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ABSTRACT

A study on the endangered Hawaiian monk seal, *Monachus schauinslandi*, on Laysan Island in the Northwestern Hawaiian Islands collected data on population structure, reproduction, and factors affecting survival (primarily adult male aggression toward adult female and immature seals) from 2 March to 30 November 1985. There were 295 individual seals identified on Laysan Island in 1985. The ratio of males to females was similar in the immature size classes but was nearly 2:1 in the adult size class. Excluding pups, a net increase of 25 identified individuals occurred between the 1984 and 1985 field seasons. At least 32 pups were born, 18 males and 14 females. Average nursing period was 40 d (range, 32-45 d). One exchange of pups between nursing females was observed. At least 59% of the adult females identified on Laysan Island pupped in 1985. The average length of time between births in successive years was 379 d (range, 361-408 d). At least 40 injuries were sustained by 37 individual seals, and 7 seals died (2 adult females, 2 subadult males, and 3 male pups). Fourteen of the injuries and five of the deaths were caused by adult male aggression. This paper describes a birth, four adult male mobbings, two similar acts of aggression by single males, and a shark attack.

CONTENTS

INTRODUCTION

Laysan Island (lat. 25°42'N, long. 171°44'W) in the Northwestern Hawaiian Islands (NWHI) is one of the major haul-out and pupping areas used by the endangered Hawaiian monk seal, *Monachus schauinslandi*. Extensive research has been conducted since 1977, e.g., Johnson and Johnson (1978, 1981a, b, 1984). The National Marine Fisheries Service (NMFS) began an ongoing research program on Laysan Island in 1981, establishing research camps for 3.5 to 9 mo annually to monitor this population. This research is authorized under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. Findings of the ongoing research are presented in Knudtson[1] for 1981, Alcorn (1984) for 1982, Alcorn and Buelna[2] for 1983, and Johanos et al. (1987) for 1984.

For the 1985 field season, the primary objective was to collect data on adult male behavior and monitor incidents of adult male aggression toward adult female and immature seals. Additional objectives were to conduct frequent censuses, monitor reproduction, tag all weaned pups, identify all adult male seals in the population, tag aggressive males, and bleach mark all molting adult and subadult males to maintain identification, continue photographic identification, monitor injuries and deaths, perform necropsies, and sample and destroy debris capable of entangling seals. This report summarizes the data collected on population structure, reproduction, and factors affecting survival. Census summaries and interisland movement data concurrently collected are presented in Becker et al.[3].

MATERIALS AND METHODS

A field camp was established from 2 March to 30 November 1985 on Laysan Island, which is located within the Hawaiian Islands National Wildlife Refuge. Its geology, flora, fauna, and history are described in detail in Ely and Clapp (1973). The island perimeter was divided into 20 sectors (Fig. 1) for the 1982 study (Alcorn 1984); these same sectors have been used for all subsequent data collection for seals on the island. Sector boundaries are marked by natural features or by plastic poles left in place from field season to field season. The itinerary of the 1985 Laysan Island fieldwork is presented in Appendix A.

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[1]Knudtson, E. P. Hawaiian monk seal observations at Laysan Island, March-July 1981. Unpubl. manuscr., 23 p. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

[2]Alcorn, D. J., and E. K. Buelna. The Hawaiian monk seal on Laysan Island: 1983. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

[3]Becker, B. L., R. J. Morrow, and J. K. Leialoha. Censuses and interatoll movements of the Hawaiian monk seal on Laysan Island, 1985. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

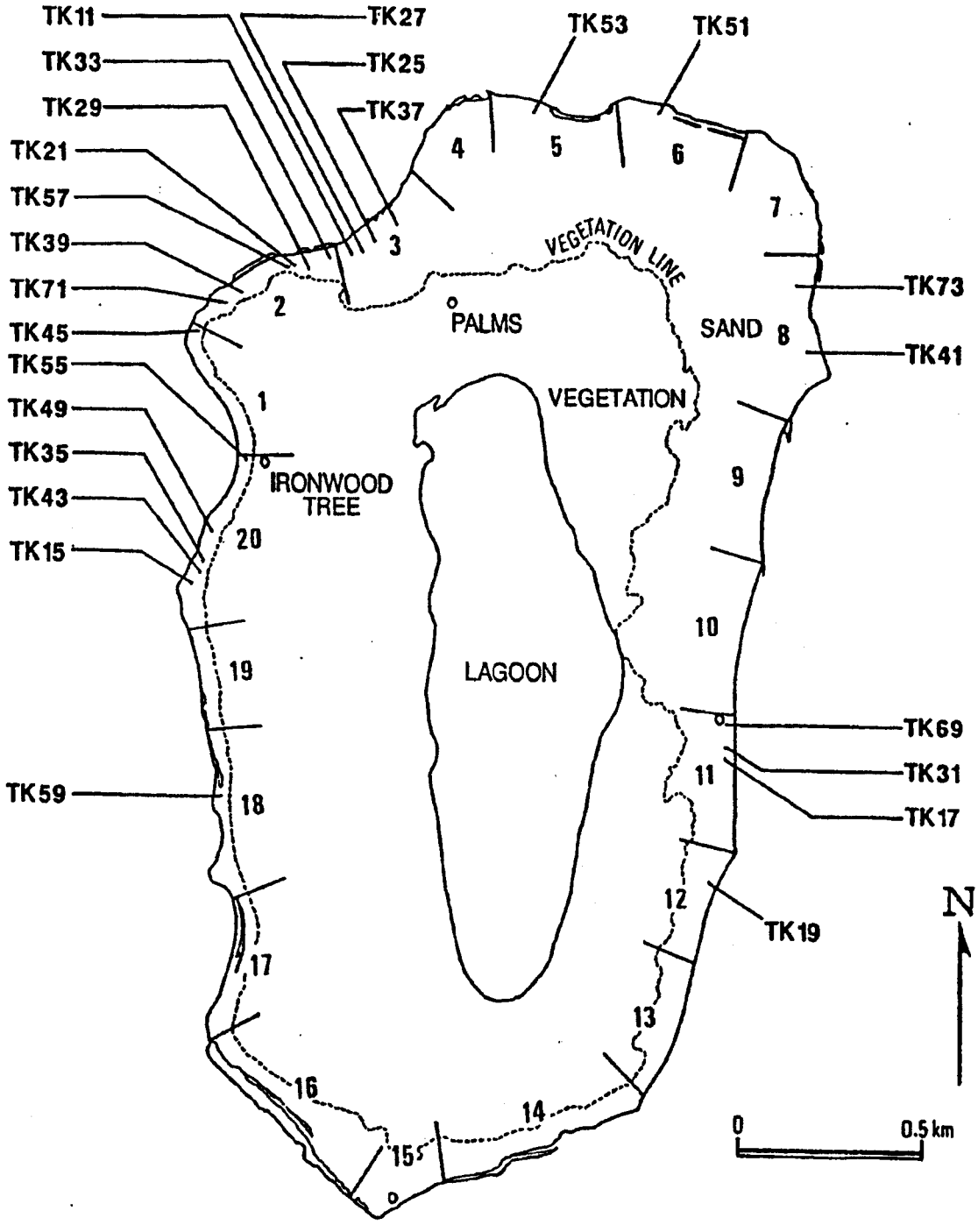

Figure 1.--Map of Laysan Island showing 20 sectors and known pupping sites of Hawaiian monk seals, 1985. Numbers represent the identification number of the pup.

Individual Identification

All individual seals mentioned in this report are referred to by permanent identification (ID) numbers and are directly comparable between islands and years unless otherwise noted. For individual identification, seals were tagged and bleach marked on a daily, opportunistic basis. They also were classified by sex and size. Procedures for seal identification and size classification are described in detail in Stone (1984). All pups were tagged with a tan, plastic Temple Tag[4] on each hind flipper (Gilmartin et al. 1986) and bleach marked (Stone 1984) as soon as possible after weaning. The composition of the bleaching solution used is described in Johanos et al. (1987). Adult males observed to harass, injure, or kill adult females or immature seals of either sex were tagged with a Monel metal tag on one hind flipper (see footnote 2 for procedures). All adult male seals without distinctive natural markings or bleach marks from the previous season were bleach marked as soon as possible for individual identification. Molting adult males were re-marked to maintain their identity. Bleach marks, scars, and other natural markings were sketched on a scar card for each seal. The scar cards were revised and updated throughout the field season to maintain a current file. Scars and natural markings were photographed; these photographs were added to the individual seal identification file begun in 1982. Special emphasis was placed on documenting the natural markings of adult females and immature seals because, in 1985, they were not bleach marked after molting.

Censuses and Patrols

A summary of census and patrol data collected on Laysan Island in 1985 and a typical daily schedule are in Appendix B. From 10 March until 30 June, the combination of censuses, behavior patrols, and mobbing patrols ensured that sectors 1-8 and 18-20, areas in which intense incidents of adult male aggression have been observed, were monitored at least twice daily 6 d per week and at least once on the remaining day of each week. After 30 June, these areas were monitored at least twice daily on census days (every third day) and once daily on noncensus days until 20 July when formal patrols ended.

Observers minimized disturbance of seals by staying above the beach crest and using vegetation for cover, where possible. Data were recorded on the standard census form (footnote 2) and followed the 1985 coding instructions (footnote 3). In addition to the standard codes listed in the census form instructions, other codes were developed for specific use on Laysan Island in 1985 (Appendix B; footnote 3).

