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Fur Seal Investigations, 1982

Edited by
Patrick Kozloff

January 1985

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A study of juvenile survival (birth-age 2 yr) on the Pribilof Islands concluded that survival on land is somewhat higher on St. George than on St. Paul. Pup production at both Adams Cove (1,029) on San Miguel Island and nearby Castle Rock (680) was greater in 1982 than in any previous year. Dietary studies based on the principal prey species of fur seals and the relative abundance of fish-squid resources suggest that fur seals are opportunistic feeders. Chlorinated hydrocarbons were found in the tissues of northern fur seals from St. Paul Island.

KEYWORDS: *Seals(Mammals), *Pribilof Islands, *North Pacific Ocean, *Callorhinus ursinus.

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FUR SEAL INVESTIGATIONS, 1982

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January 1985

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ABSTRACT

Research on the northern fur seal, Callorhinus ursinus, in 1982 was conducted on the Pribilof Islands, Alaska; on San Miguel Island, California. and nearby Castle Rock; and in the Bering Sea.

An estimate was made of the number of pups born in 1982 on St. Paul Island, Alaska, including the sizes of the 1940, 1977 and 1978 year classes.

Studies in 1982 showed that the majority of net fragments in which fur seals become entangled have a stretched mesh size of about 20-25 cm. Plastic packing bands on the necks of entangled seals are of a similar size. The ratios of closed plastic packing bands of this size to the netting of similar size, when compared on entangled animals and on beaches, indicate that mortality caused by entanglement is significant.

A study of juvenile survival (birth-age 2 yr) on the Pribilof Islands concluded that 1) survival on land is somewhat higher on St. George than on St. Paul; 2) survival on land is density-dependent--i-e., survival decreases as the number of pups born increases; 3) survival at sea is positively correlated with survival on land; and 4) since 1972, average juvenile survival ($x = 0.30$) has been less than the mean survival rate during 1950-70 ($x = 0.35$) while land survival since 1972 ($x = 0.93$) has been higher than average survival on land during 1950-70 ($x = 0.87$).

Measurements using radioactive tracers suggest that 24-26 liters of milk are required to sustain fur seal pups until weaning, maintenance metabolism of lactating females depends largely on fat metabolism, the resting metabolic rate of females is 3.3 times greater than comparably sized terrestrial mammals, and that foraging increases the resting metabolic rate by only 1.2 times.

Pup production at both Adams Cove (1,029) on San Miguel Island and nearby Castle Rock (680) was greater in 1982 than in any previous year.

Dietary studies based on the principal prey species of fur seals and the relative abundance of fish-squid resources suggest that fur seals are opportunistic feeders, i.e., they forage on the most abundant prey in a particular area.

Preliminary attempts to identify transition layers (age of first reproduction) in the teeth of female northern fur seals with known reproductive condition were inconclusive.

Pelagic studies in the southeastern Bering Sea during 1982 included the collection of 23 northern fur seals and the sampling of 50 stations with bottom trawls to study fur seal feeding preferences. Bogoslof Island, Alaska, was surveyed during October when 67 fur seals were counted.

Chlorinated hydrocarbons were found in the tissues of northern fur seals from St. Paul Island.

CONTENTS

INTRODUCTION

The research summarized in this report was conducted or completed during 1982 and was carried out by U. S. scientists, primarily those of the National Marine Mammal Laboratory, Seattle, Washington. Such research and reports fulfill, in part, the United States obligations under the Interim Convention on the Conservation of North Pacific Fur Seals. This particular report serves as the United States contribution to the 26th Annual Meeting of the Standing Scientific Committee of the North Pacific Fur Seal Commission (Washington, D.C. 1983).

The United States, Canada, Japan, and the U.S.S.R. cooperatively carry out research on the northern fur seal, Callorhinus ursinus, on land and at sea under an Interim Convention on the Conservation of North Pacific Fur Seals. Japan and Canada, two parties to the Convention without fur seal breeding grounds, share skins from fur seals taken by the U.S.S.R. and United States in return for not hunting the animals at sea.

The Pribilof Islands of St. Paui (Fig. 1), St. George (Fig. 2), and Sea Lion Rock (Fig. 1 - Sivutch) are host to an estimated 980,000 northern fur seals. Two additional colonies containing a few thousand northern fur seals breed on U.S. owned San Miguel Island and nearby Castle Rock off southern California (Fig. 3).

Approximately 25,000 male fur seals are currently harvested each year from the hauling grounds of 14 rookeries on St. Paul Island, and 350 are taken annually on St. George Island for local use as food. A moratorium on the commercial harvesting of male seals from the hauling grounds of five rookeries on St. George Island was imposed beginning in 1973 to permit research on a population as it reverts to its natural state. Fur seals are not harvested on San Miguel Island, Castle Rock, Ardiguen Rookery of St. Paul Island, South Rookery of St. George Island, or on Sea Lion Rock. However, some of the young male seals from the latter three places are known to haul out elsewhere and may be subjected to harvesting. There are four extinct rookeries on St. Paul Island (Fig. 1) and one on St. George Island (Fig. 2).

Terms having special meanings in fur seal research are described in the glossary, as are English translations of Russian names given to some of the rookeries by the Russians when they discovered the Pribilof Islands.

Charles W. Fowler
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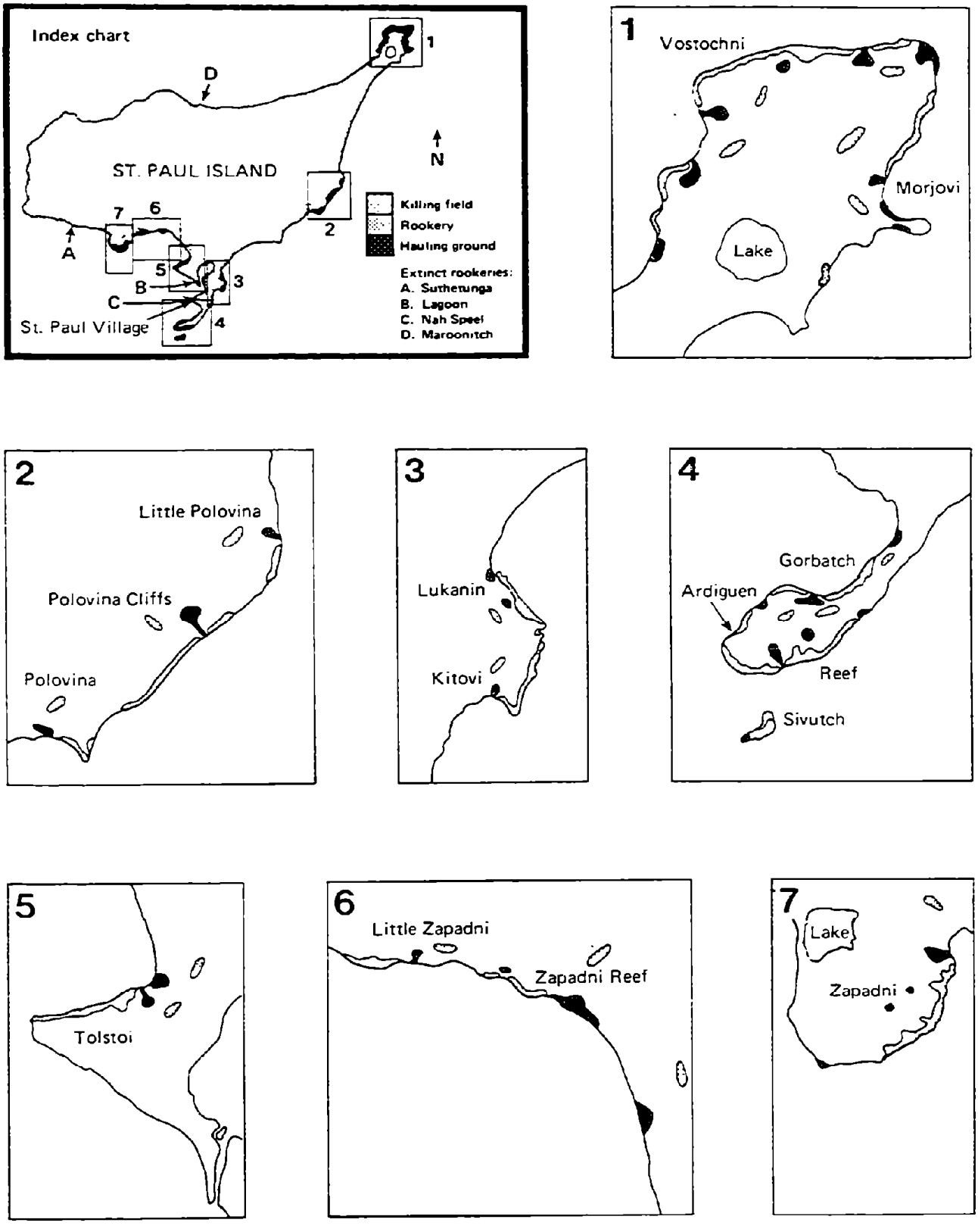

Figure 1.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. Paul Island, Alaska.

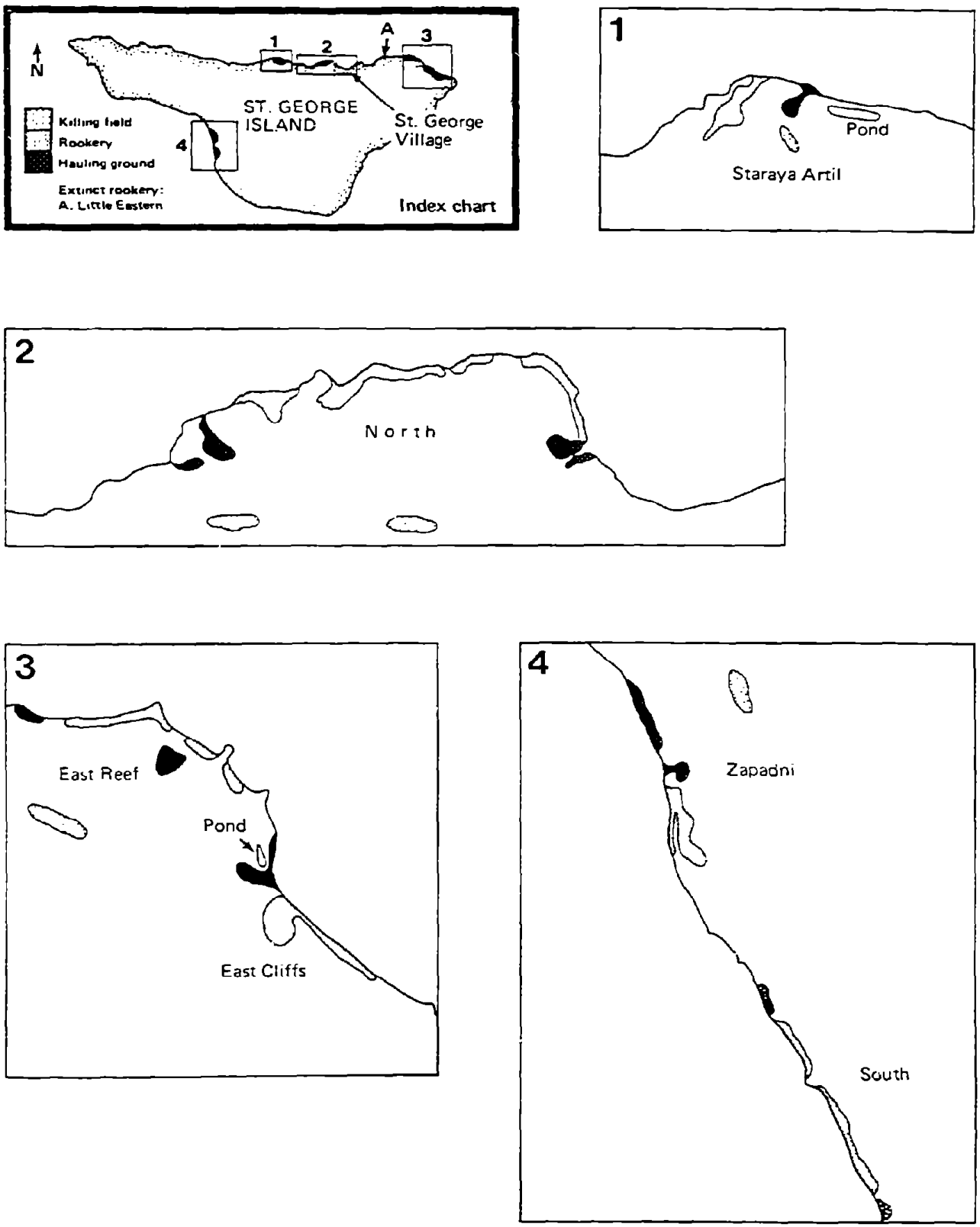

Figure 2.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. George Island, Alaska.

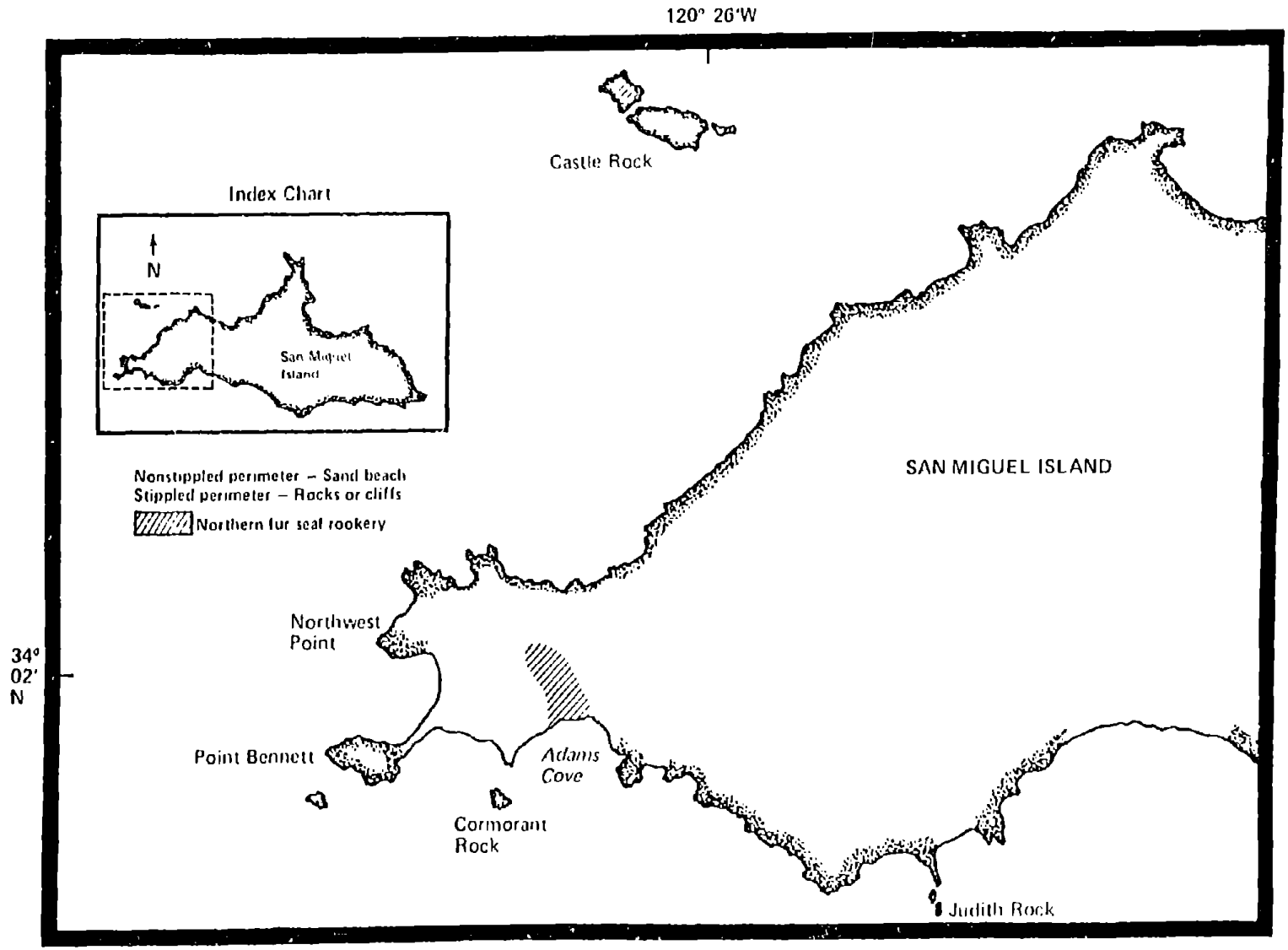

Figure 3.--Location of northern fur seal breeding colonies, San Miguel Island, California.

I. POPULATION ASSESSMENT, PRIBILOF ISLANDS

In accordance with the provisions of the Interim Convention on Conservation of North Pacific Fur Seals, the National Marine Mammal Laboratory monitors the status of the fur seal herd on the Pribilof Islands through the collection of specific kinds of information on population size, age and sex composition, estimates of natural mortality, and seals given metal tags or other marks. Information is also gathered by personnel of the Pribilof Island Program[1] on the number of seals appearing in the commercial harvest on St. Paul Island entangled in fishing net fragments and in other debris.

Population Parameters

Herd elements monitored on the Pribilof Islands in 1982 included 1) age and sex composition of seals harvested on St. Paul Island, 2) number and sex of seals taken for food on St, George Island, 3) number of live adult males and pups, and 4) number of dead pups and older seals.

Age and Sex Composition of Seals Harvested

Males--All male seals with a body length of 49 inches (124.5 cm) or less from tip of tail to tip of nose appearing in the drives from the hauling grounds on St. Paul Island were harvested from 6 July to 6 August. The age composition of these animals was determined from a 20% sample of maxillary canine teeth collected on each harvesting area (Appendix A, Tables A-1 and A-2). Seals were not harvested on Saturdays or Sundays, and seals identified as females were rejected.

Figure 4 shows the number of 3- and 4-year-old males taken in 1982, and the sizes of the year classes of male seals harvested since 1968 are shown in Figure 5 and Table 1. The age composition of males harvested on St. Paul Island since 1973 is shown in Table 2.

On St. George Island, 349 male seals were taken for food from 7 July to 20 August without restrictions on the size or sex of the animals. The seals harvested were from the east hauling ground of North Rookery. The ages of the seals were not determined but most were likely 2- to 4-year-olds, as were those taken in the past subsistence harvests.

Females--A few young females through 4 years of age are inadvertently taken during the commercial harvest of males on St. Paul Island and during the harvest for food on St. George Island because of their similarities in size and in whisker color (vibrissae) with 3-year-old males. In 1982, a total of 98 females on St. Paul Island and 1 on

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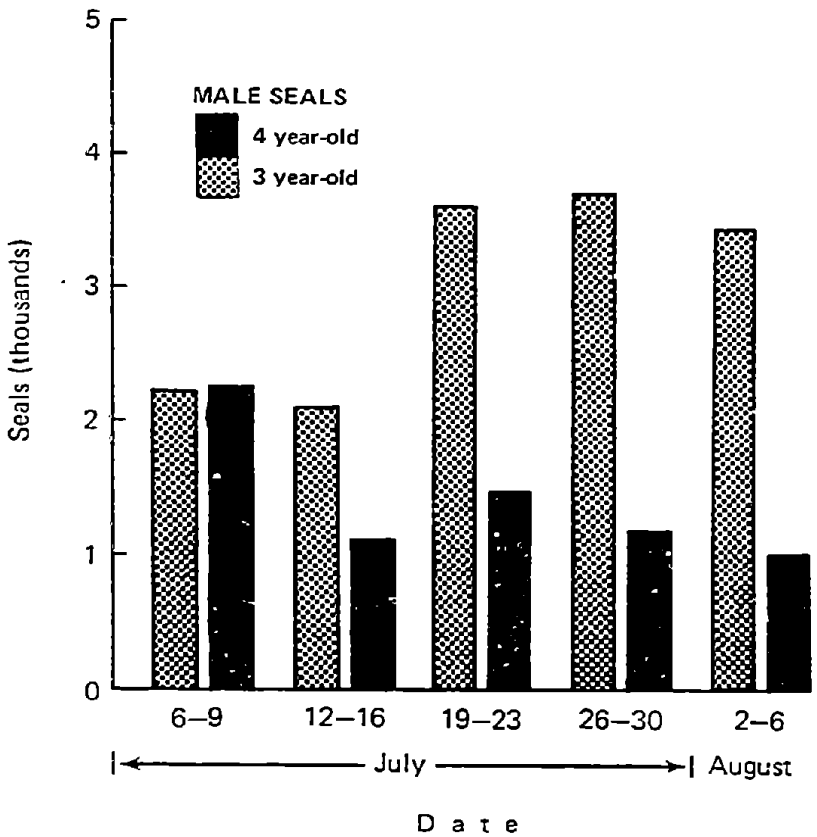

Figure 4.--Number of 3- and 4-year-old male northern fur seals harvested, St. Paul Island, Alaska, 6 July to 6 August 1982.

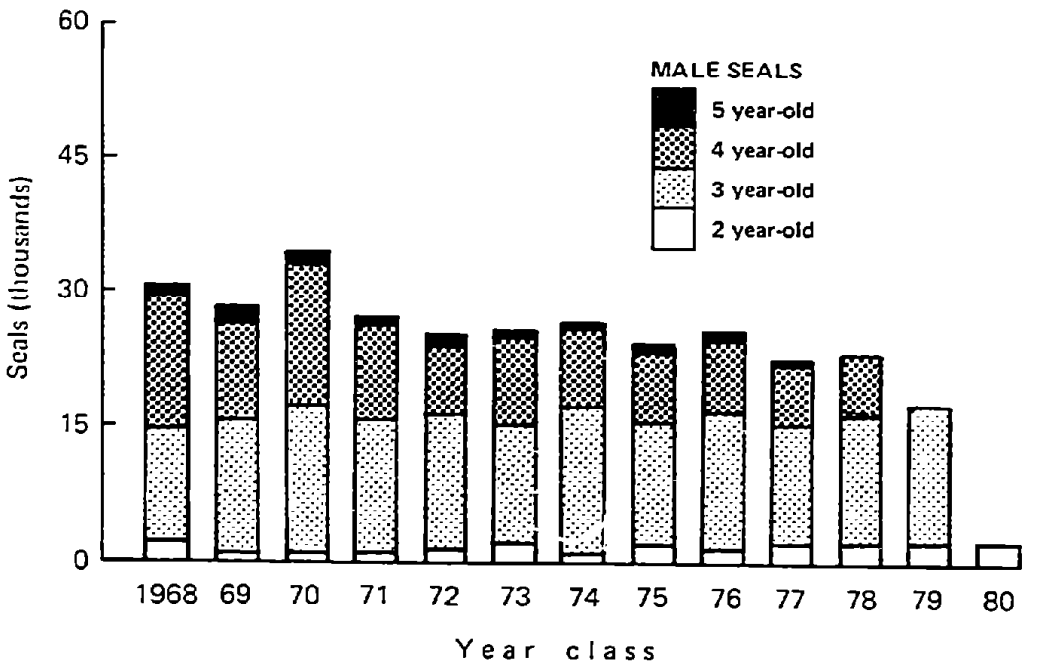

Figure 5.--Size of the male northern fur seal harvest by year class, St. Paul Island, Alaska, 1968-80.

Table 1.--Harvest of male northern fur seals, by age group, St. Paul island, Alaska, 1968-80 year classes.[a]

Year class	Age group 2	3	4	5	Total harvested
	----------Number of seals----------				
1968	1,725	12,888	14,932	721	30,266
1969	323	15,024	10,800	1,631	27,778
1970	916	16,337	15,533	1,402	34,188
1971	577	14,652	10,768	722	26,719
1972	1,025	15,186	8,050	707	24,968
1973	1,642	13,397	9,421	598	25,058
1974	893	16,476	8,955	470	26,794
1975	1,783	13,752	7,918	725	24,178
1976	1,479	15,245	8,183	651	25,558
1977	2,051	13,157	6,714	511	22,433
1978[b]	2,180	14,224	7,016	-	23,420
1979[b]	2,284	15,123	-	-	17,407
1980[b]	2,065	-	-	-	2,065
Total	18,943	175,461	108,290	8,138	310,832
Mean	1,457	14,622	9,845	814	26,794[c]

[a] Includes only 2- to 5-year-olds taken during the harvest of male seals.

[b] Incomplete returns.

[c] 1978, 1979, and 1980 year classes not included.

Table 2.--Age classification of male northern fur seals harvested, St. Paul Island, Alaska, 1973-82.

Year of harvest	Age group 2	3	4	5	6	Total harvested
	----------Number of seals----------					
1973	577	16,337	10,800	721	22	28,457
1974	1,025	14,652	15,533	1,631	135	32,976
1975	1,642	15,186	10,768	1,402	95	29,093
1976	893	13,397	8,050	722	19	23,081
1977	1,783	16,476	9,421	707	9	28,396
1978	1,479	13,752	8,955	598	45	24,829
1979	2,051	15,245	7,918	470	18	25,702
1980	2,180	13,157	8,183	725	33	24,278
1981	2,284	14,224	6,714	651	19	23,892
1982	2,065	15,123	7,016	511	15	24,730

St. George Island were harvested. The maxillary canine teeth and reproductive organs of some of those taken on St. Paul Island were collected for age and reproductive studies.

Living Adult Male Seals Counted

In 1982, 9,776 adult male fur seals (bulls) were counted on St. Paul Island from 19 to 23 July of which 5,767 were counted as harem bulls; 2,729 were counted on St. George Island from 10 to 11 July (Appendix A, Tables A-3 and A-4). Appendix A, Table A-5 lists the number of adult males counted on the Pribilof Islands in mid-July since 1973. Figure 6 illustrates the relative location of the different classes of adult males on a typical fur seal rookery-hauling ground complex.

Dead Seals Older Than Pups Counted

The rookeries and adjacent beaches of St. Paul Island were surveyed for dead seals older than pups from 2 to 9 September and totaled 117 females and 47 males. Canine teeth of the animals were collected wherever possible for studies of age at death. Table 3 lists the number of these seals found dead on the Pribilof Islands since 1965.

Dead Pups Counted

In 1982, 7,301 dead fur seal pups were counted on all rookeries of St. Paul Island from 19 August to 1 September; counts on St. George Island from 20 to 29 August totaled 1,600 (Appendix A, Table A-6). The number of dead pups counted on St. Paul and St. George Islands since 1973 is given in Appendix A, Table A-7.

Patrick Kozloff

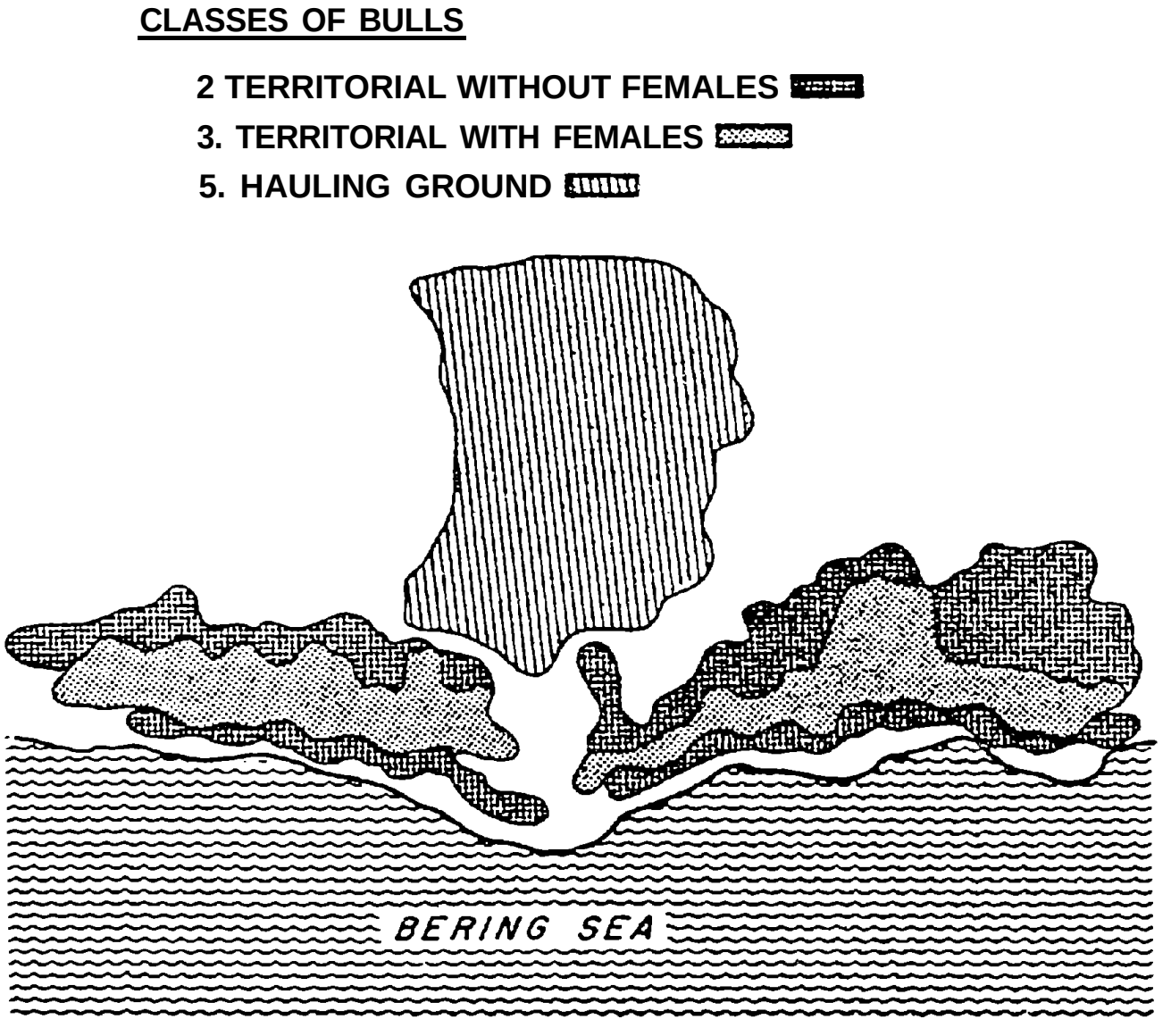

Figure 6. --General composition of a typical fur seal rookery.

