorsal wounds, punctures, scratches) (P)          |
| 03LA86          | <5/4             | A    | F <sup>b</sup> | --   | Adult male (dorsal wound) (P)                                 |
| 04LA86          | 7/8              | W    | M              | TL02 | Adult male (dorsal punctures and swelling) (P)                |

<sup>a</sup>This is the necropsy date; date of death is unknown but is thought to be 5/5 or 5/6.

<sup>b</sup>Carcass examined carefully and baculum not found; unable to determine sex from reproductive organs because of deterioration.

Table 4.--Injuries of Hawaiian monk seals on Laysan Island, 1986 (A = adult, S = subadult, J = juvenile, W = weaned pup, M = male, and F = female).

| Injury No. | Date | Size | Sex | ID No. | Description of injury |                       |                          |                                |                         | Probable cause |
|------------|------|------|-----|--------|-----------------------|-----------------------|--------------------------|--------------------------------|-------------------------|----------------|
|            |      |      |     |        | Type <sup>a</sup>     | Location <sup>b</sup> | Depth <sup>c</sup> layer | Dimension (cm) (1 x w or diam) |                         |                |
| 001        | 5/07 | A    | M   | T460   | CIR                   | MID/D                 | --                       | --                             | CC SHARK <sup>d</sup>   |                |
| 002        | 5/13 | A    | M   | TH07   | ABC                   | L/ANT                 | --                       | 5.0 X 25.0                     | UNKNOWN                 |                |
| 003        | 5/13 | S    | F   | --     | AMP                   | RHF                   | --                       | --                             | UNKNOWN                 |                |
| 004        | 5/14 | J    | M   | TK05   | LAC                   | D                     | SURF                     | --                             | ADULT MALE              |                |
| 005        | 5/14 | A    | F   | --     | LAC                   | D/L LAT               | SURF                     | --                             | ADULT MALE              |                |
| 006        | 5/16 | A    | F   | T16F   | LAC                   | D                     | SURF                     | --                             | ADULT MALE              |                |
| 007        | 5/16 | J    | F   | TT02   | CIR                   | V                     | BLUB                     | 5.0 (DIAM)                     | CC SHARK <sup>d</sup>   |                |
| 008        | 5/20 | A    | F   | --     | PUN                   | MID/D                 | --                       | 2.5 (DIAM)                     | ADULT MALE              |                |
| 009        | 5/21 | A    | M   | T711   | OTH <sup>e</sup>      | ANT                   | --                       | --                             | UNKNOWN                 |                |
| 010        | 5/29 | W    | F   | TL38   | LAC                   | D/V                   | SURF                     | 4.0 (DIAM)                     | ADULT MALE              |                |
| 011        | 5/31 | A    | F   | T51F   | LAC                   | D                     | SURF                     | --                             | ADULT MALE <sup>f</sup> |                |
| 012        | 6/05 | J    | F   | TT58   | LAC                   | ANT/V                 | SURF                     | 17-22 (LENGTH)                 | UNKNOWN                 |                |
| 013        | 6/07 | A    | F   | T37F   | GAP                   | D                     | BLUB                     | 5.0 (LENGTH)                   | ADULT MALE <sup>g</sup> |                |
| 014        | 6/07 | A    | F   | --     | PUN                   | L/ANT                 | SKIN                     | 13.0 (DIAM)                    | UNKNOWN                 |                |
| 015        | 6/07 | J    | M   | TK27   | PUN                   | D                     | SKIN                     | 1.25 (DIAM)                    | ADULT MALE              |                |
| 016        | 6/07 | W    | F   | TL18   | PUN                   | ANT/D                 | SKIN                     | --                             | ADULT MALE              |                |
| 017        | 6/11 | A    | M   | T719   | LAC                   | RHF                   | MUSC                     | 23.0 (LENGTH)                  | SHARK                   |                |
| 018        | 6/12 | A    | F   | T26F   | PUN/LAC               | D                     | MUSC                     | 50%                            | ADULT MALE              |                |
| 019        | 6/16 | A    | M   | T726   | LAC                   | MID/D                 | BLUB                     | 20.0 (LENGTH)                  | UNKNOWN                 |                |
| 020        | 6/17 | W    | F   | TL6N   | ABC                   | POST/D                | --                       | 15.0 (DIAM)                    | ADULT MALE              |                |
| 021        | 6/18 | A    | F   | T11N   | PUN/LAC               | D                     | --                       | --                             | ADULT MALE              |                |
| 022        | 6/19 | W    | F   | TL22   | LAC                   | D                     | SURF                     | --                             | ADULT MALE              |                |
| 023        | 6/22 | A    | M   | T760   | GAP                   | R/ANT                 | BLUB                     | 16.5 (LENGTH)                  | SHARK                   |                |
| 024        | 6/30 | A    | M   | T07M   | LAC                   | D                     | --                       | --                             | UNKNOWN                 |                |
| 025        | 7/10 | J    | F   | TK51   | GAP/PUN               | D                     | BLUB                     | 30.5 x 10.0                    | ADULT MALE              |                |
| 026        | 7/14 | S    | M   | --     | CIR                   | V                     | SKIN                     | --                             | CC SHARK <sup>d</sup>   |                |
| 027        | 7/19 | J    | F   | GK25   | LAC                   | L/ANT                 | BLUB                     | 13.0 (LENGTH)                  | ADULT MALE              |                |