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

Censuses

Seals were censused every third day on Laysan Island from 6 March to 26 November. Census procedures and results are detailed in Becker et al. (footnote 3); however, pertinent data collected during the censuses are included in our paper.

Behavior Patrols

Data on adult males and their behavior patterns were collected during behavior patrols. Molting seals and mother-pup pairs also were noted during certain types of behavior patrols (see Appendix B). The patrols were conducted daily from 10 March to 20 July, except they were canceled on 14 d because of logistics. They began at about 0800 Hawaii standard time and lasted from 1.25 to 9.75 h (average, 4 h). In all, 119 behavior patrols were conducted.

Behavior patrols conducted 10 March-5 April recorded only adult or large subadult males that were "paired" (i.e., within 5 m of adult or large subadult females). One observer conducted each of these patrols and traveled north from sectors 18 through 8. Behavior patrols after 5 April recorded all adult or large subadult males and their associations with any other seal. Patrols covering the entire island were conducted on noncensus days by two observers, with the exception of 1 d per week when only one observer covered the entire island. One observer traveled north from sectors 18 through 8 while the other traveled south from sectors 17 through 9. In addition, a patrol covering only sectors 18 through 8 (traveling north) was conducted by one observer on census days.

Mobbing Patrols

Mobbings are instances in which adult male seals collectively commit acts of aggression toward other seals and inflict obvious injury. Designed to detect incidents of adult male aggression, mobbing patrols were conducted in sectors 1-8 and 18-20, where adult male mobbings have been previously observed (Johnson and Johnson 1981b; Alcorn 1984; Johanos et al. 1987). Mobbing patrols were conducted daily, beginning at 0800 and lasting about 4 h, from 10 March until 20 July, except they were canceled on 13 d because of logistics. Mobbing patrols on noncensus days were repeated at 1500, except on one noncensus day per week. The morning patrol was performed in combination with the behavior patrol; the afternoon patrol was not conducted after 30 June.

One observer walked the beach crest between sectors 1-8 and 18-20, observing and noting interactions between seals. Attention was directed out to sea as much as possible. The observer carried a VHF radio to contact another observer at least once each hour. When an incident of aggression was observed, other observers were alerted and proceeded to the location, if necessary. Offshore mobbings were monitored by two observers onshore and two in an inflatable boat. Observers in the boat identified the seals with the aid of binoculars and documented the mobbing with photographs. Data were recorded in a waterproof notebook and transferred with appropriate coding to the standard census form after the boat returned to shore.

Incidental Data

Incidental data collected during the mobbing patrol included sightings of molting seals and nursing mother-pup pairs not already recorded during censuses or behavior patrols. Also, the island was monitored daily for noteworthy events such as births, deaths, weanings, adult male harassment, shark-seal interactions, entanglements, and the appearance and progress of wounds and illnesses.

Collection of Samples

Samples collected included necropsy samples, scats and spews, and debris capable of entangling seals. For each dead seal recovered, an external examination was made, photographs taken, and external measurements and observations recorded. The skulls were flensed and staked until completely dried. If the death was recent, an internal examination was made, and blood, tissue, and organ samples were collected. Detailed descriptions of necropsy procedures and sample collection are presented in Winchell[5]. Scats and spews were collected from seals of known size class or sex, following the methods in Alcorn (1984). All nets, lines, ropes, and other debris items capable of entangling seals were sampled and destroyed, following the methods in Johanos and Kam (1986).

RESULTS AND DISCUSSION

Population Structure

A summary of the individuals identified on Laysan Island in 1985, by sex and estimated midsummer size class, is presented in Table 1. A total of 295 individuals were identified by tags, bleach marks, or natural markings. Of these, 131 were adult and subadult males. Documentation of population structure was limited in 1985 because not all animals present on Laysan Island in 1984 were re-marked after molting (Johanos et al. 1987), and only adult and subadult males were bleached in 1985. A total of 122 adult and subadult males were bleached after molting, and 96 of these seals were matched with a premolt identity. The ratio of identified males to females was very similar in the immature size classes but was nearly 2:1 in the adult size class. This sex ratio was consistent with that observed on Laysan Island in 1983 and 1984 (Johanos et al. 1987; footnote 2).

Excluding pups of the year, a net increase of 25 identified individuals occurred on Laysan Island between the 1984 and 1985 field seasons. Observed population changes were due to inclusion of surviving 1984 pups as juveniles in the 1985 total, death and

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[5]Winchell, J. M. Field manual for phocid necropsies specifically *Monachus schauinslandi*. Unpubl. manuscr. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

Table 1.--Number of individual Hawaiian monk seals observed on Laysan Island, 1985, by sex and estimated midsummer size class. Sex ratio is the number of males to females.

Size	No. of seals			Sex ratio
	Males	Females	Total	
Adult	104	55	159	1.9:1
Subadult	27	30	57	0.9:1
Juvenile	24	23	47	1.0:1
Pup	18	14	32	1.3:1
Total	173	122	295	1.4:1
Total excluding pups	155	108	263	1.4:1

disappearance, immigration and emigration (footnote 3), and the translocation of nine adult males to Johnston Atoll in 1984 (Gilmartin[6]). The observed net increase was conservative: the 1984 total (238 seals) represented all seals on Laysan Island, whereas the 1985 total (263 seals) represented only part of the population because an unknown number of seals were not identified. An increase in the population also was indicated by the census data: The average census count was nearly 20 animals higher in 1985 than in 1984, whether pups were included or excluded (Johanos et al. 1987; footnote 3). Since the total number of seals in the Laysan population is estimated to be two to three times the number counted on the beach (Gerrodette[7]), an increase of nearly 20 seals on census could indicate an actual increase of 40 to 60 individuals.

Tagged Seals

All weaned pups were tagged successfully and had retained all tags when last examined in 1985. The number of pups born and tagged at Laysan Island in 1983 and 1984 and their resightings through 1985 are summarized in Table 2. All 20 pups tagged in 1983 were resighted in 1985, and tag retention was 100%. Of these 20 seals, 19 were resighted at Laysan Island; the remaining seal was resighted at French Frigate Shoals (footnote 3). Of the 29 pups tagged in 1984, 27 were resighted, and only 1 had lost a tag. Within 3 d prior to 29 May, juvenile male TT22 lost the left tag (T21) but was not retagged during the 1985 field season. Nine adult

[6]Gilmartin, W. G. Translocation of adult male seals from Laysan to Johnston Atoll. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

[7]Gerrodette, T. Estimating the 1983 population of Hawaiian monk seals from beach counts. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-85-5, 13 p.

Table 2.--Number of pups born and tagged at Laysan Island in 1983-84 and resighted through 1985.[a] Numbers in parentheses equal the numbers of males and females, respectively.

Year tagged	Known births (No.)	Pups tagged (No.)	Tags resighted by year	
			1984	1985
1983	24 (11, 13)	20 (10, 10)	20 (10, 10)[b]	20 (10, 10)[c]
1984	31 (16, 15)	29 (16, 13)	--	27 (15, 12)

[a]Birth and tag data are from the following sources: 1983 (text footnote 2) and 1984 (Johanos et al. 1987).

[b]This figure includes a Laysan pup resighted on Lisianski Island and another Laysan pup not seen in 1984 but resighted at French Frigate Shoals in 1985.

[c]This figure includes a Laysan pup resighted at French Frigate Shoals.

Table 3.--Adult male Hawaiian monk seals tagged on Laysan Island, 1985.

Tag No.[a]			
L	R	ID No.	Date
--	X062	T395	Fall
--	X063	T723	Fall
X068	--	T439	Fall
--	X076	T719	17 May
X077	--	T435	29 July
--	X078	T446	29 July
--	X079	T308	Fall
--	X080	T080	Fall
--	X089	T430	Fall

[a]L = left hind flipper; R = right hind flipper.

males received metal hind flipper tags in 1985 (Table 3) and had retained their tags when last examined in 1985. Two adult males (TP35 and TY18) tagged in 1983 (footnote 2) and observed throughout the 1984 field season (Johanos et al. 1987) were not resighted in 1985. TP35 either lost his tag or left the Laysan population (see section on disappearances), and TY18 was captured on Laysan Island and relocated to Johnston Atoll in December 1984 (footnote 6). Adult male TP46 tagged in 1984 (Johanos et al. 1987) also was captured on Laysan Island, relocated to Johnston Atoll in December 1984 (footnote 6), and not resighted on Laysan Island in 1985.

Adult female T27F was resighted on Laysan Island in 1985 and still retained her metal hind flipper tag. This female was tagged as a yearling at French Frigate Shoals in 1967 and has been resighted on Laysan Island since 1982 (Alcorn 1984; Johanos et al. 1987; footnote 2).

Three tagged subadults from Lisianski Island were resighted on Laysan Island in 1985. Females G027 and G055, born and tagged on Lisianski Island in 1982 and 1983, respectively (Johanos and Henderson 1986; Johanos and Kam 1986), have been resighted on Laysan Island since 1984 (Johanos et al. 1987). Male G065, also born and tagged on Lisianski Island in 1983, was resighted on Laysan Island for the first time in 1985 (footnote 3).

