



NOAA Technical Memorandum NMFS-AFSC-134

## **Fur Seal Investigations, 2000-2001**

by  
B. W. Robson (editor)

**U.S. DEPARTMENT OF COMMERCE**  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Alaska Fisheries Science Center

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## NOAA Technical Memorandum NMFS

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by  
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## ABSTRACT

Researchers from the National Marine Mammal Laboratory conduct field investigations on the population status of northern fur seals (*Callorhinus ursinus*) annually on the Pribilof Islands, Bogoslof Island in the eastern Bering Sea, and on San Miguel Island off the coast of California. The size of the Pribilof stock of northern fur seals in 2000 was estimated to be 919,000 individuals and the total population of fur seals in U. S. rookeries was estimated to be 947,000 individuals.

In 2000 and 2001, population parameters monitored on the Pribilof Islands included the size of the subsistence harvest and the number of adult male fur seals. Counts on St. Paul Island in 2000 yielded totals of 3,646 harem and 6,998 idle adult male seals; counts in 2001 were 3,388 and 7,174, respectively. On St. George Island in 2000, a total of 871 harem and 1,300 idle adult male seals were counted. In 2001, 842 harem males and 1,596 idle males were counted on St. George Island. There were decreases in the counts of territorial males with females on St. Paul Island both between 1999 and 2000 (-3.3%) and between 2000 and 2001 (-7.0%). The count of these males on St. George Island also decreased between 1999 and 2000 (-17.2 %) and between 2000 and 2001 (3.2%). The Pribilof Islands total for these males decreased by about 9.4% between 1999 and 2000 and by 6.3% between 2000 and 2001. On St. Paul Island, 754 and 597 sub-adult male seals were harvested in 2000 and 2001, respectively. On St. George Island, 121 and 184 sub-adult male seals were taken in the two harvest years, respectively.

In 2000, the number of pups born and the mortality rates of fur seals on both islands were assessed. The estimate for the total number of pups born in 2000 was 158,736 (SE = 17,284) on St. Paul Island and 20,176 (SE = 271) on St. George Island. On St. Paul Island, pup numbers

declined 11.4% since the census in 1998. This decline was not statistically significant as the standard error (SE) for the 2000 estimate was quite high. The point estimate in 2000 is the smallest recorded since 1921. On St. George Island, pup numbers declined 8.7% from the census in 1998; the decline was significant ( $P < 0.001$ ). The estimate for 2000 is the smallest since 1917. When data are combined for the two islands, there is evidence of a small, but statistically significant decline since 1990 of 1.8% ( $SE = 0.45\%$ ,  $P < 0.01$ ).

The mass and length of fur seal pups on the Pribilof Islands are used as indicators of population health and have been monitored semi-annually since 1989. As in previous years, the size of pups varied by sex: male pups were heavier and longer than female pups. In 2000, both male and female pups on St. George Island were longer than those on St. Paul Island. The sex ratio in 2000 was skewed toward males on St. George Island (54:46) but not on St. Paul Island (50:50). In 2001, the sex ratio was skewed toward males on St. Paul Island (53:47) but not on St. George Island (50:50).

In 2000 and 2001, the northern fur seal population at San Miguel Island continued its recovery from a decline caused by the 1998 El Niño. Pup production increased at both colonies over the 2 years, however in 2001, production at both colonies remained below the 1997 production levels by more than 24%. Other signs of population recovery included good condition of 4-month-old pups and reduced late-season pup mortality in 2000 and 2001.

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## INTRODUCTION

by

Bruce W. Robson

Between 1911 and 1984, northern fur seal (*Callorhinus ursinus*) research was conducted by Canada, Japan, Russia, and the United States under the Treaty for the Preservation and Protection of Fur Seals and Sea Otters. Since 1984, studies have been carried out independently by former member nations.