Table 3.--Number of dead northern fur seals counted that were older than pups, Pribilof Islands, Alaska, 1965-82. A dash indicates no data.

Year	St. Paul Island		St. George Island		Total	
	Males	Females	Males	Females	Males	Females
1965	158	-	-	-	158	-
1966	181	172	41	55	222	227
1967	108	157	41	28	149	185
1968	98	141	33	22	131	163
1969	94	141	22	29	116	170
1970	52	124	4	53	56	177
1971	39	91	5	37	44	128
1972	46	111	22	30	68	141
1973	61	65	7	30	68	95
1974	33	30	4	15	37	45
1975	92	99	-	-	92	99
1976	46	64	-	-	46	64
1977	60	69	-	-	60	69
1978	57	87	-	-	57	87
1979	56	66	-[a]	-[a]	56	66
1980	102	117	14	65	116	182
1981	44	83	12	61	56	144
1982	47	117	-	-	47	117

[a] A total of 70 dead fur seals of both sexes that were older than pups were counted on the rookeries of St. George Island.

Number of Pups Born in 1982

St. Paul Island--The total number of pups alive at the time of shearing and its standard error were estimated as in 1980 and 1981. From the mean estimate of two sampling periods (Table 4) and the mid-July count of harem males (Appendix A, Table A-4), we computed the ratio of live pups to bulls on the five sample rookeries. Following the procedure in the 1980 Report of Fur Seal Investigations (Kozloff 1981), we estimated total numbers of pups born by multiplying the estimated ratio by total numbers of breeding males on all rookeries and adding the count of dead pups as follows:

Rookery	Number of pups	Number of breeding males	Ratio pups/bulls	$\bar{r}$	r^*
Tolstoi	25,912	749	33.98	33.42	34.15
Zapadni	26,066	767	34.64	33.83	35.92
Ardiguen	2,144	57	37.61	33.78	34.37
Kitovi	7,968	255	31.25	33.98	33.54
Kitovi Amphitheater	685	25	27.40	33.98	33.54
Total	62,775	1,853	33.90		

where $\bar{r}$ is the ratio of pups to bulls on all but the particular sample rookery, and

$$r^* = 5r - 4\bar{r} \text{ where } r = \frac{\text{total pups}}{\text{breeding males}} = \frac{62,775}{1,852} = 33.90$$

The estimate of the ratio of pups to bulls is

$$\hat{R} = 1/5 \sum_{j=1}^{5} r^*(j) = 34.035,$$

$$\text{and } \hat{Var}(\hat{R}) = \Sigma \frac{r^*(j)^2 - 5\hat{R}^2}{20} = 0.3645 \text{ and } SE(\hat{R}) = 0.6037$$

Thus. an estimate of a 95% confidence interval for the ratio of live pups to harem males is

$$34.035 \pm (2.571)\sqrt{0.6037} \text{ or}$$

$$33.035 \pm 1.552.$$

The total number of harem males counted on all rookeries of St. Paul Island is 5,767 (Appendix A, Table A-4).

Table 4.--Estimated number of northern fur seal pups in 1982 at times of shearing and birth on four rookeries of St. Paul Island, Alaska. Pups were sheared 9-13 August; sampling periods 1 and 2 were 16-17 and 19-20 August, respectively. Values in parentheses refer to pups born in Kitovi Amphitheater and are in addition to the first Kitovi figure.

Item	Rookery				
	Zapadni	Tolstoi	Ardiguen	Kitovi	Total
No. pups sheared	3,018	2,828	217	959(98)	7,120
No. 25-pup samples					
Period 1	150	154	24	73(17)	-
Period 2	194	152	18	78(9)	-
No. sheared pups counted					
Period 1	532	490	79	252(26)	-
Period 2	475	363	37	208(31)	-
Total no. pups counted[a]					
Period 1	3,750	3,850	600	1,825(175)	-
Period 2	4,850	3,800	450	1,950(225)	-
Estimated no. pups alive[b]					
Period 1 sampling	21,273	22,220	1,648	6,945(660)	52,746
Period 2 sampling	30,815	29,604	2,639	8,990(711)	72,759
Mean, both periods	26,044	25,912	2,144	7,968(686)	62,754
No. dead pups counted	1,503	1,332	49	245(24)	3,153
Estimated no. pups born[c]	27,547	27,244	2,193	8 213(710)	65,907

[a] Number of samples X 25 = total number of sheared and unsheared pups.

[b] Estimated from $\tilde{N} = MC/R$ (M = no. pups sheared, C = total no. pups counted, and R = no. sheared pups counted).

[c] Sum of dead pups counted and mean estimate of pups alive at times of sampling.

Thus, the total numbers of pups at shearing = 196,280 + 8,950 (with 95% confidence interval);

counted number of dead pups / total number of pups born = 7 301; and == 203:581 + 8,950 (with an approximate 95% confidence interval).

Anne E. York
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Estimation of numbers of pups born on St. Paul Island during 1977 and 1978

Shearing-sampling estimates were not made on St. Paul Island during 1977 and 1978; however, it is possible to make estimates of the sizes of those year classes by using the kill-at-age information for the 1977 and 1978 year classes and by assuming that utilization rates for the 1977 and 1978 cohorts were equal to those of the estimated rates of the other year classes (1972-76 and 1979). An analysis of the age-specific utilization rates (ratio of the number of males from a given cohort killed of given age to the number of males from the same cohort alive after on-land mortality) of male fur seals on St. Paul Island during 1972-79 indicates that the 3-year-old utilization rate (Table 5) has been the least variable and would Probably provide a reliable estimate of numbers of male pups alive after on-land mortality for the respective year. Therefore, if one assumes that the exploitation rate of 3-year-old male fur seals of the 1977 and 1978 year classes was approximately equal to the exploitation rate of 3-year-old male fur seals of the 1972-76 and 1979 year classes, then estimates of the number of male fur seals pups alive after on-land mortality for 1977 and 1978 are the number of 3-year-old males taken in the 1980 and 1981 harvests divided by that average exploitation rate.

The details of the computation of the jackknife estimate of the exploitation rate for the 1972-76 and 1979 year classes appear in Table 5. The estimated average exploitation rate for these year classes is 0.119 with an approximate 95% confidence interval from 0.10 to 0.13. Since the size of the 3-year-old harvest in 1980 was 13,157, the estimate of the number of male pups alive in late August 1977 is 110,563; similarly, the number of male pups alive in late August 1978 is estimated at 119,529. The total number of pups born is estimated by multiplying the above figures by two and adding the number of dead pups counted during the respective year.

In theory. this method could be used to calculate estimates of the number of pups born during 1971. However, I believe such estimates of the 1971 year class strength would be upwardly biased because of the apparent high mortality of pups on land that year. Since survival on land (birth to age 4 mo) is correlated with ocean survival (age 4 mo to 2 yr), it is probable that the 1971 year class suffered greater mortality during its first 20 no at sea than it would have had on-land mortality been lower. Thus, the utilization rate of males from the 1981 year class was probably lower than the approximate 12% rate observed for the 1972-76 year classes.

Table 6 summarizes available estimates of the number of pups born and the number of dead pups for the 1950-82 year classes on St. Paul Island. Figure 7 presents the number of pups born over time (on St. Paul Island) and a 3-year running average of pups born.

Anne E. York

Table 5.--Number of male fur seals alive in late August (M), number of males killed at age 3 (K3), utilization rate of 3-yr-olds (U_3), and auxiliary statistics (U_3 and U_3 for 1972-76 and 1979 year classes. St. Paul Island. Alaska, and computation of average exploitation rate of 3-yr-old males for the given year classes.

Year class	N	K_3	$U_3=K_{3/N}$	$\overline{U}_3$[a]	U_3*[b]
1972	123,176	15,186	0.123	0.119	0.123
1973	107,500	13,397	0.125	0.119	0.124
1974	127,900	16,476	0.129	0.118	0.129
1975	128,818	13,752	0.107	0.123	0.106
1976	137,162	15,245	0.111	0.122	0.110
1979	119,744	15,098	0.126	0.119	0.126
Total	744,300	89,154			

Jackknife estimate of average utilization rate is the mean of U_3, 0.119 with an approximate 95% confidence interval 0.119 + 0.1.

[a] U_3 is the utilization over all years except the given year:

$$U_3 = \frac{89,154 - K_3}{744,300 (-) N}$$

[b] U_3 is the pseudovalue associated with the particular year:

$$U_3 = 6 (0.1198) - 5 (U_3)$$

where 0.1198 is the combined utilization rate for the above year classes.

Table 6.--Estimated number of pups born and number of dead pups, St. Paul Island, Alaska 1950-82.

Year class	Pups[a] born (1000s)	Dead[b] pups (1,000s)
1950	451.0	53.4
1951	447.0	70.7
1952	438.0	40.8
1953	445.0	78.2
1954	450.0	96.2
1955	461.0	75.5
1956	453.0	98.7
1957	420.0	61.7
1958	387.0	31.2
1959	335.0	40.0
1960	320.0	62.8
1961	342.8	57.9
1962	277.1	45.3
1963	262.5	32.6
1964	283.9	21.6
1965	253.8	39.1
1966	298.9	21.4
1967	291.0	14.1
1968	235.0	25.3
1969	232.9	13.3
1970	230.5	20.6
1971	not available	46.4
1972	269.0	22.6
1973	236.5	21.5
1974	266.0	13.2
1975	278.3	20.6
1976	297.7	23.7
1977	235.2	14.1
1978	247.1	8.1
1979	245.9	6.4
1980	200.0	7.9
1981	179.4	6.8
1982	204.0	7.8

a Number of pups born for 1950-79, except 1968, 1973, and 1974, from Lander (1980); for 1968, from Lander (1979); for 1973 and 1974, see Table 15 in this report; for 1980-82, from annual report of fur seal investigations for given year.

b Number of dead pups for 1950-79, except 1973 and 1974, from Lander (1980); for 1952, from Lander (1979); for 1973 and 1974, estimated from counts of sample rookeries in 1982 annual report of fur seal investigations; for 1978-82, from annual report of fur seal investigations for given year.

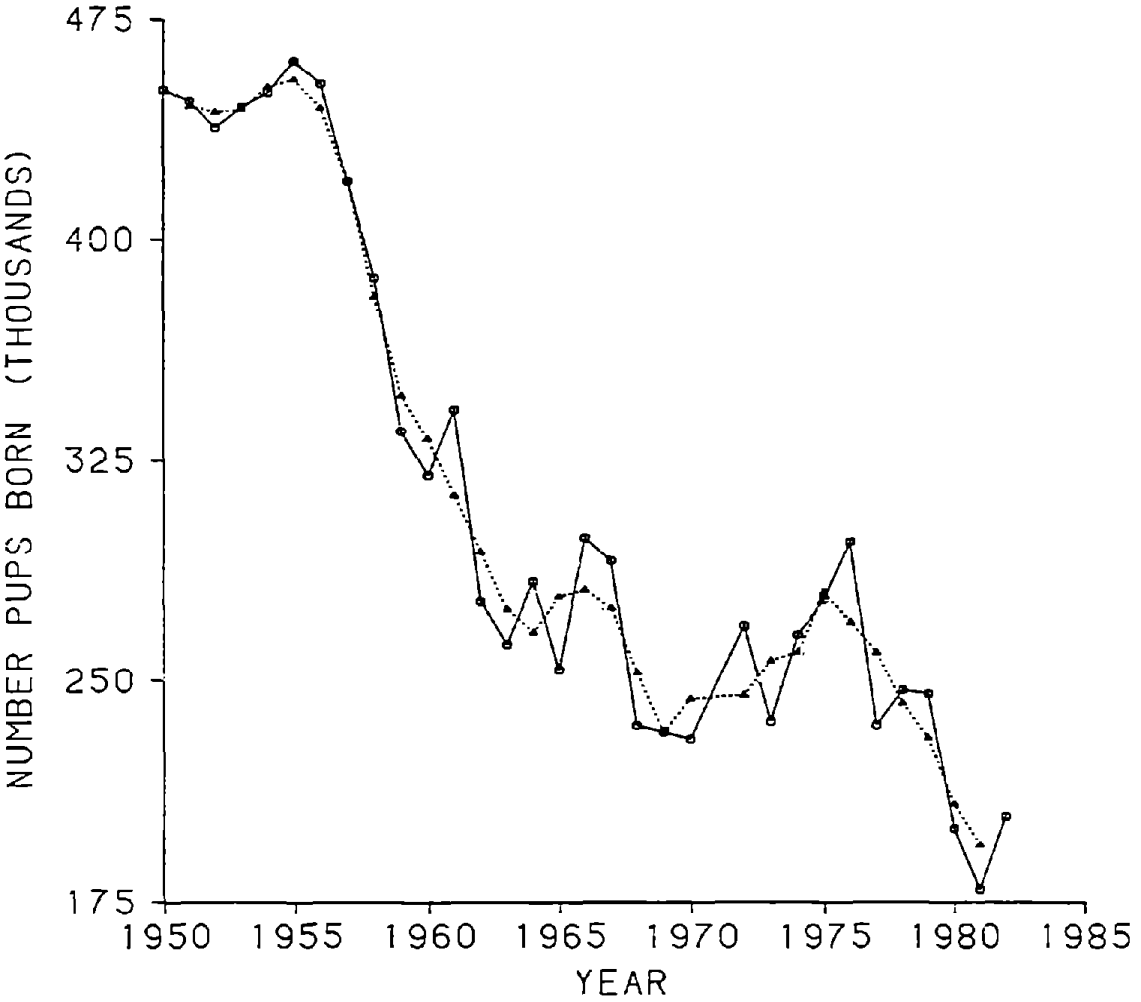

Figure 7. Estimated number of pups born, year classes 1950-82, St. Paul Island, Alaska (solid line = no. of pups born; dotted line = 3-year running average).

Estimation of the size of the 1940 year class

Scheffer et al. (1984) reported a count of the number of dead and live fur seal pups on Zapadni Reef Rookery on 13 August 1940. A count of the number of harem and idle bulls was also made during the same year in July. Although the live pup count was done on a small rookery, it still permits us to obtain an estimate of the size of the year class on St. Paul Island, if we assume that the ratio of live pups to harem males on the counted rookery was approximately equal to the ratio of live pups to harem bulls on the island as a whole, and if we assume that the mortality estimates obtained from the count of dead pups on the rookery was representative of the island as a whole. Thus, since 3,250 live pups and 68 harem males were counted on the rookery, the estimated ratio of pups to harem males is 47.794. Lander (1980) reported a total count of harem males on St. Paul Island in 1940 of 9,261. Therefore, an estimate of the total number of live pups on St. Paul Island is 9,261 x 47.49 or 442,620. Scheffer et al. (1984) also reported a dead pup count of 196 on Zapadni Reef and thus a total live and dead pup count of 3,446, and a mortality rate of 5.69%. Therefore, applying this rate to the entire island, the estimates of the total number of pups born and the total number of dead pups are 469,315 and 26,704, respectively.

We have no way of estimating the variance or bias of these estimates and advise caution when using them. However, we note that although the estimate of year class strength was obtained independently of the estimates of the sizes of the 1950-56 year classes, it is very near the estimates of the sizes of those year classes, and as such, gives us some confidence in its reliability. Furthermore, the estimate of the number of dead pups in 1940 (26,704) does not greatly exceed the count of dead pups during 1941 (19,000), and although the dead pup counts vary greatly from year to year, the data collectors did not report excessive mortality during either year.

Anne E. York

Mark Recoveries

During the commercial harvest of male northern fur seals on St- Paul Island, 17 males marked as pups on Bering and Medny Islands by the Soviet Union were recovered. Appendix A, Table A-8 lists the number of Soviet tags recovered by the United States in 1982.

Patrick Kozloff

Entanglement of Fur Seals from the Pribilof Islands

Small numbers of fur seals on the Pribilof Islands have been observed entangled in net fragments, plastic packing bands, and other man-made debris for over 20 yr. In recent years, the fraction of harvested animals observed to be entangled in such debris has been less than 0.5%. The entangled animals observed on the islands have always been recognized as only those which survived to return; some other, possibly larger, fraction dies at sea. Work conducted during 1982 resulted in additional data presented below, which relate to this problem. Further work with these data will help to understand the degree to which unobserved entanglement contributes to fur seal mortality and how it may explain recent declines in fur seal numbers (Fowler 1982a,b).

The basis for suspecting that entanglement is a significant source of mortality is presented in detail elsewhere (Fowler, 1982a. b). Briefly, data on the kinds and sizes of debris found on the entangled animals in comparison with debris on surveyed beaches indicate that if seals become entangled in large debris (especially trawl net fragments) a significant fraction of the entangled animals may not survive. The large fraction of trawl net fragments washed ashore compared to those on entangled animals suggests that mortality from entanglement is much higher than the entanglement rates observed. In combination with the process of new animals being entangled and the mortality of previously entangled animals (essentially a "turnover" in the entangled population), these arguments led to the estimate of at least 5% of the population dying each year due to entanglement (Fowler 1982a).

The potential role of entanglement as suggested by these studies provided motivation for several further studies which were conducted in the field season of 1982. The following is a summary of the information gleaned from the 1982 studies.

In 1982, debris was surveyed on sample beaches of three islands in the vicinity of the Bering Sea. St. George and St. Paul Islands were surveyed in July, and Amchitka Island was surveyed in September. Plastic packing bands and trawl net fragments were the primary elements in the observed entanglement and will therefore be emphasized in this summary. An overview of the data from these studies is presented in Tables 7, 8, 9, and 10.

In addition to beach surveys, the debris found on entangled animals was subjected to much more intensive scrutiny than in previous years. A summary of this study is shown in Tables 11 and 12: as noted in Table 11 the majority of the entanglement observed on the Pribilof Islands consisted of fragments of nets and plastic packing bands. Furthermore, the condition of captured entangled animals was evaluated.

Table 7.--Summary of sizes (by weight) of trawl net fragments sampled from beaches of three islands of the Bering Sea, 1982 (percentages shown in parentheses).

Wt. range (kg)	Island			Total
	St. George	Amchitka	St. Paul	
0.0-0.1	34 (15.0)	-	10 (40)	44 (7.6)
0.1-0.2	24 (10.5)	11 (3.3)	1 (4)	36 (6.2)
0.2-0.3	15 (6.6)	26 (7.8)	2 (8)	43 (7.5)
0.3-0.4	18 (7.9)	19 (5.7)	-	37 (6.4)
0.4-0.5	9 (0.4)	17 (5.1)	-	26 (4.5)
0.5-0.6	15 (6.6)	30 (9.0)	4 (16)	49 (8.5)
0.6-0.7	7 (3.1)	12 (3.6)	-	19 (3.3)
0.7-0.8	4 (1.8)	12 (3.6)	-	16 (2.8)
0.8-0.9	2 (0.9)	9 (2.7)	-	11 (1.9)
0.9-1.0	1 (0.4)	9 (2.7)	-	10 (1.7)
1.0-1.1	4 (1.8)	15 (4.5)	-	19 (3.3)
1.1-1.2	2 (0.5)	6 (1.8)	-	8 (1.4)
1.2-1.3	-	8 (2.4)	-	8 (1.4)
1.3-1.4	-	5 (1.5)	1 (4)	6 (1.0)
1.4-1.5	1 (0.4)	2 (0.6)	-	3 (0.5)
1.5-1.6	5 (2.2)	5 (1.5)	1 (4)	11 (1.9)
1.6-1.7	1 (0.4)	7 (2.1)	-	8 (1.4)
1.7-1.8	1 (0.4)	6 (1.8)	-	7 (1.2)
1.8-1.9	1 (0.4)	3 (0.1)	-	4 (0.7)
1.9-2.0	2 (0.9)	31 (9.3)	-	33 (5.7)
Over 2.0	72 (31.7)	101 (30.3)	6 (24)	179 (31.0)

Table 8.--Summary of the mesh sizes of trawl net fragments sampled from beaches of three islands of the Bering Sea, 1982 (percentages shown in parentheses).

Mesh size (cm)	Island			Total
	St. George	Amchitka	St. Paul	
0-5	-	2 (0.6)	-	2 (0.3)
5-10	73 (33.3)	68 (20.4)	6 (16.7)	147 (25.0)
10-15	82 (37.4)	160 (48.0)	11 (30.6)	253 (43.0)
15-20	37 (16.9)	70 (26.0)	13 (36.1)	120 (20.4)
20-25	17 (7.8)	27 (8.1)	6 (16.7)	50 (8.5)
25-30	6 (2.7)	4 (1.2)	-	10 (1.7)
30-35	1 (0.5)	1 (0.3)	-	2 (0.3)
35-40	2 (0.9)	1 (0.3)	-	3 (0.5)
40-45	-	-	-	-
45-50	1 (0.5)	-	-	1 (0.1)

Table 9.--Summary of sizes of closed plastic bands found in samples taken on beaches of three islands of the Bering Sea, 1982 (percentages shown in parentheses).

Range of stretched length (=1/2 circum) (cm)	Island			Total
	St. George	Amchitka	St. Paul	
0-10	-	-	-	-
10-20	1 (4.0)	1 (2.9)	-	2 (2.9)
20-30	1 (4.0)	2 (5.9)	-	3 (4.4)
30-40	2 (8.0)	2 (5.9)	-	4 (5.9)
40-50	7 (28.0)	7 (20.6)	-	14 (20.6)
50-60	10 (40.0)	14 (41.2)	2 (22.2)	26 (38.2)
60-70	1 (4.0)	3 (8.8)	3 (33.3)	7 (10.3)
70-80	-	1 (2.9)	3 (33.3)	4 (5.9)
80-90	2 (8.0)	1 (2.9)	-	3 (4.4)
90-100	1 (4.0)	2 (5.8)	1 (11.1)	4 (5.9)
100-110	-	-	-	-
110-120	-	-	-	-
120-130	-	-	-	-
130-140	-	-	-	-
140-150	-	-	-	-
150-160	-	1 (2.9)	-	1 (1.5)

Table 10.--Summary of samples of trawl net fragments and plastic bands found during beach surveys of three islands of the Bering Sea, 1982.

Island	Bands		Ratio of closed to open bands	Trawl net fragments	Ratio of closed bands to net fragments
	Open	Closed			
St. George[a]	167	17	0.10	-	-
	-	15	-	227	0.067
Amchitka	590	35	0.06	366	0.096
St. Paul	64	10	0.17	37	0.270
Totals		60		630	0.095
	821	62	0.08		

[a] The samples used to determine the two ratios for St. George Island involved two overlapping samples with a total of 25 closed bands. Of these, 17 were collected at the same time open bands were collected to allow for calculating the ratio of closed to open bands, and 15 were collected in conjunction with net material. Thus, 7 of the 25 closed bands are counted in both groups.

Table 11.--Types of entangling debris found on seals harvested on St. Paul Island, Alaska, and the frequency of occurrence in 1981 and 1982.

Type of debris	Percentage of total debris found	
	1981	1982
Net webbing	61	67
Plastic packing bands	25	19
Cords used in net construction and repair	4	3
Ropes	2	1
Strings	3	5
Monofilament gillnet	3	-
Rubber bands	-	3
Monofilament line	1	-
Plastic ring	-	1
Plastic six-pack holder	1	-
Lawn chair material	-	1

Table 12.--Summary of the size composition of nets (for 1982) and plastic bands (for 1981 and 1982) as found on fur seals taken in the harvest on St. Paul Island, Alaska.

Size range[a]	Nets		Bands		
	No.	Percent	1981	1982	Percent
0-5	-	-	-	-	-
5-10	1	1.7	-	-	-
10-15	-	-	-	-	-
15-20	4	6.9	-	1	2.7
20-25	47	81.0	9	18	73.0
25-30	5	8.6	1	3	10.8
30-35	-	-	-	2	5.4
35-40	1	1.7	1	1	5.4
40-45	-	-	-	-	-
45-50	-	-	-	1	2.7

[a] 1/2 circumference (or stretched length) of plastic bands and stretched mesh of trawl net fragments (in cm).

Earlier studies (reported in Fowler 1982a,b) showed that most of the net fragments found on entangled seals were very small (in weight) compared to those found on beaches. As seen from the 1982 samples, over 70% of the net fragment; found on beaches are not represented on entangled animals seen on the Pribilof Islands (Fig. 8).

New information in 1982 showed that the majority of the net fragments in which fur seals are observed to be entangled have a mash (stretched) size of about 20-25 cm (Fig. 9). Again, however, within this range of mesh sizes, well over 70% of the nets in this category (as based in weight and as found on beaches) are not represented in the debris found on entangled animals.

A very significant finding of the 1982 studies relates to the numbers of plastic packing bands found on the entangled animals compared to that observed in the debris on the beaches. Figure 10 shows the size composition of closed bands surveyed on St. George and Amchitka Islands in comparison to those bands found on entangled animals. Note that only a small fraction of the closed bands were observed on seals. These are the smaller bands (70% had a stretched length, or half-circumference, of 20-25 cm in the 1981, 1982 data). Measurements of the heads and shoulders of pups and harvested males (2- to 6-year olds) indicate that most animals of these ages can swim completely through the larger bands (40 cm half-circumference and larger).

Another important aspect of the 1982 work is seen in determining the ratio of closed loop plastic packings bands to net fragments on entangled animals and in comparing it to that from beaches. As will be seen in Table 10, the ratio of closed bands to net fragments on the beaches was 0.095. That of the entangled animals for 1982 was 0.41, and in 1981, it was 0.28. This is suggestive of a several-fold higher mortality among animals entangled in net fragments than in bands. The ratio of closed bands in the 20-25 cm (half-circumference) range to nets with a 20-25 cm stretched mesh on the beaches was 0.079. In the harvest, this ratio was 0.38.

Veterinary examinations were made of the entangled animals taken in the harvest to estimate their remaining life span, had they not been taken. In addition, the elapsed time since the animal first became entangled was estimated. These data resulted in means of approximately 10.7 months and 3.2 months, respectively. Although very subjective, these data do indicate a much higher mortality rate among animals that are entangled than among normal animals (mean "entanglement time" of about 7 months). These rates apply only to those animals observed on land (i.e., those in smaller fragments of trawl net, bands, etc.). The mortality of animals in larger pieces of net probably occurs at a much higher rate because of impaired swimming.

