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Fur Seal Investigations, 1987 and 1988

Edited by
Hiroshi Kajimura

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NOTICE

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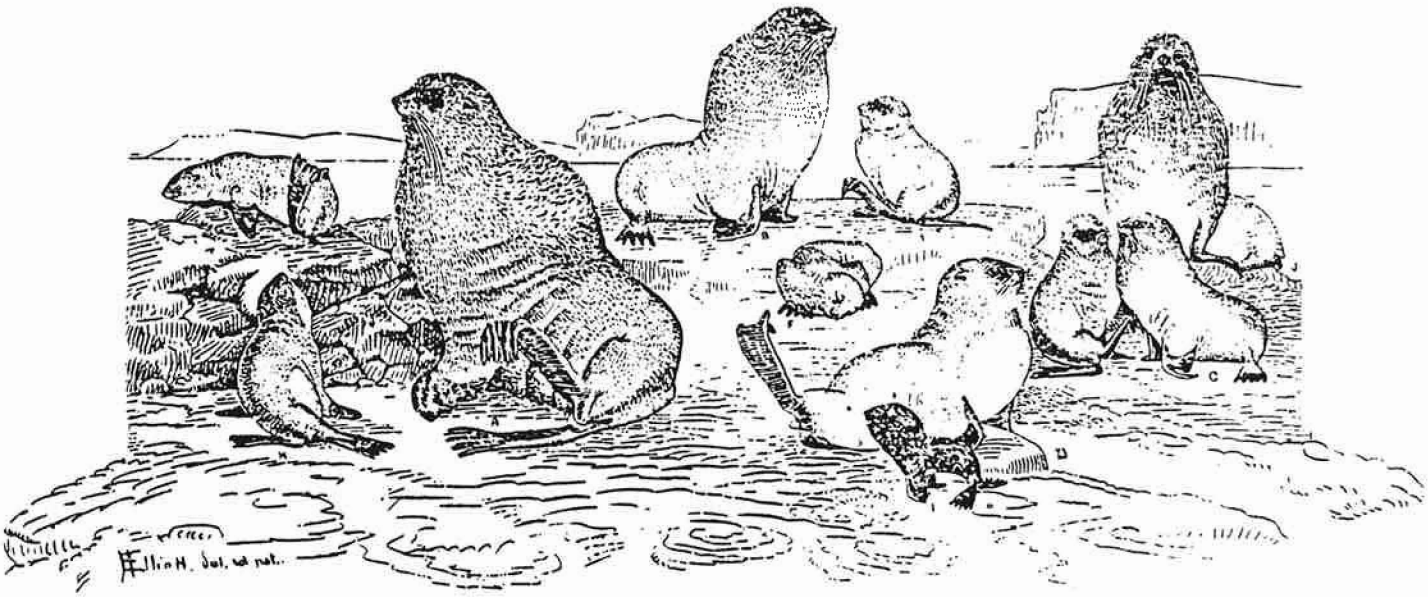

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ABSTRACT

Northern fur seal (Callorhinus ursinus) research in Alaska was conducted on the Pribilof Islands during 1987 and 1988 and on Bogoslof Island in 1988. Research on northern fur seals was also conducted on San Miguel Island and nearby Castle Rock off the California coast during 1987 and 1988.

The total number of pups born on St. Paul Island in 1987 was 2.36% higher than the 1986 but this increase was not statistically significant based on shearing sampling estimation and dead pup counts, which were conducted on all rookeries.

The estimated number of 202,312 pups born in 1988 was significantly higher than the estimated 171,600 pups born on St. Paul Island in 1987. The 1988 estimate was based on a sampling of four rookeries, also using the shearing-sampling estimation and dead pup count methodolgy.

On St. George Island, the estimated 24,862 pups born in 1988 was a decrease since the last census (1985, 28,869). This decrease was not significant at the 5% level.

An analysis of trends in pup production indicates that numbers of pups born on St. George Island have declined at 6% (SD = 0.4%) per year during 1973-88 while numbers of pups born on St. Paul Island decreased at 6.8% (SD = 1.1%) per year during 1975-83 and has shown no trend since 1984.

The weights of pups vary by sex; males outweigh females. In most cases, the mean weight of sheared pups is less than that of

nonsheared pups. The pattern of pup weight differences among rookeries was not consistent between years 1987 and 1988.

The fur seal colony at Bogoslof Island has become firmly established. The number of fur seals continues to increase from a total of one animal in 1976 to over 400 in 1988.

Research continued on the data collection on a marked population of 26 females of known age (marked as pups in 1984) on St. George Island. These females are being observed for changes in dates of parturition and copulation over years.

Preliminary efforts were made to measure northern fur seal foraging ranges using swim speed recorders and to obtain data on the physical characteristics (conductivity and temperature) of the water where fur seal dive for food.

Predation by northern sea lions (Eumetopias jubatus) on northern fur seal pups on St. George Island in 1988 suggests that the hourly loss rate has decreased about fivefold since 1975. These decreases parallel the decline in both sea lions and fur seals at St. George Island since 1975.

A Friedman two-way nonparametric analysis of variance shows that a significant difference in mortality exists between rookeries however, no definite conclusions can be made about the effect mortality may have on distribution of adult territorial males and pups born on the Pribilof Islands.

On San Miguel Island, California, a total of 722 northern fur seal pups were born at Adams Cove in 1987 and 721 pups were born i 1988. This represents a 7% increase over the numbers of

pups born in 1986. A 14% decrease in the numbers of pups born in 1987 (498) and 1988 (496) is noted for the Castle Rock population as compared to 1986 counts.

In 1988, 24,519 male seals (each approximately 105 to 125 cm in length) were rounded up and examined for entanglement in marine debris. Entanglement in trawl webbing in 1988 was about 75% of entanglement levels observed for this kind of debris in previous years. The entanglement rate fell from about 0.4 to 0.29%.

The 1988 rate of resighting for animals tagged in 1985-86 and showed that entangled animals tagged in 1985-86 were seen at a rate lower than the rate at which controls were resighted.

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INTRODUCTION

by

Hiroshi Kajimura

The National Marine Mammal Laboratory (NMML) is responsible for collecting biological and management data on the northern fur seal, (Callorhinus ursinus), under the Fur Seal Act and the Marine Mammal Protection Act in absence of the Fur Seal Convention which expired in 1984.

Scientists from NMML have routinely conducted annual surveys and studies of northern fur seals on U.S. islands under terms of the Interim Convention on the Conservation of North Pacific Fur Seals. Although this Interim Convention lapsed in October 1984, studies have continued annually by former member nations. In 1987 and 1988, the United States and Japan cooperatively carried out research on the northern fur seal, on land and at sea. In particular, studies have been conducted on the Pribilof Islands (St. Paul and St. George Islands) and Bogoslof Island in Alaska and San Miguel Island (including Castle Rock) off southern California where fur seals breed and haul out.

The Pribilof Islands of St. Paul, Sea Lion Rock (Sivutch) and St. George Island (Figs. 1 and 2), are host to breeding populations of northern fur seals. A small colony of fur seals now breeds on Bogoslof Island, Alaska (Fig. 3), in the southeastern Bering Sea. This colony was discovered in 1980 with four fur seals and by 1988 the fur seal colony increased to over

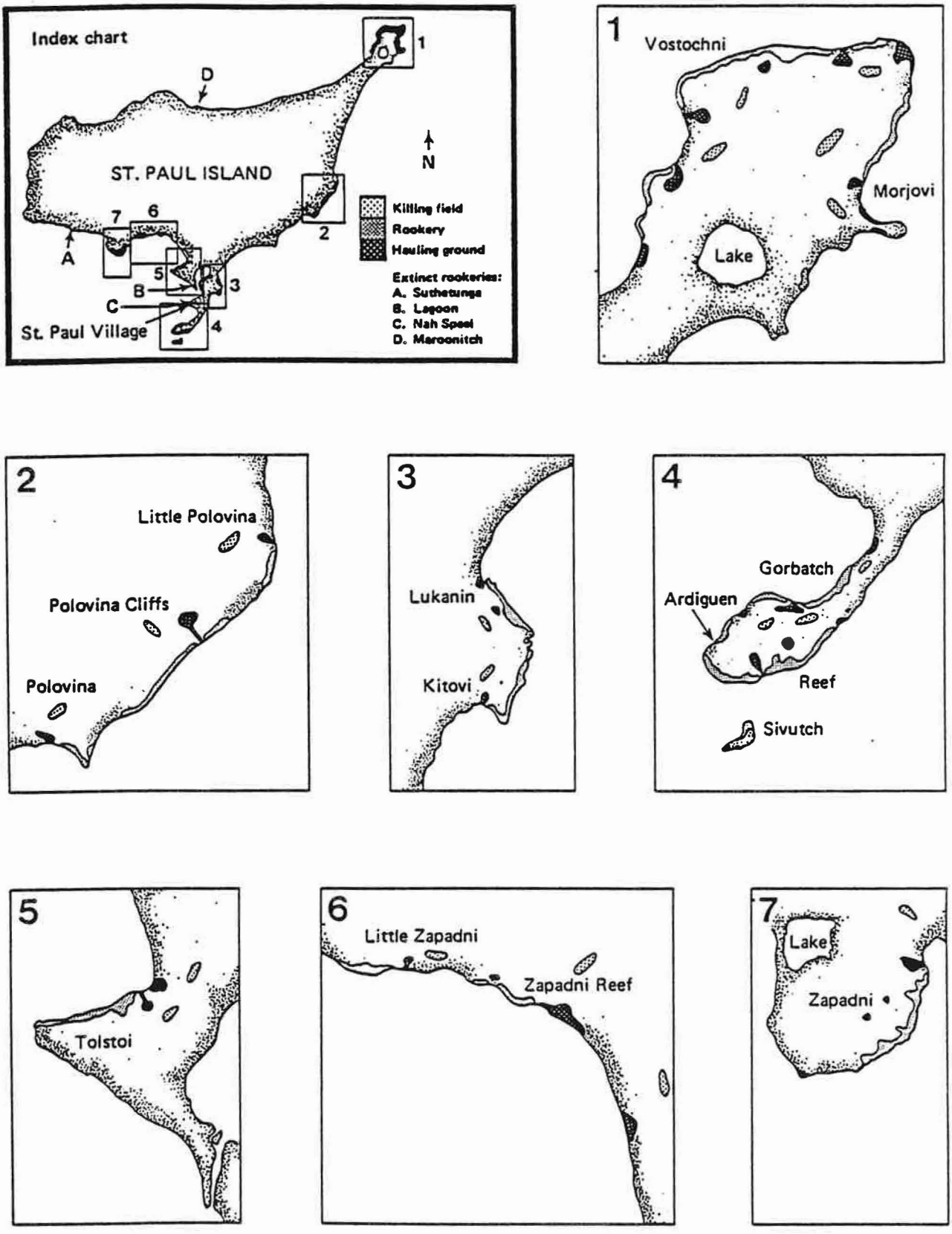
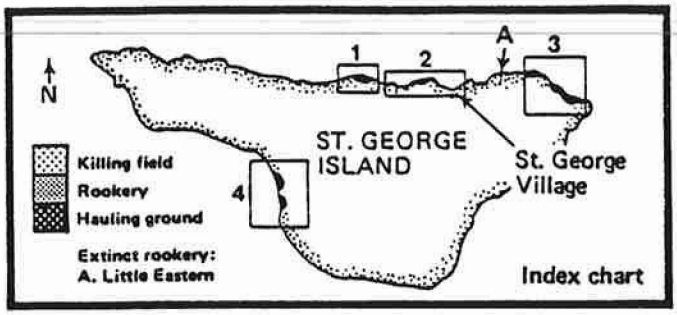
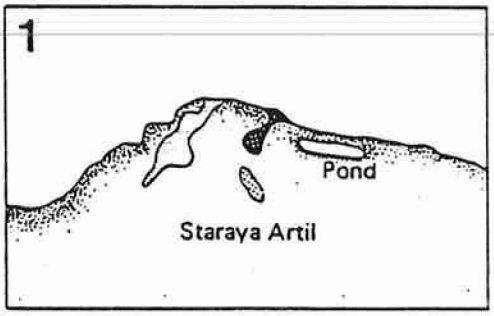
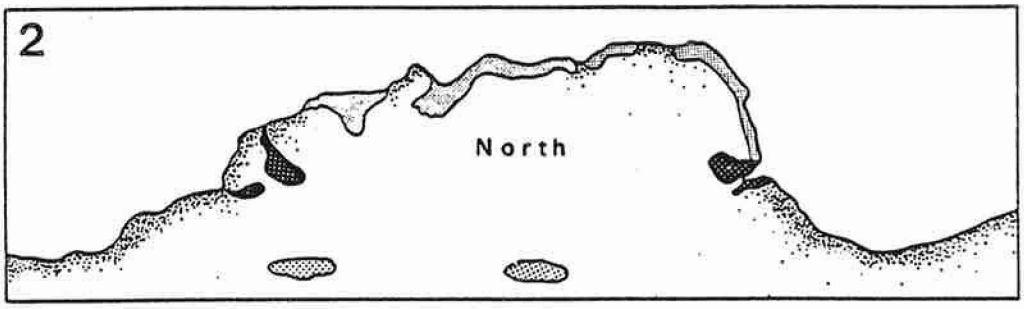
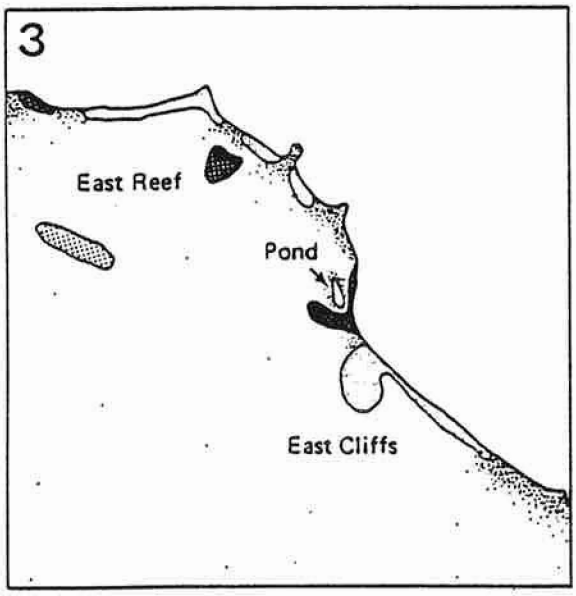


Figure 1.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. Paul Island, Alaska.









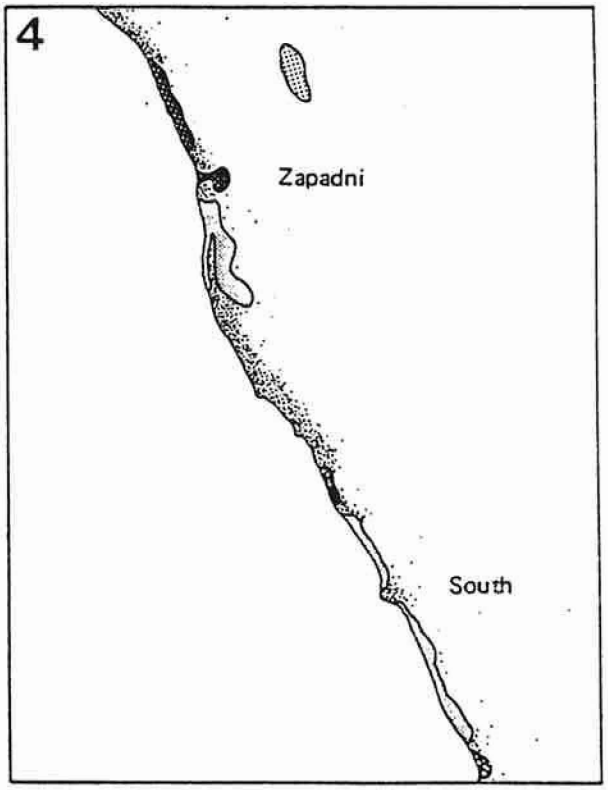


Figure 2.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. George Island, Alaska.

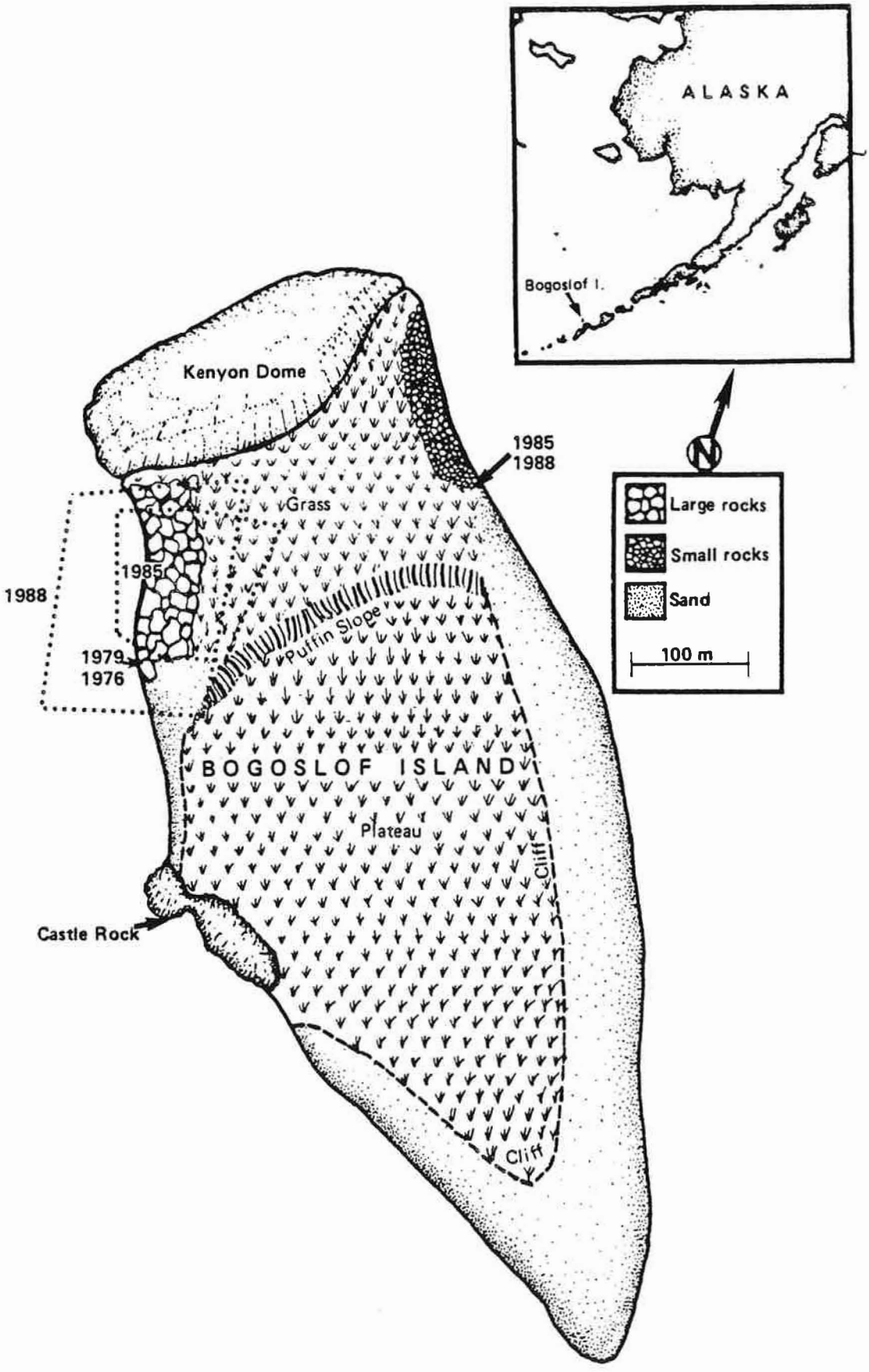


Figure 3.--Locations of fur seals as indicated by year of observation.

400 animals. Two additional colonies fluctuating between 3,000 and 4,000 northern fur seals breed on San Miguel Island and nearby Castle Rock off southern California (Fig. 4).

Fur seals have not been commercially harvested on the Pribilof Islands since 1984. A moratorium on the commercial harvesting of fur seals on St. Paul Island was imposed beginning in 1985 because of the depressed northern fur seal population on this Pribilof Island. A moratorium on commercial harvesting of fur seals was imposed earlier on St George Island (1973) to permit research on the population as it reverted to its natural state. Because of the moratorium on commercial harvesting on both islands, juvenile male fur seals (primarily 2- and 3-year-olds) are now harvested only for subsistence. In 1987, 1,802 juvenile males were taken in the subsistence harvest--1,710 were taken on St. Paul Island and 92 animals were taken on St. George Island. In 1988, 1,145 juvenile males were harvested on St. Paul Island and 113 juvenile males were harvested on St. George Island.

Fur seals are not harvested on Sea Lion Rock, Bogoslof Island, Castle Rock, or San Miguel Island. However, some males from breeding rookeries other than on St. George and St. Paul Islands may be subjected to a harvest mortality as well since young male seals occasionally haul out at some distance from their rookeries of birth. There are four extinct rookeries on St. Paul Island (Fig. 1) and one on St. George Island (Fig. 2).

Terms having special meanings in northern fur seal research are defined in the glossary (Appendix A), and Russian names given

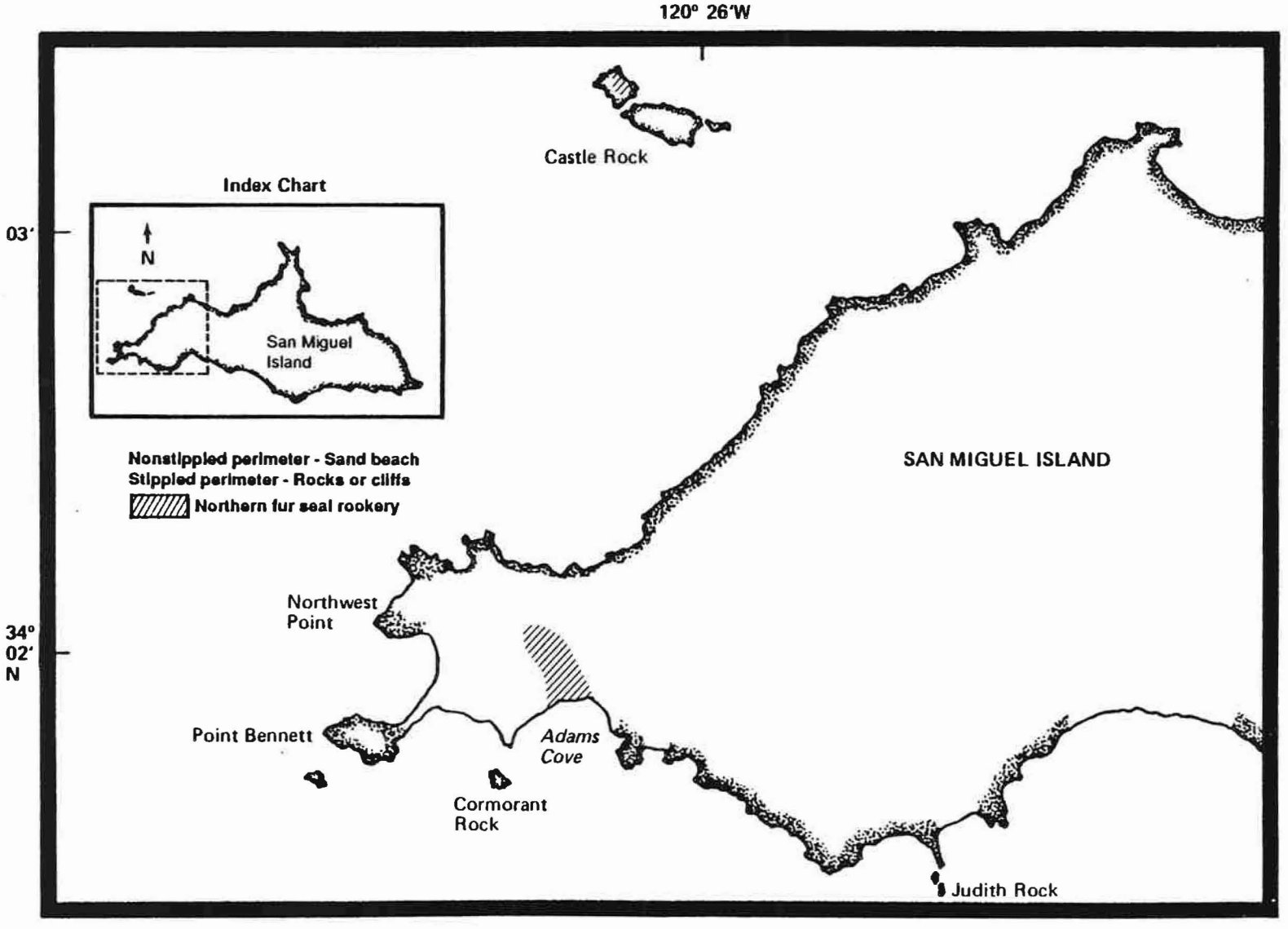


Figure 4.--Location of northern fur seal breeding colonies, San Miguel Island, California.

to some of the rookeries of the Pribilof Islands following their discovery by Russian fur hunters in 1786 are translated in Table 1.

Tabular data for this report are presented as appendices. Appendix B is the data customarily presented concerning general studies, Appendix C is entanglement-related data, and Appendix D is a list of personnel involved in fur seal research in 1987 and 1988.

This report summarizes the research carried out on these islands in 1987 and 1988 under the authority of the Marine Mammal Permit No 598.

Table 1.—English translations of Russian names for Pribilof Island rookeries and hauling grounds.

Island and Russian name	English translation	Comments and derivation of name
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	Halfway to Northeast Point from the village.
Kitovi	Of "kit" or	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 harvested over 5,000 sea otters from St. Paul Island in 1787.
Zoltoi (hauling ground)	Golden	So named to express the metallic shimmering of the sands.
St. George Island		
Staraya Artil	—	Old settlement or village. There was once a settlement or village adjacent to the rookery.
Sea Lion Rock		
Sivutch	Sea lion	These animals haul out but do not breed here.

POPULATION ASSESSMENT, PRIBILOF ISLANDS, ALASKA

by

Hiroshi Kajimura, Anne E. York,

George A. Antonelis and Charles W. Fowler

The National Marine Mammal Laboratory (NMML) continues to monitor the status of the Pribilof Islands fur seals by collecting information on population size, age and sex composition, and natural mortality. This is done in accordance with provisions established by the Interim Convention on Conservation of North Pacific Fur Seals.

Population Parameters

Herd characteristics monitored on the Pribilof Islands in both 1987 and 1988 include 1) sex composition and approximate ages of seals harvested for food on both St. Paul and St. George Island, 2) number of live adult males and pups, and 3) number of dead pups and older seals of both sex.

Age and Sex Composition of Seals Harvested

Males--The age composition of males, which is the only sex taken during the subsistence harvest from both St. Paul and St. George Island, was not determined in 1987 or 1988. Teeth, which can be used to determine age composition, were not collected because of the small number of seals harvested (small sample size) and the hunters' selection of primarily young animals ages 2 and 3 years old (even though there are no restrictions on size). The sizes harvested from each year class during 1971-86

are shown in Table 2. The age composition of males harvested on St. Paul Island during 1976-86 is shown in Table 3.

During 1987, 1,710 subadult male seals of approximate ages 2-3 years old were taken for food on St. Paul Island and in 1988, 1,145 subadult males were taken. On St. George Island, 92 subadult males of the same approximate ages were taken in 1987 and 113 subadult males were taken in 1988.

Females - No females were taken during the subsistence harvest on both islands during 1987 and 1988.

Living Adult Male Seals Counted

In 1987, 3,636 harem (class 3, see glossary for definition) and 1,892 idle (classes 1, 2, 4, and 5) adult male fur seals (bulls) were counted on St. Paul Island from 9 to 20 July (Appendix Tables B-1, B-2, and B-3). On St. George Island, 1,303 harem and 1,283 idle bulls were counted from 9 to 20 July (Appendix Tables B-2 and B-3). Figure 5 illustrates the relative location of the different classes of adult males on a typical fur seal rookery-hauling ground complex on the Pribilof Islands. Class 2 in Figure 5 corresponds to classes 1 and 2 of the glossary; class 5 corresponds to classes 4 and 5 of the glossary.

In 1988, 3,585 harem and 3,201 idle bulls were counted on St. Paul Island from 10 to 17 July (Appendix Tables B-3, B-4, and B-5). On St. George Island, 1,259 harem and 1,258 idle bulls were counted during July (Appendix Tables B-3 and B-5).

Dead Seals Older Than Pups

The rookeries and adjacent beaches of St. Paul Island were surveyed for dead seals older than pups from 20 to 23 August

Table 2.--Numbers of male northern fur seals harvested by age group, St. Paul Island, Alaska, 1971-86 year classes.[a]

Year class	Number of seals: Age group 2	3	4	5	Total harvested
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	2,180	14,224	7,016	414	23,834
1979	2,284	15,123	6,644	304	24,355
1980	2,065	15,587	4,601	4	22,257
1981	3,047	13,976	496	5	17,524
1982[b]	3,133	2,645	50	-	5,828
1983[b]	234	330	-	-	564
1984[b]	270	-	-	-	270
1985[b]	-	-	-	-	-
1986[b]	-	-	-	-	-
Total	22,663	163,750	78,816	5,108	270,337
Mean	1,619	12,596	6,568	464	19,310[c]

[a]Includes only 2- to 5-year-olds taken during the harvest of male seals. In 1984, an upper limit of 22,000 fur seals was imposed on the harvest, and following 1985, the harvest was limited to a subsistence take for food.

[b]Incomplete returns. The sample size is too small to calculate any meaningful numbers of age groups based on subsistence harvested animals.

[c]1982, 1983, and 1984 year classes not included.

Table 3.--Age classification of the numbers of male northern fur seals harvested, St. Paul Island, Alaska, 1976-86.

Year of harvest	Number of seals: Age group 1	2	3	4	5	6	Total harvested
1976	0	893	13,397	8,050	722	19	23,081
1977	0	1,783	16,476	9,421	707	9	28,396
1978	0	1,479	13,752	8,955	598	45	24,829
1979	0	2,051	15,245	7,918	470	18	25,702
1980	0	2,180	13,157	8,183	725	33	24,278
1981	0	2,284	14,224	6,714	651	19	23,892
1982	0	2,065	15,123	7,016	511	15	24,730
1983	16	3,047	15,587	6,644	414	20	25,728
1984[a]	0	3,133	13,976	4,601	304	20	22,034
1985[b]	0	234	2,645	496	4	0	3,379
1986[b]	3	521	542	81	5	0	1,149
1987	-	-	-	-	-	-	1,710[c]
1988[d]	-	-	-	-	-	-	1,149[e]

[a]An upper limit of 22,000 male fur seals was imposed in the harvest.

[b]The harvest was limited to a subsistence take for food. Numbers shown are based on tooth samples collected during the subsistence harvest.

[c]Includes 6 female seals.

[d]The harvest was limited to a subsistence take for food. Tooth samples were not collected to determine age classification. Small sized male seals (age 2 to 3 years old) were selected.

[e]Includes four seals (nonlegal) subsistence take.