The St. Paul and St. George Islands northern fur seal population in the Pribilof Islands Archipelago is the largest among U.S. fur seal rookeries (Figs. 1-3) with an estimated 919,000 northern fur seals (York et al. 2000). Smaller breeding colonies are located on the Kuril Islands in Japan, the Commander Islands in Russia, Bogoslof Island in the southeastern Bering Sea, and San Miguel Island in the Channel Islands off California. Northern fur seals were designated as depleted in 1988 under the Marine Mammal Protection Act when it was determined they were below their Optimum Sustainable Population (OSP) level. Commercial harvesting of fur seals was discontinued on St. George Island in 1973 and on St. Paul Island in 1984; however, a subsistence harvest continues on both islands. There is no subsistence or commercial harvest on the remaining U.S. rookeries (Figs. 4 and 5).

Russian names given to rookeries on the Pribilof Islands are translated in Table 1 of the 1997 *Fur Seal Investigations* (Sinclair and Robson 1999). Terms specific to northern fur seal research are defined in Appendix A. Research by the National Marine Mammal Laboratory on northern fur seals in 2000 and 2001 was conducted under Marine Mammal Permit No. 782-1455.



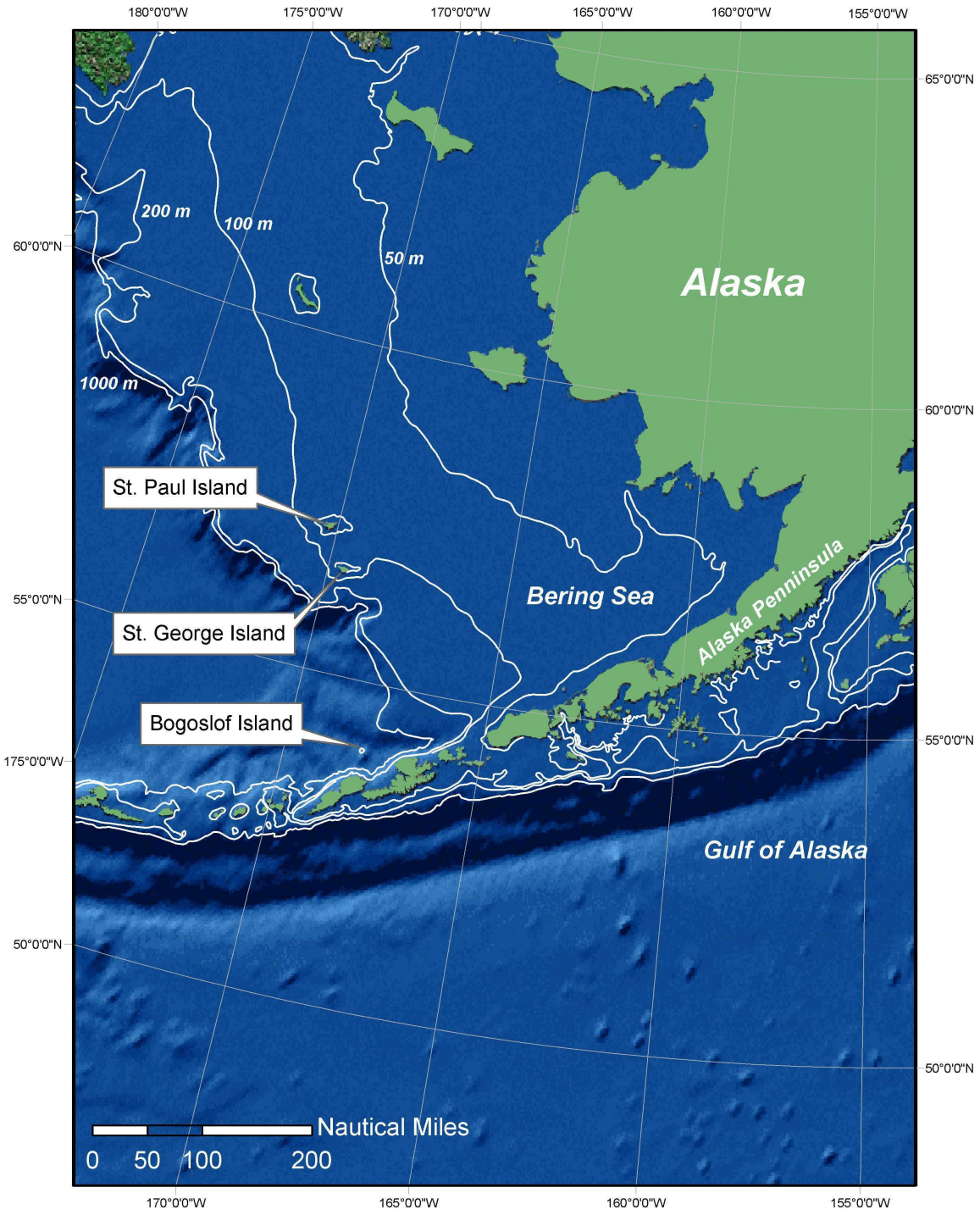


Figure 1.--Location of the three northern fur seal breeding areas within U.S. waters.