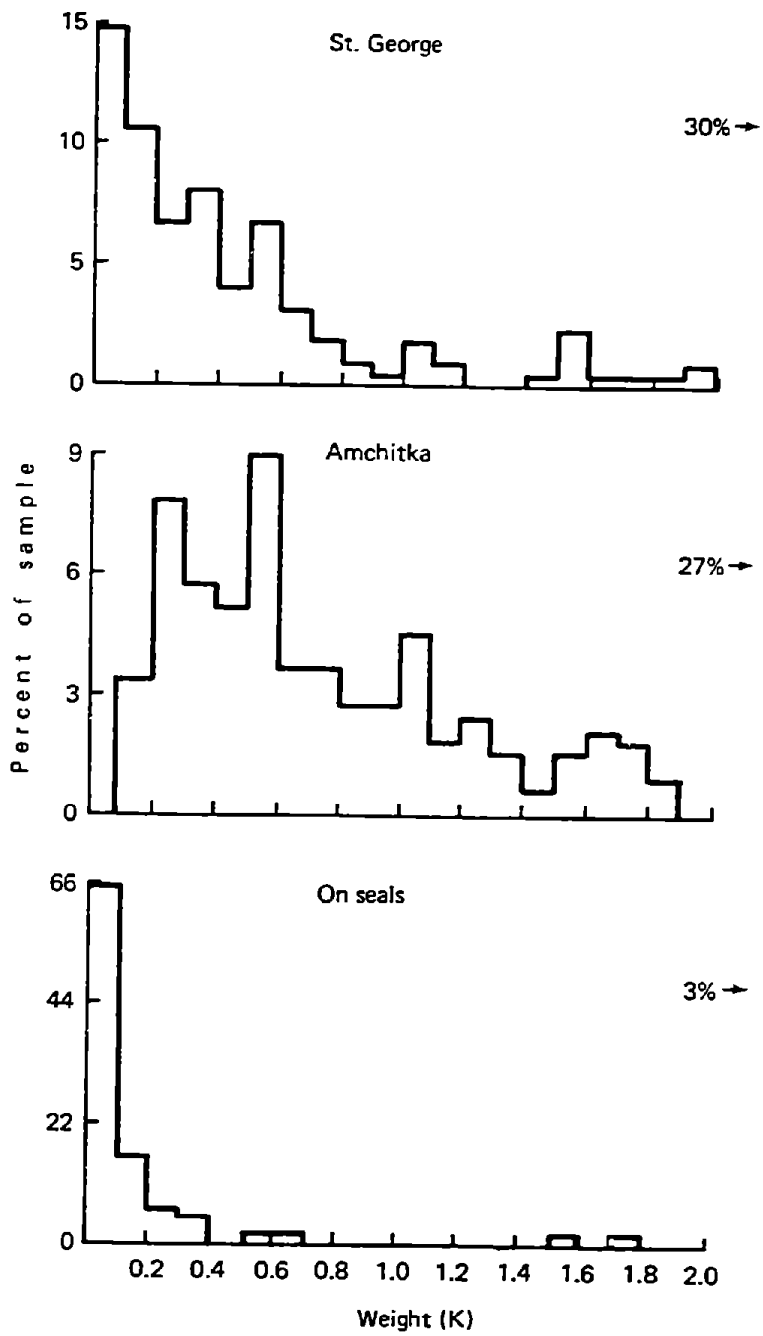

Figure 8.-- A comparison of the size frequency distribution of net fragments (based on weight) found in 1982 on two islands (St. George and Amchitka) in the vicinity of the Bering Sea with that on fur seals taken in the 1982 harvest on St. Paul island (on seals).

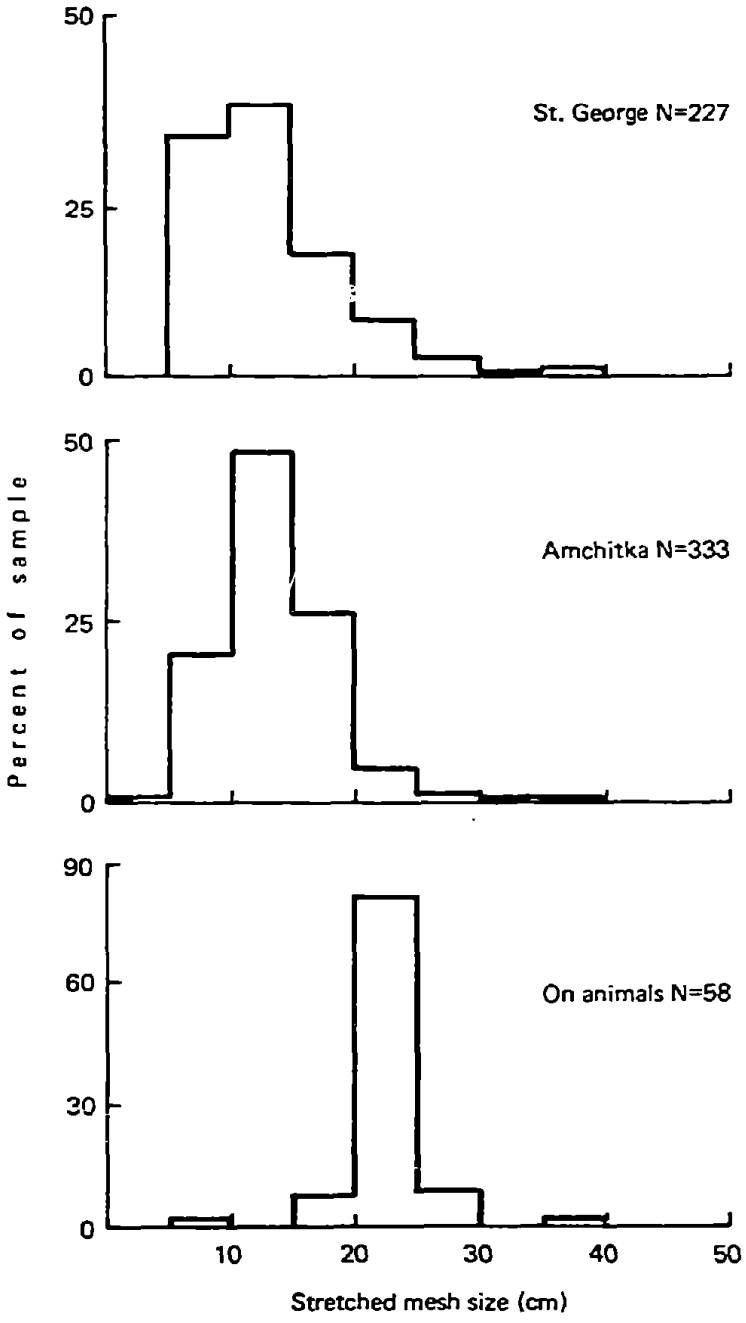

Figure 9.--A comparison of the frequency distribution of mesh sizes for net fragments found in 1982 on two islands (St. George and Amchitka) in the vicinity of the Bering Sea with that found on animals taken in the 1982 harvest on St. Paul Island.

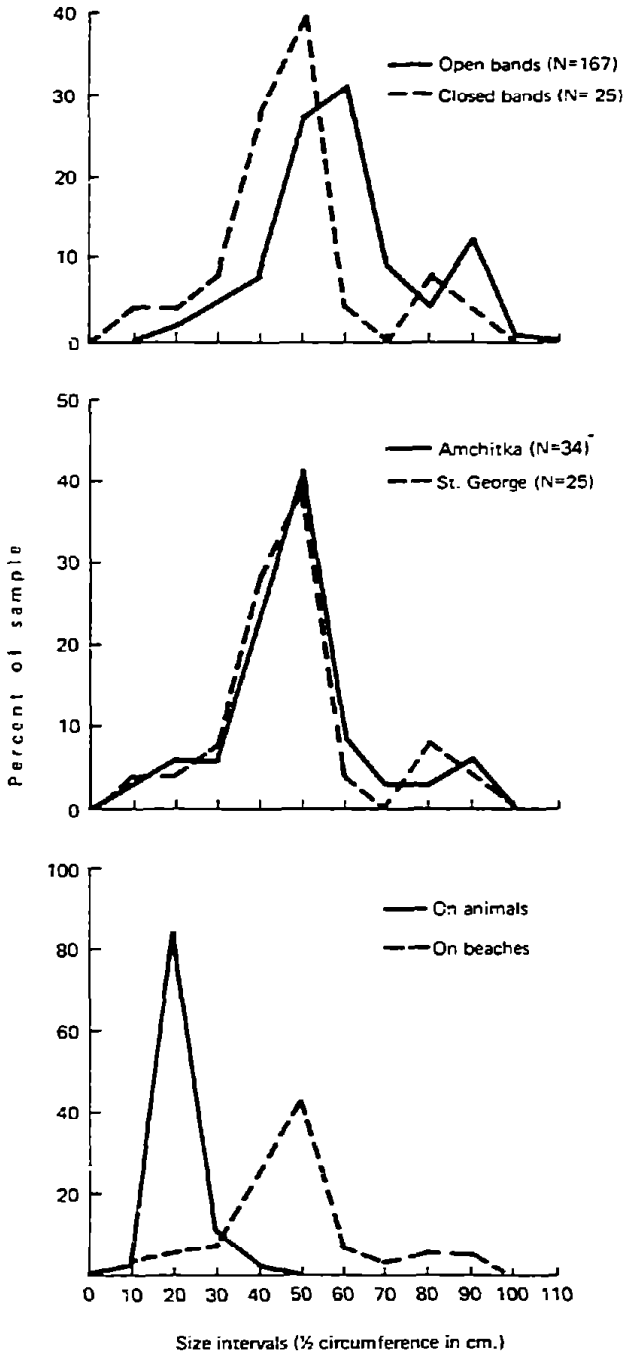

Figure 10.--Frequency distributions of plastic banding materials found on two islands in the vicinity of the Bering Sea and those found on entangled animals taken in the harvest in 1982 on St. Paul Island. Top panel: comparison of open and. closed pieces on St. George Island. Middle panel: comparison of closed loops for two islands. Bottom panel: comparison of closed loop material (both islands) with those found on entangled animals.

Comparisons of the mean weights of entangled animals with normal animals indicate a possible reduced growth rate among entangled animals, especially in the younger age classes:

Mean weight (kg) of male fur seals taken in the harvest on St. Paul Island in 1982

	2-year-olds		3-year-olds		4-year-olds	
	entangled	unentangled	entangled	unentangled	entangled	unentangled
Mean wt. (kg)	20.4	22.2	27.5	28.4	34.3	34.1
N =	13	16	43	47	30	28

Taken as a whole, these data continue to suggest that a significant portion of the population dies at sea due to entanglement. In view of the ratios of bands to nets and the size composition of the nets (both on beaches and on entangled animals), the conclusions reached by Fowler (1982a,b) may have been conservative. More analysis and further field work will help produce more precise estimates of the mortality rates involved.

The number of entangled northern fur seals appearing in the commercial harvest on St. Paul Island since 1967 is given in Appendix A, Table A-9.

Charles W. Fowler
Joe Scordino
Theodore R. Merrell
Patrick Kozloff

Juvenile Survival of Fur Seals

Introduction

Lander (1980) assembled the available counts of live pups (1912-24), estimates of the number of pups born (1949-79), and available counts of dead pups (1912-79). These data are also available for 1980 (Kozloff 1981), 1981 (Kozloff 1982), and 1982 from the appropriate tables in this report. In addition, Scheffer et al. (1984) reported a count of both dead and live pups on Zapadni Reef Rookery in 1940. Table 13 presents a summary of available estimates of the number of Pribilof Island fur seal pups born and counts of dead pups for the years 1912-81.

In order to compare annual mortality rates on land, it is important to know the date on which the count of dead pups was made. Table 14 documents the range of dates of the dead pup counts for both St. George and St. Paul Islands. Dates were obtained from a variety of sources: official U.S. Government logbooks of both islands, field notes, a study of fur seal management (Scheffer et al. 1984), and the annual reports of fur seal investigations.

The present report provides a general picture of mortality on land for all years for which data are available from 1914 to the present, compares land mortality on the islands of St. George and St. Paul, extends the results of Lander (1979) by providing estimates of juvenile mortality for the 1972-76 year classes, indicates the relationship between mortality on land and cohort size, and shows the relationship between mortality on land and mortality at sea during the first 2 yr of a cohort.

Pup Mortality on Land, 1914-81

Kenyon et al. (1954) presented counts of dead pups made on a small study area by 5-day periods from 25 June to 15 August (Fig. 11). In order to compare counts of dead pups made on different dates during the season, it was assumed that the 1954 data were representative of the daily cumulative percentage of dead pups and that a negligible mortality occurs on the rookeries after 15 August every year. Dead pup counts made before 15 August are adjusted upwards by multiplying them by the inverse value on the curve in Figure 11.

Figure 12 shows the mean adjusted (angular transformation) mortality rates with approximate 95% confidence intervals for the years 1914-81 for which both dead pup counts and estimates of pups born were made on at least one rookery. Because dead pup counts before 1924 were generally conducted earlier than those of more recent years, the mortality rates pictured in Figure 12 are higher than those calculated from data in Lander (1980).

The mean adjusted mortality rates on land pictured in Figure 12 show that mortality was low during 1914-24 and higher and much more variable for the years 1940 through the early 1970s. Recently observed survival on land is near the level of the early years (1914-24).

Table 13.--Summary of available estimates of numbers of Pribilof Island fur seal pups born (rookery specific counts or shearing-sampling estimates only) and counts of dead pups for the years 1912-81 (from Lander 1980 and Scheffer et al. 1984).

Years	Rookeries	Data available
1912-13	All rookeries	Pups counted
1914-16, 22	All rookeries	Pups counted
		Dead pups counted
1917, 21, 24	Sample rookeries (both islands)	Pups counted
		Dead pups counted
1940	Zapadni Reef	Pups counted
		Dead pups counted
1941	St. Paul Is. rookeries	Dead pups counted
1948	Northeast Point	Dead pups counted
1949	Sample rookeries (St. Paul Is.)	Pups estimated
		Dead pups counted
1950-51	St. Paul Is. rookeries	Dead pups counted
1952	Polovina	Dead pups counted
	Polovina Cliffs	
1953-54	All rookeries	Dead pups counted
1955	St. Paul Is. rookeries	Dead pups counted
1956-60	All rookeries	Dead pups counted
1961-65	St. Paul Is. rookeries	Pups estimated
	All rookeries	Dead pups counted
1966	All rookeries	Pups estimated
		Dead pups counted
1967-68	Sample rookeries (St. Paul Is.)	Pups estimated
	All rookeries	Dead pups counted
1969-70	St. Paul Is. rookeries	Pups estimated
	All rookeries	Dead pups counted
1971	All rookeries	Dead pups counted
1972-74	Sample rookeries (St. Paul Is.)	Pups estimated
	All rookeries	Dead pups counted
1975	St. Paul Is. rookeries	Pups estimated
	All rookeries	Dead pups counted
1976	Sample rookeries (St. Paul Is.)	Pups estimated
		Dead pups counted
1977	St. George Is. rookeries	Pups estimated
	All rookeries	Dead pups counted
1978	St. George Is. rookeries	Pups estimated
	All rookeries	Dead pups counted
1980	Sample rookeries (St. Paul Is.)	Pups estimated
	All rookeries	Dead pups counted
1981	St. George Is. rookeries	Pups estimated
	Sample rookeries (St. Paul Is.)	Pups estimated
	All rookeries	Dead pups counted

Table 14.--Approximate dates (with source) of counts of dead northern fur seal pups made on the Pribilof Islands during 1914-81. Notations in the center column indicate separate dates not available for St. Paul Island and St. George Island counts.

Year	St. Paul Island		St. George Island	Source
1914	8/7-8/?[c]		8/4-8/5	Island logs
1915	8/10-8/?[c]		8/5-8/7	Island logs
1916	7/31-8/3[a]		8/3-8/7	Island logs
1917	8/1-8/13		Not available	Island logs
1918	8/2-8/12		8/14-8/17	Island logs
1919	8/10-8/12[c]		8/2-8/5	Island logs
1920	8/9-8/?[c]		8/1-8/6	Island logs
1921	8/6-8/13[c]		7/31-8/3	Island logs
1922	8/2-8/7		8/8-8/13	Island logs
1924	7/31-8/4		7/28-7/29	Island logs
1940	8/13			Scheffer, 1982
1941	8/18-9/16			Scheffer, 1982
1948	8/10-8/11			Field notes in archives
1949	8/9-8/11			Kenyon, 1949
1950	8/17-8/30			Kenyon, 1950
1951	8/16			Annual report
1952	8/19			Annual report
1953		8/21-8/30		Field notes in archives
1954		8/25-9/1		Annual report
1955	8/15-8/22			Annual report
1956	8/20-8/26		8/17-8/20	Kenyon field notes
1957		8/16-9/3		Annual report
1958-60		Not available		
1961	8/22-8/25		8/20-8/21	Field notes (PK)[b]
1962		Not available		
1963	8/23-8/25		8/29-9/3	Field notes (PK[b]
1964	8/22-8/23		8/28	Field notes (PK)[b]
1965	8/21-8/24		Not available	Field notes (PK)[b]
1966	8/25-8/29		Not available	Field notes (PK)[b]
1967	8/22-8/25		8/23-8/24	Field notes (PK)[b]
1968	8/22-8/27		8/20	Field notes (PK)[b]
1969		8/25-8/27		Annual report
1970		8/21-8/30		Annual report
1971		8/20-9/3		Annual report
1972		8/21-9/2		Annual report
1973		8/20-8/26		Annual report
1974	8/23		9/8-9/13	Annual report
1975	8/27-9/2		8/20-8/21	Annual report
1976	8/19-8/26		8/23-8/24[d]	Annual report
1977	8/22-8/26		8/11-8/12	Annual report
1978		8/15-8/25		Annual report
1979		8/17-8/24		Annual report
1980	8/19-8/21		8/13-8/19	Annual report
1981	8/17-8/25		8/14-8/18	Annual report

northeast Point Rookery, 8/15-8/16.

[a] Field notes in the possession of Patrick Kozloff.

[c] St. Paul Island logs for these years are missing; dates inferred from information in St. George Island logs.

[d] East Reef Rookery, 9/21.

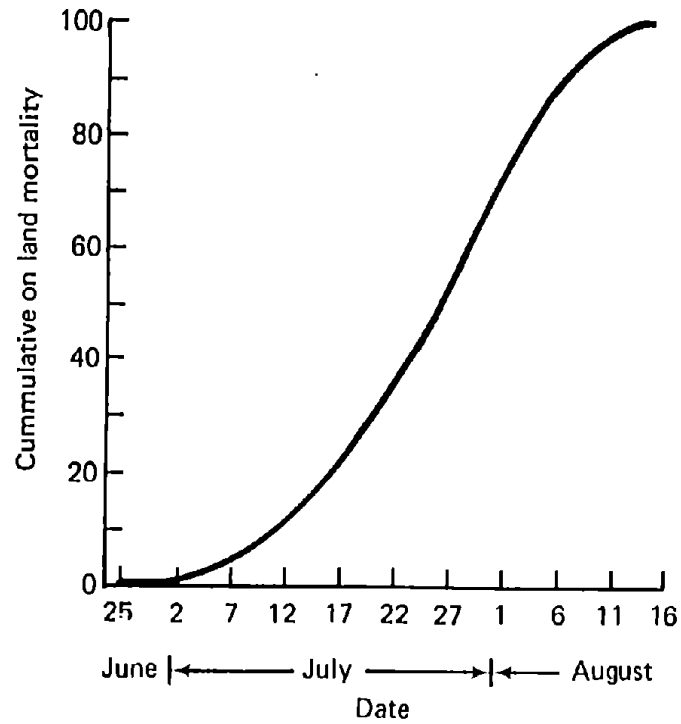

Figure 11.--Cumulative percentage of dead fur seal pups found on study areas on St. Paul Island, Alaska, 25 June-15 August 1954 (Kenyon et al, 1954).

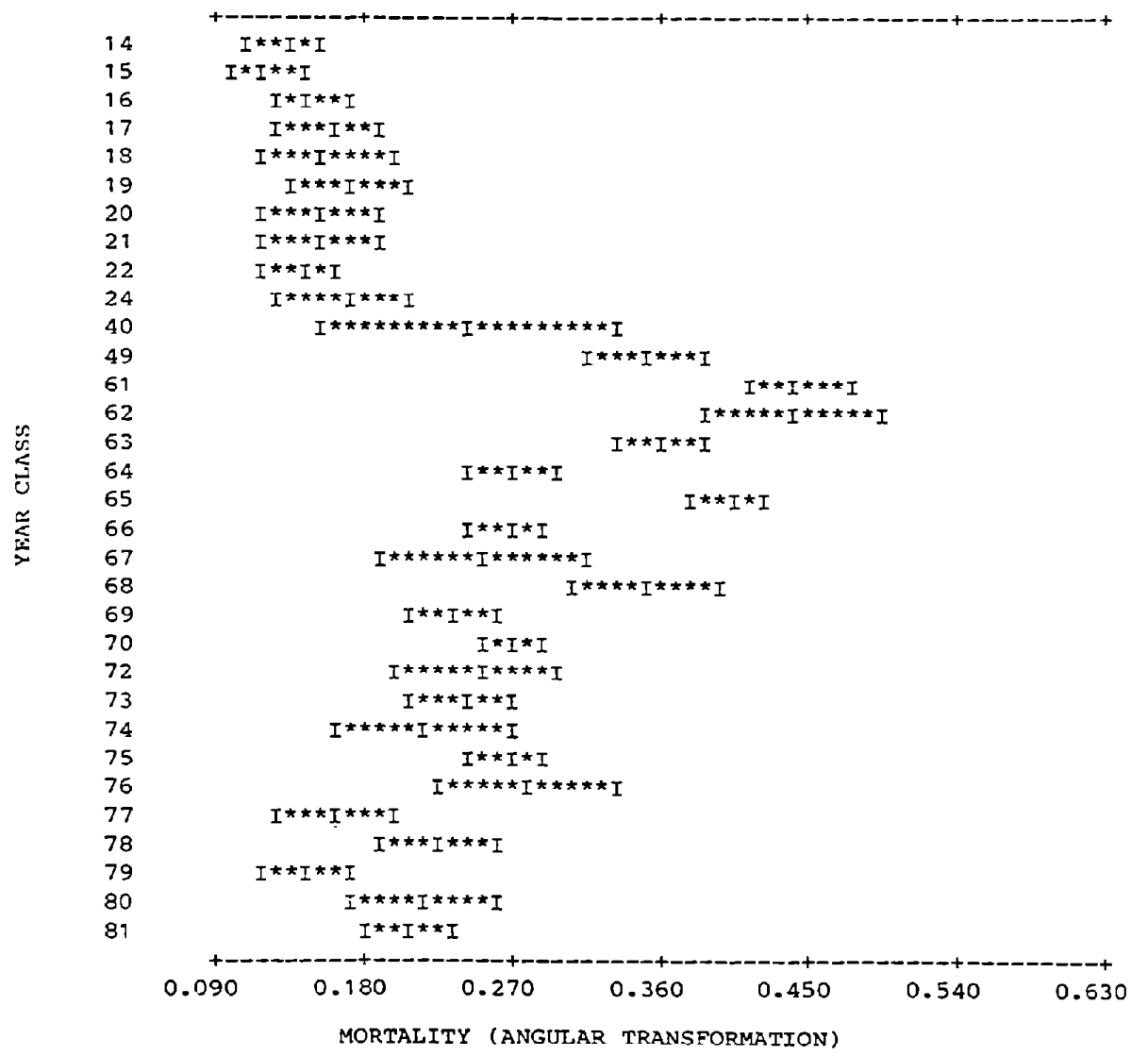

Figure 12.--Mortality rates on land with approximate 95% confidence intervals for those years 1914-81 for which dead pup counts and estimates or counts of the number of pups born were made on at least one Pribilof Island rookery.

Land Mortality and Population Size

Figure 13 presents survival on land by numbers of pups born for all available year classes 1914-82. The logit of survival on land [log(s/(l-s)] is regressed on numbers of pups born (Fig. 13). The regression is significant ($p<0.99$) but the percent of variation of survival on land that is explained by population size is 50%, indicating that density dependent factors affect survival on land, but that other factors are also important in controlling survival on land.

Comparison of Land Mortality Rates Between St. Paul and St. George Islands

Those years for which both estimates of pups born and counts of dead pups were made on at least one rookery on both islands were considered separately to compare land mortality rates on the two islands. Counts of dead pups were adjusted for the date they were made by the method described above. Figure 14 shows the transformed mortality rates (angular transformation) for the years when mortality estimates were available on both islands. Tests of combined significance (p 2 0.95) show that land mortality rates on St. George Island are generally lower than those on St. Paul Island (Fig. 14). These conclusions are consistent with those of Roger Gentry (National Marine Mammal Laboratory, Seattle, WA 98115. Pers. commun. 1981) who found that females on St. George Island make shorter feeding trips (on the average) and that the growth rate of pups there is somewhat higher than on St. Paul Island.

Computation of Juvenile Survival Rates

Lander (1979) presented estimates of juvenile survival--land survival (birth to age 4 mos), ocean survival (age 4 mos to 2 yr), and total survival (a product of the land and ocean survival components)--for the 1950-70 year classes of male fur seals born on St. Paul Island. These estimates were calculated for the 1972-76 year classes for male fur seals on St. Paul Island. The data required to calculate these estimates and the values of the estimates appear in Table 15, Since shearing-sampling estimates of the number of pups born on St. Paul Island in 1977 and 1978 were not made, survival was not calculated for these year classes.

Figure 15 summarizes fur seal survival for all available year classes on St. Paul Island from 1950 to 1976. Survival on land was relatively low in the mid-1950s, increased somewhat during the 1960s, and remained quite high during the 1970s. Ocean survival, on the other hand, seems to have been quite variable during the 195Os, less variable with little trend through 1970, and lower but less variable since 1972. Juvenile survival follows the pattern of ocean survival since its most significant component is survival at sea (age 4 mo to 2 yr). Thus, since 1972, juvenile survival ($x= 0.30$) has remained below the mean survival rate for the 1950-70 year classes ($x = 0.35$), while land survival since 1972 ($x =0.93$) has been higher than the mean land survival rate for the 1950-70 year classes ($x = 0.87$). Land survival and sea survival are positively correlated Fig. 16); biologically, this is sensible, because the individuals from year classes with higher survival on land may. on the average, be stronger and therefore better able to survive their next 2 yr at sea.

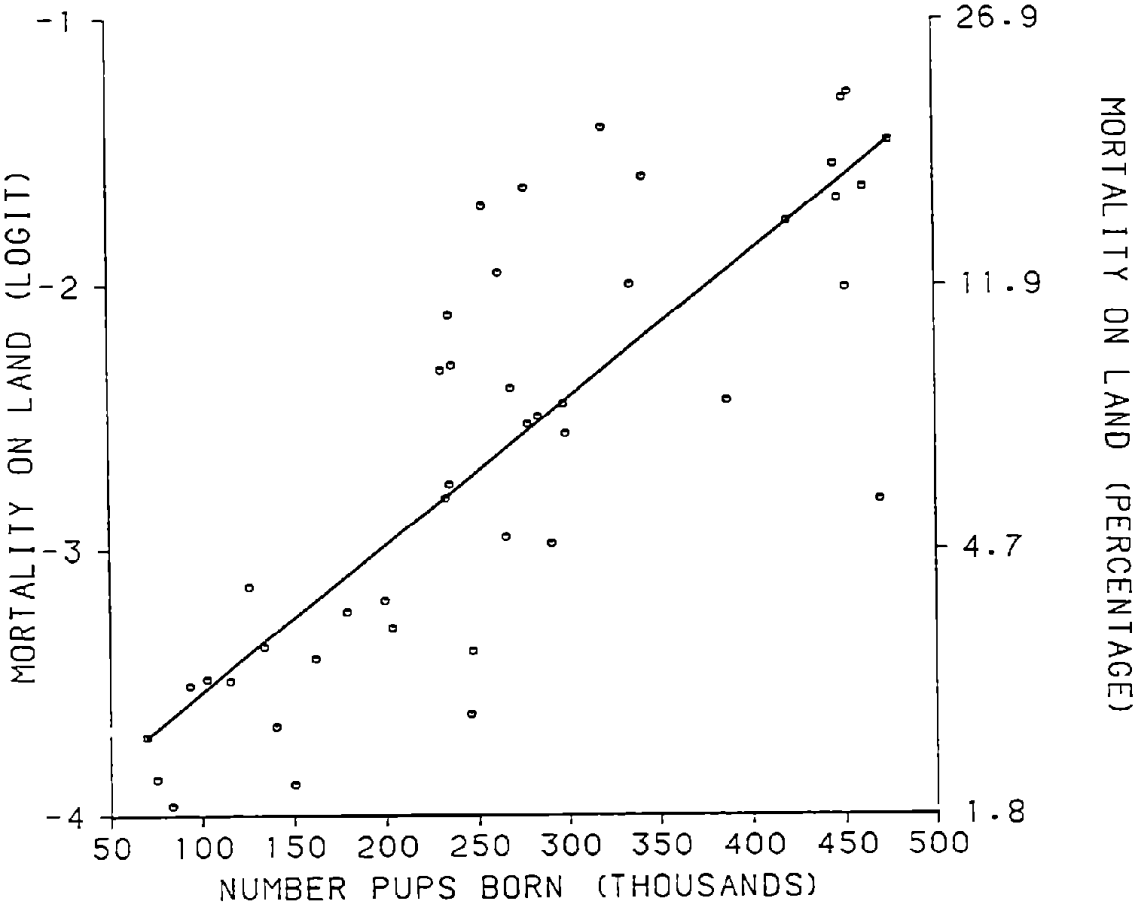

Figure 13.--.Mortality on land versus numbers of pups born for all available year classes 1914-82, St. Paul Island, Alaska.