Reproduction

Pup Production

At least 32 pups were born on Laysan Island in 1985, 18 males and 14 females (Table 4). Seven nursing pups were present on Laysan Island at the beginning of the 1985 field season. The last pup of the season was born on 15 July 1985. Of the 32 pups born, 30 survived to weaning. Although 1 weaned pup died and 4 disappeared, all the remaining 25 weaned pups were sighted within the last 8 d of the field season. The major pupping areas were along the midwest (sectors 19-20) and the northwest (sectors 2-3) portions of the island (Fig. 1), similar to previous years according to available data (e.g., Johnson and Johnson 1978; Alcorn 1984; Johanos et al. 1987). Of the known pupping sites, 60% were in these preferred areas. Four pups were born on the southeast perimeter (sectors 11-12) of the island. Complete nursing periods were observed for 23 mother-pup pairs in 1985. Average nursing period was 40 d (range, 32-45 d) (Table 4). Pup TK53 nursed only 32 d and was classified by size as a prematurely weaned pup.

Pup Exchange

One exchange of pups between nursing females was observed in 1985. The pups involved were similar in size, although their actual birth dates were not known. On 3 March, adult female T37F was first observed nursing a male pup in sector 19 while adult female GA10 was nursing a female pup in sector 20. Both mother-pup pairs were sighted in sector 19 on 2 April, and GA10 was nursing a female pup on this date. The first knowledge of a pup exchange was on 3 April, when T37F was identified with a female pup, and GA10, with a male pup. That afternoon, the pup with GA10 was "weaned." The remaining nursing female was observed on 4 April with a pup whose sex was not determined. The male pup was back with T37F by 5 April. Later that day, the mother was involved in an incident with a single, aggressive adult male (see section on adult male aggression). The male pup was separated from the mother during the incident and made two attempts to approach and nudge the adult male. During this incident, GA10's female pup approached and began nudging T37F, who snapped at both pups several times. On the morning of 6 April, T37F was seen with both pups. She was gone from the vicinity on 7 April and had no further interactions with either pup.

Table 4.--Summary of data on Hawaiian monk seal pups born on Laysan Island, 1985.

Tag No.[a]				Birth		Weaning		Nursing period	Tagging	Measurement (cm)[b]		Mother
L	R	ID No.	Sex[c]	Date	Sector	Date	Sector	(d)	date	AG	SL	ID No.
K00	K01	TK01	F	--	--	3/9-10	8	--	3/12	110.0	134.0	T374
K02	K03	TK03	F	--	--	3/30-4/1	3	--	4/4	120.0	133.0	T08F
K04	K05	TK05	M	--	--	4/7-8	12	--	4/9	99.0	119.0	T53F
K06	K07	TK07	M	--	--	4/7-8	2	--	4/9	114.0	130.0	T368
K08	K09	TK09[d]	M	--	--	4/7	19	--	4/13	101.0	135.0	T37F[e]
K10	K44	TK11	F	3/28	3	5/7-8	2	40-41	6/9	120.0	132.0	T02F
K12	K13	TK13	F	--	--	4/3	19	--	5/21	98.0	136.0	GA10[e]
K15	K14	TK15	F	3/16	20	4/24	19	39	5/21	110.0	134.0	10N[f]
K16	K17	TK17	F	3/13-14	11	4/23-25	12	40-43	5/11	103.0	138.0	TP85
K19	K18	TK19	M	3/12	12	4/23-24	14	42-43	5/17	115.0	143.0	T51F
K21	K20	TK21	F	3/16	2	4/26	3	41	5/5	127.0	133.0	T66F
K23	K22	TK23	M	--	--	4/11	2	--	5/20	93.0	124.0	T310
K25	K24	TK25	M	3/20	3	4/29	3	40	5/5	103.0	131.0	T391
K26	K27	TK27	M	3/26	3	5/10	2	45	5/26	116.0	139.0	T13F
K28	K29	TK29	F	3/25	2	5/6	2	42	7/1	110.0	152.0	T11N
K30	K31	TK31	M	4/8	11	5/13	12	35	5/14	102.0	125.0	T6F
K32	K33	TK33	M	4/11	2	5/25	2	44	6/4	110.0	144.0	T17F
K35	K34	TK35	F	4/17	20	5/28	20	41	6/8	117.5	129.0	T16F
K36	K37	TK37	F	4/21	3	5/31	2	40	6/19	109.0	141.0	T302
K38	K39	TK39	M	4/24	2	6/4	2	41	6/5	113.0	132.0	T11F
K41	K40	TK41	M	4/30	8	6/5	8	36	6/19	110.0	139.0	T12F
K43	K42	TK43	M	4/26	20	6/7	20	42	6/9	102.0	126.0	TY17
K45	K11	TK45	M	4/28	1	6/7	2	40	6/12	113.0	134.0	T03F
K46	K47	TK49	M	5/5	20	6/15-16	19	41-42	6/16	95.0	133.0	T22F
K49	K48	TK69	M	5/5	11	6/15-17	11	42-44	6/25	115.0	127.0	12N[f]
K50	K51	TK51	F	5/8	6	6/20	6	43	6/28	127.0	149.0	T27F
K53	K56	TK53	F	5/24	5	6/25	6	32	7/28	80.0	129.0	T26F
K52	K55	TK55	F	6/10	20	7/15	20	35	7/20	103.0	140.0	T34F
K57	K58	TK57	F	6/24	2	7/29-31	2	35-37	8/1	101.0	134.0	T25F
K60	K59	TK59	M	7/15	18	8/25-27	18	41-43	8/29	98.0	123.0	T39F
--	--	TK71[g]	M	4/29	2	--	--	--	--	--	--	T04F
--	--	TK73[h]	M	5/31	8	--	--	--	--	--	--	T15F

[a]L = left hind flipper; R = right hind flipper.

[b]AG = axillary girth; SL = standard length.

[c]F = female; M = male.

[d]Pup died 13 July 1985 (necropsy No. 07LA85).

[e]Pup exchange.

[f]Temporary identification number.

[g]Pup died 1-2 May 1985 (necropsy No. 02LA85).

[h]Pup died 8 June 1985 (necropsy No. 06LA85).

Parturient Females

At least 59% of the adult females identified on Laysan Island in 1985 pupped that year. This excludes adult female Y156, who pupped on French Frigate Shoals and then immigrated to Laysan Island to molt (footnote 3; Eliason and Webber[8]). Of the 32 adult females known to have pupped on Laysan Island in 1985, 29 were identifiable from previous years. Twenty-eight of these females were observed on Laysan Island in 1984, and 19 of them pupped (Johanos et al. 1987). One parturient female (T25F) was observed with a nursing pup on Lisianski Island in 1984 (Alcorn et al. in press).

Parturition dates were known in both 1984 and 1985 for 12 adult females that gave birth on Laysan Island. The average duration between births in successive years was 379 d and ranged from 361 to 408 d (1984 data are from Johanos et al. (1987)). Of the known parturient adult females in the Laysan population from 1982 through 1985, seven pupped in all 4 yr (Appendix C). Adult female T03F was observed giving birth on 28 April 1985 by four observers about 25 m away (Appendix D; see Eliason et al.[9]).

Factors Affecting Survival

Injuries

At least 40 injuries were sustained by 37 individual seals. These injuries resulted from shark attack, adult male aggression, contact with reef or debris, or unknown causes (Table 5). Twenty injuries (50% of total) appeared to have been caused by sharks: either large, clean gashes, amputations, or circular wounds inflicted by the cookiecutter shark, *Isistius brasiliensis*. Fourteen injuries (35% of total) were dorsal wounds typical of bites inflicted by adult males during mating attempts. One wound on the neck was probably inflicted by another seal. Four minor wounds (10% of total) were probably caused by the animal coming into contact with reef or debris. The probable cause of one injury (a broken hind flipper) is unknown. One of the seals had an injury that appeared to be life threatening; an adult male (T07M) received a deep shark bite during a mobbing incident (see section on deaths). This injury later showed signs of healing.

On 17 April at 0932, a ruddy turnstone, *Arenaria interpres*, was observed pecking open a healing dorsal injury. The bird appeared to feed from the scabs and open wound, causing the areas to bleed freely. The sleeping adult female (T37F) was eventually disturbed and

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[8]Eliason, J. J., and M. A. Webber. French Frigate Shoals monk seals: 1985. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

[9]Eliason, J. J., T. C. Johanos, and M. A. Webber. Parturition in the Hawaiian monk seal, *Monachus schauinslandi*. Manuscr. in prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

Table 5.--Injuries of Hawaiian monk seals at Laysan Island, 1985.

Date	Field No.	Size class[a]	Sex[b]	ID No.	Description of initial injury	P or K[c]	Cause
3/3	12	J	F	TT04	Lateral puncture	P	Shark
3/14	--	A	M	--	Large gaping shoulder wound. Missing front flipper?	P	Shark
3/15	1	A	F	T13F	Three ventral punctures	P	Shark
--	--	A	F	T09F	Dorsal abrasions	K	Adult male
3/23	2	A	M	TY33	Lateral puncture	P	Shark
3/25	3	A	F	GS86	Ventral puncture	P	Shark
3/26	4	A	M	T709	Shoulder puncture	P	Shark
3/29	5	J	F	TT02	Ventral puncture	P	Shark
4/5	13[d]	A	F	T37F	Two areas in dorsal scar reopened, 2 cm^2 each	K	Adult male
4/5	20[e]	J	M	TT36	Dorsal laceration through skin, 15 cm; abcess, 15 cm^2	P	Adult male
4/6	6	A	F	T34F	Lateral laceration through skin, 15 cm	P	Reef/debris
4/12	7	J	F	TT04	Ventral puncture	P	Shark
4/12	8	A	M	T387	Lateral puncture	P	Shark
4/15	10	A	F	TP53	Two dorsal lacerations through skin, 20 cm each	P	Adult male
4/16	12	A	F	T362	Gaping dorsal wound into blubber, 5 cm^2; numerous abrasions	P	Adult male
4/18	--	A	F	T01F	Gaping dorsal wound through skin, 4 cm^2	P	Adult male
4/28	15	J	F	TA32	Amputation of flipper tip	P	Shark
4/28	16	A	M	TY33	Dorsal abrasion	P	Reef/debris
5/1	17	J	M	TA34	Right hind flipper appears broken	--	Unknown
5/4	18	A	F	GA10	Numerous dorsal abrasions	P	Adult male
5/5	19	A	M	TY70	Old neck scar reopened	P	Seal
5/6	22	A	F	T15F	Lateral abrasion, 4 cm^2	P	Reef/debris
5/7	25[f]	A	M	T07M	Three gaping lateral-dorsal wounds (largest, 6 cm X 1 m) into blubber.	K	Shark
5/10	24	A	M	T315	Abrasion on flipper, 2 cm^2	P	Reef/debris

Table 5.--Continued.

