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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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Julie J. Eliason, John R. Henderson
Marc A. Webber

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

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U.S. DEPARTMENT OF COMMERCE

Ronald H. Brown, Secretary

National Oceanic and Atmospheric Administration

D. James Baker, Under Secretary for Oceans and Atmosphere

National Marine Fisheries Service

Nancy Foster, Acting Assistant Administrator for Fisheries

ABSTRACT

The Hawaiian monk seal, *Monachus schauinslandi*, was studied at French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands from 4 April to 11 September 1985 and during 2-19 December 1985. Data were collected on population structure, reproduction, and factors affecting survival. The total number of identifiable seals sighted was 353. Nine atoll-wide censuses resulted in a mean count of 266.7, excluding pups, and a mean of 313.4 seals, including pups. First-year survival for 85 pups tagged in 1984 was 89.4%. An estimated 96 pups were born from January to October, of which 9 died before weaning. Eighty-five pups (47 males, 38 females) were tagged after weaning. A minimum of 54.1% of females giving birth on East Island exchanged pups during the nursing period. The mean lactation period for females where the lactation period was known within 5 days was 36.6 days. Three seals moved between FFS and other islands. Twenty-three seals were observed with injuries, of which 5 were severe and 1 was fatal. Twelve seals died and two nursing pups disappeared; 4 complete necropsies and 1 partial necropsy were performed. One seal was observed entangled in wire debris but could not be captured to release it. A total of 226 debris fragments capable of entangling wildlife were inventoried and destroyed. Two underdeveloped pups were captured and sent to Honolulu for rehabilitation.

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INTRODUCTION

French Frigate Shoals (FFS) (lat 23°45'N, long. 166°10'W) is a coral atoll located 490 nm northwest of Oahu in the Hawaiian Archipelago, and is the main haul-out and pupping area for the endangered Hawaiian monk seal, *Monachus schauinslandi*. The crescent-shaped atoll consists of one large volcanic pinnacle and eleven small sandy islets (Fig. 1). Information on the history, geology, climate, and vegetation of FFS is summarized in Amerson (1971).

French Frigate Shoals is part of the Hawaiian Islands National Wildlife Refuge and is staffed year round by the U.S. Fish and Wildlife Service (FWS). Research on the Hawaiian monk seal at FFS has been regularly conducted by the National Marine Fisheries Service (NMFS) and the FWS since 1979 (Schulmeister 1981, Johnson and Johnson 1984). In 1983, a more extensive monk seal research program was initiated by the Honolulu Laboratory of the Southwest Fisheries Science Center, NMFS, NOAA. Results of the 1984 program are presented by Eliason and Henderson (1992). Research objectives for the 1985 field effort were as follows: conduct censuses on all islands; identify individual seals; monitor reproduction and pup survival; monitor survival of yearlings; establish and update pupping histories for individual females; document exchanges of pups among nursing females; determine female lactation periods; tag weaned pups; document injuries, entanglements, disappearances, and deaths; perform necropsies; collect scat and spew samples; capture underdeveloped pups; inventory and destroy debris capable of entangling wildlife; and study hauling patterns and behavior of individual mother-pup pairs. The data collected during the 1985 field season are summarized in this report.

METHODS

Dates of Activity

In 1985, a research team of two-three biologists from NMFS was present from 4 April to 11 September; during 2-19 December, a two-person team returned to FFS to tag weaned pups (Appendix A). Staff of the FWS were present the entire year. A field camp was established on East Island, which was occupied for periods of 1-5 days. Tern island was used as a research base camp for supplies and refueling.

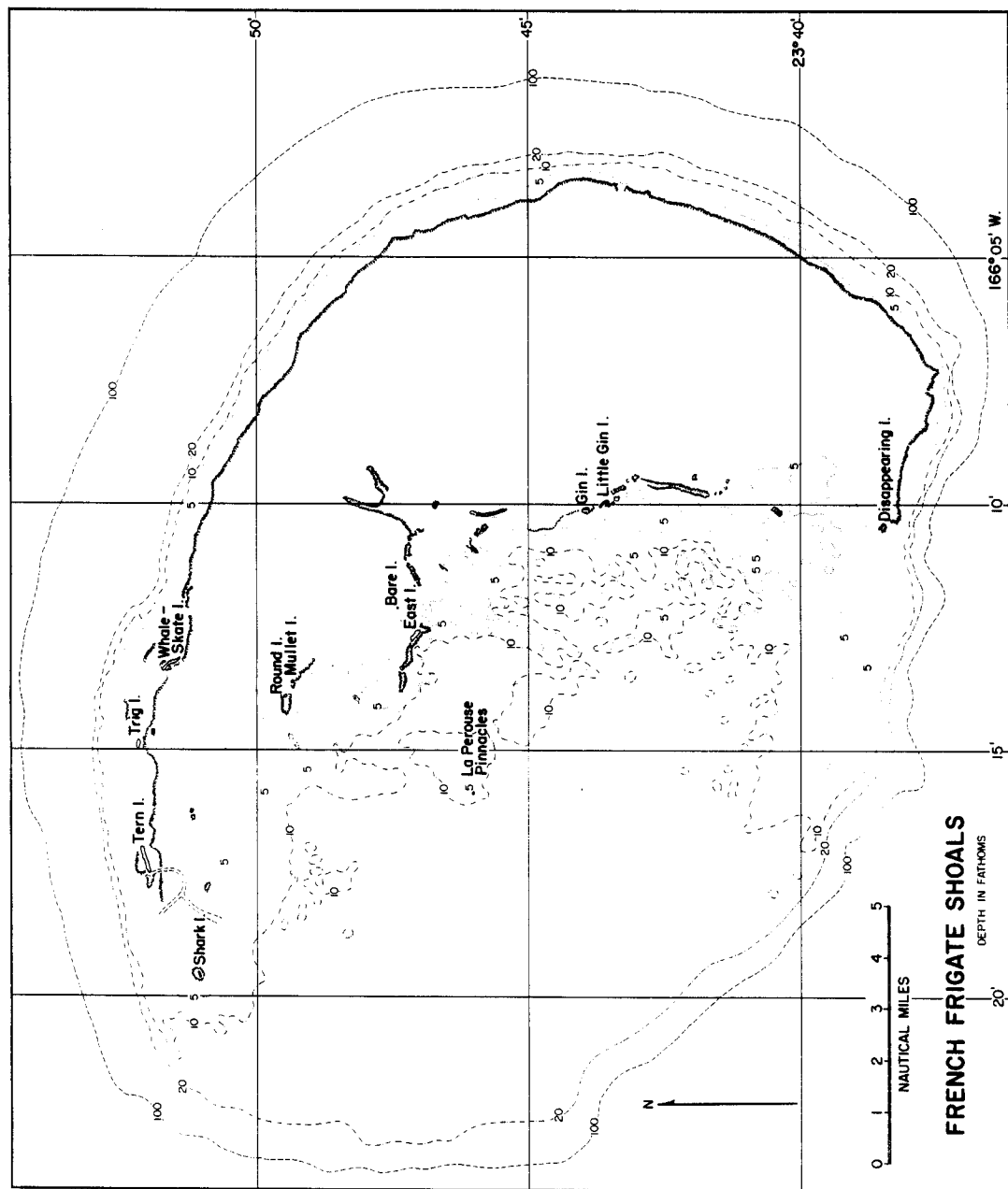


Figure 1.--French Frigate Shoals showing the 12 islands present in 1985.

Nine low sandy islands (Disappearing, East, Gin, Little Gin, Round, Shark, Tern, Trig, and Whale-Skate) were present at all times. Bare and Mullet Islands appeared intermittently throughout the field season, but were usually absent. Ephemeral sand spits periodically appearing south of Little Gin Island and north of Gin Island were considered adjuncts to those respective islands. Other sand spits appeared sporadically throughout the field season. La Perouse Pinnacle, a 36-m-high rock in the center of the atoll, slopes steeply at the water line, restricting monk seal access to this island.

Identification of Individuals

A previously established permanent monk seal identification file was periodically updated by using one or more of the following: photographs of seals with flipper tags, identifiable scars, and natural bleach marks. Seals included in the permanent identification files were considered to be "known" animals and were assigned a three-digit number with a Y prefix denoting that the seal was first identified at FFS. This letter-number combination constituted the identification (ID) number for the seal. Unidentified seals with scars or natural bleach marks sufficiently unique to distinguish them from all other seals were added to the identification file and assigned new numbers.

Emphasis was placed on identifying adult female seals, particularly parturient females, in order to monitor their reproductive activity. Scar cards were drawn for parturient females, and attempts were made to match them to seals that had pupped in previous years. Parturient females were assigned temporary field numbers according to the island of parturition (e.g., E-1, E-2, and so on, if parturient on East Island). If a female was subsequently determined to be a known seal, the temporary number was replaced by her permanent ID number. At the end of the field season, parturient females not matched to previously known individuals were assigned a P number according to island of parturition. For example, a seal parturient on East Island was designated PE1, and a seal parturient on Whale-Skate Island was designated PW1. Many females identified as parturient and assigned temporary ID numbers were reidentified in subsequent field seasons (1988-90) and assigned permanent ID numbers which have been included in this report.

Any resightings of the 85 weaned pups which had been tagged and left at FFS in 1984 were documented to monitor yearling survival.

Tagging

Weaned pups were tagged between the fourth and fifth digits of each hind flipper with yellow Temple Tags.[®] Tags were inscribed with a T, indicating the year of tagging, followed by a two- or three-digit number. Tag numbers were, in most cases, identical on

each flipper, although lost tags were replaced with numbers different from the original. At the time of tagging, the pup's body length and axillary girth were measured. Body length was measured dorsally along a straight line from the tip of the snout to the tip of the tail.

Censuses

A count of seals was considered a census if all seals on an island were counted and all associations among the seals were recorded. Censuses were conducted between 1300 and 1530 hours (Hawaii standard time) whenever possible; however, because of travel time between islands and the necessity to take advantage of favorable weather conditions, islands were frequently censused at other times. When biologists were present on one island for several days in succession, censuses were performed every other day. The length of time necessary to census one island ranged from an instantaneous count to 2.5 hours. The census data recorded for each island included time, weather conditions, permanent IDs of known seals, tag numbers, size class, sex, degree of molt, island sector, beach position, association with other animals, and behavior. Seals accompanied by nursing pups were recorded as adult females; otherwise, the sex was recorded only if the ventral side of the seal was seen or if an individual could be identified by scars, flipper tags, or natural bleach marks. Seals in the water were recorded but not included in census totals. Census techniques are detailed in Stone (1984). A census was considered to be an atoll-wide count if all islands of FFS were surveyed within a 2-day interval.

The FWS biologists conducted censuses on Tern Island every 4 days and on some of the other islands approximately every 36 days throughout the year. All other censuses were conducted by one or two NMFS biologists. A 5-m Boston Whaler was used to travel between the islands. An attempt was made to census each island in the atoll at least once per week, although weather conditions and boat malfunctions often disrupted this schedule. Most counts were made from land; however, inaccessible islands (small islands where seals might have been disturbed by landing, and islands where sea conditions prevented landing) were censused with binoculars from the boat.

Patrols

Unlike censuses, patrols were conducted by one or two observers on an opportunistic basis and may not have included all seals or all associations among seals. They ranged in duration from single observations to approximately 3 hours. Data collected during patrols included seal interactions, known animal sightings, and reproductive information.

Reproduction

When observers were camped on East Island, reproductive data were recorded twice daily. Every morning at approximately 0800 hours and again in the late afternoon or early evening a patrol was conducted to note births and weanings. Reproductive data on seals at other islands were collected during censuses, or on patrols immediately after censuses.

Several types of reproductive data were collected: identity of the mother (either field or permanent ID number), island, sector, birth date, size and sex of pup, pup's degree of molt during the observation and at weaning, and weaning date. Nursing pups were assigned to one of the following size classes: P1 signified a newborn, small, wrinkled and unmolted pup; P2 signified a small, unmolted pup that had lost its wrinkled appearance; P3, a plump, unmolted pup; P4, a molting pup; and P5, a completely molted pup. Births and weanings during the time interval between surveys of an island were considered to have occurred on any day during that interval, from the day after the previous visit until the day of the subsequent visit.