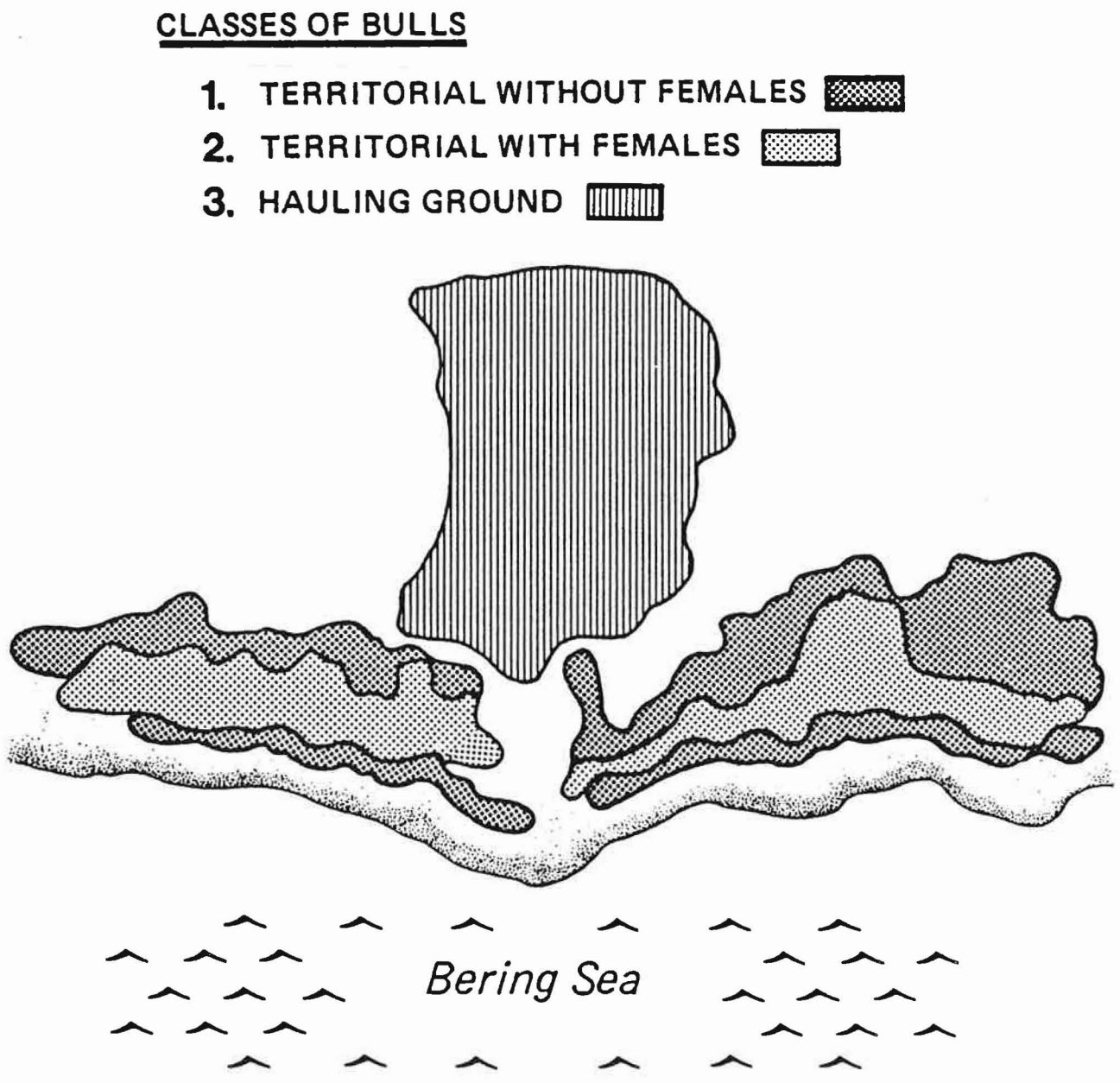


Figure 5.-- General composition of a typical fur seal rookery. Class 2 as depicted here corresponds to classes 1 and 2 of Appendix A and class 5 corresponds to classes 4 and 5 of Appendix A.

1987. The count of dead seals totaled 118 animals (80 females, 20 males, and 10 of unknown sex). When counts were made 14 to 20 August 1988, the number of dead seals on St. Paul and St. George Islands totaled 168 (112 females and 56 males) and 50 (29 females and 21 males), respectively. Table 4 lists the number of these seals counted on the Pribilof Islands since 1965.

Dead Pups Counted

During 1987, 7,651 dead fur seal pups were counted on all rookeries of St. Paul Island except Little Polovina rookery from 20 to 23 August (Appendix Table B-6). Counts of dead pups were not made on St George Island during 1987. In 1988, a total of 7,261 and 1,212 dead fur seal pups were counted on St. Paul and St. George Islands, respectively, during 14 to 20 August (Appendix Table B-7). The number of dead pups counted on both islands since 1979 are given in Appendix Table B-8.

Table 4.--Number of dead northern fur seals counted that were older than pups, Pribilof Islands, Alaska, 1965-85. 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
1983	57	66	-	-	57	66
1984	66	72	-	-	66	72
1985	5	34	17	35	22	69
1986	24	67	-	-	24	67
1987	20	90[b]	-	-	20	90[b]
1988	56	112	21	29	77	218

[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.

[b]Includes 10 dead fur seals of unknown sex.

NORTHERN FUR SEAL PUPS BORN ON ST. PAUL ISLAND 1987-88

by

Anne E. York and George A. Antonellis

Pups born at St. Paul Island (1987)

Shearing-sampling estimation and dead pup counts were conducted on all rookeries except Little Polovina rookery on St. Paul Island in August 1987. A census was not conducted on Little Polovina because the number of pups born there has declined precipitously since 1980, and it was thought additional disturbance to the rookery would be inadvisable. Shearing sampling had not been conducted on all rookeries since 1979. Therefore, it was necessary to census all rookeries this year to verify that the ratio of pups to numbers of breeding bulls was approximately constant across the rookeries; this assumption is required for computing an unbiased estimate of the numbers of pups from data on sample rookeries (York and Kozloff 1987).

Pups were sheared during 7-15 August 1987; observational samples of sheared to nonsheared pups were taken during two periods: 16-18 August and 19-21 August, respectively. Table 5 presents the shearing and sampling details for each rookery and the calculation of the numbers of pups alive at the time of sampling. Table 6 summarizes the estimated number of pups born, counts of dead pups, counts of breeding males, and ratio of pups to breeding males for all 14 rookeries of St. Paul Island. Estimated numbers of pups alive at the time of sampling are from Table 5. An estimate of numbers of live pups on Little Polovina

Table 5.--Estimated numbers of northern fur seal pups in 1987 at the time of sampling on 13 rookeries of St. Paul Island, Alaska. Pups were sheared on 7-15 August 1987; sampling periods 1 and 2 were 16-18 and 19-21 August, respectively.

Rookery	Pups Sheared	Period 1			Period 2			Mean[d]
		N25[a]	NR[b]	Est.1[c]	N25[a]	NR[b]	Est.2[c]	
Ardiguen	305	41	94	3,326	39	98	3,034	3,180
Gorbatch	1,311	152	419	11,890	148	389	12,470	12,180
Kitovi	995	186	617	7,499	110	335	8,168	7,833
Lukanin	361	108	248	3,930	56	124	4,076	4,003
Morjovi	1,147	166	468	10,171	144	348	11,866	11,018
Polovina Cliffs	1,489	210	610	12,815	194	456	15,837	14,326
Polovina	263	41	160	1,685	44	133	2,175	1,930
Reef	2,002	238	606	19,657	218	557	19,589	19,623
Tolstoi	2,260	212	568	21,088	228	541	23,811	22,450
Vostochni	2,667	322	893	24,042	264	625	28,164	26,103
Little Zapadni	1,353	170	426	13,498	142	412	11,658	12,578
Zapadni	2,157	239	610	21,128	177	463	20,615	20,871
Zapadni Reef	678	65	155	7,108	55	121	7,705	7,406
Total								163,026

[a]Number of 25 pup samples taken.

[b]Number of sheared pups sampled.

[c]Estimates of number of pups alive at the time of sampling for periods 1 and 2 are computed:

$$\text{Est.} = \frac{(\text{No. pups sheared})\ (\text{N25})\ (25)}{\text{NR}}.$$

[d]Calculated as the mean of Est. 1 and Est. 2.

Table 6.--Estimated number of northern fur seal pups alive at the time of sampling, numbers of dead pups counted, estimated number of pups born, and approximate standard deviation of the total estimate for all rookeries (except Sea Lion Rock) of St. Paul Island, Alaska, August 1987.

Rookery	Number of pups			Standard deviation
	Alive	Dead	Total	
Ardiguen	3,180	114	3,294	145.7
Gorbatch	12,180	697	12,877	290.0
Kitovi	7,833	288	8,121	334.6
Lukanin	4,003	183	4,186	72.8
Morjovi	11,018	336	11,354	847.2
Little Polovina	352[a]	16[b]	368	59.1
Polovina Cliffs	14,326	536	14,862	1,510.9
Polovina	1,930	48	1,978	245.2
Reef	19,623	880	20,503	34.0
Tolstoi	22,450	1,368	23,818	1,361.7
Vostochni	26,103	771	26,776	2,053.1
Little Zapadni	12,578	878	13,456	920.1
Zapadni	20,871	1,308	22,179	256.5
Zapadni Reef	7,406	334	7,740	298.2
Totals	163,853	7,757[c]	171,610	3,218.5[d]

[a]The number of live pups on Little Polovina was estimated by extrapolating a regression line of shearing-sampling estimates for Little Polovina for 1979, 1980, and 1984 on time.

[b]The number of dead pups on Little Polovina was estimated by assuming that the mortality rate on Little Polovina was equal to that on the other rookeries (4.47%).

[c]Total numbers of dead pups include 90 pups taken for necropsies: there were 33 from Vostochni, 53 from Reef, 1 from Lukanin, 2 from Zapadni, and 1 from Polovina.

[d]The standard error of the total estimate is calculated as the square root of the sum of the individual variances for each rookery; the individual variances are the square of the standard deviations. An approximate 95% confidence interval for the estimate is

$$171{,}610 \pm (2.16)(3218.5) \text{ or } 171{,}610 \pm 6{,}950.$$

rookery was computed by extrapolating a regression line of live pups over time for the last three censuses taken on Little Polovina rookery. Dead pups counts (from Appendix Table A-7) and an estimate of the numbers of dead pups for Little Polovina rookery, assuming that the mortality rate is the same as that observed on the other rookeries) are also given. For each sampled rookery, a standard deviation of the pup estimate is computed from the standard error of the estimates on the two sampling occasions. For Little Polovina, the standard deviation is computed from the mean square error of the regression. Table 6 and Figure 6 show the ratio of pups to breeding males on the sampled rookeries.

The estimated total number of pups born on St. Paul Island (the sum of estimates over all the rookeries plus dead pups) is 171,610 (SD = 3,218). The total numbers of dead pups was estimated at 7,757 (7,741 counted on the sampled rookeries and 16 estimated for Little Polovina Rookery); the estimated early mortality rate is 4.5%. A 95% confidence interval of the population estimate is computed by assuming that the estimates on the individual rookeries are independent and by calculating the variance of the total as the sum of the variances for each rookery. The standard deviation of the total is the square root of this variance. The total number of pups born is 2.36% higher than the 1986 estimate; this increase is not statistically significant.

The numbers of pups alive at sampling and the numbers of breeding males are again highly correlated (Figure 7). When

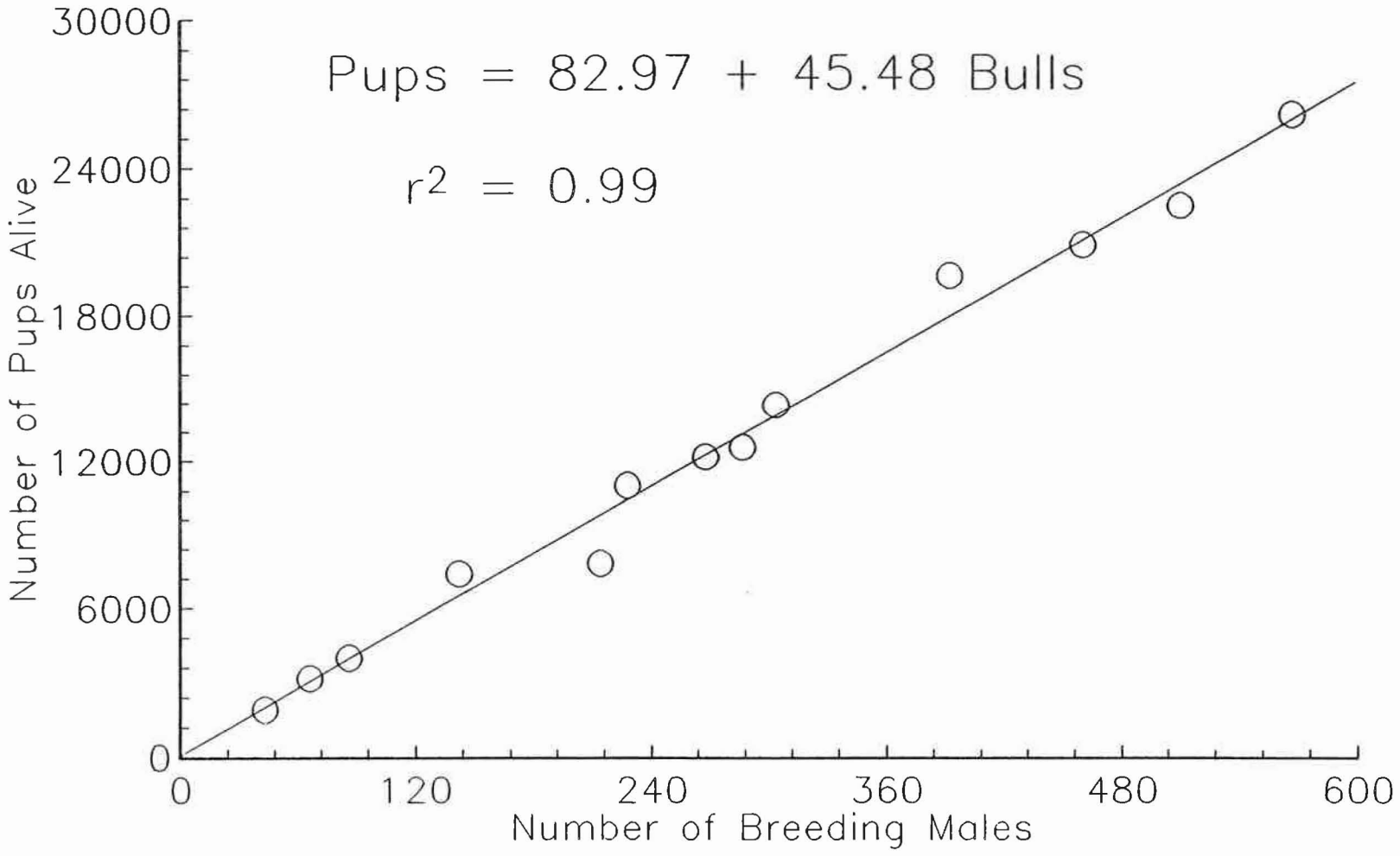


Figure 6.--Numbers of northern fur seal pups alive at the time of sampling versus numbers of breeding males for all sampled rookeries, St. Paul Island, Alaska, 1987.

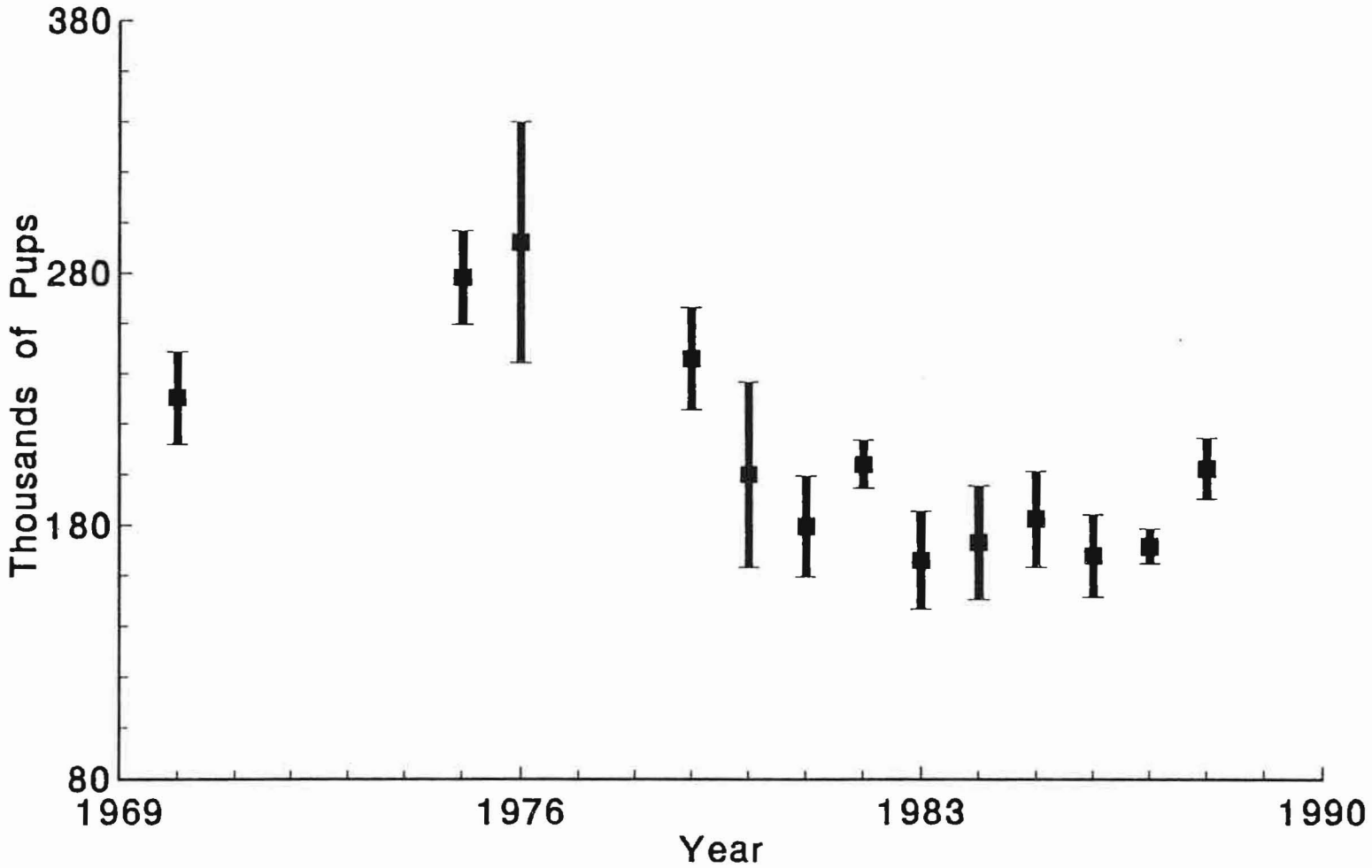


Figure 7.--Numbers of northern fur seal pups born on St. Paul Island, Alaska, 1970-88. Approximate 95% confidence intervals are shown.

numbers of pups born are regressed on numbers of males, the value of R^2 is about 0.988. The intercept of the regression line, 82.97, is not significantly different from 0; the slope of the regression line is 45.48 (SD = 1.54). Analysis of the residuals from the regression indicates that the Kitovi rookery residual was significantly greater than zero; there have also been residuals significantly greater than zero in other years (York and Kozloff 1987). It is important to monitor the rookeries for which the bull-pup relationship does not hold. If there is a tendency over several years for some rookeries to have a significantly higher or lower ratio of pups to breeding males, then the sampling procedure would have to be adjusted.

Pups born at St. Paul Island (1988)

The number of pups born on St. Paul Island during 1988 was estimated according to the method developed in York and Kozloff 1987. Pups were sheared on four sample rookeries (Lukanin, Vostochni, Little Zapadni, and Zapadni) during 7 August and 10 August, 1988. Resighting to determine the sheared to nonsheared ratio on the sample rookeries was done twice by each of two observers on each rookery during 11 August and 20 August 1988. The total number of pups born on the island is based on the ratio of pups to breeding males on the sample rookeries.

Table 7 gives the number of pups sheared, the number of sheared animals resighted, the total number of pups sampled and the estimated number of pups alive at the time of sampling for the sample rookeries. Estimates of numbers of pups born on the

Table 7.--Number of northern fur seal pups sheared, number of sheared pups resighted on two sampling occasions (R_1 and R_2), total number of pups sampled on two sampling occasions (T_1 and T_2), number of pups estimated to be alive at the time of sampling (E_1 and E_2), and the mean number alive St. Paul Island, Alaska, 1988.

Rookery	Pups sheared	Marked pups sampled		Total pups sampled		Estimated		
		R_1	R_2	T_1	T_2	E_1[a]	E_2[a]	Mean[a]
Lukanin	500	181	114	1,625	1,050	4,489	4,605	4,547
Vostochni	2,660	435	542	4,650	6,525	28,434	32,023	30,229
Little Zapadni	1,271	362	308	4,800	3,850	16,853	15,888	16,370
Zapadni	2,281	263	435	3,025	4,725	26,236	24,776	25,506

[a] $E_1 = \frac{(\text{sheared})\ (Ti)}{R_1}$ $\quad i=1,2$

[b] Calculated as the mean of E_1 and E_2.

sample rookeries are the mean of the Petersen estimates over the two sampling periods.

The estimate of the total number of pups born on St Paul Island for 1988 calculated by multiplying the count of breeding males on all rookeries by the estimated ratio of pups to bulls on the sample rookeries (c.f. York and Kozloff 1987). The estimate is derived in the following way: Let

n be the number of sample rookeries,

p_i be the estimated number of pups alive at sampling,

B_i be the count of breeding males in mid-July, and

r the ratio of pups to males on the sampled rookeries;

$r = [(\mathrm{R}\, P_i)/(\mathrm{R}\, B_i)$.

Define r^{-i} as the ratio of pups to males on all but the ith sampled rookery:

$r^{-i} = [(\mathrm{R}\, P_i) - P_i)/[(\mathrm{R}\, B_i) - B_i]$.

The ith pseudo-value r_i^* (Mosteller and Tukey 1977):

$r^*_i = n\, r - (n-1)\, r^{-i}$.

Then the jackknife estimate of the ratio of pups to adult males (R) is

$R = (\mathrm{R}\ r^*_i)/n$.

The approximate variance (V) of the jackknife ratio r is

$V=[\mathrm{R}\,(r^*_i - R)^2]/(n)(n-1)$.

Table 8 gives the details of the computation of the jackknife estimate of the ratio of pups to breeding males on the sampled rookeries. This ratio is 54.540 with an approximate standard error of 1.0464.

Table 8.--Estimates of number of pups alive at the time of sampling (E1 and E2) for periods 1 and 2, mean number of pups estimated over the two sampling periods, number of breeding males (Bulls), the ratio of the mean number of pups to breeding males (Ratio), the ratio of pups to breeding males on all but the given rookery (R-minus), and the pseudoratio (see text for details), for four sample rookeries, St. Paul Island, Alaska, 1988.

Rookery	Estimated E1	Estimated E2	Mean	Bulls	Ratio	R-minus[a]	Pseudo[b]
Lukanin	4,489	4,605	4,547	56	52.873	54.791	54.321
Vostochni	28,434	32,023	30,229	568	53.220	55.664	51.703
Little Zapadni	16,853	15,888	16,370	287	57.039	54.065	56.500
Zapadni	26,236	24,776	25,506	461	55.328	54.353	55.635

[a]R-minus is the ratio on all but the sampled rookery.

[b]The pseudovalue is calculated as 4r-3p, where p is the pseudovalue and r is the ratio on all sampled rookeries.

The jackknife estimate of the ratio of pups (alive at the time of sampling) to the number of breeding males is 54.540.

Its standard error is 1.0464.

An approximate 95% confidence interval is 51.210 to 57.869.

The usual method of estimating total pup production on St. Paul is to multiply the ratio of pups to breeding males on the sampled rookeries by the total number of breeding males on all rookeries and to add the number of dead pups. However, since the ratio of pups to breeding males on Little Polovina rookery has been significantly less than on the other rookeries, the total number of pups on Little Polovina rookery is estimated separately using a regression of the logarithm of pup numbers on time. This method was also used to estimate Little Polovina's contribution to total pup production in 1987.

Pup production on all rookeries except Little Polovina is estimated as the product of the ratio of pups to breeding males (54.540) and the count of breeding males on all but Little Polovina rookery (3,571), added to the count of dead pups 7,272 (Table 9): 194,762 + 7,272, or 202,034. The estimated standard deviation is 3,737.

The number of pups alive in mid-August on Little Polovina rookery was estimated as 268 with a standard deviation of 10.6. The number of dead pups was estimated at 10 pups using the estimated mortality rate on the other rookeries (or 3.6%) giving a total estimate of 278 pups born on Little Polovina.

Thus, the total estimated number of pups alive at sampling is 195,030 (194,762 + 268) with approximate standard deviation of 3,800. The estimated number of pups born on St Paul Island in 1988 is 202,312 $\pm$ 12,091 (approximate 95% CI). This estimate is significantly higher than the estimated 171,600 pups born on

Table 9.--Number of pups sheared, number of marked animals sampled by samplers 1 and 2 (R_1 and R_2), total number of animals resampled by samplers 1 and 2 (T_1 and T_2), estimated numbers of pups alive at the time of sampling for each sampler (E_1 and E_2), mean estimated of pups alive at the time of sampling, standard error of the number of pups alive at sampling, count of dead pups, and estimate of total number of pups alive at sampling for the rookeries of St. George Island, Alaska 1988.

Rookery	Pops sheared	Marked pups sampled		Total pups sampled		Estimated[a]		Mean[b]	SE[c]	Dead	Total alive
		R_1	R_2	T_1	T_2	E_1	E_2				
East Reef	219	64	65	175	225	599	758	678	79.6	12	690
East Cliffs	628	157	90	900	525	3,600	3,663	3,632	31.7	246	3,878
North	1,513	304	332	1,950	1,800	9,705	8,954	8,954	751.0	534	9,488
Starya Artil	455	135	71	700	425	2,359	2,541	2,541	182.2	111	2,652
Zapadni	470	164	67	1,150	550	3,296	3,577	3,577	281.2	152	3,729
South	581	161	100	1,175	725	4,240	4,226	4,226	14.0	157	4,383
									826.9[d]	1,170	24,820
Total	3,866										

An approximate 95% confidence interval for the total number of pups born on St. George Island is 24,820 + (2.447) (826.9)

$$24{,}820 \pm 2{,}023.$$

[a] $E_i = \frac{(\text{Number pups sheared})\ T_i}{R_1}$ $\quad i=1,2$

[b] Calculated is the mean for samplers 1 and 2.
[c] Calculated as the SE of $E_1 + E_2$.
[d] Calculated as the square root of the sum of the variances for each rookery.

St. Paul in 1987. Figure 7 shows numbers of pups born with 95% confidence intervals for 1970-88.

Pups born at St. George Island (1988)

The number of pups born on St. George Island was estimated from shearing-sampling on all rookeries of St. George Island during 12-15 August 1988. Resighting to determine the sheared to unsheared ratio on the sample rookeries was done once by each of two observers on each rookery during 16-17 August 1988. Counts of dead pups were made during the resampling. The estimate of total number alive at the time of sampling is the mean of the Petersen estimates of the two samplers; the variance is computed from the two independent estimates in the usual way. The total number of pups born on the island is the sum of the numbers alive on each rookery and the count of dead pups. Details of these computations are presented in Table 8. The estimate of the total number of pups born on St. George Island is 24,862; an approximate 95% confidence interval for the total number of pups born on St. George Island is 24,862 ± (2.447)(826.9), or 24,862 ± 2,023.

There was a decrease in the number of pups born on St. George Island since the last census (1985, 28,869 SD= 2,298). This decrease is not significant at the 5% level but is significant for $p < 0.92$ ($t = 2.290$ d.f.= 6). Estimates and approximate 95% confidence intervals of available numbers of pups born on St. George during 1970-88 are shown in Figure 8.

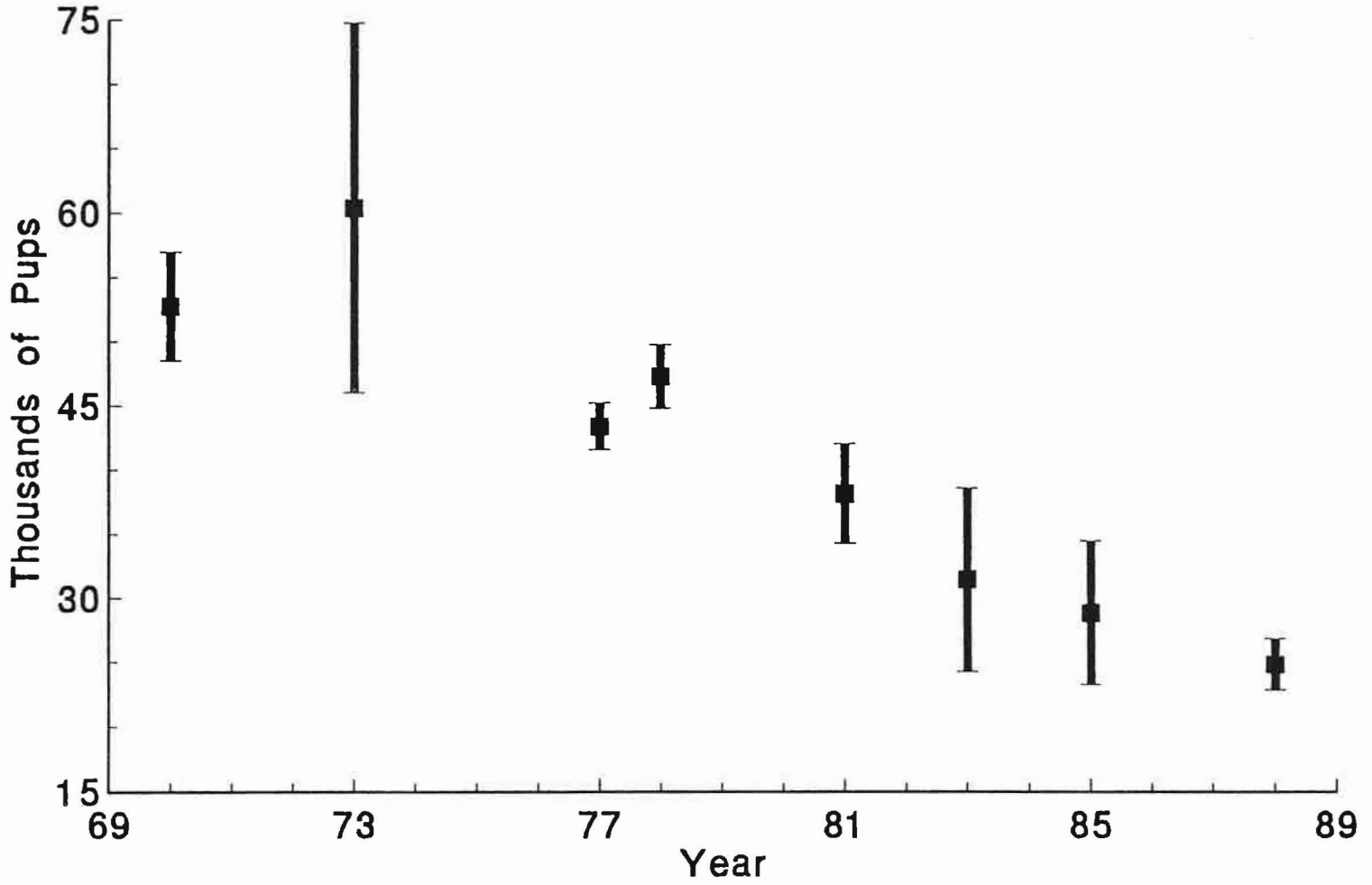


Figure 8.--Numbers of northern fur seal pups born on St. George Island, Alaska, 1970-88. Approximate 95% confidence intervals are shown.

Mark Recoveries

One fur seal tagged by the Soviet Union was sighted during the 1987 field season on St. Paul Island. During the 1988 field season, 12 tagged fur seals were resighted. Appendix Table B-9 lists the number of Soviet tags counted by the United States observers in 1987 and 1988.

TRENDS IN NUMBERS OF PUPS BORN ON ST. PAUL AND ST. GEORGE ISLANDS 1973-88

by

Anne E. York

Numbers of northern fur seal pups born on St. Paul and St. George Islands were compiled from the annual reports of Fur Seal Investigations for the years 1973-88. Widths of the approximate 95% confidence intervals were calculated according to methods developed in York and Kozloff 1987. The purpose of this report is to investigate whether trends in numbers of pups born on the two islands have been consistent over time. Such a comparison is important since the management of the herd was different: the commerical harvest of subadult males ceased after 1972 on St. George Island and after 1984 on St. Paul Island.