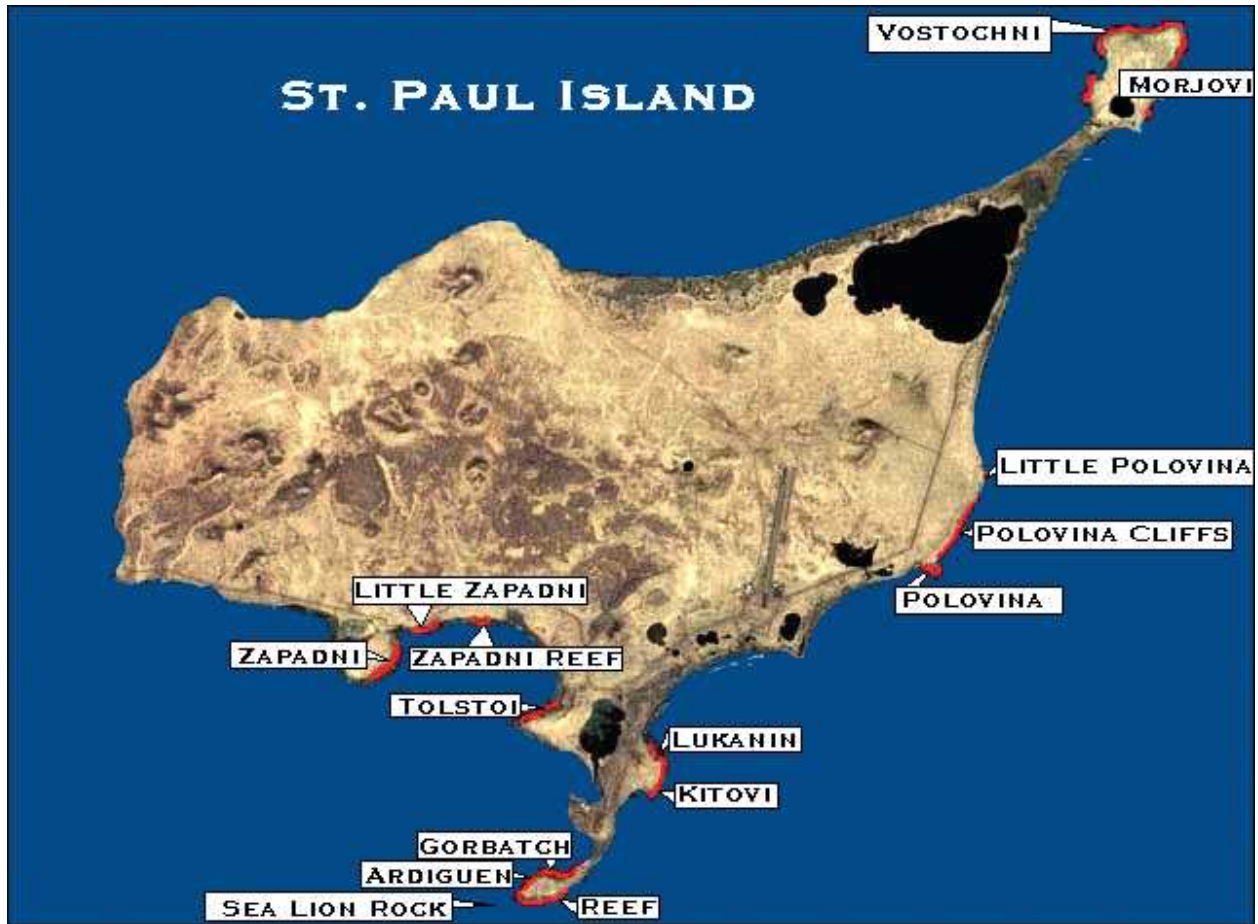


Figure 2.--Location of northern fur seal rookeries on St. Paul Island, Alaska.



Figure 3.--Location of northern fur seal rookeries on St. George Island, Alaska.