# APPENDIXES

Appendix A.--Itinerary for the 1986 Laysan Island field camp of the  
National Marine Fisheries Service (NMFS).

| Date    | Event   |
|---------|---|
| 4/29    | D. Alcorn and R. Westlake depart Honolulu on board the NOAA ship <i>Townsend Cromwell</i> , bypass Laysan Island, and arrive at Lisianski Island on 3 May. Conduct seal census, tag weaned pups, and depart same day for Laysan Island.   |
| 5/4     | <i>Townsend Cromwell</i> arrives at Laysan Island. Alcorn and Westlake disembark with E. Bean, A. Marshall, and J. Simasko of the U.S. Fish and Wildlife Service (USFWS) and P. Atkins, J. Bell, and M. DeGruy, of Moana Film Productions. Establish camp on the west side. The two USFWS researchers already present, K. McDermond and M. Morin, begin to move their camp from the northeast to the west side. The <i>Townsend Cromwell</i> departs. |
| 5/16    | The <i>Goode Wind</i> arrives, embarks Atkins, Bell, DeGruy, and Simasko, and departs.  |
| 5/26    | The <i>Feresa</i> arrives and disembarks T. Gerrodette (NMFS), D. Hu, and T. Ohashi (USFWS).  |
| 5/29    | The <i>Feresa</i> embarks Gerrodette, Hu, McDermond, and Ohashi and departs. A five-person research camp remains on Laysan Island (Alcorn, Westlake, Bean, Marshall, and Morin). Naturalists from the <i>Ashley St. Mary</i> spend half a day on the island with USFWS.   |
| 6/19-22 | The <i>Feresa</i> arrives, anchors offshore, and delivers supplies.   |
| 7/29    | The <i>Townsend Cromwell</i> arrives, disembarks P. Siepmann (NMFS), and conducts research offshore.  |
| 8/2-3   | Disband camp and load supplies on the <i>Townsend Cromwell</i> .  |
| 8/4     | All personnel on Laysan Island depart on board the <i>Townsend Cromwell</i> .   |

Appendix B.--Hawaiian monk seals counts at Laysan Island, 1986  
(M = male, F = female, and U = unknown).