Date	Field No.	Size class[a]	Sex[b]	ID No.	Description of initial injury	P or K[c]	Cause
5/14	26	A	F	T37F	Old dorsal scar reopened, 12 cm^2	K	Adult male
5/16	27	A	F	T57F	Numerous dorsal abrasions	P	Adult male
5/16	28	A	F	T368	Numerous dorsal abrasions	P	Adult male
6/1	29	J	M	TT54	Dorsal abcess, 25 X 35 cm	P	Adult male
6/6	1	A	F	T36F	Numerous dorsal abrasions	P	Adult male
6/11	32	S	F	TP31	Puncture on flipper	P	Shark
6/13	33	J	M	TT38	Two gaping lateral wounds through blubber, 10 cm^2 each	P	Shark
7/3	34	A	F	T26F	Dorsal abcess, 10 cm^2	P	Adult male
8/3	36[g]	A	M	TY60	Numerous gaping dorsal wounds area, 30 cm X 1 m; three abcesses	P	Adult male
8/7	35	--	--	--	Partial amputation of flipper, still attached by band of tissue	P	Shark
9/15	42	A	M	T414	Ventral puncture	P	Shark
10/5	38	A	M	T339	Lateral puncture	P	Shark
11/12	39	A	M	TP81	Dorsal puncture	P	Shark
11/15	37	A	M	T711	Numerous lateral lacerations over a 10-cm^2 area	P	Shark
11/15	41	A	M	T423	Numerous lateral lacerations over a 15- by 10-cm area	P	Shark
11/25	40	A	M	T432	Seven ventral lacerations (5 cm each) over a 50 cm^2 area	P	Shark

[a]A = adult, S = subadult, and J = juvenile.

[b]F = female; M = male.

[c]P = probable cause; K = known cause.

[d]Scabs reopened by ruddy turnstone on 17 April.

[e]Still infected on 5 May.

[f]Healing on 15 May.

[g]Blubber protruding from wounds on 9 August, possibly mobbed again.

rolled. The turnstone remained within 5 m of the seal and pecked at the injury again at 1014 and 1017 when the seal rolled so that the injury was accessible. This behavior might be a factor involved in the chronicity of injuries observed on some seals. Ruddy turnstones have been observed pulling on tapeworms partially extruded from the anus of an adult male at French Frigate Shoals (J. Henderson[10]), but this observation is the first of a ruddy turnstone pecking at seal injuries.

Adult Male Aggression

All adult male mobbings and similar acts of aggression by single males are summarized in Appendix E. Some prolonged adult male harassments of immature seals and nursing female-pup pairs are also included but should be viewed as a minimum number because only the more intense incidents observed were recorded. In addition to the deaths reported later, three adult females were injured by mobbings or aggression by single males. Details are presented below:

Case 1.--On 19 March, adult male T717 and adult female T09F were observed about 40 m from the water's edge in sector 8. Male T717 defended the female from a succession of four adult male challengers who remained in the general vicinity after being defeated. At 1145, as male T717 jousted with one of these males a second time, another "defeated" male (T308) quickly approached the female. The defending male rushed back towards the female, followed by the three remaining males. The males nudged and attempted to mount the female, and T308 bit her on the back, drawing blood. As male T717 unsuccessfully attempted to defend the female from the other four males, she fled up the beach, turning periodically and performing open-mouthed threats, rolls to present her ventral surface, and flipper waves at the pursuing males. Male T717 remained in proximity to the female and appeared most dominant until 1155, when he was bitten and displaced by male T308. Male T308 successfully defended the female from the other males, and the situation was quiet by 1220.

Case 2.--On 5 April, an adult male (possibly T716) was observed jousting with lactating female T37F at 1340 in the wave wash of sector 19. The male vocalized, approached, nudged, and bit the female repeatedly. The female usually responded by vocalizing, performing open-mouthed threats, or jousting with the male, and she bit the male on one occasion while they were in the water. The female was involved in a pup exchange at the time of the aggressive interaction; at 1403, a second pup, newly weaned, approached and remained next to the female (see section on pup exchange).

At 1411, the female hauled out, followed by the two pups and the adult male, and on the beach, she bit the male twice and was bitten once in return. The interaction quickly lost intensity and was reduced to nudges, vocalizations, and open-mouthed threats. The male left the beach at 1422. The nursing female's old dorsal scar was reopened in two small areas.

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[10]J. Henderson, *Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, Honolulu, HI 96822-2396, pers. commun. September 1985.*

Case 3.--On 14 May, a mobbing was observed in sector 17 at about 1130. A group of seals in the wave wash consisted of adult female T37F and six adult males. Male TP80 appeared most dominant and attempted to defend the adult female from the other males when he was not mounting and biting her. Three males bit the adult female at this time. The female eventually hauled out near a subadult female (TY09), followed by the adult males. This subadult female entered the water at 1210 and was chased by two males from the original mobbing group and a male that had just arrived, but she was able to evade the pursuing males and haul out again in sector 18. At 1225, defending male TP80 was jousting with male T723 when a new male swam up and bit the adult female. Eventually T723 displaced TP80 and was able to successfully defend the adult female. The situation was fairly quiet by about 1230. Following the mobbing, the adult female had numerous lacerations on her back.

Disappearances

Documentation of disappearances between August 1984 and March 1985 is limited to observations of the 184 seals that were identified during 1984, marked after molting, and considered present in the population at the end of the first 1984 field camp in August of that year (Johanos et al. 1987). Between August 1984 and March 1985, 12 unexplained disappearances occurred within the Laysan seal population. Two of these absent individuals (adult female T30F and adult male T03M) had very distinctive natural markings; thus, if they were sighted, the probability of recognition would be high. Adult female T30F was sighted immediately before camp termination in August 1984 but was not sighted during a second field camp from 22 October to 6 November 1984 (Johanos et al. 1987). Adult male T03M was last sighted on 25 October 1984. Tagged adult male TP35 (right hind flipper tag X026) also had a high probability of recognition and either lost his tag or left the Laysan population. Adult male TP35 was last sighted with his tag on 3 November 1984. The remaining nine seals had legible bleach marks at the end of the first 1984 field camp, but it is unknown whether all marks remained conspicuous. Adult females TY24 and G130; adult male TY16; subadult females TY10, TY26, and T58F; subadult males TY57 and TY77; and juvenile female TP48 were sighted regularly during the first 1984 field camp but not in October or November 1984 (Johanos et al. 1987) or in 1985. In addition to the 12 disappearances described above, one unexplained disappearance occurred among 45 seals of unknown original identity that were bleached in November 1984. Adult female T411 was bleached on 24 October 1984 and resighted only once (the following day).

Four pups of the year disappeared during the 1985 field season. Female pups TK11 and TK37 and male pups TK39 and TK43 disappeared 151, 150, 153, and 81 d after weaning, respectively. The time between the last sighting of each of these pups and termination of observations in 1985 was 25-94 d.

Table 6.--Monk seal deaths at Laysan Island, 1985.

Necropsy No.	ID No.	Date	Size class[a]	Sex[b]	Probable cause of death
01LA85	TY11	28 Mar.	S	M	Adult male
02LA85	TK71	1-2 May	P	M	Trauma
03LA85	T328	6 May	A	F	Adult male
04LA85	T310	12 May	A	F	Adult male
05LA85	TP27	8 June	S	M	Adult male
06LA85	TK73	8 June	P	M	Starvation
07LA85	TK09	13 July	W	M	Adult male

[a]A = adult, S = subadult, W = weaned pup, and P = nursing pup.
[b]F = female; M = male.

Deaths

Seven dead seals were found during the 1985 field season (Table 6; Appendix F). A summary of findings are presented here:

Case 1.--On 28 March, the carcass of subadult male TY11 (necropsy No. 01LA85) was found in sector 1, on wet sand at the water's edge. Adult male T723 was defending the carcass. The dead subadult had numerous, fresh, gaping wounds into the skin of the midback, with one wound penetrating into the blubber layer. Death was probably less than 4 h prior to necropsy; the viscera were still warm. Death probably was due to injuries inflicted by one or more adult males.