Figure 9 shows the logarithm of the estimated numbers of pups born on St. George Island (1973-88) and St. Paul Island (1975-88). The solid lines superimposed on the data are trends approximated from a "lowess" fit; lowess stands for locally weighted least squares, and the fit for each point is obtained with a weighted regression line through a fixed fraction of the nearest neighbors of each data point (Chambers et al. 1983). The trends for St. George and St. Paul Islands appear to be different. The situation illustrated in Figure 9 reenforced by the lowess fit suggests that the number of pups born on St. George Island has continuously declined since 1973, while the

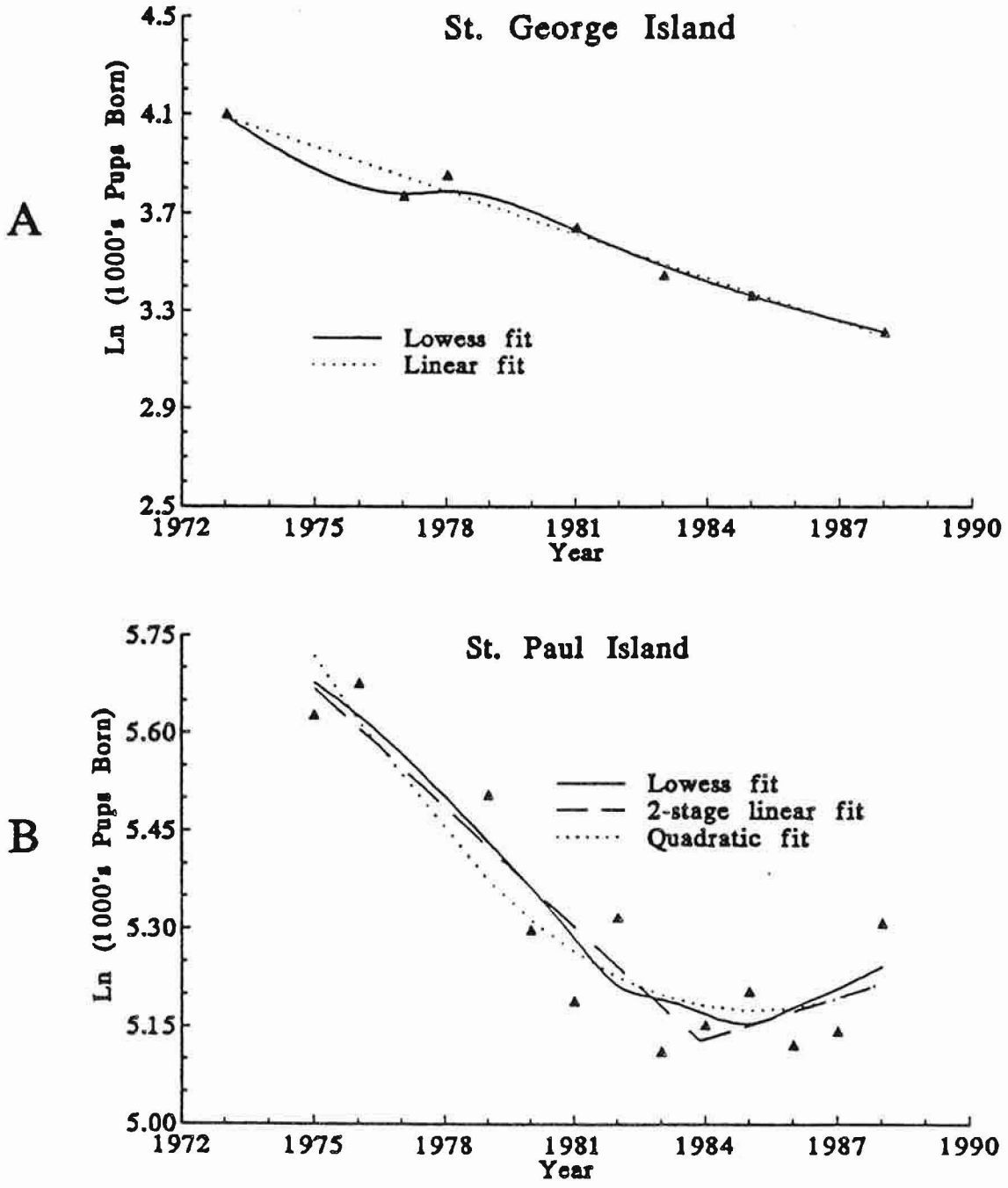


Figure 9.--(A) Logarithm of numbers of northern fur seal pups born on St. George Island, Alaska, 1973-88 with Lowess (f = 0.5) and linear regression lines (Lowess = locally weighted least squares). (B) Logarithm of numbers of fur seal pups born on St. Paul Island, Alaska, 1975-88 with regression (break point = 1983) lines.

number born on St. Paul Island declined during the late 1970s and then levelled off or increased slightly during the early 1980s.

To formally investigate this impression, two-stage linear regressions and quadratic polynomials were fit (separately for the St. George and St. Paul Island data) with the natural logarithm of numbers of pups born with year (and year^2 in the quadradic case), as the dependent variables.

Two-stage linear regressions are similar to analysis of co-variance, with the co-variate a group of years (group 1 consists of all years from 1975 to a cut point and group 2 consists of all years after the cut point); a range of cut points from 1980 to 1985 for St. Paul Island and 1978 and 1981 for St. George Island was investigated; this restriction was imposed by the number of data points available (7 for St. George Island and 12 for St. Paul Island) and the requirement that the variance of the rate of decrease within a group could only be estimated if there were at least three data points in the group. Separate lines were fit for each group and the point of intersection of the lines and its mean square error were estimated. The two-stage linear regression was considered a statistically significant improvement to the simple linear regression if the reduction in the mean residual sum of squares was large compared to the mean residual sum of squares (i.e., if it were greater than the 95th percentile of an F statistic with degrees of freedom equal to 2 and m-4, where m was the number of data points available). Table 10 shows the formulas for calculating the location of the intersection point and its standard deviation. The intersection

Table 10.--Derivation of formulas for the estimate of the intersection point (and related statistics) for 2-stage linear regression and the extrema (and related statistics) for a quadratic polynomial.

Assume $x_1 < x_2 < x_3 \ldots < x_{n1} < x_{n1+1} \ldots < x_{n1+n2} = x_m$ are years for which we have corresponding estimates of the logarithm of the number of northern fur seal pups born (L_j).

Intersection point of a 2-stage linear regression

The 2-stage linear regression model is

$$L_j = C_1 + I_1 x_j + e_j \quad j = 1, n1$$
$$L_j = C_2 + I_2 x_j + e_j \quad j = n1, m$$

The rate of increase of the population is I_1 over period 1 and I_2 over period 2. The point of intersection of the two models is the value of K such that $C_1 + I_1 K = C_2 + I_2 K$, or $K = -(C_1-C_2)/(I_1-I_2)$. Since K is to be estimated from estimates of the regression coefficients, $\hat{C}_j$ and $\hat{I}_j$, which are random variables, then $\hat{K}$ is also a random variable. Let $N=C_2 - C_1$ and $D=I_1 - I_2$. Using the δ-method,

$$E(\hat{K}) = K - Cov(N,D)/D^2 + N\ Var(D)/D^3 \quad \text{and}$$

$$Var(\hat{K}) = K^2\ (Var(N)/N^2 + Var(D)/D^2 - 2Cov(N,D)/ND)$$

Minimum (or maximum) of a quadratic polynomial regression

The quadratic regression model is

$$L_j = Const + C_1 x_j + C_2 x_j^2 + e_j.$$

The function is at a minimum when the derivative of L with respect to x is 0, that is when $C_1 + 2\ C_2\ x = 0$, or $x = -.5C_1/C_2$ and when $C_2>0$. (It reaches a maximum if $C_2<0$.) Let K be the point where the derivative is 0, then $K = -.5C_1/C_2$. Since K is to be estimated from $\hat{C}_1$ and $\hat{C}_2$, which are random variables, then as above:

$$E(\hat{K}) = K - 0.5\ Cov(C_1,C_2)/C_2^2 + C_2\ Var(C_2)/C^3 \quad \text{and}$$

$$Var(\hat{K}) = K^2\ [\ Var(C_1)/C_1^2 + Var(C_2)/C_2^2 - 2\ Cov(C_1,C_2)/C_1\ C_2\ ].$$

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point is the year the model predicts that the growth rate of the population changed.

The quadratic model was considered a statistically significant improvement to the simple linear regression if the reduction in the mean residual sum of squares was large compared to the mean residual sum of squares of the quadratic model (i.e., if it were greater than the 95th percentile of an F statistic with degress of freedom equal to 1 and m-3, where m was the number of data points available). In the quadratic model, the location of where the derivative equals 0 is the point that the model predicts where the population reached a minimum (if the coefficient for $year^2$ is negative). Table 10 also shows the formulas for estimating the location of the extreme value (a minimum if the second derivative is positive and a maximum if negative) and its bias and variance.

Table 11 shows the result for fitting the models. All of the two-stage linear models were significant ($P > 0.95$) improvements for St. Paul Island but none were for St. George Island. The quadratic model was a significant improvement for the St. Paul Island data but not for St. George Island. In the two-stage regression models for St. Paul Island, the rates of increases over the two periods (I_1 and I_2) are significantly different ($P > 0.95$) in all cases; whereas, for St. George Island, none are different. The two-stage regression with the smallest residual sum of squares (RSS) (Table 11) occurred when the change point was assumed to be between 1983 and 1984. In that case, the estimated change point was 1983.9 with a mean

Table 11.--Results of fitting logarithm of numbers of pups (L) born on year, year^2, and groups of years, for St. Paul Island and St. George Island, 1973-88. (I, yearly percent rate of increase; SD, standard deviation; RSS, the residual sum of squares; ESS, the difference between the RSS of the 1-stage linear regression and the model under consideration; RMSE, root mean square error.)

A. 1-stage linear regression (L = Const + I Year + Error)

Island	I	SD	RSS
St. Paul	-3.03	1.11	0.147
St. George	-5.95	0.42	0.0068

B. 2-stage linear regression ($L_k = Const_k + I_k$ Year + Error, k=1,2)

Group 1	Group 2	I1 (%)	SD (%)	I2 (%)	SD (%)	RSS	ESS	F	Intersection (year)	RMSE (years)
St. Paul (number of data points, m = 12)										
1975-80	1981-88	-6.57	2.13	-0.06	1.35	0.061	0.086	5.63[1]	1982.25	2.06
1975-81	1982-88	-7.57	1.79	-0.04	1.74	0.068	0.079	4.64[1]	1981.69	1.30
1975-82	1983-88	-6.38	1.23	2.52	1.91	0.057	0.096	7.38[1]	1983.65	0.94
1975-83	1984-88	-6.77	1.12	2.53	2.59	0.054	0.094	7.23[1]	1983.94	1.08
1975-84	1985-88	-6.36	0.99	3.37	3.75	0.056	0.091	6.50[1]	1984.28	1.23
1975-85	1986-88	-5.59	0.91	9.38	6.24	0.062	0.086	5.54[1]	1985.82	0.87
St. George (number of data points, m = 7)										
1973-78	1981-88	-5.85	1.93	-5.85	3.85	0.014	<0.0001	0.01[2]	1951.5	1,511.00
1973-81	1983-88	-5.57	1.06	-4.72	2.71	0.011	0.0024	0.07[2]	1991	51.38

C. Quadratic models (L = Const + C_1 Year + C_2 Year^2 + Error)

Island	Const.	SD	C_1	SD	C_2	SD	RSS	ESS	F	Minimum	RMSE
St. Paul	20913	6288	-21.066	6.347	0.00531	0.00160	0.066	0.0811	11.05[3]	1984.79	1.28
St. George	1124	3952	- 1.072	3.981	0.00026	0.00107	0.014	0.0002	0.07[3]	2097.00	1864.00

1. F = (ESS/2)/(RSS/8). Compare to $F_{2,8}(0.95) = 4.46$.
2. F = (ESS/2)/(RSS/3). Compare to $F_{2,3}(0.95) = 9.55$.
3. F = ESS/(RSS/(m-3)). Compare to $F_{1,9}(0.95) = 5.12$ (St. Paul) and $F_{1,4}(0.95) = 7.71$ (St. George).

square error of 1.09 years. The quadratic model predicts a minimum between 1984 and 1985 with a mean square error of 1.28 years.

This analysis suggests that the number of pups born on St. George Island is declining (estimated from the 1-stage linear model 5.95%, SD = 0.42%), while the number born on St. Paul Island decreased at 6.77% per year (SD = 1.12%) during 1975-83 and has shown no trend since 1984 (rate of increase 2.53%, SD = 2.59%).

There are some problems with the comparison of the pup numbers from the two islands because the range of years for which data are available was not the same and there were fewer censuses conducted on St. George Island (7) than on St. Paul Island (12) during 1973-88. The largest number of pups born on St. Paul Island during the last 20 years was during 1975-76. We have no estimate for St. George Island for those years. If the maximum number of pups born also reached a maximum during 1975-76 on St. George Island, then using of the 1973 data point as the maximum would reduce the estimated rate of decline. Therefore, it is possible that pup numbers on St. George Island are not declining as rapidly now as they did during the late 1970s, though there is not enough data at this time to verify this.

PUP WEIGHTS AND SEX RATIOS, 1987-88

by

Anne E. York and George A. Antonelis

Introduction

Some northern fur seal pups were weighed during tagging operations on St. Paul Island in 1987 and 1988. In 1987, random samples of 100 pups were weighed on all rookeries except Little Polovina and Ardiguen. During 1988, random samples of approximately 25% of the pups tagged were weighed on most rookeries; on Ardiguen, Tolstoi, and Polovina rookeries all pups that were tagged were weighed. No tagging took place on Little Polovina rookery in either year and tagging was done on Ardiguen rookery in 1987 only.

Methods

A brass spring scale was attached to a bucket with a burlap sack on the bottom; each pup was put into the bucket and weighed separately. The scale was lifted to eye level and the weight was recorded to the nearest 0.25 kg. Persons weighing the pups were rotated at the end of each group of pups or during the middle of a group if pups were particularly large.

Results

Table 12 shows the sample sizes, mean weights, and standard deviations of weights for each rookery by sex and shearing status (sheared or nonsheared). Figure 10 shows the mean and 95% confidence intervals for pup weights grouped by sex, rookery, and

Table 12.--Sample size (N), mean weights ($\bar{X}$), and standard deviations (SD) for a sample of sheared (S) and nonsheared (NS) pups tagged on St. Paul Island during August 1987 and August 1988. A dash indicates no data collected.

		1987					1988				
		Females		Males		ALL	Females		Males		ALL
Rookery		S	NS	S	NS		NS	S	NS	S	
Lukanin	N	3	42	7	47	99	45	4	57	11	117
	$\bar{X}$	8.583	8.286	9.036	9.665	9.003	8.083	7.313	9.842	8.818	8.983
	SD	0.722	1.611	0.835	1.925	1.821	1.441	1.434	1.599	2.086	1.796
Kitovi	N	7	36	7	50	100	49	0	56	0	105
	$\bar{X}$	8.143	8.139	8.286	8.940	8.550	8.816	--	9.446	--	9.152
	SD	1.695	1.421	0.756	2.014	1.757	1.578	--	1.621	--	1.624
Reef	N	6	45	6	43	100	79	0	72	0	151
	$\bar{X}$	9.292	8.906	9.375	10.442	9.618	7.981	--	9.396	--	8.656
	SD	0.941	1.502	1.922	1.877	1.807	1.592	--	1.816	--	1.839
Gorbatch	N	5	44	6	43	98	57	0	49	0	106
	$\bar{X}$	7.900	8.994	105835	9.855	9.413	8.092	--	9.821	--	8.892
	SD	1.207	1.505	1.571	2.037	1.832	1.667	--	1.683	--	1.878
Ardiguen	N	0	0	0	0	0	48	0	56	0	104
	$\bar{X}$	--	--	--	--	--	7.948	--	9.438	--	8.750
	SD	--	--	--	--	--	1.433	--	1.622	--	1.702
Morjovi	N	4	33	9	51	97	57	0	62	0	119
	$\bar{X}$	8.688	7.750	9.056	9.652	8.910	8.781	--	10.069	--	9.452
	SD	0.851	1.552	1.488	2.174	2.057	1.406	--	1.649	--	1.662
Vostochni	N	2	45	7	45	99	95	7	104	13	219
	$\bar{X}$	8.000	8.667	9.643	9.611	9.152	7.895	7.964	9.386	8.904	8.665
	SD	1.414	1.439	1.368	1.985	1.756	1.350	1.380	1.570	2.162	1.669
Polovina	N	4	42	9	45	100	57	0	43	0	100
	$\bar{X}$	8.000	8.435	8.972	9.556	8.970	8.180	--	9.901	--	8.920
	SD	1.061	1.390	2.794	1.784	1.787	1.156	--	1.650	--	1.626
Pol.Cliffs	N	3	38	8	51	100	60	1	74	0	135
	$\bar{X}$	7.417	8.336	10.094	10.190	9.394	8.042	7.000	9.274	--	8.709
	SD	0.382	1.462	1.470	1.789	1.867	1.298	--	1.655	--	1.622
Tolstoi	N	2	39	6	52	99	362	0	435	1	798
	$\bar{X}$	8.750	8.596	9.083	10.106	9.422	8.171	--	9.484	10.750	8.890
	SD	1.768	1.698	2.553	1.654	1.855	1.504	--	1.877	--	1.837
Zap.Reef	N	10	37	6	47	100	23	0	38	0	61
	$\bar{X}$	8.275	7.993	8.875	9.048	8.570	8.000	--	9.599	--	8.996
	SD	1.277	1.539	1.473	2.976	1.836	1.519	--	1.426	--	1.646
L. Zapadni	N	2	39	2	57	100	53	3	49	11	116
	$\bar{X}$	7.750	8.635	7.568	1.738	9.125	7.415	6.833	9.173	8.295	8.226
	SD	1.061	1.499	1.768	1.738	1.706	1.649	2.126	1.900	1.673	1.948
Zapadni	N	3	44	6	48	101	66	7	82	11	166
	$\bar{X}$	7.917	8.398	9.708	9.766	9.111	7.962	7.714	9.884	8.955	8.967
	SD	1.041	1.414	2.718	2.000	1.903	1.739	0.994	1.774	1.396	1.944
ALL	N	51	484	79	579	1.193	1.051	22	1.177	47	2.297
	$\bar{X}$	8.284	8.454	9.272	9.695	9.103	8.115	7.568	9.549	8.793	8.858
	SD	1.179	1.524	1.833	1.948	1.852	1.515	1.310	1.757	1.830	1.796

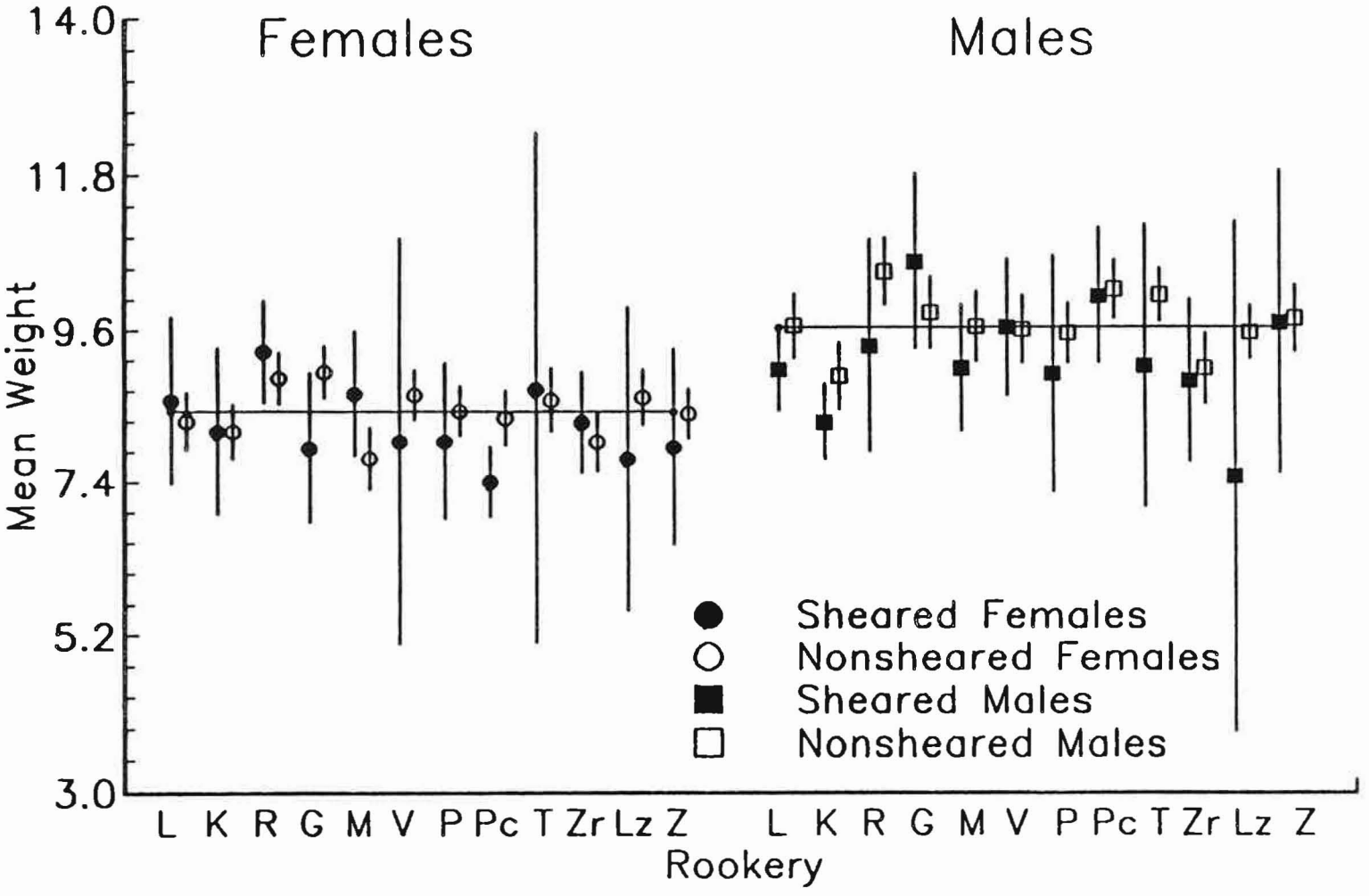

Figure 10.--Mean weights (with 95% confidence intervals) for northern fur seal pups, St. Paul Island, Alaska, 1988. Weights are shown for sheared and nonsheared males and females from Lukanin (L), Kitovi (K), Gorbatch (G), Morjovi (M), Vostochni (V), Polovina (P), Polovina Cliffs (Pc), Tolstoi (T), Zapadni Reef (Zr), Little Zapadni (Lz), and Zapadni (Z) rookeries.

shearing status for 1987; Figure 11 shows these data for 1988 for nonsheared pups; Figure 12 shows mean weights grouped by sex, rookery, and shearing status for 1988 for those rookeries where shearing was done. An analysis of variance of the weights over sex, rookery, shearing status, and year is given in Table 13. In Table 13, each factor is screened for its importance by computing the mean sum of squares due to that factor within the minimal model containing the factor. For example, the sum of squares due to the factor sex is the reduction in sum of squares derived by adding the factor sex after the correction for the mean; the sum of squares due to any three way interaction is the reduction in sum of squares from the model containing all the single factors and two-way interactions of the same variables. This technique is a useful screening device for indicating the relative importance of various factors in accounting for the variance in weights. Table 13 indicates the following: 1) male and female weights are significantly different ($P = 0.01$); 2) it is not clear if the average weight of sheared pups is or is not significantly less than that of nonsheared pups because there may be a shear x sex interaction ($P = 0.08$); 3) there is a significant year x rookery interaction, implying that there is no consistent pattern in rookery weights over the 2 years; and 4) the year x rookery interaction clouds the issue of significant difference in weights between 1987 and 1988. Table 13 also suggests no significant three- or four-way interactions, although, this could be misleading because shearing was conducted on only four sample rookeries in 1988.

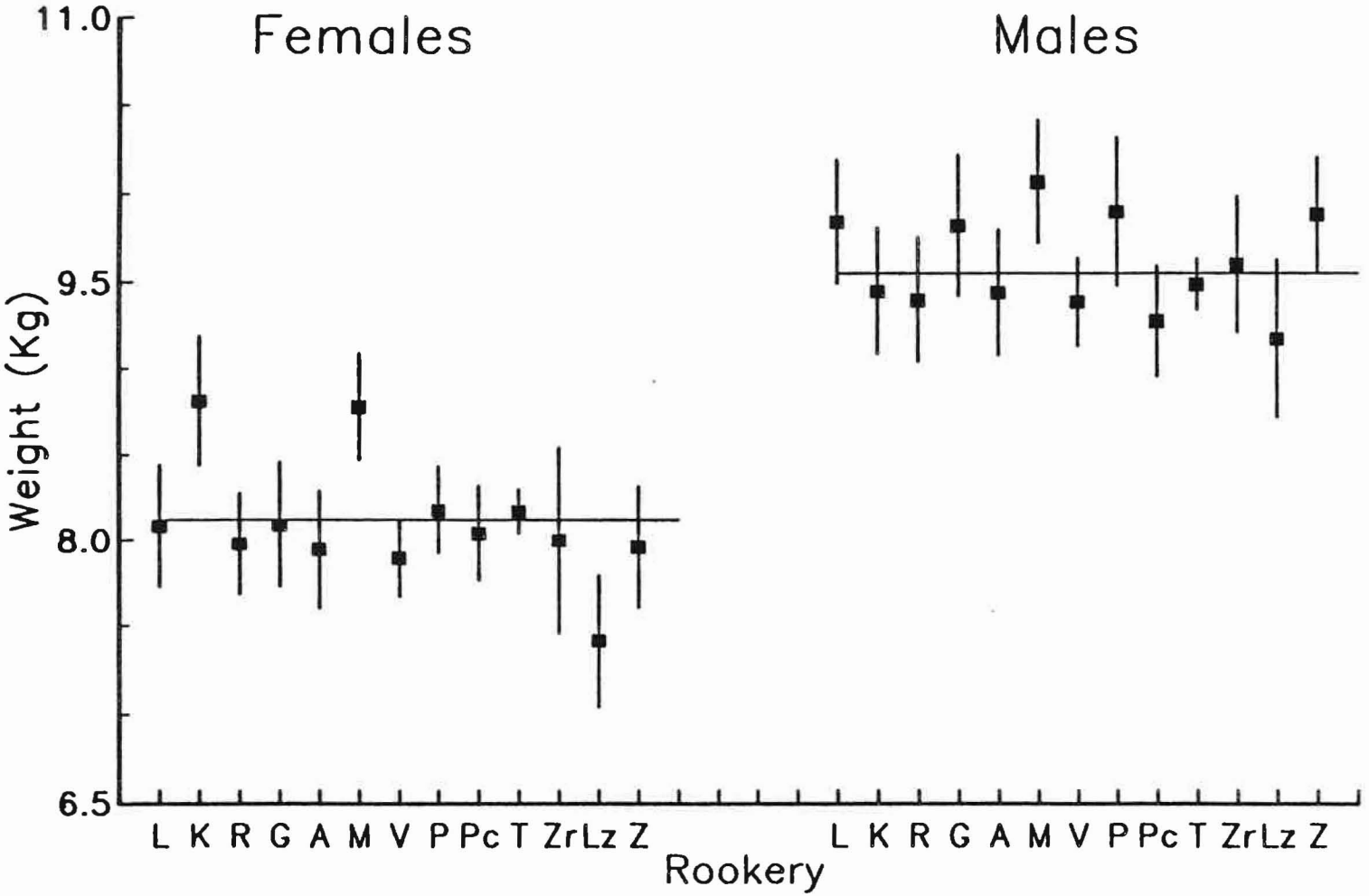

Figure 11.--Mean weights (with 95% confidence intervals) for northern fur seal pups, St. Paul Island, Alaska, 1988. Weights are shown for nonsheared males and females from Lukanin (L), Kitovi (K), Gorbatch (G), Morjovi (M), Vostochni (V), Polovina (P), Polovina Cliffs (Pc), Tolstoi (T), Zapadni Reef (Zr), Little Zapadni (Lz), and Zapadni (Z) rookeries.

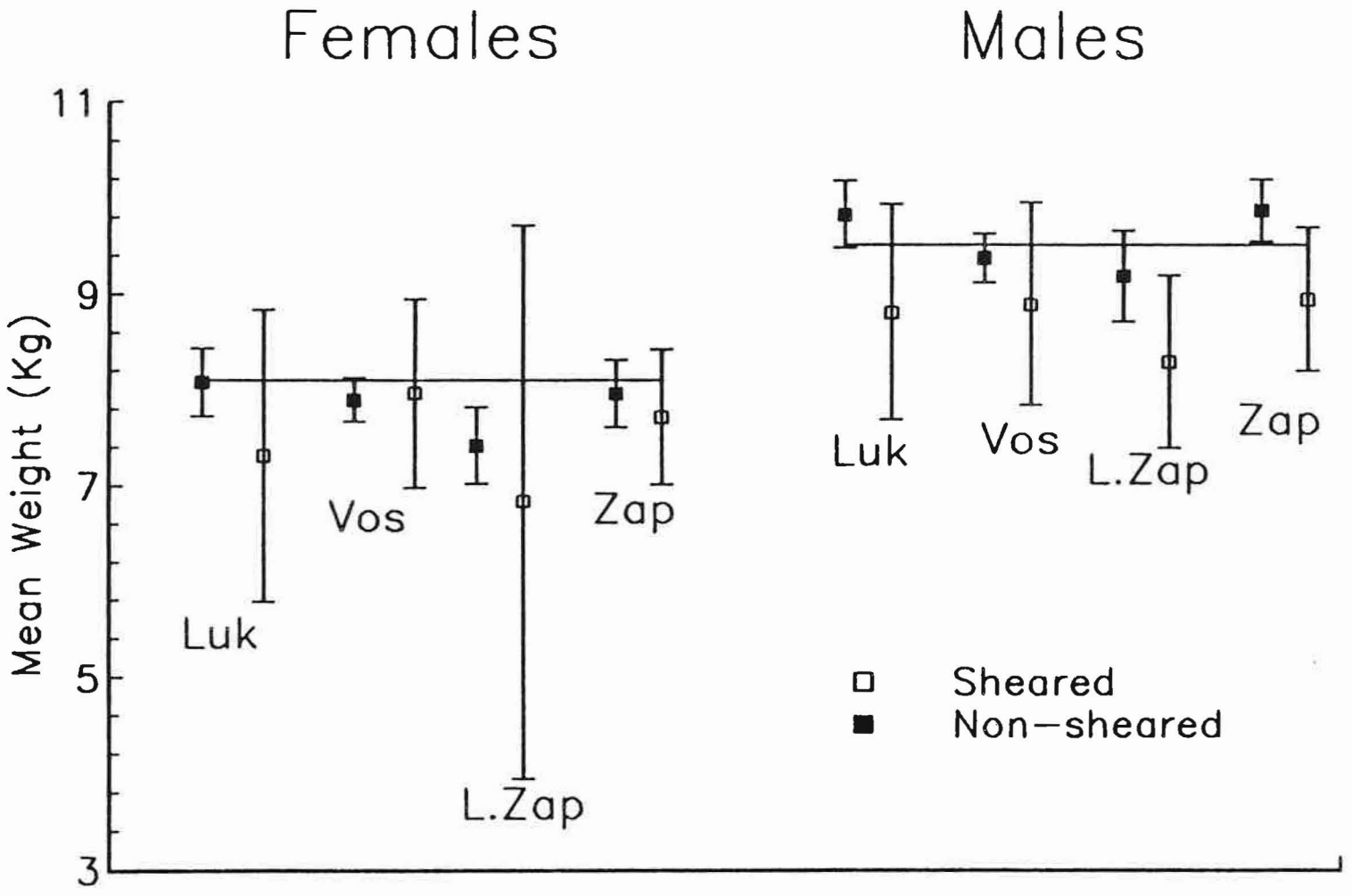

Figure 12.--Mean weights (with 95% confidence intervals) for northern fur seal pups, St. Paul Island, Alaska, 1988. Weights are shown for sheared and nonsheared males and females for those rookeries on which shearing took place: Lukanin (Luk), Vostochni (Vos), Little Zaapadni (L. Zap), and Zapadni (Zap) rookeries.

Table 13.--Analysis of variance of pup weights by sex (Sx), rookery (R), year (Y), and shearing status (S) of northern fur seal. The sum of squares (SS) due to each factor is the additional sum of squares explained by the factor within the smallest hierarchal model containing the factor.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Sex	1	1,577.0	1,577.0	9,968	3,488	551.8	1.0
Shearing	1	10.7	10.7	11,535	3,488	3.0	0.92
Rookeries	12	65.7	5.5	11,479	3,477	1.7	0.93
Year	1	46.9	46.9	11,498	3,488	14.2	>0.999
Sx·S	1	8.6	8.6	9,921	3,486	3.0	0.92
Sx·R	11	36.5	3.3	9,852	3,464	1.2	0.72
Sx·Y	1	8.6	8.6	9,922	3,486	3.0	0.92
S·R	11	20.3	1.9	11,449	3,465	0.6	0.17
S·Y	1	2.2	2.2	11,476	3,486	0.7	0.60
R·Y	11	671.7	15.6	11,256	3,465	4.8	>0.99
Sx·S·R	11	20.1	1.8	9,776	3,440	0.6	0.17
Sx·S·Y	1	0.02	0.02	9,876	3,482	0.0	0.08
S·R·Y	5	15.2	3.1	11,222	3,477	0.9	0.52
Sx·S·R·Y	3	3.8	1.3	9,520	3,406	0.5	0.32

*MMS = SS divided by dF.6

When particular variables (in this case sex and year) absorb a large fraction of the variability relative to other variables, it is often useful to examine that variable separately since the analysis of variance will not always detect significant differences over the other factors. In addition, an inspection of Table 12 indicates that the variance of male weights was consistently larger than that of female weights. Therefore, a detailed analysis was carried out separately for each sex and year combination. The analyses of variances for these cases are given in Table 14.

For females weighed in 1987, there were significant differences among rookeries ($P = 0.01$), but sheared pups were not significantly lighter than nonsheared pups ($P = 0.36$). Females from Reef, Gorbatch, and Vostochni rookeries were heavier than average and females from Kitovi, Polovina, and Zapadni Reef rookeries were lighter (i.e., their means were more than 1 standard deviation lighter or heavier than the average for females in 1987). For males weighed in 1987, there were also significant differences among rookeries ($P = 0.05$) and marginally significant differences between sheared and nonsheared pups ($P = 0.07$). Males from Reef, Gorbatch, Polovina Cliffs, and Tolstoi rookeries were heavier than average, and those from Kitovi and Zapadni Reef rookeries lighter than average (weights were more than 1 SD heavier or lighter than the average for males in 1987). These conclusions are illustrated in Figure 10.

