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Field Studies of Northern Sea Lions at Ugamak Island, Alaska During the 1985 and 1986 Breeding Seasons

by
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August 1988

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National Oceanic and Atmospheric Administration
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ABSTRACT

Field studies of northern sea lions (Eumetopias iubatus) were conducted at Ugamak Island, Alaska from 28 May to 10 July 1985, and from 15 June to 26 July 1986. These studies indicated that sea lion numbers on Ugamak Island, Alaska, declined by 85% from 1969 to 1986, and 20% between 1985 and 1986; Seven rookeries have been either abandoned or changed to haul-out status since 1969. The largest relative declines have occurred in juvenile numbers, while the largest absolute declines have occurred in numbers of adult females and pups. Pupping rates were high (0.96 and 1.06 per female) and pup mortality was low (3.4 and 4.5%). Male-to-female ratios (1:3.7 and 1:5.1) were similar to those observed at other sea lion rookeries... Diurnal and seasonal occupancy patterns were unchanged since, 1977-78. Adult females with pups spent 66% of their time ashore, after an initial 9.8 day postpartum period ashore. Females without pups spent more time at sea than those with pups. Suckling juveniles spent less time at sea than their mothers. One hundred and thirteen pups were tagged during the 1985 and 1986 field seasons. Debris surveys conducted in 1985 found little net and strapping materials on eight beaches surveyed. Five entangled animals were seen during the two seasons, a rate of 0.09-0.17%. Two dead adult sea lions were observed. Work was also done on food habits and validation of survey techniques.

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INTRODUCTION

A decline in eastern Aleutian Island northern sea lion (Eumetopias iubatus) abundance was first documented from surveys conducted during 1975-77 (Braham et al. 1980). Data from surveys conducted in 1985-86 indicated that this decline was continuing and had spread to other areas in southwestern Alaska (Merrick et al. 1987). Most of these data were gathered by aerial and ship surveys; however, Ugamak Island in the eastern Aleutian Islands has been the location for a series of on-land studies of northern sea lions.

Fiscus and Johnson (1968) surveyed major northern sea lion rookeries in the Aleutian Islands and determined that Ugamak Island would be the most appropriate site for future land-based sea lion studies in the eastern Aleutian Islands. They returned to Ugamak Island in 1969 to census animals (including pups) using rookeries on the island (Fiscus 1970). Personnel from the Marine Mammal Division of the National Marine Fisheries Service (NMFS) returned to the island in 1977-78 and conducted breeding season surveys of sea lion abundance (Braham et al. 1980). This latter work was also designed to test and validate sea lion survey procedures (Withrow 1982).

Field work conducted during the summers of 1985 and 1986 at Ugamak Island was designed to determine whether sea lion abundance at Ugamak Island was still declining. A variety of data was collected on the island's sea lions:

- 1) Age and sex of animals on land during the breeding season;

- 2) Numbers of pups born and mortality of pups in the first month postpartum;
- 3) Patterns of seasonal and daily abundance;
- 4) Ground truths of an aerial survey of the area; and
- 5) Adult female and juvenile feeding cycles.

Data were also collected on diet, amount of debris on beaches, incidence of entanglement, and degree of harassment of sea lions by aircraft and ships. Also, 113 pups were tagged as part of long-term studies of individual animal life histories.

This report documents the results of the 1985-86 fieldwork. Appendices I-III are provided to describe each rookery and its observation locations, a method for correcting pupping rate calculations, and a description of other mammals and birds seen.

METHODS

Site and Seasons

Ugamak Island is located approximately 110 km east of Dutch Harbor, Alaska, and adjoins Unimak Pass (Fig. 1). The 1985-86 field camp was located at the eastern end of the island, within 2 km of most of the sea lions. This location is within 0.5 km of the campsite used by Fiscus and Johnson in 1969, but on the opposite side of the island from the 1977-78 camp.

We define rookeries as sites where adult males actively defend territories and most females give birth and mate, while haul-outs are sites where few pups are born and where little mating takes place. For ease of observation and to facilitate

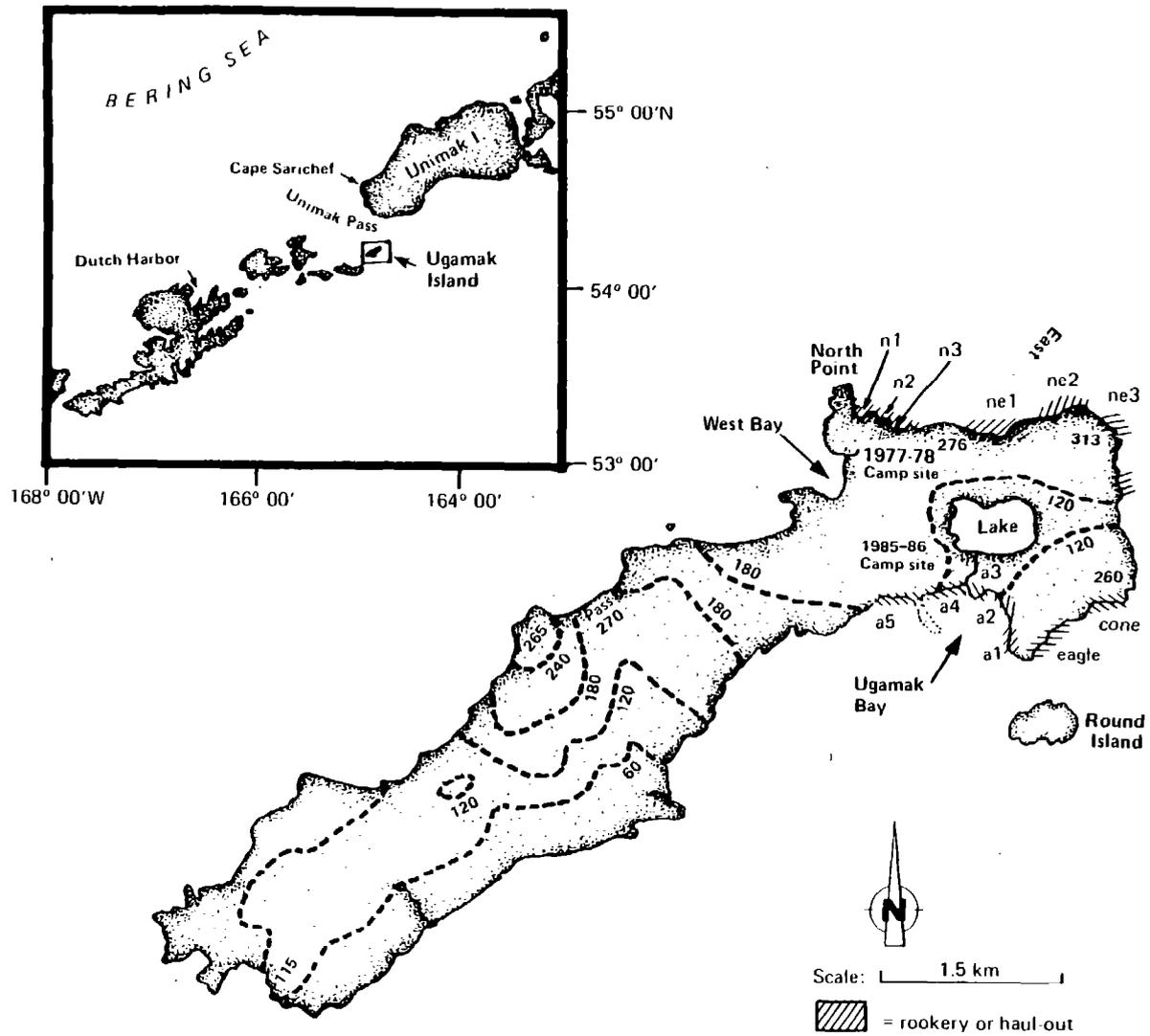


Figure 1. --Map of Ugamak Island, Alaska-study site.

analyses, sixteen separate haul-outs and rookeries (Fiscus 1970) were studied.

There has been significant change in the status and physical characteristics of many of the Ugamak rookeries since the 1968-69 and 1977-78 field seasons (Appendix I). Some of the rookeries have been altered by large rock slides (e.g., A2 and A5). Other sites which were previously denoted as rookeries are now haul outs (e.g., Cone, N2, A3) and a few sites have been abandoned altogether (e.g., N1, N3, NE3). As a result, only 10 of the 16 beaches identified by Fiscus (1970) were occupied in 1985-86:

- 1) South side - Ugamak Bay (A1,A2,A3,A4,A5), Cone, Eagle Point, and Round Island
- 2) North side - NE1 and NE2

Beach A4 was a rookery until 1985 but in 1986 contained only adult males.

Biologists were on the island from 28 May to 10 July 1985 and from 15 June to 26 July 1986. Transportation to and from the island was by commercial helicopter out of Dutch Harbor. Helicopter flights were routed over West Bay (Fig. 1) to avoid harassment of animals on the rookeries.

Abundance

Land-based counting was done from 31 May to 10 July 1985, and from 16 June to 26 July 1986 between 1200 and 1600 Alaska Standard Time (AST). A daily count was scheduled for the south side (Ugamak Bay) beaches. Only weekly counts could be made at

the north side beaches because of distance to the observation locations and the limited visibility there.

Inclement weather often reduced visibility and hampered observations on 14 of 41 days in 1985 and 27 of 41 days in 1986; however, except for one week in 1985, it was always possible to make one full island census each week.

Hourly counts were made between 0700 and 2400 AST on six days in 1986 (no hourly counts were made in 1985). A single site was counted on each day, with A2 counted thrice (21 June, 5 July, 19 July), A5 twice (28 June, 12 July), and NE1 once (9 July).

Animals counted in the daily and hourly counts were classified by age and sex:

- 1) Adult territorial males were sexually and physically mature males (probably age 10 or older) holding a territory containing females for at least part of the day;
- 2) Other adult males were sexually mature males (probably age 4 or older) not holding a territory with females;
- 3) Adult females were sexually mature females (probably age 4 plus);
- 4) Juveniles were immature animals (probably age 1 to 3 years) of either sex; and
- 5) Pups.

Visibility and time permitting, juveniles were classified by sex. Females were classified by reproductive status (i.e., with or

without a pup) during counts made the last week of June 1986.

Counts were made using 7x35 binoculars, a 15-60 power zoom spotting scope, and the unaided eye. Observation posts were located on cliffs above the beaches (Appendix I). Sea lions at beaches NE1 and NE2 were initially counted in 1985 from the cliff above N2 beach (as was done in 1977-78). This long distance view precluded counting animals by sex or age class. Observation locations were found above NE1 and NE2 in the last week of June 1985, and counts were then made for all five sex and age categories.

Pups (alive and dead) were counted from the cliffs as part of the daily census. To test the accuracy of those counts, special pup counts ("spook counts") were made in 1985 on rookeries A2, A4, and A5 after all adult animals were cleared off the beach. Counters (four at A2 and two elsewhere) then walked the beach counting live and dead pups.

Pupping rates were calculated by dividing the maximum number of pups (alive and dead) observed during the season by the maximum number of adult females counted. This overestimates the rate because some females are at sea even at times of peak abundance. A pupping rate adjusted for these missed females was calculated by the method described in Appendix II.