Pup production on all islands except Round Island was determined by summing all births recorded. However, because it was not possible to land on Round Island without disturbing nursing pairs, pup production there was estimated by two methods. One method was to track the size progression of pups on successive censuses. Small (P1) pups which could not be "accounted for" were considered to be new births, and large (P5) pups not accompanied by a female were considered to have weaned. The second method was to tally, following tagging, the number of pups considered to have weaned on Round Island. These included pups tagged on Round Island late in the field season when no nursing females were present, as well as pups tagged on islands other than Round Island, but definitely not weaned from that island (i.e., older weaned pups).

Pup Exchanges

Exchanges of nursing pups among lactating adult females were documented if at least one of the following criteria was met: (1) direct observation of an exchange; (2) the sex of pup differed in successive observations; (3) the pup's size differed greatly in successive observations, or (4) the natural marking allowed positive identification of an exchanged individual.

Injuries

When an injured seal was observed, the island, size class, and sex of the animal were recorded, and the injury was photographed when possible. If the injured seal was identified, its permanent identification file and its photograph file were updated with the new information. Progression and healing of injuries were documented whenever injured seals were resighted.

Deaths

Dead seals were photographed and measured. Endoparasites and stomach contents were collected, and gross abnormalities were recorded. If the specimen was fresh, tissue samples of major organs were preserved in 10% formalin, and a set of tissue samples was also frozen. Skulls and skeletons were flensed and either frozen or dried.

Collection of Scats and Spews

Seal scats and spews were collected and stored in plastic bags. Samples of the freshest scats from seals of all size classes were frozen for hormone analysis, and samples of most spews were frozen for ciguatera testing. The remaining scat and spew samples were processed under running seawater through a series of three sieves (2.80, 1.18, and 0.71 mm mesh). Recorded were the date, island, sector, degree of freshness (wet or dry), size class, and ID number of the seal, if known. Representative samples of the remaining hard parts were stored in vials containing 90% alcohol for keying to prey species.

Rehabilitation Program

Undersized pups were captured for rehabilitation. Selection was based on an axillary girth of less than 90.0 cm measured within 2 weeks post-weaning. Pups were taken to Tern Island and were force-fed pieces of fish for 2-6 days and then flown to Honolulu via chartered aircraft.

RESULTS AND DISCUSSION

Population Structure

Identified Individuals

Based upon appearance, 95 seals were moved to larger size classes in 1985: seals Y018, Y119, Y125, Y181, and Y186 were newly classified as subadults, and seals Y047, Y055, Y101, Y162, and Y276 were newly classified as adults. Moreover, the 85 pups weaned in 1984 were classified as juveniles (excludes 7 pups collected in 1984 for rehabilitation).

Additional seals with recognizable characteristics were added to the permanent identification files during and after the field season. The number of identified seals sighted in 1985 was 353: 53 adult males, 111 adult females, 6 subadult males, 11 subadult females, 48 juvenile males, 39 juvenile females, 47 weaned male pups, and 38 weaned female pups. This total identified constitutes an unknown fraction of the total seal population at FFS.

First-Year Survival

Of the 85 tagged weaned pups remaining at the close of the 1984 field season, 75 were resighted as yearlings at FFS. One yearling (Y318) was also resighted at Necker Island (see Interatoll Movement). First-year survival was therefore 89.4%, slightly higher than the 83.0% observed for yearlings in the 1984 field season (Eliason and Henderson 1992). The higher survival rate for 1985 may be attributed to the removal for rehabilitation of seven undersized, prematurely weaned pups from the FFS population in 1984. Had these pups remained at FFS, they would probably have died, resulting in lower survival rate for 1985.

Atoll-Wide Counts

Nine counts comprising the entire atoll within 2 days were completed (Appendix B). The mean number of seals counted, including pups, was 313.4 (SD = 44.1). The mean number of seals, excluding pups, was 266.7 (SD = 40.7). The greatest number of animals sighted (403) was on 30 July.

Censuses

Census results are presented in Table 1, and are summarized individually in Appendix C.

Table 1.--Summary of census counts of Hawaiian monk seals at French Frigate Shoals, 1985. Counts include pups.

Island	No. counts	Mean	SD
Bare	11	4.1	2.9
Disappearing	13	44.0	8.7
East	48	49.2	12.5
Gin	18	18.6	6.4
La Perouse	1	0.0	---
Little Gin	18	14.8	6.7
Mullet	4	3.3	1.7
Round	43	15.7	6.2
Shark	15	13.0	5.9
Tern	86	83.1	28.2
Trig	32	16.4	8.1
Whale-Skate	35	59.5	11.6
Unnamed spits	14	5.6	3.9

Reproduction

Pup Production

The estimated total pup production was 96. Births occurred on seven islands: East, 40; Gin, 1; Little Gin, 4; Round, 22; Tern, 1; Trig, 1; and Whale-Skate, 27. Eighty-five pups (47 males and 38 females) (Table 2) and 1 male juvenile were tagged. The juvenile was tagged late in the season and was mistaken for an older pup.

Known preweaning mortality was 9 pups, or 9.4%, similar to the 7.0% observed in 1984. Seven pups were presumed to have been stillborn according to criteria in Eliason and Henderson (1992), and two pups disappeared less than 2 weeks after birth. Two untagged pups were therefore unaccounted for, probably resulting from either an overestimation of pup production on Round Island, or dispersal of pups from Round Island to other islands in the atoll where they were not detected during tagging operations.

The pupping season extended from January to October, with the greatest number of births occurring in April (Fig. 2). The number of births in March is estimated based upon the size of pups first seen by NMFS biologists when they arrived in April. One premature stillborn pup was found on Tern Island in January (G. Fairaizl, FWS, P.O. Box 50167, Honolulu, HI 96850, pers. commun., January 1985), and two pups were born on East and Whale-Skate Islands in October. Maximum pup production occurred in April on East and Round Islands, and in May on Whale-Skate Island (Fig. 2). As in 1984, maximum pup production on East Island preceded that on Whale-Skate Island. Maximum pupping on Round Island, however, occurred 2 months earlier than in 1984 (Eliason and Henderson 1992).

From 1980 to 1985, pup production at FFS ranged from an estimated 94 in 1980 to a high estimate of 114 in 1982 (Table 3). Prior to 1984, pup production was estimated using various methods as described in Table 3. More accurate pup counts for 1984 and 1985 were determined by monitoring all births and deaths. In all six years, more than 90% of the pups at FFS were born at East, Round, and Whale-Skate Islands.

A total of 71 parturient females were identified and documented on the basis of natural markings (Table 4) and assigned either provisional or permanent ID numbers. Most females parturient on Round Island have been excluded from this table because they were observed only from a boat at a distance, allowing only heavily scarred females to be recognized.

Table 2.--Summary of Hawaiian monk seal pups tagged at French Frigate Shoals, 1985.

ID No.	Tag No.		Sex ^b	Date tagged	Measurement (cm) ^a		Birth date	Birth island ^c	Weaning date	Mother ID ^d	Days nursing
	Left	Right			AG	SL					
Y383	K00	K00	M	4/27	106.5	132.0	<4/8	EA	4/30-5/4	Y521	--
Y384	K01	K01	F	4/17	110.0	129.5	<4/8	EA	4/14-16	P-E-34	--
Y385	K02	K02	M	4/28	107.0	129.5	<4/8	EA	4/28	Y272	--
Y386	K03	K03	F	5/4	102.0	120.0	<4/7	TR	4/26-5/4	P-T-3	--
Y387 ^e	K04	K04	M	5/4	109.0	129.0	--	EA	--	--	--
Y388	K05	K47	M	5/4	109.5	132.0	<4/8	EA	4/30-5/4	Y524	--
Y389	K06	K06	F	5/4	107.5	128.0	<4/8	EA	4/30-5/4	P-E-39	--
Y390	K07	K07	M	5/5	101.0	123.0	<4/13	LG	4/19-5/4	Y571	--
Y391 ^e	K08	K08	M	5/6	76.5	107.0	--	EA	--	--	--
Y392 ^{e,f}	K09	K09	F	5/13	107.0	130.0	<4/8	EA	5/13	--	--
Y393 ^{e,g}	K10	K10	F	5/14	88.0	113.0	4/14-16	EA	5/14	--	43-44
Y394	K11	K11	M	5/14	110.0	129.0	--	EA	--	--	--
Y395 ^h	K12	K12	M	5/14	111.5	131.0	--	EA	--	--	--
Y396	K13	K13	M	5/18	88.5	119.0	--	WS	--	--	--
Y397	K14	K14	M	5/18	102.5	120.0	--	WS	--	--	--
Y398	K15	K15	M	5/18	102.0	122.0	<4/8	EA	5/16-18	Y206	--
Y399	K16	K16	M	5/18	98.5	120.0	4/8	EA	5/16-18	Y458	38-40
Y400 ^e	K17	K17	M	5/18	92.0	116.0	--	EA	--	--	--
Y401	K18	K18	M	5/23	97.5	124.0	4/8-16	WS	5/19-23	Y070	33-45
Y402	K19	K19	M	5/25	110.0	129.0	--	EA	--	--	--
Y403	K20	K20	M	5/25	90.0	123.0	--	RO ⁱ	--	--	--
Y404	K21	K21	M	5/30	87.0	112.0	<4/7	WS	5/24-30	P-W-24	--
Y405 ^e	K22	K22	F	5/25	98.0	121.0	4/23	EA	5/25	--	32
Y406 ^j	K23	K23	F	5/30	89.5	127.0	--	RO ⁱ	--	--	--
Y407	K24	K24	M	5/30	122.0	129.0	--	EA	--	--	--
Y408 ^e	K25	K25	M	5/31	122.5	137.0	<4/8	EA	5/27-30	--	--
Y409 ^e	K26	K26	M	6/1	83.5	113.0	5/6	EA	6/1	--	26
Y410 ^e	K27	K27	F	6/2	103.5	128.0	4/26-27	EA	6/2	--	36-37
Y411	K28	K28	F	6/3	95.0	117.0	4/24	EA	6/3	P-E-42	40
Y412	K29	K29	F	6/6	115.0	135.0	4/23-27	WS	5/31-6/6	P-W-25	34-44
Y413	K30	K30	M	6/12	95.0	130.0	--	RO ⁱ	--	--	--
Y414	K31	K31	F	6/15	98.0	121.0	5/14	EA	6/15	Y128	31

Table 2.--Continued.

ID No.	Tag No.		Sex ^b	Date tagged	Measurement (cm) ^a		Birth date	Birth island ^c	Weaning date	Mother ID ^d	Days nursing
	Left	Right			AG	SL					
Y415	K32	K32	F	6/19	86.5	121.0	--	RO ¹	--	--	--
Y416	K33	K33	M	6/22	88.5	115.0	5/19-23	WS	6/18-22	P-W-27	26-34
Y417	K34	K34	M	6/25	84.0	121.0	5/5-11	WS	6/18-25	Y281	36-51
Y418 ^e	K35	K35	M	6/27	106.0	122.0	5/27-30	EA	6/27	--	28-31
Y419 ^e	K36	K36	M	6/27	104.0	117.0	5/9-11	EA	6/27	--	47-49
Y420 ^j	K37	K37	F	6/29	85.5	119.0	5/18	EA	6/29	Y251	42
Y421 ^e	K38	K38	F	6/30	110.0	131.0	--	EA	--	--	--
Y422	K39	K39	M	6/30	104.0	122.0	--	EA	--	--	--
Y423	K40	K40	M	7/5	130.0	132.0	--	WS	--	--	--
Y424	K41	K41	F	7/5	107.5	124.0	--	WS	--	--	--
Y425	K42	K42	F	7/5	91.5	105.0	--	WS	--	--	--
Y426	K43	K43	M	7/5	105.0	135.0	--	WS	--	--	--
Y427 ^e	K44	K44	M	7/5	112.5	126.0	5/21	EA	7/1-5	--	41-45
Y428	K45	K45	M	7/8	109.0	125.0	5/24-30	WS	7/6-8	Y535	37-45
Y429	K46	K46	F	7/9	101.0	118.0	6/1	EA	7/6-8	Y457	35-37
Y430	K48	K48	F	7/11	124.0	139.0	5/12-18	WS	7/6-11	Y213	49-60
Y431	K49	K49	M	7/11	113.0	124.0	5/24-30	WS	7/9-11	Y152	37-45
Y432	K50	K50	F	7/15	96.0	128.0	--	RO ¹	--	--	--
Y433 ^e	K51	K51	M	7/15	109.0	123.0	5/21	EA	7/12-15	--	52-55
Y434 ^e	K52	K52	M	7/16	92.0	117.0	6/12	EA	7/16	--	34
Y435	K53	K53	F	7/22	85.0	125.0	--	RO ¹	--	--	--
Y436 ^e	K54	K54	F	7/22	97.0	118.0	--	WS	--	--	--
Y437 ^e	K55	K55	F	7/22	116.0	132.0	6/8	EA	7/19-22	--	41-44
Y438	K56	K56	M	7/30	104.0	136.0	--	RO ¹	--	--	--
Y439	K57	K57	F	7/30	108.0	136.0	6/13-15	WS	7/25-30	Y067	40-47
Y440	K58	K58	M	7/31	79.0	119.0	--	RO ¹	--	--	--
Y441	K59	K59	F	8/1	103.0	137.0	6/18-22	WS	7/31-8/1	Y570	39-44
Y442	K60	K60	M	8/4	102.5	124.0	6/20	EA	8/2-4	Y009	43-45
Y443	K61	K61	F	8/4	105.5	129.0	6/23-25	WS	8/2-4	Y227	38-42
Y444	K62	K62	F	8/12	96.0	118.0	6/27-7/16	LG	8/5-12	Y468	20-46
Y445	K63	K63	M	7/22	102.0	114.0	--	WS	--	--	--
Y446	K64	K64	M	8/12	106.0	130.0	--	RO ¹	--	--	--

Table 2.--Continued.