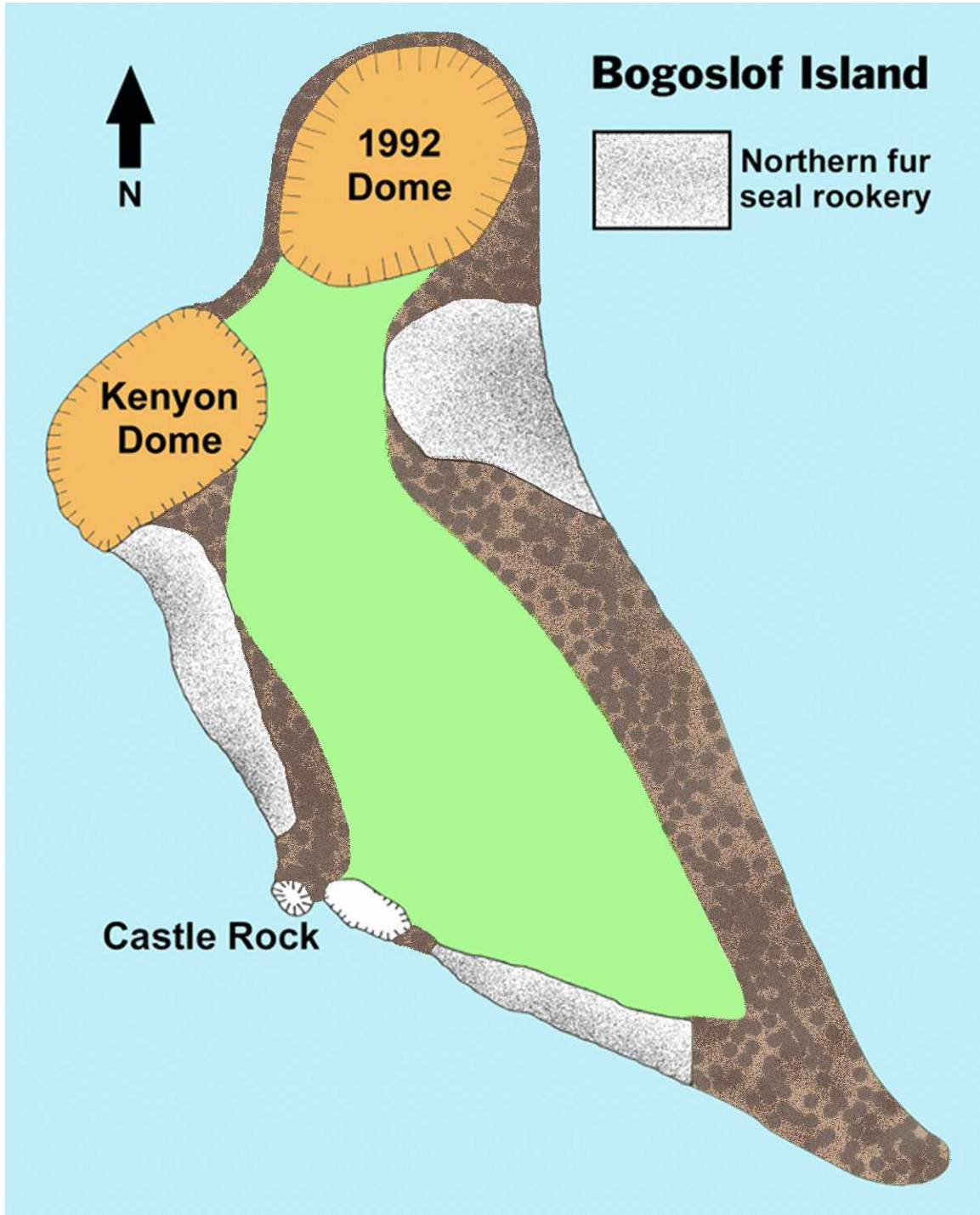


Figure 4.--Fur seal rookeries on Bogoslof Island, Alaska.



Figure 5.--Location of northern fur seal breeding colonies, San Miguel Island, California.

## POPULATION ASSESSMENT, PRIBILOF ISLANDS, ALASKA, 2000 - 2001

by

Anne E. York, Rodney G. Towell, Rolf R. Ream, and Charles W. Fowler

In accordance with provisions originally established by the Interim Convention on Conservation of North Pacific Fur Seals, the National Marine Mammal Laboratory (NMML) continues to monitor the status of fur seal populations on the Pribilof Islands. To meet this objective, data on population size, age and sex composition, and natural mortality are collected annually following the methods described by Antonelis (1992).

#### Population Parameters

Population characteristics monitored in 2000 include the size of the sub-adult male subsistence harvest, the counts of adult males, estimates of numbers of pups born, and mortality rates of fur seal pups on St. Paul and St. George Islands. The subsistence harvest and counts of adult males were the only population characteristics monitored in 2001

#### Sex Composition of Seals Harvested

A total of 754 sub-adult male seals were harvested in 2000 on St. Paul Island and 597 sub-adult males were killed in 2001 (Table 1). A single female and one adult male fur seal were killed accidentally during the 2000 subsistence harvest and two females were accidentally killed in 2001. On St. George Island, 121 sub-adult male seals were taken in the subsistence harvest in 2000 and 184 were killed in 2001 (Table 2).