Finally, an aerial photographic survey of the island was conducted on 10 June 1985 as part of a northern sea lion survey of southwestern Alaska (Merrick et al. 1987). Ground counts were conducted simultaneous to the overflight to compare the accuracy

of the two census techniques. Photographs were made of sea lion concentrations using a hand held 35 mm camera with a 70-210 mm zoom telephoto and motor drive. Photographs taken (Ektachrome ASA 200 film¹ were later developed into slides. These slides were projected onto white paper and the number of adult and juvenile sea lions counted (Braham et al. 1980).

Adult Female and Juvenile Feeding Cycles

We collected data on feeding cycles (the combination of time spent at sea on a feeding trip and the subsequent time spent onshore prior to the next trip) by two methods. The number of adult females moving to and from sea at beach A2 were logged for 2 to 4 hours each day from 20 June to 5 July 1985 for a total observation period of 41.5 hours. Group size and the direction of travel away from the beach were also recorded.

We also monitored the movements of individually recognizable adult females at A2 beach between 4 June and 3 July 1985 (n = 19) and between 17 June and 26 July 1986 (n = 31). Animals were identified either from natural marks (e.g., scars and fungal patches) or by marking them with black Nyansol-D dye. Forty of these animals had pups, three were accompanied by yearlings, two had both, and five were alone. The remaining animals' locations were recorded two to four times a day between 0700 and 2400 AST for each day of the survey. A history card (Merrick 1987) was maintained for each animal which described the

1/ Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

a

animal's marks, whether or not she had a pup, pertinent life history events, and her location at the time of each census.

Any female seen on the rookery once in a day was assumed to be there for the whole day. However, some females were observed to depart only during the evening and return early the next morning.

Four juveniles at A2 were followed through the 1986 season to determine the time juveniles spent on land and at sea. Observation procedures were the same as used with adult females.

Other Fieldwork and Observations

Pup tagging

Four pups were tagged on 6 June 1985 on A4 as a pilot test of the effects of tagging on northern sea lion pups. Each was double-tagged using Allflex double medium tags with red for females (Nos. 1 and 2) and white for males (Nos. 101 and 102). Animals Nos. 1 and 101 were bleach marked on the head using Miss Clairol Seventh Stage hair lightener. These four animals were observed for the next 19 days to determine the effect of tags and bleach marks on pup behavior and health. Another 48 females (Nos. 3-50) and 48 males (Nos. 103-150) were tagged and bleached on 26 June 1985 at A2.

Nine male and four female pups were double tagged on A5 in 1986, five on 13 July and eight on 20 July. Tagging was performed as in 1985 with females tagged Nos. 151-154 (red) and males Nos. 51-52 and 54-60 (white).

Scat collection

Sea lion fecal material (scat) was collected in 1985 (n = 24) and 1986 (n = 12) for food habit analysis. Each sample was individually bagged and labelled when collected. Scats were soaked for several days in a mixture of dishwashing detergent and water, and once emulsified were filtered through three nested sieves (4.75 mm, 1.4 mm, 1.0 mm) to retrieve hard parts for identification (Treacy and Crawford 1981).

Debris surveys

Debris surveys were conducted at beaches A1, A4, Eagle Point, N1, N2, Braham's Bay, and West Bay. These beaches were selected because of ease of access and the lack of sea lions on the beaches at the time of the survey. Beach surveys involved walking a beach and recording the size and amount of debris found using methods of Merrell (1985).

Other observations

Entangled and dead adult sea lions, vessels, other marine and terrestrial mammals, and avifauna were recorded when seen.

RESULTS

Abundance

Adults and Juveniles

The island's maximum daily counts of adult and juvenile northern sea lions occurred in the last week of June through the first week of July with 2,185 and 1,751 animals recorded in 1985 and 1986, respectively (Table 1). Declines in numbers between

1985 and 1986 were due to a decrease in the number of adult females (-26.2%).

The most abundant group on the island was adult females-- 1,765 (80.8%) in 1985 and 1,302 (74.4%) in 1986. There were 333 (15.2%) adult males in 1985 and 349 (19.9%) in 1986. Juvenile numbers included up to 87 animals (4.0%) in 1985 and 100 (5.7%) in 1986. Increases in juvenile numbers between 1985 and 1986 were probably an artifact due to more frequent counting on the north side in 1986, as south side numbers indicated a decline from 1985 to 1986 (Table 2 and 3).

Nearly two-thirds of the island's sea lions were found on the six south beaches, where maximum numbers were 1,509 and 1,221 animals in 1985 and 1986, respectively (Table 2). Maximum numbers on the north side were 690 and 700 in 1985 and 1986, respectively (Table 3).

Sex ratios for all adult animals were 1:5-1 male per females in 1985 and 1:3.7 in 1986. The ratios of adult territorial males to adult females were 1:14.6 and 1:16.4 in 1985 and 1986, respectively.

Ratios of juveniles to females averaged 3.3 per 100 females in 1985 and 7.6 per 100 females in 1986. Most of these juveniles appeared to accompany adult females, and thus can be assumed to be unweaned. Both male and female juveniles were observed on beaches A1, A2 and A5, with males making up 67-75% of the small (11-14 animals) number of juveniles on A2 (the only beach where most juveniles were classified by sex). Two males tagged

Table 1. --Ugamak Island weekly maximum counts of northern sea lions by age and sex classes for total island, 1985 and 1986 field seasons.

Date	<u>Adult male</u>			Adult female	Juv.	Total all	<u>Pups</u>		
	Terr.	Other	Total				Live	Dead	
1985:									
June	3- 9	na	na	na	na	na	1,169	na	na
	10-16	97	162	259	na	na	2,004	na	na
	17-23	na	na	311	na	na	2,164	1,037+	na
	24-30	117	216	333	1,765	87	2,185	1,492	34
July	1- 7	na	na	na	na	na	na	na	na
	8-14	71	88	159	1,138	45	1,342	1,580	58
1986:									
June	10-16	nc	nc	nc	nc	nc	nc	nc	nc
	17-23	95	230	325	1,269	92	1,686	989	17
	24-31	98	225	323	1,250	91	1,664	1,174	33
July	1- 7	81	268	349	1,302	100	1,751	1,254	48
	8-14	59	276	335	1,121	94	1,550	1,333	53
	15-21	49	172	221	1,011	87	1,319	1,268	59
	22-28	na	265	265	1,311	85	1,661	1,252	62

nc = no count

na = not available

Table 2. --Ugamak Island *weekly maximum counts of northern sea lions by age and sex classes for south side of island, 1985 and 1986 .field seasons.

Date	<u>Adult male</u>			Adult female	Juv.	Total all	<u>Pups</u>		
	Terr.	Other	Total				Live	Dead	
1985:									
June	3- 9	34	122	156	708	68	932	322	14
	10-16	76	128	204	1,133	68	1,405	728	23
	17-23	83	162	245	1,188	76	1,509	864	29
	24-30	79	156	235	1,188	72	1,495	964	32
July	1- 7	66	74	140	1,072	37	1,249	960	35
	8-14	47	40	87	634	29	750	905	35
1986:									
June	10-16	48	160	208	906	63	1,177	395	2
	17-23	57	184	241	911	57	1,221	574	13
	24-30	63	172	235	848	52	1,135	730	22
July	1- 7	55	164	219	810	60	1,089	717	25
	8-14	44	156	200	825	63	1,088	795	28
	15-21	36	77	113	650	53	816	741	31
	22-28	na	151	151	759	51	961	719	34

na = not applicable

Table 3. --Ugamak Island weekly maximum counts of northern sea lions by age and sex classes for north side of island, 1985 and 1986 field seasons.

Date	Adult male			Adult female	Juv.	Total all	Pups		
	Terr.	Other	Total				Live	Dead	
1985:									
June	3- 9	na	na	na	na	na	237	na	na
	10-16	21	34	55	na	na	599	na	na
	17-23	na	na	66	na	na	655	173+	na
	24-30	38	60	98	577	15	690	528	2
July	1- 7	na	na	na	na	na	na	na	na
	8-14	24	48	72	504	16	592	675	23
1986:									
June	10-16	nc	nc	nc	nc	nc	nc	nc	nc
	17-23	30	58	88	421	29	538	415	4
	24-30	33	56	89	531	32	652	444	11
July	1-7	26	104	130	492	40	662	537	23
	8-14	18	111	129	409	37	575	538	25
	15-21	13	95	108	361	34	503	527	28
	22-28	na	114	114	552	34	700	533	28

nc = no count

na = not available

as pups in 1985 (No. 25 red and No. 126 white) were observed in 1986. Animal No. 25 (which was missexed in 1985) spent the entire season at A2 and A3 beaches, while animal No. 126 was observed to haul out at A1, A2 and A5. Both animals appeared healthy and robust and animal No. 25 was still suckling.

Pups

At least 1,638 and 1,386 pups were born in 1985 and 1986, respectively (Table 1). The uncorrected pupping rate (pups per female) for the island was 0.93 in 1985 and 1.06 in 1986. An 18% decline in total island pup production occurred between 1985 and 1986. Declines were observed at A1 (-22%), A4 (-100%), and A5 (-17%), with Eagle Point remaining constant, and numbers increasing by 17% at A2.

Observed pup mortality on land was at least 3.4% (n = 58) through 10 July 1985 and 4.5% (n = 62) through 26 July 1986. We feel this approximated true mortality during this period because of the considerable amount of time we spent looking for dead pups, and because it took more than a week for a carcass to be scavenged or to decompose. However, it was possible that some unobserved mortalities occurred at sea because pups had begun to swim in the ocean by the first week of July.

Three spook counts of live pups conducted in 1985 produced:

- 1) One count lower than the cliff count (beach A2 = 386 from spook count and 447 from cliff count), and
- 2) Two counts somewhat higher than the cliff counts (A4 = 272 vs 259, A5 = 309 vs 273).

On 23 June 1986 (the only day when a full island count of females with and without pups was made) 962 (75.8%) of the 1,269 females on the island that day appeared to be with pups. Only 81 (7.8%) of the 1,043 pups appeared unattended. Rookeries with the greatest percentage of females with pups (Eagle Point--76.9% and A2--82.7%) had few juveniles (zero and eight, respectively). Rookeries with the lowest percentage of females with pups (A1--51.6% and A5--57.6%) had the most juveniles (24 and 31, respectively). The two north side rookeries, NE1 and NE2, had intermediate numbers of females with pups (63.5% and 61.8%), and intermediate numbers of juveniles (17 and 12).

Diurnal and Seasonal Patterns

Adult and juvenile sea lions peaked in abundance during the last 2 weeks of June and first week of July in 1985-86 (Fig. 2). This was followed by declining numbers, and then a second peak (at least in 1986) in the fourth week of July. This second peak was seen on only 1 day during that week and was due to an influx of adult females. Similar patterns were apparent on the south and north sides of the island (Tables 2 and 3).

Juvenile abundance followed a pattern similar to the abundance as a whole, with a peak in the first week of July followed by a decline (Tables 1, 2, and 3). A second peak of juvenile abundance was not evident.

Viable births occurred prior to 31 May (the first day of observations in 1985) and continued through 6-7 July. Median pupping dates (the date by which one-half of all pups are born)

on the south side of the island were 12 June in 1985 and 15 June in 1986. The median date for the north side was 18 June in 1986, and could not be determined for 1985. At least 90% of the pups seen on the island were born by the last week of June.