Case 2.--On 1 May, 3-d-old male pup TK71 (necropsy No. 02LA85) was first observed separated from its mother by 30 m at 1510 in sector 2. The mother was accompanied by an adult male. Mucus was present in the pup's nostrils, and fecal material lay near the anus. The pup was alive but did not react to stimulus. At 1710, the mother was back with her pup, and observers were unable to determine the pup's condition. The pup was found dead at about 0900 on 2 May, in the same position and location as when first observed separated from its mother. The mother had moved a short distance away from the carcass and was again accompanied by an adult male. No external wounds or abnormalities were present on the carcass. An internal examination revealed hemorrhaging and discolored muscle tissue on the right side, indicating that death was probably due to trauma.

Case 3.--On 6 May, adult female T328 (necropsy No. 03LA85) was observed at 1350 in sector 18. She was in shallow water and had fresh, major back wounds. She raised her head periodically to breathe but was otherwise inactive. She was alone but was approached three times within 20 min by passing adult males. She was found dead at 1700 on the same day, her carcass defended by adult male T717. Death probably was due to injuries inflicted by one or more adult males.

Case 4.--On 7 May, adult female T310 (necropsy No. 04LA85) was mobbed and received serious dorsal injuries. Splashing was observed at 1130 about 100 m offshore of sector 19. Observations were made from shore until 1155, when observers arrived on the scene in a boat. At that time the group of seals consisted of the female and 12 adult males; 2 males were mounted on the female, and the other males formed a rough circle around the mating seals. The composition of the adult male group was constantly changing. The number of males present at any one time varied from 5 to 13. Between 1155 and 1700, 24 individual males were identified in the immediate vicinity of the female, and 18 of these males mounted and bit the female at least once. Visible amounts of blood entered the water as the female received additional dorsal bite wounds.

The number of males simultaneously mounted on the female varied from one to three, and the mounted males were frequently challenged or displaced. When possible, apparently to protect her back, the female rolled so that her ventral surface faced the closest male. The female vocalized and performed open-mouthed threats toward approaching males and occasionally either jousted with or bit an adult male. She repeatedly broke away from the surrounding males and traveled a short distance before being caught again.

Tiger sharks, *Galeocerdo cuvieri*, were present during the entire mobbing incident; one or two sharks either circled the area or maintained a position about 10 m under the group of seals. At 1200, a 3-m tiger shark lunged upward toward the copulating male-female pair and bit male T07M (the only male mounted on the female at that time), creating a posterior gash (6 cm x 1 m) that extended from his left side and across the back to his right side. There was a flurry of splashing as the wounded male disengaged from the female, and then the shark disappeared, leaving the male swimming slowly away and losing a substantial amount of blood into the water. (T07M was sighted onshore on 15 May, and his wound showed signs of healing.) Tiger sharks approached within 2 m of the copulating seals on three other occasions but did not attack.

By 1227, the group of seals was offshore of sector 17. The action took place mostly on the water's surface, but at 1234, the female dove about 5 m underwater, followed by six males. By 1300, the group was about 400 m offshore of sector 15. At 1416, the female dove again, followed by one male. The maximum offshore distance of the mobbing was about 800 m. Between 1419 and 1505, the female broke away from the adult males six times and swam for extended distances towards shore, for a total of about 250 m. Whenever a male caught her, the female vocalized and rolled to protect her back, so that the male was forced to clasp her ventrally. By 1515, the mobbing was about 100 m offshore, and only five males were in the immediate vicinity of the female. By 1521, observers could no longer approach closely with a boat because the seals had entered an area of high surf about 30 m offshore. At this time, primary observation was resumed by observers onshore. At 1535, the female hauled out in sector 15 and was followed by seven males. Male T752 was able to successfully defend the female from other males once the group was onshore. The female lay quietly, and although some males jousted among themselves, they generally left the female alone. At 1553, two males left the beach, leaving six males. Another male left at 1606, and by 1616, the group was inactive except for low level interactions between the female and male T752. The female had numerous abrasions and puncture wounds into the blubber. One laceration (15 cm long)

for at least 5 h during the heat of the day. By evening, the pup's struggles against the placenta had weakened. The mother hauled back up to the beach crest, again leaving the pup behind. Observers intervened at this point because the rising tide threatened to cover the pup. Observers cut the umbilical cord and carried the pup to the beach crest where the mother joined her pup. The pup was never observed nursing and appeared progressively weaker each day. The pup was found dead at 1530 on 8 June. The carcass lay on the dry sand, and adult female T15F was no longer in the vicinity. The carcass was extremely thin, and death probably was due to starvation.

Case 7.--Male pup TK09 (necropsy No. 07LA85) was attacked and injured by an adult male on 13 July, 97 d after weaning. The pup was first observed in shallow water at about 1900 in sector 1. It appeared lethargic and swam slowly to an area of reef.

Observation resumed at about 1930. At that time, two adult male seals were jousting, and another adult was swimming away. The pup was in the area, swimming close to shore. One of the jousting adult males eventually chased the other adult male away from the area. The remaining adult male (possibly GS33) approached the pup and nudged it. The pup vocalized and moved away about 1 m. The adult then bit the pup, who rolled in response and tried to flee again. The adult male then began to repeatedly bite and mount the pup. The pup lay passively in the water. Observers intervened, but the adult male persisted for some time before leaving the area at about 2000. As a result of the aggressive incident, the pup had lacerations on his foreflippers and back, and the lower back showed evidence of damage. It is unknown if the pup was injured prior to the incident described above.

At 2018, adult male T369 approached the pup and nudged him several times. The pup vocalized and raised his head but did not otherwise respond. The adult male swam away at 2023. After T369 left, observers lifted the pup from the surf on a stretcher and placed him near the water on the dry sand. The pup was found dead in the same location at 2230. Death was probably due to injuries inflicted by adult males.

Samples Collected and Entanglement Debris

Organ samples were collected from all seven dead seals. The complete reproductive tracts were saved from the two adult females, and a blood sample was obtained from one very fresh carcass. Stomach contents and parasites were recovered from six and five seals, respectively. Six skulls and one entire skeleton were collected. There were no observed seal entanglements. Eleven fishing debris items were sampled and destroyed. Scats and spews from seals of known size and sex were collected and processed. Analysis of all samples is ongoing and will be reported elsewhere.

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APPENDIXES

Appendix A.--Itinerary of fieldwork conducted on Laysan Island in 1985 by the National Marine Fisheries Service.

Date	Event
3/2	NOAA ship *Townsend Cromwell* arrives at Laysan Island.
3/3	*Townsend Cromwell* disembarks S. Austin, B. Becker, J. Henderson, R. Watson, and two cooperating U.S. Fish and Wildlife Service (USFWS) scientists at Laysan Island and departs for Honolulu. Field camp is established. Incidental patrols and bleach marking begin.
3/6	Censuses begin.
3/10	Early behavior patrols begin. Mobbing patrols begin.
4/1	The fishing vessel *Feresa* arrives at Laysan Island and disembarks T. Johanos and three cooperating USFWS scientists.
4/5	Early behavior patrols end.
4/6	Later behavior patrols begin.
4/9	*Feresa* embarks Henderson and four cooperating USFWS scientists and departs for Honolulu.
6/16	*Townsend Cromwell* arrives, embarks Johanos and Watson, disembarks M. Pillos, and departs for Lisianski Island. *Feresa* arrives, disembarks two cooperating USFWS scientists.
6/30	Afternoon mobbing patrols end.
7/20	Later behavior patrols end. Mobbing patrols end.
7/21	*Townsend Cromwell* arrives, embarks Austin, Pillos, and three cooperating USFWS scientists, disembarks R. Morrow, and departs for Honolulu.
8/14	Incidental patrols end.
8/15	*Townsend Cromwell* arrives and disembarks J. Leialoha.
8/19	*Townsend Cromwell* embarks Becker and departs for Gardner Pinnacles.
11/26	Censuses end.
11/29	Observational monitoring and bleach marking end.
11/30	The Laysan Island field camp is disbanded. *Townsend Cromwell* arrives, embarks Leialoha and Morrow, and departs for French Frigate Shoals.

Appendix B.--Data type summary, typical daily schedule, and additional codes for Hawaiian monk seal research at Laysan Island, 1985.

DATA TYPE

1. *C*: Census data

   Data: Standard census
   Area: Total island
   Frequency: Every third day
   Time: 1300-1600
   Observers: 2

2. *S*: Patrol type A (early bahavior patrol): 10 March-5 April

   Data: Only adult (A) or large subadult (S4) males associated with A or S4 females
   Area: Sectors 18-8 (traveling north)
   Frequency: Daily
   Time: 0800-1200
   Observer: 1

3. *Q*: Patrol types B-E (later behavior patrols): 6 April-20 July

   a) Patrol type B (AM mob)
   Data: All A or S4 males and their associations, also mother-pup pairs
   Area: Sectors 18-8 (traveling north)
   Frequency: Every noncensus day except day off
   Time: 0800-1200
   Observer: 1

   b) Patrol type C (south patrol)
   Data: All A or S4 males and their associations, also mother-pup pairs and molting seals
   Area: Sectors 17-9 (traveling south)
   Frequency: Every noncensus day except day off
   Time: 0800-1200
   Observer: 1

   c) Patrol type D ("on" patrol)
   Data: All A or S4 males and their associations, also mother-pup pairs and molting seals
   Area: Entire island
   Frequency: On the day off (once a week)
   Time: 0800-1500
   Observer: 1

   d) Patrol type E (census mob)
   Data: All A or S4 males and their associations
   Area: Sectors 18-8
   Frequency: Census days (every third day)
   Time: 0800-1200
   Observer: 1

Appendix B.--Continued.