ID No.	Tag No.		Sex ^b	Date tagged	Measurement (cm) ^a			Birth date	Birth island ^c	Weaning date	Mother ID ^d	Days nursing
	Left	Right			AG	SL	Birth date					
Y447	K65	K65	M	8/12	105.5	128.0	6/26-7/8	WS	8/9-12	Y552	38-47	
Y448	K66	K66	M	8/16	89.0	131.0	--	RO ⁱ	--	--	--	
Y449	K67	K67	F	8/20	91.5	129.0	--	EA	--	--	--	
Y450	K68	K68	F	8/20	91.0	129.0	--	RO ⁱ	--	--	--	
Y451	K69	K69	F	8/20	104.0	130.0	--	EA	--	--	--	
Y452	K70	K70	M	8/23	118.5	138.0	6/27-7/16	GI	8/21-23	Y466	36-57	
Y453	K71	K71	M	8/23	85.0	127.0	--	RO ⁱ	--	--	--	
Y454	K72	K72	F	8/29	94.0	135.0	7/25-30	WS	8/24-29	Y199	25-35	
Y471	K73	K73	M	9/4	102.0	134.0	--	RO ⁱ	--	--	--	
Y472	K74	K74	F	9/4	100.0	132.0	--	RO ⁱ	--	--	--	
Y473	K75	K75	M	9/4	98.5	129.0	7/25-30	WS	8/30-9/4	Y465	31-41	
Y474	K76	K76	F	9/4	100.0	--	--	RO ⁱ	--	--	--	
Y475	K77	K77	F	9/8	90.0	127.0	--	RO ⁱ	--	--	--	
Y476	K78	K78	F	12/3	102.0	120.0	--	--	--	--	--	
Y477	K79	K79	F	12/3	83.0	117.0	--	--	--	--	--	
Y478	K80	K80	M	12/5	94.0	121.0	--	--	--	--	--	
Y479	K81	K81	M	12/5	112.0	140.0	--	--	--	--	--	
Y480	K82	K82	F	12/6	100.0	126.0	--	--	--	--	--	
Y481	K83	K83	F	12/5	100.0	127.0	--	--	--	--	--	
Y482	K84	K84	F	12/6	86.0	110.0	--	--	--	--	--	
Y483	K85	K85	M	12/5	107.0	110.0	--	--	--	--	--	
Y484 ^k	K86	K86	M	12/6	84.0	144.0	--	--	--	--	--	

^aAG = axillary girth; SL = straight length, nose to tip of tail, measured dorsally.

^bM = male; F = female.

^cEA = East Island, GI = Gin Island, LG = Little Gin Island, RO = Round Island, TR = Trig Island, and WS = Whale-Skate Island.

^dMother ID is included only if no pup exchanges were noted.

^epup nursed from more than one female.

^fpup nursed for an additional 15-16 days on two foster mothers after being tagged and measured.

^gpup nursed for an additional 15 days on foster mother after being tagged and measured.

^hpup nursed for an additional 3-4 days on foster mother after being tagged and measured.

ⁱpup presumed to be from Round; older pup tagged at another island but known not to have weaned from that island.

^jpup sent to Honolulu for rehabilitation.

^kNot a weaned pup; seal was a juvenile.

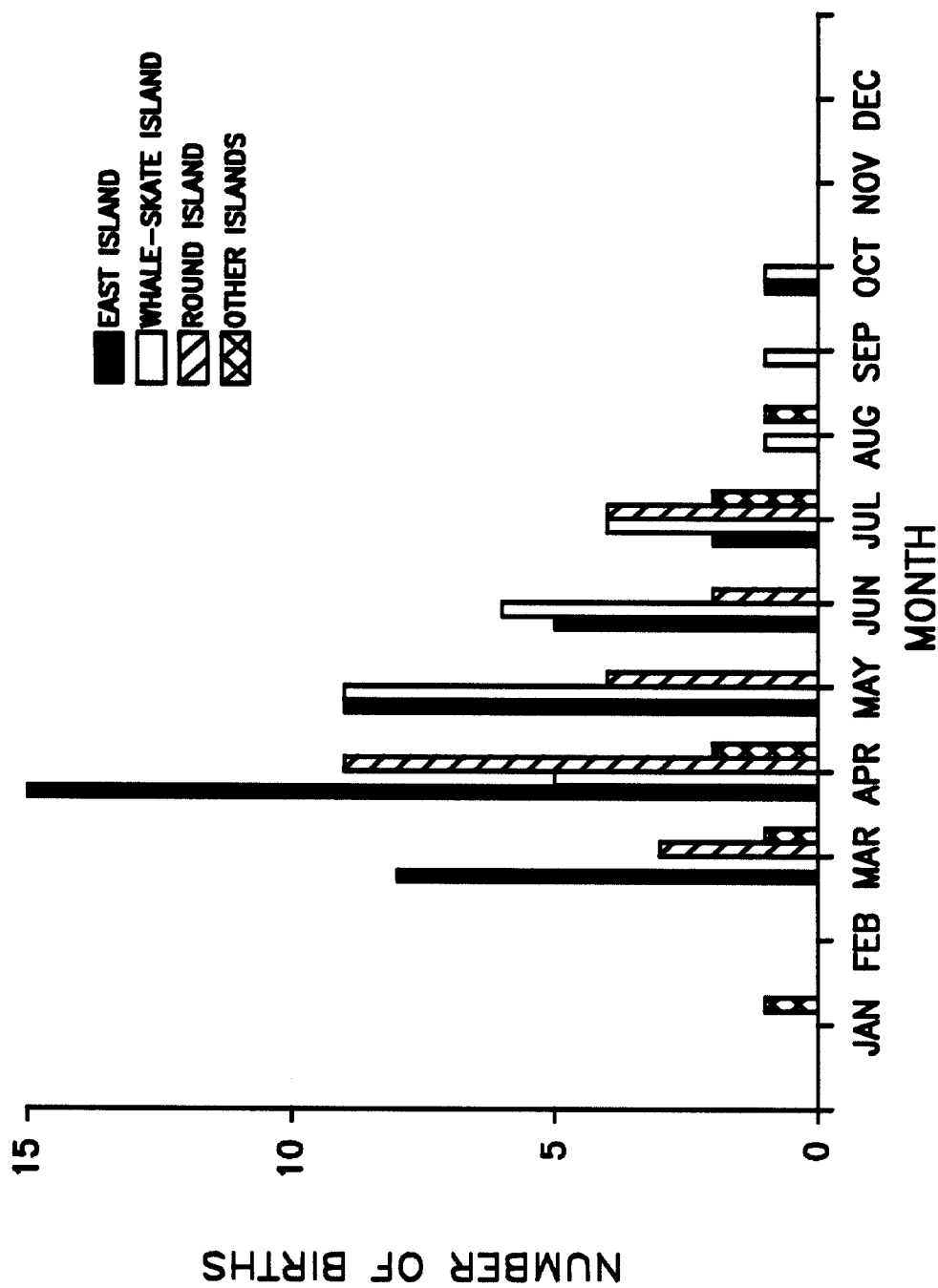


Figure 2. Number of pups born each month on each island at French Frigate Shoals, 1985. Totals include stillborn pups.

Table 3.--Island distribution of pups born at French Frigate Shoals, 1980-85 (No. = Total numbers of pups born; number in parentheses indicates number of perinatal pup deaths included in totals).

Island ^f	1980 ^a		1981 ^b		1982 ^c		1983 ^d		1984 ^e		1985	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
EA	32	34.0	(2-3)		53	46.5	48(2)	49.0	44(1)	41.5	40(4)	41.7
WS	25	26.6	(1)		40(3)	35.1	32(1)	32.7	29(2)	27.4	27	28.1
RO	28	29.8	(1)		21	18.4	10	10.2	24	22.6	22(1)	22.9
EA RO WS	85	90.4	105 (4-5)	93.8	114	100.0	90	91.8	97	91.5	89	92.7
DI	3	3.2	6	5.4	0	0	0	0	0	0	0	0
GI	1	1.1	0	0	0	0	0	0	1	0.9	1	1.0
LG	3	3.2	1	0.9	0	0	1	1.0	5	4.7	4(1)	4.2
MU	0	0	0	0	0	0	5	5.1	0	0	0	0
SH	1	1.1	0	0	0	0	0	0	0	0	0	0
TE	0	0	0	0	0	0	0	0	1(1)	0.9	1(1)	1.0
TR	1	1.4	0	0	0	0	2(1)	2.0	2(1)	1.9	1	1.0
Total	94		112(4-5)		114(3) ^g		98(4)		106(5)		96(7)	

^aJohnson and Johnson, 1984. Nursing pups counted at 40-day intervals. A higher estimate of 104 pups was made by adjusting the counts for 36-day intervals. The number of stillborn pups was not reported; however, a minimum of 5 pups were known to have died or been abandoned prior to normal weaning.

^bSchulmeister, 1984. Summary of Hawaiian monk seal (*Monachus schauinslandi*) data collected at French Frigate Shoals from July 1979 through December 1981. Unpubl. Rep. Southwest Fish. Sci. Cent. Honolulu Lab. Natl. Mar. Fish. Serv. NOAA. Nursing pups counted at 36-day intervals.

Table 3.--Continued.

^cIttner, 1983. The Hawaiian monk seal, *Monachus schauinslandi*, at French Frigate Shoals, 1982. Unpubl. Rep. Southwest Fish. Sci. Cent. Honolulu Lab. Natl. Mar. Fish. Serv. NOAA. Nursing pups counted at 36-day intervals. Pup counts excluded Disappearing, Gin, Little Gin, and Shark Islands; percentages are therefore biased.

^dNMFS Unpubl. Data. Pup production was determined by counting the number of pups marked after weaning.

^eEliason and Henderson, 1992. Pup production was determined by monitoring all births and weanings, with the exception of production from Round Island, which was estimated by monitoring the size progression of pups and by the number of weaned pups tagged from that island.

^fDI = Disappearing Island, EA = East Island, GI = Gin Island, LG = Little Gin Island, MU = Mullet Island, RO = Round Island, SH = Shark Island, TE = Tern Island, TR = Trig Island, and WS = Whale-Skate Island.

^gKnown perinatal deaths were three; however, three other pup deaths were suspected.

Table 4.--Identified female Hawaiian monk seals parturient at French Frigate Shoals, 1985.