Hourly count data from 1986 indicated that at least 90% of the peak number of animals on a rookery was ashore between 1000 and 2100 AST (Fig. 3). This period of stability was preceded in the morning by a period of increasing abundance and followed in the late evening by a period of sharp decline. Similar patterns were found at all beaches surveyed and for both adult females and juveniles. However, juvenile numbers changed less through the day. Numbers of territorial males remained relatively constant throughout the day.

Aerial Survey Results

The 1985 aerial survey of the island conducted on 10 June produced a count of 1,456 adult and juvenile animals (Table 4). The simultaneous ground count found 1,684 animals, a difference of 13.4%. Most of the difference was due to an under count from the aerial photography of the A4 and A5 rookeries (not all of the beaches were photographed). If A4 and A5 are excluded the difference was 3.6%.

Despite this accuracy, the aerial photo count of 10 June 1985 was 24% lower than the maximal ground count of 25 June 1985. This bias was likely a consequence of the aerial survey occurring slightly before the period of peak abundance.

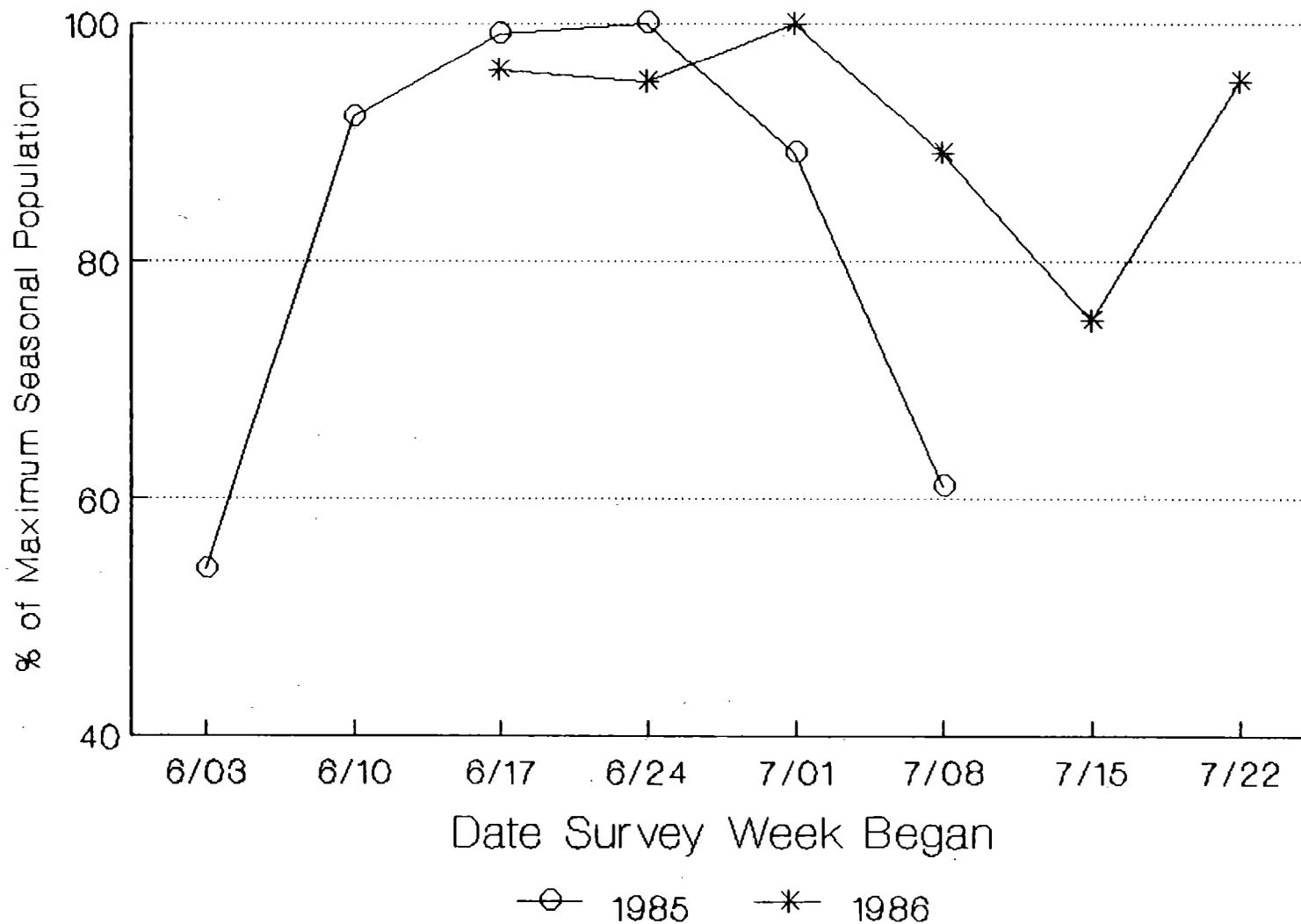


Figure 2.--Percent of maximum seasonal population of adult and juvenile northern sea lions by week for Ugamak Island during the 1985-86 field seasons.

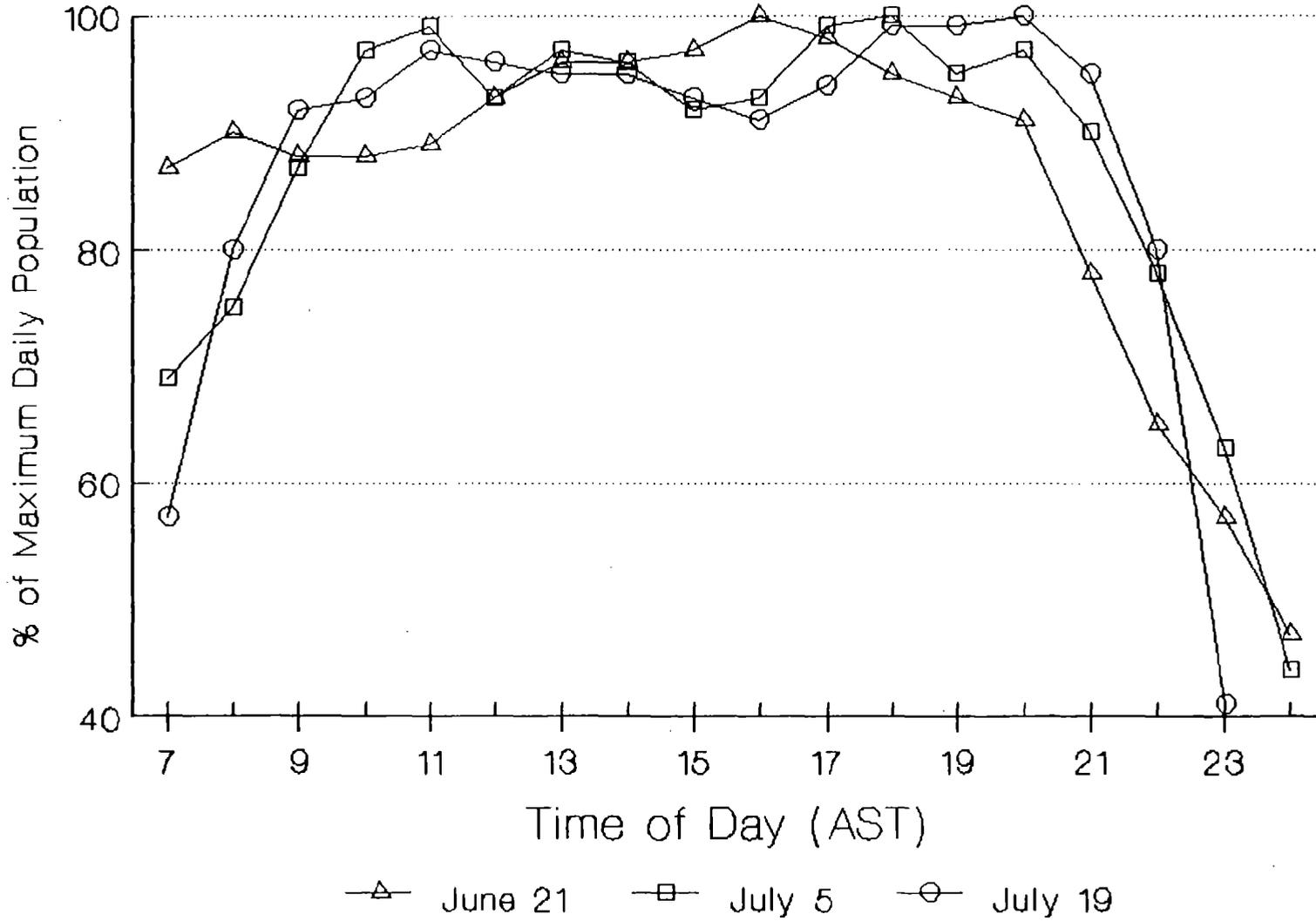


Figure 3.--Diurnal occupancy patterns of adult and juvenile northern sea lions observed at A2 rookery on Ugamak Island during 1986.

Table 4. --Ground counts and aerial survey counts of adult and juvenile northern sea lions observed at Ugamak Island on 10 June 1985. Excludes sites not counted in ground counts.

Location	Time of ground count	Ground count	Aerial count
N1	12:45	0	0
N2	12:45	15	0
N3	12:45	2	0
NE1	11:30	299	330
NE2	12:58	<u>327</u>	<u>314</u>
Subtotal	-	643	644
RI	16:35	23	74
CO	16:30	66	62
EP	16:10	75	64
A1	15:10	122	115
A2	15:30	338	355
A3	14:45	5	6
A4	14:45	138	nc
A5	13:50	<u>274</u>	<u>136+</u>
Subtotal	-	1,041	812+
Total	-	1,684	1,456+

nc = no count

Adult Female and Juvenile Feeding Cycles

Adult females began arriving from sea prior to our first observations during the day (Fig. 4). This was followed by a hiatus between 1000 and 1900 AST. There was then a rapid exodus to sea beginning around 2000 AST, with the number of females departing increasing from 5 to 35 animals per hour. These observations match those of the hourly counts (Fig. 3).

Of 164 adult females observed arriving onshore, 138 (84.1%) were alone (Table 5). Average group size for arrivals was 1.1 animals ($n = 149$ groups, range = 1 to 3 animals). The departure pattern was different, because females typically formed small groups at the waters edge before leaving. Only 59 (18.1%) of 326 departing females were observed to depart alone. Average departing group size was 2.6 animals ($n = 126$ groups) with a range from 1 to 15 animals.

Fifty known females observed in 1985-86 made 195 trips of one day or more in duration, and at least 97 trips of less than one day (Table 6). Patterns of absence and presence were similar for the 2 years. The only notable difference between years was that six of the 1985 females made only short trips (less than one day) while all of the 1986 females made trips of more than one day. This difference in results may have been due to the early termination of observations in 1985 (10 July) as compared to 1986 (27 July).