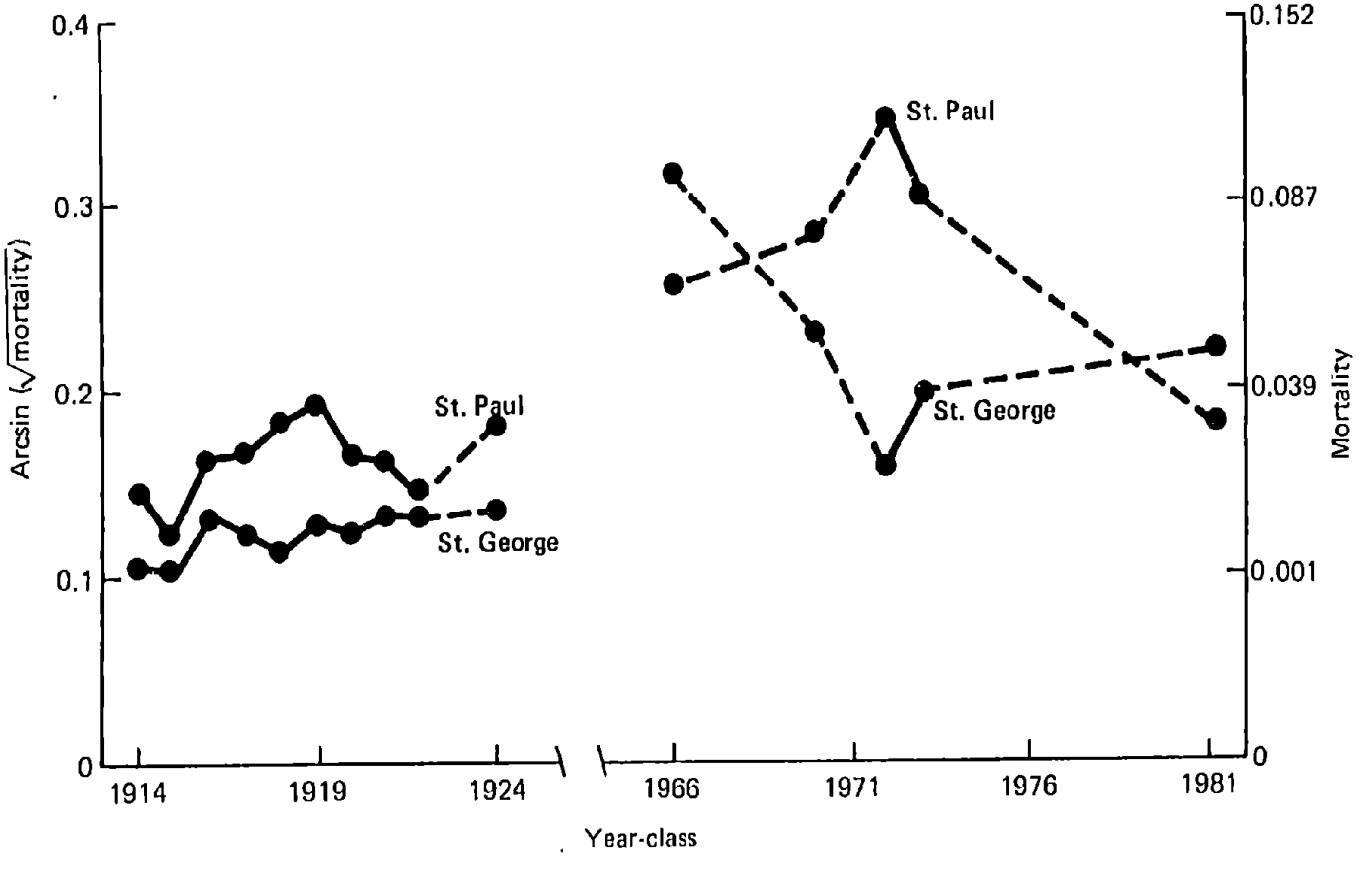

Figure 14.--Comparison of fur seal pup mortality on land for St. Paul and St. George Islands.

Table 15.--Estimated numbers of northern fur seal pups born, dead pups counted by late August, commercial harvest of males at ages 2-5 yr (K_2 - K_5), estimated land survival (S_L), estimated ocean survival (SO) from age 4 mo to 2 yr based on Lander (1979) and estimated survival birth to age 2 yr (S_J) for the 1972-76 year classes of St. Paul Island, Alaska.

Year class	Pups born	Dead pups	K_2	K_3	K_4	K_5	S_L	S_O	S_J
1972	269,000[a]	22,649	1,025	15,186	8,050	707	.92	.33	.30
1973	236,500[b]	21,500[c]	1,642	13,397	9,421	598	.91	.36	.33
1974	266,000[b]	13,200[c]	893	16,476	8,955	470	.95	.33	.31
1975	278,261	20,625	1,783	13,752	7,918	725	.93	.31	.29
1976	298,000	23,676	1,479	15,245	8,183	651	.92	.31	.29

B (i) = estimate of total number of harem bulls on all rookeries of St. Paul Island, year i.
B (i) = count of harem bulls on all rookeries of St. Paul Island, year i.
B_S (i) = count of harem bulls on sample rookeries of St. Paul Island, year i.
P_S (i) = estimate of pups born on sample rookeries of St. Paul Island, year i.
P (i) = estimate of total pups born on St. Paul Island, year i.
D_S (i) = late August count of dead pups on sample rookeries of St. Paul Island, year i.
D (i) = estimate of total number of dead pups by late August, St. Paul Island, year i.

[a] $B(72) = [B_S(72)/B_S(70)]\ B(70)$; $P(72) = [P_S(72)/B_S(72)]\ B(72)$.

[b] $B(i) = [B_S(i)/B_S(75)]\ B(75)$; $P(i) = CP_S(i)/B_S(i)]\ B(i)$; $i = 73, 74$.

[c] $D(i) = [D_S(i)/P_S(i)]\ P(i)$; $i = 73, 74$.

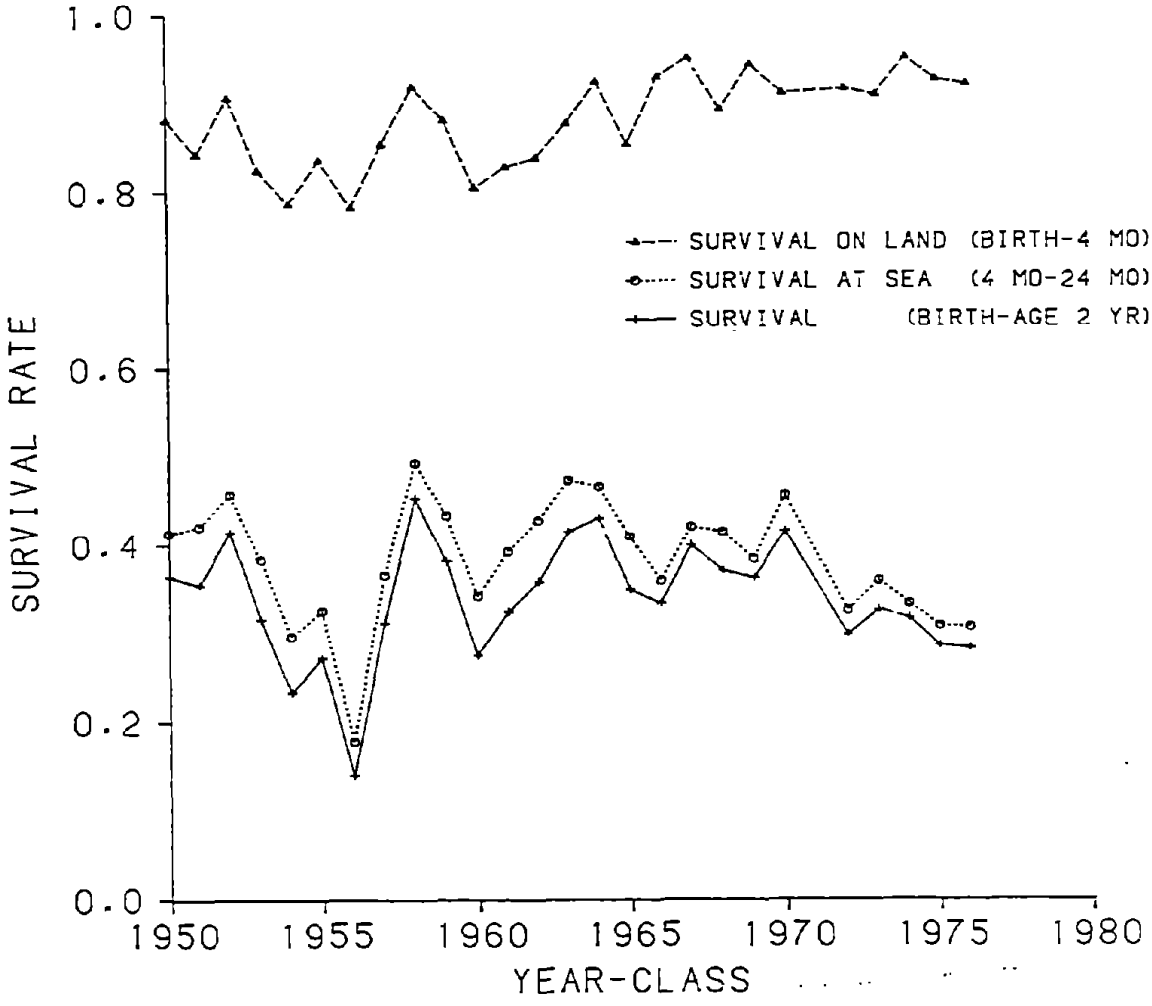

Figure 15.--Survival on land (birth - age 4 mo), survival at sea (age 4 mo-2 yr), and total survival (birth-2 yr) for male northern fur seals of the 1950-76 year classes of St. Paul Island, Alaska.

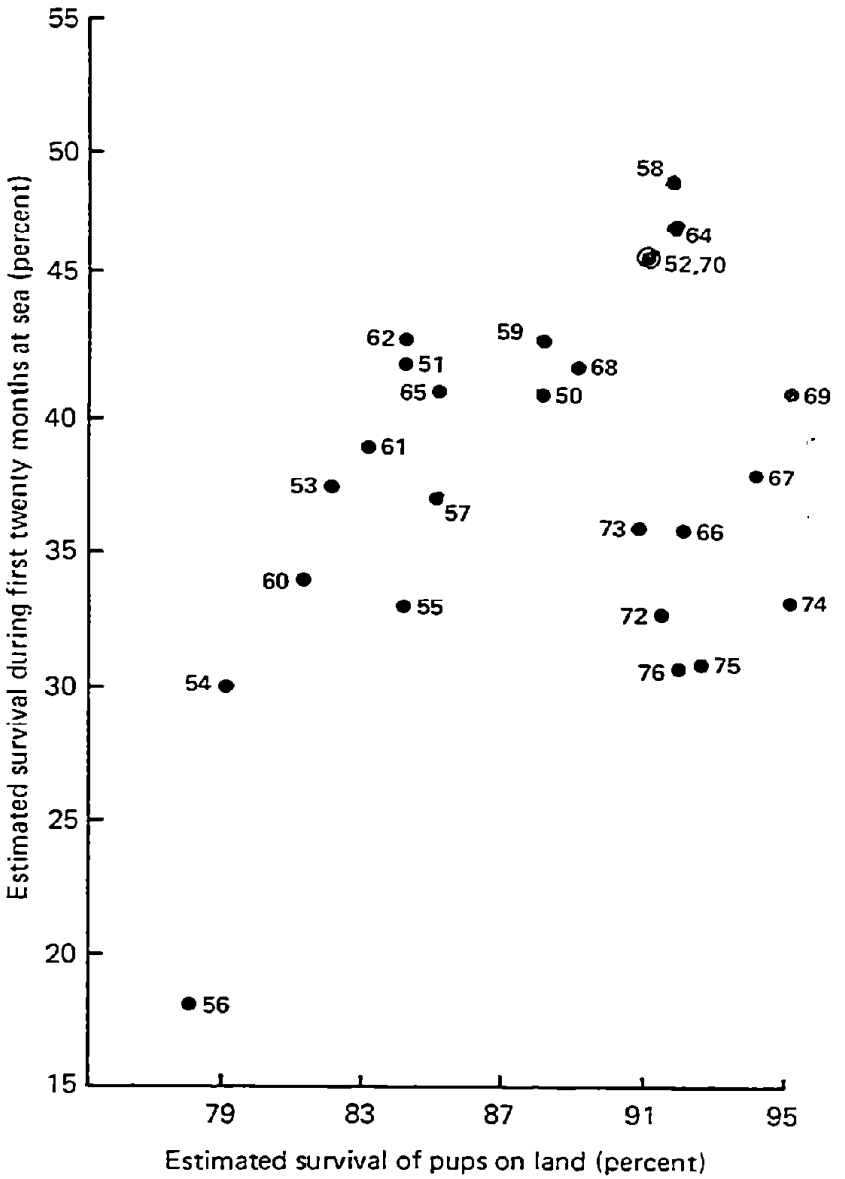

Figure 16.--Survival at sea (age 4 mo-age 24 mo) versus survival on land (birth-age 4 mo) for male northern fur seals of the 1950-76 year classes of St. Paul Island, Alaska.

The grouping of years in Figure 16 suggests that the relationship between survival at sea and survival on land was shifting during the late 1960s and that the high survival rates on land after 1970 are associated with lower survival rates at sea than those occurring before 1965. The pattern in Figure 16 is similar to Figure 17 (Fig. 2 in York 1983) which shows age at first reproduction of females versus juvenile survival. Age at first reproduction is lower for cohorts with higher survival, but that relationship appears to have shifted abruptly beginning with the 1956 year class in such a way that the same survival rate for post-1956 cohorts was associated with an older age at first reproduction than for pre-1956 cohorts. It is possible that the phenomena illustrated in Figures 16 and 17 are related. One interpretation is that pups born to females from post-1956 year classes exhibit lower fitness--measured by the ability to survive at sea. This is consistent with age at first reproduction decreasing abruptly and oceanic survival (from age 4 mo to age 24 mo) decreasing slowly, since pre-1964 pup classes were from mothers of pre-1956 cohorts, pups born from 1964-70 were from mothers of a mixture of pre- and post-1956 cohorts, and almost all pups born after 1970 were born of mothers from post-1956 cohorts.

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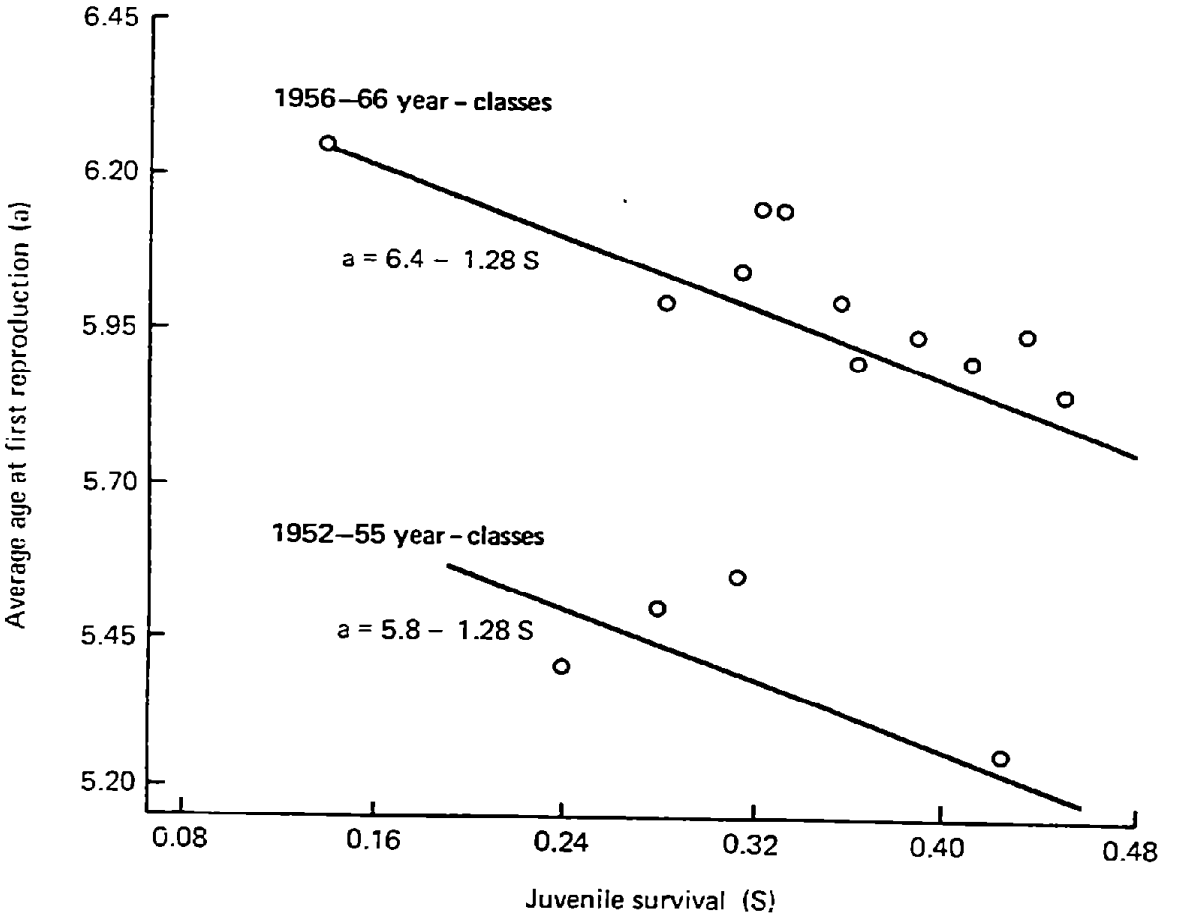

Figure 17.--Age at first reproduction of female northern fur seals as a function of Lander's (1979) juvenile survival estimates for the 1952-66 year classes. Age is regressed on survival with separate intercepts for the 1952-55 and 1956-66 year classes (Fig. 2, from York 1983).

II. BEHAVIOR AND BIOLOGY, PRIBILOF ISLANDS

In 1982, baseline behavioral studies were repeated at Zapadni and East Reef Rookeries, and additional studies were conducted on the energetics of lactation using radioactive tracers. Six females were released with time-depth recorders; these females were also injected with a radioactive substance by which an estimate will be made of the energetic cost of carrying the instrument. Another attempt was made to start a new rookery near East Reef Rookery, and special studies were conducted on sea lion predation of fur seal young and on the movements of marked pups on the rookery. Finally. 1,025 pups were tagged on East Reef and Zapadni Rookeries, and 106 adult females were tagged at Kitovi Rookery for future behavioral studies.

Work Plan

Observations were made daily on East Reef and Zapadni Rookeries from 20 May through 29 August (approximately 778 worker hours) to collect data on herd size, composition, and behavior. The energetics of lactation were studied from 7 July to 30 August (approximately 1,000 worker hours), and 370 h were devoted to studying pup movements. Six workers comprised the 1982 field effort. Table 16 shows the age and sex classes, number. and locations of seals permanently marked in 1982.

Energetics of Lactation

Emaciation syndrome is the largest single cause of death among newborn fur seals. It represents some interruption in the flow of energy from pelagic prey species to young fur seals in the form of milk. In 1981 and 1982, an attempt was made to characterize energy flow by dividing a female's energy budget into components and measuring each by the dilution rate of injected radioactive substances. The components were 1) the rate of energy consumption during the first 7 days postpartum when females fast and lactate, 2) the rate of energy expenditure while foraging, and the energy obtained as food during 6-day feeding excursions, and 3) the rate of energy expenditure on 2-day visits to shore separating trips to sea.

Rate of energy consumption immediately postpartum--The energy expended during fasting is composed of maintenance metabolism plus the metabolic cost of lactation. To measure maintenance metabolism, six females were taken captive before parturition, and were injected intravenously with tritiated water (HTO) immediately postpartum. Blood samples taken 3 h later gave an estimate of initial total body water. Blood samples drawn serially over the next 7 days were analyzed for plasma specific activity. In a fasting, nondrinking animal, body water is derived only from metabolic processes (mainly fat catabolism). Therefore, the dilution rate of labeled water molecules in the initial pool of body water was proportional to the influx of metabolic water, which was proportional to metabolic rate. The contribution of protein

Table 16.--Tags applied to northern fur seals for studies of behavior, Pribilof Islands, Alaska, 1982.

Type and color of tag	Tag number	Age-sex class	Number of seals tagged	Rookery[a]
Monel, white	X466-X470 X472	Adult male	5	Zapadni
Plastic Roto, white	1787-1788	Adult female	2	East Cliff
	1789-1820 1823-1824	Adult female	33	East Reef
	1821-1822	Adult female	2	Staraya Artil
	1836-2000	Female pup	165	East Reef
Plastic Roto, yellow	3913-3916	Subadult male	4	East Reef
Plastic Roto, blue	1201-1339	Female pup	139	East Reef
Plastic Roto, green	231-236(less 234) 260-269 280 300-306(less 304) 309-316 321-323 326,333 342,399	Male or female pup	34	East Reef
	401-587	Female pup	187	Zapadni
	588-668	Adult female	80	Zapadni
Plastic Riese, yellow	4501-4805	Male pup	305	East Reef
	4806-5000	Male pup	195	Zapadni
	5001-5002	Subadult male	2	East Reef
	5004-5114 (less 5049, 5050, 5093)	Adult female	107	Kitovi (St. Paul Is.)

[a] Tags were applied to seals on St. George Island uniess otherwise specified.

contribution of protein metabolism to total maintenance metabolism was determined by injecting the same females with ^{14}C-labeled urea. The dilution rate of this molecule over time gave an index to total urea production which was proportional to protein deamination. The contribution of fat metabolism to total maintenance metabolism was obtained by subtracting protein metabolism from total metabolism. Protein metabolism contributed only 1.9% of total metabolism, an amount comnparable to fasting elephant seals, but much lower than in fasting terrestrial mammals.

The metabolic cost of lactation was estimated for the six females by determining the amount of milk obtained by their suckling offspring. Since milk is the only source of preformed water for pups, its consumption rate can be estimated by the difference between total water turnover, via the HTO turnover technique, and metabolic water production. (Metabolic water production was measured independently in the fasting pups.) The relative contributions of fat and of protein to energetics of milk production were estimated from the composition of milk samples from the same females (46% fat, 13% protein. 46% water, 0% carbohydrate).

The average rate of energy expenditure during the first 7 days postpartum was 7.0 W/kg, of which 3.0 W/kg were attributable to the energetic cost of lactation (Fig. 18). This rate is equivalent to the transference of 3,920 ml of milk over the 7-day period. This rate of energy expenditure is approximately 3.3 times higher than the standard metabolic rate for a terrestrial lactating mammal of equal mass.

Rate of energy expenditure at sea--The energy budget of females at sea consists of the total amount of food ingested minus the energy utilized while foraging. The total amount of food consumed by the six females was estimated by the turnover rate of HTO that was injected before they went to sea, and sampled upon their return to land. This method assumes that females do not drink seawater, and it gives different values depending on the assumptions used in the composition of the diet. Separate validation studies have shown that seawater ingestion during feeding is negligible. Total energy obtained is estimated as 5.5 W/kg assuming the diet is 100% squid and 10.7 W/kg assuming 100% herring.

Using the hypothetical diet of 66% fish and 34% squid (Perez and Bigg in press), total ingested energy was estimated as 7.7 W/kg during 6-day trips to sea. On this estimated amount of food, all of the females gained weight at an average rate of 2.3% per day (0.74 kg/day).

The metabolic cost of foraging was estimated by the doubly-labeled water method. In this method, HTO indicates total water turnover. ^{O}18 labeled water indicates water and CO_2 turnover, and the difference between the two dilutions gives CO_2 production from metabolism.

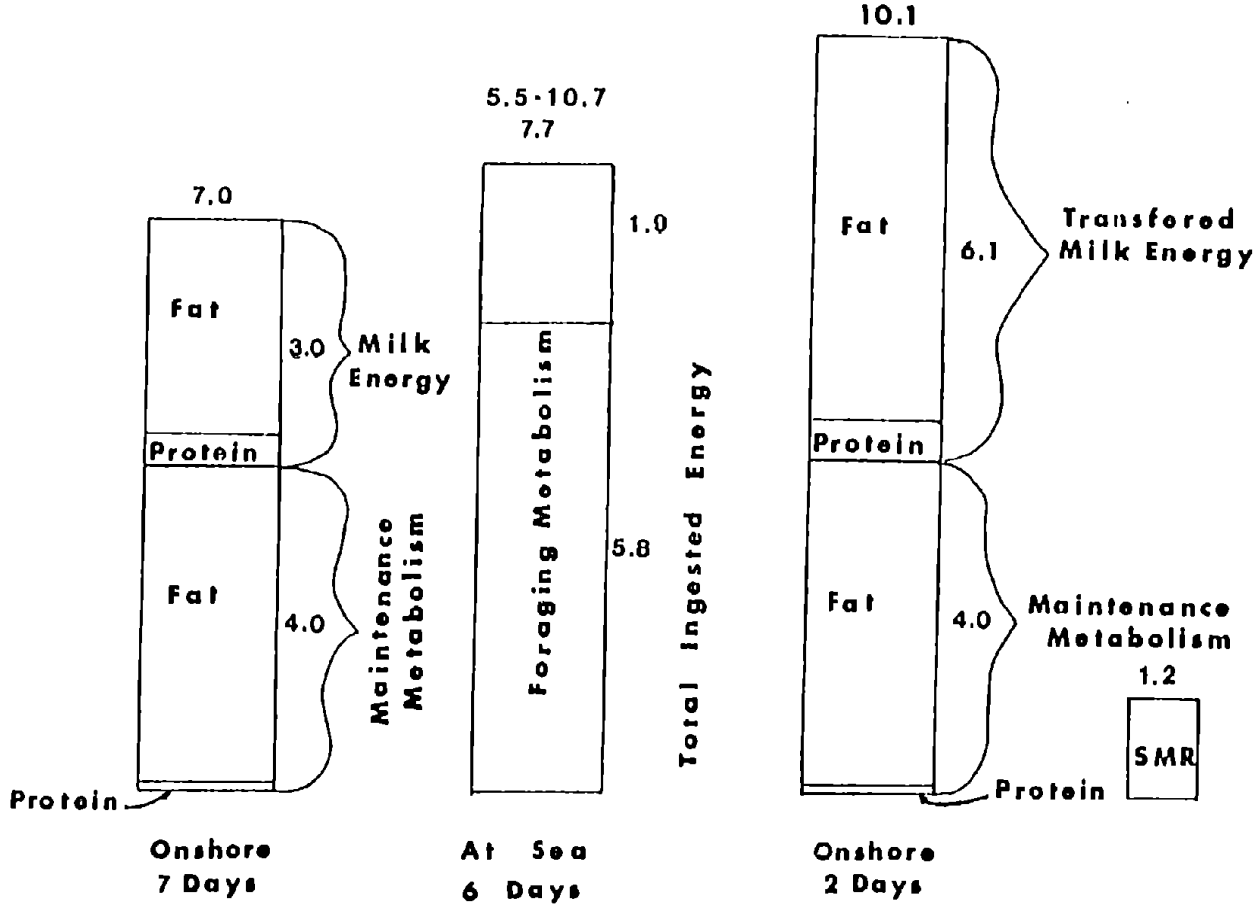

Figure 18.--The energy budget for lactating female Callorhinus during the first 7 days postpartum while the female fasts and lactates, during a 6-day trip to sea during which lactation is suspended and the female gains energy from foraging and uses energy swimming, and during a typical 2-day visit to shore between trips to sea when the female again fasts and lactates. Total energy in W/kg is reported at the top of each column with the proportion attributable to fat and protein metabolism listed separately. SMR = Standard Metabolic Rate of a terrestrial mammal of comparable mass.

The energetic cost of foraging, 5.8 W/kg (Fig. 18), was only 1.2 times greater than the fasting metabolic rate while on shore. This indicates the females foraged at sea with relatively little metabolic cost. The foraging efficiency while at sea was 1.3 (7.7 W/kg gross energy consumed/5.8 W/kg foraging metabolism). No equivalent measure is available for any other seal species. A small deduction must be made from the net gain of energy (1.9 W/kg) for the energetic cost of urine and feces production. The foraging metabolic rate of 5.8 W/kg equals 4.8 times the standard metabolic rate of a typical terrestrial mammal of the same mass.