For females weighed in 1988, there were significant differences among rookeries ($P = 0.01$), but no significant

Table 14.--Analyses of variance of pup weights on shearing status (S) and rookeries (R) for each sex and year combination.

Source	Sum squares	df	MSS	F	p
Females 1987 (Mean weight 8.437 kg SE = 0.065 kg)					
Total	1,193.2	534			
Rookeries	52.9	11	4.81	2.18	0.986
Shearing	0.5	1	0.50	0.22	0.361
S•R	15.8	11	1.44	0.65	0.214
Residual	1,124.0	511	2.20		
Males 1987 (Mean weight 9.664 kg SE = 0.076 kg)					
Total	2,467.7	657			
Rookeries	110.0	11	10.0	2.73	0.945
Shearing	12.9	1	12.4	3.31	0.931
S•R	20.3	11	1.9	0.51	0.140
Residual	2,324.5	634	3.7		
Females 1988 (Mean weight 8.104 kg SE = 0.046 kg)					
Total	2,451.5	1,072			
Rookeries	91.6	12	7.63	3.42	>0.999
Shearing	2.2	1	2.20	0.99	0.680
S•R	2.5	4	0.63	0.28	0.109
Residual	2,355.2	1,055	2.23		
Males 1988 (Mean weight 9.520 kg SE = 0.050)					
Total	3,809.0	1,223			
Shearing	25.9	1	25.90	8.41	0.996
Rookeries	61.0	12	5.83	1.89	0.968
S•R	6.0	4	1.50	0.49	0.257
Residual	3,716.1	1,206	3.08		

MSS = Mean square/error.
SE = Standard error.

difference due to shearing status (P = 0.32) (i.e., sheared pups did not weigh significantly less than nonsheared pups). Females from Kitovi and Morjovi rookeries were heavier than average and those from Vostochni and Little Zapadni rookeries were lighter than average (weights were more than 1 SD heavier or lighter than the average for females in 1988). For males weighed in 1988, there were significant rookery differences (P = 0.968) and sheared males weighed 0.75 kg more (Standard error = 0.26 kg) than nonsheared males (P = 0.004).

In order to assess differences between years, a separate analysis was carried out for the nonsheared animals. On face value, there is a significant difference (of about 0.2 kg) between 1987 and 1988 weights. However, it is difficult to interpret this difference because the sampling designs during the 2 years were sufficiently different to invite doubt of the reliability of the assertion of significant differences--especially since there were significant differences in pup weights among the rookeries for all year and sex combinations. Therefore, mean weights for the island were calculated for males and females for both years. The estimated mean is a weighted sum of the means for each rookery (Ardiguen and Little Polovina were excluded because data were not obtained there both years); the means were weighted using the fraction of breeding bulls contributed by that rookery to the total number of breeding bulls on the island (excluding Little Polovina and Ardiguen) (Table 15). These fractions are known to be representative of the size of the pup population. The variance of the weighted mean is estimated

Table 15.--Fraction of breeding males contributed by each rookery to total breeding male numbers (excluding Little Polovina and Ardiguen rookeries) for 1987 and 1988.

Rookery	Fraction of bulls on rookery 1987	1988
Lukanin	0.025	0.021
Kitovi	0.061	0.061
Reef	0.112	0.120
Gorbatch	0.076	0.081
Morjovi	0.065	0.069
Vostochni	0.162	0.160
Polovina	0.012	0.016
Polovina Cliffs	0.087	0.089
Tolstoi	0.146	0.135
Zapadni Reef	0.041	0.041
Little Zapadni	0.082	0.078
Zapadni	0.132	0.127

Table 16.--Estimated mean weight (kg) (with its standard error) for female and male pups for 1987 and 1988.

Sex	Year 1987	1988	Standard error 1987	1988
Females	8.518	8.057	0.077	0.057
Males	9.811	9.531	0.091	0.061

as the sum of the product of the squared weights with the variances of the mean weights from each of the rookeries.

The calculations were carried out in the following way: Let $B_{1,k}$, $B_{2,k}$, ... $B_{12,k}$ be bull counts on the 12 rookeries on which weights were taken in both years in year k (k = 1987 and 1988). Let $W_{i,j,k}$ be the corresponding mean weight of nonsheared animals on rookery i (i = 1 $\bar{V}$ 12) for sex j (j = 1 females; 2, males) and year k (k = 1987 and 1988) from Table 12. Let $V_{i,j,k}$ be the variance for $W_{i,j,k}$; $V_{i,j,k}$ is calculated as the square of the standard deviation (in Table 9) divided by the sample size (from Table 9). For example, $V(1,1,1988) = 1.441^2/45$. For each rookery, i, and year, k, compute the fraction of bulls contributed by that rookery (f):

$$f_{i,k} = B_{i,k} \; / \sum_{i=1}^{12} B_{i,k}.$$

Then, the weighted mean (m) for sex j and year k is

$$M_{j,k} = \sum_{i=1}^{12} f_{i,k} \; W_{i,j,k},$$

with variance $S_{j,k} = \sum_{i=1}^{12} f^2_{i,k} \; V_{i,j,k}$.

Table 16 shows the weights and the estimated total weight of all fur seals on the island and its standard error for each sex in 1987 and 1988. The weights for 1987 are significantly greater than the weights for 1988 for both sexes. For females the difference is 0.46 kg (SD = 0.096 kg, t_{12}=4.81, P = 0.01) and

for males the difference is 0.28 kg (SD = 0.11 kg, t_{12}=2.56, P = 0.01).

Sex Ratios

An analysis of the sex ratios was conducted by analyzing the fraction of male fur seals in each year, rookery, and shear-status combination. The analysis was carried out using the General Linear Interactive Modelling (GLIM) program assuming that the fraction of males was a binomial random variable; the logit of the fraction of males [log p/(1-p)] was modelled as a linear function of year, rookery, shearing status, and average weight of nonsheared males. Table 17 presents the results from sex ratio analysis. The results can be interpreted like an analysis of variance except that the significance of a factor is judged by comparing the mean deviance (total deviance divided by the degrees of freedom of the factor) with a chi-square random variable over its degrees of freedom (1968 CRC Handbook Table V.2).

The only factor which reduced the sum of squares significantly was shearing status. The parameters and their standard errors are given for that model; in addition, the transformed parameters (indicating the fraction of males instead of their logits) are also provided.

Table 17 shows that the fraction of males was significantly greater than 50%; it did not vary significantly between years; it did not vary significantly over rookeries; it did vary significantly (P = 0.01) over shearing status. Averaged over the 2 years, males comprised 53.3% (54.5% in 1987 and 52.8% in 1988)

Table 17.--Analysis of deviance for dependence of sex-ratio on year (Y), shearing status (S), rookeries (R), and mean weight of males (W). Deviance for all factors was determined from the minimum hierarchal model containing the factor. (e.g., YS is conditioned on both Y and S).

Factor	df	Deviance	Mean deviance	p
Single factors:				
Year (Y)	1	1.100	1.10	0.706
Shearing status(S)	1	7.742	7.742	0.995
Rookeries(R)	12	11.752	0.979	0.534
Mean Wt males(W)	1	2.010	2.010	0.844
Second order interactions:				
Y·S	1	1.613	1.613	0.796
Y·R	11	7.230	0.657	0.220
Y·W	1	0.923	0.923	0.663
S·R	11	10.575	0.966	0.798
S·W	1	0.255	0.255	0.386
R·W	11	11.264	1.024	0.580
Third order interactions:				
Y·S·W	1	1.624	1.624	0.788
Y·S·R	Insufficient data			
S·R·W	Insufficient data			
Fourth order interactions:				
Y·S·R·M	Insufficient data			

of the nonsheared tagged animals; on the other hand, a significantly ($P < 0.01$) higher percentage (63.3%) of the sheared animals (68.1% in 1988 and 60.8% in 1987) were males.

Discussion

The results indicate that the clearest pattern of how weights of pups vary is by sex; males outweigh females. In many cases, the mean weight of sheared pups is less than that of the nonsheared pups but not always. The pattern of differences among rookeries is not consistent across years or sex. The sex ratio of tagged animals is significantly skewed towards male pups and even more highly skewed towards males among tagged animals which had been sheared.

GROWTH OF THE BOGOSLOF ISLAND NORTHERN FUR SEAL COLONY

by

Thomas R. Loughlin

From 1976 to 1981 small numbers of northern fur seals were sighted on Bogoslof Island, Alaska (Fig. 3), in the southeastern Bering Sea; pups were first observed there in 1980 (Lloyd et al. 1981). Scientists from the National Marine Mammal Laboratory, Alaska Fisheries Science Center, have visited the island at infrequent intervals to monitor the trend in fur seal abundance. This report summarizes counts obtained for Bogoslof Island during 1988.

On 2 August 1988, the Japanese Fisheries Agency research vessel Shunyo Maru traveled to Bogoslof Island to conduct population studies. A field party consisting of the author, M. Kiyota (Chief Scientist), Onada (First Officer), and Mory (Sailor) landed on the east beach at 1045. The group counted a total of 449 fur seals, consisting of 80+ pups, 22 territorial males, 159 females, and 188 other males. Two males and one female were on the rocks north of the landing beach on the east side of the island; all other fur seals were amongst the large boulders on the west side of the island south of Kenyon Dome. We returned to the ship at 1400.

We sighted only two animals with tags. One territorial male was tagged on each flipper with monel tags; one female had green, plastic Riese tags in the front flipper. We were unable to read

the numbers on either the tagged male or female. No tags were applied during 1988.

The fur seal colony at Bogoslof Island has become firmly established. The number of animals continues to increase from the total of just one animal in 1976 to over 400 in 1988 (Loughlin and Miller 1989) (Table 18). Pup production has increased from two observed pups in 1980 to over 80 in 1988. The amount of unoccupied space on the rookery is substantial, and I expect that this rookery will continue to grow in numbers and space during the next few years and beyond.

Table 18.--Number of northern fur seals observed at Bogoslof Island 1976-88 by sex (Loughlin and Miller 1989).

Year	Pups	Females	Territorial males*	Other males	Total adults
1976	-	-	-	1	1
1979	-	-	-	2	2
1980	2	2	-	3	5
1982	3	3	-	2	5
1983	13	18	-	47	65
1984	14	14	-	14	28
1985	9	37	-	66	103
1986	yes	30	-	15	45
1988	80	159	22	188	369

*Territorial and other males were not distinguished before 1988.

BEHAVIOR AND BIOLOGY OF NORTHERN FUR SEALS, PRIBILOF ISLANDS ALASKA, 1987 and 1988

by

Roger L. Gentry and Camille A. Goebel-Diaz

Research Conducted in 1987.

Field research was conducted from 28 June through 3 August by observing tagged animals from the observation blind at East Reef rookery (Fig. 2). This research focused exclusively on obtaining estimates of return and natality rates of female northern fur seals marked in 1984, and counts of adult male northern fur seals. The return rate is defined as the estimated proportion of tagged adult females that returns to the same site each year, and the natality rate is defined as the proportion that produces a pup at term. No animals were handled, and no tags were applied.

Research Conducted in 1988

Research continued on the data collection of return and natality rates of female northern fur seals and counts of adult male northern fur seals. This information was collected from 21 June through 28 July, and from 20 September through 17 October, by observing tagged animals from the observation blind at East Reef rookery. Four animals (three juvenile males and one pup) were freed of netting material in which they had become entangled.

The marked population at East Reef rookery in 1988 included 26 females of known age (marked as pups). They comprised four 7-year-olds, one 6-year-old, nine 5-year-olds, and twelve 4-year-olds. These females are being observed for changes in dates of parturition and copulation over years.

Return and Natality Rates

Survival and pregnancy rates of adult females are essential for understanding population trends. Presently, no means are available for measuring survival and pregnancy rates directly; therefore, return and natality rates are used. Return rate differs from survival rate because it does not differentiate between loss due to death and loss by emigration or tag loss. Natality rate is always lower than the true pregnancy rate because losses due to abortion or resorption have already occurred when natality is measured. To estimate return and natality rates we marked 107 females at East Reef rookery in August 1984 and followed them in each subsequent year. The animals were all adults of unknown age at the time of marking. Each was given paired plastic flipper tags and a spot brand on top of the head that a) ensured their being seen by observers, and b) acted as a check against double tag loss. Other previously tagged females that lack head brands are less visible; they are, therefore, of secondary value for estimating return and natality rates.

To obtain full reproductive records on the marked cohort, daily observations were conducted from late June through the end

of July in each year since 1984. Head-branded females were sought by observers using binoculars and telescopes from the elevated blind, and from two 5 m towers at either end of the 100 m long study site. Detailed records were kept on dates of arrival, parturition, and copulation; land and sea movements, location, behavior, and presence or absence of suckling young; and tag losses.

Our records to date are summarized in Table 19. Return rate is shown by its reciprocal, failure-to-return rate, or loss from the marked population. This rate cannot be calculated for the 1984-85 interval because some of the original 107 females marked were seen suckling pups on other rookeries in 1984, implying that they were not residents of East Reef rookery but were only visiting there on the days marking occurred. The number of such females is unknown, so they cannot be separated from losses that year due to death or emigration.

Table 19 shows that loss rate in 1987 was significantly lower ($P > 0.95$) than in the other years, which did not differ significantly ($P < 0.95$) from each other (exact binomial test). The geometric mean loss rate for all 3 years was 14.5%, very close to the mortality rate given in Lander's life table (Lander 1981). No significant differences were found in yearly natality rates (chi-square = 2.73, 3 df). These rates are similar to pregnancy rates of females 8-13 years of age given by Lander (1981), although the data were collected differently.

Only two head-branded females have been seen with double tag loss--one in 1985 and one in 1987 (both were included in Table 16

Table 19.--Loss and natality rates for 107 females marked with plastic (green Riese) tags and head brand in 1984 at East Reef rookery, St. George Island, Alaska.

	Loss rate[a]				Natality rate[b]		
Year	No. that failed to survive since previous year	No. surviving in the previous year.[c]	Ratio	C.I.[d]	Number suckling	Number in population	Ratio
1985	(cannot calculate due to "visitor" problem)				61	71	0.847
1986	12	72	0.167	0.089-.0273	56	60	0.933
1987	6	60	0.100	0.028-0.185	46	54	0.852
1988	12	55	0.218	0.117-0.355	36	43	0.839

[a]Loss rate = loss of marked females from population. Does not discriminate mortality from emigration.

[b]Natality rate = proportion of females with young during breeding season. Females seen less than six times, and those seen more than six times without a pup were considered nonsuckling.

[c]Included two females having double tag loss.

[d]C.I. = confidence interval, calculated from exact binomial test.

[e]Loss rate for 1987 differs significantly (>0.95) from other years.

as survivors). The rates of single tag loss (females that lost one tag/all head-branded females present) were 1986, 5%; 1987, 7.4%; and 1988, 21.4%. Loss rate seems to have increased with time. In 1988 many of these 1985 tags were abraided and faded to the point of being almost unreadable.

Swim Speed

Preliminary efforts were made to 1) measure northern fur seal foraging ranges from St. George Island using swim speed recorders and 2) obtain data on the physical characteristics (conductivity and temperature) of the water where fur seals dive for food. Microprocessors were deployed to measure swim speed by means of a paddlewheel attached to the front of the instrument. Eight females were instrumented; two of these females had not previously been tagged and were given new plastic identification tags (Table 20). Three others were given replacement identification tags for the unreadable tags they already carried (Table 20). All three swim speed recorders malfunctioned. Future attempts to measure swim speed will be deferred until more reliable units can be obtained from another manufacturer.

Temperature Measurements

To date, most studies on diving in northern fur seals have focused on describing diving behavior in terms of depth, duration, and temporal patterning of dives. No attention has been paid to the physical environment where seals dive, mainly because the technology to do so has not been available. With the

Table 20.--New tags applied to northern fur seals at East Reef rookery, St. George Island, Alaska, 1988.

New tag		Age and sex class	Old tag	
Color of tag	Number		Color and type	Number
Green Riese	2130	Adult female	-	-
White Riese	2741	Adult female	-	-
White Riese	2739	-	White Roto	1687
White Riese	2740	-	Green Riese	2102
White Riese	2742	-	Green Riese	2084

advent of new instruments it is now possible to measure where seals feed in relation to the thermocline, haloclines, and, hopefully, oceanographic fronts. The latter are of particular interest since fur seals encounter fronts in many parts of their migratory range. These studies will contribute to our understanding of oceanographic processes that determine where fur seals congregate.

Six microprocessors were deployed to measure water parameters during diving. The instruments were prototypes designed to measure conductivity, temperature, and depth every 10 seconds. The conductivity feature did not function, but six good records were obtained, containing hundreds of temperature and depth profiles. Analysis is under way.

Predation by Northern Sea Lions on Fur Seal Pups

Northern sea lion (Eumetopias jubatus) predation rate data were collected for comparison with similar measurements made in 1974 and 1975 (Gentry and Johnson 1981). The northern fur seal population has now declined to the point that the water area occupied by the entire St. George Island northern fur seal pup population can be seen from three rookery sites (Staraya Artil/North, East Reef/East Cliff, and South/Zapadni), rather than the five rookery sites required for full coverage in 1975. In 1988, these three rookery sites were occupied in regular rotation by two observers, working concurrent 2-hour periods during calm weather on seven different days between 25 September and 5 October. Eight hours of observation were made at each

site, and three additional hours were spent observing from the blind at East Reef rookery, consonant with other research there.

The results suggest that the hourly loss rate has decreased about fivefold since 1975. Four kills by northern sea lions were verified (fur seal flippers or fur seal fur were seen while a sea lion was feeding) during this study, with rates of 0.13, 0.18, and 0.13 kills per hour for the three rookery sites in the order listed above. From the summed kill rates for all sites, approximately 0.44 seals were lost per hour from the entire St. George Island population in 1988, compared to 2.17 per hour (based on 205 hours observed between 26 September and 4 November) in 1975, about a five fold drop. If predation occurs for 12 hours per day from 15 August to 10 November (assumed duration of predation in 1975) then the loss of (calculated) 549 pups would represent 2.2% of the 24,862 pups estimated to be alive in August 1988 (compared to 3.4% in 1975).

These decreases parallel the decline in both northern fur seals and northern sea lions (Unpubl. data. National Marine Mammal Laboratory, 7600 Sand Point Way N.E., Seattle, WA 98115-0070) at St. George Island since 1975. Northern sea lion censuses have not yet been collated. But the high counts of 1974 (ca. 1,000) and 1988 (164) are very different.

POPULATION AND BEHAVIORAL STUDIES, SAN MIGUEL ISLAND, CALIFORNIA

1987 and 1988

(Adams Cove and Castle Rock)

by

Robert L. DeLong

Because of the brief field season no effort was made to record the phenology pupping. All observational study of northern fur seals in Adams Cove has become more difficult as most of the reproductive territories are now located in western Adams Cove where they are mixed with California sea lions (Zalophus californianus). Most of the territories are located several hundred meters from the locations from which observations are conducted making it very difficult to reliably enumerate pups, detect tagged animals, or recognize individually marked animals.

The 1987 field season extended from 8 July through 8 August. Northern fur seal research activities at San Miguel Island, California were limited to censuses to assess population structure and pup productions.

There was a maximum of 46 adult males occupying territories containing adult females and as many as 28 additional adult males some of which maintained territories but were not associated with reproductive females. There were at least 722 pups born in Adams Cove and 498 born on Castle Rock in 1987.

One hundred pups were tagged in Adams Cove on 22 September 1987 (tag numbers are listed in Appendix Table B-10). No pups were tagged on Castle Rock as heavy winds created sea conditions

which did not allow landing at Castle Rock.

In 1988 the field season extended from 14 July through 3 August. Pup production was similar to 1987 with 721 pups born in Adams Cove and 496 on Castle Rock.

A study on the effects of pup age at the time of tagging on survival was begun in 1988. The study has its origin in the findings of a study by York (Pers. Commun.) in which tagged animals appeared to have lower survival than nontagged animals taken in the harvest and that pups tagged late in the season had higher survival than pups tagged during August. Also at San Miguel Island, the highest survival was experienced by the tagged pups from the 1975 cohort. In 1975, pups were tagged in October, whereas all other cohorts were tagged a month earlier during September. The current study plan calls for pups to be tagged during September and October in two successive years. The survival of pups tagged at the two times will be compared based upon resightings of tagged animals at San Miguel Island through age 4 or 5 for both cohorts. Much better survival among pups tagged late in the season would suggest that all pup tagging should be planned late in the season in order to maximize survival.

In 1988, 175 pups were double-tagged with pink roto tags on 23 September and a second group of 175 pups were tagged on 20 and 21 October. Tags numbers, sex and weight of pups tagged are listed in Appendix Table B-11.

DISTRIBUTION OF ADULT TERRITORIAL MALES AND PUPS BORN ON ST. PAUL AND ST. GEORGE ISLANDS

by

Laurie Briggs

Throughout the extensive history of research on northern fur seals on the Pribilof Islands, biologists have raised questions concerning dynamics in the distribution of fur seals on the rookeries. What are the factors that determine rookery size? What determines the distribution among the rookeries and between islands? Are there patterns in observed changes? In view of the correlation between the numbers of adult males and the numbers of pups born (York and Kozloff 1987) it is possible to examine for changes in the distribution of seals by looking at the apportionment among the rookeries of adult territorial males and pups.

Since early in fur seal research, biologists have speculated about the types of disturbances and environmental factors that might affect fur seal distribution and how the fur seal population might respond. Some of the factors that affect distribution may be a result of differential mortality among rookeries, movement, or differential reproduction. For example, differential mortality may explain observed declines in the fraction of males breeding on a particular rookery. There is also the possible effect of increasing air traffic on the east

side of St. Paul Island, where the Polovina rookeries are located within the air traffic corridors. Another possible influence is the effect of the female harvest during 1956-68. Pup mortality studies were performed on four study areas including Reef and Vostochni rookeries in the early 1970s and 1980s, which are reported in annual reports of "Fur Seal Investigations" for these years (see Marine Mammal Biological Laboratory, 1972). There is reason, therefore, to question the effects of research activities on seal distribution among rookeries. It is not known to what extent these observed changes are a result of any one of these possibilities or if there are other important factors.

The purpose of this paper is to explore rookery dynamics over time and suggest reasons as to why some rookeries show marked change and others little or no change. Most male fur seals return to the same rookery for breeding each year and defend the same territorial site until replaced by a stronger male (Gentry 1980); therefore, each rookery should exhibit population changes in approximately the same proportion as the number of territorial males. This proportion may be influenced by the males establishing their first territories, although site fidelity results in localized distribution.

Methods

Total territorial male counts have been taken on St. Paul and St. George Island during mid-July since 1911 (Appendix Tables B-10 and B-11). There are a few years where mid-July counts were not completed on some rookeries, (1967-68 and 1971-74 on St. Paul

Island and 1911-14, 1956, 1972, and 1983 on St. George Island). All other years up to the present are complete and a database exists with counts for each rookery for territorial males which is complete and updated annually. This automated database includes counts for both territorial and nonterritorial males, estimates for pups born, and dead pup counts. The counts for the early years, 1911-56, were verified using territorial male and pups born tables in the "Bureau of Fisheries" (1912-57). A summary of the available data through 1979 is presented in Lander (1980). Data for years after 1979 can be found in Fur Seal Investigations annual reports.

Previous to 1940 the number of fur seal pups born were counted. After 1962 the numbers were estimated by the "shearing-sampling" method (York and Kozloff 1987) for selected years. For intermediate years estimates of pup numbers are based on mark recapture techniques involving tags placed on pups and recovered in the harvest (Lander 1980). There are 14 years with estimates of pups born on St. Paul Island for all rookeries (Appendix Table B-14) and 9 years on St. George Island (Appendix Table B-15). These years do not include those for which estimates are based on tag recovery. For several years the number of pups born has been estimated for a selection of rookeries, which needed to be represented to produce comparable fractions of the total for a true picture of distribution.

To examine changes in fur seal distribution on the Pribilof Islands (see rookery Figs. 1 and 2) territorial male counts from 1912 to 1987 have been converted to a percent of the total

territorial male count (Fig. 13 a and b). In the same way, estimated number pups born have been converted to a percent of the total of pup estimates by year (Fig. 13 c and d) for each rookery on each island. These data are summarized in Appendix Tables B-12 and B-13 by island, rookery, and year. Treating the data in this manner provides a means for comparing the relative change in numbers of territorial males and pups for all rookeries (14 on St. Paul Island and 6 on St. George Island) from 1912 to 1988. Such a comparison permits a study of changes in distribution, independent of the large variation of both adult male and pup numbers which occurred over the 76-year period (Fig. 12 a-d).

In view of the correlation between the numbers of adult males and the numbers of pups born (York and Hartley 1981), it is expected that changes in the distribution of adult territorial males and pups will also be correlated. Geometric mean regression analysis was applied to the mutually variable percent of pups and percent of territorial males for all years where all rookeries have data.

In looking at potential explanations, an index of pup mortality rates calculated for each rookery and year were represented as dead pups per territorial male. A Friedman distribution-free two-way analysis of variance was performed to determine if there is any systematic variation in the mortality rates across rookeries. After establishing that systematic variation existed between rookeries, a distribution-free multiple comparison analysis was applied to the mortality ranks at a

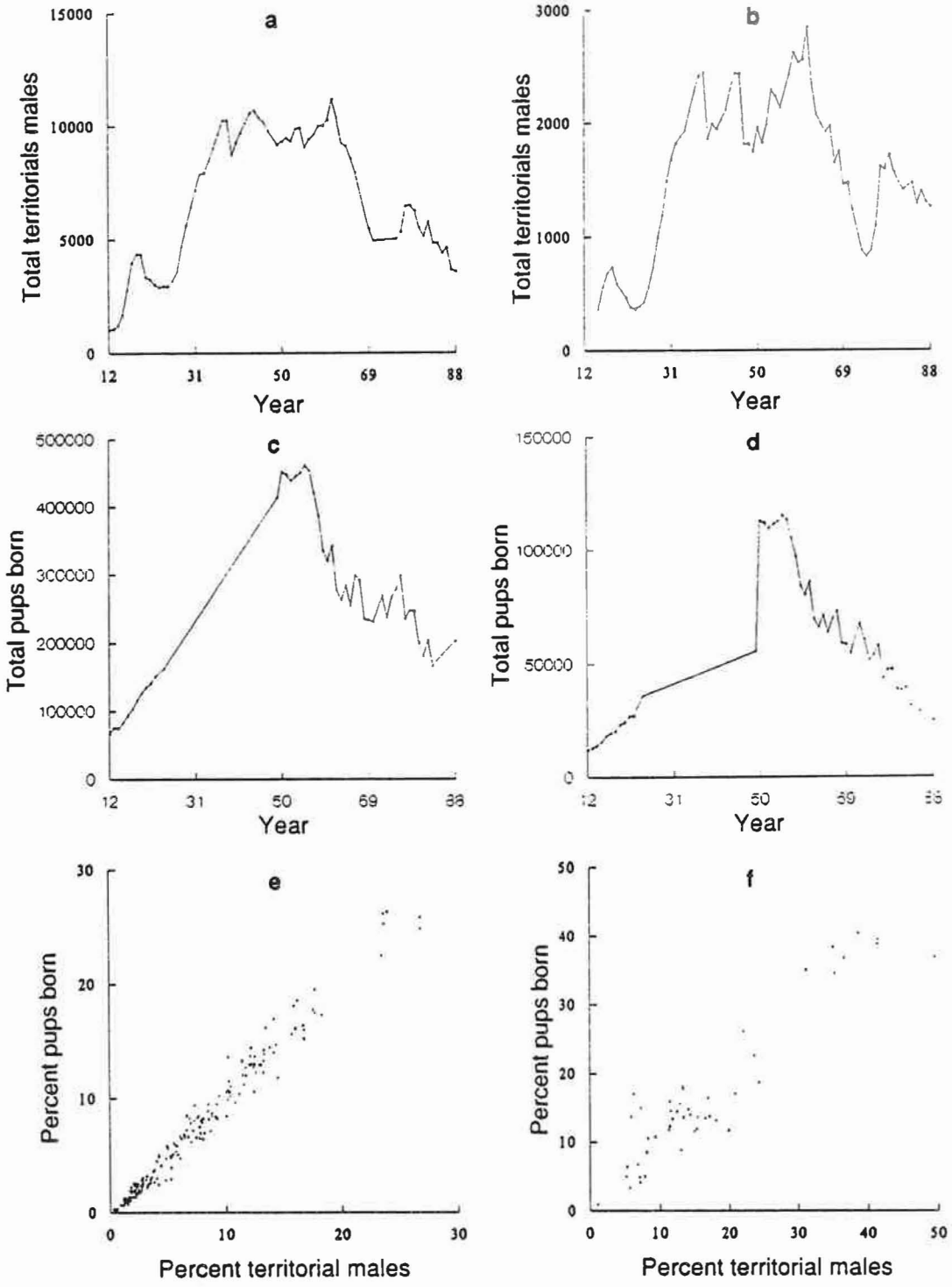

Figure 13.--The numbers of territorial male northern fur seals with females and pups born on the Pribilof Islands, Alaska, from 1912 to 1988. a. The total number of territorial males for St. Paul Island. b. The total number of territorial males for St. George Island. c. The total number of pups born for St. Paul Island. d. The total number of pups born for St. George Island. e. Percent of pups born verses percent territorial males for St. Paul Island. f. Percent of pups born verses percent territorial males for St. George Island.

probability of 0.01 using the chi-square distribution (Hollander and Wolf 1973). The test statistics of 428.6 for St. Paul Island and 115.4 for St. George Island indicate that there is significant differences in mortality between all rookeries.

It should be noted that in the graphic presentation of data it was necessary to use different scales for the percentage values on the ordinate. The reason for this method of presentation is to display the relative changes rather than the absolute values, in view of the fact that the rookeries vary in size.

Results

The total number of territorial males and pups born each year has varied over the 75-year period in a similar pattern for each of the two islands (see Fig. 13 a and b). Between 1926 and 1940 there was a steady increase in the number of territorial males after which time the increase stabilized and showed little variation for 20 years. In 1960, a decline began which continued for about 10 years, presumably in response to the harvest of females which started in 1956 (York and Hartley 1981). The decline subsided in the early 1970s with increases occurring prior to 1980. This increase was particularly abrupt on St. George Island, coinciding with the cessation of the harvest on St. George Island in 1973. A declining trend has occurred on both islands since 1980. The similarities between the two islands in the variation of fur seal numbers over the 75-year period seem to suggest that the factors that contribute to the

major population changes affect both islands simultaneously. If both islands are compared as a percentage of the total Pribilof Island population, St. Paul represents 75-90% of the total and St. George represents 10-25%.

There are 14 rookeries represented on St. Paul Island shown in Figures 14 through 17 and 6 rookeries on St. George displayed in Figures 18 and 19. Appendix Tables B-10 thru B-14 present the same information in tabular form. Comparing the relationship between the distribution of territorial males and pups born on each rookery, a definite correlation exists. In a given year pup production is directly proportional to the number of breeding males (York and Kozloff 1987). Figure 13 e and f present the percent of pups born verses percent of territorial males for all rookeries for all years for both islands. The geometric mean regression analysis for the data from St. Paul Island (Fig. 13 e) shows a correlation coefficient of 0.99 and 0.95 for St. George Island ($P < 0.001$) (Fig. 13 f).