Analysis of the frequency of short trips indicated that these trips occurred most frequently in the first feeding cycles

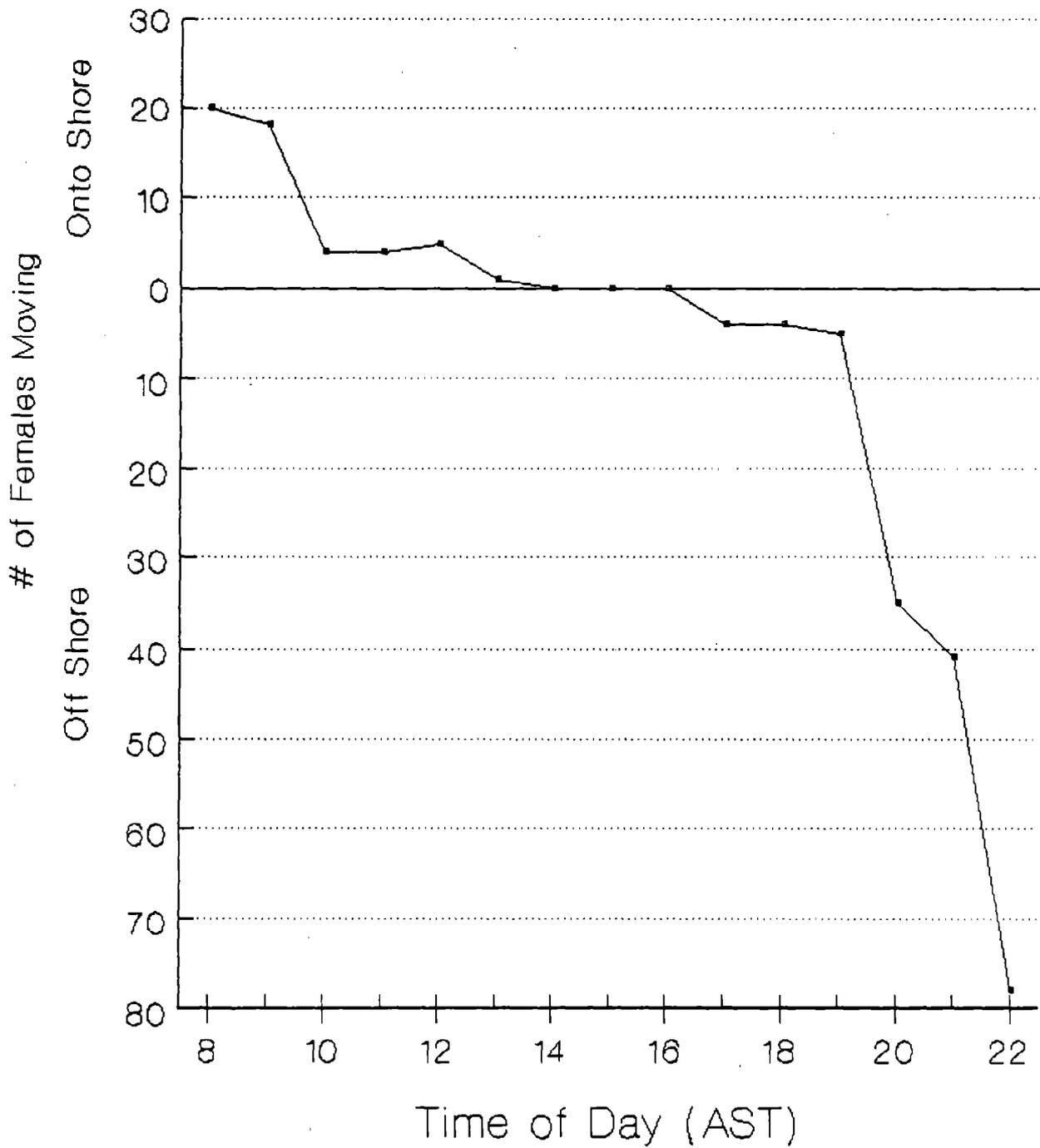


Figure 4.--Diel movement patterns of adult female northern sea lions to and from A2 rookery on Ugamak Island during the 1985 field season.

Table 5.--Group size for arriving and departing adult female northern sea lions at Ugamak Island during 1985.

Group Size	Arrivals		Departures	
	No. of Groups	No. of Females	No. of Groups	No. of Females
1	138	138	59	59
2	7	14	24	48
3	4	12	14	42
4	0	0	16	64
5	0	0	3	15
6	0	0	2	12
7	0	0	2	14
8	0	0	3	24
9	0	0	1	9
14	0	0	1	14
15	<u>0</u>	<u>0</u>	<u>1</u>	<u>15</u>
No. groups	149	-	126	-
No. animals	-	164	-	326
\bar{x} group size	1.1		2.6	

Table 6. --Duration (days) of adult female northern sea lion visits and trips to sea at Ugamak Island during 1985 and 1986. Excludes marked females not observed for more than one feeding cycle.

Year	Female type	<u>Time to first trip</u>		<u>Duration of trips</u>		<u>Duration of visits</u>	
		n	Ave.	n	Ave.	n	Ave.
1985	With pup ^{a/}	9	10.6	63	1.1	61	2.3
	With juvenile	1	5.8	6	1.3	5	1.6
	With both	1	3.0	4	0.4	2	2.9
	Alone	-	-	-	-	-	-
1986	With pup ^{a/}	10	9.0	175	1.2	167	2.2
	With juvenile	2	4.2	16	1.4	16	1.3
	With both	1	2.0	13	1.1	13	1.1
	Alone	5	2.6	15	2.8	15	1.3
All	With pup	19	9.8	238	1.2	228	2.3
	With juvenile	3	4.7	22	1.4	21	1.4
	With both	2	2.5	17	0.9	15	1.4
	Alone	5	2.6	15	2.8	15	1.3

^{a/} Excludes females with pups whose date of parturition was unknown.

postpartum (Fig. 5). Thus in 1985, if we had continued to observe the six females after 10 July, they too may have begun to make longer trips.

Female movements varied with maternal status (Table 6). For 19 females whose date of pupping was known, the time to the first trip postpartum was 9.8 days. Their average trip duration was 1.2 day while the average visit onshore was 2.3 days. Overall and excluding the postpartum period onshore, these females spent 66% of their time onshore. Females with pups spent progressively less time onshore through the third week postpartum (Fig. 6). The proportion of time onshore then appeared to stabilize through the fifth week.

Limited data available for solitary females and females with juveniles types indicated they spent 32-61% of their time onshore (Table 6). Lone females spent the least time onshore (mean = 1.3 days), and the most at sea (mean = 2.8 days). Females with juveniles were intermediate to lone females and those with pups.

One yearling (1985 tag No. 126) hauled out on 9 days of an 18 day observation period, alternately occupied A1 (3 days), A2 (2 days) and A5 (4 days). Three other juveniles were observed only at A2. These were all suckling, and spent an average of 89.8% of their time at A2. One individual (No. 11) seemed to accompany his mother to sea. He was absent from beach A2 for four, 1-day periods which coincided with his mother's absences during a 13-day observation period. The two other juveniles

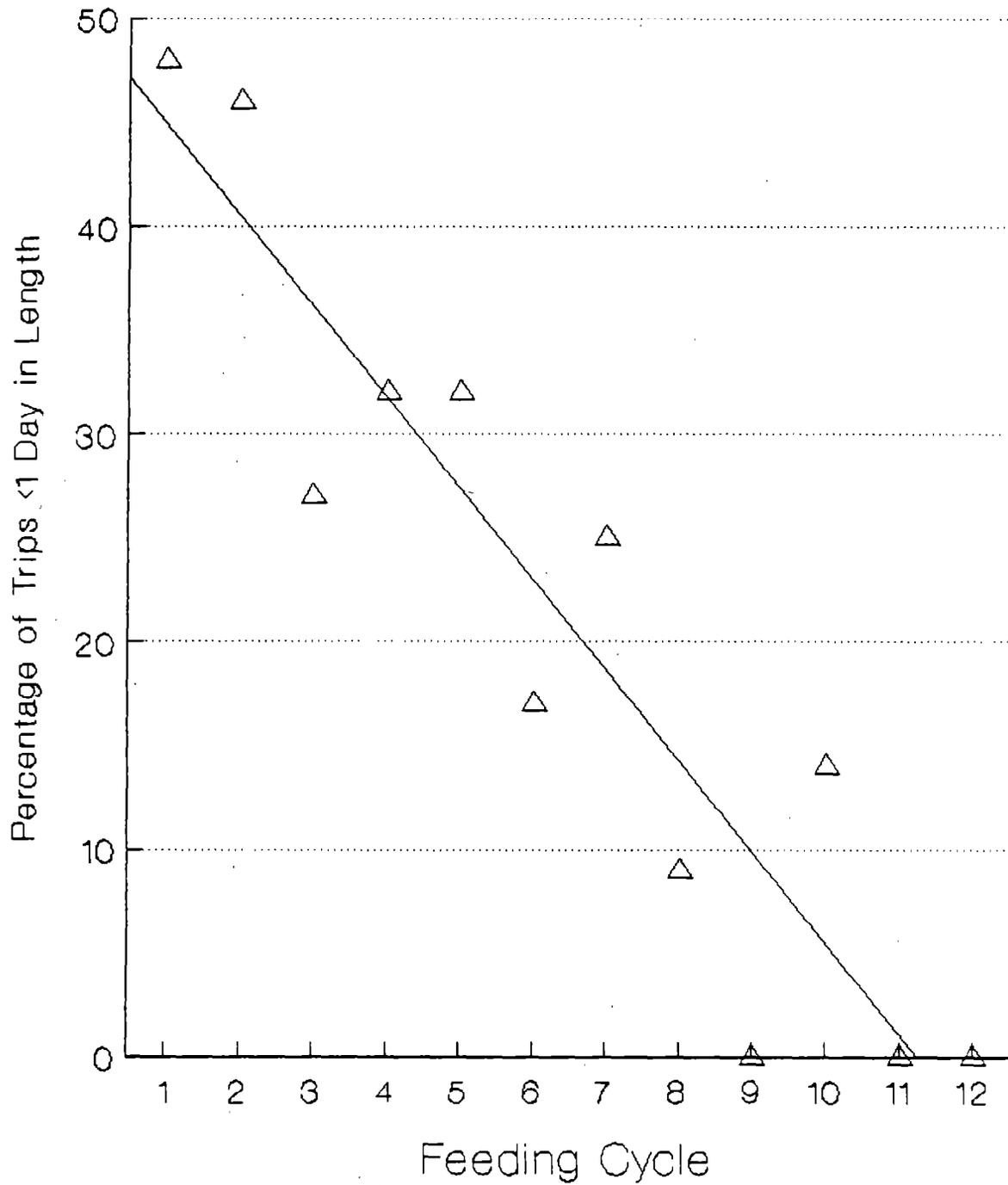


Figure 5.--Frequency of trips shorter than 1 day in duration made by adult female northern sea lion feeding cycle as observed at Ugamak Island during the 1986 field season.