Rate of energy consumption during two-day suckling visits--Energy expended during 2-day visits to shore was measured as during the first 7 days postpartum. No direct measures of maintenance metabolism were made during these short visits. Instead, it was assumed that this rate would be the same as during the 7-day postpartum interval. The energetic cost of lactating was measured indirectly via the amount of milk consumed by a pup during its mother's visit. The pups were captured just prior to their mothers' returns from sea and were injected with HTO. After their mothers had suckled and departed, the pups were recaptured and blood samples were taken. The decline in labeled molecules in postsuckling samples, compared to presuckling levels, indicated the total milk consumed when appropriate corrections were made for milk composition and for metabolic water production by the pups.

Milk was consumed at a greater rate during the P-day visits than during the 7 days following birth (6.1 compared to 3.0 W/kg) (Fig. 18). This trend may reflect a pup's greater stomach capacity and greater suckling efficiency with advancing age. The cost of lactation (6.1 W/kg) is the equivalent of transferring 1,961 ml of milk in 2 days. Females make an average of 10 such visits to the island before weaning occurs. Validation studies in which captive pups were force-fed known quantities of milk show that the HTO estimation method was from -4% to 7% accurate, and that the efficiency of converting milk into body mass was 28% for four pups- It is estimated that 24-26 liters of milk are required for pups to reach weaning weight.

Predation by Northern Sea Lions

Predation on fur seal young by sea lions at St. George Island occurs from the time the pups first enter the water until they are weaned and leave the island. In 1975, a comprehensive study of this predation was conducted; results included an estimate of total rate as well as hourly and geographic variations in rate (Gentry and Johnson 1981). Sea lion predation has not been quantified since 1975, and long-term changes are unknown.

In 1982, sea lion predation was observed and quantified at East Reef Rookery, one of the five sites used in the 1975 study. Observations were made from a blind during 14-29 August, totaling 57 hours of observation and ranging from 0700 until 1200, and from 1900 to 2200 by hour of day. Observations were made in the same manner as in 1975 except that a kill was recorded only when the prey was positively identified as a fur seal pup.

Table 17 categorizes total kills, observer hours, and kills per hour for 1975 and 1982 by hour of day. A comparison of the mean hourly kill-rate per site in 1975 (0.41, SD = 0.18) and the hourly kill-t-ate in 1982 for East Reef only (0.17, SD = 0.28) showed they were not significantly different (t test, p= 0.06).

The comparison between years is tentative because 1982 data were collected a month earlier and later into the evening than the 1975 data. Furthermore. the island-wide estimate from 1975 included two areas having very high rates whereas the 1982 data covered only one site. Therefore, long-term comparisons of rate are not valid using the 1982 data. These observations do demonstrate, however, that sea lion predation is a continuing phenomenon at St. George Island, and was not a one-time event relevant only to the early 1970s.

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Table 17.--Sea lion predation on northern fur seal young, predation rate by hour for 1975 and 1982. (1975 data represent predation at five sites from 23 September to 4 November; 1982 data represent predation East Reef Rookery from 14 to 29 August)

Hour	Total kills		Observer hours		Kills per hour	
	1975	1982	1975	1982	1975	1982
0701-0800	-	0	-	7.00	-	0.00
0801-0900	12	2	18.80	15.00	0.64	0.13
0901-1000	11	0	30.00	14.50	0.37	0.00
1001-1100	8	0	30.00	10.75	0.27	0.00
1101-1200	5	0	24.10	0.50	0.21	0.00
1201-1300	-	-	-	-	-	-
1301-1400	9	-	19.30	-	0.47	-
1401-1500	5	-	29.00	-	0.17	-
1501-1600	15	-	30.00	-	0.50	-
1601-1700	15	-	23.80	-	0.63	-
1701-1800	-	-	-	-	-	-
1801-1900	-	-	-	-	-	-
1901-2000	-	0	-	2.25	-	0.00
2001-2100	-	2	-	4.25	-	0.47
2101-2200	-	2	-	2.75	-	0.73
	80	6	205.00	57.00	$\bar{x}$=0.41 SD=0.18	$\bar{x}$=0.17 SD=0.28

III. POPULATION GROWTH AND BEHAVIOR, SAN MIGUEL ISLAND (ADAMS COVE AND CASTLE ROCK)

Adams Cove

During the 1982 field season, research activities included population monitoring, a pup tagging program, a female feeding behavior study, and a female nursing cycle study.

Population Information

The more important population information for the Adams Cove colony is summarized in Table 18. The 1982 field season commenced on 9 June, at which time there were 7 large adult territorial males. 28 subadult males (bachelors), 20 adult females, and 5 live pups. In 1982, a total of 1,029 pups were born, representing an increase of 8.5% from 1981.

The total number of territorial males increased from 21 in 1981 to 30 in 1982. Five of these territorial males were known to be 7 years of age (tagged as pups in 1975). A maximum count of 88 bachelors was recorded on 31 August.

The greatest number of adult females on land occurred on 8 July when 628 were counted.

Tagging Program and Records

The fur seal pup tagging program on San Miguel Island began in 1975, and the subsequent resightings of these tagged animals on the island are shown in Appendix A, Table A-10. Tag resightings have also been obtained when dead or emaciated pups of the year are found on beaches or adrift at sea. Most of these tag recoveries have been recorded north of Point Conception along the coasts of California, Oregon and Washington. The northernmost record of the stranding of a pup occurred in the Queen Charlotte Islands, at Shingle Bay, Sandspit, British Columbia.

In order to compare tag longevity (durability and retention) and long-distance identification, three different types of tags were used to mark 300 fur seal pups at Adams Cove. On 29 September, 100 fur seal pups were double-tagged with pink Roto-tags (hard plastic), 100 were double-tagged with green Riese-tags (flexible plastic), and 100 were double-tagged with modified (round posts) monel cattle ear tags.[2] All tagged pups were checkmarked by removing the cartilaginous extension of the first digit on the left hind flipper (Appendix A, Tables A-11, A-12, and A-13).

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

Table 18.--Summary of some observations of the northern fur seal colony in Adams Cove, San Miguel Island, California, 1969-82.

Observation	1969	1970	1971	1972	1973	1974	1975
Season span							
Beginning date[a]	16 May	23 May	15 May	16 May	9 May	20 May	19 May
Ending date	1 Oct.	20 Sept.	6 Sept.	7 Sept.	15 Aug.	9 Sept.	6 Sept.
First male	16 May	29 May	24 May	16 May	26 May	20 May	12 May
First female	27 May	28 May	25 May	22 May	17 May	20 May[b]	19 May
First birth	6 June	28 May	31 May	22 May	7 June[c]	27 May	27 May
Mean birth date	24 June	21 June	26 June	22 June	24 June	23 June	27 June
Total births	28	33	45	70	68	220	329
Total pup deaths	2	14	15	21	17	52	46
Total females (maximum counted and date)[d]	175 23 Aug.	179 23 Aug.	274 2 Sept.	310 16 Aug.	394 4 Aug.	551 8 Sept.	563 24 Aug.
Total large adult males	4	2	4	6	6	6	10[e]
Total small adult males	4	4	6	7	5	6	6
Total bachelors[f]	4	5	6	10+	6	8	7

Table 18.--Continued.

Observation	1976	1977	1978	1979	1980	1981	1982
Season span							
Beginning date[a]	29 May	18 May	17 May	15 May	17 May	9 June	9 June
Ending date	14 Sept.	22 Sept.	9 Sept.	15 Sept.	23 Sept.	13 Sept.	6 Dec.
First male	29 May[g]	18 May[h]	17 May[b]	21 May	17 May[j]	9 June[k]	9 June[p]
First female	29 May[g]	18 May[h]	17 May[l]	16 May[m]	23 May	9 June[k]	9 June[p]
First birth	29 May[i]	29 May	30 May	28 May	24 May	9 June[k]	9 June[p]
Mean birth date	29 June	25 June[n]	24 June	29 June	29 June	26 June	25 June[n]
Total births	417	421	635	834	896	941	1,029
Total pup deaths	91	64	77	72	103	289	51
Total females (maximum counted and date)[d]	495 14 July	681 26 Aug.	584 18 Aug.	702 25 Aug.	665 31 Aug.	717 1 July	628 8 July
Total large adult males	7	7	13[f]	11	9	10	30
Total small adult males	5	3	12[o]	13[o]	10	11	22[q]
Total bachelors[f]	11	7+	19	50	68	95	88

[a] Beginning and ending dates of continuous observations.
[b] May have arrived earlier.
[c] One still birth occurred on 19 May.
[d] A few 2-, 3-, and 4-year-old males may have been included because they are about the same size as adult females.
[e] Includes two males who arrived in late August and were not territorial (probably from Castle Rock).
[f] Subadult males about 104-127 cm in body length, tip of nose to tip of tail.
[g] Four males, nine females present 29 May--arrived prior to 29 May.
[h] Three males and 2 females present 18 May--arrived prior to 18 May.
[i] One pup present 29 May--born prior to 29 May.
[j] Two males present 17 May--arrived prior to 17 May.
[k] Seven males, 86 females, and 24 pups present 9 June--arrived prior to 9 June.
[l] Two females present 17 May--arrived prior to 17 May.
[m] Four females present 16 May--arrived prior to 16 May.
[n] Estimated from previous breeding season information.
[o] Includes six small adult males who were not territorial.
[p] Seven adult males, 28 subadult males, 20 females, and 5 pups present.
[q] None of these males were territorial.

Records have been kept of tagged seals observed ashore in Adams Cove since 1968. In recent years, reading tag numbers has become increasingly difficult due to a redistribution of fur seals into areas which are in excess of 200 m from observational sites. The redistribution resulted in a relatively small number of monel tag returns for 1982 and a proportionally higher frequency of plastic Roto-tag returns which had numbers that were more easily read.

In 1982, the only record of a fur seal from another rookery was a female with a pup of the year (U5791, St. George Island, Alaska). Other records of tag resightings have been kept for adult females and juvenile males that have been tagged on San Miguel Island (Appendix A, Tables A-14. A-15, and A-16).

Mortality on Land

The mortality of the fur seal pups born in Adams Cove decreased from 31% (289) in 1981 to 5% (51) in 1982. The primary reason for the difference in mortality between the 2 yr was that periods of abnormally hot weather conditions occurred more frequently in 1981 (i.e., high air and sand temperatures, solar radiation, and low wind speed combine to raise a fur seal's body temperature and cause heat prostration). In 1982, this phenomenon only occurred on two occasions (29 June and 3 July), when 24 pups died; the cause of death for the other 27 was undetermined. One adult male fur seal and another seal of unknown sex died on land of unexplained causes during the 1982 field season.

Female Nursing Cycle

In 1982, a study of female nursing cycles was conducted in order to determine how they partitioned their time on land and at sea during the period from parturition to weaning. Forty-eight females with distinct natural markings were studied from 15 June to 27 November. Of these females, the cycles of 22 individuals with the most complete records were used to calculate the information presented in this report.

After parturition, the females remained on land for an average of 6.5 days before beginning feeding forays at sea which averaged 8.7 days. The mean time on land was 1.8 days; however, the final time period on land was usually longer, averaging 3.5 days. The mean duration from birth to weaning was 142 days (range: 101-180 days), assuming that the date of weaning began with the last day a female was observed on land. This assumption may have biased the results towards a longer mean time from parturition to weaning since some pups reportedly wean themselves by going to sea before their mothers return to land for the last time. (Macy 1982).

Female Diving/Feeding Behavior Study

In order to obtain information about possible competition for food between northern fur seals and California sea lions, Zalophus californianus, in the waters around San Miguel Island, a comparative feeding behavior study of the two species was conducted at Adams Cove. Seven parturient female fur seals and 13 parturient female sea lions were fitted with harnesses upon which were attached time-depth recorders and radio frequency transmitters. The instruments were removed from the animals upon their return to the island after a single feeding foray at sea. The instruments were recovered from six fur seals and from all the sea lions; one fur seal failed to return to the island and was assumed to have died. At the time of recapture, the animals were given enemas to recover identifiable hard parts from food remains. Scats from each species were also collected from their rookeries to determine feeding modes and to compare with food remains obtained from the instrumented females.

Time at sea for the instrumented female fur seals averaged 15 days (range: 7-26 days, n=6) which was more than twice as long as noninstrumented females observed during the same time period (x=6.5 days, n=22). To assess if the drag created by the harness or the added mass of the time-depth recorder was responsible for extending an animal's at-sea time, we instrumented one female with only a harness and radio frequency transmitter. The animal remained at sea 12 days compared to at-sea times of 12, 13, and 7 days for three other females instrumented with radio frequency transmitters and time-depth recorders at about the same time. Thus, it appears that the encumberance of the harnesses was responsible for extending the nursing females' feeding cycles.

Castle Rock

A summary of census information for Castle Rock is presented in Table 19 for 1972-82. In 1982, a count of 680 pups (646 live and 34 dead) was obtained on 21 July, representing an increase in pup production of 83 animals (14%) from 1981. For the last 7 years, however, pup production on Castle Rock has fluctuated within a range of + 80 pups, suggesting a stabilization in that colony's growth in contrast to the continued growth of the Adams Cove colony.

Twenty-seven breeding males were counted on Castle Rock from aerial photographs taken on 2 July 1982, representing a decrease of 1 breeding male since 1981. On 1 October, 100 fur seal pups were double-tagged with monel and pink Roto-tags. Monel and pink Roto-tags were attached to the right and left foreflippers of the males, respectively. The placement of the tags was reversed for the female pups. Each seal was checkmarked by removing the cartilaginous extension on the first digit of the left hind flipper (Appendix A, Table A-17).

Robert L. DeLong
George A. Antonelis, Jr.

Table 19. --Summary of censuses of northern fur seals, Castle Rock, California, 1972-82.

Fur seals	Numbers observed, methods and date of observation				
	1972	1973	1974	1975	1976
Females	223[a] 1 Aug.	345[a] 11 July	301(+)[d] 2 Aug.	396(+)[d] 2 Aug.	526[c] 27 June
Pups (total observed)[e]	95[a] 1 Aug.	193[b] 28 July	301(+)[b] 2 Aug.	396[b] 2 Aug.	521[b] 25 July
Pups (dead observed)	- -	33[b] 28 July	21[b] 2 Aug.	28[b] 2 Aug.	27[b] 25 July
Reproductive large adult males[f]	9[a] 1 Aug.	13[a] 11 July	11[a] 2 July	15[a] 1 July	16[c] 27 June
Total large adult males	10[a] 1 Aug.	14[a] 11 July	20[a] 2 July	20[a] 1 July	18[c] 27 June
Total small adult males	- -	- -	- -	- -	- -

Table 19.--Continued.

Fur seals	Numbers observed, methods and date of observation					
	1977	1978	1979	1980	1981	1982
Females	617(+)[d] 29 July	533(+)[d] 2 Aug.	653(+)[d] 1 Aug.	563(+)[d] 1 Aug.	597(+)[d] 27 July	680(+)[d] 31 July
Pups (total observed)[e]	617[b] 29 July	533[b] 2 Aug.	653[b] 1 Aug.	563[b] 1 Aug.	597[b] 27 July	680[b] 31 July
Pups (dead observed)	20[b] 29 July	26[b] 2 Aug.	27[b] 1 Aug.	38[b] 1 Aug.	29[b] 27 July	34[b] 31 July
Reproductive large adult males[f]	9(+)[a] 26 July	20[a] 1 July	27[a] 3 July	27[a] 1 July	28[a] 2 July	27[a] 2 July
Total large adult males	9(+)[a] 26 July	25[a] 1 July	32[a] 3 July	32[a] 1 July	29[a] 2 July	38[a] 2 July
Total small adult males	- -	- -	7[a] 3 July	2[a] 1 July	12[a] 2 July	7[a] 2 July

[a] Counts obtained through aerial photographs.
[b] Land based counts from afoot.
[c] Offshore counts from skiff.
[d] Minimum estimate from pup count.
[e] Includes dead pup count.
[f] Territorial adult males with females.

IV. PELAGIC ECOSYSTEM

Opportunistic Feeding of Northern Fur Seals in the Eastern North Pacific Ocean

Background

This summary of the basis for concluding that the feeding of northern fur seals in the eastern North Pacific is opportunistic in nature is taken from Kajimura (1984). The information used in reaching this conclusion was obtained primarily in areas off California and the eastern Bering Sea and focused on the principal forage species of fur seals as based or stomach content volume and the relative abundance of fishery resources available in the area.

The dietary studies reported here are based on feeding data collected during pelagic fur seal research carried out by Canada and the United States during 1958-74 from California to the eastern Bering Sea. For this study the eastern North Pacific region was divided into seven collection areas (Fig. 19) with boundaries [in brackets] as follows: 1) California [32°00' to 42°00'N]; 2) Oregon [42°OO' to 46°00'N]; 3) Washington [46°00' to 49°00'N]; 4) British Columbia [49°00' to 54°30'N and 146°OO'W]; 5) Gulf of Alaska [54°30'N to coast and 158°OO'W, and 49°OO' to 54°30'N between 146°OO' and 158°OO'W]; 6) western Alaska [west of 158°OO'W and north of 49°00'N, and north to the Alaska Peninsula and Aleutian Islands]; and 7) eastern Bering Sea [north of the Alaska Peninsula and Aleutian Islands].

General Distribution and Feeding at Sea

The eastern Pacific (Pribilof Islands) populations of northern fur seals are found throughout their subarctic range from California to the Bering Sea in nearly all months of the year with peak abundance varying by time and area. Most of the Pribilof Island fur seals spend about half the year at sea (Gulf of Alaska to California from November through May-June). Two additional rookeries of the eastern North Pacific Ocean population are located near the southern limit of the fur seal's range off southern California on San Miguel Island (discovered 1968 with about 100 animals) and nearby Castle Rock (discovered in 1972). Censuses in 1979 showed that the number of seals in these colonies had grown to about 3,000 animals, and as a result. they now may be playing an important role as year-round residents in California waters (e.g., marine mammal-fishery interaction).

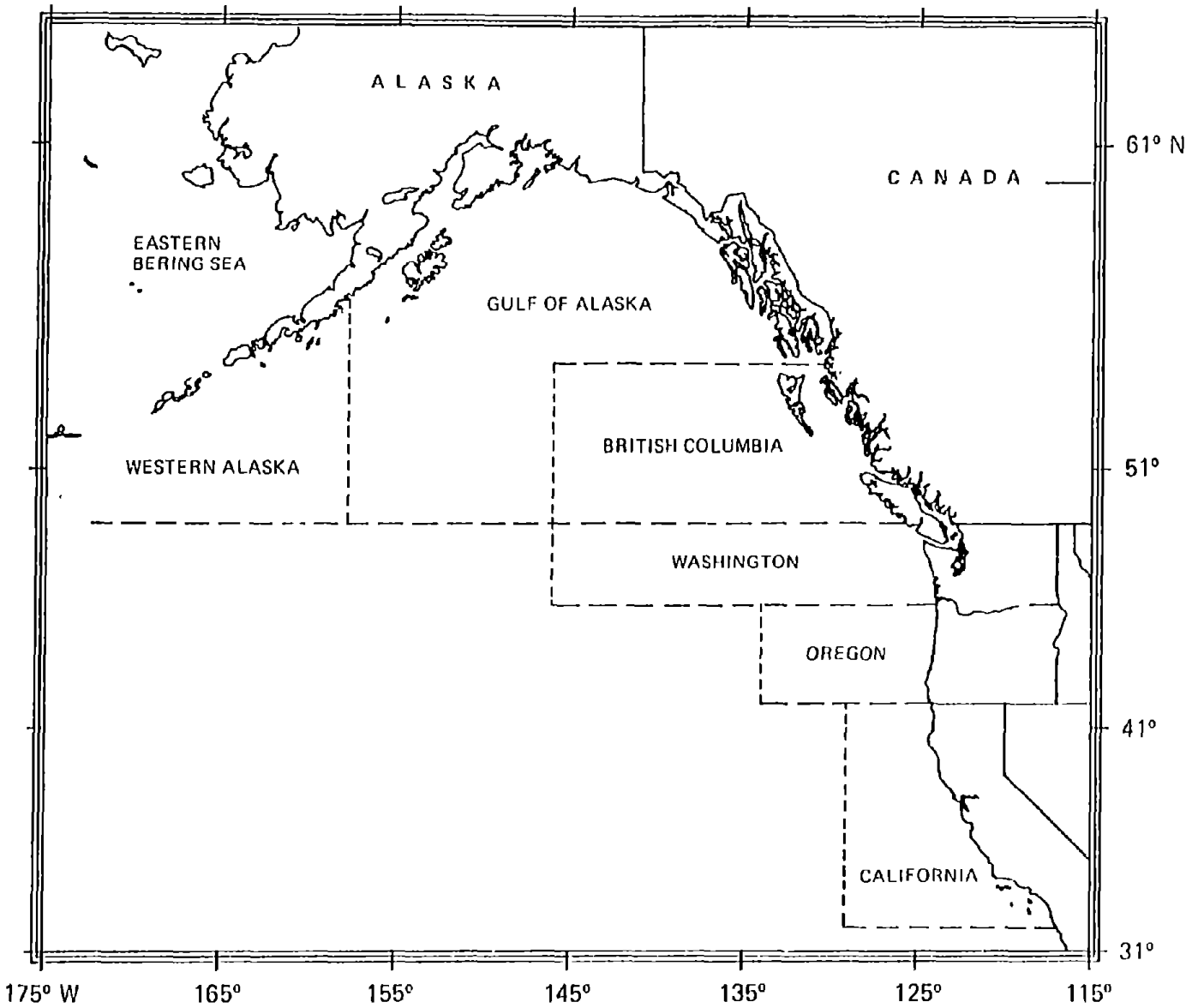

Figure 19. --The collection areas of northern fur seals, 1958-74.

Fur seals are most frequently seen in greatest numbers along the continental shelf and slope throughout their range primarily because of abundant food resources in these areas. Fur seals feed on a variety of fishes and squids throughout their range. As a general rule, smaller schooling fishes and "coastal" squids are the principal forage species over the continental shelf region and oceanic squids are important over deep-water areas seaward of the continental shelf and slope.

Fishery Resources Significant to Fur Seals

Examining the variety of prey consumed by fur seals throughout their eastern Pacific range has led to the identification of about 53 species of fish and 10 species of squid from the stomachs of fur seals (Tables 20 and 21). From this total, about 14 species of fish and 6 species of squid are considered the principal prey of fur seals (Table 22). The principal prey species of fur seals in each study area, based on stomach content volume (four largest by month and area), does not change even though the ranking by volume within this list may change from area to area.

California--The leading four prey species (Engraulis mordax, Meriuccius productus, Loligo opalscens, and Cololabis saira) consumed by fur seals during 6 yr of collection (January through June 1958-66) off California contributed 82% to 99% of the total stomach content volume. From a total of 26 species of fish and 8 species of squid identified in stomachs of fur seals taken off California, a total of 6 species of fish and 2 species of squid (Trachurus symmetricus, Sebastes spp., Anoplopoma fimbria, and Onychoteuthis considered the principal prey of fur seals in this area based on percentage of total stomach content volume (Table 22).

The relative abundance of fishery resources available in the California Current System have been determined from egg and larvae surveys conducted by the California Cooperative Oceanic Fisheries Investigations (CalCOFI). The comparison of the leading prey species of fur seals and the relative abundance of major fishery resources off California is shown in Table 23.

Bering Sea--Similarly to California, the principal prey species in the Bering Sea (Table 22) contributed 75% to 99% of the total stomach content volume during the 7 yr of collection. The majority of the samples were collected during July, August, and September while others were taken in June and October. From a total of 23 species of fish and 3 species of squid identified in stomachs of fur seals taken in the Bering Sea, only 4 species of fish and 2 species of squid were considered the principal prey of fur seals in this area. The comparison of the leading prey species of fur seals and the relative abundance of major fishery resources in the eastern Bering Sea is shown in Table 23. Principal forage species of fur seals not among the trawl catches include Atka mackerel, Pleurogrammus monopterygius, and oceanic squids of the family Gonatidae.

Table 20---Fishes eaten by northern fur seals in the eastern North Pacific Ocean and eastern Bering Sea, 1958-74 by area.

Food items	Location						
	California	Oregon	Washington	British Columbia	Gulf of Alaska	Western Alaska	Bering Sea
Lampetra tridentata	+	+	+	+	+	+	+
Squalus acanthias	+	-	-	-	-	-	-
Hydrolagus colliei	-	-	+	+	-	-	-
Clupeidae	+	-	+	+	+	-	-
Alosa sapidissima	+	+	+	-	-	-	-
Clupea harengus pallasi	+	+	+	+	+	+	+
Engraulis mordax	+	+	+	-	-	-	-
Salmonidae	-	-	+	-	-	+	+
Oncorhynchus spp.	+	+	+	+	+	+	+
O. gorbuscha	-	-	+	-	+	+	+
O. keta	-	-	+	+	+	+	+
O. kisutch	-	-	+	-	+	+	-
O. nerka	-	-	+	-	-	+	+
O. tshawytscha	-	-	+	-	+	+	-
Salmo gairdneri	-	-	+	-	-	-	-
Osmeridae	-	-	+	+	+	+	+
Hypomesus pretiosus	+	-	+	+	-	-	-
Mallotus villosus	-	-	+	-	+	+	+
Thaleichthys pacificus	+	-	+	+	+	-	+
Bathylagidae	-	-	+	-	-	-	+
Tactostoma macropus	+	-	-	-	-	-	-
Scopelosaurus sp.	-	+	-	-	-	-	-
Paralepis atlantica	+	-	+	-	-	-	-
Myctophidae	+	+	+	-	+	-	+
Tarletonbeania crenularis	+	+	+	-	-	-	-
Symbolophorus californiensis	+	-	-	-	-	-	-
Lampanyctus sp.	-	-	-	-	-	-	+
Anotopterus pharao	-	-	-	-	+	-	-
Cololabis saira	+	+	+	+	+	-	-
Gadidae	-	-	+	+	+	+	+
Gadus macrocephalus	-	-	-	+	+	+	+
Merluccius productus	+	+	+	+	-	-	-
Microgadus proximus	-	-	+	-	+	-	-
Theragra chalcogramma	-	-	+	+	+	+	+
Gasterosteus aculeatus	-	-	+	+	+	-	-

Table 20.--Continued.

Food items	Location						
	California	Oregon	Washington	British Columbia	Gulf of Alaska	Western Alaska	Bering Sea
Trachipteridae	+	-	+	-	-	-	-
Trachipterus altivelis	+	+	+	-	-	-	-
Trachurus symmetricus	+	+	+	-	-	-	-
Sciaenidae	+	-	-	-	-	-	-
Brama japonica	+	-	+	-	-	-	-
Medialuna californiensis	+	-	-	-	-	-	-
Scomber japonicus	+	-	-	-	-	-	-
Sebastes spp.	+	+	+	+	+	+	+
S. alutus	-	-	-	-	+	-	-
S. entomelas	-	-	+	-	-	-	-
S. jordani	+	+	-	-	-	-	-
Anoplopoma fimbria	+	-	+	+	+	+	+
Hexagrammidae	-	-	+	-	-	-	+
Pleurogrammus monopterygius	-	-	-	-	-	+	+
Cottidae	-	-	-	-	-	+	+
Cyclopteridae	-	-	-	-	+	+	+
Aptocyclus ventricosus	-	-	-	-	-	-	+
Trichodontidae	-	-	-	-	-	-	+
Trichodon trichodon	-	-	-	-	+	+	+
Ammodytes hexapterus	-	-	+	+	+	+	+
Bathymasteridae	-	-	-	-	-	-	+
Bathymaster signatus	-	-	-	-	-	+	-
Anarhichadidae	-	-	-	-	-	-	+
Anarhichas orientalis	-	-	-	-	-	-	+
Zoarcidae	-	-	+	-	-	-	-
Tetragonurus cuvieri	-	-	+	-	-	-	-
Atherinopsis californiensis	+	-	-	-	-	-	-
Pleuronectiformes	-	-	+	-	-	-	-
Citharichthys sp.	+	-	-	-	-	-	-
Pleuronectidae	+	-	+	+	+	-	+
Atheresthes stomias	-	-	-	-	+	+	-
Hippoglossus stenolepis	-	-	-	-	-	-	+
Lyopsetta exilis	+	+	-	-	-	-	-
Reinhardtius hippoglossoides	-	-	-	-	-	-	+
Porichthys notatus	+	-	-	-	-	-	-
Unidentified	+	+	+	+	+	+	+

Table 21.--Squids eaten by northern fur seals in the eastern North Pacific Ocean and Bering Sea, 1958-74, by area.