4. *I*: Incidental

a) Patrol type F (PM mob)

Data:	Adult male harassments or mobbings and molting seals
Area:	Sectors 18-8 (traveling north)
Frequency:	On every noncensus day except day off
Time:	1500-1800
Observer:	1

b) Patrol type G (incidental data--no criteria)

TYPICAL SCHEDULE

1. Census day (every third day)

0800-1200	census mob
1300-1600	census

2. Every noncensus day except day off

0800-1200	AM mob; south patrol
1500-1800	PM mob

3. Day off

0800-1500	"on" patrol

ADDITIONAL CODES[a]

1. Behavior codes:

A1	Approach $\leq$2 body lengths
A2	Approach $\geq$2 body lengths
V	Vocalizations indistinguishable or undefined
G	Gulp vocalization
U	Rolling growl vocalization
S	Snort vocalization
H	Head raise
T	Open-mouthed threat
K	Nudge
KV	Ventral nudge
KS	Side nudge
KM	Muzzle nudge
KB	Back nudge
KF	Foreflipper nudge
KH	Hind flipper nudge

2. Distance codes

3	5-10 m
4	$\geq$10 m

3. Associated line number

Z = 96	Nonseal association
X = 97	Undirected behaviors

[a]All data types except *C* can use the additional codes developed for specific use on Laysan Island in 1985.

Appendix C.--Pupping sites and pupping histories of parturient Hawaiian monk seals, Laysan Island, 1982-85. The 1982-84 data are from Alcorn (1984), Johanos et al. (1987), and Alcorn and Buelna (text footnote 2) (p = pupped, sector location not on Laysan, s = sighted but not known to have pupped, x = known to have died prior to current field season, and LIS = Lisianski Island).

ID No.	Pupping location[a]				1982		1983		1984		1985	
	1982	1983	1984	1985	Pupped	Weaned pup	Pupped	Weaned pup	Pupped	Weaned pup	Pupped	Weaned pup
T01F	--	s	(20)	s	--	--	--	--	--	5/5	--	--
T02F	--	s	(3)	3	--	--	--	--	--	4/25	3/28	5/7-8
T03F	2	(2)	1	1	3/17-18	4/24-25	--	5/10	4/17	5/28	4/28	6/7
T04F	5	(5)	3	2	3/20-21	4/22-23	--	5/11-12	5/3	6/6	4/29	5/1-2[b]
T06F	(10)	s	10	11	--	3/23-26[b]	--	--	3/30	5/8	4/8	5/13
T07F	(2)	--	--	--	--	4/2	--	--	--	--	--	--
T08F	(3)	sLIS	s	(2)	--	4/6	--	--	--	--	--	3/30-4/1
T09F	(2)	--	2	s	--	4/10-11	--	--	4/7	5/11[c]	--	--
T10F	(2)	--	--	--	--	4/23-25	--	--	--	--	--	--
T11F	(20)	(20)	20	2	--	4/24-25	--	5/13-15	4/16	5/30	4/24	6/4
T12F	20	(1)	8	8	3/18-21	4/23-25	--	5/3	4/12	5/21	4/30	6/5
T13F	3	s	(2)	3	3/30	5/17-18	--	--	--	4/29	3/26	5/10
T14F	10	11	11	s	4/2-3	5/15	4/24-26	6/6	5/1	6/14	--	--
T15F	2	--	2	8	4/5-6	5/15-17	--	--	4/18	5/27[c]	5/31	6/8[b]
T16F	20	20	7	20	4/8-9	5/18-19	4/29	6/9-10	4/11	4/11[b]	4/17	5/28
T17F	20	--	2	2	4/14-15	5/24-25	--	--	3/30	5/11	4/11	5/25
T18F	2	2	--	--	4/11-12	5/18-19[d]	4/27	6/1-2	--	--	--	--
T19F	11	--	--	--	4/20	5/31	--	--	--	--	--	--
T20F	2	--	--	--	4/23-24	6/1-2	--	--	--	--	--	--
T21F	19	--	--	--	4/28-29	6/10-11	--	--	--	--	--	--
T22F	18	s	18	20	5/5	6/12-14	--	--	4/16	6/1	5/5	6/15-16
T23F	13	s	s	s	5/5-7	6/12-14	--	--	--	--	--	--
T24F	19	19	5	s	5/12-13	6/26	6/14	7/20[d]	7/7-8	--	--	--
T25F	2	2	pLIS	2	5/15-16	6/21-22	5/23-24	7/3-4	--	7/13	6/24	7/29-31
T26F	2	s	s	5	5/20-21	6/22-23	--	--	--	--	5/24	6/25
T27F	s	s	6	6	--	--	--	--	4/10	5/24	5/8	6/20
T29F	--	s	4	s	--	--	--	--	5/7	6/22	--	--
T32F	20	20	s	x	5/29	--	6/22	--	--	--	--	--
T33F	4	--	--	--	5/25-27	--	--	--	--	--	--	--

Appendix C.--Continued.

ID No.	Pupping location[a]				1982		1983		1984		1985	
	1982	1983	1984	1985	Pupped	Weaned pup	Pupped	Weaned pup	Pupped	Weaned pup	Pupped	Weaned pup
T34F	20	2	s	20	6/5	--	6/30-7/1	--	--	--	6/10	7/15
T35F	20	s	--	--	6/7	--	--	--	--	--	--	--
T36F	s	11	11	s	--	--	4/29	6/6-7	5/18	6/27	--	--
T37F	s	s	s	(19)	--	--	--	--	--	--	--	4/7
T39F	19	19	19	18	6/18	--	6/28	--	7/13	--	7/15	8/25-27
T41F	s	(3)	x	x	--	--	--	5/11-12	--	--	--	--
T45F	s	(2)	2	s	--	--	--	5/1	4/7	5/15	--	--
T51F	--	s	(12)	12	--	--	--	--	--	4/21	3/12	4/23-24
T53F	--	s	s	(12)	--	--	--	--	--	--	--	4/7-8
T66F	--	s	(2)	2	--	--	--	--	--	4/11	3/16	4/26
T11N	--	--	--	2	--	--	--	--	--	--	3/25	5/6
TP85	--	s	(12)	11	--	--	--	--	--	4/21	3/13-14	4/23-25
TY17	--	--	20	20	--	--	--	--	4/11	5/23	4/26	6/7
T302	--	--	(3)	3	--	--	--	--	--	5/11	4/21	5/31
T310	--	s	s	(2)	--	--	--	--	--	--	--	4/11
T368	--	--	s	(3)	--	--	--	--	--	--	--	4/7-8
T374	--	--	s	(9)	--	--	--	--	--	--	--	3/9-10
T391	--	s	(6)	3	--	--	--	--	--	4/20	3/20	4/29
GA10	--	sLIS	s	(20)	--	--	--	--	--	--	--	4/3
GA59	sLIS	sLIS	(20)	sLIS	--	--	--	--	--	4/3	--	--
10N[e]	--	--	--	20	--	--	--	--	--	--	3/16	4/24
12N[e]	--	--	--	11	--	--	--	--	--	--	5/4	6/15-17

[a]Number indicates the sector in which female-pup pair was first sighted and is in parentheses if pup was born prior to field season.

[b]Female prematurely ended lactation because of the death or disappearance of pup.

[c]Female weaned a foster pup after pup exchange.

[d]Female weaned a foster pup after death of her own pup.

[e]Temporary identification numbers assigned in 1985.

Appendix D.--Observation of an adult female Hawaiian monk seal (T03F) giving birth on 28 April 1985 at Laysan Island. Her beach position was coded as 2 (midbeach and dry sand).

Time	Observation
0930	Adult female (T03F) first observed in labor. She was arching her hindquarters and appeared restless.
1001	Contractions occurring about every 30 s.
1004	Vaginal dilation about 10 cm.
1005	Female looks up and is alert.
1006	Female is alert, vocalizes twice.
1007	Cephalic presentation of the pup's head. Female lifts and twists hindquarters, and entire pup is expelled. The interval from first emergence to birth is about 1 min.
1008	Amniotic sac still surrounds the pup's shoulders and body. Pup is along female's side and crawls forward. Female vocalizes.
1009	Female vocalizes and bends to sniff the pup. Amniotic sac still surrounding the pup's shoulders and body.
1010	Pup crawls completely out of the membranes and approaches the mother's head.
1011	Female noses pup, vocalizes. Pup nuzzles its mother. Female vocalizes twice at adult male located about 10 m away.
1014	Female has periodic contractions, vocalizes at the pup, nuzzles the pup, and vocalizes at the adult male.
1015	Placenta partially emerges; female turns to look back. Pup is at female's head.
1016	Female looks behind her and vocalizes.
1018	Female looks at the adult male.
1019	Female vocalizes and moves up beach about 0.5 m. Female and pup nuzzle noses, both vocalize.
1021	Pup nuzzles the female along neck, possibly searching for a nipple. Female moves up the beach and then pivots so she is facing down the beach; she keeps pup at her head.
1022	Female rolls on her side. Pup is still at her head.
1023	Female nuzzles the pup. No vocalization. Pup searches around mother's head.
1024	Female vocalizes at the adult male and moves about 0.5 m down the beach and rolls on her side.

Appendix D.--Continued.