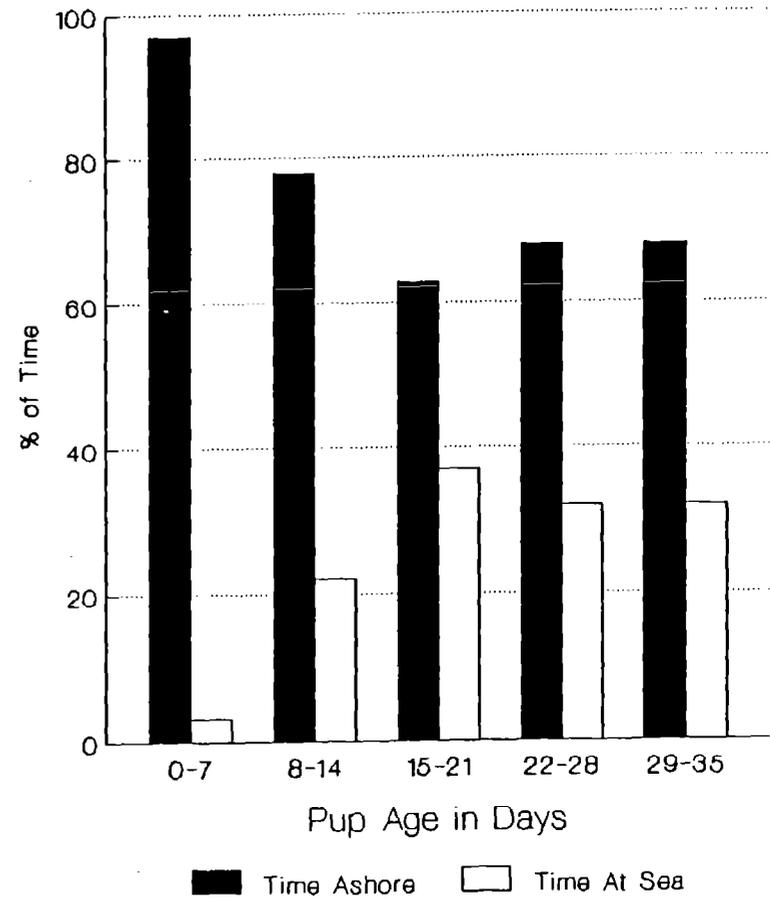
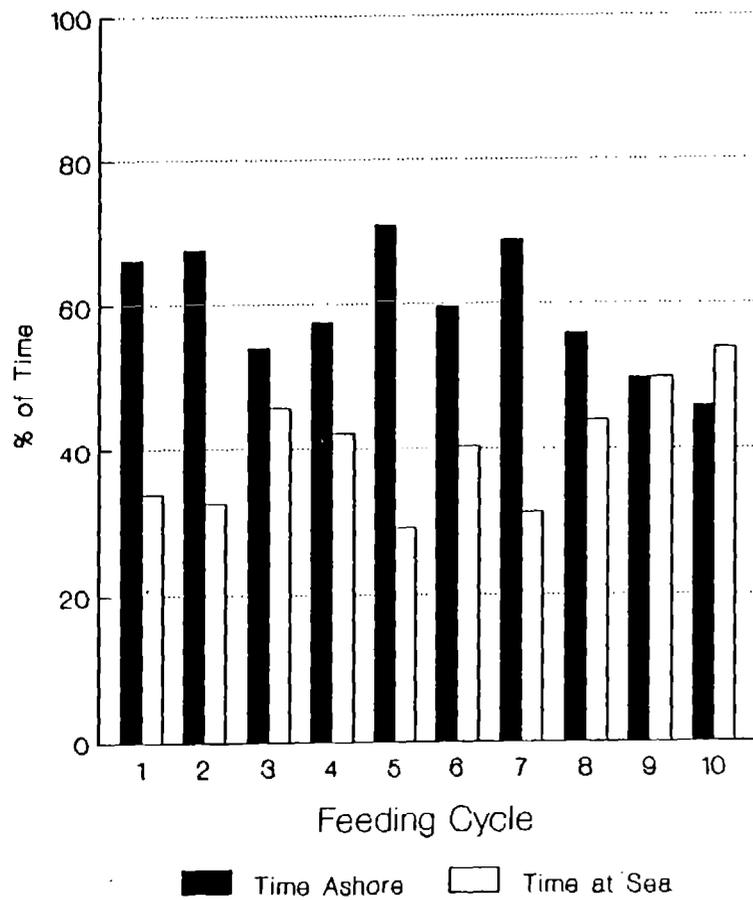


Figure 6.-Amount of time adult female northern sea lions with pups spent on and off shore at Ugamak Island during the 1986 field season by a) feeding cycle and b) age of pup.

were observed over a 37-38 day period and remained at A2, with the exception of one long absence (>1 day) each and short overnight trips, 4 and 2, respectively.

Other Fieldwork and Observations

Pup Tagging

Three of the four pups tagged on 6 June 1985 appeared to behave normally during the 20 days of their observation. Pup No. 102, however, drowned 2 days after tagging. The death did not appear tag related. The remaining three animals were recaptured and examined the morning of 26 June. Neither the tag nor the bleach mark had caused any trauma. Thus it was agreed to proceed with tagging 96 more pups that afternoon.

Pups appeared robust and healthy. Tagged pups were observed during the remainder of the 1985 survey period to determine their reaction to the tags and bleach. These pups were counted each day as part of the regular pup count, with a high of 63 tagged pups recorded on 3 July 1985. About half of the pups had retained obvious bleach marks. Marks on the remainder were washed off by rain on the tagging day or because they went to sea before the bleach had set. Indeed, two tagged pups swam with their mothers from A2 to A4 on the tagging day. The only mortality among the remaining 99 tagged pups was No. 31 who was observed dead on 3 July; cause of death was unknown.

Pup tagging in 1986 was limited to 13 animals because of insufficient personnel and the absence of animals at A4 (the preferred site for tagging). Pups again appeared healthy. The

single exception was animal No. 59, who seemed thin and weak.

The Allflex tags worked well. They went on easily, stayed on for least 1 year with some animals (the 1986 resightings of 1985 tagged pups), and were readable at 1 year.

Scat Collection

Twenty-four scats were collected in 1985 and 12 in 1986. Most contained fish remains, seven with otoliths. Most of the otoliths were from walleye pollock (Therasra chalcogramma).

Debris Surveys

Little net, rope, or banding materials were found on beaches A1, A4, Eagle Point, N1, N2, Braham's Bay, and West Bay in 1985 (Table 7). Seventy percent of the debris was found at West Bay, which represented less than 43% of the area surveyed, an indication of the patchiness of the distribution of debris.

Entangled Animals

Two entangled animals were observed in 1985 and three in 1986, which yielded entanglement rates of 0.09% and 0.17%. A 6 to 10-year-old nonterritorial male with a packing band or line around its neck was seen on A2 on 8 June 1985. A 3-to 4-year-old female with what was probably a packing band around her neck (the neck was swollen around the band) was seen on A5 on 3 July 1985. Aside from necrosis around the male's wound, both appeared healthy and acted normally.

An adult (4+ years old) female was observed on A2 between 17 June and 14 July 1986, with an open, necrotic wound at the base of the skull. No netting or banding material was observed around

Table 7. --Summary of debris found at Ugamak Island in 1985 for each beach surveyed.

Location	Survey date	Length (m)	Substrate	<u>Pieces of debris found</u>			
				Net	Band	Rope	Float
N1	6/01	201	Small boulder and cobble	1	0	1	3
Braham Bay	6/01	nm	Boulder	nc	nc	nc	19
N1A	6/01	nm	Large boulder	1	nc	nc	6
N2	6/01	nm	Small boulder and cobble	0	0	3	8
A4	6/08	262	Small boulder and cobble	0	0	9	37
A1	6/15	123	Cobble	1	0	0	4
Eagle Pt.	6/15	163	Cobble	0	0	0	40
West Bay	7/04	610	10% large boulder with cobble and small-medium boulder on rest	7	19	111	169
Total	-	<u>1,426+</u>	-	<u>10</u>	<u>19</u>	<u>124</u>	<u>286</u>

nm = not measured

nc = not counted

the neck. The animal's behavior appeared relatively normal, although she seemed to avoid contact with other females (e.g., she went off to feed alone). A young adult (6 to 10-years-old) male was observed at several beaches (A2, Eagle Point, NE1, and NE2) between 3 July and 11 July. This animal had a neck wound surrounding a white band. The wound was necrotic with the skin swollen at the edge. He seemed to relate normally to other males. Finally, a young (1 to 2-year-old) suckling male with a neck wound was observed on NE2 between 9 July and 25 July. Again, no netting or banding material was observed around the neck. Its behavior also appeared normal.

Dead Adult Animals

No dead adults were observed in 1985, but two were seen in 1986. A dead adult male sea lion was observed on A5 beach between 12 July and 23 July. This animal was not available for close inspection on the two days that we visited the beach, so cause of death was unknown. The second dead animal was an adult female with a juvenile. She was observed on 29 June on A5. We assumed she had been shot because of the blood draining from her head.

Vessel Traffic

Six boats and two aircraft approached the island during the two field seasons. Only one of these resulted in major harassment of sea lions in Ugamak Bay.

DISCUSSION

Trends in Abundance

The first aerial counts of the Ugamak Island sea lion population were made by Mathisen and Lopp (1963) in the fall of 1956 when 14,536 adult and juvenile sea lions were observed. At least 10 additional aerial surveys of the site have been conducted since then. Review of these surveys revealed that the island's northern sea lion numbers were stable until at least 1968; however, surveys conducted in 1975-77 indicated that numbers had declined to about 5,000 animals (Braham et al. 1980). The June 1985 aerial survey showed that numbers had declined to 1,456 animals.

Our on land studies confirm the aerial survey results (Fig. 7). Northern sea lion numbers at Ugamak Island declined 85% between 1969 and 1986, and 20% between 1985 and 1986. Declines have occurred at all rookeries on the island (Table 8). Numbers declined on both sides of the island by 64-66% between 1969 and 1977. Declines on the south side, especially in Ugamak Bay appeared to moderate after 1977, while declines on the north side continued. By 1985, two south side sites (A3 and Cone) and four north side sites (N1, N2, N3, and NE3) were no longer in use as rookeries. A seventh rookery (A4) was abandoned by adult females between 1985 and 1986. Declines have occurred since 1985 in adult and juvenile numbers at Eagle Point (-18%), A4 (-88%), A5 (-11%), and NE1 (-28%), while numbers remained constant at A1, and increased by 11% at A2 and 12% at NE2.