Area and year	Species												
	Loligo opalescens	Onychoteuthis sp.	Onychoteuthis borealijaponicus	Moroteuthis robusta	Abraliopsis spp.	Octopoteuthis sp.	Gonatidae	Gonatus spp.[a]	Berryteuthis magister	Gonatopsis borealis	Chiroteuthidae	Chiroteuthis sp.	Unidentified squid
California													
1958	+	+	+	-	-	-	-	+	-	-	-	-	+
59	+	+	-	-	-	-	-	+	-	-	-	-	+
61	+	+	-	-	+	-	+	-	-	+	-	-	+
64	+	-	+	-	-	-	+	+	-	-	-	-	+
65	+	-	+	+	+	-	+	+	+	+	-	-	+
66	+	-	+	+	+	-	+	+	-	-	-	-	+
Oregon													
1958	+	+	-	-	-	-	-	-	-	-	-	-	+
59	+	+	-	-	-	-	-	+	-	-	-	-	+
61	+	-	-	-	-	-	+	-	-	-	-	-	+
64	+	-	+	-	-	-	+	+	-	-	-	-	+
65	-	-	+	-	+	-	-	-	+	-	+	-	+
Washington													
1958	-	-	-	-	-	-	-	-	-	-	-	-	+
59	+	+	-	-	-	-	-	+	-	-	-	-	+
60	+	-	-	-	-	-	-	-	-	-	-	-	+
61	+	+	-	-	-	-	+	-	-	+	-	-	+
62	+	-	-	-	-	-	-	-	-	-	-	-	+
63	-	-	-	-	-	-	-	-	-	-	-	-	+
64	+	-	+	-	-	-	+	+	+	+	-	-	+
65	+	-	-	-	-	-	+	+	-	-	-	-	+
66	-	-	+	-	+	+	-	+	+	-	-	-	+
67	+	+	+	-	-	-	+	+	+	-	-	-	+
68	+	+	+	-	-	-	+	+	+	-	-	+	+
69	+	+	+	-	+	-	+	+	-	-	-	+	+
70	+	+	+	+	+	+	+	+	+	+	+	+	+
71	+	+	+	-	+	+	+	+	+	+	+	+	+
72	+	+	-	+	+	+	+	+	+	+	-	+	+
73	+	-	-	-	-	-	-	-	-	-	-	-	-
74	+	-	-	-	-	-	-	-	-	-	-	-	-
British Columbia													
1958	-	-	-	-	-	-	-	-	-	-	-	-	+
59	+	-	-	-	-	-	-	-	-	-	-	-	+
60	-	-	-	-	-	-	-	-	-	-	-	-	+
61	+	-	-	-	-	-	+	-	+	-	-	-	+

Table 21.--Continued.

Area and year	Species												
	Loligo opalescens	Onychoteuthis sp.	Onychoteuthis borealijaponicus	Moroteuthis robusta	Abraliopsis spp.	Octopoteuthis sp.	Gonatidae	Gonatus spp.[a]	Berryteuthis magister	Gonatopsis borealis	Chiroteuthidae	Chiroteuthis sp.	Unidentified squid
British Columbia													
62	+	-	-	-	-	-	-	-	+	-	-	-	+
63	-	-	-	-	-	-	-	-	-	-	-	-	+
64	-	-	+	-	-	-	-	-	+	-	-	-	+
66	-	-	+	-	-	-	-	-	+	-	-	-	+
67	-	-	+	-	-	-	-	-	+	-	-	-	-
68	-	-	+	-	-	-	-	+	+	-	-	-	+
69	+	-	-	-	-	-	-	-	-	-	-	-	-
Gulf of Alaska													
1958	+	-	-	-	-	-	-	-	-	-	-	-	+
59	-	-	-	-	-	-	-	-	-	-	-	-	+
60	-	+	-	-	-	-	-	+	-	-	-	-	+
61	-	-	-	-	-	-	-	-	-	-	-	-	+
62	+	-	-	-	-	-	-	-	+	-	-	-	+
63	-	-	-	-	-	-	-	-	-	-	-	-	+
68	-	-	-	-	-	-	+	+	+	+	-	-	+
Western Alaska													
1958	-	-	-	-	-	-	-	-	-	-	-	-	+
60	-	-	-	-	-	-	-	-	-	-	-	-	+
62	-	-	-	-	-	-	+	-	+	+	-	-	+
68	-	-	-	-	-	-	+	+	+	+	-	-	+
Bering Sea													
1960	-	-	-	-	-	-	-	-	-	-	-	-	+
62	-	-	-	-	-	-	+	+	+	+	-	-	+
63	-	-	-	-	-	-	+	+	+	+	-	-	+
64	-	-	-	-	-	-	+	+	+	+	-	-	+
66	-	-	-	-	-	-	+	-	-	-	-	-	-
68	-	-	-	-	-	-	+	+	+	+	-	-	+
73	-	-	-	-	-	-	+	+	+	+	-	-	+
74	-	-	-	-	-	-	+	+	+	+	-	-	+

[a] Squids identified as Gonatus fabricii in earlier reports have been listed as Gonatus spp.

Table 22.-- Principal forage species utilized by northern fur seals in the eastern North Pacific Ocean and the eastern Bering Sea, 1958-74, by area.

Forage species	Location						
	California	Oregon	Washington	British Columbia	Gulf of Alaska	Western Alaska	Bering Sea
Fish:							
Clupea harengus pallasi	-	-	+	+	+	+	+
Engraulis mordax	+	+	+	-	-	-	-
Oncorhynchus spp.	-	-	+	+	+	+	-
Mallotus villosus	-	-	+	-	+	+	+
Thaleichthys pacificus	-	-	+	+	-	-	-
Cololabis saira	+	+	-	+	-	-	-
Gadidae	-	-	-	-	-	-	+
Gadus macrocephalus	-	-	-	+	-	-	-
Merluccius productus	+	+	+	+	-	-	-
Theragra chalcogramma	-	-	-	+	+	+	+
Trachurus symmetricus	+	-	-	-	-	-	-
Sebastes spp.	+	+	+	+	+	-	-
Anoplopoma fimbria	+	-	+	+	-	+	-
Pleurogrammus monopterygius	-	-	-	-	+	+	+
Ammodytes hexapterus	-	-	-	-	+	+	-
Cephalopods:							
Loligo opalescens	+	+	-	+	-	-	-
Onychoteuthis sp.	+	+	+	-	-	-	-
Onychoteuthis borealijaponicus	-	-	-	-	+	-	-
Gonatus sp.	-	-	-	-	+	-	-
Berryteuthis magister	-	-	-	-	+	+	+
Gonatopsis borealis	-	-	-	-	-	-	+
unidentified squid	-	-	-	-	+	-	-

Table 23.--The comparison of the principal prey species of fur seals and the relative abundance of major fishery resources.

Area	Principal prey species: Rank by stomach content volume	Principal prey species: Species	Major fishery resources: Rank by abundance	Major fishery resources: Species
California[a]				
	1	Engraulis mordax	1	E. mordax
	2	Merluccius productus	2	M. productus
	3	Loligo opalescens	3	Sebastes spp.
	4	Cololabis saira	4	T. symmetricus
	5	Trachurus symmetricus	5	C. saira
	6	Sebastes spp.	6	L. opalescens
Bering Sea[b]				
	1	Theragra chalcogramma	1	T. chalcogramma
	2	Oceanic squids[c]	2	Reinhardtius hippoglossoides
	3	Mallotus villosus	11	C. h. pallasi
	4	Clupea harengus pallasi	17	M. villosus

[a] From California Cooperative Oceanic Fisheries Investigations.

[b] From trawl surveys. Estimates of relative abundance are representative only for those species which are accessible to the trawl. Rank order by frequency of occurrence (%) among 20 most common species based on trawl catches.

[c] Includes Berryteuthis magister and Gonatopsis borealis.

Discussion and Summary

Northern fur seals feed on a variety of fishes and squids throughout their range and probably restrict their diet to certain sized species. However. evidence gathered on the abundance and distribution of the principal prey species known to be consumed by fur seals suggests that they are opportunistic when foraging, preying on the most available food resource in the area. The predominance of single food items in the stomachs of fur seals probably reflects the abundance, seasonal availability, and distribution of fish-squid species in a particular area more than it reflects the selection or preference of one particular species over another. Location is important in considering the diet of fur seals since prey species generally differ in abundance from area to area (north-south; inshore-offshore) and seasonally. As a result, knowledge of the migratory patterns of the prey species is important when considering the diet of fur seals in a particular area. Generally speaking, the migration of fur seals is probably not influenced by the movement of the migratory fishes on which they feed. Fur seals will move to and feed in areas where food is abundant and then depart in search of other areas of concentrated prey when it becomes scarce.

Data gathered on the principal prey species of fur seals (determined from stomach contents) and on the relative abundance of the fish-squid resources off California and the eastern Bering Sea (based on trawl surveys) suggest that fur seals are opportunistic feeders and will forage on the most abundant prey species available to them in an area. This feeding behavior prevails not only off California and the eastern Bering Sea, but throughout their range in the eastern North Pacific Ocean.

Hiroshi Kajimura

Trophic Interactions

Objectives

The NOAA ship Miller Freeman was used during the period from 22 September to 12 October 1982 with the objectives of: 1) comparing the species composition and relative abundance of fish found in northern fur seal stomachs to the species composition and relative abundance of fish in the water column; 2) assessing the distribution of northern fur seals as they migrate from the Pribilof Islands, Alaska, through the southeastern Bering Sea, Unimak Pass, and into the North Pacific Ocean; 3) recording the distribution and abundance of fish captured during bottom and/or mid-water trawl operations: and 4) collecting whole fish specimens, length-frequency distribution data, weights, and otoliths for those fish species known to be consumed by northern fur seals. Figure 20 shows the area (within dotted line) surveyed.

Distribution of Fur Seals

One of the major accomplishments of this cruise was the verification of the presence of northern fur seals on Bogoslof Island at lat. 53°56'N and long- 168°O2'W in the eastern Bering Sea (Fig. 20). In 1979, two animals were observed hauled out on the island, and again in 1980, fur seals were seen there.. including two pups. Five adults and three pups were seen there during a visit in July 1982. During another survey on 17 October 1982, we found 67 individuals there. It may be that some pups are produced on Bogoslof Island and we intend to survey the island more thoroughly in the future.

Collection of Fur Seals

During this study. 23 northern fur seals were collected at sea on the shelf area between Unimak Pass and the Pribilof Islands. Nine of the fur seals were males; the remaining 14 were females (Table 24).

To insure maximum utilization of each seal collected, the fol lowing samples were taken for subsequent laboratory analysis:

Organ	Purpose	Institution
teeth	age classification	NWAFC[3]
reproductive tract	sex and reproductive history	NWAFC
stomach - intestines	food studies	NWAFC
throat - anus swabs	virology	Univ. Oregon
liver sample	toxicology	Univ. Oregon
blood serum	toxicology and virology	Univ. Oregon
samples of liver, blubber, muscle, spleen, pancreas, kidney and blood	protein analysis and toxicology	Marin Veterinary Clinic

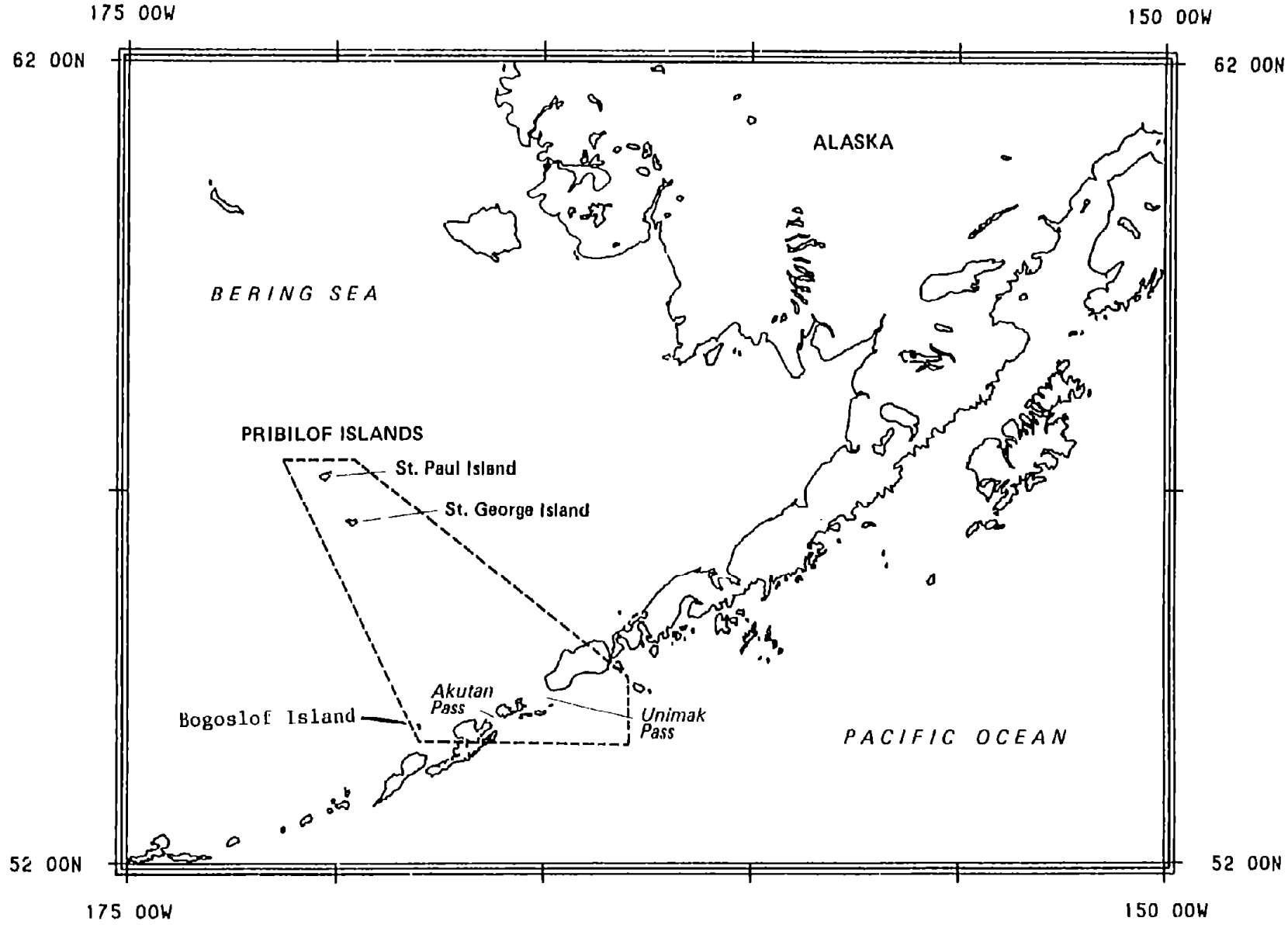

Figure 20.--Area of survey (within dotted line), NOAA ship Miller Freeman 22 September to 12 October 1982.

Table 24.--Northern fur seals collected at sea during NOAA ship Miller Freeman cruise MF-82-03, Leg II, 22 September to 12 October 1982.

Specimen No.	Collection date	Location lat. / long.	Sex	Weight (kg)	Standard length (cm)
1901	9/24	55.10/165.08	F	28.2	135.0
1902	9/26	54.50/166.63	F	33.9	133.4
1903	9/26	54.50/166.24	F	31.5	141.2
1904	9/26	54.57/166.20	F	25.5	129.5
1905	9/26	55.02/166.20	F	32.7	118.0
1906	9/26	55.08/166.21	F	36.7	128.0
1907	10/1	55.52/169.17	M	30.6	118.5
1908	10/1	56.51/168.58	M	28.3	112.5
1909	10/1	56.51/168.55	F	18.0	100.0
1910	10/1	56.51/168.54	F	27.8	122.0
1911	10/3	56.26/170.11	F	24.9	118.0
1912	10/3	56.27/170.11	M	20.1	110.5
1913	10/3	56.27/170.11	F	17.2	112.5
1914	10/3	56.28/170.11	M	17.6	104.0
1915	10/3	56.30/170.12	M	17.7	106.5
1916	10/3	56.31/170.12	F	21.1	107.0
1917	10/3	56.34/170.12	F	38.1	131.0
1918	10/3	56.39/170.12	M	21.8	118.0
1919	10/3	56.41/170.12	M	18.1	91.0
1920	10/3	56.42/170.12	F	25.4	114.0
1921	10/3	56.45/170.13	M	21.8	101.5
1922	10/3	56.49/170.13	F	31.3	122.0
1923	10/6	55.45/168.12	M	16.6	101.0

Collection of Whole Fish Specimens

During the study, 50 bottom trawl stations were sampled with a total biomass of 79,906.2 lb. (36,255-1 kg) caught. Walleye pollock was the major fish contributor, comprising 14,169.9 lb. (6,429-2 kg), or 18.0% of total weight. Walleye pollock was followed in percent of total weight by yellowfin sole (14-2%), Pacific cod (1-0%), sablefish (4-0%), and an assortment of flatfish and miscellaneous roundfish. Snow (Tanner) crabs totaled 9.0% of the catch and other invertebrates comprised the remainder. It should be noted that these estimates are preliminary.

A total of 281 otoliths was collected from 14 fish species for which the length, sex, and weight are known. Twenty-two fish species were measured for length-frequency comparison, totaling 17,143 fish, and 280 fish were collected for stomach analysis.

Thomas R. Loughlin

[3] Northwest and Alaska Fisheries Center.

V. RELATED STUDIES

Chlorinated Hydrocarbons in Tissues of Northern Fur Seals from St. Paul Island, Alaska

Introduction

Over one million northern fur seals migrate to the Pribilof Islands each summer. As a result of an international agreement signed in 1911 between the United Stares, Japan, Soviet Union, and Great Britain (for Canada), the northern fur seal population increased from a depleted level in the early 1900s to a peak in the mid-1950s. An experimental harvest of females was conducted from 1956 to 1968 and was designed to increase the production of harvestable animals. The failure of this experiment to increase productivity and recent evidence of further declines in the northern fur seal population have not yet been fully explained.

Chlorinated hydrocarbon pollutants are now virtually ubiquitous in the marine environment and have been documented in the tissues of a variety of marine mammals (Risebrough 1978). Polychlorinated biphenyls (PCBs) and DDT, the two most prevalent chlorinated hydrocarbons found in the environment, have been associated with reproductive difficulties in several species of marine mammals. Though a causal relationship has not been demonstrated, these contaminants have been linked to premature births in California sea lions (DeLong et al. 1973, Gilmartin et al. 1976), pathological changes in the uterus of ringed seals in the Baltic Sea (Helle et al. 1976a, 1976b), and birth defects and pup mortality of harbor seals in Puget Sound, Washington (Arndt 1973, Calambokidis et al. 1978).

Our report on the concentration of chlorinated hydrocarbons found in the tissues of four subadult male northern fur seals collected on St. Paul Island follows.

Methods

In 1980, samples of blubber and liver from four subadult male northern fur seals were taken during the annual harvest of 2- to 6-year-old males on St. Paul Island. Blubber was taken from the ventral surface between the front flippers. All samples were wrapped in aluminum foil and immediately frozen.

Subsamples of approximately 4 g of blubber and 10 g of liver were analyzed for PCB and DDT metabolites using methods described by Mowrer et al. (1977), and Calambokidis et al. (1978). In summary, this procedure involves digestion in BFM solution, extraction with hexane, clean-up with concentrated sulfuric acid, and injection on an electron-capture gas chromatograph.

A duplicate subsample of the blubber from one of the animals was also analyzed for a broader spectrum of chlorinated hydrocarbons. This sample was ground with sodium sulfate and Soxhlet-extracted with hexane for 24 h. Five ml of the concentrated hexane extracted was eluted as three fractions from a Florisil column using hexane and methylene chlorine.

Control blanks were run simultaneously with the samples, utilizing identical chemicals and glassware applied in the process to check for any possible contamination from laboratory materials or methods. Standards of the chlorinated hydrocarbons being tested were run through the Florisil column to determine percent recovery.

Samples were injected on Hewlett-Packard 5700A gas chromatograph with electron-capture (Ni^{63}) detector. Two columns were used in the gas chromatograph, a 10.0% DC-200 column with an alkaline pre-column and a 1-50% OV-17 + 1.95% QF-1 column. The gas chromatographs were linked to Hewlett-Packard 3380A Integrators.

Samples were quantified based on comparison to known standards. PCB was quantified based on the sum of individual homologs present (Calambokidis et al. 1979).

Results

Results of the single analysis conducted for a broad spectrum of chlorinated hydrocarbons are shown in Table 25. In addition to PCBs and DDT, four other chlorinated hydrocarbon contaminants were found in measurable or trace quantities. Concentrations of PCBs and DDT were in an order of magnitude or higher than that of the other chlorinated hydrocarbons detected.

Concentrations of PCB and DDE (the principal metabolite of DDT) found in the blubber and liver samples of the four subadults are shown in Table 26. Concentrations were higher in the blubber than in the liver samples primarily because of the higher lipid content of the blubber. Concentrations of PCB and DDE expressed in terms of lipid weight were similar for the two tissues.

Discussion

The concentrations of DDT we measured in the liver fell within the range of values reported by Anas and Wilson (1970a, 1970b) for northern fur seals collected in 1968 and 1969. Concentrations of PCB were not reported. The concentrations of DDE found in the liver were higher than the mean concentration observed by Anas and Wilson (1970a) in nine 3- to 4-year-old males, with the difference approaching significance ($t=2.23$, $p=0.0527$).

Table 25,--Concentrations (ppm) of chlorinated hydrocarbons inthe blubber of subadult male northern fur seal, specimen #488. Sample was run for a broad spectrum of chlorinated hydrocarbons.

Basis of concentration	Lipids (%)	o p[a] DDT	p p[a] DDT	DDD	p p DDE	Total DDT	PCB	HCB	Gamma chlordane	Alpha chlordane	Oxy-chlordane	Heptachlor epoxide	Die drin
Wet weight	79.10	ND	ND	0.31	12.40	12.70	2.60	ND	ND	T	0.156	0.110	0.310
Lipid weight	-	ND	ND	0.39	15.60	16.00	3.28	ND	ND	T	0.197	0.139	0.391

[a] op = ortho para, pp= para para; refers to position of chlorine molecules on the benzene rings.

Table 26.--Concentrations of PCB and DDE found in the blubber and liver of four subadult northern fur seals.

Sample	Lipids (%)	Wet weight (ppm) DDE	Wet weight (ppm) PCB	Lipid weight (ppm) DDE	Lipid weight (ppm) PCB
Blubber					
486	83.8	2.69	1.51	3.21	1.80
487	78.6	7.77	2.21	9.89	2.81
488	71.5	12.50	4.00	17.50	5.60
491	70.3	7.13	2.24	10.10	3.19
Mean	76.1	7.52	2.49	10.20	3.35
S.D.	6.3	4.01	1.06	5.84	1.61
Liver					
486	5.2	0.136	0.092	2.61	1.77
487	2.6	0.197	0.094	7.59	3.61
488	3.0	0.357	0.106	11.80	3.51
491	3.7	0.259	0.123	6.95	3.31
Mean	3.6	0.237	0.104	7.23	3.05
S.D.	1.1	0.094	0.014	3.74	0.86

The concentrations of PCB and DDE found were well below the levels detected in other pinnipeds that were showing reproductive dysfunctions. The levels measured for DDT, PCB, and dieldrin fell into the lower range of the levels reported in other healthy pinniped populations (Risebrough 1978). California sea lions giving birth to premature pups had mean concentrations of DDT and PCB of 603 ppm and 55 ppm, respectively, in the blubber (Gilmartin et al. 1976), Female ringed seals in the Baltic Sea with uterine occlusions had mean concentrations of DOT and PCB in the blubber of 130 ppm and 110 ppm, respectively. Harbor seals in Puget Sound, where high levels of premature births and birth defects have been reported (Newby 1973), had mean concentrations of DDT and PCB in the blubber of 15 ppm and 171 ppm, respectively (Calambokidis et al. 1978).

There is no evidence at this time that chlorinated hydrocarbons are having a deleterious effect on the fur seal population. However, the possibility that there has been an increase in the concentration of DDT in fur seal subadult males since 1969 makes monitoring of these pollutants important.

John Calambokidis
John Peard

Female Tooth Studies

Several researchers have reported being able to assess the reproductive history of female pinnipeds from analyses of growth rings of their teeth. Carrick and Ingham (1962) showed complete reproductive histories for southern elephant seals, Mirounga leonina, by analyzing differences in the shading of stained annual (dentine) on their teeth. Scheffer (National Marine Mammal Laboratory, retired, Seattle, WA 98115. Pers. commun., 1983) attempted to duplicate this work during the late 1950s but reported no success for northern fur seals. Laws (1977) reported analyzing the relative size of cementum layers of Grey seals, Halichoerus grypus, and showed that the size of growth rings becomes smaller during the first pregnancy of the individual. This "transition layer" is interpreted as the age of first reproduction in pinnipeds. Klevezal (1964) analyzed the relative width of dentine layers for several species of pinnipeds to estimate the average age at sexual maturity of each species.

We attempted to assess teeth by searching for "transition layers" in teeth of female northern fur seals whose reproductive condition was known when they were taken during our pelagic sampling program (1958-74). If the deposition rate of dentine by northern fur seals is similar to that of other species of seals, we would not expect to see "transition layers" in nulliparous seals, whereas "transition layers" would be present in multiparous seals and in primiparous nonpregnant seals corresponding to the age of the animal at least 1 yr before it was taken in the pelagic collections.

The decalcified thin sections were stained to highlight differential deposition of dentine between the more prominent annual deposits of dentine which are used for age classification purposes. The maxillary canine teeth for this study were prepared by a commercial microtechnique company. Each tooth was decalcified (a longitudinal section was taken near the midline pulp canal), stained, and mounted on slides. The readability (clarity) of each section depends primarily on the plane of sectioning.

The following table presents the number of teeth for each age and reproductive condition that were decalcified and stained. It would have been ideal to have had equal sample sizes for each category but there were very few parous-nonpregnant animals in the younger age classes.

Numbers of teeth decalcified and sectioned for each age and for reproductive condition

		Reproductive condition			
		Primiparous		Multiparous	
Age (yrs)	Nulliparous	Preg.	Nonpreg.	Preg.	Nonpreg.
3	5	0	0	0	0
4	4	5	0	0	1
5	5	5	0	5	0
6	5	5	1	4	0
7	3	5	1	5	2
	22	20	2	14	3

N = 61

Findings and Future Research

The teeth were examined for the presence of "transition layers," but our results were inconclusive. Further work in progress will include different sectioning (various oblique planar sections and cross sections) and different types of staining.

Hiroshi Kajimura
Anne E. York

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Research on San Miguel Island, California, was completed with the cooperation of the staff of the Channel Islands National Monument, National Park Service, Ventura, California; and the Public Works Department, Pacific Missile Range Headquarters, U.S. Navy, Point Magu, California.

GLOSSARY

The following terms used in fur seal research and management on the Pribilof Islands, San Miguel Island, and Castle Rock have special meanings or are not readily found in standard dictionaries:

Bachelor Young male seals of ages 2-5 years.

Check Mark A notch, slit, hole, or other mark made on a seal flipper, when a tag is applied, to ensure recognition of an animal that has lost its tag.

Drive The act of surrounding and forcing groups of seals to move on land from one location to another.

Escapement Seals that were not harvested because they were too old, too large, or were not available.

Hauling Ground An area. usually near a rookery, on which nonbreeding seals congregate. See Rookery.

Haul Out The act of seals moving from the sea to a rookery or hauling ground on shore.

Known-Age Refers to a seal whose age is known because the animal bears an inscribed tag or other type of mark.

Male Seals, Adult Class 1 (Shoreline) --Full-grown males apparently with established territories spaced along the water's edge at intervals of 10-15 m. Most of these animals are wet or partly wet, and some acquire harems of one to four females between 10 and 20 July. They would then be called harem males (Class 3). Shoreline or Class 1 males should not be confused with Class 2 animals. The latter definitely have territories, whereas the shoreline males appear to be attached to such sites but may not be in all cases.

Class 2 (Territorial without females)--Full-grown males that have no females, but are actively defending territories. Most of these animals are located on the inland fringe of a rookery, some are between Class 1 (Shoreline) and Class 3 (Territorial with females) males, and an occasional Class 2 male may be completely surrounded by Class 3 males and their harems.