ID No.	Temp. ID	Island ^a	Date pupped ^b	Date weaned ^c	Days nursing	ID of pup ^d	Sex of pup ^e	Comments
Y008	E11	EA	<4/8	5/6	---	U	U	Pup exchange
Y009 ^f	---	EA	6/20	8/2-4	43-45	Y442	M	
Y010 ^f	---	EA	5/9-11	6/27	47-49	U	M	Pup exchange
Y011	W10	WS	5/19-23	6/26-7/5	34-47	U	M	
Y027	W2	WS	<4/7	5/12-18	---	U	M	
Y033	---	TE	1/8	---	---	U	U	Pup stillborn
Y046 ^f	---	EA	5/22-23	6/30	38-39	U	M	Pup exchange
Y056 ^f	E37	EA	6/12	7/19-22	37-40	U	M	Pup exchange
Y063 ^f	---	EA	4/26-27	5/27-30	30-34	Y410	F	
Y067	W16	WS	6/13-15	7/25-30	40-47	Y439	F	
Y070	---	WS	4/8-16	5/19-23	33-45	Y401	M	
Y103	---	WS	4/17-22	5/12-18	20-31	U	M	
Y128 ^f	---	EA	5/14	6/15	32	Y414	F	
Y145	R3	RO	<4/27	---	---	U	U	
Y150	---	WS	6/18-22	---	---	U	M	Pup disappeared
Y152	W12	WS	5/24-30	7/9-11	40-48	Y431	M	
Y156	E5	EA	<4/8	5/14	---	U	M	
Y159	W19	WS	7/6-8	---	---	U	U	
Y173 ^f	---	EA	5/21	6/27	37	U	M	Pup disappeared
Y180 ^{f,8}	E22	EA	4/13	5/26-27	43-44	U	M	Pup exchange
Y199	W22	WS	7/25-30	8/24-29	25-35	Y454	M	
Y201	E38	EA	7/12-15	8/17-20	33-39	U	F	Pup exchange
Y206	E4	EA	<4/8	5/16-18	---	Y398	M	
Y213	W6	WS	5/12-18	7/6-11	49-60	Y430	F	
Y214 ^{f,h}	E31;PE43	EA	5/6	6/16-17	41-42	U	M	Pup exchange
Y218 ^f	E39	EA	7/17	8/17-20	31-34	U	F	
Y223 ^f	E26	EA	4/17	6/3	47	U	M	Pup exchange
Y227 ^f	W18	WS	6/23-25	8/2-4	38-42	Y443	F	
Y232	W11	WS	5/19-23	6/26-7/5	34-47	U	F	
Y251 ^f	E32	EA	5/18	6/29	42	Y420	F	Pup to Honolulu
Y253 ^{f,i}	E28	EA	4/19-22	6/1	40-43	U	U	Pup exchange
Y264	E14	EA	<4/8	5/13	---	Y392	F	
Y272	E1	EA	<4/8	4/28	---	Y385	M	
Y279 ^{f,j}	E29	EA	4/23	6/3	41	U	F	Pup exchange
Y281	W5	WS	5/5-11	6/18-25	38-51	Y417	M	

Table 4.--Continued.

ID No.	Temp. ID	Island ^a	Date pupped ^b	Date weaned ^c	Days nursing	ID of pup ^d	Sex of pup ^e	Comments
Y457 ^f	E36;PE1	EA	6/1	7/6-8	35-37	Y429	F	
Y458 ^f	E3;PE3	EA	4/8	5/16-18	38-40	Y399	M	
Y459 ^f	PE6	EA	6/8	7/16	38	U	F	Pup exchange
Y460 ^f	E33;PE11	EA	5/21	6/30	40	U	M	Pup exchange
Y461	E23;PE26	EA	4/12	---	---	U	M	Pup disappeared
Y462	E35	EA	5/27-30	7/12-15	43-49	U	F	Pup exchange
Y463	W9;PW15	WS	5/19-23	6/26-7/5	34-47	U	M	
Y464	W15;PW17	WS	6/13-15	7/19-22	34-39	U	U	
Y465	W21;PW4	WS	7/25-30	8/30-9/4	31-41	Y473	M	
Y466	G1;PG1	GI	6/27-7/16	8/21-23	36-57	Y452	M	
Y467	R20;PR13	RO	<7/22	---	---	U	U	
Y468	LG2;PLG3	LG	6/8-18	7/27-31	20-46	Y444	F	
Y502 ^f	PE41	EA	4/14-16	5/25	39-41	Y405	F	Pup exchange
Y521	PE35	EA	<4/8	4/30-5/4	---	Y383	M	Pup exchange
Y524	PE36	EA	<4/8	4/30-5/4	---	Y388	M	Pup exchange
Y531	PE40	EA	<4/8	4/24	---	U	M	Pup exchange
Y535	PW8	WS	5/24-30	7/6-8	37-45	Y428	M	Pup exchange
Y541	PE33	EA	<4/8	5/14	---	U	M	
Y552	PW21	WS	6/26-7/8	8/9-12	32-47	Y447	M	
Y556	PLG5	LG	8/17-20	>9/8	---	U	M	
Y565	PE30	EA	5/22-23	7/1-5	39-44	U	U	Pup exchange
Y567	PW6	WS	6/7-12	7/19-22	37-45	U	U	
Y570	PW18	WS	6/18-22	7/31-8/1	39-44	Y441	F	
Y571	PLG1	LG	<4/13	4/19-5/4	---	Y390	M	
-----	PE34	EA	<4/8	4/14-16	---	Y384	F	
-----	PE37	EA	<4/8	5/14	---	U	M	Pup exchange
-----	PE38	EA	<4/8	4/30-5/4	---	U	U	
-----	PE39	EA	<4/8	4/30-5/4	---	Y389	F	Pup exchange
-----	PE42 ^f	EA	4/24	6/3	40	Y411	F	
-----	PT3	TR	<4/7	4/26-5/4	---	Y386	F	
-----	PW24	WS	<4/7	5/24-30	---	Y404	M	
-----	PW25	WS	4/23-27	5/31-6/6	34-44	Y412	F	
-----	PW26	WS	5/18	6/23-7/5	36-48	U	F	
-----	PW27	WS	5/19-23	6/18-22	26-34	Y416	M	
-----	PW29	WS	8/17-21	>9/9	---	U	F	
-----	PW30	WS	9/5-8	>9/9	---	U	M	

Table 4.--Continued.

^aEA = East Island, GI = Gin Island, LG = Little Gin Island, RO = Round Island, TE = Tern Island, TR = Trig Island, and WS = Whale-Skate Island.

^bDate is first day seen with a pup; if interval is given, dates are the day following when female was last seen without a pup and first day female was seen with pup.

^cDate is first day seen without a pup; if interval is given, dates are the day following when female was last seen with a pup and first day female was seen without a pup.

^dID is pup born to female, and is included only when no pup exchanges were noted.

^eM = male, F = female, and U = unknown sex.

^fLactation period was known within 5 days and the midpoint of the range was therefore used to calculate mean lactation period.

^gFemale weaned her pup 22 May and adopted weaned pup Y395 which she nursed 3-4 days.

^hFemale adopted two pups after they had weaned from their mothers and nursed them 3-6 and 15-16 days, respectively.

ⁱFemale gave birth to stillborn pup and nursed pup from female Y541.

^jFemale adopted weaned pup Y393 on 19 May and nursed it an additional 15 days.

Lactation Periods

Exact birth and weaning dates for most pups were unknown because field effort was concentrated on East Island, and intervals between visits to other islands varied. Furthermore, when several pups were weaned in one day, the mother of each pup could not always be determined. Lactation periods for females were therefore usually determined as a range (Table 4). Mean lactation periods were calculated from the midpoint of each range whenever the lactation period was known within five days. The mean lactation period for 20 females parturient on East Island and 1 female on Whale-Skate Island was 36.6 days. In 1984, the mean lactation period for 24 females was 38.2 days (Eliason and Henderson 1992). Because variance about the midpoint of the interval was unknown, no statistical tests for differences between the 2 years were conducted.

Pup Exchange

Pup exchanges were only observed on East Island where parturient females were monitored more closely than on other islands. Twenty (54.1%) of the 37 females parturient on East Island exchanged pups; 7 females exchanged pups once, 8 exchanged twice, 4 exchanged three times, and 1 female exchanged four times. Four females were observed to nurse four different pups. All females which exchanged pups ultimately weaned pups born to other females. Frequency of pup exchanges was probably directly related to the concentration of nursing pairs on the island, since the greatest number of pup exchanges occurred in mid- to late-April, when the greatest number of nursing pairs were on the island, and decreased as the number of nursing pairs decreased.

In some instances, pups which were exchanged could be monitored to determine their nursing periods, which differed from the lactation periods for the affected foster females. On East Island, four such pups were identified: (1) Pup Y392 weaned from its mother (Y264) on 13 May, was adopted by Y223 on 1 June, exchanged to female Y214 on 2 June, and weaned from Y214 on 16-17 June, for an additional 15-16 days' nursing; (2) On 14 May, pup Y393 was weaned from a foster female (Y541) and was tagged and measured. The pup was adopted by female Y279 on 19 May, and weaned from her on 3 June, having nursed for an additional 15 days; (3) Pup Y395 was weaned from its mother 14 May and was tagged and measured. It nursed for an additional 3-4 days from female Y180 during 23-25 May; (4) Pup Y410 weaned from its mother (Y063) during 27-30 May and nursed an additional 3-6 days from foster female Y214 until 2 June, resulting in a total nursing period of 36-37 days.

Birth Observed

On 24 April the birth of a monk seal pup was observed on East Island. Female PE42 was seen at 1429 hours lying near the water's edge on the northwest side of the island undergoing labor

contractions. The pup was born at 1527 hours. Presentation was caudal, and the umbilicus and amniotic sac tore during birth. The placenta was expelled 22 minutes postpartum. The female-pup pair was observed for 2 hours and 51 minutes following birth, during which no suckling occurred. Details of this birth were presented in Eliason et al. (1990).

Interatoll Movement

Interatoll movement was documented for three seals which moved between FFS and other islands (Table 5). Two seals moved between Laysan Island and FFS, one of which (Y156) also made a round trip between the two locations in 1984 (Eliason and Henderson 1992). One seal traveled to Necker Island from FFS.

Factors Affecting Survival

Injuries

Twenty-three seals were observed with injuries from various causes; 6 of the injuries were considered severe or fatal (Table 6).

Shark related injuries.--Three (13.0%) of the 23 injuries were attributed to shark attacks. One injury, first observed in May, was fresh. The remaining 2 injuries were inflicted on two (tagged) yearling seals after they were last seen in 1984. Both of these attacks resulted in severed digits on the animals' foreflippers and had completely healed when the seals were first observed in 1985.

Adult male-inflicted injuries.--Thirteen (56.5%) of the injuries were either open wounds along the victim's midline or dorsal abscesses, both of which were suggestive of injuries caused by adult males during mating attempts and agonistic encounters. These wounds were observed throughout the 1985 field season, unlike 1984, when they were observed only in July and August (Eliason and Henderson 1992). One severe dorsal wound resulted in the death of an adult female (Table 7, Appendix D).

Entanglements

A subadult male seal was found entangled at Tern Island on 1 September. The animal's chest was encircled with wire, but mobility was not restricted. The seal disappeared before biologists were able to remove the wire.

Net and Rope Inventory

A total of 226 debris fragments capable of entangling seals and other wildlife were inventoried, and samples were taken from 216 fragments. The remainder was burned to prevent future entanglements.

Table 5.--Observations of interatoll movement to and from French Frigate Shoals (FFS) by Hawaiian monk seals in 1985.

ID No.	Size ^a	Sex ^b	Movement from		Movement to		Comments
			Location ^c	Date last seen	Location ^c	Date first seen	
Y156	A	F	Laysan ^d	11/2/84	FFS, EA	4/8/85	With nursing pup.
Y156	A	F	FFS, EA	5/13/85	Laysan ^d	5/31/85	
TA10	J	M	Laysan	5/27/83	FFS, EA	7/8/85	Not sighted in 1984.
Y318	J	F	FFS,	5/8/85	Necker	8/24/85 ^e	

^aA = adult; J = juvenile.

^bM = male; F = female.

^cEA = East Island.

^dBecker et al. (1989).

^eNMFS unpubl. data.

Table 6.--Injuries of Hawaiian monk seals observed at French Frigate Shoals, 1985.