| Date  | Adult |    |    | Sub-adult |    |    | Juvenile |    |   | Pup |    |    | Total              |       |          |
|-------|-------|----|----|-----------|----|----|----------|----|---|-----|----|----|--------------------|-------|----------|
|       | M     | F  | U  | M         | F  | U  | M        | F  | U | M   | F  | U  | Nonpup             | Pup   | Combined |
| 05/09 | 31    | 20 | 16 | 10        | 10 | 18 | 17       | 13 | 4 | 4   | 4  | 14 | 139                | 22    | 161      |
| 05/16 | 37    | 25 | 3  | 8         | 10 | 14 | 14       | 16 | 1 | 11  | 12 | 5  | 128                | 28    | 156      |
| 05/19 | 43    | 20 | 10 | 19        | 15 | 11 | 16       | 11 | 2 | 10  | 9  | 8  | 147                | 27    | 174      |
| 05/21 | 32    | 21 | 5  | 13        | 12 | 11 | 19       | 14 | 2 | 10  | 7  | 5  | 129                | 22    | 151      |
| 05/24 | 36    | 24 | 7  | 10        | 13 | 10 | 13       | 5  | 2 | 9   | 9  | 4  | 120                | 22    | 142      |
| 05/27 | 28    | 25 | 9  | 15        | 17 | 6  | 9        | 12 | 2 | 10  | 15 | 0  | 123                | 25    | 148      |
| 05/30 | 32    | 17 | 12 | 13        | 10 | 11 | 18       | 15 | 1 | 10  | 11 | 3  | 129                | 24    | 153      |
| 06/03 | 39    | 27 | 6  | 9         | 14 | 8  | 17       | 10 | 2 | 9   | 9  | 5  | 132                | 23    | 155      |
| 06/07 | 30    | 24 | 9  | 15        | 16 | 6  | 9        | 6  | 3 | 8   | 7  | 4  | 118                | 19    | 137      |
| 06/11 | 39    | 22 | 2  | 14        | 14 | 4  | 12       | 7  | 2 | 10  | 9  | 0  | 116                | 19    | 135      |
| 06/14 | 27    | 19 | 9  | 11        | 13 | 7  | 19       | 11 | 2 | 11  | 14 | 3  | 118                | 28    | 146      |
| 06/18 | 34    | 25 | 9  | 14        | 13 | 5  | 12       | 15 | 3 | 10  | 13 | 0  | 130                | 23    | 153      |
| 06/22 | 40    | 15 | 7  | 13        | 9  | 13 | 10       | 11 | 5 | 11  | 8  | 1  | 123                | 20    | 143      |
| 06/26 | 39    | 16 | 4  | 15        | 13 | 9  | 13       | 15 | 1 | 9   | 13 | 1  | 125                | 23    | 148      |
| 06/30 | 30    | 20 | 2  | 13        | 9  | 6  | 15       | 16 | 4 | 8   | 10 | 0  | 115                | 18    | 133      |
| 07/07 | 30    | 22 | 2  | 10        | 9  | 7  | 13       | 11 | 3 | 7   | 8  | 0  | 107                | 15    | 122      |
| 07/14 | 35    | 13 | 4  | 9         | 9  | 5  | 15       | 11 | 1 | 12  | 11 | 0  | 102                | 23    | 125      |
| 07/21 | 30    | 18 | 0  | 10        | 8  | 8  | 17       | 17 | 4 | 8   | 12 | 0  | 112                | 20    | 132      |
| 07/28 | 33    | 17 | 2  | 14        | 10 | 3  | 20       | 18 | 4 | 11  | 10 | 0  | 121                | 21    | 142      |
| 08/02 | 33    | 14 | 7  | 9         | 8  | 10 | 17       | 8  | 3 | 8   | 13 | 2  | 109                | 23    | 132      |
|       |       |    |    |           |    |    |          |    |   |     |    |    | Mean               | 122.2 | 144.4    |
|       |       |    |    |           |    |    |          |    |   |     |    |    | Standard Deviation | 10.9  | 12.8     |

Appendix C.--Hawaiian monk seal males (non-pup) tagged with metal tags on Laysan Island, 1986 (A = adult, S = subadult, or J = juvenile).