The plots presented as percent of territorial males and pups born plotted over time (Figs. 14-19) portray a picture of how territorial males and pups have been distributed on each island over time. In the eastern St. Paul Island rookeries, which are located in a heavily used air traffic corridor, it appears that the fur seals tend to concentrate on Polovina Cliffs rookery rather than on Polovina and Little Polovina rookeries. The number of animals on Polovina Cliffs rookery has been steadily increasing over all years in terms of the fraction of territorial males and pups from the island total (Fig. 16 e and f). The

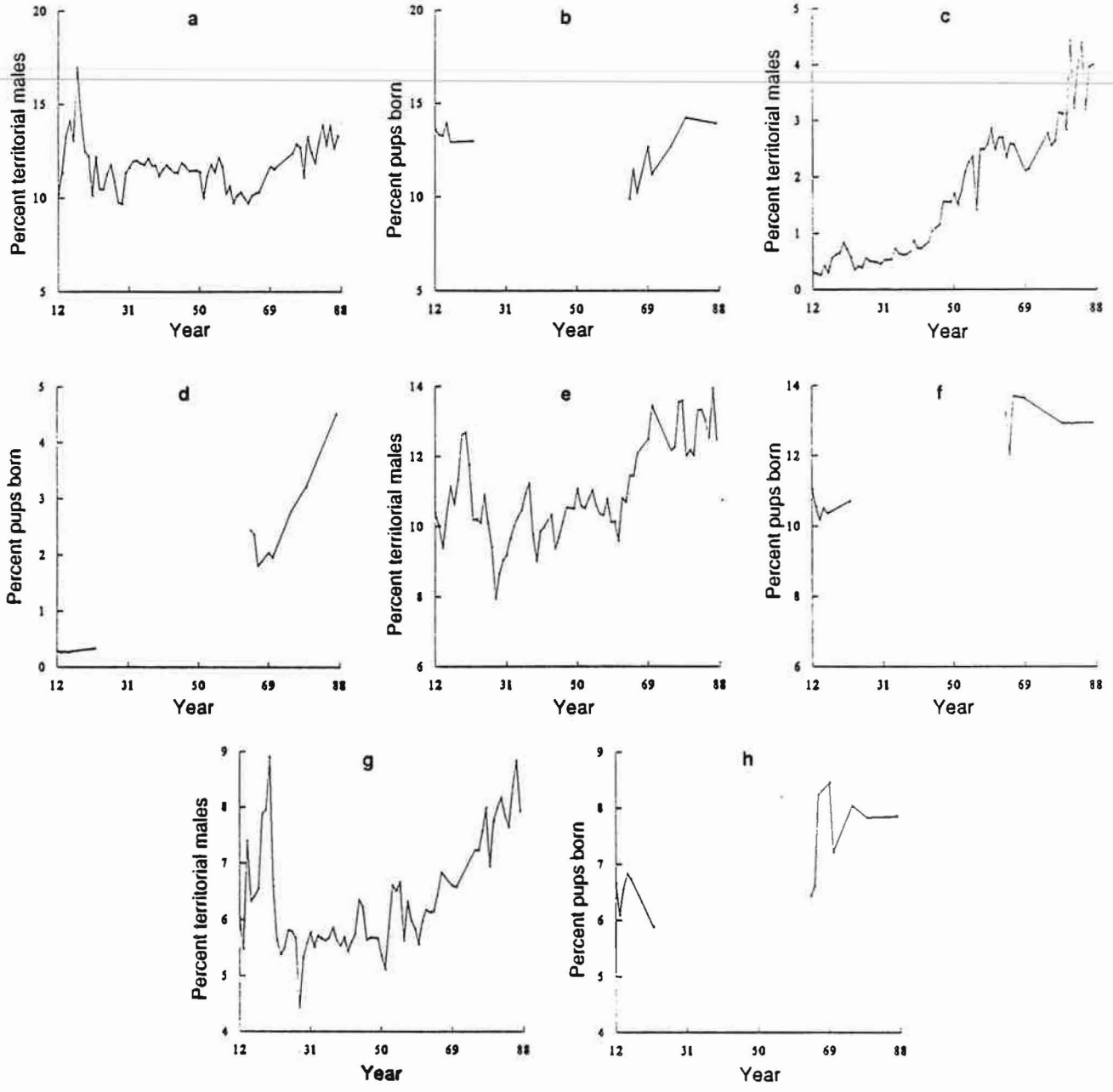

Figure 14.--The percent of the total number of territorial male northern fur seals with females and the percent of the total number of pups born for St. Paul Island, Alaska, 1912-1988, that occurred on the rookeries: a and b. Tolstoi; c and d. Zapadni Reef; e and f. Zapadni; g and h. Little Zapadni.

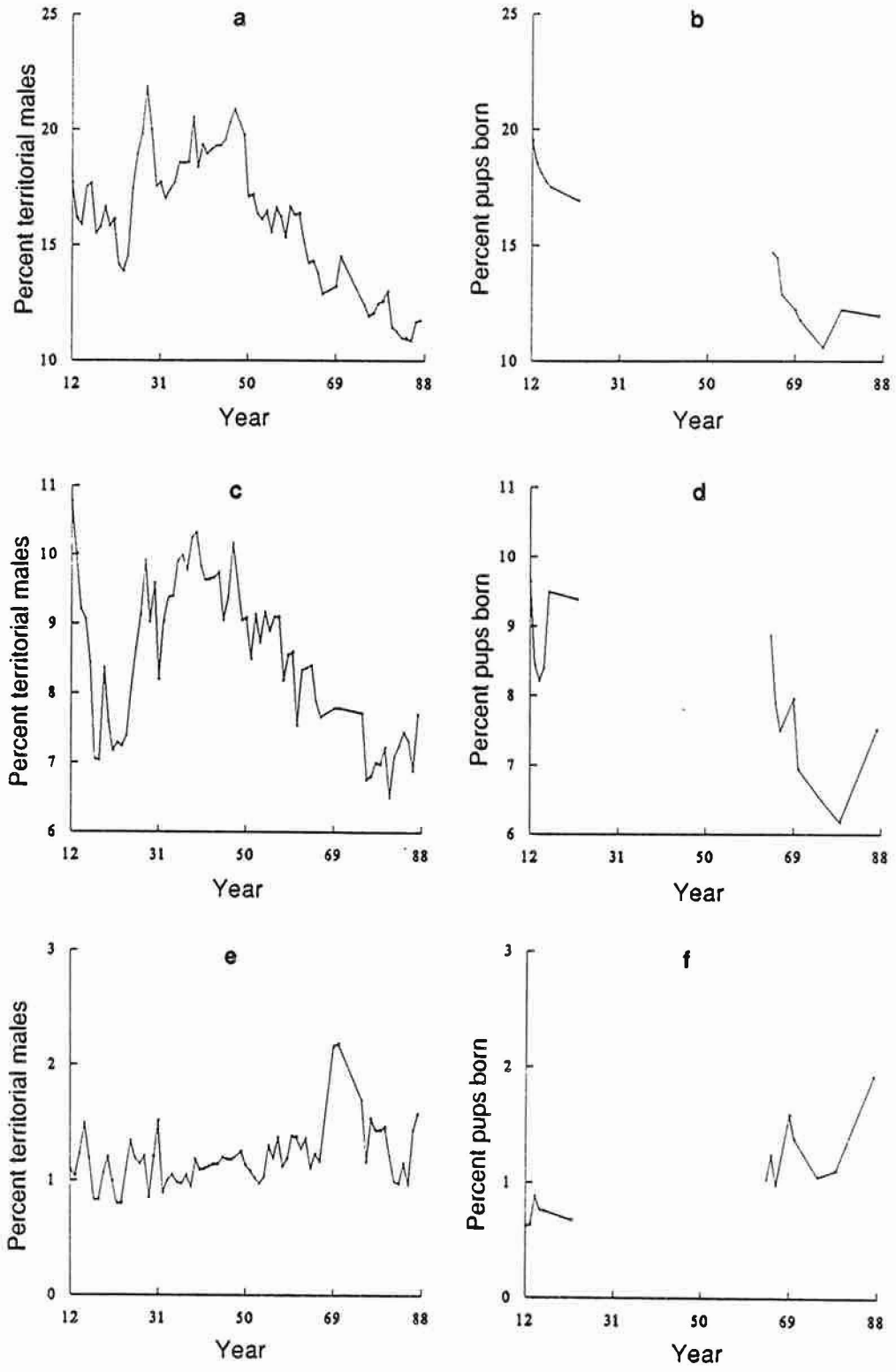

Figure 15.--The percent of the total number of territorial male northern fur seals with females and pups born for St. Paul Island, Alaska, 1912-1988, that occurred on the rookeries; a and b. Reef; c and d. Gorbatch; e and f. Ardiguen.

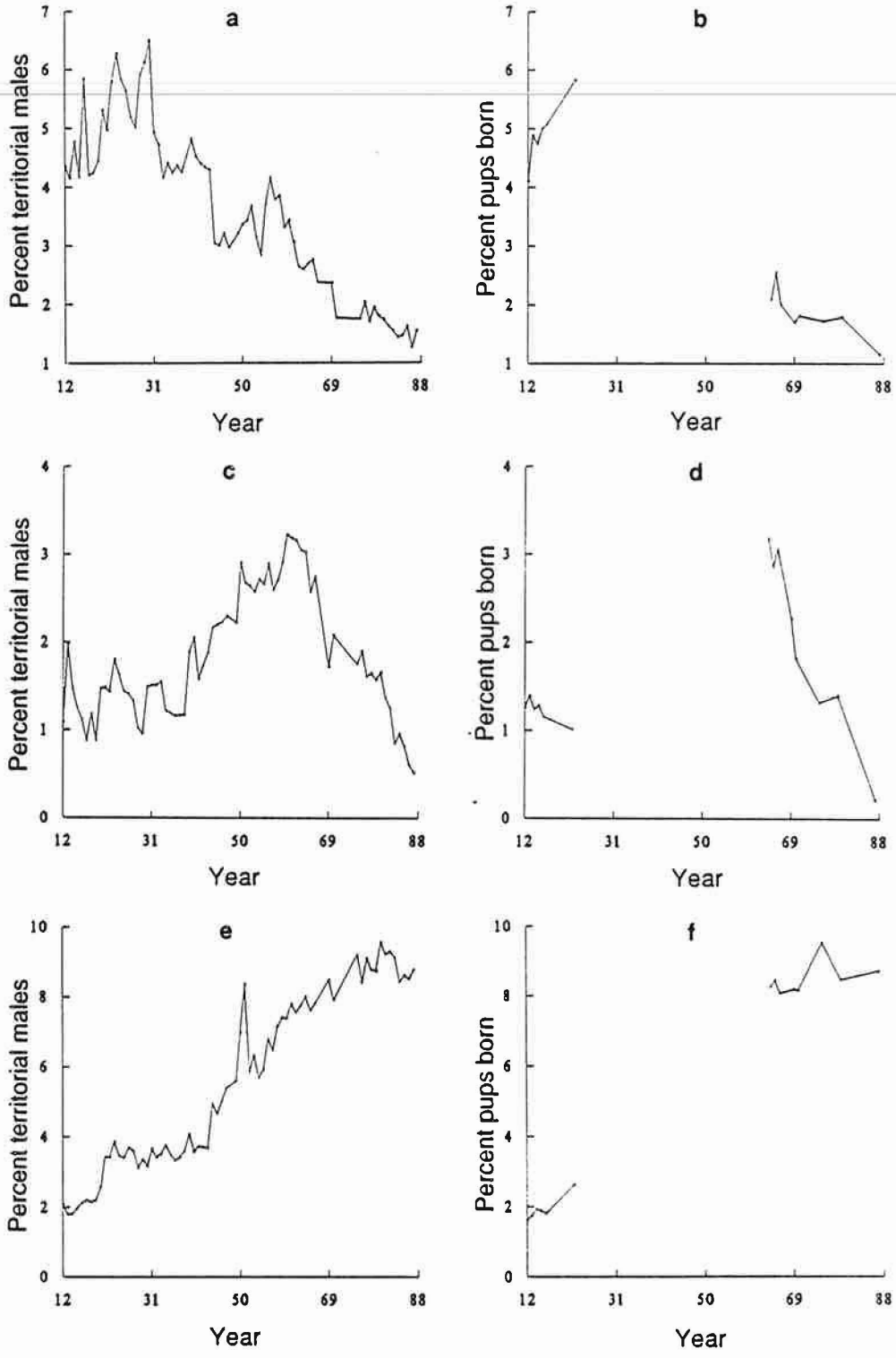

Figure 16.--The percent of the total number of territorial male northern fur seals with females and pups born for St. Paul Island, Alaska, 1912-1988, that occurred on the rookeries: a and b. Polovina; c and d. Little Polovina; e and f. Polovina Cliffs.

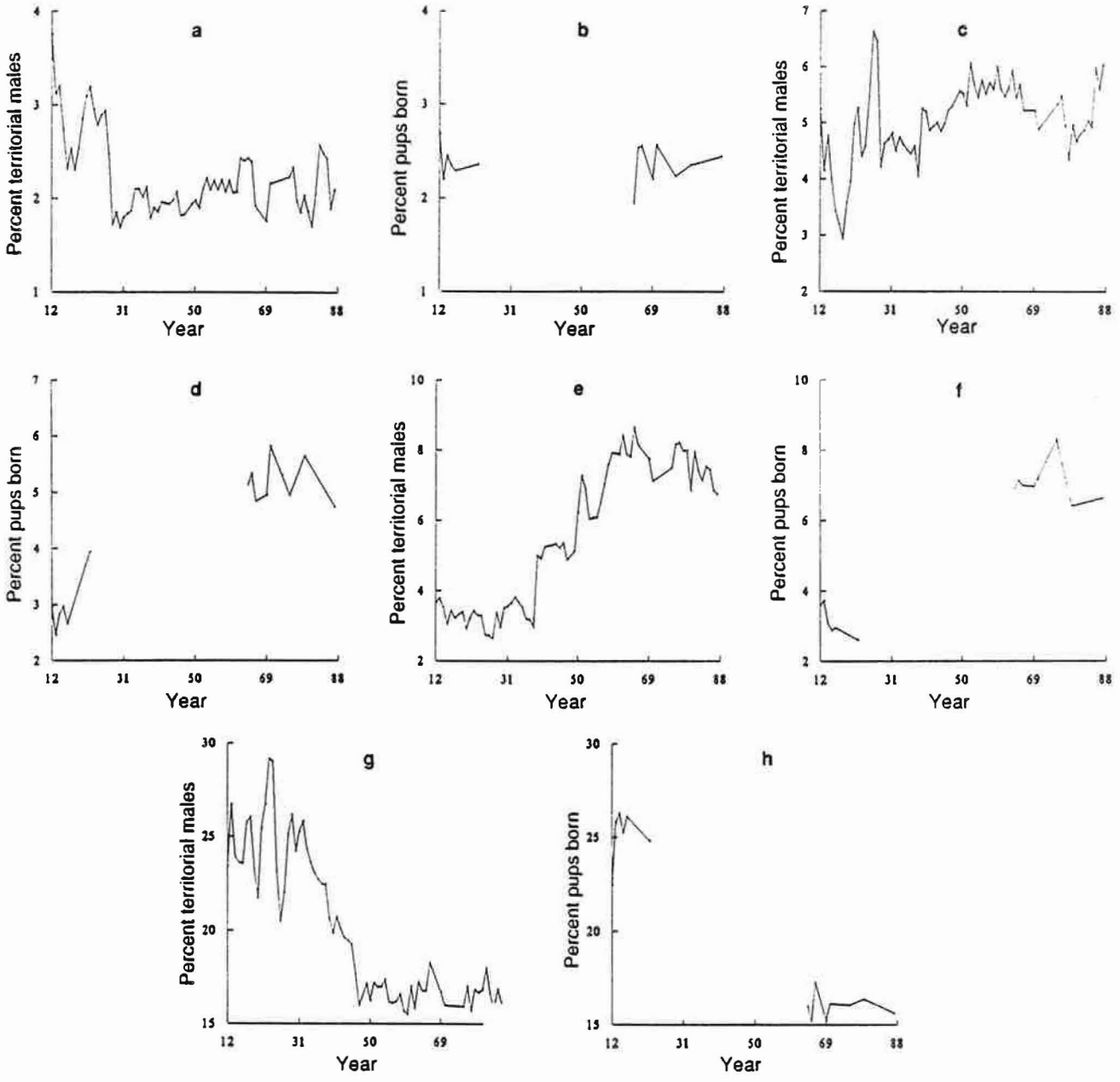

Figure 17.--The percent of the total number of territorial male northern fur seals with females and pups born for St. Paul Island, Alaska, 1912-1988, that occurred on the rookeries: a and b. Lukanin; c and d. Kitovi; e and f. Morjovi; g and h. Vostochni.

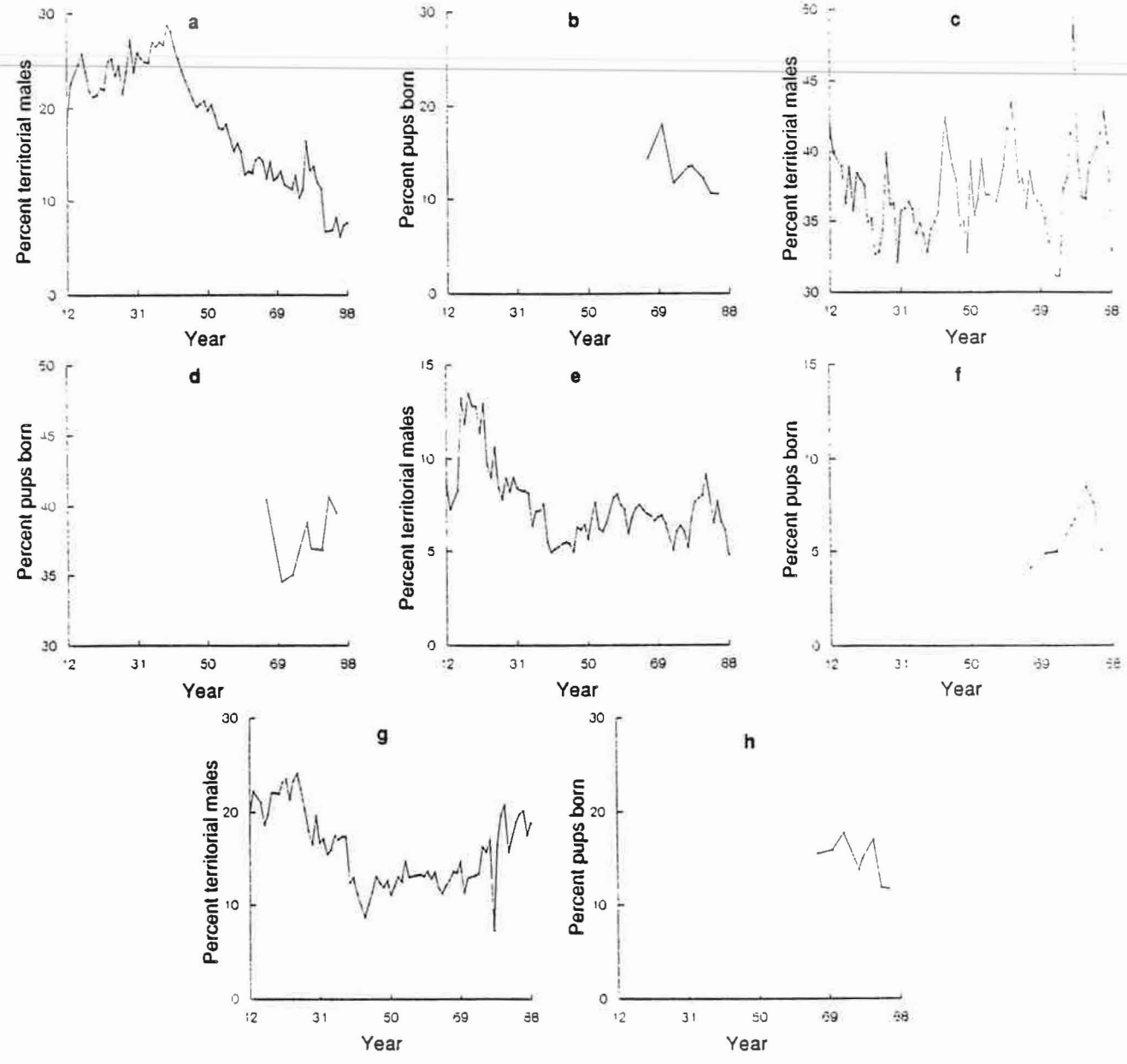

Figure 18.--The percent of the total number of territorial male northern fur seals with females and pups born for St. George Island, Alaska, 1912-1988, that occurred on the rookeries: a and b. Staraya Artil; c and d. North; e and f. East Reef; g and h. East Cliffs.

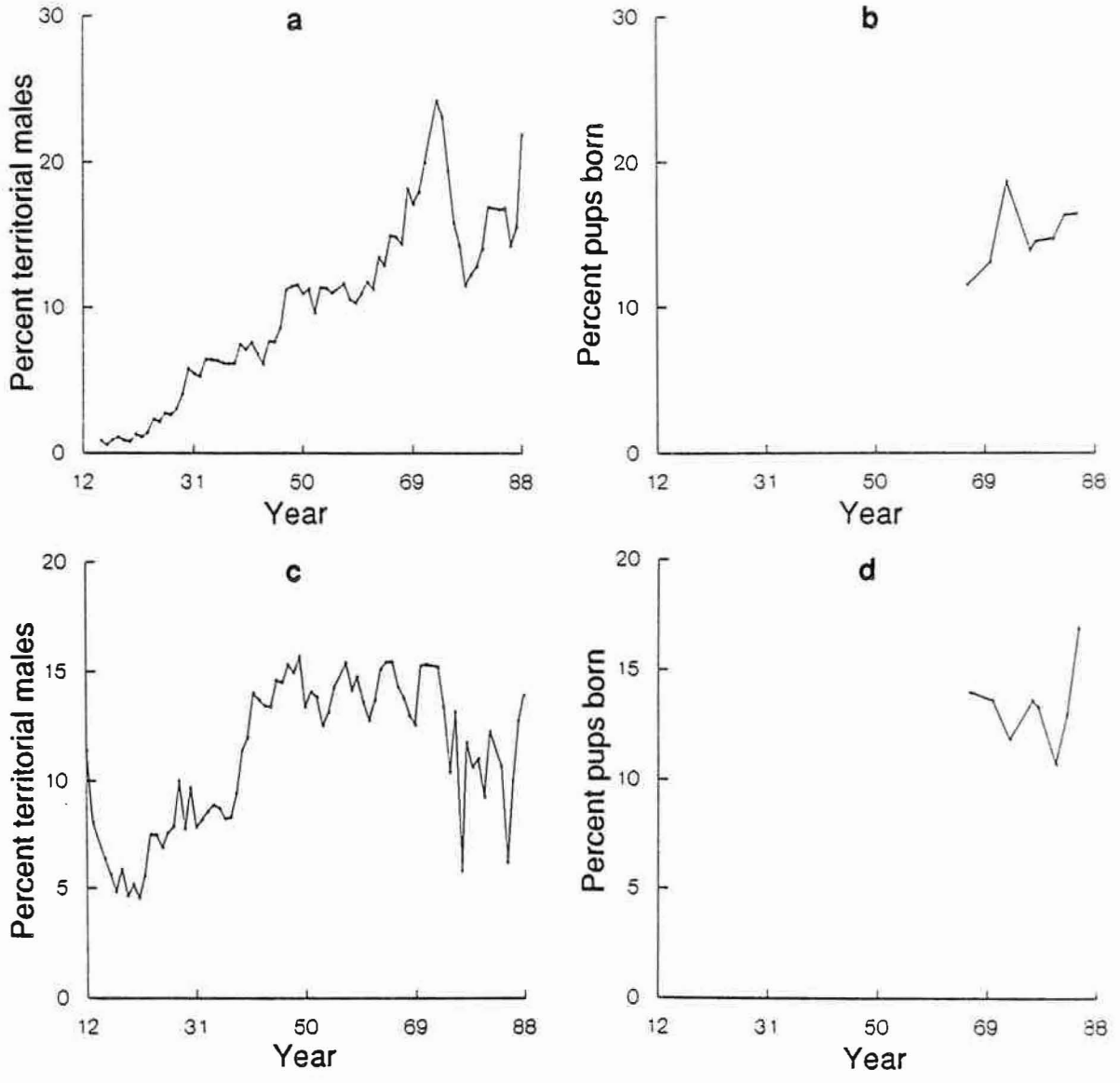

Figure 19.--The percent of the total number of territorial male northern fur seals with females and pups born for St. George Island, Alaska, 1912-1988, that occurred on the rookeries: a and b. South; c and d. Zapadni.

rookeries Lukanin, Kitovi, Tolstoi, Reef, Zapadni, and Little Zapadni displayed a quick rise and fall in territorial males between 1911 and 1933 and then, except for Reef rookery, experienced a slight increase after 1933. Reef rookery showed a definite decline from 1948 (Fig. 15 a and b). This is significant in terms of numbers of animals because it is second in size only to Vostochni, which is the largest rookery.

The rank sums assigned to pup mortality values for each rookery on both islands are shown in Appendix Table B-14. On St. Paul Island Zapadni rookery shows the highest pup mortality and Ardiguen rookery the least. For St. George Island, Staraya Artil rookery has the highest pup mortality and South and East Reef rookeries the least. The test statistics of 143.1 chi-square (13, $P < 0.001$) for St. Paul Island and 49.4 chi-square (5, $P < 0.001$) for St. George Island reject the hypotheses that there is no systematic variation in mortality between rookeries. Zapadni rookery (Fig. 14 e and f) shows a relatively stable distribution with a general increase in animals since the mid-1960s and Ardiguen rookery (Fig. 16 e and f) is also stable. There is no clear correlation between the relative mortality for each rookery and animal distribution trends. Little Zapadni rookery (Fig. 14 g and h) is increasing in relative size and has a higher mortality than 10 other rookeries, whereas Gorbatch rookery (Fig. 15 c and d) has a low mortality and is decreasing. The portion of territorial males and pups born on Vostochni rookery have apparently stabilized since 1947 after a marked decline in relative size (Fig. 17 g and h). No definite

conclusions can be reached about the effect mortality may have on animal distribution.

There are two rookeries on St. George Island which demonstrate dramatic change in relative size: South rookery with an increasing trend (Fig. 19 a and b) and Staraya Artil rookery with a decreasing trend (Fig. 18 a and b). Major research on Staraya Artil, Zapadni and East Reef rookeries showed no trend in relative size on the latter two rookeries.

Discussion

Based on the above analysis and results, several points are to be noted. Polovina and Little Polovina rookeries show declines in the numbers of territorial males, while Polovina Cliffs rookery (sandwiched between the other two) shows an increase (Fig. 16). Little Polovina rookery shows major declines after 1960. In comparing the three rookeries, Polovina Cliffs rookery offers protected inlets and coves among which the seals tend to congregate. All three Polovina rookeries are subject to disturbances from air traffic and historically have been research sites. Further study will be required to determine if the observed changes are related to such disturbance or not.

Comparisons can be drawn among the southern rookeries of St. Paul Island. Reef rookery is declining in relative size whereas the Zapadni rookeries and Tolstoi rookery are increasing, particularly Zapadni Reef rookery. Differential mortality on Reef rookery is about average (Appendix Table B-16).

Biologists have raised questions about the effects of pup mortality studies done on Reef rookery (Fig. 14 a and b) and Vostochni rookery (Fig. 16 g and h) in the early 1970s and 1980s (see annual reports of Fur Seal Investigations) and the effects of the female harvest during 1956-68 (York and Hartley 1980). Both rookeries experienced declines in relative size immediately after the pup sampling periods.

Of note is the observation that the two largest rookeries (Reef and Vostochni) have displayed substantial declines over time. One possible reason is that seals may move away from the larger rookeries in favor of available space on other rookeries where there is less competitive stress. Although seals generally have site fidelity, it would seem reasonable to test the hypothesis that some seals may move onto rookeries where reproductive success may be improved.

Vostochni and Morjovi rookeries (Fig. 17 e-h) present an example of possible rookery drift, being adjacent to each other and secluded from other rookeries. It could be surmised that animals are moving south from Vostochni to Morjovi rookeries.

Comparing other groups of rookeries, grouped by size or area, some interesting observations can be made. Lukanin and Kitovi are small rookeries in proximity and relatively stable. Gorbatch, Ardiguen, and Reef rookeries share the southern tip of St. Paul Island. Reef and Gorbatch rookeries share a very similar pattern of decline with Reef rookery being twice the size of Gorbatch rookery. Ardiguen rookery and Tolstoi rookery are very stable.

The Zapadni rookeries (Fig. 14 e-h) present an interesting situation, all showing increasing trends and all very different in rookery size. Zapadni is the largest, Little Zapadni average, and Zapadni Reef relatively small.

Comparing rookeries on St. George Island grouped by location, it is interesting to note that East Reef and East Cliffs rookeries are in proximity and display a similar trend of decrease until approximately 1940 when the rookeries stabilized. East Cliffs rookery is twice the size of East Reef rookery. North rookery is near Staraya Artil rookery and shows wide variability in relative population size over time. Staraya Artil and South are large rookeries with small ratios of territorial to nonterritorial males. Both have been the focus of major research efforts. In comparing these rookeries with the others on St. George Island, it has been noted that they are characterized by a significant number of males holding territory without females (Gentry pers. commun.). There are no apparent events or activities which may explain the steady increase on South rookery up to the early 1970s and the decrease on Staraya Artil rookery.

Research activities described in Fur Seal Investigations annual reports (e.g. Fur Seal Investigations, 1971) take place on Zapadni rookery as well as on Staraya Artil and East Reef rookeries. East Reef rookery shows a rise in territorial males until 1940 and then a general stabilization. North rookery is the largest rookery on St. George Island and shows the least amount of change over the 75-year period.

One aspect of the data shown for both St. Paul and St. George Islands is that, for the most part, changes seem gradual. However, the exceptions to this pattern should be noted. Prominent fluctuations occurred on St. Paul Island on Little Zapadni, Gorbatch, Kitovi, Vostochni, and Polovina rookeries in the early 1900s. Short periods of rapid fluctuation are also observed for the other rookeries, but the magnitude of the fluctuations for small rookeries (i.e., those with 4% or less of the territorial males and pups) may be overemphasized by the method of presentation. Even so, the largest rookery, Vostochni, exhibited several sizable fluctuations in the 1920s. To what extent such changes in the data are due to statistical variability (changes in counters, errors in counting, errors in data transcription, etc.) is not known.

CONCLUSION

Based on the results of this study it is clear that changes in the distribution of northern fur seals among their breeding rookeries have occurred. At this time, however, it is difficult to draw specific conclusions concerning patterns, causes, or effects. As a continuation of this research effort, it may be worthwhile to choose rookeries that show dramatic change over time and analyze the historical details which may provide answers to questions concerning the causes of seal movement into or away from specific areas. Substrata type, human activities, exposure (to weather), distance to food resources, and related factors are

of interest in this regard and should be kept in mind in any future studies.

ENTANGLEMENT STUDIES, ST. PAUL ISLAND, 1988

JUVENILE MALE ROUNDUPS[1]

by

Charles W. Fowler, Richard Merrick, and Norihisa Baba

Recent studies of northern fur seals have included efforts to determine the effects of entanglement in marine debris. Juvenile males (aged 2 to 5 years) comprise the component of the population most readily studied in this regard. Entanglement among these males is studied during roundups wherein animals are grouped together on or near haul-out areas adjacent to breeding rookeries. A total of 66 roundups were completed during studies on St. Paul Island during July 1988 (Appendix Table C-1).

During roundup studies conducted in 1988, 24,519 male seals of the size historically taken in the commercial harvest (roughly 105 to 125 cm in total length) were examined for debris. (Unless indicated otherwise, data in this report apply to seals of this size.) Among these, the entangled animals were counted to estimate the entanglement rate for comparison with rates observed in the commercial harvest prior to 1985. All but one of 53 entangled subadult male seals were captured and tagged with blue numbered Allflex tags bearing the address of the National Marine Mammal Laboratory (Appendix Table C-2). Tags were placed on the

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inner trailing edge of the front flipper, near the hairline, according to standard practice for this species. For each entangled seal, two controls were also tagged to compare rates of return in succeeding years (Appendix Table C-2). This resulted in the tagging of 104 similarly sized seals with no debris entangling them in addition to the entangled animals that were tagged.

Thirty juvenile male seals were instrumented with radio tags to study the effects of entanglement on patterns of hauling out on land. Specifically, this part of the 1988 entanglement research was carried out to examine the probability of being on land with respect to entanglement to evaluate data on the relative occurrence of entangled versus unentangled seals.

All seals, regardless of size, were examined for tags during roundups. As shown in Appendix Table C-3, seals tagged in previous years were resighted along with seals tagged during the 1988 season. As in previous years, some of the resighted seals were seen on more than one occasion during the 1988 season. Of the resighted tagged seals for which the tags were read, 60 wore Allflex tags from a study in 1985 and 1986, which evaluated the mortality of young male seals in small debris. Fifty-three of these were seals tagged earlier as controls and 7 were entangled when tagged. One entangled seal that had been tagged as an entangled animal in 1984 was also resighted. Six of 8 seals previously entangled had lost their entangling debris. All lost debris had been noted at the first sighting as being small, but was otherwise similar to commonly observed debris. Ten

additional tags from previous years (9 orange Allflex and 1 Roto tag that appeared to be white) were sighted but not read; none of these animals were entangled at the time of the resighting.

Fifty-three entangled juvenile male seals of harvestable size encountered in the roundups were examined to determine the nature of the entangling debris. Information noted included the size and kind of the debris, the extent of any wounds, and how tightly the debris was lodged on the animal (Appendix Table C-4). One seal was so badly wounded by its entangling debris that it was bleeding profusely and was not expected to live long. The debris was removed from this animal, which, in turn, was released without applying tags. (This animal was resighted later in the season, alive, but continuing to show signs of severe debilitation caused by the wound.) The remainder were tagged as indicated in Appendix Tables C-2 and C-4.

Of the entangled harvestable sized seals examined (53), 27 (50.9%) carried fragments of trawl webbing, 14 (26.4%) plastic packing bands, and 10 (18.9%) string, small line or cords. The overall entanglement rate is estimated by the ratio of all (both initial and all subsequent) entanglement sightings to the total number of seals examined (thus including the resightings in both cases, i.e., a sampling with replacement design). The entanglement rate for 1988 was 0.285% (70/24519, Appendix Table C-1). This rate of entanglement is less than the observed rate of 0.4% between 1976 and 1985 (Fowler 1985). Appendix Table C-5 shows that the majority of the reduction can be attributed to a reduction in the rate of entanglement in trawl webbing.