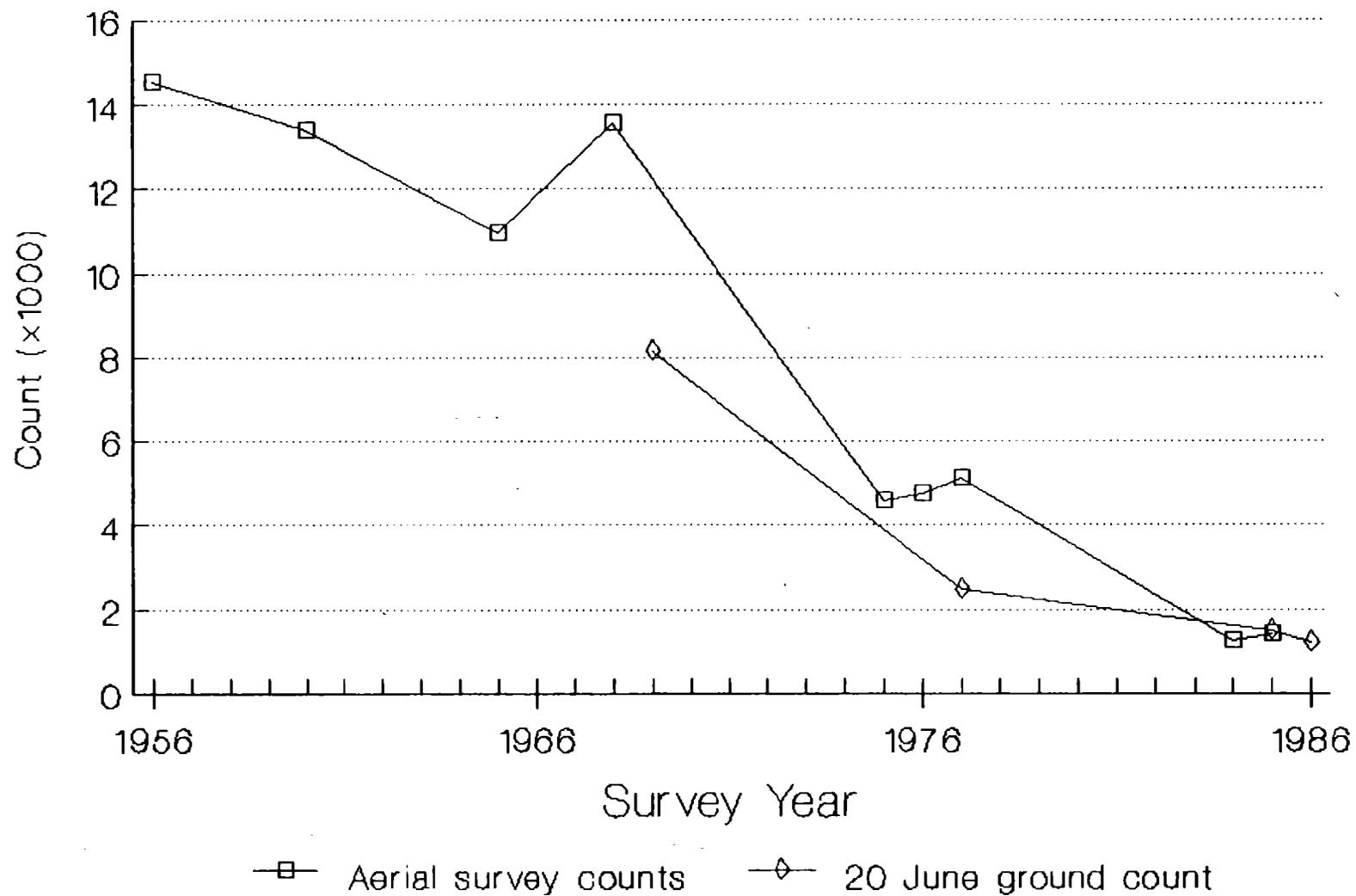


Figure 7.--Trends in the abundance of adult and juvenile northern sea lions at Ugamak Island from 1956 to 1986.

There has also been a change in the utilization of rookery space since 1985, because some females that pupped at A4 in 1985 must have survived to pup at Ugamak Island in 1986, but chose another site for pupping (e.g., A2). This may also have happened on the north side, since animal numbers declined at NE1, but increased at NE2. This suggests that some females do not show fidelity to a specific beach for pupping, and that there may be preferred sites for pupping (e.g., NE2 and A2). Thus, a declining population may abandon a rookery beach in preference for another, rather than reducing its density uniformly throughout all sites. This may explain the abandonment between 1978 and 1985 of the North Bay, Cone and A3 rookeries.

Although since the late 1960s rookeries have declined in size and number, and decreases have been observed in all sex and age classes, the ratio of adult females to adult males has remained relatively constant between 1977-78 (1:4.5; Withrow 1986:25 and 1985-86 (1:3.7 and 1:5.1).

An analysis of comparable areas of the island (e.g., N1-N3 and AZ-A4) indicates that the juvenile portion of the population decreased significantly ($\chi^2 = 4.09$, $p < 0.05$) from 9.0% in 1977 to 1.4-1.6% in 1985-86. Comparably low proportions during the breeding season have been observed only at Ano Nuevo Island, California in 1967-69 (2%: Gentry 1970) and Sugarloaf

2/D. Withrow, unpubl. data. Northwest and Alaska Fisheries Center, National Marine Mammal Laboratory, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Seattle, WA 98115.

Table 8. --Comparison of counts of adult and juvenile northern sea lions on Ugamak Island on or around 20 June.

Location	<u>1969^a</u>		<u>1977^b</u>		<u>1985</u>		<u>1986</u>	
	Date	Count	Date	Count	Date	Count	Date	Count
<u>South Areas</u>								
RI	6/20	700+	nc	nc	6/20	38	6/20	12
Cone	6/20	400+	nc	nc	6/20	68	6/20	59
Eagle	6/18	1,000	nc	nc	6/20	95	6/20	85
A1	6/19	639	6/20	148	6/20	139	6/20	133
A2	6/19	1,583	6/20	406	6/20	439	6/20	546
A3	6/19	257	6/20	27	6/20	3	6/20	35
A4	6/19	<u>1,467</u>	6/20	<u>369</u>	6/20	<u>272</u>	6/20	<u>15</u>
Total A1-A4		3,946	6/20	950	6/20	853	6/20	729
A5	6/12	<u>720</u>	nc	<u>nc</u>	6/20	<u>361</u>	6/20	<u>336</u>
Total South		6,766		-		1,415		1,221
<u>North Areas</u>								
N1	6/19	576	6/19	80	6/20	1	6/20	0
N2	6/19	262	6/19	56	6/20	9	6/20	15
N3	6/19	197	6/19	330	6/20	3	6/20	2
NE1	6/14	975	6/19	429	6/20	328	6/20	156
NE2	6/14	1,400	6/28	500	6/20	315	6/20	302
N. Haul	6/19	<u>819</u>	6/28	<u>119</u>	6/20	<u>0</u>	6/20	<u>0</u>
Total North		4,229		1,514		656		475
TOTAL ALL		10,995		-		2,071		1,696

nc = no count

a/ Fiscus (1970)b/ Withrow (1983)

Island, Alaska in 1978 (<2%; Johnson and Smith 1978). Higher proportions have been observed at Marmot Island, Alaska in 1979 (>10%; Aumiller and Orth 1979, British Columbia (25%: Pike and Maxwell 1958), and Rogue Reef, Oregon in 1982 (18%; Merrick 1987). It is unknown whether this decline in juvenile abundance is unique to Ugamak Island or is a recent characteristic of the eastern Aleutian Islands.

The 18% decline in pup production for 1985-86 is indicative of a general decline in pupping at the site. Pup counts were available for six rookeries (i.e., N1, N2, N3, A2, A3, A4) for 1969, 1977, 1985, and 1986 (Fiscus 1970; Withrow 1983). The number of pups declined by 72% between 1969 and 1977, and 35% between 1977 and 1986,. Pupping has probably declined elsewhere on the island, because the number of breeding animals decreased at other rookeries where pups were not counted in 1969 and 1977 (Table 8). Despite the decline in the number of pups born, the ratio of pups to adult females increased from 0.75 in 1968 to 0.73-0.81 in 1977-78 to 0.96-1.06 in 1985-86. The rates for 1985-86 are extraordinarily high both in comparison to the earlier rates at Ugamak Island and to rates calculated in a similar fashion for rookeries in other areas. The rate at Marmot Island's beach 3 rookery was 0.69 in 1983 (Merrick 1987) and at Ano Nuevo Island was 0.68 in 1967-69 (Gentry 1970). It is apparent that Ugamak Island is different in some respect.

Data on the proportion of females without pups and the amount of time females spent on land were collected to further

study the pupping rate. These data imply the rate is high. First, Ugamak Island's proportion of females with pups in 1986 (0.76) was higher than that observed at Ano Nuevo Island (0.43; Gentry 1970), Marmot Island's beach 3 (0.48; Merrick 1987), and Rogue Reef, Oregon (0.28; Merrick 1987). Second, the 1986 pupping rate corrected for females at sea (Appendix II) was 0.59. This corrected rate was comparable to the uncorrected rates of other sites, and was almost twice the corrected rate for Ano Nuevo Island (0.35; Gentry 1970). Thus it seems, compared to previous years at Ugamak Island, and to other sites, a greater proportion of the adult females hauling out at Ugamak Island pupped in the summer of 1986. This, however, does not preclude the possibility that some females remained away from the island during the breeding season. A significant number of these animals would reduce the observed pupping rate.

Our observations of diurnal and seasonal abundance patterns confirm Withrow's (1982) estimates of the proper times for aerial censusing (1000-2000 AST in late June to early July). The 24% bias in the aerial survey count compared to the maximum ground count illustrated the need to survey in late rather than early June. Results of juvenile counts indicated that juveniles on rookeries were ashore at least as much as the adult females. Finally, comparisons of spook counts with cliff counts indicated cliff counts were preferable when they were logistically possible because they provided counts reasonably similar to spook counts with little or no disruption to a rookery (Lewis 1987).

Adult Female and Juvenile Feeding Cycles

Our data on hourly abundance patterns and movements of individual animals support the hypothesis that adult females depart for feeding trips in the evening and return in the early morning. Differences in sizes of arrival and departure groups may be due to the formation of departure groups as a mechanism to elude capture by bulls waiting offshore for females. The departure groups frequently split up once they had passed those bulls, and individuals or smaller groups then proceeded out to sea. Returning individuals, as they could not be seen in advance by the bulls, could elude the bulls as they approached the beach.

Similarity of the times at sea and onshore obtained in 1985 and 1986 for females with pups indicates that we have a consistent measure of the feeding cycles of these females for Ugamak Island (given the current prey resource). We still, however, lack data on other female groups.

Other data on female feeding cycles in Alaska are available from Sandegren (1970). His data indicated that females with pups ($n = 11$ females) made their first trip at 9 days postpartum, as compared to 9.8 days at Ugamak Island. Wooded Island, Alaska females spent 50.5% of the time on land with times onshore and at sea of 17.0 hours and 16.7 hours, respectively. Differences from the Ugamak Island data could be due to the availability, abundance, and quality of the local prey resource.

Data are also available from Ano Nuevo Island, California. Gentry (1970) estimated that females with pups spent 63% of the

time onshore, while those without pups spent 47% on land. Both estimates are comparable to the Ugamak Island data. Gentry also noted that many females made short, overnight trips. Higgins et al. (1988) observed that at Ano Nuevo Island, a female's first trip postpartum was at 6.7 days, 3 days earlier than in Alaska. These females then spent progressively less time onshore (as at Ugamak Island). However, by the sixth week they were onshore only 30% of the time, the opposite of what we and Gentry (1970) found. Data from Higgins et al. were collected in 1983, the year of an El Nino event. The effects of this El Nino event on California sea lions (Zalophus californianus) in southern California was to increase times at sea (Ono et al. 1987; Heath and Francis 1984), and these conditions may have also affected the feeding cycles of northern sea lions at Ano Nuevo Island. That trip lengths at Ugamak Island were so much shorter may also reflect a generally greater abundance of food in that area as compared to the central and southern California areas (Pearcy and Schoener 1987).