| Tag no. <sup>a</sup> |       | Identification |                            |      |                   |
|----------------------|-------|----------------|----------------------------|------|-------------------|
| Left                 | Right | ID no.         | 1985 bleach no. (postmolt) | Size | Date <sup>b</sup> |
| X102                 |       | T438           | 438                        | A    | 5/10              |
| X103                 |       | T448           | 448                        | A    | 5/21              |
|                      | X105  | TY07           | 450                        | A    | 5/23              |
| X156                 | X106  | TY75           | Y75                        | A    | 5/23              |
| X107                 |       | T460           | 460                        | A    | 5/28              |
|                      | X108  | TH05           | H05                        | A    | 5/28              |
|                      | X109  | T768           | 768                        | A    | 5/29              |
|                      | X110  | TP87           | P87                        | S    | 5/29              |
| X111                 |       | T725           | 725                        | A    | 5/29              |
| X112                 |       | T424           | 424                        | A    | 6/3               |
| X114                 |       | T732           | 732                        | A    | 6/5               |
| X116                 |       | GS33           | S33                        | A    | 6/7               |
|                      | X117  | T434           | 434                        | A    | 6/4               |
| X118                 |       | TP09           | P09                        | S    | 6/4               |
| X119                 |       | T717           | 717                        | A    | 6/5               |
|                      | X120  | T770           | 770                        | A    | 6/9               |
|                      | X122  | T729           | 729                        | A    | 6/13              |
| X123                 |       | T364           | 748                        | A    | 6/16              |
|                      | X124  | T715           | 715                        | A    | 6/16              |
| X125                 |       | T462           | 462                        | A    | 6/17              |
|                      | X126  | T758           | 758                        | S    | 6/9               |
|                      | X127  | TY55           | Y55                        | A    | 6/12              |
|                      | X128  | TY74           | 700                        | A    | 6/13              |
|                      | X129  | T340           | 340                        | S    | 6/13              |
|                      | X131  | T718           | 718                        | A    | 6/22              |
| X132                 |       | TP41           | P41                        | A    | 6/28              |
|                      | X133  | T803           | 803                        | A    | 6/28              |
|                      | X134  | T412           | 412                        | A    | 6/13              |
| X144                 | X135  | T723           | 723                        | A    | 6/15              |
|                      | X136  | T778           | 778                        | A    | 6/16              |
|                      | X137  | T415           | 415                        | A    | 6/16              |
| X138                 |       | T734           | 734                        | A    | 6/16              |
| X139                 |       | T435           | 435                        | A    | 6/17              |
| X140                 |       | TH07           | H07                        | A    | 6/22              |
|                      | X142  | T757           | 757                        | S    | 6/22              |
| X143                 |       | T716           | 716                        | A    | 6/20              |
|                      | X145  | T349           | 349                        | A    | 6/23              |
|                      | X146  | T764           | 764                        | A    | 6/17              |
| X147                 |       | T395           | 707, 704                   | A    | 6/23              |
| X148                 |       | T720           | 720                        | A    | 6/24              |
| X149                 |       | T741           | 741                        | A    | 6/24              |

## Appendix C.--Continued.

| Tag no. <sup>a</sup> |       | Identification |                            | Size | Date <sup>b</sup> |
|----------------------|-------|----------------|----------------------------|------|-------------------|
| Left                 | Right | ID no.         | 1985 bleach no. (postmolt) |      |                   |
| X150                 |       | T421           | 421                        | A    | 6/24              |
| X151                 |       | T746           | 746                        | A    | 6/28              |
|                      | X153  | T426           | 426                        | A    | 7/4               |
| X154                 |       | T763           | 763                        | A    | 7/7               |
| X155                 |       | TY41           | Y41                        | A    | 7/9               |
| X158                 | X157  | T808           | 808                        | A    | 6/27              |
| X160                 |       | T708           | 708                        | A    | 6/28              |
| X161                 |       | T766           | 766                        | S    | 7/1               |
|                      | X162  | T743           | 743                        | A    | 7/4               |
|                      | X163  | T726           | 726                        | A    | 7/4               |
|                      | X164  | T759           | 759                        | A    | 7/7               |
|                      | X165  | T429           | 429                        | A    | 7/10              |
|                      | X166  | T339           | 705                        | A    | 7/9               |
|                      | X167  | TP49           | P49                        | S    | 7/11              |
| X168                 |       | TY60           | Y60                        | A    | 7/12              |
|                      | X169  | T701           | 701                        | A    | 7/14              |
| X170                 |       | T731           | 731                        | A    | 7/15              |
|                      | X171  | T735           | 735                        | S    | 7/10              |
| X172                 |       | T709           | 709                        | A    | 7/10              |
| X173                 |       | TY88           | Y88                        | A    | 7/11              |
| X174                 |       | T445           | 445                        | A    | 7/14              |
|                      | X175  | T408           | 408                        | A    | 7/16              |
|                      | X177  | T080           | 417                        | A    | 7/18              |
|                      | X178  | T750           | 750                        | A    | 7/18              |
|                      | X179  | T749           | 749                        | S    | 7/22              |
|                      | X180  | T745           | 745                        | A    | 7/25              |
| X181                 |       | T755           | 755                        | A    | 7/17              |
|                      | X182  | --             | XXX                        | A    | 7/18              |
|                      | X183  | T762           | 762                        | A    | 7/28              |
| X184                 |       | T442           | 442                        | A    | 7/28              |
| X185                 |       | T765           | 765                        | A    | 7/28              |
| X186                 |       | --             | 744                        | A    | 8/2               |
| X189                 |       | T710           | 710                        | A    | 7/25              |
|                      | X190  | TY33           | Y35                        | S    | 7/28              |
| X191                 |       | T75M           | --                         | J    | 8/1               |
| X192                 |       | T711           | 711                        | A    | 8/1               |

<sup>a</sup>The following tags were used in 1986, but are not on seals: X101, X115, and X200 were used on cloth to test the tagging pliers; X113, X121, X130, X141, X152, X159, and X176 fell off the hind flippers after being applied.