Historically the rate of entanglement in trawl webbing has been about 0.27%, whereas in 1988 that rate dropped to about 0.15%.

Appendix Table C-6 shows the record of tags applied to juvenile males during entanglement studies for each year since 1985 (Fowler et al. 1989). Of 257 seals tagged in 1985, 85 (33%) were entangled animals. Of the tags released in 1985 and recovered in 1986 (49), 12 (24%) were originally tagged as entangled animals. This change is not statistically significant (Chi-square test,
$P < 0.5$). There was no field effort in 1987 so no samples were collected in that year. Of the 14 seals tagged in 1985 and resighted in 1988, 1 (7%) had been tagged as entangled. In this case, the change in ratio from 0.33 to 0.07 is statistically significant (binomial probability tests, $P < 0.05$). Of the 407 animals tagged in 1986, 128 (31.4%) were entangled. Of 46 seals tagged in 1986 and resighted in 1988, 6 (13%) were tagged as entangled seals in 1986. This is also a statistically significant change (Chi-square test, $P < 0.05$). A total of 192 tagged seals were released in 1988 to be resighted in 1989. Changes in the ratios, as reported above, relate to the additional mortality suffered by entangled animals but may also be influenced by any difference in the probability of being resighted. The analysis of these data with the estimated rates of survival due to entanglement will be presented elsewhere.

In summary, the 1988 results of entanglement research through roundups of juvenile males showed the following:

1) A reduction of the entanglement rate from about 0.4

to 0.29%.

2) Entanglement in trawl webbing in 1988 was about half of entanglement levels observed for this kind of debris in previous years.

3) The rate of resighting for animals tagged in 1985 and resighted in 1988 showed that entangled animals tagged in that year were seen at a rate that was significantly less than the rate at which controls were resighted.

4) The rate of resighting for animals tagged in 1986 and resighted in 1988 showed that entangled animals tagged in that year were seen at a rate that was significantly less than the rate at which controls were resighted.

Future analyses will involve the data in this report in combination with the data obtained from radio tagging studies conducted in 1988. This work will examine the rates of occurrence on land (i.e., the probability of being included in the roundups) of animals tagged as entangled or control animals during the same season in continuing efforts to provide estimated rates of mortality due to entanglement.

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APPENDIX A

Glossary

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

Bachelor	Young male seals of age 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 if the animal should lose its tag.

Classifications of adult male fur seals

Class 1 (shoreline)	Full-grown males apparently attached to "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). Class 1 males should not be confused with Class 2 animals, which have definite 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 a few are 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 sandy beaches, and in corridors leading to inland hauling grounds. Some territorial males have as few as one or two 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 are 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.
Drive	The act of surrounding and moving groups of seals from one location to another.
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 onto shore at either a rookery or hauling ground.
Kleptogyny	The act of an adult male seal (primarily classes 1, 2, or 3) seizing an adult female from another male's territory.
Known-age	Refers to a seal whose age is known because the animal bears an inscribed tag or other type of mark.
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 hair-clipping, or by bleaching.
Mark recoveries	Recovery (sighting) of a seal that has been marked by one of everal methods. See Marked.
Rookery	An area on which breeding seals congregate. See Hauling ground.
Roundup	Biologists surround and herd juvenile male fur seals close to the location they haul out.
Vibrissae (facial whiskers)	To determine the relative age structure of females in a population, the color of their facial whiskers are used. Facial vibrissae are black at birth and remain black through age 3 years; become mixed (black and white) at ages 4 and 5 years; and by age 7, the vibrissae usually are entirely white.

APPENDIX B

Tabulations of northern fur seal data collected on the Pribilof Islands, Alaska, 1987-88.

APPENDIX B (Continued)

Table B-1.--Number of adult male northern fur seals counted, by class[a] and rookery section, St. Paul Island, Alaska, 9-20 July 1987. 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	6	10	-	-	-	-	-	-	-	-	-	-	-	-	16
3	45	31	-	-	-	-	-	-	-	-	-	-	-	-	76
5	24	5	-	-	-	-	-	-	-	-	-	-	-	-	29
Kitovi[b]															
2	4(2)	1	2	10	2	-	-	-	-	-	-	-	-	-	21
3	35(16)	15	49	50	54	-	-	-	-	-	-	-	-	-	219
5	0(2)	3	6	5	29	-	-	-	-	-	-	-	-	-	45
Reef															
2	9	17	7	4	2	5	4	5	4	1	0	-	-	-	58
3	45	77	59	41	28	50	19	32	44	28	4	-	-	-	427
5	3	14	17	7	74	3	20	26	0	20	12	-	-	-	196
Gorbatch															
2	13	32	8	0	1	12	-	-	-	-	-	-	-	-	66
3	86	44	57	0	14	79	-	-	-	-	-	-	-	-	280
5	43	5	7	58	17	14	-	-	-	-	-	-	-	-	144
Ardiguen															
2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4
3	57	-	-	-	-	-	-	-	-	-	-	-	-	-	57
5	12	-	-	-	-	-	-	-	-	-	-	-	-	-	12
Morjovi[c]															
2	8(3)	3	5	4	8	5	-	-	-	-	-	-	-	-	36
3	29(22)	31	54	25	54	30	-	-	-	-	-	-	-	-	245
5	50(9)	3	15	2	0	28	-	-	-	-	-	-	-	-	107
Vostochni															
2	2	1	3	7	2	20	6	2	11	3	4	3	10	4	78
3	24	10	29	34	21	65	44	48	37	15	37	62	89	55	570
5	10	3	3	29	38	26	9	0	9	0	0	16	13	45	201
Little Polovina															
2	0	0	-	-	-	-	-	-	-	-	-	-	-	-	0
3	5	14	-	-	-	-	-	-	-	-	-	-	-	-	19
5	0	34	-	-	-	-	-	-	-	-	-	-	-	-	34
Polovina															
2	5	3	-	-	-	-	-	-	-	-	-	-	-	-	8
3	34	22	-	-	-	-	-	-	-	-	-	-	-	-	56
5	71	43	-	-	-	-	-	-	-	-	-	-	-	-	114

Table B-1--Continued.

Rookery and class of male	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Polovina Cliffs															
2	3	2	2	2	4	6	8	-	-	-	-	-	-	-	27
3	25	24	22	36	47	67	97	-	-	-	-	-	-	-	318
5	5	3	5	5	6	3	27	-	-	-	-	-	-	-	54
Tolstoi															
2	1	3	3	2	4	9	10	4	-	-	-	-	-	-	36
3	45	27	85	49	74	77	71	55	-	-	-	-	-	-	483
5	0	0	7	0	7	8	7	104	-	-	-	-	-	-	132
Zapadni Reef															
2	8	1	-	-	-	-	-	-	-	-	-	-	-	-	9
3	114	31	-	-	-	-	-	-	-	-	-	-	-	-	145
5	19	32	-	-	-	-	-	-	-	-	-	-	-	-	51
Little Zapadni															
2	4	3	5	3	3	3	-	-	-	-	-	-	-	-	21
3	10	38	55	71	58	56	-	-	-	-	-	-	-	-	288
5	1	4	2	4	1	36	-	-	-	-	-	-	-	-	48
Zapadni[d]															
2	14(0)	12	7	9	10	11	5	1	-	-	-	-	-	-	69
3	51(0)	62	66	77	60	61	68	16	-	-	-	-	-	-	461
5	14(67)	9	9	14	53	11	14	84	-	-	-	-	-	-	275

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

[b]Numbers in parentheses are the adult males counted in Kitovi Amphitheater.

[c]Numbers in parentheses are the adult males counted on the second point south of Sea Lion Neck.

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

Table B-2.--Number of adult male northern fur seals counted, by rookery, Pribilof Islands, Alaska, July 1987.

Island and rookery	Date (July)	Class of adult male[a] 2	3	5	Total
St Paul Island					
Lukanin	9	16	76	29	121
Kitovi	18	21	219	45	285
Reef	18	58	427	196	681
Gorbatch	18	66	280	144	490
Ardiguin	9	4	57	12	73
Morjovi	17	36	245	107	388
Vostochni	17	78	570	201	849
Little Polovina	14/19	0	19	34	53
Polovina	19	8	56	114	178
Polovina Cliffs	19	27	318	54	399
Tolstoi	19	36	483	133	652
Zapadni Reef	20	9	145	51	205
Little Zapadni	20	21	280	48	357
Zapadni	20	69	453	275	797
Island total		449	3,636	1,443	5,528
St. George Island[b]					
Zapadni	19	109	166	182	457
South	19	90	203	49	342
North	18	207	529	98	834
East Reef	18	22	80	32	134
East Cliffs	18	70	229	266	565
Staraya Artil	18	110	96	48	254
Island total		608	1,303	675	2,586

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

[b]St. George counts for males without females (classes 2 and 5) combined in one count.

Table B-3.--Number of harem and idle male northern fur seals counted in mid-July, Pribilof Island, Alaska, 1978-87. A dash indicates no data.

Year	St. Paul Island		St. George Island		Total	
	Harem	Idle	Harem	Idle	Harem	Idle
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
1983	4,827	4,242	-	-	-	-
1984	4,803	3,977	1,473	1,452	6,276	5,429
1985	4,372	3,363	1,286	1,601	5,658	4,964
1986	4,603	1,865	1,394	1,342	5,997	3,207
1987	3,636	1,892	1,303	1,283	4,939	3,175

Table B-4.--Number of adult male northern fur seals counted, by class[a] and rookery section, St. Paul Island, Alaska, 10-17 July 1988. 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	8	-	-	-	-	-	-	-	-	-	-	-	-	17
3	45	38	-	-	-	-	-	-	-	-	-	-	-	-	86
5	47	7	-	-	-	-	-	-	-	-	-	-	-	-	54
Kitovi[b]															
2	7(5)	2	7	6	8	-	-	-	-	-	-	-	-	-	35
3	31(12)	10	46	64	51	-	-	-	-	-	-	-	-	-	214
5	6(8)	12	8	7	54	-	-	-	-	-	-	-	-	-	95
Reef															
2	13	11	21	12	7	9	1	19	4	4	3	-	-	-	104
3	50	61	49	25	32	50	14	39	37	30	6	-	-	-	393
5	10	12	11	13	87	10	25	28	0	18	10	-	-	-	224
Gorbatch															
2	19	12	7	0	2	7	-	-	-	-	-	-	-	-	47
3	86	61	40	0	13	68	-	-	-	-	-	-	-	-	268
5	124	7	24	60	16	11	-	-	-	-	-	-	-	-	232
Ardiguen															
2	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7
3	66	-	-	-	-	-	-	-	-	-	-	-	-	-	66
5	8	-	-	-	-	-	-	-	-	-	-	-	-	-	8
Morjovi[c]															
2	10(4)	10	10	6	8	10	-	-	-	-	-	-	-	-	58
3	27(21)	29	41	29	56	25	-	-	-	-	-	-	-	-	228
5	62(11)	3	54	0	3	86	-	-	-	-	-	-	-	-	217
Vostochni															
2	6	0	6	2	3	13	10	2	11	2	7	8	14	6	90
3	39	13	34	31	21	72	41	53	26	17	32	46	102	41	568
5	5	0	0	49	54	31	16	5	15	0	4	26	57	33	295
Little Polovina															
2	1	4	-	-	-	-	-	-	-	-	-	-	-	-	5
3	5	9	-	-	-	-	-	-	-	-	-	-	-	-	14
5	13	68	-	-	-	-	-	-	-	-	-	-	-	-	81
Polovina															
2	5	5	-	-	-	-	-	-	-	-	-	-	-	-	10
3	33	10	-	-	-	-	-	-	-	-	-	-	-	-	43
5	112	87	-	-	-	-	-	-	-	-	-	-	-	-	199

Table B-4--Continued.

Rookery and class of male	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Polovina Cliffs															
2	6	5	6	15	13	13	26	-	-	-	-	-	-	-	84
3	29	24	22	45	48	38	98	-	-	-	-	-	-	-	304
5	11	24	7	2	8	7	19	-	-	-	-	-	-	-	78
Tolstoi															
2	8	3	4	8	6	13	9	6	-	-	-	-	-	-	57
3	47	59	56	51	79	92	68	59	-	-	-	-	-	-	511
5	3	7	9	0	23	14	17	245	-	-	-	-	-	-	318
Zapadni Reef															
2	18	4	-	-	-	-	-	-	-	-	-	-	-	-	22
3	109	33	-	-	-	-	-	-	-	-	-	-	-	-	142
5	49	64	-	-	-	-	-	-	-	-	-	-	-	-	113
Little Zapadni															
2	2	9	13	18	12	9	-	-	-	-	-	-	-	-	63
3	14	40	56	69	49	59	-	-	-	-	-	-	-	-	287
5	16	11	26	13	17	81	-	-	-	-	-	-	-	-	161
Zapadni[d]															
2	15(0)	20	23	13	17	11	15	2	-	-	-	-	-	-	116
3	45(0)	77	69	56	56	86	62	9	-	-	-	-	-	-	461
5	9(134)	15	17	29	112	19	11	65	-	-	-	-	-	-	411

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

[b]Numbers in parentheses are the adult males counted in Kitovi Amphitheater.

[c]Numbers in parentheses are the adult males counted on the second point south of Sea Lion Neck.

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

Table B-5.—Number of adult male northern fur seals counted, by rookery, Pribilof Islands, Alaska, July 1988.

Island and rookery	Date (July)	Class of adult male* 2	3	5	Total
St Paul Island					
Lukanin	13	17	86	54	157
Kitovi	13	35	214	95	344
Reef	11	104	393	224	721
Gorbatch	12	47	268	232	547
Ardiguin	12	7	66	8	81
Morjovi	15	58	228	217	503
Vostochni	15	90	568	295	953
Little Polovina	10	5	14	81	100
Polovina	10	10	43	199	252
Polovina Cliffs	10	84	304	78	466
Tolstoi	17	57	511	318	886
Zapadni Reef	14	22	142	113	277
Little Zapadni	14	63	287	161	511
Zapadni	14	116	461	411	988
Island total		715	3,585	2,486	6,786
St. George Island					
Zapadni	15	42	175	100	317
South	15	103	276	44	423
North	14	255	415	287	957
East Reef	13	38	60	14	112
East Cliffs	13	78	237	113	428
Staraya Artil	15	89	96	95	280
Island total		605	1,259	653	2,517

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

Table B-6.—Number of dead northern fur seal pups counted, by rookery section, Pribilof Islands, Alaska, 1987.

Rookery	Date	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
St. Paul Island	August															
Vostochni	22	36	14	37	40	33	118	70	53	40	12	19	59	139	68	738
Marjovi	22	49	50	60	39	60	32	—	—	—	—	—	—	—	—	290
Tolstoi	21	108	97	[1]37	119	206	244	249	208	—	—	—	—	—	—	1,368
Zapadni	23	57	150	227	246	174	207	171	74	—	—	—	—	—	—	1,306
Little Zapadni	23	14	114	170	235	178	167	—	—	—	—	—	—	—	—	878
Zapadni Reef	23	244	90	—	—	—	—	—	—	—	—	—	—	—	—	334
Polovina Cliffs	20	43	62	40	56	64	95	176	—	—	—	—	—	—	—	536
Polovina	20	38	9	—	—	—	—	—	—	—	—	—	—	—	—	47
Reef	23	53	125	153	89	83	79	35	43	114	43	10	—	—	—	827
Gorbatch	22	225	154	174	2	19	123	—	—	—	—	—	—	—	—	697
Ardiguen	22	114	—	—	—	—	—	—	—	—	—	—	—	—	—	114
Kitovi	20	46	11	80	85	66	—	—	—	—	—	—	—	—	—	288
Lukanin	20	89	93	—	—	—	—	—	—	—	—	—	—	—	—	182
Point South	22	46	—	—	—	—	—	—	—	—	—	—	—	—	—	46
															Total	7,651

St. George Island: No counts of dead pups made during 1987.

Table B-7.—Number of dead northern fur seal pups counted, by rookery section, Pribilof Island, Alaska, 1988.

Rookery	Date	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total*
St. Paul Island	August															
Vostochni	19	31	15	41	49	44	182	114(38)	76	39	5	36	54	193	80	959(38)
Morjovi	16	24	92	61	44	89	49	-	-	-	-	-	-	-	-	391
Tolstoi	20	80	85	96	115	189	264	251	234	-	-	-	-	-	-	1,314
Zapadni	19	81	142	236	194	125	160	113	18(3)	-	-	-	-	-	-	1,069
Little Zapadni	20	20	104	176	224	121	175	-	-	-	-	-	-	-	-	820
Zapadni Reef	18	278	106	-	-	-	-	-	-	-	-	-	-	-	-	384
Polovina Cliffs	15	23	46	41	59	55	91	136	-	-	-	-	-	-	-	451
Polovina	19	45	8	-	-	-	-	-	-	-	-	-	-	-	-	53
Reef	14-15	41	96	79	67	69(17)	111	68(23)	61	92	35	8	-	-	-	727(50)
Gorbatch	14	167	95	121	4	22	78	-	-	-	-	-	-	-	-	487
Aridiguen	14	63	-	-	-	-	-	-	-	-	-	-	-	-	-	63
Kitovi	18-19	44	22	99	79	63	-	-	-	-	-	-	-	-	-	307
Lukanin	20	72	132	-	-	-	-	-	-	-	-	-	-	-	-	204
Point South	16	32	-	-	-	-	-	-	-	-	-	-	-	-	-	32
														Total		7,261(91)
St George Island																
East Reef	15	12	-	-	-	-	-	-	-	-	-	-	-	-	-	12
East Cliffs	15	246	-	-	-	-	-	-	-	-	-	-	-	-	-	246
Staraya Artil	15	93	13	-	-	-	-	-	-	-	-	-	-	-	-	111
North	16	82	160	164	64	26	38	-	-	-	-	-	-	-	-	534
Zapadni	17	80	44	28	-	-	-	-	-	-	-	-	-	-	-	152
South	17	30	104	23	-	-	-	-	-	-	-	-	-	-	-	157
														Total		1,212
														Grand Total		8,473

*Number in parentheses represents dead pups collected between 10 July and 4 August during mortality studies.

Table B-8.--Number of dead northern fur seal pups counted, by rookery, Pribilof Islands, 1979-88.[a]
A dash indicates no data.

Island and rookery	Year									
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
St. Paul Island										
Morjovi	269	508	346	348	274	336	247	441	290	391
Vostochni	573	932	889	837	747	973	604	891	738	959(38)[b]
Little Polovina	90	28	77	41	49	46	14	29	-	-
Polovina Cliffs	433	627	463	570	438	397	367	591	536	451
Polovina	85	127	89	97	79	75	56	67	47	53
Ardiguen	31	76	38	49	33	46	6	75	114	63
Gorbatch	260	699	379	399	414	522	371	578	697	487
Reef	651	790	623	654	649	411	624	778	827	727(50)
Kitovi	171	256	187	269	223	142	211	429	288	307
Lukanin	132	206	102	139	171	104	149	214	182	204
Tolstoi	1,645	1,488	1,547	1,332	1,178	1,407	919	1,062	1,368	1,314
Little Zapadni	637	645	377	779	562	580	485	815	878	820
Zapadni Reef	161	243	266	276	258	301	197	390	334	384
Zapadni	1,368	1,185	1,451	1,503	925	807	1,001	1,417	1,306	1,069(3)
Point South	-,,	-	-	-	-	-	-	-	46	32
Counted total	6,444	7,859	6,798	7,301	5,997	6,115	5,266	7,767	7,651	7,261(91)
Estimated oversight 5%[b]	322	393	340	365	300	306	263	388	363	363
Total	6,766	8,252	7,138	7,666	6,297	6,421	5,529	8,155	8,034	7,624(91)
St. George Island										
North	774	949	810	649	367	-	317	-	-	534
Zapadni	277	350	186	190	124	-	134	-	-	152
South	186	197	177	110	111	-	128	-	-	157
East Reef	104	121	74	56	25	-	22	-	-	12
East Cliffs	285	284	402	340	128	-	106	-	-	246
Staraya Artil	565	484	376	315	148	-	99	-	-	111
Counted total	2,191	2,385	2,025	1,660	903	-	806	-	-	1,209
Estimated oversight 5%[b]	110	119	101	83	45	-	40	-	-	60
Total	2,301	2,504	2,126	1,743	948	-	846	-	-	1,269

Table B-8.--Continued.

Island and rookery	Year									
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Pribilof Islands counted total	8,635	10,244	8,823	8,961	6,900	6,115	6,072	7,767	7,651	8,470
Estimated oversight 5%[b]	432	512	441	448	345	306	303	-	383	423
Total	9,067	10,756	9,264	9,409	7,245	6,421	6,421	-	8,034	8,893

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

[b]Number in parenthesis represents dead pups collected between 10 July and 4 August during mortality studies.

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

Table B-9.--Sightings of northern fur seals with Soviet tags, St. Paul Island, Alaska, 1987 and 1988.

Date	Tag number	Sex	Island of tagging	Rookery of sighting	Comments
1987					
12 July	YM 3168	F	Medny	Kitovi	With pup no tag on right flipper
1988					
17 July	MC 1488	M	Medny	Reef	Tag on left flipper
21 July	bE 608	M	Bering	Zapadni	-
26 July	bC 2249	M	Bering	Morjovi	No tag on right flipper
26 July	MA 3307	M	Medny	Morjovi	-
26 July	ME 263	M	Medny	Morjovi	-
26 July	ME 3119	M	Medny	Morjovi	Hole in right flipper
26 July	bE 2376	M	Bering	Morjovi	Tag scar in left flipper
29 July	ME 137	M	Medny	Vostochni	-
29 July	ME 971	M	Medny	Vostochni	-
29 July	bE 2376	M	Bering	Northeast Point	Tag scar on left flipper
30 July	bE 608	M	Bering	Zapadni Reef	Scar on right flipper
30 July	ME 248	M	Medny	Zapadni	-

Table B-10.--Northern fur seal pups tagged with pink Roto tags, San Miguel Island, California, 1987

Month	Left tag	Right tag	Sex	Weight (kg)
September				
22	A000601	A000601	F	8.0
22	A000602	A000602	M	11.0
22	A000603	A000603	M	12.5
22	A000604	A000604	M	11.5
22	A000605	A000605	M	13.0
22	A000606	A000606	F	9.0
22	A000607	A000607	F	10.0
22	A000608	A000608	F	10.0
22	A000609	A000609	M	14.0
22	A000610	A000610	F	10.0
22	A000611	A000611	F	12.5
22	A000612	A000612	M	13.5
22	A000613	A000613	F	9.5
22	A000614	A000614	F	11.0
22	A000615	A000615	M	13.0
22	A000616	A000616	M	15.0
22	A000617	A000617	F	11.0
22	A000618	A000618	M	13.0
22	A000619	A000619	M	13.5
22	A000620	A000620	F	11.5
22	A000621	A000621	F	10.5
22	A000622	A000622	M	11.0
22	A000623	A000623	F	12.5
22	A000624	A000624	F	9.0
22	A000625	A000625	F	11.5
22	A000626	A000626	F	13.0
22	A000627	A000627	F	12.5
22	A000628	A000628	F	10.0
22	A000629	A000629	F	9.0
22	A000630	A000630	M	10.0
22	A000631	A000631	F	10.0
22	A000632	A000632	M	11.0
22	A000633	A000633	F	12.0
22	A000634	A000634	F	8.5
22	A000635	A000635	M	14.0
22	A000636	A000636	F	8.5
22	A000637	A000637	F	12.0
22	A000638	A000638	M	14.0
22	A000639	A000639	M	13.0
22	A000640	A000640	M	10.0
22	A000641	A000641	F	10.0
22	A000642	A000642	M	12.5
22	A000643	A000643	M	10.0
22	A000644	A000644	F	14.0
22	A000645	A000645	M	12.5

Table B-10.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)
September				
22	A000646	A000646	M	11.0
22	A000647	A000647	F	8.0
22	A000648	A000648	F	10.0
22	A000649	A000649	F	11.0
22	A000650	A000650	F	13.0
22	A000651	A000651	F	13.5
22	A000652	A000652	M	9.0
22	A000653	A000653	F	11.5
22	A000654	A000654	M	10.0
22	A000655	A000655	M	11.0
22	A000656	A000656	F	9.0
22	A000657	A000657	F	9.0
22	A000658	A000658	F	10.0
22	A000659	A000659	F	8.5
22	A000660	A000660	F	9.5
22	A000661	A000661	F	10.5
22	A000662	A000662	M	12.5
22	A000663	A000663	F	11.0
22	A000664	A000664	F	12.0
22	A000665	A000665	F	8.0
22	A000666	A000666	M	11.5
22	A000667	A000667	F	9.5
22	A000668	A000668	M	13.0
22	A000669	A000669	F	11.0
22	A000670	A000670	M	13.0
22	A000671	A000671	M	15.0
22	A000672	A000672	F	12.0
22	A000673	A000673	M	12.0
22	A000674	A000674	M	12.0
22	A000675	A000675	F	8.5
22	A000676	A000676	M	9.0
22	A000677	A000677	F	8.0
22	A000678	A000678	F	9.0
22	A000679	A000679	M	13.0
22	A000680	A000680	F	11.0
22	A000681	A000681	M	11.5
22	A000682	A000682	F	11.0
22	A000683	A000683	M	13.0
22	A000684	A000684	M	12.0
22	A000685	A000685	F	9.5
22	A000686	A000686	M	11.0
22	A000687	A000687	M	12.0
22	A000688	A000688	F	12.0
22	A000689	A000689	F	7.5
22	A000690	A000690	M	12.5
22	A000691	A000691	F	13.5

Table B-10.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)
September				
22	A000692	A000692	M	10.0
22	A000693	A000693	F	11.0
22	A000694	A000694	M	12.5
22	A000695	A000695	U	8.5
22	A000696	A000696	M	13.0
22	A000697	A000697	F	6.0
22	A000698	A000698	F	8.5
22	A000699	A000699	M	13.5
22	A000700	A000700	F	8.0

Table B-11.--Northern fur seal pups tagged with pink Roto tags, San Miguel Island, California, 1988.

Month	Left tag	Right tag	Sex	Weight (kg)	Sample
September					
23	A000701	A000701	F	11.0	
23	A000702	A000702	F	12.5	
23	A000703	A000703	F	12.0	
23	A000704	A000704	F	12.0	
23	A000705	A000705	M	15.0	
23	A000706	A000706	M	15.5	
23	A000707	A000707	F	10.0	
23	A000708	A000708	F	13.0	
23	A000709	A000709	F	14.0	
23	A000710	A000710	F	14.0	
23	A000711	A000711	M	10.0	
23	A000712	A000712	F	14.0	
23	A000713	A000713	M	14.0	
23	A000714	A000714	F	13.0	
23	A000715	A000715	F	12.0	
23	A000716	A000716	M	16.5	
23	A000717	A000717	F	8.0	
23	A000718	A000718	M	12.0	
23	A000719	A000719	M	15.0	
23	A000720	A000720	F	12.0	
23	A000721	A000721	M	10.5	
23	A000722	A000722	F	8.0	
23	A000723	A000723	F	13.0	
23	A000724	A000724	F	10.5	
23	A000725	A000725	M	12.0	
23	A000726	A000726	F	12.0	
23	A000727	A000727	M	11.0	
23	A000728	A000728	M	14.0	
23	A000729	A000729	F	11.0	
23	A000730	A000730	F	11.5	
23	A000731	A000731	M	12.5	
23	A000732	A000732	F	10.5	
23	A000733	A000733	M	12.5	
23	A000734	A000734	M	10.5	
23	A000735	A000735	F	13.0	
23	A000736	A000736	F	10.5	
23	A000737	A000737	F	13.0	
23	A000738	A000738	F	9.0	
23	A000739	A000739	F	8.0	
23	A000740	A000740	F	15.5	
23	A000741	A000741	M	13.0	
23	A000742	A000742	F	9.5	
23	A000743	A000743	F	10.5	
23	A000744	A000744	M	15.0	
23	A000745	A000745	M	10.0	

Table B-11.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)	Sample
September					
23	A000746	A000746	F	13.0	
23	A000747	A000747	M	13.5	
23	A000748	A000748	M	9.5	
23	A000749	A000749	M	12.0	
23	A000750	A000750	M	14.0	
23	A000751	A000751	F	11.0	
23	A000752	A000752	M	9.0	
23	A000753	A000753	M	10.5	
23	A000754	A000754	M	12.5	
23	A000755	A000755	M	9.0	
23	A000756	A000756	M	14.0	
23	A000757	A000757	M	15.0	
23	A000758	A000758	M	14.0	
23	A000759	A000759	F	15.0	
23	A000760	A000760	M	13.0	
23	A000761	A000761	M	13.5	
23	A000762	A000762	M	9.5	
23	A000763	A000763	F	9.5	
23	A000764	A000764	F	12.0	
23	A000765	A000765	M	14.5	
23	A000766	A000766	M	14.0	
23	A000767	A000767	M	12.5	
23	A000768	A000768	M	8.0	
23	A000769	A000769	M	11.0	
23	A000770	A000770	M	14.5	
23	A000771	A000771	M	13.0	
23	A000772	A000772	F	11.5	
23	A000773	A000773	F	11.5	
23	A000774	A000774	M	14.0	
23	A000775	A000775	M	12.5	
23	A000776	A000776	F	8.0	
23	A000777	A000777	F	11.0	
23	A000778	A000778	M	16.5	
23	A000779	A000779	F	11.0	
23	A000780	A000780	F	16.0	
23	A000781	A000781	F	11.5	
23	A000782	A000782	F	11.5	
23	A000783	A000783	F	8.5	
23	A000784	A000784	M	12.5	
23	A000785	A000785	F	10.0	
23	A000786	A000786	M	11.5	
23	A000787	A000787	F	11.0	
23	A000788	A000788	F	11.0	
23	A000789	A000789	F	8.0	
23	A000790	A000790	M	13.0	
23	A000791	A000791	M	11.5	

Table B-11.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)	Sample
September					
23	A000792	A000792	F	10.0	
23	A000793	A000793	F	13.0	
23	A000794	A000794	M	11.5	
23	A000795	A000795	F	12.0	
23	A000796	A000796	F	10.0	
23	A000797	A000797	F	10.0	
23	A000798	A000798	M	15.0	
23	A000799	A000799	F	7.0	
23	A000800	A000800	M	10.0	
23	A000801	A000801	M	12.0	Rectal swabs
23	A000802	A000802	M	11.0	Rectal swabs
23	A000803	A000803	F	10.0	Rectal swabs
23	A000804	A000804	F	10.5	Rectal swabs
23	A000805	A000805	F	10.0	Rectal swabs
23	A000806	A000806	F	10.0	Rectal swabs
23	A000807	A000807	M	8.0	Rectal swabs
23	A000808	A000808	M	10.0	Rectal swabs
23	A000809	A000809	F	13.0	Rectal swabs
23	A000810	A000810	F	12.5	Rectal swabs
23	A000811	A000811	F	11.5	Rectal swabs
23	A000812	A000812	F	11.0	Rectal swabs
23	A000813	A000813	F	12.0	Rectal swabs
23	A000814	A000814	F	12.0	Rectal swabs
23	A000815	A000815	M	15.0	Rectal swabs
23	A000816	A000816	M	10.0	Rectal swabs
23	A000817	A000817	M	11.5	Rectal swabs
23	A000818	A000818	M	14.5	Rectal swabs
23	A000819	A000819	F	9.5	Rectal swabs
23	A000820	A000820	M	15.0	Rectal swabs
23	A000821	A000821	M	16.5	Rectal swabs
23	A000822	A000822	M	11.5	Rectal swabs
23	A000823	A000823	F	12.0	Rectal swabs
23	A000824	A000824	F	12.5	Rectal swabs
23	A000825	A000825	M	16.0	Rectal swabs
23	A000826	A000826	F	12.0	Rectal swabs
23	A000827	A000827	M	13.0	Rectal swabs
23	A000828	A000828	M	15.0	Rectal swabs
23	A000829	A000829	M	16.0	Rectal swabs
23	A000830	A000830	F	14.5	Rectal swabs
23	A000831	A000831	M	17.0	Rectal swabs
23	A000832	A000832	F	14.0	Rectal swabs
23	A000833	A000833	F	13.5	Rectal swabs
23	A000834	A000834	M	12.5	Rectal swabs
23	A000835	A000835	M	13.5	Rectal swabs
23	A000836	A000836	M	10.0	Rectal swabs
23	A000837	A000837	M	9.5	Rectal swabs