Class 3 (Territorial with females)--Full-grown males actively defending territories and females. Most Class 3 males and their harems combine to form a compact mass of animals. Isolated individuals, usually with small harems, may be observed at each end of a rookery, on sand beaches, and in corridors leading to inland hauling grounds. Some territorial males have as few as 1 or 2 females. Should these females be absent during the counts, their pups are used as a basis for putting the adult male into Class 3 rather than Class 2.

Class 4 (Back fringe)--Full- and partly-grown males on the inland fringe of a rookery. A few animals too young and too small to include in the count may be found here. Though some Class 4 males may appear to be holding territories, most will flee when approached or when prodded with a pole.

Class 5 (Hauling ground)--The hauling grounds contain males from May to late July and a mixture of males and females from then on. The counts include males that obviously are adults and all others that have a mane and the body conformation of an adult. Males included in this count will be approximately 7 years of age and older.

Prior to 1966, Class 3 males were called harem bulls, and Classes 1, 2, 4, and 5 were collectively called idle bulls. From 1966 through 1974, the adult male seals were classified into five groups (Classes 1, 2, 3, 4, and 5). Beginning in 1975, Classes 1 and 2 were combined and designated as Class 2, Class 3 remained the same, and Classes 4 and 5 were combined and designated as Class 5.

Marked Describes a seal that has been marked by removing the cartilaginous tip of a digit from a hind flipper, by attaching an inscribed metal or plastic tag to one or more of its flippers, by freeze marking, by hair-clipping, or by bleaching.

Mark Recoveries Includes the recoveries of seais marked by one of several methods. See Marked paragraph.

Rookery An area on which breeding seals congregate. See Hauling Ground.

Round The sequence in which hauling grounds are visited for the drive to harvest seals. A circuit or round of the hauling grounds is completed in 5 days, and the procedure is repeated throughout the harvest of males.

The fallowing are English translations of names given to some of the rookeries or hauling grounds by the Russians in the 1700s:

Russian	English
St. Paul Island	
Vostochni	From "Novoctoshni" meaning "place of recent growth"; applied to Northeast Point which was apparently at one time an island that has since been connected to St. Paul Island by drifting sand.
Morjovi	Walrus. Historically, walruses hauled out here in summer.
Polovina	Halfway (to Northeast Point from the village).
Kitovi	Of "Kit" or whale. When whaling fleets were active in the Bering Sea between 1849 and 1856, a large right whale killed by some ship's crew drifted ashore here.
Gorbatch	Humpback. Apparently refers to the "hump like" nature of the scoria slope above the rookery.
Tolstoi	Thick. In this case, thick headland on which the rookery is located.
Zapadni	West. Western part of the island.
Lukanin	So named after a Russian pioneer sailor who was said to have taken over 5,000 sea otters from St. Paul Island in 1787.
Zoltoi (hauling ground)	Golden.
St. George Island	
Staraya Artil	Old settlement or village. There was once a settlement or village adjacent to the rookery.
Zapadni	West. Western part of the island.
Sea Lion Rock	
Sivutch	Sea lion. These animals haul out but do not breed here.

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APPENDIX A

Tabulations of northern fur seal data collected on the Pribilof Islands, Alaska. and on San Miguel Island, California, and nearby Castle Rock in 1982.

APPENDIX A (continued)

Table A-1.--Age classification of male northern fur seals harvested, St, Paul Island, Alaska, 6 July to 6 August 1982.

Date/Rookery[a]	Males harvested	Tooth sample	Percent in each age group of sample					Estimated number harvested by age group				
			2	3	4	5	6	2	3	4	5	6
July 6 NEP (e)	490	98	1.0	37.8	55.1	6.1	0.0	5	185	270	30	0
6 NEP (w)	662	134	0.7	38.1	56.7	4.5	0.0	5	252	375	30	0
7 POL	352	63	3.2	36.5	55.5	4.8	0.0	11	129	195	17	0
7 L-K	332	65	1.5	44.6	43.1	10.8	0.0	5	148	143	36	0
8 REEF	1,026	201	1.5	44.3	52.2	2.0	0.0	15	454	536	21	0
9 TZR	1,000	185	1.6	55.7	42.2	0.5	0.0	16	557	422	5	0
9 ZAP	830	154	1.3	61.0	37.0	0.7	0.0	11	506	307	6	0
12 NEP (e)	89	16	0.0	50.0	43.8	6.2	0.0	0	44	39	6	0
12 NEP (w)	650	113	4.4	69.0	25.7	0.9	0.0	29	448	167	6	0
13 POL	138	31	0.0	45.2	48.4	6.4	0.0	0	62	67	9	0
13 L-K	202	41	0.0	58.5	41.5	0.0	0.0	0	118	84	0	0
14 REEF	637	131	1.5	64.1	32.1	2.3	0.0	10	408	204	15	0
15 TZR	832	155	3.9	58.7	33.6	3.2	0.6	32	488	280	27	5
16 ZAP	901	173	4.6	59.0	31.8	4.0	0.6	41	532	287	36	5
19 NEP (e)	1,015	211	3.8	66.3	28.0	1.9	0.0	39	673	284	19	0

Table A-1 .--Continued.

Date/Rookery[a]	Males harvested	Tooth sample	Percent in each age group of sample					Estimated number harvested by age group				
			2	3	4	5	6	2	3	4	5	6
July 19 NEP (w)	409	93	4.3	60.2	33.3	2.2	0.0	18	246	136	9	0
20 POL	244	57	1.7	63.2	31.6	3.5	0.0	4	154	77	9	0
20 L-K	173	39	5.1	76.9	18.0	0.0	0.0	9	133	31	0	0
21 REEF	1,124	240	4.2	67.5	26.7	1.6	0.0	47	759	300	18	0
22 TZR	536	119	5.0	65.6	28.6	0.8	0.0	27	352	153	4	0
23 ZAP	1,995	449	9.6	65.7	23.8	0.9	0.0	191	1,311	475	18	0
26 NEP (e)	510	103	12.6	62.1	21.4	2.9	1.0	64	317	109	15	5
26 NEP (w)	695	132	10.6	70.4	16.7	2.3	0.0	74	489	116	16	0
27 POL	525	105	6.7	67.6	20.9	4.8	0.0	35	355	110	25	0
27 L-K	89	19	36.9	52.6	10.5	0.0	0.0	33	47	9	0	0
28 REEF	1,450	257	10.1	68.5	21.0	0.4	0.0	146	993	305	6	0
29 TZR	1,108	188	12.2	60.7	26.6	0.5	0.0	135	673	295	5	0
30 ZAP	1,214	198	12.1	68.2	19.2	0.5	0.0	147	828	233	6	0
Aug. 2 NEP (e)	641	104	10.6	57.7	30.8	0.9	0.0	68	370	197	6	0
2 NEP (w)	582	85	12.9	70.6	16.5	0.0	0.0	75	411	96	0	0

Table A-1 .--Continued.

Date/Rookery[a]	Males harvested	Tooth sample	Percent in each age group of sample					Estimated number harvested by age group				
			2	3	4	5	6	2	3	4	5	6
Aug. 3 POL	786	109	19.3	56.0	23.8	0.9	0.0	152	440	187	7	0
3 L-K	635	95	9.5	70.5	17.9	2.1	0.0	60	448	114	13	0
4 REEF	1,445	208	26.5	61.5	10.6	1.4	0.0	383	889	153	20	0
5 TZR	722	97	6.2	67.0	21.6	5.2	0.0	45	484	156	37	0
6 ZAP	691	120	19.2	60.8	15.0	5.0	0.0	133	420	104	34	0

[a] NEP (e) = East or Morjovi side of Northeast Point; NEP (w) = West or Vostochni side of Northeast Polnt; TZR = Tolstoi, Zapadni Reef, and Little Zapadni; POL = Polovina, Polovina Cliffs, and Little Polovina; ZAP = Zapadnl; REEF = Reef, Gorbatch, and Ardiquen; and L-K = Lukanin and Kitovi.

Table A-2.--Cumulative age classification of male northern fur seals harvested, St. Paul Island, Alaska, G July to 6 August 1982.

Date/Rookery[a]	Estimated number harvested by age group					Total harvest to date	Percent harvested by age group				
	2	3	4	5	6		2	3	4	5	6
July 6 NEP (e)	5	185	270	30	0	490	1	38	55	6	0
6 NEP (w)	10	437	645	60	0	1,152	1	38	56	5	0
7 POL	21	566	840	77	0	1,504	1	38	56	5	0
7 L-K	26	714	983	113	0	1,836	1	39	54	6	0
8 REEF	41	1,168	1,519	134	0	2,862	1	41	53	5	0
9 TZR	57	1,725	1,941	139	0	3,862	1	45	50	4	0
9 ZAP	68	2,231	2,248	145	0	4,692	1	48	48	3	0
12 NEP (e)	68	2,275	2,287	151	0	4,781	1	48	48	3	0
12 NEP (w)	97	2,723	2,454	157	0	5,431	2	50	45	3	0
13 POL	97	2,785	2,521	166	0	5,569	2	50	45	3	0
13 L-K	97	2,903	2,605	166	0	5,771	2	50	45	3	0
14 REEF	107	3,311	2,809	181	0	6,408	2	51	44	3	0
15 TZR	139	3,799	3,089	208	5	7,240	2	52	43	3	0
16 ZAP	180	4,331	3,376	244	10	8,141	2	53	42	3	0
19 NEP (e)	219	5,004	3,660	263	10	9,156	2	55	40	3	0
19 NEP (w)	237	5,250	3,796	272	10	9,565	2	55	40	3	0
20 POL	241	5,404	3,873	281	10	9,809	2	55	40	3	0

TABLE A-2.--Continued.

Date/Rookery[a]	Estimated number harvested by age group					Total harvest to date	Percent harvested by age group				
	2	3	4	5	6		2	3	4	5	6
July 20 L-K	250	5,537	3,904	281	10	9,982	3	55	39	3	0
21 REEF	297	6,296	4,204	299	10	11,106	2	57	38	3	0
22 TZR	324	6,648	4,357	303	10	11,642	3	57	37	3	0
23 ZAP	515	7,959	4,832	321	10	13,637	4	58	36	2	0
26 NEP (e)	579	8,276	4,941	336	15	14,147	4	59	35	2	0
26 NEP (w)	653	8,765	5,057	352	15	14,842	5	59	34	2	0
27 POL	688	9,120	5,167	377	15	15,367	5	59	34	2	0
27 L-K	721	9,167	5,176	377	15	15,456	5	59	34	2	0
28 REEF	867	10,160	5,481	383	15	16,906	5	60	33	2	0
29 TZR	1,002	10,833	5,776	388	15	18,014	6	60	32	2	0
30 ZAP	1,149	11,661	6,009	394	15	19,228	6	61	31	2	0
Aug. 2 NEP (e)	1,217	12,031	6,206	400	15	19,869	6	61	31	2	0
2 NEP (w)	1,292	12,442	6,302	400	15	20,451	6	61	31	2	0
3 POL	1,444	12,882	6,489	407	15	21,237	7	61	30	2	0
3 L-K	1,504	13,330	6,603	420	15	21,872	7	61	30	2	0

Table A-2 .--Continued.

Date/Rookery[a]	Estimated number harvested by age group					Total harvest to date	Percent harvested by age group				
	2	3	4	5	6		2	3	4	5	6
Aug. 4 REEF	1,887	14,219	6,756	440	15	23,317	8	61	29	2	0
5 TZR	1,932	14,703	6,912	477	15	24,039	8	61	29	2	0
6 ZAP	2,065	15,123	7,016	511	15	24,730	8	61	29	2	0

[a] NEP (e) = East or Morjovi side of Northeast Point; NEP (w) = West or Vostochni side of Northeast Point; TZR = Tolstol, Zapadni Reef, and Little Zapadni; POL = Polovina, Polovina Cliffs, and Little Polovina; ZAP = Zapadni; REEF = Reef, Gorbatch, and Ardiquen; and L-K = Lukanin and Kitovi.

Table A-3.--Number of adult male northern fur seals counted. by class and rookery section, St. Paul Island. Alaska. 19-23 July 1982. A dash Indicates no numbered sections.

Rookery and class of male	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Lukanin															
2	9	7	-	-	-	-	-	-	-	-	-	-	-	-	16
3	59	59	-	-	-	-	-	-	-	-	-	-	-	-	118
5	95	1	-	-	-	-	-	-	-	-	-	-	-	-	96
Kitovi[a]															
2	3(3)	14	-	10	3	-	-	-	-	-	-	-	-	-	30
3	41(25)	71	-	78	65	-	-	-	-	-	-	-	-	-	225
5	0(0)	0	-	0	153	-	-	-	-	-	-		-	-	153
Reef															
2	6	14	17	4	7	11	5	8	11	7	3	-	-	-	93
3	64	94	112	44	55	59	66	59	41	42	13	-	-	-	649
5	10	13	0	5	108	0	107	49	0	39	13	-	-	-	344
Gorbatch															
2	10	4	9	4	3	10	-	-	-	-	-	-	-	-	40
3	104	71	76	15	43	100	-	-	-	-	-	-	-	-	409
5	101	0	0	124	0	14	-	-	-	-	-	-	-	-	239
Ardiguen															
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Morjovi[b]															
2	6(6)	16	6	15	19	17	-	-	-	-	-	-	-	-	85
3	59(32)	59	57	79	80	61	-	-	-	-	-	-	-	-	427
5	74(50)	2	53	0	5	43	-	-	-	-	-	-	-	-	227
Vostochni															
2	7	6	10	6	8	22	17	19	10	11	17	11	23	17	184
3	58	38	69	43	35	114	73	76	62	29	58	68	160	76	959
5	131	1	38	3	147	17	13	7	44	0	0	66	66	115	648
Little Polovina															
2	5	4	-	-	-	-	-	-	-	-	-	-	-	-	9
3	42	30	-	-	-	-	-	-	-	-	-	-	-	-	72
5	173	6	-	-	-	-	-	-	-	-	-	-	-	-	179
Polovina															
2	10	8	-	-	-	-	-	-	-	-	-	-	-	-	18
3	50	39	-	-	-	-	-	-	-	-	-	-	-	-	89
5	317	21	-	-	-	-	-	-	-	-	-	-	-	-	338
Polovina Cliffs															
2	9	6	5	9	8	14	23	-	-	-	-	-	-	-	74
3	33	41	40	64	78	126	153	-	-	-	-	-	-	-	535
5	17	0	0	0	0	19	3	-	-	-	-	-	-	-	39
Tolstoi															
2	10	5	8	7	3	5	7	14	-	-	-	-	-	-	59
3	85	58	62	66	122	132	114	109	-	-	-	-	-	-	748
5	0	0	0	0	7	11	0	193	-	-	-	-	-	-	211
Zapadni Reef															
2	4	14	-	-	-	-	-	-	-	-	-	-	-	-	18
3	50	135	-	-	-	-	-	-	-	-	-	-	-	-	185
5	113	0	-	-	-	-	-	-	-	-	-	-	-	-	113
Little Zapadni															
2	0	2	11	4	11	8	-	-	-	-	-	-	-	-	36
3	28	69	111	135	25	104	-	-	-	-	-	-	-	-	472
5	1	0	0	7	0	104	-	-	-	-	-	-	-	-	112
Zapadni[c]															
2	4(0)	12	11	15	9	12	8	3	-	-	-	-	-	-	74
3	76(0)	110	132	151	90	96	99	13	-	-	-	-	-	-	767
5	0(112)	30	25	38	69	0	0	290	-	-	-	-	-	-	564

[a] Numbers in parentheses are the adult males counted in Kitovi Amphitheater. Section 2 includes adult males counted in Section 3.

[b] Numbers in parentheses are the adult wales counted on the second point South of Sea Lion Neck.

[c] Numbers in parentheses are the adult males counted on Zapadni Point Reef.

Table A-4.--Number of adult male northern fur seals counted. by rookery, Pribilof Islands, Alaska, July 1982.

Island and rookery	Date	Class of adult male[a] 2	3	5	Total
St. Paul Island	July				
Lukanin	23	16	118	96	230
Kitovi	23	33	280	153	466
Reef	21	93	649	344	1,086
Gorbatch	21	40	409	239	688
Ardiguen	21	7	57	0	64
Morjovi	19	85	427	227	739
Vostochni	19	184	959	648	1,791
Little Polovina	21	9	72	179	260
Polovina	21	18	89	338	445
Polovina Cliffs	21	74	535	39	648
Tolstoi	22	59	748	211	1,018
Zapadni Reef	22	18	185	113	316
Little Zapadni	22	36	472	112	620
Zapadni	23	74	767	564	1,405
Island total		746	5,767	3,263	9,776
St. George Island	July				
Zapadni	10	59	173	95	327
South	10	87	239	74	400
North	11	224	553	280	1,057
East Reef	10	86	129	41	256
East Cliffs	11	45	222	169	436
Staraya Artil	10	85	94	74	253
Island total		586	1,410	733	2,729
Total both islands		1,332	7,177	3,996	12,505

[a] See glossary for a description of the classes of adult male seals.

Table A-5.--Number of harem and idle male northern fur seals counted in mid-July. Pribilof Islands, Alaska. 1973-87.

Year	St. Paul Island		St. George Island		Both islands	
	Harem	Idle	Harem	Idle	Harem	Idle
1973	4,906[a]	2,550[a]	875	375	5,781	2,925
1974	4,563[b]	1,782[b]	822	481	5,385	2,263
1975	5,018	3,535	877	1,427	5,895	4,962
1976	5,324	4,041	1,093	996	6,417	5,037
1977	6,457	3,845	1,610	899	8,067	4,744
1978	6,496	3,908	1,590	1,220	8,086	5,128
1979	6,242	4,457	1,716	1,942	7,958	6,399
1980	5,490	4,248	1,563	1,795	7,053	6,043
1981	5,120	4,003	1,472	1,646	6,592	5,649
1982	5,767	4,009	1,410	1,319	7,177	5,328

[a] Total numbers of harem and idle males in July were extrapolated from counts of harem and idle males on all rookeries in June and from counts of harem and idle males on sample rookeries (Zapadni, Little Zapadni, Zapadni Reef. and Tolstoi) in July using the following procedure:

1) Assume $\frac{\text{June } (h+i)}{\text{July } (h+i)} = \frac{\text{June } (H+I)}{\text{July } (H+I)}$

2) Assume $\frac{\text{July } (h)}{\text{July } (h+i)} = \frac{\text{July } (H)}{\text{July } (H+I)}$

3) Solve July (H+I) - July (H) = July (I);

where h, H = respective counts of harem males on sample rookeries and all rookeries;

i, I = respective counts of idle males on sample rookeries and all rookeries.

[b] Total numbers of hat-an and idle males in July were extrapolated from counts of harem and idle males on all rookeries in June and from counts of harem and idle males on sample rookeries (Reef, Gorbatch, and Ardiguen) in July using the same procedure applied in 1973 (see footnote [a] of this table).

Table A-6.--Number of dead northern fur seal pups counted, by rookery section, Pribilof Islands, Alaska, 1982.

Island and rookery	Date	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
St. Paul Island	August															
Morjovi	31	134[a]	42	40	50	49	33	-	-	-	-	-	-	-	-	348
Vostochni	31	25	13	41	42	54	189	94	75	40	16	36	32	129	51	837
Little Polovina	19	22	27	-	-	-	-	-	-	-	-	-	-	-	-	49
Polovina Cliffs	25	108	39	83	77	69	86	108	-	-	-	-	-	-	-	570
Polovina	23	18	79	-	-	-	-	-	-	-	-	-	-	-	-	97
Ardiguen[b]	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49
Gorbatch	24	162	109	25	51	27	25	-	-	-	-	-	-	-	-	399
Reef	30	48	125	117	67	43	107	27	50	49	14	7	-	-	-	654
Kitovi	20	76[c]	26	45	72	50	-	-	-	-	-	-	-	-	-	269
Lukanin	20	36	103	-	-	-	-	-	-	-	-	-	-	-	-	139
Tolstoi	25	75	116	54	84	217	232	296	258	-	-	-	-	-	-	1,332
Little Zapadni	24	24	99	145	224	105	182	-	-	-	-	-	-	-	-	779
Zapadni Reef	19	87	189	-	-	-	-	-	-	-	-	-	-	-	-	276
	September															
Zapadni	1	100	205	249	388	177	185	164	35	-	-	-	-	-	-	1,503
															Total	7,301
St. George Island[d]	August															
North	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	649
Zapadni	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	190
South	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110
East Reef	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	56
East Cliffs	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	340
Staraya Artil	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	315
															Total	1,660
														Grand total		8,961

[a] Includes 41 dead pups counted on second point south of Sea Lion Neck.
No numbered sections.
[c] Includes 24 dead pups counted in Kitovi Amphitheater.
[d] Dead pups were not counted by rookery section.

Table A-7 .--Number of dead northern fur seal pups counteda, by rookery, Pribilof Islands, 1973-82.

Island and rookery	1973[b]	1974[b]	1975	1976	1977	1978	1979	1980	1981	1982
St. Paul Island										
Morjovi	-	-	1,765	1,829	870	606	269	508	346	348
Vostochni	-	-	3,259	3,826	2,021	1,041	573	932	889	837
Little Polovina	-	-	252	316	103	90	28	77	41	49
Polovina Cliffs	-	-	1,529	1,862	733	761	433	627	463	570
Polovina	-	-	419	378	160	151	85	127	89	97
Ardiguen	-	111	142	212	112	15	31	76	38	49
Gorbatch	-	1,188	1,025	1,341	860	475	260	699	379	399
Reef	-	1,580	1,837	2,055	1,233	593	651	790	623	654
Kitovi	-	-	787	846	331	203	171	256	187	269
Lukanin	-	-	505	385	250	197	132	206	102	139
Tolstoi	3,613	-	4,141	4,241	3,291	1,488	1,645	1,488	1,547	1,332
Little Zapadni	1,783	-	1,204	1,977	1,133	674	637	645	377	779
Zapadni Reef	661	-	508	638	427	129	161	243	266	276
Zapadni	3,851	-	3,252	3,770	2,559	1,650	1,368	1,185	1,451	1,503
Counted total	9,908	2,879	20,625	23,676	14,083	8,073	6,444	7,859	6,798	7,301
Estimated oversight 5%[c]	495	144	1,031	1,184	704	404	322	393	340	365
Total	10,403	3,023	21,656	24,860	14,787	8,477	6,766	8,252	7,138	7,666
St. George Island										
North	1,153	545	1,230	791	408	1,068	774	949	810	649
Zapadni	338	278	470	373	92	179	277	350	186	190
South	112	196	344	280	98	225	186	197	177	110
East Reef	75	59	102	37	60	164	104	121	74	56
East Cliffs	431	275	434	354	140	292	285	284	402	340
Staraya Artil	552	- [d]	709	454	410	590	565	484	376	315
Counted total	2,661	1,353	3,289	2,289	1,208	2,518	2,191	2,385	2,025	1,660
Estimated oversight 5%[c]	133	68	165	114	60	126	110	119	101	83
Total	2,794	1,421	3,454	2,403	1,268	2,644	2,301	2,504	2,126	1,743

Table A-7 .--Continued.

Island and rookery	1973[b]	1974[b]	1975	1976	1977	1978	1979	1980	1981	1982
Pribilof Islands										
counted total	12,569	4,232	23,914	25,965	15,291	10,591	8,635	10,244	8,823	8,961
Estimated oversight 5%[c]	628	212	1,196	1,298	764	530	432	512	441	448
Total	13,197	4,444	25,110	27,263	16,055	11,121	9,067	10,756	9,264	9,409

[a] The dead pups are counted after 15 August each year: most mortality has occurred by that date.

[b] The dead pups were counted only on selected rookeries on St. Paul Island.

[c] As established by survey conducted in 1960: C. E. Abegglen, A, Y. Rappel, and F. Wilke. 1960. Alaska fur seal investigations, Pribilof Islands, Alaska. Unpubl. manuscr., 165 p. Natl, Mar. Mammal lab., Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way N. E., Seattle, WA 98115.

[d] Dead pups were not counted.

Table A-8.--Soviet tags recovered in the U.S. harvest of male northern fur seals, St. Paul Island, Alaska. 6 July to 6 August 1982.

Date	Tag number	Age (years)	Sex	Island of tagging (Commander Is.)	Rookery of recovery
9 July	YB-2170	3	M	Bering	Little Zapadni
2 Aug.	YM-32	3	M	Medny	Northeast Point
28 July	YM-61	3	M	Medny	Reef
26 July	YM-96	3	M	Medny	Northeast Point
19 July	YM-559	3	M	Medny	Northeast Point
5 Aug.	YM-825	3	M	Medny	Zapadni Reef
9 July	YM-1642	3	M	Medny	Zapadni
26 July	YM-5050	3	M	Medny	Northeast Point
29 July	XB-172	4	M	Bering	Zapadni Reef
29 July	XB-3906	4	M	Bering	Zapadni Reef
7 July	XB-5323	4	M	Bering	Polovina
5 Aug.	XB-5365	4	M	Bering	Reef
5 Aug.	XM-868	4	M	Medny	Reef
15 July	XM-1703	4	M	Medny	Zapadni Reef
15 July	XM-4685	4	M	Medny	Tolstoi
6 July	XM-5235	4	M	Medny	Northeast Point
23 July	XM-5785	4	M	Medny	Zapadni

Table A-9---Northern fur seals entangled in fishing debt-is and other materials, U.S. commercial harvest of northern fur seals, St. Paul Island, Alaska, 1967-82.[a]

Year	Number of seals harvested[b]	Number of entangled seals observed on the harvesting area[b]	Percent of harvest
1967	50,229	75	0.15
1968	46,893	75	0.16
1969	32,819	66	0.20
1970	36 307	101	0.28
1971	27,289	113	0.41
1972	33,173	144	0.43
1973	28,482	137	0.48
1974	33,027	190	0.58
1975	29,148	206	0.71
1976	23,096	97	0.42
1977	28,444	99	0.35
1978	24,885	115	0.46
1979	25,762	104	0.40
1980	24,327	119	0.49
1981	23,928	102	0.43
1982	24,828	102	0.41

[a] Some of these data are different from previously published tables (see Scordino and Fisher. 1983. Investigations of fur seal entanglement in net fragments, plastic bands, and other debris in 1981 and 1982, St. Paul Island, Alaska. Background paper submitted to the 26th annual meeting of the Standing Scientific Committee, North Pacific Fur Seal Commission held March 28-April 8. 1983 in Washington, D.C.)

[b] Includes both sexes.

Table A-10---Northern fur seals tagged as pups in Adams Cove, San Miguel Island, California. and the date first observed in subsequent years at Adams Cove, 1977-82.

Tag number Monel	Tag number Roto	Year tagged	Sex	Date of first resighting 1977	1978	1979	1980	1981	1982
SMI- 4		1975	F	-	31 Aug.	6 Aug.	21 Aug.	-	-
5		1975	F	-	-	11 Aug.[b]	-	-	-
11		1975	M	-	-	7 July	24 May	-	-
15		1975	M	-	18 Aug.	28 May	-	-	-
16		1975	F	-	-	1 Aug[b]	17 July[b]	-	-
17		1975	M	-	-	16 June	-	-	-
20		1975	M[a]	-	22 Aug.	12 June	22 June[b,c,d]	-	-
21		1975	M	-	9 Aug.	-	-	-	-
22		1975	M	-	9 Aug.	23 June	8 Aug.	-	9 June
24		1975	M	-	9 Aug.	24 May	13 July	-	17 July
32		1975	M	-	-	9 June	11 June	12 Aug.	-
40		1975	M	-	-	9 July	-	-	-
41		1975	F	18 Aug.	-	-	-	-	-
42		1975	M	-	-	5 May	28 June	18 June	-
44		1975	F	-	21 Aug.	-	-	16 Aug.	-
46		1975	M	-	29 Aug.	-	15 July	13 July	8 July
52		1975	F	-	21 Aug.	-	-	-	-
54		1975	F	-	-	-	1 Aug.	-	-
55		1975	F	-	13 Aug.	16 Aug.	-	-	-
58		1975	F	-	-	24 Aug.	-	-	-
61		1975	F	-	22 Aug.	15 Aug.	19 July	-	-
63		1975	M	-	-	2 June	-	-	-
65		1975	M	-	-	-	25 July	-	-
70		1975	F	-	19 Aug.	-	26 June	4 Aug.	-
72		1975	F	-	1 Sept.	-	-	-	-
73		1975	M	-	29 July	2 Aug.	30 June	-	-
75		1975	F	2 Sept.	17 Aug.	27 May	10 July	-	-
83		1975	F	-	-	5 Aug.	14 Aug.	-	-
85		1975	F	-	6 Sept.	-	-	-	-
86		1975	M	-	17 July	18 June	-	-	-
89		1975	M	-	-	9 Aug.	18 July	9 July	-
90		1975	F	-	9 Sept.	4 Sept.	-	-	-
99		1975	F	-	-	8 Aug.	-	-	-
304		1975	M	-	1 Sept.	-	26 June	-	-
312		1976	F	-	-	8 Aug.	3 Aug.	-	-
313		1976	M[a]	-	16 Sept.	5 June	24 May	-	-
315		1976	F	-	-	-	14 June	-	-
322		1976	F	-	-	-	10 Aug.	4 Sept.	-
325		1976	M	-	-	-	24 May	-	-
328		1976	F	-	-	-	3 Aug.	-	-
330		1976	M	-	-	23 July	22 June	-	-
334		1976	F	-	-	3 Sept.	11 July[b,d]	-	-
344		1976	F	-	-	-	7 Aug.	-	-
351		1976	M	-	-	-	21 July	-	-

Table A-10,--Continued.