<sup>b</sup>The date when the first tag was applied in 1986 is given when more than one tag was applied.

## Appendix D.--Hawaiian monk seal necropsy reports, Laysan Island, 1986.

NECROPSY NO.: 01LA86  
 DATE OF DEATH: 6 May  
 DATE OF NECROPSY: 6 May  
 SEX: Female  
 SIZE CLASS: Adult  
 IDENTIFICATION NO.: T23F

**CIRCUMSTANCES OF DEATH:** Found dead, floating on back in surf (sector 2) guarded by an adult male (T308). Carcass fresh; death within past 5 hours. Found on our first circuit of Laysan Island.

**EXTERNAL DESCRIPTION:** Numerous, fresh, gaping wounds on the middorsal. Blood coming from the right nare; yellow fluid from left. Rigor mortis evident. No milk exuded from teats. Thin appearance.

*Measurements:* Standard length (ventral side up) = 205.0 cm  
 Axillary girth (no bloat) = 106.0 cm  
 Blubber thickness (base of sternum) = 2.3 cm

**INTERNAL DESCRIPTION:** No gross abnormalities noted for: lymph nodes, abdominal cavity, adrenals, female reproductive tract (and no blockage of fallopian tubes), gall bladder, heart, respiratory tract, kidney, or liver. Thymus not found.

The following was noted: stomach (omentum) red, thin with many holes; many roundworms (some still alive); and a few small ulcerated areas with worms attached. Stomach contents consisted of lobster, cephalopod beaks, and yellow fluid. Pancreatic cyst (7 x 6 x 4 cm) filled with white fluid.

| <i>Measurements:</i> | <i>Organs</i>   | <i>Size</i>      | <i>Weight</i> |
|----------------------|-----------------|------------------|---------------|
|                      | thyroid (right) | --               | 9.5 g         |
|                      | adrenal (left)  | 60 x 20 x 11 mm  | 17.0 g        |
|                      | adrenal (right) | 57 x 16 x 9 mm   | 12.0 g        |
|                      | ovary (left)    | 24 x 16 x 4 mm   | 4.0 g         |
|                      | ovary (right)   | 24 x 15 x 4 mm   | 4.0 g         |
|                      | uterus          | 12 cm            | --            |
|                      | vagina          | 19 cm            | --            |
|                      | kidney (left)   | 25 x 9 x 4 cm    | --            |
|                      | kidney (right)  | 25 x 9 x 5 cm    | --            |
|                      | spleen          | 29 x 10 x 1.2 cm | 270.0 g       |

**SAMPLES COLLECTED:** Preserved in formalin--thyroids, adrenals, lymph node (retroperitoneal), ovaries, uterus, vagina, kidneys, spleen, pancreas, stomach omentum and associated parasites, mesenteric nodes, liver, gall bladder, heart muscle, and lungs. Frozen for toxicology--blubber, kidney, and liver. Skull and entire skeleton saved.

## Appendix D.--Continued.

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NECROPSY NO.: 02LA86  
 DATE OF DEATH: 5 June  
 DATE OF NECROPSY: 6 June  
 SEX: Male  
 SIZE CLASS: Juvenile (1 year old)  
 IDENTIFICATION NO.: TK31

**CIRCUMSTANCES OF DEATH:** Found dead in surf (sector 4) with muzzle pushed into sand; adult male T726 against and partly on top of carcass. Death within 24 hours of the necropsy.

**EXTERNAL DESCRIPTION:** Numerous dorsal and lateral scratches into the skin; a few pink dorsal punctures. The largest puncture, 16 x 10 mm, extended into the muscle layer. Nares bloody. Rigor. Green on pelage and no sign of molt. A small, thin seal, but not unusually so for a yearling. The Temple Tag had ripped from the left hind flipper; both tags were on when the seal was last seen alive on 3 June. We removed the remaining tag and noted there was no irritation from the tag; the hole was slightly larger than the tag insertion diameter, and the edges of the hole were healed.