Date	Seal ID	Size ^a	Sex ^b	Island ^c	Location on seal	Description of Injury	Probable cause
4/27	--	A	U	WS	Dorsal	Gaping wound, 30 x 20 cm ^d	Seal
5/4	--	A	U	WS	Dorsal	Gaping wound, 9 x 4 x 3 cm	Seal
5/11	--	A	F	EA	Dorsal	Previous wound reopened 4 x 4 cm	Seal
5/18	--	A	U	WS	Dorsal	Numerous small lacerations	Seal
5/18	--	A	F	WS	Dorsal	Deep gaping wound, 56 x 26 cm ^e	Seal
5/19	--	J	M	EA	Foreflipper	Laceration, 3 cm long	Unknown
5/23	--	J	M	TR	Foreflipper & lateral	Three lacerations 16-21 cm long	Shark
6/5	--	S	U	TE	Postero-dorsal	Two lacerations 2-6 cm diameter	Unknown
6/6	--	A	M	EA	Above eye	Laceration, 3-4 cm diameter	Unknown
6/14	--	A	U	EA	Dorsal	Gaping wound, 2 x 5 cm; lacerations	Seal
6/18	--	A	U	DI	Dorsal	Several lacerations, 6 cm long	Seal
6/18	Y321	J	M	EA	Foreflipper	Three digits amputated; healed	Shark
7/1	--	S	U	TE	Dorsal	Gaping wound, 50 x 30 cm ^d	Seal
7/15	--	S	F	EA	Dorsal	Gaping wound, 20 cm diameter ^d	Seal
7/15	--	A	M	WS	Muzzle	Small laceration or abrasion	Unknown
7/16	Y332	J	M	DI	Foreflipper	Distal end amputated; healed	Shark
7/19	--	J	F	TE	Dorsal	Numerous small lacerations	Seal
7/22	Y430	W	F	WS	Antero-dorsal	Abscess, 25 cm diameter ^d	Seal
8/1	Y396	W	M	WS	Lateral	Two shallow lacerations	Unknown
8/9	--	A	U	TE	Hind flipper	Laceration	Unknown
8/12	--	A	F	DI	Dorsal	Gaping wound, 30 x 15 cm	Seal
8/12	Y446	W	M	WS	Antero-dorsal	Open abscess, 21 x 15 x 10 cm ^d	Seal
8/16	Y448	W	M	WS	Head	Three lacerations	Unknown

^aA = adult, J = juvenile, S = subadult, and W = weaned pup.

^bM = male, F = female, and U = unknown sex.

^cDI = Disappearing Island, EA = East Island, TE = Tern Island, TR = Trig Island, and WS = Whale-Skate Island.

^dSevere wound.

^eFatal wound.

Deaths

Twelve seals died and two nursing pups disappeared (Table 7). Seven of these deaths were perinatal pups which were probably stillborn. One entire pup carcass was frozen, four complete necropsies, and one partial necropsy were performed (Appendix D). Descriptions of each death and disappearance follow.

Case 1.--An aborted fetus was found on Tern Island in January (G. Fairaizl, USFWS, P.O. Box 50167, Honolulu, HI 96850, pers. commun., January 1985). The identity of the female was Y033; the fetus was not collected.

Case 2.--The carcass of a fresh newborn male pup was found on East Island on 12 April. Based on the observation that a section of lung tissue did not float in water and the placenta was still attached to the pup, the animal was considered to be stillborn. A necropsy was performed (necropsy FFS-85-1, Appendix D).

Case 3.--A dried and decayed carcass of a neonate pup was found on Little Gin Island on 13 April. Only the skeleton was collected.

Case 4.--On 13 April a decayed carcass of a newborn pup was found on East Island. Because of advanced decomposition, the carcass was not collected.

Case 5.--On 16 April the decayed and flattened carcass of a newborn pup was seen on Round Island from the boat. The carcass was not retrieved because of the proximity of nursing females on the island.

Case 6.--The dead newborn pup of female Y253 was observed on 22 April on East Island, and the female was nursing the pup of another female (Y541). East Island had last been visited on 19 April, indicating that the pup had been born and died during 19-22 April. The carcass was frozen and sent to Honolulu.

Case 7.--On 18 May an adult female with a massive dorsal wound (56 by 26 cm) was observed on Whale-Skate Island. The wound was bleeding, appeared to be infected, and probably resulted from mating attempts by adult male seals. The female may have been dead at that time, but the death was not confirmed until 23 May when biologists returned to the island. A partial necropsy was performed (necropsy FFS-85-3, Appendix D).

Case 8.--On 11 June the carcass of a newborn pup was found on East Island. The pup was very small and was still attached to the placenta. Only the skeleton was collected.

Table 7.--Hawaiian monk seal deaths and disappearances recorded at French Frigate Shoals, 1985.

Case No.	Date noted	Island ^a	Size ^b	Sex ^c	Cause of death
1	Jan	TE	P	U	Stillborn ^d
2	12 Apr	EA	N	M	Stillborn
3	13 Apr	LG	N	U	Stillborn
4	13 Apr	EA	N	U	Stillborn
5	16 Apr	RO	N	U	Stillborn
6	22 Apr	EA	N	U	Stillborn
7	23 May	WS	A	F	Unknown
8	11 Jun	EA	N	F	Stillborn
9	18 Jun	LG	A	M	Unknown
10	22 Jun	TE	A	M	Unknown
11	5 Jul	WS	N	M	Disappeared
12	8 Jul	WS	N	U	Disappeared
13	16 Jul	DI	A	M	Unknown
14	9 Sep	TE	J	F	Unknown

^aDI = Disappearing Island, EA = East Island, LG = Little Gin Island, RO = Round Island, TE = Tern Island, and WS = Whale-Skate Island.

^bA = adult, J = juvenile; N = neonate, and P = premature pup.

^cM = male, F = female, and U = unknown sex.

^dG. Fairaizl, USFWS, P.O. Box 50167, Honolulu, HI 96850, pers. commun., January 1985.

Case 9.--An adult male was found on Little Gin Island on 18 June. The seal appeared emaciated, and blood was present about its mouth and nostrils. Necropsy revealed an empty stomach and ulcers. Cause of death was unknown (necropsy FFS-85-6, Appendix D).

Case 10.--An adult male was found dead on the runway of Tern Island, 80 m from the beach, on 22 June. Several tracks indicated that the seal may have attempted to find its way back to the beach. A necropsy performed on 23 June revealed an empty stomach and no external wounds. Cause of death was unknown, although histopathological examination revealed atrophy and fibrosis of the exocrine pancreas (necropsy FFS-85-5, Appendix D).

Case 11.--Adult female Y150 was observed on Whale-Skate Island with a newborn male pup on 22 and 25 June. On 5 and 8 July this pair was not observed on the island. On 11 July the female was observed without the pup. The carcass of the pup was never found.

Case 12.--On 8 July on Whale-Skate Island, adult female Y159 was observed swimming with a newborn pup in deep water approximately 30 m from shore, an unusual behavior for a female with a new pup. Several minutes later the female was seen without the pup, swimming back and forth along the shoreline vocalizing. Neither the pup nor its carcass was found; cause of death is unknown.

Case 13.--The carcass of a very thin adult male seal was found on Disappearing Island on 16 July. A thin, lethargic seal had been sighted at this island on a previous census and was probably the same seal. Due to extensive decomposition, a necropsy was not performed. The skull and baculum were collected.

Case 14.--A dead juvenile female was found at Tern Island on 9 September, and may have died up to 2 days earlier. The seal had no external injuries and appeared in good condition. A necropsy revealed a large amount of bones in the animal's stomach. Cause of death was not determined (necropsy FFS-85-9, Appendix D).

Miscellaneous

Rehabilitation Program

Two prematurely weaned female pups (Y406 and Y420) were captured and sent to Honolulu for rehabilitation. They were flown to Kure Atoll on 6 May, 1986, temporarily maintained in an enclosure, and released on 20 May (Y406) and 18 June (Y420).

Attack on Gray Reef Shark by a Nursing Female Seal

At approximately 1740 hours on 12 May at East Island a 2-m-long gray reef shark, *Carcharhinus amblyrhynchos*, was observed on the south side of the island thrashing in shallow water inside the fringing reef, approximately 30 m from shore. Apparently the shark had been caught inside the reef by the receding tide and could not find its way to deeper water. After thrashing for several minutes, the shark swam towards shore and rested on the sand bottom with 75% of its body above the surface. At 1747 hours, adult female Y458 and her 5-week-old pup were observed swimming along the shoreline towards the shark. When the female seal was 18-20 m from the shark, she suddenly charged the shark, vocalized, and bit its side near the pelvic fin. The shark immediately fled 80 m away from shore. At 1748 hours the female seal slowly swam along the shoreline for 30 m, turned towards the reef, and again charged the shark, vocalizing and biting it until it fled 50 m away. The seal immediately charged and bit the shark a third time, after which the shark fled out of view towards the east end of the island. Female Y458 and her pup continued to swim slowly west along the shoreline.

Molt of Adult Female while Nursing a Pup

On 4 September adult female PW29 had completed 70% of her molt although she was nursing a 2-3-week-old pup at the time. Adult

females usually molt approximately two months after weaning their pups (Stone 1984), although a fully molted female gave birth at Kure Atoll in 1981 (JRH observation), and a female molted while nursing a pup at Laysan Island in 1991 (B. Becker, NMFS, SWFSC, 2570 Dole St. Honolulu, HI 96822-2396, pers. commun., September 1992).

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APPENDIXES

Appendix A.--Itinerary for field program at French Frigate Shoals, 1985.

Date	Event
4 April	J. Eliason and M. Webber arrive via NOAA ship <i>Townsend Cromwell</i> .
11 April	Field camp established on East Island.
12 April	J. Henderson arrives via fishing vessel <i>Feresa</i> .
14 April	E. Miller arrives and J. Henderson departs via charter flight.
30 April	E. Miller departs via charter flight.
27 May	R. Withrow arrives via charter flight.
28 May	J. Eliason departs via charter flight.
11 June	G. Balazs, J. Eliason and G. Peiterson arrive via charter flight.
12 June	G. Balazs and R. Withrow depart via charter flight. Underdeveloped pup Y406 flown to Honolulu.
2 July	T. Gerrodette arrives via research vessel <i>Kila</i> .
3 July	G. Peiterson and M. Webber depart via charter flight. Underdeveloped pup Y420 flown to Honolulu.
23 July	M. Webber arrives and T. Gerrodette departs via <i>Townsend Cromwell</i> .
20 August	Field camp at East Island disbanded.
11 September	J. Eliason and M. Webber depart via charter flight; NMFS summer field effort terminated.
2 December	J. Leialoha and R. Morrow arrive via charter flight.
19 December	J. Leialoha and R. Morrow depart via charter flight. NMFS field effort terminated.

Appendix B.--Summary of atoll-wide counts of Hawaiian monk seals at French Frigate Shoals, 1985 (M = male, F = female, and U = unknown sex).

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
5/23	28	45	38	9	12	27	19	12	56	11	5	33	249 ^a	49	298
6/17	18	40	35	6	19	32	17	12	25	14	8	24	204	46	250
6/25	22	56	32	14	13	43	16	23	25	17	9	28	247 ^a	54	301
7/30	24	61	31	31	22	58	41	32	46	23	15	19	346	57	403
8/ 4	33	48	41	26	26	44	42	20	30	23	11	17	311 ^a	51	362
8/12	17	37	25	18	20	33	32	26	44	19	15	10	252	44	296
8/16	17	45	25	14	15	38	39	19	41	11	12	14	256 ^a	37	293
8/20	21	40	18	21	17	39	32	24	50	18	14	11	263 ^a	43	306
8/23	22	43	14	25	19	47	43	23	36	18	13	9	272	40	312
Mean	22.4	46.1	28.8	18.2	18.1	40.1	31.2	21.2	39.2	17.1	11.3	18.3	266.7	46.8	313.4
SD	5.3	7.8	9.0	8.3	4.4	9.3	11.2	6.4	11.0	4.5	3.4	8.5	40.7	6.6	44.1

^aTotal includes some seals which were not placed in any size class.

Appendix C.--Summary of census counts of Hawaiian monk seals at French Frig Shoals, 1985 (M = male, F = female, and U = unknown sex).