Time	Observation
1026	Female vocalizes twice at the pup, who is still at her head.
1027	Female is on her ventrum; she vocalizes.
1028	Female vocalizes at the adult male. The pup is at her head. She rolls on her side. Pup moves down the female's belly to vicinity of nipples.
1032	Female rolls on her ventrum. Pup continues to search near nipples.
1034	Female vocalizes and rolls, presenting her dorsal to the pup. She turns her head to look at the pup.
1035	Female vocalizes and rolls. Female and pup sniff noses.
1037	The placenta is still attached to the female. Mother and pup nuzzle.
1039	Female flips the pup back toward her tail and vocalizes, then rolls on her side.
1041	Female nuzzles the pup. The pup is very close to the nipples.
1044	The pup searches back and forth over the nipple area. Placenta remains partially in female's vagina.
1046	Female vocalizes and shifts her body ventrally.
1047	Females vocalizes, twists her hindquarters, and sniffs the pup.
1049	Female rolls on her side, away from observers. Pup is out of view.
1050	Observation terminated.

Appendix E.--Mobbings by adult male Hawaiian monk seals and incidents of single male aggression observed on Laysan Island, 1985. Some prolonged adult male harassments of immature seals and nursing female-pup pairs also are included but should be viewed as a minimum number because only the more intense incidents observed were recorded.

Date	Field No.	Sector No.	Time		Initial beach position[a]	Victim			No. of adult males	Type of interaction
			Begin	End		Size[b]	Sex[c]	ID		
3/19	1	8	1145	1215	3	A	F	T09F	5	Mobbing
4/5	2	19	1340	1422	0	A	F	T37F	1	Single
						P	M	--		
						P	F	--		
4/14	3	5-7	0950	1016	0	S	F	TY09	2	H[d]
5/7	4	19-15	1155	1623	0	A	F	T310	24	Mobbing[e]
5/10	5	17	1732	1744	1	--	--	--	5	?
5/14	6	17	1130	1230	1	A	F	T37F	7	Mobbing
		17-18	1210	--	1	S	F	TY09	3	H[d]
6/4	7	19	0841	1055	0	S	M	TP27	10+	Mobbing[e]
6/30	8	1	1200	1214	1	A	F	T34F	6	H[d]
						P				
			1200	1204		S	M			
7/8	9	8	1012	1014	0	W	M	TT27	4	H[d]
7/13	10	1	1930	2000	0	W	M	TT09	1	Single[e]
7/18	11	20	1315	--	1	W	F	TT55	1	H[d]
7/20	12	20	0730	0745?	0	W	F	TT55	2	H[d]

[a]0 = in the water, 1 = on wet sand, and 3 = beach crest.

[b]A = adult, S = subadult, W = weaned pup, and P = nursing pup.

[c]M = male; F = female.

[d]H = harassment.

[e]Incident resulted in the death of the victim.

Appendix F.--Hawaiian monk seal necropsy reports, Laysan Island, 1985.

NECROPSY NO.: 01LA85
DATE OF DEATH: 28 March
DATE OF NECROPSY: 28 March
SEX: Male
SIZE CLASS: Subadult
IDENTIFICATION NO: TY11

CIRCUMSTANCES OF DEATH: The dead subadult (TY11) was first observed in sector 1. The carcass was on the wet sand at the water's edge. Adult male T723 was defending the carcass. Death was probably <4 h prior to the necropsy.

EXTERNAL DESCRIPTION: Numerous, fresh, gaping wounds into the skin of the midback; one wound penetrated to the blubber layer. The subadult was blind in the left eye. Rigor mortis evident.

Measurements: Central length (ventral side up)--178.0 cm
Curvilinear length--192.0 cm
Anterior length front flipper--32.5 cm
Anterior length hind flipper--35.0 cm
Blubber thickness--0.6 cm
Axillary girth--116.0 cm

INTERNAL: Viscera still warm. Organs and tissue grossly normal, except for slight pulmonary edema and fat deposit in the right ventrical of the heart. Stomach empty except for bolus of cestodes and nematodes. Band of pale muscle in dorsal neck musculature (sample saved). Considerable subdermal trauma in vicinity of dorsal bite wounds; the skin separated from the underlying fat, the fascia evidently broken or damaged.

SAMPLES COLLECTED: Heart, lung, liver, pancreas, spleen, kidney, testes, eyes, stomach contents, ectoparasites, endoparasites, and skeleton.

PATHOLOGY REPORT A: Microscopic: skeletal mm (x-sect)--Zenker's degen. Duct surrounded by fat tissue--NSL (no significant lesions). Squamous epithelium--NSL. Spleen--NSL. Kidney--Hyaline casts in few tubules; mild tubular degeneration; mild hyaline thickening of few tubules and capillary loops of few glomeruli. Small section of myocardium--NSL. Lymph node--NSL. Liver--NSL. Myocardium--NSL. Spleen--mild hypoplasia of Mal. corpuscles. Pancreas--capillary hyperplasia. Large section LN--NSL. Skel. m.--NSL. Lung--mild congestion. Mesenteric LN--edema, lymphoid hyperplasia, thrombi, bacterial embolis.

PATHOLOGIST: T. Sawa, D.V.M., State of Hawaii, Department of Agriculture, Animal Industry Veterinary Laboratory, Honolulu, Hawaii.

PATHOLOGY REPORT B: Microscopic: Lymph node: marked lysis of lymphocytes in stroma. Well-defined germinal centers. Many neutrophiles in lymphatic channels and channel walls. These surround dense clumps of bacteria (species?). Diagnosis: Acute septic lymphadenitis. Lung, liver, kidney, ureter, heart, and pancreas, in normal limits but showing considerable congestion of venules and capillaries. Little or no autolysis of the renal tubular or pancreatic acinar epithelium, suggesting that the lysis of cells in the lymph node stroma was secondary to disease rather than delay in fixation. The spleen showed active hemopoesis. Of two sections of skeletal muscle, one showed vacuolar degeneration (artifact due to poor fixation or necrosis secondary to systemic sepsis?). Conclusion: This animal had acquired a systemic infection and almost certainly had terminal septicemia. From the configuration of the glomeruli, I would assume that it was an adult. Primary site of infection not identified.

PATHOLOGIST: G. Stemmerman, M.D., Department of Pathology, Kuakini Medical Center, Honolulu, Hawaii 96817.

Appendix F.--Continued.

NECROPSY NO.:	02LA85
DATE OF DEATH:	1-2 May
DATE OF NECROPSY:	2 May
SEX:	Male
AGE:	Pup, 3 d old
IDENTIFICATION NO.:	TK71

CIRCUMSTANCES OF DEATH: The pup was first observed unconscious on 1 May at 1510, separated from its mother (T04F) by 30 m. The mother was accompanied by an adult male. Mucus was present in the pup's nostrils, and fecal material lay near the anus. The pup was covered with flies. At 1710, the mother was back with her pup, and observers were unable to determine its condition. The pup was found dead at about 0900 on 2 May. The mother had moved a short distance away from her pup and again was accompanied by an adult male.

EXTERNAL DESCRIPTION: No external wounds or abnormalities. Maggots present in the mouth, nares, and anus and on the umbilicus and flipper tips. The mouth was a mottled light pink color, and the tongue was pale.

Measurements: Standard length--102.5 cm
Blubber thickness--0.7 cm
Axillary girth--54.4 cm

INTERNAL: Blood vessels along right side next to rib cage appear clotted. Discolored right abdominal wall. Clear, red fluid (about 240 ml) found in abdominal cavity. Stomach contains orange fluid. Pericardial fluid clear pink-yellow, about 60 ml. Atrial window open; blood in atria clotted. Yellowish fluid and froth present in the trachea.

SAMPLES COLLECTED: No ectoparasites or endoparasites found. Heart, lung, liver, pancreas, spleen, kidney, adrenal, thymus, thyroid, stomach contents, and skull.

PATHOLOGY REPORT: Microscopic: adrenal--NSL. Lymphoid tissue (?thymus)--congestion. Pancreas--NSL. Liver--autolysis. Myocardium--NSL. Lung-- congestion, (?)edema. Spleen--congestion. Kidney--NSL.

PATHOLOGIST: T. Sawa, D.V.M., State of Hawaii, Department of Agriculture, Animal Industry Veterinary Laboratory, Honolulu, Hawaii.

Appendix F.--Continued.

NECROPSY NO.: 03LA85
DATE OF DEATH: 6 May
DATE OF NECROPSY: 7 May
SEX: Female
SIZE CLASS: Adult
IDENTIFICATION NO.: T328

CIRCUMSTANCES OF DEATH: Adult female T328 was observed, with major back wounds, in shallow water in sector 18 at 1350 on 6 May. She raised her head periodically to breathe but was otherwise inactive. The wounded seal was alone but was approached three times within 20 min by passing adult males. The adult female was found dead at 1700; her carcass defended by adult male T717. The carcass was defended by subadult male GS45 on the morning of 7 May.

EXTERNAL DESCRIPTION: Ten large gaping wounds (the largest, 14.5 x 9 cm) within a swollen 1-m-long area on the carcass's midback. Many small nicks present on the ventral and flippers. Froth exuded from the nostrils. The vaginal and anal areas and the tissue between the two openings swollen; scratches present around the vaginal opening. Mucus present in the mouth, and the gums mottled purple.

Measurements: Standard length (dorsal side up)--270.0 cm
Blubber thickness--4.5 cm
Axillary girth--141.0 cm

INTERNAL: Discolorations in the blubber on the ventral surface; four areas (the largest, 21.5 x 9 cm) of pink, fibrous, harder tissue present. Hemorrhage and clotted blood vessel present under the pelage of the ventral neck region. Anterior portion of the right ovary swollen and harder than the left ovary and has distended capillaries. The kidneys, especially the left, are loose and diffuse. Fat on exterior of heart. Bloody froth present in trachea. The necropsy was interrupted by a mobbing incident, and the carcass was in a state of advanced decomposition when observers returned.