*Measurements:* Standard length (ventral side up) = 141.5 cm  
 Axillary girth (no bloat) = 86.0 cm  
 Blubber thickness (base of sternum) = 2.5 cm

**INTERNAL DESCRIPTION:** Ribs intact; no abdominal fluids nor blood. Organs not discolored--no smell. Stomach had a few small ulcers, none perforating the wall; large numbers of both roundworms and tapeworms in stomach (some still alive); small amount of fluid, fish bones, cephalopod beaks and one lens; heavy tapeworm load in entire intestinal tract.

| <i>Measurements:</i> | <i>Organs</i>      | <i>Size</i>         | <i>Weight</i> |
|----------------------|--------------------|---------------------|---------------|
|                      | thyroid (left)     | 29 x 11 x 4 mm      | 14 g          |
|                      | thyroid (right)    | 31 x 11 x 4 mm      | 12 g          |
|                      | lymph node (scap.) | 4 x 2 x 0.8 cm      | 11 g          |
|                      | adrenal (left)     | 4.5 x 1.2 x 0.7 cm  | 9 g           |
|                      | adrenal (right)    | 5.9 x 1.7 x 0.9 cm  | 10 g          |
|                      | testis (left)      | 3.7 x 2.4 x 1.6 cm  | 8 g           |
|                      | testis (right)     | 3.5 x 1.7 x 1.9 cm  | 8 g           |
|                      | kidney (left)      | 16.5 x 6.5 x 3.0 cm | --            |
|                      | kidney (right)     | --                  | --            |
|                      | spleen             | 27 x 5.5 x .3 cm    | 93 g          |
|                      | thymus             | --                  | 22 g          |

**SAMPLES COLLECTED:** Preserved in formalin--thyroids, lymph nodes (left and right scapular), adrenalis, testes and epididymis, kidney, spleen, pancreas and associated lymph node, stomach/intestines and associated parasites, liver, gall bladder, thymus, heart (entire), lung, and brain.

Frozen for toxicology--blubber and kidneys. Skull saved.

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## Appendix D.--Continued.

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NECROPSY NO.: 031A86  
 DATE OF DEATH: <4 May (mid-April)  
 DATE OF NECROPSY: 27 June  
 SEX: Female ?  
 SIZE CLASS: Adult  
 IDENTIFICATION NO.: --

**CIRCUMSTANCES OF DEATH:** U.S. Fish and Wildlife Service personnel (Ken McDermond) found seal dead prior to 4 May, the first day of the National Marine Fisheries Service's 1986 field camp at Laysan Island. He had seen it alive with massive dorsal wounds a few days prior to its death; posterior half of back laid open with gaping wound into muscle.

**EXTERNAL DESCRIPTION:** Seal dead approximately 2-3 weeks on 4 May; face down in sand (sector 4), .5-1.5 m feet from high tide line; rotten, bloated, pelage slipping, maggots. Open dorsal wound about 77 cm long. Teeth worn, some missing. Hind flippers rotting; no tags found on them or in sand.

*Measurements:* Standard length (dorsal side up) = 208 cm<sup>a</sup>

**INTERNAL DESCRIPTION:** Organs still discernable anterior of seal but not posterior. No baculum found.

**SAMPLES COLLECTED:** Rectal fecal matter. Skull and right pelvis.

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<sup>a</sup>Length measurement should be considered an estimate because of deteriorated state of the carcass. This appeared to be an old, large seal.

## Appendix D.--Continued.

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NECROPSY NO: 04LA86  
DATE OF DEATH: 8 July  
DATE OF NECROPSY: 8 July  
SEX: Male  
SIZE CLASS: Weaned pup  
IDENTIFICATION NO.: TL02

CIRCUMSTANCES OF DEATH: Weaned pup found dead on dry sand (sector 2); last seen alive the night before, 1732 hours.

EXTERNAL DESCRIPTION: Dorsal scratches and punctures, slight posterior-dorsal swelling. No injuries on ventrum. Eyes clear, nares clean--no blood, mucous, or mites.

*Measurements:* Standard length (ventral side up) = 123.0 cm  
Axillary girth (no bloat) = 86.0 cm  
Blubber thickness (base of sternum) = 2.7 cm

INTERNAL DESCRIPTION: Intestines not gaseous; color of organs normal. No parasites nor ulcers in stomach; a few tiny tapeworms in intestines. Teeth well developed. Pup in "fatted" condition throughout, including heart. Skull intact.

SAMPLES COLLECTED: *Preserved in formalin*--lymph node (scapular), left adrenal, testes and epididymis, kidneys, pancreas, stomach and contents, intestinal parasites, mesenteric node, liver, gall bladder, thymus, heart (entire), and lung. No samples frozen for toxicology. Skull saved.