Based on our small sample, suckling juveniles appeared to spend more time onshore than their mothers. Presumably, this is because these juveniles are not yet foraging independently and are relying (at least in part) on their mother's milk for nutrition.

Debris and Entanglement Surveys

Density of net scraps and packing bands (the debris most commonly associated with entanglement of marine animals) observed during surveys of eight beaches at Ugamak Island was less than 25% of that observed during 1982 surveys at Amchitka Island and St. Paul Island (Table 9; Merrell 1984; Scordino and Fisher 1983). However, the densities of rope scraps and fishing floats were comparable to or greater than observed at the other two sites. These findings indicated how local conditions may influence the distribution of debris, and the need for care in generalizing from one site to the others.

The percentage of entangled adult northern sea lions observed at Ugamak Island in 1985-86 (0.09% to 0.17%) was similar to that observed during a 1985 survey of major sea lion hauling sites in the Aleutian Islands (0.07%; Loughlin et al. 1986). These rates were lower than that observed for juvenile male northern fur seals (Callorhinus ursinus) in the Pribilof Islands (0.4%; Fowler 1987) where entanglement has been implicated as one of the causes of recent declines-in the fur seal population. The low density of net fragments and packing bands observed at Ugamak Island may explain the relatively low incidence of entanglement observed there; however, adult sea lions may be simply too large to become entangled in most debris. In any event, the observed entanglement is insufficient to support the hypothesis that declines in sea lion numbers are due to entanglement.

Table 9. --Comparison of marine debris observed at Ugamak Island in 1985 and at Amchitka and St. Paul Islands in 1982.

Location	Year	Number per kilometer			
		Fishing net	Packing band	Rope	Fishing float
Ugamak Island	1985	7.0	13.3	87.0	200.6
Amchitka Island ^{a/}	1982	34.0	57.6	24.5	67.7
St. Paul Island ^{b/}	1982	155.0	54.2	103.4	nc

^{a/} Merrell 1984

^{b/} Scordino and Fisher 1983

nc = no count

Proximate Reasons for the Decline

Data from 1985-86 Ugamak Island field work provide some insight into causes of the decline. First, there is no evidence that would point towards falling reproductive rates or reduced survival of pups on rookeries., Pupping rates were high and pup mortality in the first month postpartum was low.

Second, the stability of adult sex ratios from at 1976-77 to the present seems to indicate that both sexes are equally affected by the decline. This may mean that incidental takes in fisheries, (mostly adult females and juveniles of both sexes; Loughlin and Nelson 1986), cannot account for- all of the decline.

Third, low juvenile abundance observed at Ugamak Island in 1985-86 may be particularly significant. An agent (e.g., disease, lack of food, or shooting) acting equally on animals at this age would result in fewer sea lions of both sexes recruited.

In conclusion, the Ugamak Island data point towards a causative factor or agent which either decreases juvenile survival or has no sex-specific effect on adult survival. Irrespective of the cause of the decline in female numbers, the 'lack of females translates itself into a decline in pup production. Because declines in pup numbers have been observed elsewhere in 1986 (Loughlin 1986^{3/}), it is unlikely that females have moved to another site to pup.

^{3/} T. Loughlin, unpublished data. Northwest and Alaska Fisheries Center, National Marine Mammal Laboratory, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Seattle, WA 98115.

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REFERENCES

- Aumiller, L., and G. Orth. 1979. Steller sea lion investigation at Marmot Island 1979. Unpubl. rep., Alaska Dept. Fish and Game, 333 Raspberry Road, Anchorage, AK.
- Braham, H. W., R. D. Everitt, and D. J. Rugh. 1980. Northern sea lion population decline in the eastern Aleutian Islands. *J. Wildl. Manage.* 44:25-33.
- Fiscus, C. H. 1970. Steller sea lions at Ugamak Island, Aleutian Islands, Alaska, June 1969. Unpubl. rep., U.S. Fish Wildl. Serv., Bur. Commer. Fish., Mar. Mammal Biol. Lab., Seattle. Available from National Marine Mammal Laboratory library, 7600 Sand Point Way NE, Seattle, WA 9.8115.
- Fiscus, C. H., and A. M. Johnson. 1968. Site for research on the Steller sea lion, June-July 1968. Processed Rep., 33 p. U.S. Fish Wildl. Serv., Bur. Commer. Fish., Mar. Mammal Biol. Lab., Seattle.
- Fowler, C. W. 1987. Marine debris and northern fur seals: a case study. *Mar. Poll. Bull.* 18:326-335.
- Gentry, R. L. 1970. Social behavior of the Steller sea lion. Ph.D. dissertation, Univ. California, Santa Cruz, 113 p.
- Heath, C. B., and J. M. Francis. 1984. Results of research on California sea lions, San Nicolas Island, 1983. U.S. Dep. Commer., NOAA SWFC Admin. Rep., LJ-84-41C, 28 p.

- Higgins, L. V., D. P. Costa, A. C. Huntley, and B. J. LeBoeuf. 1988. Behavioral and physiological measurements of maternal investment in the Steller sea lion, Eumetopias jubatus. Mar. Mammal Sci. 4:44-58.
- Johnson, D. and L. Smith. 1978. Steller sea lion investigation at Sugarloaf Island, Alaska - 1978. Unpub. rep., Alaska Dept. Fish and Game, 333 Raspberry Road, Anchorage, AK.
- Lewis, J. 1987. An evaluation of a census-related disturbance of Steller sea lions. M.S. thesis, Univ. Alaska, Fairbanks, 93 p.
- Loughlin, T. R., and R. Nelson, Jr. 1986. Incidental mortality of northern sea lions in Shelikof Strait, Alaska. Mar. Mammal Sci. 2:14-33.
- Loughlin, T. R., P. J. Gearin, R. L. DeLong, and R. L. Merrick. 1986. Assessment of net entanglement on northern sea lions in the Aleutian Islands, 25 June-15 July 1985. NWAFC Processed Rep. 86-02, 50 p. Northwest and Alaska Fish. Cent., 7600 Sand Point Way NE, Seattle, WA 98115.
- Mathisen, O. A. , and R. J. Lopp. 1963. Photographic census, of the Steller sea lion herds in Alaska, 1956-58. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 424, 20 p.
- Merrell, T. R., Jr. 1984. A decade of change in nets and plastic litter from fisheries off Alaska. Mar. Poll. Bull. 15:378-384.

- Merrell, T. R., Jr. 1985. Fish nets and other plastic litter on Alaska beaches. In R. S. Shomura and H. O. Yoshida (editors), Proceedings of the workshop on the fate and impact of marine debris, 27-29 November 1984, Honolulu, Hawaii, p. 179-206. U.S. Dep. Commer., NOM Tech. Memo. NMFS SWFC-54.
- Merrick, R. L. 1987. Behavioral and demographic characteristics of northern sea lion rookeries. M.S. thesis, Oregon State Univ., Corvallis, 124 p.
- Merrick, R. L., T. R. Loughlin, and D. G. Calkins. 1987. Decline in abundance of the northern sea lion, Eumetopias jubatus, in Alaska, 1956-86. Fish. Bull., U.S. 85:351-365.
- Ono, K. A., D. J. Boness, and O. T. Oftedal. 1987. The effect of natural environmental disturbance on maternal investment and pup behavior in the California sea lion. Behav. Ecol. Sociobiol. 21:109-118.
- Pearcy, W. G., and A. Schoener. 1987. Changes in the marine biota coincident with the 1982-1983 El Nino in the northeastern subarctic Pacific Ocean. J. Geophys. Res. 92:14,417-14,428.
- Pike, G. C., and B. E. Maxwell. 1958. The abundance and distribution of northern sea lion (Eumetopias jubata[sic]) on the coast of British Columbia. J. Fish. Res. Board Can. 15:5-17.

- Sandegren, F. E. 1970. Breeding and maternal behavior of the Steller sea lion (Eumetopias jubata[sic]) in Alaska. M.S. thesis, Univ. Alaska, College, 138 p.
- Scordino, J., and R. Fisher. 1983. Investigations on fur seal entanglement in net fragments, plastic bands and other debris in 1981 and 1982, St. Paul Island, Alaska. Unpubl. manuscr., 90 p. (Background paper submitted to the 26th Annual Meeting of the Standing Scientific Committee of the North Pacific Fur Seal Commission, 28 March--8 April 1983, Washington, D.C.). Available from National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
- Treaty, S. D., and T. W. Crawford. 1981. Retrieval of otoliths and statoliths from gastrointestinal contents and scats of marine mammals. J. Wildl. Manage. 45:990-993.
- Withrow, D. E. 1982. Using aerial surveys, ground truth methodology, and haul out behavior to census Steller sea lions, Eumetopias jubatus. M.S. thesis, Univ. Washington, Seattle, 102 p.

APPENDIX I

DESCRIPTION OF ROOKERIES AND HAUL OUTS

Ten northern sea lion rookery and haul out sites were observed at Ugamak Island during the 1985-86 field seasons (Appendix Table 1). All could be viewed from land based observation posts on Ugamak Island. These sites are concentrated on the northeast and southeast sides of the island. One offshore site is found on Round Island, a small islet which lies about 1 km off the southeast side of Ugamak Island.

North Side Sites

Braham's Bay (former status--haul out,
present status--abandoned)

This site was described by Withrow (1982) as containing a peripheral rookery and haul site. Braham's Bay is the first small cove west of North Point. This site can be observed from above the west side of North Point. Sea lions were not observed hauled out along the shore of Braham's Bay during the 1985-86 study. In 1985, small groups of subadult males and adult females were seen hauled out on Withrow Rock, which is located in the middle of Braham's Bay: however, none were observed in 1986.

North 1 (former status--rookery.
present status--abandoned)

North 1 (N1) is the cove to the east of North Point. It includes the beach area and rock ledges on either side. Large irregular shaped rocks and steep cliffs border both sides. N1 can be approached from above with the aid of a safety line or can

Appendix Table 1. -List of rookeries and haul outs on Ugamak Island with current and status and censusing location.

Location	Status ^a		Observation Posts ^b	
	Former	Present	Former	Present
Braham's Bay	Haul site	Abandoned	North Point-west	North Point-west
North 1	Rookery	Abandoned	North Point-east	North Point-east
North 2	Rookery	Haul out	Above	Above
North 3	Rookery	Abandoned	Above	Above
NE-1	Rookery	Rookery	North Point-east	Above
NE-2	Rookery	Rookery	North Point-east	Above
NE-3	Rookery	Abandoned	none	none
East Beach	Not noted	Haul out	none	East Cliffs
Cone	Rookery	Haul out	none	Cone Cliff
Eagle	Rookery	Rookery	Eagle Cliff	Eagle Cliff
Round Island	Rookery	Rookery	Eagle Cliff	Cone & Eagle
A-1	Rookery	Rookery	OP-5	OP5 & above
A-2	Rookery	Rookery	OP-2,3,5	OP2 & above
A-3	Rookery	Haul out	OP-2,5	OP2 & OP5
A-4	Rookery	Haul out	Rookery	OP4 & OP5
A-5	Rookery	Rookery	OP-1	Above

^a/ Former status refers to site description by Fiscus (1970) and Withrow (1982).

^b/ Observation post refers to the locations from which censuses were made.

be viewed and counted from above on the east side of North Point.