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
Bare Island															
4/18	0	0	2	0	0	1	0	0	0	0	0	0	3	0	3
5/24	1	0	0	0	0	0	0	0	3	0	0	0	4	0	4
6/ 7	0	0	4	0	0	1	0	0	0	0	0	0	5	0	5
6/25	0	0	1	2	1	2	0	0	3	0	0	0	11 ^a	0	1
6/26	0	0	0	0	0	3	0	0	3	0	0	0	6	0	6
7/22	1	0	0	0	0	0	0	0	2	0	0	0	3	0	3
7/31	0	0	1	0	0	3	0	0	0	0	0	1	4	1	5
8/ 4	0	0	0	0	0	0	0	0	2	0	0	0	2	0	2
8/16	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1
8/20	0	0	0	0	0	0	0	0	2	0	1	2	2	3	5
8/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	.2	0	.7	.2	.1	1.0	0	0	1.4	0	.1	.3	3.7	.4	4
Disappearing Island															
4/13	0	0	7	2	0	7	10	5	11	0	0	0	42	0	4
5/ 5	2	1	3	1	1	6	6	3	22	0	0	0	45	0	4
5/24	6	5	3	1	2	3	6	6	13	0	0	0	45	0	4
6/ 7	3	5	5	6	4	6	1	0	3	0	0	0	33	0	3
6/18	4	2	5	0	2	3	5	5	4	0	0	0	30	0	3
6/26	1	4	4	4	1	6	4	5	8	0	0	0	37	0	3
7/16	0	8	4	2	3	6	5	2	4	0	0	0	34	0	3
7/31	2	4	5	4	1	11	10	5	15	1	0	0	57	1	5
8/ 4	4	6	4	1	4	8	12	3	3	0	0	0	45	0	4
8/12	1	6	4	2	3	4	8	7	12	0	1	0	47	1	4
8/16	1	5	5	4	4	8	12	3	8	0	0	0	50	0	5
8/20	2	3	3	2	1	8	6	6	13	3	1	0	44	4	4
8/23	2	8	5	2	4	14	6	5	10	1	0	0	56	1	5
Mean	2.2	4.4	4.4	2.4	2.3	6.9	7.0	4.2	9.7	.4	.2	0	43.5	.5	44
East Island															
4/ 8	5	15	4	0	3	2	2	4	1	3	1	9	36	13	4
4/12	5	16	5	0	0	0	1	0	1	1	0	12	28	13	4
4/17	0	15	3	3	1	4	1	1	1	2	2	11	29	15	4
4/19	3	12	3	0	0	1	0	3	2	3	0	7	24	10	3
4/23	3	19	7	0	0	0	1	1	2	2	0	14	33	16	4
4/24	4	18	7	0	2	2	0	0	5	2	1	9	38	12	5
4/28	3	16	2	2	0	1	0	0	1	3	3	9	25	15	4
5/ 6	5	15	4	1	0	0	1	2	1	6	4	10	29	20	4

Appendix C.--Continued.

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
East Island--Continued															
5/ 7	3	18	1	0	0	0	0	1	1	4	3	9	24	16	4
5/12	5	15	5	1	0	0	1	5	1	6	3	8	33	17	5
5/14	3	16	1	0	1	0	3	2	1	7	5	9	27	21	4
5/19	5	12	7	0	2	0	3	1	0	9	3	7	31 ^a	19	5
5/20	4	13	2	0	1	2	1	0	0	11	4	5	23	20	4
5/24	1	13	5	0	3	1	0	0	2	9	3	10	25	22	4
5/25	5	17	4	1	4	0	1	2	0	7	4	10	34	21	5
5/31	3	19	5	0	2	1	1	1	0	10	4	11	32	25	5
6/ 2	2	11	1	2	3	6	1	0	2	13	7	6	28	26	5
6/ 7	1	17	2	1	4	1	1	1	1	5	5	5	29	15	4
6/ 9	5	12	3	0	2	3	0	0	0	15	9	1	25	25	5
6/13	4	17	5	0	2	3	1	0	2	12	5	14	34	31	6
6/14	1	17	5	1	1	2	3	3	1	14	8	10	34	32	6
6/18	2	12	10	1	4	3	2	1	3	7	7	9	38	23	6
6/20	3	15	5	1	4	3	3	1	0	7	5	5	35	17	5
6/25	0	15	7	3	2	4	2	1	2	13	7	5	36	25	6
6/27	4	13	6	1	7	4	2	2	5	11	7	8	45 ^a	26	7
6/29	1	9	8	3	5	6	2	0	0	7	9	4	34	20	5
7/ 5	3	14	6	1	3	3	4	1	2	10	9	6	37	25	6
7/ 9	4	15	6	3	3	6	2	5	2	15	7	6	46	28	7
7/10	3	10	5	1	5	4	4	4	3	14	6	4	39	24	6
7/15	4	12	4	3	3	5	5	4	2	9	8	3	42	20	6
7/17	4	12	4	1	2	6	2	2	2	9	5	3	35	17	5
7/22	0	9	6	1	1	13	2	1	11	9	6	2	44	17	6
7/24	3	12	7	2	2	7	4	3	6	6	6	8	46	20	6
7/25	3	13	6	2	5	7	4	4	6	8	9	2	50	19	6
7/30	2	11	5	3	3	5	3	2	4	8	7	2	38	17	5
8/ 1	3	12	4	0	1	3	2	2	6	5	3	2	33	10	4
8/ 4	1	10	5	0	4	6	4	1	6	12	5	1	37	18	5
8/ 6	5	11	2	2	1	3	4	3	2	6	3	4	33	13	4
8/ 8	1	8	2	3	1	0	3	2	3	1	1	0	23	2	2
8/12	0	4	4	0	1	8	2	4	3	5	3	1	26	9	3
8/16	2	11	3	0	2	3	7	0	6	4	2	4	34	10	4
8/20	0	4	3	3	0	5	2	5	7	6	5	2	29	13	4
8/23	2	5	1	0	1	5	8	2	1	6	3	2	25	11	3
8/29	3	3	2	3	1	7	2	1	6	5	4	1	28	10	3
9/ 4	3	3	3	2	0	3	4	3	1	6	5	1	22	12	3
9/ 8	6	3	1	2	0	2	3	5	3	5	5	1	25	11	3
12/ 3	3	4	2	1	1	2	3	2	1	3	1	1	19	5	2
12/18	2	4	2	0	0	1	3	2	2	1	0	0	16	1	1
Mean	2.9	12.0	4.2	1.1	1.9	3.2	2.3	1.9	2.5	7.1	4.4	5.7	32.0	17.2	49

Appendix C.--Continued.

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Gran
Gin Island															
4/13	3	1	2	0	0	1	0	1	2	0	0	0	10	0	1
4/18	3	0	7	1	0	2	0	2	3	0	0	0	18	0	1
5/ 5	0	0	6	0	1	0	0	0	0	0	0	0	11 ^a	0	1
5/24	3	2	6	1	1	4	0	0	5	0	0	0	25 ^a	0	2
6/ 7	0	1	19	1	0	7	0	1	4	0	0	0	34 ^a	0	3
6/18	0	2	1	0	0	3	1	1	2	0	0	0	10	0	1
6/26	1	0	6	0	0	2	0	2	2	0	0	0	14 ^a	0	1
7/16	4	5	2	0	0	0	2	1	2	1	0	0	16	1	1
7/25	1	5	1	2	0	2	1	1	6	1	0	1	19	2	2
7/31	2	2	5	1	1	5	1	1	3	1	0	0	21	1	2
8/ 4	4	3	9	0	0	4	1	1	1	1	0	0	24 ^a	1	2
8/12	2	3	6	1	0	1	1	0	4	0	0	1	18	1	1
8/16	1	4	10	0	0	1	1	0	4	1	0	1	24 ^a	2	2
8/20	0	1	2	0	1	1	2	2	2	1	0	0	12 ^a	1	1
8/23	2	1	1	1	0	2	1	0	4	1	0	0	12	1	1
9/ 4	0	3	3	1	1	6	2	0	4	1	0	1	20	2	2
9/ 8	2	2	1	0	1	3	0	0	4	1	0	2	13	3	1
12/18	4	2	1	3	2	1	3	0	0	1	1	0	16	2	1
Mean	1.8	2.1	4.9	.7	.4	2.5	.9	.7	2.9	.6	.1	.3	17.6	.9	18
La Perouse Pinnacle															
8/23 ^b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Gin Island															
4/13	2	1	1	0	0	1	2	0	0	0	0	1	7	1	8
4/18	2	1	2	0	0	0	0	1	1	1	0	0	7	1	8
5/ 5	1	3	3	1	0	0	0	1	3	0	0	0	12	0	1
5/24	1	2	7	2	2	2	3	1	4	1	0	0	24	1	2
6/ 7	2	0	4	0	0	3	0	0	3	0	0	0	12	0	1
6/18	2	0	5	0	0	1	2	0	2	1	0	0	12	1	1
6/26	1	0	3	0	0	2	0	0	3	0	0	0	9	0	9
7/16	2	2	2	1	1	0	0	1	1	1	1	0	10	2	1
7/25	2	3	2	1	0	0	4	3	2	0	0	1	17	1	1
7/31	4	7	1	1	0	3	4	4	4	1	0	1	28	2	3
8/ 4	5	3	7	2	0	1	2	1	2	0	1	0	23	1	2
8/12	1	2	4	0	0	2	0	0	4	1	1	2	13	4	1
8/16	1	2	1	0	0	1	1	0	3	0	0	0	9	0	9
8/20	3	5	1	1	1	1	3	1	4	1	1	1	20	3	2

Appendix C.--Continued.

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
Little Gin Island--Continued															
8/23	4	4	0	0	0	0	2	1	2	0	1	1	13	2	1
9/ 4	1	0	0	0	0	1	1	1	2	2	1	1	6	4	1
9/ 8	1	3	3	0	0	2	0	1	0	2	2	0	10	4	1
12/18	3	0	0	1	1	0	0	1	0	1	1	0	6	2	8
Mean	2.1	2.1	2.6	.6	.3	1.1	1.3	.9	2.2	.7	.5	.4	13.2	1.6	14
Mullet Island															
4/ 8	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
6/ 3	0	0	2	0	0	0	0	0	1	0	0	0	3	0	3
7/ 5	0	0	0	0	0	0	0	0	3	0	0	1	3	1	4
7/18	0	0	1	0	1	1	0	0	1	0	0	1	4	1	5
Mean	0	0	1.0	0	.3	.3	0	0	1.3	0	0	.5	2.8	.5	3
Round Island															
4/ 8	1	2	1	0	0	1	0	0	0	0	0	1	5	1	6
4/16	1	9	3	0	0	1	0	0	0	0	0	8	14	8	2
4/19	0	6	3	0	0	0	0	0	0	1	0	5	9	6	1
4/22	0	6	0	0	0	0	0	0	1	0	0	8	7	8	1
4/27	0	8	1	0	0	0	0	1	1	1	0	7	11	8	1
4/29	1	5	3	0	0	1	0	0	1	0	0	7	11	7	1
5/ 4	0	6	0	0	0	0	0	0	0	0	0	7	6	7	1
5/ 8	0	8	6	0	0	0	0	0	3	0	1	9	17	10	2
5/11	0	10	3	0	0	1	0	0	1	1	0	10	15	11	2
5/18	1	8	1	0	0	1	0	0	2	0	0	12	13	12	2
5/21	0	4	2	0	0	0	0	0	0	0	0	6	6	6	1
5/23	0	6	1	0	0	0	0	0	2	0	1	13	9	14	2
5/26	0	10	0	0	0	0	0	0	1	0	0	13	11	13	2
5/30	0	8	4	0	0	1	0	0	0	0	0	11	13	11	2
6/ 3	0	8	4	0	0	1	0	0	0	0	0	10	13	10	2
6/ 6	0	10	1	0	0	1	0	0	1	0	0	13	13	13	2
6/12	0	7	0	0	0	0	0	0	1	0	0	10	8	10	1
6/15	1	5	1	0	0	0	0	0	1	0	0	5	8	5	1
6/17	0	4	1	0	0	0	0	0	0	0	0	7	5	7	1
6/22	0	6	3	0	0	1	0	0	1	0	0	8	11	8	1
6/25	0	5	0	0	0	0	0	0	1	0	0	12	6	12	1
6/30	0	4	0	0	0	1	0	0	2	0	0	6	7	6	1
7/ 5	0	2	3	0	0	0	0	0	0	1	0	6	5	7	1
7/ 8	0	5	2	0	0	2	0	0	3	1	0	11	12	12	2
7/11	0	2	2	0	0	0	0	0	0	2	0	6	4	8	1
7/15	0	0	1	0	0	2	0	0	2	1	1	7	5	9	1

Appendix C.--Continued.