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Appendix E.--Overview of the death of weaned pup caused by an adult male, Laysan Island 1986.

| Date | Event  |
|------|--|
| 5/17 | Male pup TL36 weaned (from T04F) in sector 18.   |
| 5/21 | Numerous superficial scratches on pup's back; adult male TY75 attended pup.  |
| 5/24 | Pup was tagged and measured; size small (axillary girth 96.0 cm, standard length 121.0 cm). Pup active and appeared health except for the minor scratches.   |
| 5/28 | New dorsal injuries: deeper, more extensive rake marks and associated swelling.  |
| 5/31 | Pup lethargic: breathing labored and frequent.   |
| 6/1  | Pup still lethargic and breathing labored. Extensive dorsal swelling with small pink area in center.   |
| 6/2  | At 1208 hours, the pup was swimming alone inside the reef in sector 18 when adult male (TY75) approached him, attempted to mount, and bit him on the back. By 1210, one-half the back was ripped open. The pup was still alive at 1248 when observations temporarily ceased but it appeared dead at 1300 when observations resumed. TY75 swam with the carcass until he was displaced by adult male T723 at 1332. T723 attended the carcass until one or more sharks consumed it at 1439. (See Appendix F for more details.) |
| 6/4  | Adult male T723 seen resting on shore; no shark injuries.  |

## Appendix F.--Detailed observations of weaned pup's death on 2 June 1986.

| Time | Observation   |
|------|---|
| 1202 | D. Alcorn checks pup (TL36). Pup swimming alone, 30-55 m offshore, inside the fringing reef. Pup's condition similar to night before: large dorsal swelling with pink center; frequent breathing; head lifts above water every 6-30 seconds.  |
| 1208 | Adult male (TY75) approaches pup, jousts, and rolls. Pup attempts to swim away. TY75 bites the pup's back and attempts to mount. Pup vocalizes and rolls. Adult bites, pulling the dorsal skin, and about one-half of the back rips open. Pup and adult drift outside the reef about 67 m offshore, over the deep drop-off frequented by tiger sharks.  |
| 1211 | Pup hauls out on wave-washed reef and rests on belly. TY75 hauls out within 2 m of the pup.   |
| 1218 | Wave washes pup off reef, and TY75 follows pup into the water. Both seals start moving towards shore. During the next 0.5 hour, TY75 repeatedly bites and mounts pup; pup rolls onto back, vocalizes. Between biting and mounting, TY75 rests against or within 2 m of pup; touches noses or places chin on pup's open dorsal wound, or presses nose deep into wound and closes eyes; follows pup as pup slowly swims away. |
| 1248 | Pup still alive when Alcorn ends observations and returns to camp to get spotting scope and R. Westlake. (Alcorn arrives at camp at 1254, and Westlake arrives at site and resumes observations at 1300; Alcorn arrives about 10 minutes later with additional gear.)   |
| 1300 | Pup floats, appears lifeless when observations are resumed. TY75 defends the pup's carcass from an unknown adult male.  |
| 1310 | TY75 and pup carcass drift within 75 feet of shore. TY75 noses, bites, and mounts carcass; vocalizes although no other seals in vicinity.   |
| 1329 | An adult male (T723) approaches TY75. TY75 rapidly swims towards him; they joust near the carcass 2.5 minutes. TY75 is driven away, but for a few minutes remains within 15 m of T723 which is circling the carcass.  |
| 1333 | T723 continues to closely circle the carcass; drifts north (into sector 19) about 18 m offshore.  |
| 1342 | T723 mounts carcass for the first time, pushing it underwater.  |
| 1347 | T723 pushes nose into dorsal wound of carcass. They drift into a channel, and the current pulls them seaward.   |
| 1402 | Now 55 m offshore ; T723 nosing, mounting but is not seen to bite.  |

## Appendix F.--Continued.

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| Time | Observation   |
|------|---|
| 1403 | T723 becoming more "active," pushing the carcass in addition to mounting and circling.  |
| 1407 | T723 mounts the carcass.  |
| 1408 | T723 circles.   |
| 1411 | T723 dives, then circles carcass at surface.  |
| 1417 | Pushes nose into dorsal wound and continues to circle carcass.  |
| 1421 | Shark hits carcass; fin, blood, and splashing but T723 remains next to carcass.   |
| 1429 | Splashing. T723 appears to be mounting, but far offshore and difficult to see.  |
| 1438 | Oil slick on water. T723 stays close to what remains of carcass.  |
| 1439 | Much splashing. Many small shark fins, water red. T723 sticks head out of water. Entire back of a large shark (over 3.65 m total length) thrashes high out of water next to T723. No sign of shark, T723, nor carcass (but difficult to see at distance). |
| 1442 | Frigate birds diving at scene, but no sign of anything else.  |
| 1443 | Nothing in area except slick on water. End observations.  |