#### Counts of Adult Male Seals

Adult male seals were counted by section for each rookery (see Appendix A glossary

Table 1.-- Date, location, and number of subadult male seals killed in subsistence harvest drives on St. Paul Island, Alaska, in 2000 and 2001.

2000			2001		
Date	Rookery	Number killed	Date	Rookery	Number killed
July 5	Reef	31	June 28	Zapadni	39
July 10	Polovina	42	July 9	Gorbatch	43
July 14	Zapadni	44	July 18	Polovina	35
July 17 <sup>1</sup>	Zapadni Reef	61	July 20	Zapadni	42
July 19 <sup>2</sup>	Reef	51	July 27	Gorbatch	39
July 21 <sup>3</sup>	Polovina	35	August 3	Zapadni	87
July 22	Lukanin	41	August 7	Lukanin	45
August 1	Zapadni	58	August 8	Gorbatch	99
August 2	Zapadni Reef	33	August 16 <sup>5</sup>	Polovina	62
August 3 <sup>4</sup>	Polovina	59	August 17 <sup>6</sup>	Gorbatch	106
August 4	Reef	46		Total	597
August 5	N.E. Point	45			
August 7	Zapadni	85			
August 8	Reef	123			
	Total	754			

<sup>1</sup> Includes 1 seal that died of heatstroke.

<sup>2</sup> Includes 1 seal that died of heatstroke.

<sup>3</sup> Includes 2 seals that died of heatstroke and 1 female killed.

<sup>4</sup> Includes 1 bull accidentally struck and killed.

<sup>5</sup> Includes 1 female killed.

<sup>6</sup> Includes 1 female killed.

Table 2.-- Date, location, and number of subadult male seals killed in subsistence harvest drives on St. George Island, Alaska, in 2000 and 2001.