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Gran
Round Island--Continued															
7/18	0	2	0	0	0	1	0	0	1	0	0	2	4	2	6
7/22	0	4	0	0	0	0	0	0	3	1	0	10	7	11	1
7/24	0	3	1	0	0	1	1	0	0	1	0	13	6	14	2
7/30	0	3	0	0	0	0	0	1	1	0	0	12	5	12	1
8/ 1	0	3	0	0	0	0	0	0	1	0	1	8	4	9	1
8/ 4	1	4	1	0	0	1	0	0	1	0	0	15	8	15	2
8/ 8	0	5	1	0	0	0	0	0	1	0	0	6	7	6	1
8/12	0	2	0	0	0	0	0	0	1	1	1	5	3	7	1
8/16	0	2	0	0	0	0	0	0	1	0	0	7	3	7	1
8/20	1	3	1	0	0	0	0	0	2	0	0	4	7	4	1
8/23	0	4	0	0	0	1	0	0	1	0	0	6	6	6	1
8/29	0	2	1	0	0	0	0	0	0	0	0	6	3	6	9
9/ 4	0	2	0	0	1	0	0	0	1	0	0	5	4	5	9
9/ 8	0	2	1	0	0	0	0	0	1	0	1	5	4	6	1
9/10	0	2	0	0	0	0	0	0	0	0	0	6	2	6	8
12/ 3	0	2	0	0	0	0	0	0	1	0	3	0	3	3	6
12/18	0	1	0	1	0	1	1	0	1	1	1	0	5	2	7
Mean	.2	4.7	1.2	0	0	.4	0	0	1.0	.3	.2	7.6	7.6	8.1	15
Shark Island															
4/13	0	1	3	2	4	9	4	3	2	0	0	0	28	0	2
4/29	0	0	0	0	0	0	0	0	0	0	0	0	5 ^a	0	5
5/23	1	1	3	0	1	3	0	0	7	0	0	0	16	0	1
6/ 6	3	2	5	0	1	1	1	2	4	0	0	0	19	0	1
6/17	2	0	1	1	0	2	3	2	1	0	0	0	12	0	1
6/25	2	0	0	1	0	1	1	2	2	0	0	0	9	0	9
7/13	1	1	1	3	2	0	1	0	0	0	0	0	9	0	9
7/29	1	2	0	0	2	3	1	2	0	0	1	0	11	1	1
7/30	3	3	1	0	1	4	1	1	3	0	1	0	17	1	1
8/ 4	0	0	0	1	2	3	2	3	0	0	0	0	11	0	1
8/ 8	3	3	1	0	0	0	0	3	2	2	1	0	12	3	1
8/12	0	0	1	0	0	1	0	0	4	1	0	0	6	1	7
8/16	0	1	0	0	1	2	1	0	2	0	0	0	7	0	7
8/20	1	3	3	0	0	3	3	1	1	1	0	0	15	1	1
8/23	1	2	0	1	0	3	2	0	2	0	0	0	11	0	1
Mean	1.2	1.3	1.3	.6	.9	2.3	1.3	1.3	2.0	.3	.2	0	12.5	.5	13

Appendix C.--Continued.

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Gran
Tern Island															
1/ 4	14	6	23	4	7	20	4	5	10	0	0	0	93	0	9
1/ 8	25	5	24	4	6	17	7	5	14	0	0	0	107	0	10
1/12	14	7	23	1	0	20	5	4	8	0	0	0	82	0	8
1/16	22	17	24	8	9	18	7	8	18	0	0	0	131	0	13
1/20	10	6	22	2	3	13	5	8	16	0	0	0	85	0	8
1/24	18	6	11	4	4	15	16	7	12	0	0	0	93	0	9
1/28	7	0	18	3	3	22	5	5	18	0	0	0	81	0	8
2/ 1	19	8	12	13	10	14	14	12	22	0	0	0	124	0	12
2/ 9	9	6	13	9	1	35	14	13	21	0	0	0	121	0	12
2/13	11	5	11	17	11	28	16	11	16	0	0	0	126	0	12
2/17	13	1	9	15	9	20	8	4	11	0	0	0	90	0	9
2/21	8	9	4	14	4	29	10	4	8	0	0	0	90	0	9
2/25	10	4	14	13	7	22	6	5	13	0	0	0	94	0	9
3/ 1	10	5	21	10	5	44	9	12	24	0	0	0	140	0	14
3/ 5	16	8	20	25	13	51	12	18	18	0	0	0	181	0	18
3/ 9	10	8	19	6	11	28	8	8	20	0	0	0	118	0	11
3/13	18	7	9	15	14	24	18	12	13	0	0	0	130	0	13
3/17	17	3	11	12	9	20	18	9	13	0	0	0	112	0	11
3/21	13	5	6	14	10	18	12	11	12	0	0	0	101	0	10
3/25	7	2	11	12	9	21	13	14	19	0	0	0	108	0	10
3/29	26	10	6	12	10	17	15	14	12	0	0	0	122	0	12
4/ 2	20	5	19	15	4	24	14	12	25	0	0	0	138	0	13
4/ 6	14	7	8	7	8	13	18	16	24	0	0	0	115	0	11
4/10	14	3	4	4	6	9	9	5	15	0	0	0	69	0	6
4/14	15	6	7	4	4	4	8	4	10	0	0	0	62	0	6
4/18	12	8	10	6	2	10	5	8	12	0	0	0	73	0	7
4/22	12	5	12	4	4	5	6	6	11	0	0	0	65	0	6
4/26	6	1	11	1	2	8	7	2	13	0	0	0	51	0	5
4/30	10	5	15	4	3	8	6	7	5	0	0	0	63	0	6
5/ 4	9	7	11	7	3	5	4	5	7	0	0	0	58	0	5
5/ 8	16	7	11	4	4	4	5	5	4	0	0	0	60	0	6
5/12	11	3	10	6	7	8	9	6	4	0	0	0	64	0	6
5/16	7	3	14	3	3	5	10	3	6	0	0	0	54	0	5
5/20	10	4	5	4	2	12	6	7	10	0	0	0	60	0	6
5/24	10	4	3	2	1	7	3	1	6	0	0	0	37	0	3
5/28	6	0	5	5	7	3	5	4	3	0	0	0	38	0	3
6/ 1	9	4	8	4	5	2	2	3	3	0	0	0	40	0	4
6/ 5	11	7	9	3	4	3	2	0	1	0	0	0	40	0	4
6/ 9	10	2	8	5	4	3	7	2	4	0	0	0	45	0	4
6/14	6	9	6	4	10	10	4	1	2	0	0	0	52	0	5
6/17	8	5	6	2	7	9	0	3	3	0	0	0	43	0	4
6/21	7	9	7	3	3	5	5	4	2	0	0	0	45	0	4

Appendix C.--Continued

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Gran
Tern Island--Continued															
6/25	9	8	4	1	3	11	4	2	0	0	0	0	42	0	4
6/29	6	6	9	4	5	12	5	3	1	0	0	0	51	0	5
7/ 3	7	8	3	10	8	15	7	6	10	0	0	0	74	0	7
7/ 7	7	7	8	4	6	18	4	2	13	0	0	0	69	0	6
7/11	10	5	2	9	6	17	8	10	8	0	0	1	75	1	7
7/15	4	4	1	14	10	16	4	5	9	1	0	0	67	1	6
7/19	5	5	7	12	13	25	2	7	9	1	0	0	85	1	8
7/23	2	5	7	8	8	23	6	9	16	0	1	0	84	1	8
7/27	8	9	5	15	10	13	14	10	9	3	0	0	93	3	9
7/31	10	11	2	15	10	24	12	7	10	3	0	0	101	3	10
8/ 4	11	9	6	19	13	14	12	6	9	2	0	1	99	3	10
8/ 8	8	7	2	15	15	13	8	7	10	2	0	0	85	2	8
8/12	11	8	0	14	11	14	6	6	5	0	1	0	75	1	7
8/16	8	8	2	9	4	18	4	5	3	1	0	0	61	1	6
8/20	10	12	1	13	11	13	4	3	8	1	0	0	75	1	7
8/23	9	9	5	17	9	15	11	6	3	2	1	0	84	3	8
8/28	4	4	1	16	7	11	14	8	5	3	1	0	70	4	7
9/ 1	6	4	4	9	5	13	11	3	16	0	1	0	71	1	7
9/ 5	11	8	5	6	4	14	6	3	10	0	1	0	68 ^a	1	6
9/ 9	7	3	1	8	8	11	9	10	5	1	1	0	62	2	6
9/13	10	3	4	7	2	19	4	3	4	1	0	0	56	1	5
9/17	7	1	2	6	6	13	5	4	4	0	0	0	48	0	4
9/21	9	6	9	8	4	10	6	5	2	2	1	0	59	3	6
9/25	7	5	5	10	4	11	6	7	5	1	1	1	60	3	6
9/29	12	5	3	10	6	13	5	4	3	0	0	0	61	0	6
10/ 3	10	2	6	7	2	8	8	1	6	1	2	1	50	4	5
10/ 7	17	6	9	9	4	12	8	5	2	3	0	0	72	3	7
10/11	15	1	20	4	2	9	9	5	8	4	2	0	73	6	7
10/15	20	2	17	10	2	5	9	11	3	2	1	0	79	3	8
10/19	24	1	11	7	2	9	8	4	4	4	2	0	70	6	7
10/23	13	0	23	6	0	16	8	4	9	3	2	0	79	5	8
10/31	27	9	19	10	6	9	12	6	4	2	1	0	102	3	10
11/ 4	26	10	22	2	1	4	13	7	6	3	0	1	91	4	9
11/ 8	36	4	15	5	7	7	10	9	7	3	3	0	100	6	10
11/12	40	5	22	3	2	10	8	9	4	2	3	0	103	5	10
11/16	35	12	23	6	5	12	5	8	7	3	2	2	113	7	12
11/20	32	11	29	10	5	9	7	6	7	1	3	0	116	4	12
11/25	24	5	31	6	11	10	11	9	14	5	1	0	121	6	12
12/ 3	23	8	18	6	3	15	10	3	9	4	3	3	95	10	10
12/ 9	31	2	18	3	5	9	8	8	7	3	1	0	91	4	9
12/16	25	13	8	12	5	5	9	5	3	1	2	0	85	3	8

Appendix C.--Continued.

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Gran
Tern Island--Continued															
12/18	7	7	3	13	5	15	6	8	3	2	0	0	67	2	6
12/23	9	9	4	12	6	12	4	6	6	1	2	0	68	3	7
12/30	18	15	5	3	5	10	7	6	2	3	3	1	71	7	7
Mean	13.4	6.0	10.5	8.2	6.0	14.1	8.1	6.4	9.0	.9	.5	.1	81.7	1.5	83
Trig Island															
4/ 7	3	4	0	1	1	1	3	4	4	0	1	0	21	1	2
4/16	0	3	2	0	0	0	1	1	3	0	1	0	10	1	1
4/22	0	1	0	1	0	1	1	0	0	0	1	0	4	1	5
4/26	2	1	2	1	0	0	3	2	2	0	1	0	13	1	1
5/ 4	4	2	1	0	1	0	3	3	1	0	0	0	15	0	1
5/11	3	1	0	0	2	2	0	4	2	0	0	0	14	0	1
5/18	1	3	3	0	1	4	5	3	3	0	1	0	23	1	2
5/23	3	3	2	1	1	2	1	4	8	0	1	0	25	1	2
5/30	1	0	0	1	0	3	3	5	9	0	0	0	22	0	2
6/ 6	0	2	3	0	0	1	0	1	1	0	0	0	8	0	8
6/12	1	1	0	1	1	0	1	1	4	0	0	0	10	0	1
6/15	3	0	1	0	0	2	1	2	4	0	0	0	13	0	1
6/17	1	0	1	0	1	1	2	0	3	0	0	0	9	0	9
6/22	0	0	2	0	2	3	1	1	3	1	0	0	12	1	1
6/25	3	5	3	1	3	4	2	4	0	1	0	0	25	1	2
7/ 5	2	2	7	0	0	2	0	0	0	0	0	0	13	0	1
7/ 8	2	1	2	0	1	2	3	1	3	0	0	0	15	0	1
7/15	0	0	2	0	0	1	0	1	2	0	0	0	6	0	6
7/18	0	1	2	0	0	0	1	0	1	0	0	0	5	0	5
7/22	2	3	3	0	2	1	4	2	3	0	0	1	20	1	2
7/24	3	3	2	1	0	1	2	3	0	0	1	0	15	1	1
7/30	0	4	4	1	1	1	1	5	2	0	0	0	19	0	1
8/ 4	4	2	3	1	0	2	0	0	0	0	0	0	12	0	1
8/12	0	1	1	0	0	0	3	1	2	2	0	0	8	2	1
8/16	0	2	0	1	1	0	6	2	1	0	5	0	13	5	1
8/21	0	1	0	0	0	5	2	0	2	0	1	0	10	1	1
8/23	1	1	2	1	1	2	1	3	5	0	0	0	17	0	1
8/29	2	4	3	1	2	2	1	2	7	2	2	0	24	4	2
9/ 4	0	3	1	2	0	2	5	3	1	0	2	0	17	2	1
9/ 8	1	1	0	1	2	0	4	2	2	0	0	0	13	0	1
12/ 3	12	10	0	0	2	5	3	2	3	2	3	1	37	6	4
12/18	1	5	5	2	0	5	3	2	1	4	0	0	24	4	2
Mean	1.7	2.2	1.8	.6	.8	1.7	2.1	2.0	2.6	.4	.6	.1	15.4	1.1	16

Appendix C.--Continued.