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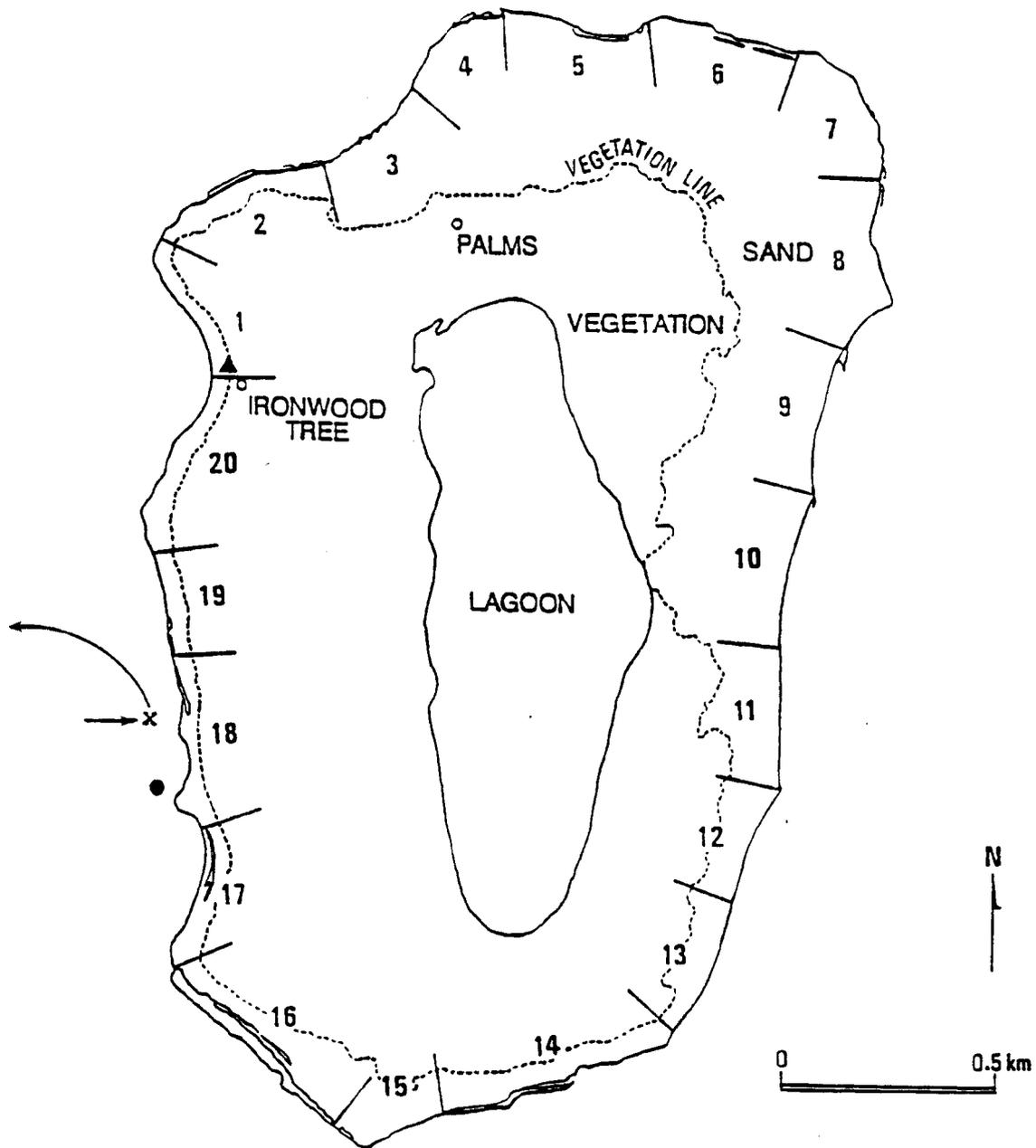


Figure 1.--Map of Laysan Island showing the location of the camp site (▲), the 20 sectors, mobbing site (●), and where an adult male killed a weaned pup (x).

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