2000			2001		
Date	Rookery	Number killed	Date	Rookery	Number killed
July 5	North	13	July 8	North	12
July 12	Zapadni	17	July 12	Zapadni	11
July 17	North	12	July 15	North	15
July 19	Zapadni	8	July 20	Zapadni	15
July 21	North	5	July 26	North	8
July 24	Zapadni	13	July 28	Zapadni	13
July 27*	North	12	August 1	North	22
July 31	Zapadni	6	August 3	Zapadni	14
August 5	North	17	August 7	North	35
August 6	Zapadni	8	August 11	Zapadni	13
August 8	Zapadni	10	August 22	North	26
	Total	121		Total	184

\* Includes one seal that died of heatstroke.






for definitions of terms) on St. Paul Island from 8 to 18 July 2000 and from 8 to 12 July 2001 (Appendix Tables B-1 and B-2). A total of 3,646 harem (Class 3) and 6,998 idle (Classes 2 and 5) adult male seals, also referred to as bulls, were counted on St. Paul Island in 2000 (Table 3). In 2001 on St. Paul Island, 3,388 harem males and 7,174 idle males were counted (Table 4). On St. George Island, a total of 871 harem (Class 3) and 1,300 idle (Classes 2 and 5) adult male seals were counted from 10 to 11 July 2000 (Table 3). From 7 to 9 July 2001, 843 harem males and 1,596 idle males were counted on St. George Island (Table 4). The relative location of the different classes of adult males is illustrated for a typical fur seal rookery-hauling ground complex on the Pribilof Islands in Figure 6. Total numbers of harem and idle bulls counted since 1973 are given in Appendix Table B-3, and the classification and number of adult males counted by rookery for St. Paul and St. George Islands are presented in Tables 3 and 4.

There was a decrease in the count of territorial males with females (Class 3) on St. Paul Island between 1999 and 2000 (-3.3%), and another decrease between 2000 and 2001 (-7.0%). The count of these males on St. George Island also decreased between 1999 and 2000 (-17.2 %) and 2000 and 2001 (-3.2%). Owing to the larger size of the population on St. Paul Island, the Pribilof Island total for these males decreased by about 9.4% between 1999 and 2000 and decreased 6.3% between 2000 and 2001.

#### Number of Pups Born on St. Paul Island in 2000

The number of fur seal pups was estimated on six sample rookeries in August 2000 using the shearing-sampling method. Sample rookeries were chosen following the protocol