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Gran
Whale-Skate Island															
4/ 7	5	6	8	1	1	7	6	4	14	0	0	2	52	2	5
4/16	1	7	1	2	2	3	5	6	11	0	0	3	38	3	4
4/22	7	8	4	2	0	1	6	3	9	0	0	4	40	4	4
4/27	2	10	3	4	3	2	8	4	9	1	0	3	45	4	4
5/ 4	5	10	3	0	0	3	3	4	6	0	0	4	34	4	3
5/11	3	9	1	0	1	3	5	4	5	2	0	3	31	5	3
5/18	3	10	2	2	4	4	7	6	6	1	1	3	44	5	4
5/23	2	9	8	2	1	5	6	1	6	1	0	10	40	11	5
5/30	3	15	5	3	3	2	2	3	1	3	2	9	37	14	5
6/ 6	7	16	7	0	1	2	0	3	2	3	5	3	38	11	4
6/12	2	13	10	1	5	6	5	7	9	5	4	5	58	14	7
6/15	2	18	4	2	2	5	4	4	6	1	0	9	47	10	5
6/17	0	15	4	2	5	7	3	1	5	6	1	7	42	14	5
6/22	2	18	2	1	4	9	2	7	3	3	2	6	48	11	5
6/25	4	19	4	2	3	8	3	7	2	4	2	11	52	17	6
7/ 5	1	16	4	1	6	5	1	4	4	2	1	7	42	10	5
7/ 8	2	14	6	1	3	3	7	10	5	7	1	4	51	12	6
7/11	4	17	6	1	6	6	4	1	5	5	5	3	50	13	6
7/15	4	10	12	2	4	4	3	6	6	6	3	4	51	13	6
Whale-Skate Island--Continued															
7/18	2	12	4	3	7	2	5	3	6	6	3	6	44	15	5
7/22	4	12	3	3	2	1	7	8	5	7	2	4	45	13	5
7/24	3	11	4	1	2	7	7	2	7	11	7	0	44	18	6
7/30	1	16	7	6	5	2	9	6	4	10	7	3	56	20	7
8/ 1	2	17	11	0	3	5	5	8	11	9	6	4	62	19	8
8/ 4	3	11	6	2	3	5	9	5	6	8	5	0	50	13	6
8/ 8	5	15	9	2	4	7	10	6	10	7	4	4	68	15	8
8/12	2	11	5	1	5	3	12	8	9	9	8	1	56	18	7
8/16	4	10	4	0	3	4	7	10	13	5	5	2	55	12	6
8/21	4	8	4	2	3	3	10	7	9	5	5	2	50	12	6
8/23	1	9	0	3	4	5	13	6	8	8	8	0	49	16	6
8/29	1	12	2	0	1	2	9	9	13	6	5	1	49	12	6
9/ 4	5	9	4	7	3	3	13	11	6	6	7	3	61	16	7
9/ 8	3	8	2	3	1	4	9	7	10	13	6	1	47	20	6
12/ 3	14	5	1	1	2	5	3	6	2	6	2	1	39	9	4
12/18	5	8	7	4	1	7	10	4	7	5	4	0	53	9	6
Mean	3.4	11.8	4.8	1.9	2.9	4.3	6.2	5.5	6.9	4.9	3.2	3.8	47.7	11.8	59

Appendix C.--Continued.

Date	Adults			Subadults			Juveniles			Pups			Totals		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Gran
Unnamed Sand Spits															
4/ 8 ^c	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
4/16 ^d	0	1	7	0	0	3	0	0	0	0	0	0	11	0	1
4/22 ^d	0	0	6	0	0	5	0	0	3	0	0	0	14	0	1
4/26 ^d	0	0	5	0	0	4	0	0	0	0	0	0	9	0	9
5/ 4 ^d	0	0	2	0	0	1	0	0	0	0	0	0	3	0	3
5/ 5 ^e	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
5/11 ^d	0	0	2	0	0	2	0	0	2	0	0	1	6	1	7
6/17 ^d	0	0	1	0	0	3	0	0	2	0	0	1	6	1	7
6/22 ^d	0	0	1	0	0	1	0	0	3	0	0	0	5	0	5
6/25 ^d	1	0	0	0	0	3	0	0	2	0	0	0	6	0	6
7/ 5 ^d	0	0	2	0	0	1	0	0	0	0	0	0	3	0	3
7/ 8 ^d	0	0	0	0	0	1	0	0	1	0	0	0	2	0	2
7/15 ^d	0	0	0	0	0	1	0	0	2	0	0	0	3	0	3
7/16 ^e	0	0	2	0	0	2	0	0	3	0	0	0	7	0	7
Mean	.1	.1	2.3	0	0	1.9	0	0	1.3	0	0	.1	5.5	.1	5

^aTotal includes some seals which were not placed in any size class.

^bThree seals were seen in the water near La Perouse.

^cReef east of Mullet Island.

^dSand bar west of Trig Island.

^eSand bar south of Gin Island.

Appendix D.--Hawaiian monk seal necropsy reports, French Frigate Shoals, 1985.

NECROPSY NO.: FFS-85-1

DATE OF DEATH: Estimated 12 April 1985

DATE OF NECROPSY: 12 April 1985

ISLAND: East Island

SEX: Male

SIZE: Newborn pup

CIRCUMSTANCES OF DEATH: Freshly dead, most likely stillborn.

EXTERNAL DESCRIPTION: Placenta attached to pup; skin beginning to slip when pup was carried.

Measurements: Standard length (dorsal side up)--88.0 cm
Curvilinear length-----94.0 cm
Anterior length foreflipper-----20.0 cm
Anterior length hind flipper-----19.5 cm
Axillary girth-----46.5 cm
Blubber thickness (at sternum)-----0.5 cm

INTERNAL: Section of lung tissue did not float in water. Stomach contained yellowish liquid. No endoparasites observed.

SAMPLES COLLECTED: Adrenal, blubber, heart, kidney, liver, lung, muscle, pancreas, skull, spleen, stomach, testes.

Appendix D.--Continued.

NECROPSY NUMBER: FFS-85-3
DATE OF DEATH: Estimated 5-6 days prior to necropsy
DATE OF NECROPSY: 23 May 1985
ISLAND: Whale-Skate Island
SEX: Female
SIZE: Adult

CIRCUMSTANCES OF DEATH: Probable cause of death was infection due to massive dorsal wound. Seal was observed on 18 May with back wound, and may have been dead at that time. On 23 May seal was confirmed to be dead.

EXTERNAL DESCRIPTION: 56 x 26 x 2 cm dorsal wound to the muscle layer. Wound was infected and bleeding. Seal had natural bleach mark on left side behind foreflipper.

Measurements: Standard length (dorsal side up)--222.0 cm
 Curvilinear length-----N/A
 Anterior length foreflipper-----40.0 cm
 Anterior length hind flipper-----36.0 cm
 Axillary girth-----N/A
 Blubber thickness (at sternum)-----2.5 cm

INTERNAL: Stomach was empty except for brownish liquid.

SAMPLES COLLECTED: Endoparasites, ovary, skull; no other samples were collected because of decay.

Appendix D.--Continued.

NECROPSY NUMBER: FFS-85-6

DATE OF DEATH: Estimated 1-2 days prior to necropsy.

DATE OF NECROPSY: 18 June 1985

ISLAND: Little Gin Island

SEX: Male

SIZE: Adult

CIRCUMSTANCES OF DEATH: Postmortem autolysis was too severe for adequate histologic appraisal. Cause of death unknown.

EXTERNAL DESCRIPTION: Seal was very emaciated; 18 x 12 cm section of pelage was scraped away on dorsum; blood was present around mouth and nostrils.

Measurements:

Standard length (dorsal side up)	--203.5 cm
Curvilinear length	-----211.5 cm
Anterior length foreflipper	-----33.0 cm
Anterior length hind flipper	-----34.0 cm
Axillary girth	-----104.0 cm
Blubber thickness (at sternum)	-----1.3 cm

INTERNAL: Stomach was empty; ulcers were present in stomach lining; small amount of fluid in epididymides.

SAMPLES COLLECTED: Blubber, endoparasites, gall bladder, heart, kidney, liver, lung, muscle, pancreas, skull, spleen, stomach (ulcer), testes.

Appendix D.--Continued.

NECROPSY NUMBER: FFS-85-5

DATE OF DEATH: 22 June 1985 prior to 1000 hours

DATE OF NECROPSY: 23 June 1985, 0800 hours

ISLAND: Tern Island

SEX: Male

SIZE: Adult

CIRCUMSTANCES OF DEATH: On 22 June seal was sighted in the middle of the runway 80 m from the beach. Tracks indicated that the seal had moved in several directions and may have attempted to find its way back to the beach. By 1000 hours on 22 June the seal was most likely dead. Severe autolysis prevented most histologic appraisal, although atrophy and fibrosis of the exocrine pancreas was evident.

EXTERNAL DESCRIPTION: No visible wounds; right hind flipper was missing two distal lobes.

Measurements: Standard length (dorsal side up)--193.0 cm
 Curvilinear length-----203.5 cm
 Anterior length foreflipper-----34.0 cm
 Anterior length hind flipper-----37.5 cm
 Axillary girth-----108.0 cm
 Blubber thickness (at sternum)-----1.5 cm

INTERNAL: Stomach was empty except for brownish fluid; fluid present in epididymides.

SAMPLES COLLECTED: Baculum, blubber, endoparasites, kidney, liver, muscle, skull, skeleton, testes.

Appendix D.--Continued.

NECROPSY NUMBER: FFS-85-9
DATE OF DEATH: Estimated 1-2 days prior to necropsy
DATE OF NECROPSY: 9 September 1985, 1430 hours
ISLAND: Tern Island
SEX: Female
SIZE: Juvenile

CIRCUMSTANCES OF DEATH: Seal was observed at 1000 hours on 9 September and may have been dead at that time. Cause of death could not be ascertained, although evidence existed of nonspecific pathological change, including extreme splenic congestion and congested edematous lungs.

EXTERNAL DESCRIPTION: Seal was freshly molted; no apparent injuries were present. A dried scat was located near the seal's hind flippers. The seal appeared in good condition.

Measurements: Standard length (dorsal side up)--148.0 cm
 Curvilinear length-----152.0 cm
 Anterior length foreflipper-----25.0 cm
 Anterior length hind flipper-----28.0 cm
 Axillary girth-----80.0 cm
 Blubber thickness (at sternum)-----2.0 cm

INTERNAL: Stomach contained fish bones and parasites. Contents preserved in alcohol.

Appendix D.--Continued.

SAMPLES COLLECTED: Adrenals, bladder, blubber, brain,
endoparasites, heart, kidney, liver, lung, muscle, ovary, pancreas,
skeleton, spleen, stomach contents. One set of tissue samples was
frozen and one set was preserved in formalin. Scat was frozen.