Table B-11.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)	Sample
September					
23	A000838	A000838	F	13.5	Rectal swabs
23	A000839	A000839	F	11.0	Rectal swabs
23	A000840	A000840	M	13.0	Rectal swabs
23	A000841	A000841	M	11.5	Rectal swabs
23	A000842	A000842	M	12.0	Rectal swabs
23	A000843	A000843	F	7.5	Rectal swabs
23	A000844	A000844	M	15.5	Rectal swabs
23	A000845	A000845	F	10.0	Rectal swabs
23	A000846	A000846	M	17.5	Rectal swabs
23	A000847	A000847	M	12.5	Rectal swabs
23	A000848	A000848	F	8.0	Rectal swabs
23	A000849	A000849	F	10.0	Rectal swabs
23	A000850	A000850	F	10.5	Rectal swabs
23	A000851	A000851	M	11.5	
23	A000852	A000852	M	16.5	
23	A000853	A000853	M	12.5	
23	A000854	A000854	M	11.0	
23	A000855	A000855	F	9.6	
23	A000856	A000856	M	13.0	
23	A000857	A000857	F	12.5	
23	A000858	A000858	M	16.0	
23	A000859	A000859	F	11.5	
23	A000860	A000860	F	6.0	
23	A000861	A000861	F	11.5	
23	A000862	A000862	F	13.0	
23	A000863	A000863	M	10.0	
23	A000864	A000864	F	15.0	
23	A000865	A000865	M	11.5	
23	A000866	A000866	M	12.5	
23	A000867	A000867	M	11.0	
23	A000868	A000868	F	11.5	
23	A000869	A000869	F	10.5	
23	A000870	A000870	M	13.0	
23	A000871	A000871	M	13.0	
23	A000872	A000872	M	15.5	
23	A000873	A000873	F	10.5	
23	A000874	A000874	F	13.0	
23	A000875	A000875	M	12.0	
October					
20	C000322	C000322	M	18.0	
20	C000323	C000323	M	17.0	
20	C000324	C000324	M	15.0	
20	C000325	C000325	M	16.5	
20	C000326	C000326	M	16.5	
20	C000327	C000327	F	12.0	

Table B-11.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)	Sample
October					
20	C000328	C000328	F	14.0	
20	C000329	C000329	M	15.5	
20	C000330	C000330	F	14.0	
20	C000331	C000331	F	14.0	
20	C000332	C000332	F	14.0	
20	C000333	C000333	F	17.0	
20	C000334	C000334	M	13.5	
20	C000335	C000335	F	18.0	
20	C000336	C000336	F	12.0	
20	C000337	C000337	F	14.0	
20	C000338	C000338	F	12.0	
20	C000339	C000339	M	16.0	
20	C000340	C000340	M	18.0	
20	C000341	C000341	M	12.0	
20	C000342	C000342	F	16.5	
20	C000343	C000343	M	17.5	
20	C000344	C000344	M	14.0	
20	C000345	C000345	F	17.0	
20	C000346	C000346	F	16.0	
20	C000347	C000347	F	13.0	
20	C000348	C000348	M	17.0	
20	C000349	C000349	F	11.5	
20	C000350	C000350	M	14.0	
20	C000351	C000351	F	11.0	
20	C000352	C000352	M	15.5	
20	C000353	C000353	F	17.0	
20	C000354	C000354	F	9.5	
20	C000355	C000355	F	13.0	
20	C000356	C000356	F	15.5	
20	C000357	C000357	M	14.5	
20	C000358	C000358	F	14.0	
20	C000359	C000359	F	11.0	
20	C000360	C000360	F	15.0	
20	C000361	C000361	M	9.5	
20	C000362	C000362	F	14.0	
20	C000363	C000363	F	16.0	
20	C000364	C000364	M	10.0	
20	C000365	C000365	M	12.5	
20	C000366	C000366	F	11.5	
20	C000367	C000367	M	16.0	
20	C000368	C000368	F	11.0	
20	C000369	C000369	M	17.0	
20	C000370	C000370	F	15.5	
20	C000371	C000371	F	7.0	
20	C000372	C000372	F	12.0	
20	C000373	C000373	M	12.5	

Table B-11.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)	Sample
October					
20	C000374	C000374	M	17.5	
20	C000375	C000375	M	19.0	
20	C000376	C000376	M	15.5	
20	C000377	C000377	F	12.0	
20	C000378	C000378	M	19.5	
20	C000379	C000379	M	16.0	
20	C000380	C000380	F	14.5	
20	C000381	C000381	F	15.5	
20	C000382	C000382	F	14.0	
20	C000383	C000383	M	15.0	
20	C000384	C000384	F	13.0	
20	C000385	C000385	F	11.5	
20	C000386	C000386	M	22.0	
20	C000387	C000387	F	16.0	
20	C000388	C000388	F	11.0	
20	C000389	C000389	M	15.5	
20	C000390	C000390	F	13.0	
20	C000391	C000391	M	15.0	
20	C000392	C000392	M	15.5	
20	C000393	C000393	F	16.5	
20	C000394	C000394	F	12.0	
20	C000395	C000395	M	22.0	
20	C000396	C000396	M	15.0	
20	C000397	C000397	F	15.5	
20	C000398	C000398	F	11.0	
20	C000399	C000399	M	12.0	
20	C000400	C000400	M	20.0	
20	C000701	C000701	M	15.5	
20	C000702	C000702	F	16.0	
20	C000703	C000703	M	17.0	
20	C000704	C000704	M	17.5	
20	C000705	C000705	M	15.5	
20	C000706	C000706	M	16.5	
20	C000707	C000707	M	13.5	
20	C000708	C000708	F	12.5	
20	C000709	C000709	F	11.0	
20	C000710	C000710	M	12.5	
20	C000711	C000711	F	15.0	
20	C000712	C000712	M	14.5	
20	C000713	C000713	M	15.5	
20	C000714	C000714	M	17.5	
20	C000715	C000715	F	13.0	
20	C000716	C000716	F	12.0	
20	C000717	C000717	M	14.0	
20	C000718	C000718	F	18.0	
20	C000719	C000719	M	10.0	

Table B-11.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)	Sample
October					
20	C000720	C000720	M	10.5	
20	C000721	C000721	F	7.5	
20	C000722	C000722	F	10.0	Rectal swabs
20	C000723	C000723	M	11.0	Rectal swabs
20	C000724	C000724	F	14.0	Rectal swabs
20	C000725	C000725	M	15.0	Rectal swabs
20	C000726	C000726	M	16.0	Rectal swabs
20	C000727	C000727	M	16.5	Rectal swabs
20	C000728	C000728	F	12.0	Rectal swabs
20	C000729	C000729	F	17.5	Rectal swabs
20	C000730	C000730	M	12.5	Rectal swabs
20	C000731	C000731	F	12.0	Rectal swabs
20	C000732	C000732	M	17.5	Rectal swabs
20	C000733	C000733	M	13.0	Rectal swabs
20	C000734	C000734	M	11.0	Rectal swabs
20	C000735	C000735	F	12.0	Rectal swabs
20	C000736	C000736	F	10.0	Rectal swabs
20	C000737	C000737	M	18.0	Rectal swabs
20	C000738	C000738	M	16.0	Rectal swabs
20	C000739	C000739	M	16.0	Rectal swabs
20	C000740	C000740	F	14.0	Rectal swabs
20	C000741	C000741	M	15.0	Rectal swabs
20	C000742	C000742	M	10.0	Rectal swabs
20	C000743	C000743	F	15.0	Rectal swabs
20	C000744	C000744	F	13.0	Rectal swabs
20	C000745	C000745	F	15.0	Rectal swabs
20	C000746	C000746	M	13.5	Rectal swabs
20	C000747	C000747	M	13.0	Rectal swabs
20	C000748	C000748	F	11.0	Rectal swabs
20	C000749	C000749	M	16.0	Rectal swabs
20	C000750	C000750	M	12.5	Rectal swabs
20	C000751	C000751	F	11.0	Rectal swabs
20	C000752	C000752	F	10.0	Rectal swabs
20	C000753	C000753	M	17.5	Rectal swabs
20	C000754	C000754	M	10.5	Rectal swabs
20	C000755	C000755	M	14.5	Rectal swabs
20	C000756	C000756	M	12.5	Rectal swabs
20	C000757	C000757	M	13.5	Rectal swabs
20	C000758	C000758	M	16.0	Rectal swabs
20	C000759	C000759	M	12.0	Rectal swabs
20	C000760	C000760	F	15.0	Rectal swabs
20	C000761	C000761	M	15.0	Rectal swabs
20	C000762	C000762	M	15.5	Rectal swabs
20	C000763	C000763	M	14.0	Rectal swabs
20	C000764	C000764	F	12.0	Rectal swabs
20	C000765	C000765	M	16.0	Rectal swabs

Table B-11.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)	Sample
October					
20	C000766	C000766	F	11.0	Rectal swabs
20	C000767	C000767	F	14.0	Rectal swabs
20	C000768	C000768	F	12.0	Rectal swabs
20	C000769	C000769	M	14.5	Rectal swabs
20	C000770	C000770	M	16.0	Rectal swabs
20	C000771	C000771	F	13.0	Rectal swabs
20	C000772	C000772	F	12.0	
20	C000773	C000773	F	16.5	
20	C000774	C000774	F	10.0	
20	C000775	C000775	M	12.5	
20	C000776	C000776	F	14.5	
20	C000777	C000777	F	12.0	
20	C000778	C000778	M	11.0	
20	C000779	C000779	M	14.0	
20	C000780	C000780	M	19.5	
20	C000781	C000781	M	15.0	
20	C000782	C000782	M	18.0	
20	C000783	C000783	F	16.5	
20	C000784	C000784	M	13.5	
20	C000785	C000785	F	11.5	
20	C000786	C000786	F	12.5	
20	C000787	C000787	M	9.5	
20	C000788	C000788	F	14.5	
20	C000789	C000789	M	16.0	
20	C000790	C000790	F	16.5	
20	C000791	C000791	M	17.0	
20	C000792	C000792	F	9.0	
20	C000793	C000793	M	16.0	
20	C000794	C000794	F	15.0	
20	C000795	C000795	M	19.0	
20	C000796	C000796	F	15.0	
20	C000797	C000797	F	11.0	Blood
20	C000798	C000798	M	15.0	Blood
20	C000799	C000799	M	13.0	Blood
20	C000800	C000800	F	13.0	Blood
20	A000876	A000876	F	14.0	Blood
20	A000877	A000877	F	12.5	Blood
20	A000878	A000878	F	13.0	Blood
20	A000879	A000879	F	12.5	Blood
20	A000880	A000880	M	20.0	Blood
20	A000881	A000881	M	19.5	Blood
20	A000882	A000882	M	17.0	Blood
20	A000883	A000883	F	15.0	Blood
20	A000884	A000884	F	13.5	Blood
21	A000885	A000885	F	15.0	Blood
21	A000886	A000886	F	15.5	Blood

Table B-11.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)	Sample
October					
21	A000887	A000887	F	17.0	Blood
21	A000888	A000888	M	14.0	Blood
21	A000889	A000889	F	12.5	Blood
21	A000890	A000890	M	13.0	Blood
21	A000891	A000891	M	14.0	Blood
21	A000892	A000892	M	19.0	Blood
21	A000893	A000893	F	13.0	Blood
21	A000894	A000894	M	17.5	Blood
21	A000895	A000895	F	20.0	Blood
21	A000896	A000896	F	13.5	Blood
21	A000897	A000897	F	10.5	Blood
21	A000898	A000898	M	16.5	Blood
21	A000899	A000899	F	14.5	Blood
21	A000890	A000890	F	12.0	Blood
21	C000501	C000501	M	13.5	Blood
21	C000502	C000502	M	20.5	Blood
21	C000503	C000503	M	15.5	Blood
21	C000504	C000504	F	13.0	Blood
21	C000505	C000505	F	10.5	Blood
21	C000506	C000506	F	11.5	Blood
21	C000507	C000507	M	16.0	Blood
21	C000508	C000508	M	13.0	Blood

Table B-12.--Percent adult territorial males as distributed by rookery for seven rookeries on St. Paul Island, Alaska, 1912-87.

Year	Rookery						
	Lukanin	Kitovi	Reef	Gorbatch	Ardiguen	Morjovi	Vostochni
1912	3.8	5.2	17.7	10.8	1.1	3.7	23.4
1913	3.1	4.2	16.2	10.0	1.0	3.8	26.7
1914	3.2	4.8	15.9	9.2	1.2	3.5	23.9
1915	2.7	4.0	17.5	9.1	1.5	3.0	23.6
1916	2.3	3.4	17.7	8.4	1.2	3.4	23.6
1917	2.5	3.2	15.5	7.1	0.8	3.2	25.7
1918	2.3	2.9	15.8	7.0	0.8	3.3	26.0
1919	2.5	3.6	16.6	8.4	1.1	3.4	23.2
1920	2.9	4.0	15.8	7.6	1.2	2.9	21.7
1921	3.1	5.0	16.1	7.2	1.0	3.2	25.4
1922	3.2	5.3	14.1	7.3	0.8	3.4	26.7
1923	3.0	4.4	13.9	7.2	0.8	3.3	29.2
1924	2.8	4.6	14.5	7.4	1.1	3.3	29.0
1925	2.9	5.5	17.4	8.1	1.3	2.8	23.2
1926	2.9	6.6	18.9	8.6	1.2	2.7	20.5
1927	2.5	6.5	19.8	9.1	1.1	2.6	22.0
1928	1.7	4.2	21.8	9.9	1.2	3.4	25.1
1929	1.9	4.6	20.0	9.0	0.9	3.0	26.2
1930	1.7	4.7	17.5	9.6	1.2	3.5	24.2
1931	1.8	4.8	17.7	8.2	1.5	3.6	25.3
1932	1.8	4.5	17.0	9.0	0.9	3.7	25.8
1933	1.9	4.7	17.4	9.4	1.0	3.8	24.4
1934	2.1	4.6	17.7	9.4	1.1	3.7	23.6
1935	2.1	4.5	18.5	9.9	1.0	3.5	23.1
1936	2.0	4.4	18.5	10.0	1.0	3.2	22.7
1937	2.1	4.6	18.6	9.8	1.1	3.2	22.5
1938	1.8	4.0	20.5	10.3	0.9	3.0	22.5
1939	1.9	5.3	18.4	10.3	1.2	5.0	20.6
1940	1.9	5.2	19.3	9.8	1.1	4.9	19.9
1941	2.0	4.9	18.9	9.6	1.1	5.2	20.7
1942	2.0	4.9	19.1	9.6	1.1	5.3	20.1
1943	1.9	5.0	19.3	9.7	1.1	5.3	19.6
1944	2.0	4.8	19.3	9.8	1.1	5.3	19.5
1945	2.1	5.0	19.5	9.1	1.2	5.2	19.3
1946	1.8	5.2	20.3	9.4	1.2	5.4	17.7
1947	1.8	5.3	20.9	10.2	1.2	4.9	16.0
1948	1.8	5.3	19.9	9.8	1.0	5.0	16.5
1949	1.9	5.6	19.7	9.1	1.3	5.1	17.2
1950	2.0	5.5	17.1	9.1	1.1	6.2	16.3
1951	1.9	5.3	17.2	8.5	1.1	7.3	17.2
1952	2.1	6.1	16.3	9.1	1.0	6.9	17.0

Table B-12.--Continued.

Year	Rookery						
	Lukanin	Kitovi	Reef	Gorbatch	Ardiguen	Morjovi	Vostochni
1953	2.2	5.7	16.1	8.7	1.0	6.0	17.0
1954	2.1	5.4	16.5	9.2	1.0	6.1	17.4
1955	2.2	5.8	15.5	8.9	1.3	6.1	16.2
1956	2.1	5.5	16.6	9.1	1.2	6.5	16.1
1957	2.2	5.7	16.2	9.1	1.4	7.0	16.2
1958	2.1	5.6	15.3	8.2	1.1	7.6	16.6
1959	2.2	6.0	16.6	8.6	1.2	7.9	15.7
1960	2.1	5.6	16.3	8.6	1.4	7.9	15.5
1961	2.1	5.5	16.4	7.5	1.4	7.9	17.0
1962	2.4	5.6	15.1	8.3	1.3	8.4	15.8
1963	2.4	5.9	14.2	8.4	1.4	7.9	17.3
1964	2.4	5.4	14.3	8.4	1.1	7.8	16.8
1965	2.4	5.7	13.8	7.9	1.2	8.6	16.8
1966	1.9	5.2	12.9	7.7	1.2	8.1	18.3
1967	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-
1969	1.8	5.2	13.2	7.8	2.2	7.7	16.7
1970	2.2	4.9	14.0	7.8	2.2	7.1	16.0
1971	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-
1975	2.2	5.3	12.4	7.7	1.7	7.5	15.9
1976	2.3	5.5	11.9	6.8	1.2	8.1	17.0
1977	2.0	4.9	12.1	6.8	1.5	8.2	15.7
1978	1.9	4.3	12.5	7.0	1.4	8.0	16.8
1979	2.0	5.0	12.6	7.0	1.4	8.0	16.7
1980	1.9	4.7	13.0	7.2	1.5	6.9	16.9
1981	1.7	4.8	11.4	6.5	1.2	8.0	18.0
1982	2.1	4.9	11.3	7.1	1.0	7.4	16.6
1983	2.6	5.0	11.0	7.3	1.0	7.1	15.7
1984	2.5	4.9	11.0	7.5	1.2	7.5	16.9
1985	2.4	6.0	10.8	7.3	1.0	7.4	16.1
1986	1.9	5.6	11.7	6.9	1.4	6.8	16.0
1987	2.1	6.0	11.7	7.7	1.6	6.7	15.7

Table B-12.--Continued.

Year	Rookery						
	Polovina	Little Polovina	Polovina Cliffs	Tolstoi	Zapadni Reef	Little Zapadni	Zapadni
1912	4.4	1.1	2.1	10.2	0.3	6.0	10.4
1913	4.2	2.0	1.8	11.3	0.3	5.5	10.0
1914	4.8	1.5	1.8	13.2	0.3	7.4	9.4
1915	1.3	4.2	2.0	14.1	0.4	6.3	10.3
1916	1.1	5.8	2.1	13.0	0.3	6.4	11.1
1917	0.9	4.2	2.2	17.0	0.6	6.6	10.6
1918	1.2	4.3	2.1	14.4	0.6	7.9	11.3
1919	0.9	4.4	2.2	12.4	0.7	8.0	12.6
1920	1.5	5.3	2.6	12.2	0.8	8.9	12.7
1921	1.5	5.0	3.4	10.1	0.7	6.6	11.7
1922	1.4	5.8	3.4	12.2	0.6	5.6	10.2
1923	1.8	6.3	3.9	10.5	0.4	5.4	10.2
1924	1.6	5.8	3.5	10.4	0.4	5.5	10.1
1925	1.4	5.6	3.4	11.2	0.4	5.8	10.9
1926	1.4	5.2	3.7	11.8	0.6	5.8	10.1
1927	1.3	5.0	3.6	10.9	0.5	5.7	9.4
1928	1.0	5.9	3.1	9.8	0.5	4.4	7.9
1929	1.0	6.1	3.4	9.7	0.5	5.3	8.7
1930	1.5	6.5	3.2	11.3	0.5	5.6	9.0
1931	1.5	4.9	3.7	11.6	0.5	5.8	9.2
1932	1.5	4.7	3.4	11.9	0.5	5.5	9.7
1933	1.6	4.2	3.5	12.0	0.5	5.7	10.0
1934	1.2	4.4	3.8	11.8	0.7	5.7	10.3
1935	1.2	4.2	3.5	11.8	0.6	5.6	10.5
1936	1.2	4.4	3.3	12.1	0.6	5.7	10.9
1937	1.2	4.3	3.4	11.7	0.6	5.9	11.2
1938	1.2	4.5	3.6	11.7	0.7	5.6	9.8
1939	1.9	4.8	4.1	11.2	0.9	5.5	9.0
1940	2.1	4.5	3.6	11.5	0.7	5.7	9.9
1941	1.6	4.4	3.7	11.8	0.7	5.4	10.0
1942	1.7	4.3	3.7	11.5	0.8	5.6	10.2
1943	1.9	4.3	3.7	11.3	0.8	5.8	10.3
1944	2.2	3.0	4.9	11.3	1.0	6.4	9.4
1945	2.2	3.0	4.7	11.9	1.1	6.2	9.7
1946	2.2	3.2	5.0	11.7	1.2	5.6	10.1
1947	2.3	3.0	5.4	11.4	1.6	5.7	10.5
1948	2.3	2.9	5.8	12.0	1.6	5.6	10.4
1949	2.2	3.2	5.6	11.5	1.6	5.7	10.5
1950	2.9	3.4	7.0	11.4	1.7	5.4	11.1
1951	2.7	3.4	8.4	10.0	1.5	5.1	10.6
1952	2.6	3.7	5.9	11.2	1.8	5.9	10.5

Table B-12.--Continued.

Year	Rookery						
	Polovina	Little Polovina	Polovina Cliffs	Tolstoi	Zapadni Reef	Little Zapadni	Zapadni
1953	2.6	3.1	6.3	11.8	2.1	6.6	10.8
1954	2.7	2.8	5.7	11.3	2.3	6.5	11.0
1955	2.7	3.7	5.9	12.2	2.4	6.7	10.6
1956	2.9	4.2	6.8	11.7	1.4	5.6	10.3
1957	2.6	3.8	6.5	10.2	2.5	6.3	10.3
1958	2.7	3.9	7.2	10.6	2.5	6.0	10.8
1959	2.9	3.3	7.4	9.7	2.6	5.8	10.1
1960	3.2	3.4	7.4	10.1	2.9	5.6	10.1
1961	3.2	3.1	7.8	10.3	2.5	6.0	9.6
1962	3.2	2.6	7.5	10.0	2.7	6.2	10.8
1963	3.1	2.6	7.7	9.7	2.7	6.1	10.7
1964	3.0	2.7	8.0	10.1	2.3	6.2	11.4
1965	2.8	2.6	7.6	10.2	2.6	6.4	11.4
1966	2.4	2.8	7.8	10.3	2.6	6.8	12.1
1967	-	-	-	-	-	-	-
1968	-	-	-	-	-	-	-
1969	2.4	1.7	8.5	11.7	2.1	6.6	12.5
1970	2.1	1.8	7.9	11.5	2.1	6.6	13.4
1971	-	-	-	-	-	-	-
1972	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-
1975	1.8	1.8	9.2	12.4	2.8	7.2	12.2
1976	1.9	2.0	8.4	12.9	2.6	7.2	12.3
1977	1.6	1.7	9.1	12.7	2.6	7.6	13.5
1978	1.9	1.7	8.8	11.1	3.1	8.0	13.6
1979	1.8	1.6	8.7	13.3	3.1	6.9	12.0
1980	1.7	1.7	9.5	12.4	2.8	7.8	12.2
1981	1.6	1.4	9.2	11.8	4.4	8.0	12.0
1982	1.5	1.3	9.3	13.0	3.2	8.2	13.3
1983	1.4	0.9	9.1	13.9	3.9	7.9	13.3
1984	1.5	1.0	8.4	12.8	4.4	7.6	13.0
1985	1.6	0.8	8.6	13.8	3.2	8.4	12.5
1986	1.3	0.6	8.5	12.6	3.9	8.8	13.9
1987	1.5	0.5	8.8	13.3	4.0	7.9	12.5

Table B-13.--Percent adult territorial males as distributed by rookery for six rookeries on St. George Island, Alaska, 1915-88.

Year	Rookery					
	South	North	East Reef	East Cliffs	Staraya Artil	Zapadni
1915	0.8	39.0	8.3	21.0	24.6	6.4
1916	0.5	36.2	13.2	18.7	25.7	5.6
1917	0.9	38.9	11.8	19.7	23.8	4.8
1918	1.1	35.7	13.5	22.1	21.8	5.9
1919	0.9	38.5	12.8	22.1	21.2	4.6
1920	0.8	38.0	12.8	22.0	21.4	5.2
1921	1.3	37.6	11.4	23.2	22.1	4.5
1922	1.1	34.9	13.0	23.5	22.0	5.6
1923	1.4	35.2	9.7	21.3	24.9	7.5
1924	2.3	32.7	9.0	23.4	25.2	7.5
1925	2.1	32.9	10.6	24.1	23.4	6.9
1926	2.7	34.3	8.5	22.5	24.5	7.6
1927	2.6	39.9	7.8	20.4	21.5	7.8
1928	3.0	36.1	9.0	18.1	23.8	10.0
1929	4.0	36.3	8.2	16.6	27.2	7.7
1930	5.8	32.1	9.0	19.7	23.8	9.7
1931	5.4	35.7	8.4	16.8	25.8	7.8
1932	5.2	35.9	8.3	17.2	25.2	8.2
1933	6.4	36.3	8.3	15.5	24.9	8.6
1934	6.4	35.8	8.1	16.0	24.8	8.9
1935	6.3	34.1	6.4	17.5	27.0	8.7
1936	6.1	34.9	7.2	17.1	26.5	8.2
1937	6.1	34.0	7.2	17.4	27.0	8.3
1938	6.2	32.8	7.6	17.4	26.6	9.4
1939	7.5	34.5	5.5	12.4	28.7	11.4
1940	7.1	34.9	4.9	13.0	28.1	12.0
1941	7.6	35.6	5.1	11.2	26.5	14.0
1942	6.8	39.2	5.2	9.9	25.2	13.7
1943	6.1	42.4	5.4	8.6	24.0	13.4
1944	7.7	40.5	5.5	10.1	22.9	13.4
1945	7.6	39.0	5.4	11.4	22.0	14.6
1946	8.6	37.9	4.9	13.2	20.9	14.5
1947	11.2	34.6	6.3	12.4	20.1	15.3
1948	11.5	35.0	6.2	12.0	20.5	14.9
1949	11.6	32.8	6.5	12.7	20.8	15.7
1950	10.9	39.3	5.6	11.1	19.7	13.4
1951	11.3	35.4	6.8	12.1	20.4	14.1
1952	9.6	36.5	7.7	13.1	19.3	13.8
1953	11.4	39.5	6.2	12.6	17.9	12.5
1954	11.3	36.8	6.1	14.9	17.8	13.2
1955	11.0	36.8	6.5	13.1	18.3	14.3

Table B-13.--Continued.

Year	Rookery					
	South	North	East Reef	East Cliffs	Staraya Artil	Zapadni
1956	-	-	-	-	-	-
1957	11.6	36.4	7.9	13.3	15.4	15.4
1958	10.5	37.6	8.1	13.4	16.3	14.1
1959	10.3	38.9	7.5	13.1	15.4	14.8
1960	10.9	41.6	7.3	13.7	12.9	13.6
1961	11.8	43.4	5.9	12.9	13.2	12.8
1962	11.3	41.6	6.8	13.6	13.0	13.7
1963	13.5	37.7	7.3	11.8	14.5	15.1
1964	12.9	38.0	7.5	11.3	14.8	15.4
1965	15.0	35.8	7.3	12.2	14.3	15.4
1966	14.9	38.6	7.0	12.8	12.4	14.3
1967	14.4	36.9	6.9	13.7	14.3	13.8
1968	18.3	36.4	6.6	13.6	12.2	13.0
1969	17.2	36.1	6.9	14.8	12.6	12.6
1970	18.0	35.2	7.0	11.3	13.2	15.3
1971	20.0	33.5	6.5	13.0	11.7	15.3
1972	-	-	-	-	-	-
1973	24.2	31.1	5.0	13.3	11.2	15.2
1974	23.1	31.1	6.1	13.5	12.8	13.4
1975	19.4	37.3	6.4	16.3	10.3	10.4
1976	15.8	38.1	6.0	15.7	11.2	13.2
1977	14.3	41.2	5.2	17.1	16.5	5.8
1978	11.5	49.4	6.7	7.2	13.3	11.8
1979	12.2	39.3	7.7	16.4	13.8	10.6
1980	12.9	36.7	7.9	19.6	12.0	11.0
1981	14.1	36.6	8.0	20.8	11.4	9.2
1982	17.0	39.2	9.1	15.7	6.7	12.3
1983	-	-	-	-	-	-
1984	16.8	40.3	6.5	18.9	6.9	10.7
1985	16.9	41.3	7.7	19.8	8.2	6.1
1986	14.3	42.8	6.6	20.2	6.2	10.0
1987	15.6	40.6	6.1	17.6	7.4	12.7
1988	21.9	33.0	4.8	18.8	7.6	13.9

Table B-14.--Percent pups born as distributed by rookery for 14 rookeries on St. Paul Island, Alaska.

Year	Rookery						
	Lukanin	Kitovi	Reef	Gorbatch	Ardiguen	Morjovi	Vostochni
1912	2.7	3.0	19.5	9.6	0.6	3.6	22.5
1913	2.2	2.5	18.5	8.4	0.6	3.7	25.8
1914	2.5	2.8	18.1	8.2	0.9	3.1	26.3
1915	2.4	3.0	17.7	8.4	0.8	2.9	25.2
1916	2.3	2.7	17.5	9.5	0.8	3.0	26.1
1922	2.4	3.9	16.9	9.4	0.7	2.6	24.8
1964	1.9	5.1	14.7	8.9	1.0	6.9	16.0
1965	2.5	5.3	14.5	7.9	1.2	7.1	15.1
1966	2.6	4.8	12.9	7.5	1.0	7.0	17.3
1969	2.2	5.0	12.2	8.0	1.6	7.0	15.2
1970	2.6	5.8	11.8	6.9	1.4	7.2	16.1
1975	2.2	4.9	10.6	6.5	1.1	8.3	16.0
1979	2.4	5.6	12.2	6.2	1.1	6.4	16.4
1987	2.4	4.7	12.0	7.5	1.9	6.6	15.6

Year	Rookery						
	Polovina	Little Polovina	Polovina Cliffs	Tolstoi	Zapadni Reef	Little Zapadni	Zapadni
1912	4.1	1.3	1.6	13.6	0.3	6.7	11.0
1913	4.9	1.4	1.8	13.3	0.3	6.1	10.5
1914	4.7	1.2	1.9	13.3	0.3	6.6	10.2
1915	5.0	1.3	1.9	14.0	0.3	6.8	10.5
1916	5.1	1.2	1.8	12.9	0.3	6.7	10.4
1922	5.8	1.0	2.6	13.0	0.3	5.9	10.7
1964	2.1	3.2	8.2	9.9	2.4	6.4	13.2
1965	2.6	2.9	8.4	11.5	2.4	6.6	12.0
1966	2.0	3.1	8.1	10.2	1.8	8.2	13.7
1969	1.7	2.3	8.2	12.7	2.0	8.5	13.6
1970	1.8	1.8	8.1	11.2	2.0	7.2	16.2
1975	1.7	1.3	9.5	12.7	2.8	8.0	14.4
1979	1.8	1.4	8.4	14.2	3.2	7.8	12.9
1987	1.2	0.2	8.7	13.9	4.5	7.9	12.9

Table B-15.--Percent pups born as distributed by rookery for six rookeries on St. George Island, Alaska.

Year	Rookery					
	South	North	East Reef	East Cliffs	Staraya Artil	Zapadni
1922	0.9	38.4	8.8	22.6	26.1	3.3
1966	11.6	40.4	4.1	15.5	14.4	14.0
1970	13.1	34.5	4.9	15.9	18.0	13.6
1973	18.7	35.0	5.0	17.8	11.7	11.9
1977	13.9	38.8	6.4	13.8	13.5	13.6
1978	14.5	36.9	6.7	15.0	13.6	13.3
1981	14.7	36.8	8.5	17.0	12.3	10.7
1983	16.4	40.6	7.6	11.8	10.6	13.0
1985	16.4	39.5	5.0	11.7	10.5	16.9

Table B-16.--Rank sums for pup mortality for each rookery from Friedman analysis of variance.

Island - Rookery	Rank sum
St. Paul	
Ardiguen	59
Kitovi	100
Gorbatch	189
Polovina Cliffs	208
Zapadni Reef	212
Little Polovina	215
Morjovi	227
Lukanin	229
Vostochni	243
Reef	245
Little Zapadni	257
Polovina	304
Tolstoi	309
Zapadni	348
St. George	
South	24
East Reef	24
East Cliffs	50
North	57
Zapadni	58
Staraya Artil	81

APPENDIX C

Tabulations of northern fur seal entanglement data.

Table C-1.--Summary of roundups of juvenile (subadult) males conducted on St. Paul Island, Alaska, July 1988.

Date (July)	Location	Total seals in roundup[a]	Tagged seals resighted[b]	Entangled seals seen[c]	Total seals tagged
16	Zapadni Reef	44	0	0	0
16	Zapadni Reef	45	2	0	0
16	Zapadni Reef Sands	379	2	1	3
16	Zapadni	335	3	3	9
17	Reef	349	3	3	9
17	Reef	401	2	2	4
17	Reef	267	1	0	0
18	Kitovi	271	0	1	3
18	Tolstoi	520	2	0	0
18	Tolstoi Sands	590	3	2	3
18	Zoltoi Sands	1,019	11	3	3
19	Gorbatch	904	3	1[d]	8
19	Reef	451	5	1	3
20	Northeast Point West	158	0	0[e]	0
20	Northeast Point West	374	1	4	1
20	Northeast Point West	625	0	2	5
20	Northeast Point West	174	0	2	7
21	Little Zapadni	639	0	0	1
21	Zapadni	1,176	7	2	4
21	Zapadni	170	1	0	0
22	Lukanin	273	0	0	0
22	Polovina	403	0	2	6
22	Polovina	556	1	0	0
22	Northeast Point West	307	2	1	0
23	Northeast Point West	294	0	0	0
23	Northeast Point West	276	0	1	3
23	Northeast Point West	198	2	0	0
24	Reef	100	0	0	2
24	Zapadni	331	1	0	0
24	Zapadni	394	0	0	0
24	Zapadni Reef Sands	439	4	2	3
25	Tolstoi	549	3	1	3
25	Tolstoi	578	4	3	3
25	Zapadni Reef	137	0	1	3
25	Zapadni Reef	133	3	0	0
26	Kitovi	372	1	2	6
26	Northeast Point East	511	5	1	0
26	Northeast Point East	649	7	3	6
26	Reef	285	1	2	6
28	Little Zapadni	515	5	1	0
28	Lukanin	337	1	0	0
28	Polovina	270	3	1	0
28	Polovina	525	2	2	3

Table C-1.--Continued.