Tag number		Year		Date of first resighting					
Monel	Roto	tagged	Sex	1977	1978	1979	1980	1981	1982
SMI- 368		1976	F	-	-	-	17 Aug.	-	-
377		1976	M	-	-	-	11 June	-	-
615		1976	F	-	-	28 Aug.	-	-	-
678		1977	F	-	-	-	23 Aug.	-	-
904		1977	F	-	-	-	3 Sept.	-	-
908		1977	F	-	-	-	31 July	-	-
912		1977	F	-	-	-	19 July	-	-
921		1977	F	-	-	-	21 July	-	-
926		1977	F	-	-	-	10 Aug.	-	-
927		1977	M	-	-	-	31 July	-	23 June
928		1977	F	-	-	-	3 Sept.	-	27 Oct.
931		1977	M	-	-	-	7 Aug.	18 June	-
946		1977	M	-	-	-	10 July	18 June	-
956		1977	M	-	-	5 July	9 June	-	-
961		1977	F	-	-	15 Aug.	7 Aug.	-	-
962		1977	F	-	-	-	23 Aug.	-	-
973		1977	M[a]	-	-	-	26 July	9 June	16 June
977		1977	M	-	-	-	15 July	-	-
986		1977	M	-	-	-	-	-	17 June
997		1977	F	-	-	3 Aug.	30 July	-	-
999		1977	M	-	-	-	3 Aug.	-	-
1187		1978	M	-	-	-	-	9 July	-
1188		1978	F	-	-	-	-	26 Sept.	-
1189		1978	F	-	-	-	4 Oct.	-	24 Nov.
1200		1978	M	-	-	-	10 Aug.	18 June	-
1205		1978	F	-	-	-	-	6 July	-
1206		1978	M	-	-	-	26 July	23 July	-
1216		1978	F	-	-	-	-	31 Aug.	-
1217		1978	M	-	-	-	3 Aug.	18 June	-
1228		1978	F	-	-	-	8 Sept.	-	10 Oct.
1261		1978	M	-	-	-	26 July	-	-
1263		1978	M	-	-	-	16 Aug.	20 July	-
1264		1978	M	-	-	-	10 Aug.	-	4 Aug.
1368		1979	F	-	-	-	9 Sept.	-	-
1578		1979	M	-	-	-	-	-	-
2021		1980	F	-	-	-	-	17 July	-
2031		1980	F	-	-	-	-	26 July	-
2113		1980	M	-	-	-	-	-	12 Aug.
2118		1980	M	-	-	-	-	-	25 July
2144	427[e]	1980	F	-	-	-	-	-	2 Sept.
	429	1980	M	-	-	-	-	-	14 July
	435	1980	F	-	-	-	-	-	2 Oct.
	437	1980	M	-	-	-	-	-	25 July
	446	1980	M	-	-	-	-	-	6 Sept.

Table A-10.--Continued.

Tag number		Year		Date of first resighting					
Monel	Roto	tagged	Sex	1977	1978	1979	1980	1981	1982
	452	1980	F	-	-	-	-	-	27 Oct.
	458	1980	M	-	-	-	-	-	17 June
SMI-1977	469[e]	1980	F	-	-	-	-	-	28 Sept.
2005	473[e]	1980	M	-	-	-	-	-	7 Sept.
	486	1980	F	-	-	-	-	-	7 Sept.
	487	1980	F	-	-	-	-	-	18 Sept.
2072	488[e]	1980	F	-	-	-	-	-	21 Sept.
	651	1980	M	-	-	-	-	-	10 Sept.
2511	735[e]	1981	F	-	-	-	-	-	19 Oct.

[a] Mistakenly identified as a female and tagged on the left flipper.
[c] Observed nursing a pup of the year.
[c] Tag recorded as being floppy and/or reversed in flipper at least Once.
[d] Pup was used in growth study.
[e] Double-tagged.

Table A-11.--One hundred northern fur seal pups double-tagged with pink Roto-tags at Adams Cove, San Miguel Island, California. on 29 September 1982. All seals were checkmarked by removal of the cartilaginous extension of the first digit on the left hind flipper.

Tag number	Sex	Weight (kg)	Remarks
A-101	M	11.0	
102	F	12.5	
103	M	11.5	
104	F	9.0	
105	F	10.0	
106	M	10.5	
107	F	10.0	
108	M	10.0	
109	F	10.5	
110	M	11.5	
111	M	12.0	
112	F	9.5	
113	M	12.5	
114	F	12.5	
115	M	8.0	
116	F	9.0	
117	F	12.5	
118	F	7.0	
119	M	9.5	
120	M	12.5	
121	F	9.5	Less than 1% molt completed
122	F	8.0	
123	F	7.5	
124	F	11.0	
125	M	12.5	
126	M	13.0	
127	F	8.0	
128	F	10.5	
129	F	8.5	
130	M	12.5	
131	M	12.0	
132	M	9.0	
133	M	11.5	30% molt completed
134	F	12.0	
135	F	10.5	
136	F	10.0	
137	M	9.0	30% molt completed
138	M	10.0	
139	F	9.0	
140	F	10.5	
141	M	10.0	
142	F	9.5	95% molt completed
143	F	9.5	50% molt completed 144
144	M	9.5	30% molt completed
145	F	8.0	

Table A-11 .--Continued.

Tag number	Sex	Weight (kg)	Remarks
A-146	F	10.0	
147	F	10.5	
148	M	10.5	
149	M	10.5	
150	M	10.5	
151	M	9.5	Less than 1% molt completed
152	M	11.0	
153	M	10.0	
154	F	9.5	90% molt completed
155	M	10.0	
156	M	9.0	5% molt completed
157	F	9.0	
158	M	14.0	
159	M	9.5	
160	M	10.5	3% molt completed
161	F	9.5	
162	F	13.5	
163	M	12.0	
164	F	9.0	Less than 1% molt completed
165	F	7.0	20% molt completed
166	M	11.5	
167	M	18.0	
168	F	11.5	
169	F	13.0	
170	M	8.0	
171	F	10.0	
172	F	9.5	
173	M	10.0	
174	M	15.0	
175	F	10.0	
176	F	9.0	
177	M	7.0	
178	M	11.5	99% molt completed
179	F	12.5	
180	M	12.5	
181	M	12.0	
182	M	11.5	
183	M	13.5	
184	F	10.5	
185	M	12.5	
186	F	12.0	
187	M	12.0	
188	F	9.5	
189	F	9.0	
190	F	10.0	

Table A-11.--Continued.

Tag number	Sex	Weight (kg)	Remarks
A-191	F	9.5	
192	F	10.5	
193	M	11.5	
194	F	9.5	
195	F	12.5	
196	F	9.0	99% molt completed
197	M	11.5	
198	M	13.5	
199	M	13.0	
200	M	12.0	

Table A-12.--One hundred northern fur seal pups double-tagged with green Riese-tags at Adams Cove, San Miguel Island, California, on 29 September 1982. All seals were checkmarked by removal of the cartilaginous extension of the first digit on the left hind flipper.

Tag number	Sex	Weight (kg)	Remarks
A-101	F	8.0	
102	F	7.0	
103	F	12.5	
104	M	11.0	
105	M	11.5	
106	F	7.0	75% molt completed
107	F	11.5	
108	F	9.5	
109	M	13.0	
110	M	10.0	
111	M	11.5	
112	F	12.5	
113	F	8.5	
114	F	9.0	
115	M	13.5	
116	F	6.5	
117	M	11.5	
118	F	11.5	
119	F	8.0	
120	F	12.0	
121	F	12.0	
122	M	11.5	
123	M	10.5	
124	F	12.5	
125	M	11.5	
126	M	10.0	
127	F	13.5	Right flipper bleeding at tag
128	M	12.5	
129	M	10.5	
130	M	13.0	
131	M	13.5	
132	F	9.5	
133	M	13.0	Left flipper bleeding at tag
134	F	10.5	
135	M	14.0	
136	M	14.0	
137	F	11.0	
138	M	10.5	
139	F	11.5	
140	F	9.5	
141	M	10.0	
142	F	9.5	
143	M	11.0	90% molt completed
144	F	9.5	Left flipper bleeding at tag
145	M	10.5	

Table A-12.--Continued.

Tag number	Sex	Weight (kg)	Remarks
A-146	M	9.0	90% molt completed
147	F	11.0	
148	F	8.0	
149	F	10.0	
150	F	10.0	
151	M	13.5	
152	M	11.0	
153	F	10.5	
154	F	9.0	
155	F	8.0	
156	F	9.0	
157	M	13.0	
158	M	11.0	
159	F	11.5	
160	F	9.5	
161	F	11.0	
162	M	11.0	
163	M	9.5	
164	F	9.0	
165	F	12.0	
166	M	9.5	
167	F	12.0	
168	F	16.5	
169	F	6.0	
170	M	14.0	
171	M	11.0	
172	M	9.5	
173	F	10.5	
174	F	7.0	Less than 1% molt completed
175	F	10.0	
176	M	13.5	
177	M	10.0	
178	F	12.0	
179	F	12.0	
180	F	10.0	
181	F	11.5	
182	M	11.0	
183	M	13.0	
184	F	11.5	
185	M	8.0	
186	M	13.0	
187	M	12.0	
188	F	11.0	
189	F	9.0	
190	F	9.0	
191	M	12.5	

Table A-12.--Continued.

Tag number	Sex	Weight (kg)	Remarks
A-192	M	6.0	10% molt completed
193	F	12.0	Right flipper bleeding at tag
194	M	11.5	
195	M	11.0	
196	M	11.5	
197	M	10.0	Left eye red and dilated
198	M	10.5	
199	M	9.0	2% molt completed
200	M	12.5	

Table A-13.--One hundred northern fur seal pups double-tagged with monel tags at Adams Cove. San Miguel Island, California, on 29 September 1982. All seals were checkmarked by removal of the cartilaginous extension of the first digit on the left hind flipper.

Tag number	Sex	Weight (kg)	Remarks
SMI-2574	M	10.5	
2575			
2576	M	8.5	
2577			
2578	F	10.5	
2579			
2580	F	7.5	
2581			
2582	F	12.0	
2583			
2584	F	10.0	
2585			
2586	F	7.0	
2587			
2588	F	10.0	
2589			
2590	M	12.0	
2591			
2592	F	9.5	
2593			
2594	M	12.0	
2595			
2596	F	11.0	
2597			
2598	F	12.0	
2599			
2600	F	7.5	
2601			
2602	F	9.5	
2603			
2604	F	10.0	
2605			
2606	M	10.5	
2607			
2608	F	8.5	
2609			
2610	F	11.5	
2611			
2612	F	12.0	
2613			
2614	F	12.5	
2615			
2616	F	10.0	
2617			
2618	F	14.0	
2619			
2620	M	13.5	
2621			

Table A-13.--Continued.

Tag number	Sex	Weight (kg)	Remarks
SMI-2622	M	11.0	
2623			
2624	F	13.0	
2625			
2626	F	13.0	
2627			
2628	F	9.5	Right flipper bleeding at tag
2629			
2630	M	11.5	
2631			
2632	F	10.0	
2633			
2634	M	10.5	
2635			
2636	F	7.5	1% molt completed
2637			
2638	M	14.5	
2639			
2640	F	10.5	
2641			
2642	F	10.0	
2643			
2644	F	7.5	
2645			
2646	M	11.5	
2647			
2648	F	10.0	
2649			
2650	M	9.0	
2651			
2652	M	11.0	1% molt completed
2653			
2654	F	8.0	
2655			
2656	F	11.5	
2657			
2658	F	9.5	No pigment on tip of right fore-flipper
2659			
2660	F	12.5	
2661			
2662	M	13.5	
2663			
2664	M	13.0	
2665			
2666	F	9.0	
2667			

Table A-13.--Continued.

Tag number	Sex	Weight (kg)	Remarks
SMI-2668	F	8.0	
2669			
2670	M	12.5	
2671			
2672	F	10.5	
2673			
2674	M	13.0	
2675			
2676	F	10.5	
2677			
2678	M	16.5	
2679			
2680	F	9.0	
2681			
2682	M	9.0	
2683			
2684	M	11.5	
2685			
2686	M	8.5	2% molt completed
2687			
2688	F	13.0	
2689			
2690	M	17.5	
2691			
2692	F	9.5	
2693			
2694	F	9.0	
2695			
2696	F	13.5	
2697			
2698	F	10.0	
2699			
2700	M	12.5	
2801			
2802	F	11.5	
2803			
2804	M	12.5	
2805			
2806	M	12.5	
2807			
2808	M	14.0	
2809			
2810	M	14.5	
2811			
2812	M	13.0	
2813			

Table A-13.--Continued.

Tag number	Sex	Weight (kg)	Remarks
SMI-2814	M	10.5	
2815			
2816	M	10.0	
2817			
2818	F	10.5	
2819			
2820	M	8.0	10% molt completed
2821			
2822	M	10.5	
2823			
2824	M	13.0	
2825			
2826	F	12.5	
2827			
2828	F	11.0	
2829			
2830	M	10.5	
2831			
2832	F	9.0	
2833			
2834	M	13.0	
2835			
2836	F	9.5	
2837			
2838	F	9.5	
2839			
2840	F	11.0	
2841			
2842	F	5.5	50% molt completed
2843			
2844	M	12.0	40% molt completed
2845			
2846	M	12.0	
2847			
2848	F	9.5	
2849			
2850	M	11.5	30% molt completed
2851			
2852	F	11.5	
2853			
2854	M	12.0	
2855			
2856	F	12.5	
2857			
2858	F	10.0	
2859			

Table A-13.--Continued.

Tag number	Sex	Weight (kg)	Remarks
SMI-2860	F	13.5	
2861			
2862	F	10.0	
2863			
2864	M	12.0	
2865			
2866	F	12.0	
2867			
2868	M	16.0	
2869			
2870	F	10.5	
2871			
2872	M	13.0	
2873			

Table A-14.--Northern fur seal females double-tagged with white plastic Roto-tags in Adams Cove, San Miguel Island. California, on 18 November 1979, and dates first resighted, 1980-82.

Tag number [a]			Date resighted [b]		
Right flipper	Left flipper	Vibrissae color [c]	1980	1981	1982
401	402	white	23 July*	6 July*	-
404	403	mixed	10 Aug.*	5 July*	19 Nov.
405	406	white	5 July*	5 July	3 Nov.*
407	408	white (tag lost, right side)	-	-	-
410	409	white	1 July*	18 June	17 Sept.
411	412	white	6 July**	-	18 Oct.*
413	414	mixed	5 July	15 July	1 Sept.
416	415	white	21 June**	11 July	17 June*
417	419	white	5 July*	23 July*	29 Sept.
420	421	white	4 July	9 July	4 Nov.*
422	423	white	18 July*	15 July	2 Sept.
424	425	white	15 Aug.	19 July	3 Sept.
426	427	white	27 June*	6 July*	11 July*
428	430	white	21 June*	6 July*	29 June*
431	432	white	29 July	12 Aug.	10 Sept.*
433	434	white	29 July	13 Aug.*	17 July
435	437	white	2 June	18 June	-
438	439	white	5 July	20 June	2 Sept.
440	441	white	5 July*	15 July	2 Oct.
442	443	mixed	18 June*	23 July	22 Aug.*
445	444	mixed	23 July	-	22 Aug.
447	446	white	6 Sept.	29 June**	9 Sept.*
448	449	white	Died 16 Aug., due to cliff collapse, right-side tag lost.		
450	451	white	28 June*	24 June	23 June*
452	453	white	-	-	-
454	455	white	-	-	-
456	457	white	-	-	25 July*
458	459	white	21 June	23 Sept.[d]	-
460	461	white	13 Aug.*	-	-

[a] Tags destroyed: 418, 429 and 436.

[b] "*" indicates the female was known parturient that year and "**" indicates the pup was stillborn or died shortly after birth.

[c] Mixed = combination of black and white.

[d] Resighted on Castle Rock.

Table A-15.--Adult female northern fur seals double-tagged with consecutively numbere monel cattle ear tags in Adams Cove, San Miguel Island, California, on 9 October 1975, and the dates first resighted, 1976-82-a

Tag number	Date of first resighting						
	1976	1977	1978	1979	1980	1981	1982
SMI-201	23 Aug.	-	13 July	12 July	22 June	17 July	26 Oct.
202							
203	-	21 Sept.	2 Sept.	-	-	-	-
204							
205	-	-	-	-	26 July	-	-
206							
207	-	-	-	-	-	-	-
208							
209	-	-	-	-	-	-	-
210							
211	12 Aug.	-	-	16 Aug.	29 June	-	-
212							
213	-	-	-	7 Aug.	19 July	-	-
214							
215	17 July	8 Sept.	-	-	-	-	-
216							
217	12 July	4 Sept.	19 Aug.	3 Aug.	9 June	-	-
218							
219	11 July	-	30 Aug.	9 Aug.	16 July	-	-
220							
221	-	-	22 Aug.	-	13 July	-	-
222							
223	-	4 Sept.	22 July	-	-	-	22 Oct.
224							
225	Tag lost in sand of arroyo west of Mallo Roses, Adams Cove						
226	11 July	18 Aug.	-	14 July	8 Sept.	17 July	24 June
227							
228	25 Aug.	-	27 Aug.	16 Aug.	14 July	13 Aug.	14 July
229							
230	-	-	-	-	-	-	-
231							
232	-	18 Aug.	18 Aug.	-	4 Aug.	-	-
233							
234	-	-	-	-	-	-	-
235							
236	22 Aug.	-	18 Aug.	-	25 July	-	-
237							
238	2 Aug.	6 Aug.	25 July	6 Aug.	8 Sept.	-	25 July
239							
240	-	-	-	6 July	-	-	-
241							
242	-	12 Aug.	-	-	-	-	-
243							
244	12 July	18 Aug.	12 July	8 July	-	-	-
245							

Table A-15.--Continued.

Tag number	Date of first resighting						
	1976	1977	1978	1979	1980	1981	1982
SMI-246	-	20 Aug.	9 Aug.	-	-	-	-
247							
248	11 July	-	-	6 Aug.	-	-	-
249							
250	-	20 Aug.	-	5 Aug.	-	-	-
251							
252	-	19 Aug.	-	-	-	-	-
253							
254	-	-	16 Aug.	1 Sept.	-	1 July	-
255							
256	-	-	-	-	-	-	-
257							
258	-	-	20 Aug.	-	-	-	-
259							
260	-	-	-	23 Aug.	13 July	13 July	-
261							
262	-	10 July	10 July	-	-	-	-
263							
264	10 July	18 Aug.	22 July	11 June	5 Aug.	-	-
265							
266	26 July	12 Aug.	9 Aug.	-	10 Aug.	-	-
267							
268	29 July	-	-	-	10 Aug.	-	-
269							
270	29 July	12 Aug.	-	-	18 July	-	-
271							
272	23 July	20 Aug.	18 Aug.	-	17 July	-	-
273							
274	5 Sept.	-	10 July	1 Sept.	-	-	-
275							
276	21 Aug.	3 Sept.	16 Aug.	-	-	-	-
277		Tag destroyed					
278							
279	5 Aug.	-	17 July	30 July	-	-	-
280							
281	23 July	4 Sept.	22 July	-	-	-	-
282							
283	24 July	12 Aug.	20 July	-	7 Aug.	-	-
284							
285	25 Aug.	-	20 July	16 Aug.	-	-	-
286							
287	-	-	-	-	-	-	-
288							
289	-	30 July	-	15 Aug.	-	-	-
290							

Table A-15.--Continued.

Tag number	Date of first resighting						
	1976	1977	1978	1979	1980	1981	1982
SMI-291	-	-	-	23 Aug.	10 Aug.	-	-
292							
293	10 Aug.	-	-	-	-	-	-
294							
295	22 July	-	30 Aug.	-	17 July	-	-
296							
297	29 Aug.	-	1 Sept.	18 Aug.	10 July	24 July	-
298							
299	8 Aug.	30 July	28 Aug.	9 Aug.	4 Aug.	-	-
300							
301	21 Aug.	-	20 Aug.	24 Aug.	23 June	-	-
302							

[a] Fifty adult females were tagged.

Table A-16.--Northern fur seal males double-tagged with white Roto-tags in Adams Cove, San Miguel Island, California, 1 May 1981. and dates first resighted, 1982. [a]

Tag number		Age [b]	
Right flipper	Left flipper	(years)	Date resighted
465	464	3-4 (e)	6 July
466	SMI-1211 (monel)	3 (a)	4 August
468	467	3-4 (e)	-
470	469	3-4 (e)	17 June

[a] Some fur seals had been tagged previously as pups with different tag types and number series.

[b] (e) = estimated age;
(a) = actual age.

Table A-17.--One hundred northern fur seal pups double-tagged with monel tags and pink Roto-tags on Castle Rock, San Miguel Island, California, on 1 October 1982. Monel tags were attached to the right foreflippers of males and the left foreflippers of females. Pink Roto-tags were attached to the right foreflippers of females and the left foreflippers of males. All seals were checkmarked by removal of the cartilaginous extension of the first digit on the left hind flipper.

Tag number [a]				
Monel	Roto	Weight (kg)	Sex	Remarks
SMI-2701	C-52	6.5	F	
2702	53	9.5	M	
2703	54	12.5	M	
2704	55	4.5	F	
2705	56	8.5	F	
2706	57	13.0	M	
2707	58	12.5	M	
2708	59	11.5	M	
2709	60	13.5	F	
2710	61	9.0	F	
2711	62	10.0	M	
2712	63	7.8	M	
2713	64	11.0	M	
2714	65	12.0	F	
2715	66	9.5	F	
2716	67	10.0	F	Tar on 5% of body
2717	68	9.0	M	Tar on 5% of body
2718	69	10.0	M	
2719	70	10.0	M	
2720	71	9.0	F	
2721	72	10.0	M	
2722	73	9.0	M	
2723	74	8.5	F	
2724	75	8.5	F	
2725	76	12.0	M	
2726	77	10.5	M	
2727	78	10.0	F	
2728	79	7.5	F	Monel on right flipper, Roto on left flipper
2729	80	12.5	M	
2730	81	8.0	F	
2731	82	11.0	F	
2732	83	10.5	M	
2733	84	12.0	M	
2734	85	13.0	M	
2735	86	13.5	M	
2736	87	10.5	F	Monel on right flipper, Roto on left flipper

Table A-17.--Continued.

Tag number [a]				
Monel	Roto	Weight (kg)	Sex	Remarks
SMI-2737	C-88	9.0	F	
2738	89	12.0	M	
2739	90	8.5	F	
2740	91	9.0	M	
2741	92	9.5	F	
2742	93	7.5	F	
2743	94	8.5	F	
2744	95	7.5	F	
2745	96	8.0	F	
2746	97	10.5	M	
2747	98	10.5	M	
2748	99	10.0	M	
2749	100	9.5	F	
2750	101	11.0	M	
2751	102	7.0	M	
2752	103	10.5	M	
2753	104	9.0	M	
2755	105	9.0	F	Tar on 1% of body
2756	106	12.5	M	
2757	107	12.5	M	Tar on 2% of body
2758	108	8.0	F	
2759	109	8.5	F	
2760	110	8.5	F	
2761	111	9.0	M	
2762	112	10.5	M	
2763	113	8.5	M	
2764	114	10.0	F	
2765	115	9.0	F	
2766	116	9.0	M	
2767	117	13.0	M	
2768	118	14.5	M	
2769	119	9.0	F	
2770	120	9.5	F	
2771	121	7.0	F	
2772	122	10.5	M	
2773	123	11.5	M	
2774	124	8.5	F	
2775	125	11.0	M	

Table A-17.--Continued.

Tag number [a]				
Monel	Roto	Weight (kg)	Sex	Remarks
SMI-2776	C-126	8.0	M	
2777	127	6.0	F	
2778	128	11.0	M	Monel on left flipper, Roto on right flipper
2779	129	9.0	M	
2780	130	10.5	F	
2781	131	11.5	F	
2782	132	9.0	F	
2783	133	10.0	M	
2784	134	13.5	M	
2785	135	9.0	F	
2786	136	7.5	F	
2787	137	10.5	F	
2788	138	9.5	M	
2789	139	11.0	M	
2790	141	7.5	F	
2791	142	11.0	M	
2792	143	7.5	F	
2793	144	14.0	M	
2794	145	9.5	M	
2795	146	12.5	M	
2796	147	8.5	F	
2797	148	10.5	M	
2798	149	12.0	M	
2799	150	11.0	M	
2800	151	10.0	F	
2874	152	10.0	M	

[a] Destroyed tags: SMI-2754, C-140.

APPENDIX B

Persons engaged in northern fur seal research in 1982
National Marine Mammal Laboratory (NMML)
Michael F. Tillman, Director
Robert V. Miller, Deputy Director
Charles W. Fowler, Manager, Fur Seal Program

Name	Affiliation	Assignment
Scientific Staff, Fur Seal Program		
Permanent		
Patrick Kozloff	NMML	Population Assessment
Roger L. Gentry	NMML	Behavior and Biology
Robert L. DeLong	NMML	Behavior and Biology
George A. Antonelis, Jr.	NMML	Behavior and Biology
Mark C. Keyes	NMML	Veterinary Medical Services
Hiroshi Kajimura	NMML	Pelagic Ecosystem
Anne E. York	NMML	Population Dynamics
Temporary		
Michael E. Goebel	NMML	Behavior and Biology
Kathlene Newell	NMML	Behavior and Biology
Logan P. Tetoff	NMML	Population Assessment
M. Robert Kochergin	NMML	Population Assessment
Alfey L. Hanson	NMML	Population Assessment
Igor V. Melovidov	NMML	Population Assessment
Charles A. Melovidov	NMML	Population Assessment
Myron A. Melovidov	NMML	Population Assessment
Teresa L. Clocksin	NMML	Population Assessment
Laurie Briggs	NMML	Population Assessment
Darlene Stepetin	Pribilof Isl. Prog.	Population Assessment
Lavrenty Stepetin	Pribilof Isl. Prog.	Population Assessment
Patrick Gearin	NMML	Behavior and Biology
Cooperators[a]		
Linda L. Jones	NMML	Fur Seal Fisheries Interaction
Thomas R. Loughlin	NMML	Pelagic Studies
Alton Y. Roppel	NMML	Population Assessment
Douglas DeMaster	SWFC[b]	Feeding Study
Larry Hansen	SWFC	Behavior and Biology
John Anderson	SWFC	Pup Tagging Project
Lou Palmasero	SWFC	Pup Tagging Project
Mark Lowry	SWFC	Pup Tagging Project
Reed McCluskey	Nat'l. Park Serv.[c]	Pup Tagging Project

APPENDIX B (continued)

Name	Affiliation	Assignment
Cooperators (continued)		
Sandy Breeden	Nat'l. Park Serv.	Pup Tagging Project
Marc Webber	Calif. Mar. Mammal Center	Pup Tagging Project
Theodore R. Merrell	NWAFC, Auke Bay, Alaska	Fur Seal Entanglement
John Calombokidis	Cascadia Research, Olympia, Wash.	Chlorinated Hydrocarbons
John Peard	Cascadia Research, Olympia, Wash.	Chlorinated Hydrocarbons
Steven Feldkamp	Scripps Inst. of Oceanogr., La Jolla, Calif.	Feeding Study

[a] Financed wholly or in part by the National Marine Mammal Laboratory or other Federal Agency.

[b] Southwest Fisheries Center, National Marine Fisheries Service, NOAA, P.O. Box 271, 8604 La Jolla Shores Drive, La Jolla, CA 92038.

[c] The National Park Service manages San Miguel Island, California, for the Department of Navy and frequently assists in wildlife management activities when needed.