CLASSES OF ADULT MALES

- 1. TERRITORIAL WITHOUT FEMALES 
- 2. TERRITORIAL WITH FEMALES 
- 3. HAULING GROUND 

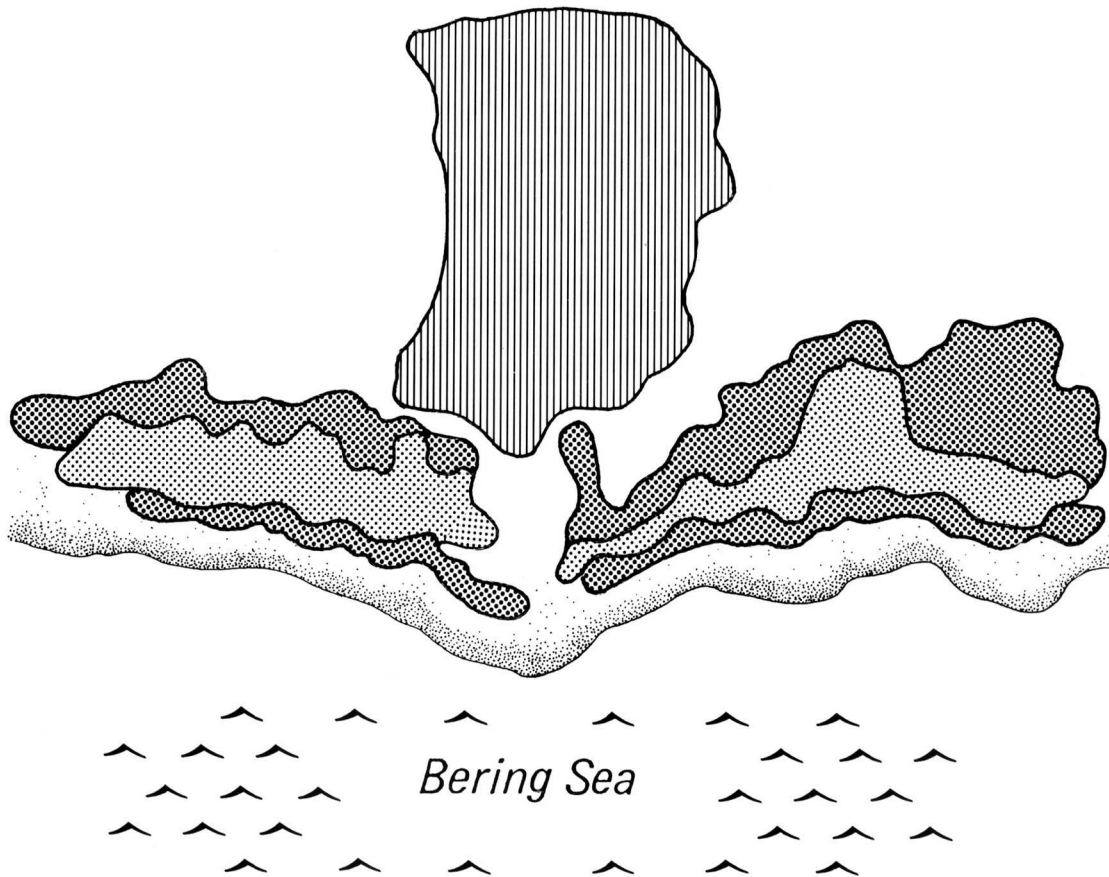


Figure 6.--The relative location of the different classes of adult males for a typical fur seal rookery.

Table 3.--Number of adult male northern fur seals counted, by rookery, Pribilof Islands, Alaska, July 2000.

Rookery	Date (July)	Class of adult male *			Total
		2	3	5	
<u>St. Paul Island</u>					
Lukanin	12	32	98	65	195
Kitovi	12	101	187	172	460
Reef	10	212	380	556	1,148
Gorbatch	9	184	273	794	1,251
Ardiguen	9	22	43	7	72
Morjovi	15	126	310	399	835
Vostochni	15/16	230	793	931	1,954
Little Polovina	12	3	5	241	249
Polovina	12	30	71	279	380
Polovina Cliffs	12	189	368	147	704
Tolstoi	8	214	378	457	1,049
Zapadni Reef	14	67	117	182	366
Little Zapadni	13	132	233	251	616
Zapadni	13	<u>220</u>	<u>390</u>	<u>755</u>	<u>1,365</u>
Island total		1,762	3,646	5,236	10,644
<u>St. George Island</u>					
South	11	96	181	90	367
North	11	187	309	218	714
East Reef	10	41	72	87	200
East Cliffs	10	77	184	202	463
Staraya Artil	11	39	44	74	157
Zapadni	11	<u>37</u>	<u>81</u>	<u>152</u>	<u>270</u>
Island total		477	871	823	2,171

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

Table 4.--Number of adult male northern fur seals counted, by rookery, Pribilof Islands, Alaska, July 2001.

Rookery	Date (July)	Class of adult male *			Total
		2	3	5	
<u>St. Paul Island</u>					
Lukanin	8	54	89	99	242
Kitovi	8	84	158	178	420
Reef	9	188	438	745	1,371
Gorbatch	9	172	262	850	1,284
Ardiguen	9	11	53	12	76
Morjovi	12	117	260	500	877
Vostochni	12	229	740	832	1,801
Little Polovina	11	3	2	193	198
Polovina	11	49	34	175	258
Polovina Cliffs	11	143	301	59	503
Tolstoi	8	214	361	641	1,216
Zapadni Reef	10	54	102	207	363
Little Zapadni	10	116	214	216	546
Zapadni	10	<u>198</u>	<u>374</u>	<u>835</u>	<u>1,407</u>
Island total		1,632	3,388	5,542	10,562
<u>St. George Island</u>					
South	7	85	183	153	421
North	8	153	271	362	786
East Reef	9	28	71	137	236
East Cliffs	9	72	192	272	536
Staraya Artil	8	30	34	143	207
Zapadni	7	<u>39</u>	<u>92</u>	<u>122</u>	<u>253</u>
Island total		407	843	1,189	2,439