Date (July)	Location	Total seals in roundup[a]	Tagged seals resighted[b]	Entangled seals seen[c]	Total seals tagged
29	Northeast Point	276	3	2	6
29	Northeast Point West	183	0	2	6
29	Northeast Point West	248	1	2	6
29	Northeast Point West	55	1	0	0
29	Northeast Point West	285	5	2	0
29	Northeast Point West	121	1	0	0
29	Northeast Point West	234	2	0	0
29	Northeast Point West	354	1	1	3
29	Northeast Point West	200	1	2	6
30	Zapadni	302	2	2	2
30	Zapadni	129	1	0	4
30	Zapadni	190	1	1	3
30	Zapadni	81	2	1	0
30	Zapadni	627	6	0	0
30	Zapadni	84	0	0	0
30	Zapadni	660	0	0	0
30	Zapadni Reef	38	1	0	0
30	Zapadni Reef	1,253	2	0	0
30	Zapadni Reef	44	4	0	0
31	Gorbatch	259	3	2	3
31	Kitovi	366	1	0[f]	3
31	Tolstoi	963	2	3	6
31	Tolstoi	274	0	1	3
Totals		24,519	131	70	158

[a]Seals that are of the same approximate size as those taken in the commercial harvest prior to 1985.

[b]Seals which had any kind of tag in either foreflipper and that were successfully restrained to allow observers to read the tag. Includes any that were resighted more than once this year.

[c]Entangled seals seen, regardless of whether or not they had been seen before (i.e., tagged or not).

[d]Seal with tag number 43 was taken independent of roundups. It can not be used to calculate entanglement rates and is not included in this table.

[e]An entangled male too large to count was seen in this roundup.

[f]An entangled female was found in this roundup but not counted.

Table C-2.--List of blue Allflex tags applied to northern fur seals during roundups conducted on St. Paul Island, Alaska, 1988.

Tag number	Date (July)	Sex	Location	Entangled (e) or control (c)	Notes
1	16	m	Zapadni Reef Sands	e	
2	16	m	Zapadni Reef Sands	c	
3	16	m	Zapadni Reef Sands	c	
4	16	m	Zapadni	e	
5	16	m	Zapadni	e	
6	16	m	Zapadni	c	
7	16	m	Zapadni	c	
8	16	m	Zapadni	c	
9	16	m	Zapadni	c	
10	16	m	Zapadni	e	
11	16	m	Zapadni	c	
12	16	m	Zapadni	c	
13	17	m	Reef	e	
14	17	m	Reef	e	Radio tagged
15	17	m	Reef	c	
16	17	m	Reef	c	
17	17	m	Reef	c	
18	17	m	Reef	e	Radio tagged
19	17	m	Reef	e	Radio tagged
20	17	m	Reef	e	Radio tagged
21	17	m	Reef	c	Radio tagged
22	17	m	Reef	c	
23	17	m	Reef	c	Radio tagged
24	17	m	Reef	c	
25	17	m	Reef	c	
26	17	m	Reef	c	Radio tagged
27	18	m	Tolstoi	e	
28	18	m	Tolstoi	c	
29	18	m	Tolstoi	c	
30	18	m	Kitovi	e	Radio tagged
31	18	m	Kitovi	c	
32	18	m	Kitovi	c	Radio tagged
33	18	m	Zoltoi Sands	e	Radio tagged
34	18	m	Zoltoi Sands	c	
35	18	m	Zoltoi Sands	c	Radio tagged
36	19	m	Gorbatch	e	Radio tagged
37	19	m	Gorbatch	c	
38	19	m	Gorbatch	c	Died
39	19	m	Gorbatch	c	Radio tagged
40	19	m	Gorbatch	c	
41	19	m	Gorbatch	c	Radio tagged
42	19	m	Gorbatch		Imitation satellite tag

Table C-2.--Continued.

Tag number	Date (July)	Sex	Location	Entangled (e) or control (c)	Notes
43	19	m	Gorbatch	e	
44	19	m	Reef		Imitation satellite tag
45	19	m	Reef	c	
46	19	m	Reef	c	
47	20	m	Northeast Point West	e	
48	20	m	Northeast Point	c	
49	20	m	Northeast Point	e	Radio tagged
50	20	m	Northeast Point	c	Radio tagged
51	20	m	Northeast Point	e	Radio tagged
52	20	m	Northeast Point	c	
53	20	m	Northeast Point West	e	Radio tagged
54	20	m	Northeast Point West	c	Radio tagged
55	20	m	Northeast Point West	c	
56	20	m	Northeast Point West	e	
57	20	m	Northeast Point West	c	
58	20	m	Northeast Point West	c	
59	20	m	Northeast Point West	c	Radio tagged
60	21	m	Little Zapadni	c	Radio tagged
61	21	m	Zapadni	e	
62	21	m	Zapadni	e	Radio tagged
63	21	m	Zapadni	c	
64	21	m	Zapadni	c	Radio tagged
65	22	m	Polovina	e	Radio tagged
66	22	m	Polovina	e	Radio tagged
67	22	m	Polovina	c	
68	22	m	Polovina	c	Radio tagged
69	22	m	Polovina	c	
70	22	m	Polovina	c	Radio tagged
71	23	m	Northeast Point West	e	
72	23	m	Northeast Point West	c	
73	23	m	Northeast Point West	c	
74	24	m	Zapadni Reef	e	
75	24	m	Zapadni Reef	c	
76	24	m	Zapadni Reef	c	
77	24	m	Reef	c	
78	24	m	Reef	c	Radio tagged
79	25	m	Tolstoi	e	
80	25	m	Tolstoi	c	
81	25	m	Tolstoi	c	
82	25	m	Tolstoi	e	
83	25	m	Tolstoi	c	
84	25	m	Tolstoi	c	
85	25	m	Zapadni Reef	e	
86	25	m	Zapadni Reef	c	
87	25	m	Tolstoi	c	

Table C-2.--Continued.

Tag number	Date (July)	Sex	Location	Entangled (e) or control (c)	Notes
88	26	m	Kitovi	e	
89	26	m	Kitovi	e	
90	26	m	Kitovi	c	
91	26	m	Kitovi	c	
92	26	m	Kitovi	c	
93	26	m	Kitovi	c	
94	26	m	Northeast Point	c	
95	26	m	Northeast Point	c	
96	26	m	Northeast Point East	e	
97	26	m	Northeast Point East	e	
98	26	m	Northeast Point East	c	
99	26	m	Northeast Point East	c	
100	26	m	Reef	e	
101	26	m	Reef	c	
102	26	m	Reef	c	
103	26	m	Reef	e	Radio tagged
104	26	m	Reef	c	
105	26	m	Reef	c	Radio tagged
106	27	f	Zapadni Reef		Footnote a
107	27	f	Zapadni Reef		Footnote a
108	28	m	Polovina	c	
109	28	m	Polovina	c	
110	28	m	Polovina	e	
111	29	m	Northeast Point	e	
112	29	m	Northeast Point	c	
113	29	m	Northeast Point	c	
114	29	m	Northeast Point	e	
115	29	m	Northeast Point	c	
116	29	m	Northeast Point	c	
117	29	m	Northeast Point West	e	
118	29	m	Northeast Point West	e	
119	29	m	Northeast Point West	c	
120	29	m	Northeast Point West	c	
121	29	m	Northeast Point West	c	
122	29	m	Northeast Point West	c	
123	29	m	Northeast Point West	e	
124	29	m	Northeast Point West	c	
125	29	m	Northeast Point West	c	
126	29	m	Northeast Point West	e	
127	29	m	Northeast Point West	c	
128	29	m	Northeast Point West	c	
129	29	m	Northeast Point West	e	
130	29	m	Northeast Point West	c	
131	29	m	Northeast Point West	c	
132	29	m	Northeast Point West	c	

Table C-2.--Continued.

Tag number	Date (July)	Sex	Location	Entangled (e) or control (c)	Notes
133	29	m	Northeast Point West	c	
134	29	m	Northeast Point West	e	
135	29	m	Northeast Point West	c	Footnote b
136	29	m	Northeast Point West	e	Footnote c
137	29	m	Northeast Point West	c	
138	30	m	Zapadni	e	
139	30	m	Zapadni	e	
140	30	m	Zapadni	c	
141	30	m	Zapadni	c	
142	30	m	Zapadni	c	
143	30	m	Zapadni	c	
144	30	m	Zapadni	e	
145	30	m	Zapadni	c	
146	30	m	Zapadni	c	
147	31	m	Tolstoi	e	
148	31	m	Tolstoi	c	
149	31	m	Tolstoi	c	
150	31	m	Tolstoi	e	
151	31	m	Tolstoi	e	
152	31	m	Tolstoi	c	
153	31	m	Tolstoi	c	
154	31	m	Tolstoi	c	
155	31	m	Tolstoi	c	
156	31	f	Kitovi	e	Debris removed
157	31	m	Kitovi	e	
158	31	m	Kitovi	c	
159	31	m	Kitovi	c	
160	31	m	Gorbatch	e	
161	31	m	Kitovi	c	
162	31	m	Kitovi	c	

[a]This tag was applied to a female at Zapadni Reef on 27 July. This female was used to attach a transmitter and power pack for Japanese research on feeding and diving.

[b]The left flipper of this animal is tagged 135 top and bottom. The right flipper is tagged 135 top and 136 bottom.

[c]The right flipper of this animal has tag number 135 on the bottom side.

Table C-3.--List of tagged fur seals seen during July 1988 juvenile male roundup activities on St. Paul Island. Tags were seen on both foreflippers unless noted otherwise.

Date (July)	Location	Tag number	Tag color	Tag type	Entangled (e)[a] or control (c)	Notes
16	Zapadni Reef	879	blue	Roto		Hole noted in left flipper.
16	Zapadni Reef	5157	white	Allflex		Tagged on 3 Aug. 1986 as and entangled animal at Polovina, with gray rope tight around its neck.
16	Zapadni Reef	0234	orange	Allflex	c	Tagged 10 Aug. 1985 at Northeast Point.
16	Zapadni Reef	0478	orange	Allflex	c	Tagged on 24 Aug. 1986 at Zapadni. Right flipper had tag number 0479.
16	Zapadni	0401	orange	Allflex	c	Tagged on 25 July 1986 at Zapadni.
16	Zapadni	0109	orange	Allflex		Tagged on 29 July 1985 at Reef as an entangled animal with white chord on it.
16	Zapadni	0756	orange	Allflex	c	Tagged on 25 Aug. 1986 at Polovina. Right flipper had tag number 0757 .
17	Reef	MC1488	monel	monel		No tag read in right flipper.
17	Reef	0382	orange	Allflex	c	Tagged on 23 July 1986 at Gorbatch. No tag read in right flipper.
17	Reef	0460	orange	Allflex	c	Tagged on 24 Aug. 1986 at Zapadni.
17	Reef	5127	white	Allflex	c	Tagged on 1 Aug 1986 at Gorbatch.
17	Reef	5174	white	Allflex	c	Tagged on 4 Aug. 1986 at Tolstoi.
17	Reef	5174	white	Allflex	c	Sighted earlier in previous roundup.
18	Tolstoi	5	blue	Allflex	e	Same entanglement as when tagged.
18	Tolstoi	8	blue	Allflex	c	Tagged on at Zapadni on July 16.
18	Tolstoi	0034	orange	Allflex	c	Tagged on 12 July 1985 at Northeast Point.
18	Tolstoi	0191	orange	Allflex	c	Tag read on left only, but tags present on both sides. Tagged on 7 Aug. 1985, at Tolstoi.
18	Tolstoi	5178	white	Allflex	c	Tagged on 3 Aug. 1986 at Tolstoi.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag color	Tag type	Entangled (e)[a] or control (c)	Notes
18	Zoltoi Sands	18	blue	Allflex	e	Debris and radio same as when tagged.
18	Zoltoi Sands	20	blue	Allflex	e	Debris and radio same as when tagged.
18	Zoltoi Sands	9	blue	Allflex	c	Tagged on 16 July at Zapadni Sands.
18	Zoltoi Sands	15	blue	Allflex	c	Tagged on 17 July at Reef.
18	Zoltoi Sands	0073	orange	Allflex	c	Tagged on 20 July 1985 at Tolstoi.
18	Zoltoi Sands	0380	orange	Allflex	c	Tagged on 23 July 1986 at Gorbatch.
18	Zoltoi Sands	0383	orange	Allflex	c	Tagged on 23 July 1986 at Gorbatch.
18	Zoltoi Sands	0478	orange	Allflex	c	Tagged on 24 Aug. 1986 at Zapadni. Tag number 0479 in right flipper.
18	Zoltoi Sands	0602	orange	Allflex	c	Tagged during August 1986 at Zapadni.
18	Zoltoi Sands	0702	orange	Allflex	c	Tagged on 24 August 1986 at Reef. Tag number 0703 on right flipper.
19	Reef	16	blue	Allflex		Assumed to be male, exhibited some female behavior.
19	Reef	1	blue	Allflex	e	Debris same as when tagged.
19	Reef	0234	orange	Allflex	c	See previous sighting this year.
19	Reef	0456	orange	Allflex	c	Tagged on 24 Aug. 1986 at Reef. Tag number 0457 on right flipper.
19	Gorbatch	412	yellow	Roto		Footnote b
19	Gorbatch	9	blue	Allflex	c	
19	Gorbatch	22	blue	Allflex	c	
20	Vostochni	0718	orange	Allflex	c	Tagged on 24 Aug. 1986 at Vostoshni. Tag number 0719 on right flipper.
21	Zapadni	bE608	monel	monel		
21	Zapadni	0481	orange	Allflex	c	Tagged on 24 Aug 1986, at Zapadni. No tag read in left flipper.
21	Zapadni	6	blue	Allflex	c	
21	Zapadni	8	blue	Allflex	c	
21	Zapadni	12	blue	Allflex	c	
21	Zapadni	25	blue	Allflex	c	
21	Zapadni	37	blue	Allflex	c	

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag color	Tag type	Entangled (e)[a] or control (c)	Notes
21	Zapadni	0964	orange	Allflex	c	Tagged on 11 Oct. 1986 at Zapadni. Right flipper had tag number 0965.
21	Zapadni	0966	orange	Allflex	c	Tagged on 11 Oct. 1986 at Zapadni. No tag read in right flipper.
23	Vostochni	825	pink	Roto		Tag may have been a different color originally. No tag read in left flipper.
23	Vostochni	0444	orange	Allflex	c	Tagged on 31 July 1986 at Vostochni. No tag read in left flipper.
23	Vostochni	54	blue	Allflex	c	Radio intact.
23	Vostochni	57	blue	Allflex	c	
24	Zapadni Reef	14	blue	Allflex	e	Debris and tags same as when tagged earlier.
24	Zapadni Reef	0478	orange	Allflex	c	Seen twice earlier this year. Tag number 0479 in left flipper.
24	Zapadni	60	blue	Allflex	c	Radio intact.
24	Zapadni	70	blue	Allflex	c	Radio intact.
24	Zapadni	0712	orange	Allflex	c	Tagged on 24 Aug 1986 at Vostoshni. Tag number 0713 in left flipper.
25	Tolstoi	62	blue	Allflex	e	Debris, and radio as when originally tagged.
25	Tolstoi	5193	white	Allflex	e	Tagged on 5 Aug. 1986 at Vostoshni with a 30 degree wound.
25	Tolstoi	0034	orange	Allflex	c	Tagged on 12 July 1985 at Northeast Point.
25	Tolstoi	0225	orange	Allflex	c	Tagged on 9 Aug. 1985 at Lukanin.
25	Tolstoi	0358	orange	Allflex	c	Tagged on 22 July 1986 at Zoltoi Sands.
25	Tolstoi	0702	orange	Allflex	c	Tagged on 24 Aug. 1986 at Reef. Left flipper had tag number 0703.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag color	Tag yype	Entangled (e)[a] or control (c)	Notes
25	Tolstoi	5112	white	Allflex	c	Tagged on 15 Oct. 1986 at Little Zapadni.
25	Zapadni Reef	0025	orange	Allflex	c	Tagged on 11 July 1985 at Zapadni.
25	Zapadni Reef	0994	orange	Allflex	c	Tagged on 12 Oct. 1986 at English Bay. Left flipper had tag number 0995.
25	Zapadni Reef	5153	white	Allflex	c	Tagged on 2 Aug. 1986 at Zapadni Reef.
26	Morjovi	412	yellow	Roto		
26	Morjovi	bC2249	monel	monel		No tag in right flipper.
26	Morjovi	MA3307	monel	monel		
26	Morjovi	ME263	monel	monel		
26	Morjovi	ME3119	monel	monel		Hole in right flipper.
26	Morjovi	bE2376	monel	monel		Tag scar in left flipper.
26	Morjovi	49	blue	Allflex	e	Debris same as when tagged. Radio had slight bend in its antenna.
26	Morjovi	56	blue	Allflex	e	Debris and radio same as when tagged.
26	Morjovi	5161	white	Allflex	c	Tagged on 31 Aug. 1986 at Polovina. Left flipper not examined.
26	Morjovi	59	blue	Allflex	c	Radio intact.
26	Morjovi	0089	orange	Allflex	c	Tagged on 24 July 1985 at Morjovi.
26	Morjovi	5115	white	Allflex	c	Tagged on 16 Oct. 1986 at Polovina.
26	Kitovi	0082	orange	Allflex	c	Tagged on 23 July 1985 at Gorbatch.
26	Reef	93	blue	Allflex	c	Tagged earlier in day at Kitovi.
28	Polovina	2054	pink	Roto		Left flipper not examined.
28	Polovina	30	blue	Allflex	e	Debris and radio as when first tagged.
28	Polovina	66	blue	Allflex	e	Debris, and radio as when tagged.
28	Polovina	69	blue	Allflex	c	
28	Polovina	0343	orange	Allflex	c	Tagged on 22 July 1986 at Polovina.
28	Little Zapadni	61	blue	Allflex	e	Debris as when tagged.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag color	Tag type	Entangled (e)[a] or control (c)	Notes
28	Little Zapadni	29	blue	Allflex	c	
28	Little Zapadni	0135	orange	Allflex	c	Tagged on 30 July 1985 at Tolstoi.
28	Little Zapadni	5139	white	Allflex	c	Tagged on 1 Aug. 1986 at Zapadni.
28	Little Zapadni	5143	white	Allflex	c	Tagged on 1 Aug. 1986 at Zapadni.
28	Lukanin	92	blue	Allflex	c	
29	Vostochni	0042	orange	Allflex		Tagged on 15 July 1985 at Zapadni as a netmarked animal.
29	Vostochni	0332	orange	Allflex		Tagged as an entangled animal 20 July 1986 at Vostoshni. It had been entangled in a small piece of green trawl webbing.
29	Vostochni	5151	white	Allflex		Tagged on 1 Aug. 1986 as an entangled animal at Zapadni. It had been entangled in a blue packing band.
29	Vostochni	5366	yellow	Riese		Tag scar on right flipper.
29	Vostochni	544	blue	Roto		The tag on the left flipper of this animal was broken. This animal was originally tagged on 17 July 1984 at Polovina with a small piece of gray trawl webbing on its neck with a 90 degree wound and only one mesh around its neck.
29	Vostochni	ME137	monel	monel		
29	Vostochni	ME971	monel	monel		Side of tag not noted, whether or not both tags present not noted.
29	Northeast Point	bE2376	monel	monel		Tag scar on left.
29	Vostochni	71	blue	Allflex	e	Debris as when tagged.
29	Vostochni	114	blue	Allflex	e	Debris as when tagged.
29	Vostochni	0420	orange	Allflex	c	Tagged on 27 July 1986 at Little Zapadni.
29	Northeast Point	0716	orange	Allflex	c	Tag hole on right. Tagged on 24 Aug. 1986 at Vostochni.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag color	Tag type	Entangled (e)[a] or control (c)	Notes
29	Vostochni	0718	orange	Allflex	c	Tag number 0719 on right. Already sighted once this year.
29	Northeast Point	0958	orange	Allflex	c	Tag number 0959 on right. Tagged on 8 Oct. 1986 at Morjovi.
29	Vostochni	0986	orange	Allflex	c	Tag number 0987 on right. Tagged on 12 Oct. 1986 at English Bay.
30	Zapadni Reef	0060	orange	Allflex	c	Tag read on right only. Tag number was originally read as 0900. Since this number was not applied it is being assumed that it is actually 0060. This tag was applied to a control on 18 July 1985 at Polovina.
30	Zapadni Reef	831	pink	Roto		Tag was seen on one side only and the side on which it was seen was not noted.
30	Zapadni Reef	bE608	monel	monel		Scar on right.
30	Zapadni Reef	0404	orange	Allflex	c	Tagged on 25 July 1986 at Zapadni. Only one tag read not verified for both sides.
30	Zapadni Reef	0466	orange	Allflex	c	Tag number 0467 in right flipper. Tagged on 24 Aug. 1986 at Zapadni.
30	Zapadni Reef	0994	orange	Allflex	c	Tag number 0995 in right flipper. Seen previously in this season.
30	Zapadni	0394	orange	Allflex		Tagged as an entangled animal on 25 July 1986, at Zapadni. It had been loosly entangled in a piece of sheet plastic.
30	Zapadni	ME248	monel	monel		
30	Zapadni	85	blue	Allflex	e	Debris as when first tagged.
30	Zapadni	0052	orange	Allflex	c	Tagged on 16 July 1985 at Gorbatch.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag color	Tag type	Entangled (e)[a] or control (c)	Notes
30	Zapadni	0245	orange	Allflex	c	Tagged on 10 Aug. 1985 at NEP West.
30	Zapadni	0401	orange	Allflex	c	Same as seen in earlier roundup same day.
30	Zapadni	0401	orange	Allflex	c	Seen earlier this year.
30	Zapadni	0464	orange	Allflex	c	Tag number 0465 in right flipper. Tagged on 24 Aug. 1986 at Zapadni.
30	Zapadni	0964	orange	Allflex	c	Tag number 0965 in right flipper. Same as when seen in earlier roundup.
30	Zapadni	0998	orange	Allflex	c	Hole in right flipper. Tagged on 14 Oct. 1986 at Polovina Cliffs.
30	Zapadni	5138	white	Allflex	c	Tagged on 1 Aug. 1986 at Zapadni.
30	Zapadni	5141	white	Allflex	c	Tagged on 1 Aug. 1986 at Zapadni.
31	Tolstoi	61	blue	Allflex	e	As when tagged.
31	Tolstoi	84	blue	Allflex	c	
31	Kitovi	0094	orange	Allflex	c	Tagged on 24 July 1985 at NEP East.
31	Gorbatch	0352	orange	Allflex	e	Seen in right flipper only. Tagged on 22 July 1986 at Zoltoi Sands.
31	Gorbatch	101	blue	Allflex	c	
31	Gorbatch	0908	orange	Allflex	c	Tag number 0909 in right flipper. Tagged on 6 Oct. 1986 at Tolstoi.

[a]State of the animal at time of resighting. No animals tagged as controls were resighted as entangled. Animals not part of the entanglement study are not designated as controls, whereas any entangled animals is so noted.

[b]It is possible that this is an animal tagged in 1983 as an entangled animal. If so, it was originally tagged with a blue roto tag. A seal was tagged on "Reef" (which may have been a term including Gorbatch since the Reef harvests were usually of animals driven from several locations on the point) on 8 July 1983 with gray trawl net loosly entangling its neck.

Table C-4.--List of juvenile male fur seals tagged as entangled animals during surveys conducted in July 1988, St. Paul Island, Alaska, showing the nature of the debris on each animal.

Tag number	Date	Location	Description of debris						
			Type	Size[a]	Color	Tightness[b]	Wound[c]	Mesh size	Twine size
1	July 16	Zapadni Reef	trawl	s	orange	vt	360°	20.0cm	
4	" 16	Zapadni	rubber band	s	black	t	0		
5	" 16	Zapadni	packing band	s	white	t	0		
10	" 16	Zapadni	packing band	s	white	l	0		
13	" 17	Reef	trawl	s	green	t	180°	16.0cm	3.5mm
14	" 17	Reef	trawl	s	green	vt	300°		
18	" 17	Reef	trawl	s	grey	l	0		
19	" 17	Reef	packing band	s	white	t	360°		
20	" 17	Reef	trawl	m	grey	t	0	21.5cm	3.0mm
27	" 18	Tolstoi	packing band	s	blue	l	0		
30	" 18	Kitovi	trawl	s	blue	vt	360°		
33	" 18	Zoltoi Sands	trawl	m	green	t	0	20.0cm	3.0mm
36	" 19	Gorbatch	trawl	m	grey	t	0	23.0cm	4.0mm
43	" 19	Gorbatch	trawl	l	green	t	0		
47	" 20	Vostochni	trawl	l	green	t	0	22.0cm	5.0mm
49	" 20	Vostochni	trawl	m	green	vt	0	21.5cm	3.0mm
51	" 20	Morjovi	trawl	m	white	vt	0	20.0cm	4.0mm
53	" 20	Vostochni	packing band	s	green	vt	360°		
56	" 20	Vostochni	packing band	s	green	vt	360°		
61	" 21	Zapadni	chord	s	white	vt	360°		3.5mm
62	" 21	Zapadni	trawl	m	white	t	0	20.0cm	4.0mm
65	" 22	Polovina	trawl	s	blue	t	30°	20.0cm	3.0mm
66	" 22	Polovina	trawl	m	white	t	0	21.0cm	5.5mm
71	" 23	Vostochni	twine	s	white	vt	270°		
74	" 24	Zapadni Reef	packing band	s	green	t	0		
79	" 25	Tolstoi	synth. twine	s	white	vt	240°		
82	" 25	Tolstoi	twine	s	white	t	360°		
85	" 25	Zapadni Reef	trawl	s	grey	t	360°		
88	" 26	Kitovi	twine	s	green	t	180°		
89	" 26	Kitovi	string	s	white	t	270°		
96	" 26	Morjovi	trawl	l	grey	vt	0	19.0cm	3.5mm
97	" 26	Morjovi	packing band	s	yellow	l	0		
100	" 26	Reef	thread	s	white	t	360°		
103	" 26	Reef	trawl	l	grey	vt	0		
110	" 28	Polovina	trawl	s	grey	vt	360°	20.0cm	5.0mm
111	" 29	Morjovi	trawl	s	green	t	360°		
114	" 29	Morjovi	packing band	s	green	l	0		
117	" 29	Vostochni	trawl	l	green	t	0	27.0cm	3.5mm
118	" 29	Vostochni	packing band	s	yellow	vt	360°		
123	" 29	Vostochni	packing band	s	yellow	t	100°		
126	" 29	Vostochni	trawl	m	blue	t	0	20.0cm	4.5mm
129	" 29	Vostochni	hemp line	s	brown	vt	60°		6.0mm
134	" 29	Vostochni	fish net	s	yellow	vt	360°	19.0cm	1.2mm
136[d]	" 29	Vostochni	packing band	s	clear	t	0		
138	" 30	Zapadni	mixed	l	mixed	t	360°	24.5cm	2.0mm
139	" 30	Zapadni	trawl	s	green	t	15°	24.0cm	3.5mm
144	" 30	Zapadni	trawl	l	white	t	0	20.5cm	2.5mm
147	" 31	Tolstoi	trawl	s	yellow	t	0	20.0cm	4.0mm
150	" 31	Tolstoi	chord	s	green	vt	360°		
151	" 31	Tolstoi	trawl	s	grey	t	360°		
156	" 31	Kitovi	chord	s	unknown	vt	360°		0.6cm
157	" 31	Kitovi	chord	s	green	vt	360°		0.6cm
160	" 31	Gorbatch	packing band	s	yellow	t	0		

[a] s = < 150 grams of debris; m = 150 - 500 grams of debris; l = > 500 grams of debris.

[b] t = debris attached tightly; vt = debris attached very tightly; l = debris loosely attached.

[c] Open wound along point of entanglement expressed as degree of a circle.

[d] The right flipper of this animal has tag number 135 on the bottom side.

Table C-5.--Composition of the debris found on fur seals in 1988 compared to six earlier years and data for the same comparison regarding the entanglement rate (percent of juvenile male seals entangled by debris category).

Type of debris	Percent of debris* 1981-86	Percent of debris* 1988	Entanglement rate (%) 1981-86	Entanglement rate (%) 1988
Trawl net fragments	65.2	50.9	0.27	0.15
Monofilament net fragments	2.1	0.0	0.00	0.00
Plastic packing bands	18.1	26.4	0.08	0.07
Chord, rope, string	11.0	18.9	0.05	0.05
Miscellaneous items	3.5	3.8	0.01	0.01
Total	100.0	100.0	0.41	0.28

*Fowler et al. 1989.

Table C-6.--Comparison of numbers and percentages of tags applied and resighted by year for entangled and unentangled seals. Numbers in parentheses are those applied; numbers in brackets are the percent resighted.

	Year			
	1985*	1986*	1987	1988
Controls (Unentangled)	(172)	37	-	13
		[21.5]	-	[7.6]
		(279)	-	40
			-	[14.3]
			-	-
			-	-
				(104)
Entangled	(85)	12	-	1
		[14.1]	-	[1.2]
		(128)	-	6
			-	[4.7]
			-	-
			-	-
				(52)

*Fowler et al. 1989

APPENDIX D

Scientific staff engaged in northern fur seal research, 1987-88.

National Marine Mammal Laboratory (NMML)
Howard W. Braham, Director
Robert V. Miller, Deputy Director
Thomas R. Loughlin, Leader, Bering Sea Ecosystem Program

Name	Year 1987	Year 1988	Affiliation	Assignment
Permanent employee				
Mike Goebel	+	-	NMML	Behavior Studies
Pat Gearin	+	-	NMML	Behavior Studies
Charles W. Fowler	+	+	NMML	Population Assessment
George A. Antonelis	+	+	NMML	Population Assessment
Howard W. Braham	-	+	NMML	Population Assessment
Tom Loughlin	-	+	NMML	Population Assessment
Dick Merrick	-	+	NMML	Population Assessment
Anne E. York	-	+	NMML	Population Dynamics
Roger L. Gentry	+	+	NMML	Behavior Studies
Marilyn Dahlheim	-	+	NMML	Acoustics
Temporary employee				
Jason Baker	+	+	NMML	Population Assessment
Ron Ryel	+	-	Volunteer	Population Assessment
Larry Ryel	+	-	Volunteer	Population Assessment
Harriet Huber	+	-	NMML	Population Assessment
Blaine Ebberts	+	-	NMML	Population Assessment
Mark Lowry	+	-	SWFC	Population Assessment
Corinne Melmer	+	-	UM	Population Assessment
Mark Houghton	+	-	UW	Population Assessment
Sarah Pumphrey	+	-	Volunteer	Population Assessment
Peter Boveng	+	-	SWFC	Population Assessment
Ben Carney	+	-	WSU	Population Assessment
Tim Ragen	+	+	SWFC, SIO	Population Assessment
Alfey Hanson	+	+	NMML	Population Assessment
Paula White	-	+	NMML	Population Assessment
Donald Benoit	-	+	NMML	Population Assessment
Steve Insley	-	+	NMML	Population Assessment
Beth Sinclair	-	+	NMML	Population Assessment
Patrick Kozloff	-	+	NMML	Population Assessment
Jim Harvey	-	+	NMML	Population Assessment
Cooperators*				
Steve Zimmerman	+	+	NMFS	Resource Management
John Sease	+	-	NMFS	Resource Management

APPENDIX D (Continued)

Name	Year 1987	Year 1988	Affiliation	Assignment
Kazumoto Yoshida	+	-	FSFRL	Entanglement Research
Norihisa Baba	-	+	FSFRL	Entanglement Research
Shojiro Miyahara	+	-	FSFRL	Entanglement Research
Hideyoshi Yoshida	-	+	FSFRL	Entanglement Research
Terry Spraker	+	+	CSU	Mortality Research
Darlene Deghetto	+	+	CSU	Mortality Research

Affiliation Code:

UM	University of Minnesota
UW	University of Washington
NMFS	National Marine Fisheries Service
WSU	Washington State University
SWFC	Southwest Fisheries Center
SIO	Scripps Instituion of Oceanography
FSFRL	Far Seas Fisheries Research Laboratory, Japan
CSU	Colorado State University

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