SAMPLES COLLECTED: Heart, lung, liver, pancreas, spleen, kidney, reproductive tract, stomach contents, endoparasites, and skull.

PATHOLOGY REPORT: Microscopic: glandular tissue (mammary)--NSL. Spleen--autolysis, many megakaryocytes. Ovary--few, small vesicular follicles. Lymporeticular tissue--NSL. Kidney--severe autolysis. Liver--severe autolysis. Lymphoid tissue--autolysis. Lung--severe autolysis. Myocardium-- autolysis. Stomach (?)--autolysis. Glandular tissue (?)--severe autolysis.

PATHOLOGIST: T. Sawa, D.V.M., State of Hawaii, Department of Agriculture, Animal Industry Veterinary Laboratory, Honolulu, Hawaii.

Appendix F.--Continued.

NECROPSY NO.: 04LA85
DATE OF DEATH: 12 May
DATE OF NECROPSY: 12 May
SEX: Female
SIZE CLASS: Adult
IDENTIFICATION NO.: T310

CIRCUMSTANCES OF DEATH: Adult female T310 was mobbed and received numerous dorsal injuries on 7 May. She was observed alive following the mobbing on 7 and 8 May but was not observed on 9-11 May. The adult female was found dead on 12 May near the site where she hauled out after the mobbing. The carcass was alone when found and may have washed ashore.

EXTERNAL DESCRIPTION: Many small lacerations over a 1-m-long area of the back; no deep external wounds. Within this injured area, an area 45 x 40 cm was soft and swollen. Considerable subdermal trauma in the vicinity of the dorsal bites; the skin had separated from the underlying fat, the fascia evidently broken or damaged. The underlying tissue was soft and bruised, spongy with a yellowish fluid. Vaginal aperture was bloody and swollen. Reddish fluid, cestodes, and nematodes around the nares. Skin slipping. Side bruised and cut, possibly from washing against rocks. Gums mottled pink; some maggots present in the mouth. Eyes clouded.

Measurements: Standard length (dorsal side up)--260.0 cm
Blubber thickness--2.3 cm
Axillary girth--126.5 cm

INTERNAL: The carcass is very thin; no fat present around the heart. Discolored blubber patch on midventral. A pinkish lump was found in the left kidney (collected). Two unidentified bodies found posterior to the kidneys, 11.5 x 8.5 cm each (collected). Stomach enlarged, foamy area on wall of stomach (collected). Stomach empty except for cestodes and nematodes. Blood clotted in heart. Left ovary is hardened. Bloody liquid is present in the vagina. Where the bladder connects with the reproductive tract, the tissue is broken down and engorged with about 240 ml of clotted blood.

SAMPLES COLLECTED: Heart, lung, liver, pancreas, spleen, kidney, adrenal, reproductive tract, stomach contents, endoparasites, and skull.

PATHOLOGY REPORT: Microscopic: pancreas--autolysis, no cellular details. Lymphoid tissue (possibly lymph node)--NSL. Portion of reproductive tract(?)--possibly hyperplasia of mucosa. Ovary--graafian follicles, follicles, areas of hyalinization of connective tissue. Pancreas--autolysis, no cellular details.

PATHOLOGIST: T. Sawa, D.V.M., State of Hawaii, Department of Agriculture, Animal Industry Veterinary Laboratory, Honolulu, Hawaii.

Appendix F.--Continued.

NECROPSY NO.: 05LA85
DATE OF DEATH: 8 June
DATE OF NECROPSY: 8 June
SEX: Male
SIZE CLASS: Subadult
IDENTIFICATION NO.: TP27

CIRCUMSTANCES OF DEATH: Subadult male TP27 was mobbed on 4 June and received numerous dorsal injuries. He was observed alive following the mobbing on 5 and 6 June. The subadult was found dead on 8 June. The carcass lay on the wet sand, defended by adult male T723.

EXTERNAL DESCRIPTION: Much of the dorsal skin was scraped off, probably from the carcass being washed over the reef. Few major back wounds but many small scratches. The dimensions of the damaged dorsal area were 119 x 56 cm. Considerable subdermal trauma; the underlying tissue was soft and gassy. Lump on midright lateral measuring 4 x 4.5 cm; fluid oozed from this site and the tissue underlying the lump was slightly redder than the surrounding tissue. No apparent broken bones. Eyes clouded; gums a mottled purple. Bloody fluid exuded from the mouth and anus, and a nematode protruded from the anus.

Measurements: Standard length (dorsal side up)--180.0 cm
Blubber thickness--1.2 cm
Axillary girth--123.5 cm

INTERNAL: Blubber stiff in an area 13 x 41 cm on the midventral. Blood present in the fatty tissue on the ventral surface. Muscle tissue along ribs globular and contains blood (collected). Bloody froth present in trachea. Approximately 240 ml pericardial fluid; clotted blood found in the heart. Parasites found in abdominal cavity. No food in stomach, but tapeworms present. Tissue generally gassy.

SAMPLES COLLECTED: No ectoparasites or endoparasites found. Heart, lung,liver, pancreas, spleen, kidney, adrenal, stomach contents, endoparasites,gonads, gallbladder, and skull.

PATHOLOGY REPORT: Microscopic: kidney--distended blood vessels. Pancreas--distended blood vessels. Adrenal glands--distended blood vessels. Testes--no abnormality, juvenile or younger, no sperm. Lymph nodes--distended blood vessels, sinus histiocytes. Spleen--no abnormality; a great deal of hemopoesis (indicative of pathological need or of newborn) (megakaryocytes). Lungs--alveoli filled with blood. All organs tremendously congested.

PATHOLOGIST: G. Stemmerman, M.D., Department of Pathology, Kuakini Medical Center, Honolulu, Hawaii 96817.

Appendix F.--Continued.

NECROPSY NO.: 06LA85
DATE OF DEATH: 8 June
DATE OF NECROPSY: 8 Jun
SEX: Male
AGE: Pup, 8 d old
IDENTIFICATION NO.: TK73

CIRCUMSTANCES OF DEATH: The placenta was attached to pup TK73 most of its first day of life, and the pup was observed 2 m away from its mother (T15F), unable to reach her because of the weight of the placenta. Both the mother and pup appeared undersized. The pup was never observed nursing, appeared progressively weaker, and was found dead at 1530 on 8 June. The carcass lay on the dry sand, and the mother was not in the vicinity.

EXTERNAL DESCRIPTION: No external wounds. The carcass was extremely thin. No maggots or fly eggs present. The carcass was loose and very fresh.

Measurements: Standard length--92.5 cm
Blubber thickness--0.3 cm
Axillary girth--41.8 cm

INTERNAL: Body musculature in good condition. Approximately 48 ml of pericardial fluid. Blood found in the tubes of the left lung. No lumps or abnormalities found in liver or pancreas. Stomach contains clear, yellowish, foamy fluid; apparently no milk. White froth in trachea. Blood in heart beginning to clot.

SAMPLES COLLECTED: No ectoparasites or endoparasites found. Heart, lung, liver, pancreas, spleen, kidney, adrenal, whole blood, and skull.

Appendix F.--Continued.

NECROPSY NO: 07LA85
DATE OF DEATH: 13 July
DATE OF NECROPSY: 14 July
SEX: Male
AGE: Pup, 4 to 5 mo old
IDENTIFICATION NO: TK09

CIRCUMSTANCES OF DEATH: Weaned pup TK09 was seen at 1900 in sector 1 in shallow water. Upon investigation, the pup swam lethargically away to a reef patch. Pup was bit and mounted by an adult male at 1930. After the adult male left, the pup was lifted from the surf on a stretcher and placed near the water. Pup was found dead at 2230.

EXTERNAL DESCRIPTION: Bite wounds present on front flippers and back. A 12 x 14 cm area was bruised on the lower back. Maggots were around the eyes, and the carcass exhibited rigor mortis.

Measurements: Standard length (dorsal side up)--124.0 cm
Blubber thickness--3.5 cm
Axillary girth--85.0 cm

INTERNAL: Bloody area in blubber of lower abdomen. Very little pericardial fluid, about 48 ml. Clotted blood in heart. A clump of fatty tissue 4 x 6 cm present on left ventrical (collected). Small amount of white froth in trachea; no froth in bronchials. Stomach contains yellowish fluid and parasites (collected), no ulcers or lesions. Parasites found and collected in small intestine.

SAMPLES COLLECTED: Heart, lung, liver, pancreas, spleen, kidney, adrenal, stomach contents, endoparasites, gonads, and skull.

PATHOLOGY REPORT: Microscopic: glandular tissue (testis?)--NSL. Spleen-- NSL. Nervous tissue, primarily nerves--NSL. Lung--congestion. Kidney-- ?congestion. Myocardium--NSL. Glandular tissue (composed of much connec- tive, supportive tissue, possibly endocrine gland, many blood vessels)--NSL. Adrenal--NSL. Lymphoid tissue--NSL. Liver--NSL. Pancreas--NSL. Testis-- NSL. Vascular tissue (blood vessel), autolysis--NSL. Unidentified tissue (glandular-adrenal?)--autolysis.

PATHOLOGIST: T. Sawa, D.V.M., State of Hawaii, Department of Agriculture, Animal Industry Veterinary Laboratory, Honolulu, Hawaii.

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