North 2 (former status--rookery,
present status--haul out)

North 2 (N2) is the next cove east of N1. The site runs from the rocky outcrop on the west side to the east end of the sand and cobble beach. N2 can be approached from above through a chute near its eastern end. It can be viewed and censused from the cliffs above. This site was utilized as a haul out by a few sea lions during 1985-86.

North 3 (former status--rookery,
present status--haul out)

North 3 (N3) is the next cove east of N2. It was divided into 4 subsections by Withrow (1982) including a major rookery and 3 haul-out sites. N3 was utilized by small numbers of bachelor males as a haul out in 1985, but was empty in 1986. The site can be viewed and censused from the cliffs above.

Northeast 1 (former status--rookery,
present status--rookery)

Northeast 1 (NE1) is located in a cove below and to the west of the pass between the mountains on the northeast side of Ugamak Island. It is the first beach to the east of N3. NE1 can presently be viewed from above on an outcrop of bird mounds above and to the west of the pass (a safety line is needed). This site was counted from N2/N3 during the 1969 and 1977-78 studies.

Northeast 2 (former status--rookery.
present status--rookery)

Northeast 2 (NE2) is the next beach to the east of NE1. It consists of a series of rock ledges and offshore rocks at its western end and a sand and cobble beach to the east. The rock ledges are used as a bachelor male haul out and the western beach area as a rookery. Large pieces of rusted metal from a shipwreck are scattered over the beach area in the vicinity of the rookery group. NE2 can be censused from above from a rocky outcrop just to the west of the pass (a safety line is needed). This site was also counted from N2/N3 in previous studies.

Northeast 3 (former status--rookery.
present status--abandoned)

Northeast 3 (NE3) is located to the east of NE2 at the NE point of Ugamak Island. This site cannot be viewed from above: however, based on aerial surveys it has been abandoned.

East Beach (former status--not noted.
present status--haul out)

East beach haul out is located on the east end of Ugamak Island between NE and SE points. Most of the east beach area can be viewed from the cliff between the two mountains. East beach was not censused in 1985-86 but small numbers of males were observed or heard hauled out there on several occasions.

South Side Sites

Cone [former status--rookery.
present status--bachelor haul out)

Cone is located at the SE end of Ugamak Island. It begins at the 100 m pinnacle (the "conel") lying offshore and extends

west to a large rock outcrop. The central portion of Cone consists of a sand and cobble beach. The eastern portion of this beach was used by bachelor males as a haul-out site. Small numbers of males were also observed hauled out on the ledges to the east of the beach area. Cone can be censused from a perch above and to the west of the beach (safety line required). Cone may be possible to approach on foot by crossing over from Eagle rookery on a low tide.

Round Island (former status--rookery,
present status--rookery)

Round Island (RI) is a small islet about 1 km off the southeast side of Ugamak. RI can be viewed from Cone and Eagle lookouts with the aid of a spotting scope. The sea lions there were noted at three general locations: the southeast ledge, the northeast ledge, and the west point. Censuses of RI in 1985 may not have counted all animals present due to the viewing distance. These counts, therefore, represent a minimum number hauled out.

Eagle Point (former status--rookery,
present status--rookery)

Eagle Point (EP) is located along the southeast shore of Ugamak, to the west of Cone. The rookery was fully visible from above by using several vantage points at (EP). The eastern boundary of EP is the rock outcrop just west of Cone, while the western boundary is the point formed by another rock outcropping at the base of the cliff. A small rookery group used the central beach portion of EP in 1985, and the western beach in 1986. EP can be reached by foot by descending the chute leading to Al and

then climbing back up over the saddle and down into EP.

Area 1 (former status--rookery,
present status--rookery)

Area 1 (A1) rookery is the site just west of EP. This site extends from the detached rocks and reef at the south end of Ugamak Bay to the large moss covered rock which borders Area 2. Counts of A1 were initially made from observation post 5 (OP5), a distance of about 1 km. Later a new observation post was discovered which offered a clear view of this rookery from above. This OP is located about 500 feet above the center of A1 on a flat square rock. This OP can be reached by going up and around to the east of the rock outcrop near OP1. A1 can be reached on foot by descending the chute near Eagle Point.

Area 2 (former status--rookery,
present status--rookery)

Area 2 (A2) rookery is located to the west of A1 from the large moss covered rock (east side) to the flat rock ledge (west side) called Area 3 (A3). A2 appears to have changed since 1978 due to a large rock slide which covered much of the west and central portions. A2 was censused from OP2 near the waterfall and from a series of locations along the cliff above the rookery. A2 can be approached on foot by following the trail down the central waterfall and then crossing over the base of A3.

Area 3 (former status--rookery,
present status--haul out)

Area 3 (A3) is the large roughly shamrock-shaped basalt outcrop just west of A2. A3 was censused from above at OP2 and OP5. A3 can be reached on foot in the same manner as A2. A3

presently acts as a bachelor bull haul out during the breeding season.

Area 4 (former status--rookery,
present status--haul out)

Area 4 (A4) is located just west of A3. It extends from A3 to the beginning of a large slide area and includes a large cobble and boulder beach, as well as the reef at its western end. A4 was censused from above at OP4 and OP5. A4 can be reached on foot by the same manner as A2 and A3. A4 was occupied as a rookery in 1985, but in 1986 contained only a few adult males.

Area 5 (former status--rookery,
present status--rookery)

Area 5 (A5) is located west of A4, beginning at the slide area and extending west until cut off by a sheer cliff. A5 was censused from above at two locations: one was slightly, west of the slide area at the east end of A5, and the second was above animals at the far western end of the site. Area 5 can be reached on foot by crossing through A-4.

APPENDIX II

METHOD FOR PUPPING RATE CALCULATION

A corrected 1986 pupping rate can be determined for Ugamak Island given these data:

Females with pups = number of pups = 1,386

Females without pups = $F_{max} * P * 1/T$

$$= (1311)(0.24)(1/0.32) = 983$$

where F_{max} = Maximum females ashore (1311)

P = Proportion of females ashore without young (0.24)

T = Proportion of time females without young spend onshore (0.32)

Total number of females = $1,386 + 983 = 2,369$

Corrected pupping rate = $1,386/2,369 = 0.59$

APPENDIX III

SIGHTINGS OF OTHER MAMMALS AND AVIFAUNA

Other Marine Mammals

A maximum of three adult sea otters (Enhydra lutris) and one juvenile were observed in Ugamak Bay, and five in the North Point area. Another five sea otters were observed at the west end of the island during the 26 July-1986 helicopter trip from the island.

Two to three harbor seals (Phoca vitulina) were observed hauled out in West Bay on several occasions and another was observed swimming near the NE1 rookery. An adult male fur seal was observed at N2 on 30 May 1985.

A branded male northern sea lion (right shoulder X) hauled out at A2 on 29 June 1985. This brand indicates that the animal was a g-year-old born at Sugarloaf Island in the Gulf of Alaska.

A single adult male killer whale (Orcinus orca) was observed swimming less than 1 km offshore of the Ugamak Bay beaches the morning of 3 July 1986. This whale moved very slowly and appeared to pause offshore of each beach. Sea lions did not appear alarmed and continued to transit to and from beaches while the whale was nearby. No predation by the whale was observed.

A dead gray whale (Eschrichtius robustus) washed ashore on A4 beach on 5 July. The head and most of the right side was missing from the animal, but there were no obvious signs of the cause of death. The animal was a male, and measured 6 m from the tail notch to the pectoral fin. Based on this measurement the

overall length was around 8 m, thus indicating the animal was probably a juvenile (M. Dahlheim, 1986^{4/}).

A dead minke whale (Balaenontera acutorostrata) was observed on a beach at Avatanak Island. The animal's length appeared to be 20-30 ft, and the carcass was in good condition.

Terrestrial Mammals

Arctic fox (Alopex lagopus) were common on the west end of the island. We estimated that at least 16 occupied the area, and three active dens were located. Two to four foxes were usually present around the camp. Foxes were also heard during our excursions to the eastern two-thirds of the island. Numerous winter runs of an unknown vole species were observed at the eastern end of the island, and one vole was seen.

Avifauna

Twenty-seven species of birds were identified during the period (Appendix Table 2). We located one peregrine falcon (Falco peregrinus) nest, one rough-legged hawk (Buteo lagopus) nest, and three bald eagle (Haliaeetus leucocephalus) nests. All five nests had chicks in them. Puffins were not observed to nest on the island, although numerous puffins were observed transiting around the eastern end of the island, presumably to and from nests on nearby Aiktak Island. Withrow observed that the number

^{4/}M. Dahlheim, Northwest and Alaska Fisheries Center, National Marine Mammal Laboratory, National Marine Fisheries Center, NOAA, 7600 Sand Point Way N.E., Seattle, WA 98115. Pers. commun., August 1986.

Appendix Table 2. --Birds observed at Ugamak Island during the summers of 1985-86.

Species	Notes
Bald eagle (<u>Haliaeetus leucocephalus</u>)	U; N; 3 pairs+1 imm.
Rough-legged hawk (<u>Buteo lagopus</u>)	U; N; 1 pair
Peregrine falcon (<u>Falco peregrinus</u>)	U; N; 1 pair
Short-eared owl (<u>Asio flammeus</u>)	R; 1 sighting 1986
Tufted puffin (<u>Lunda cirrhata</u>)	C
Horned puffin (<u>Fratercula corniculata</u>)	C
Common murre (<u>Uria aalge</u>)	R
Pigeon guillemot (<u>Cephus columba</u>)	F
Rock sandpiper (<u>Erolia ptilocnemis</u>)	U; N
Black oystercatcher (<u>Haematopus bachmani</u>)	F
Double-crested cormorant (<u>Phalacrocorax auritus</u>)	R
Pelagic cormorant (<u>Phalacrocorax pelagicus</u>)	C
Storm petrel (<u>Oceanodroma</u> sp.)	R; carcass only
Barrow's goldeneye (<u>Bucephala islandica</u>)	R; 1 pair 1986
Harlequin duck (<u>Histrionicus histrionicus</u>)	C
Glaucous-winged gull (<u>Larus glaucescens</u>)	C
Common raven (<u>Corvus corax</u>)	C; 4+
Lapland longspur (<u>Calcarius lapponicus</u>)	C; N
Savannah sparrow (<u>Passerculus sandwichensis</u>)	C; N
Song sparrow (<u>Melospiza melodia</u>)	C
Winter wren (<u>Troglodytes troglodytes</u>)	C
Snow bunting (<u>Plectrophenax nivalis</u>)	C
Gray-crowned rosy finch (<u>Leucosticte tephrocotis</u>)	C
Yellow wagtail (<u>Motacilla flava</u>)	R
Water pipit (<u>Anthus spinoletta</u>)	R
Willow ptarmigan (<u>Lagopus lagopus</u>)	R; 1 female with chicks
Sandhill crane (<u>Grus canadensis</u>)	R; 6 once 1985

R = Rare; U = Unusual; F = Frequent; C = Common; N = Nesting

of tufted puffins (Fratercula cirrhata) was less than he had seen in previous visits to the site. Numerous horned puffin (Fratercula corniculata) carcasses were found on the beaches in 1985, and our helicopter pilot (J. Sinks) commented that he had seen thousands of their carcasses on the Pacific beaches of Unimak Island during that spring.