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

described in York and Towell (1997): two large, two medium and two small-sized rookeries were chosen at random. Counts of dead pups were made only on these six sample rookeries. The formulas described by York and Towell (1996) were used to calculate the production estimate and their standard errors. Two researchers determined the fraction of marked pups on the entire rookery for each of the sample rookeries on two occasions. The total number of pups alive at the time of sampling was determined for each of the sampled rookeries using a Peterson estimate (York and Towell 1996). Estimates of the numbers of pups alive at the time of sampling (live pups), counts of dead pups, and estimates of total pup production for the six sampled rookeries are presented in Table 5. We estimated the total number of pups alive at sampling on all rookeries by multiplying the jackknife ratio of the pups (alive at sampling) to breeding males by the total number of breeding males (York and Kozloff 1987, York and Towell 1996). The standard error was estimated by multiplying the jackknife standard error of the ratio by a finite population correction  $(1 - \text{breeding males on sample rookeries}/\text{total breeding males})^{0.5}$ . The total number of dead pups was estimated from the mortality rate on the sampled rookeries. The total number of pups born was estimated by summing the estimates of live and dead pups. Variances of numbers of pups and mortality rates were estimated following York and Kozloff (1987) and York and Towell (1997); in addition, 2,000 bootstrapped estimates of the parameters were obtained.

From 8 to 13 August, 9,273 pups were marked by shearing. The number of pups sheared on each rookery was 10% of the last estimate of pup production for the sample rookeries from either 1996 or 1998. Shear marks were allocated proportionally on each rookery by section (Appendix Table B-4) according to the fraction of the rookery total for breeding males

Table 5.-- Total number of northern fur seal pups sheared, number of pups estimated to be alive at the time of marking (E1 and E2), mean number alive (Mean) and standard error (SE), on sample rookeries of St. Paul Island, Alaska, in 2000.

Rookery	Sheared	E1	E2	Mean	SE
Kitovi	682	6,751	5,780	6,266	485.5
Gorbach	1,414	13,388	13,486	13,437	49.0
Vostochni	2,932	27,755	26,849	27,302	453.0
Polovina	276	2,905	2,748	2,826	78.5
Little Zapadni	1,572	14,660	14,258	14,459	201.0
Zapadni	2,359	20,703	20,989	20,846	143.0

counted in each section of the sampled rookery. The ratio of marked to unmarked pups was determined by two researchers on two occasions for each rookery from 14 to 19 August. Each researcher obtained counts of marked and unmarked pups independently to ensure that the entire rookery was well sampled. Each sampling day was considered an independent replicate from which the variance was computed for each rookery.

A summary of the number of pups sheared, the estimated mean number of pups alive at the time of marking, and the standard error of the estimate for each sampled rookery is given in Table 5. The estimated number of pups born, the standard error of the estimate, number of dead pups, counts of breeding males, and ratios of pups to breeding males for each sampled rookery on St. Paul Island are summarized in Table 6. For each sampled rookery, the standard deviation of the pup estimate is computed from the standard error of the two estimates; in addition, we calculated bootstrapped estimates of the standard error of the estimate for each rookery based on 2,000 replicates of the estimation process (York and Towell, 1996).

The estimate for the total number of pups alive on St. Paul Island at the time of marking in 2000 was 153,958 with an estimated standard error of 16,763. The median of the bootstrapped estimates was 154,902 with a standard deviation of 9,510. Dead pups were counted on all sampled rookeries from 18 to 21 August. The numbers of dead pups counted by section are given in Appendix Table B-5. The number of dead pups was estimated to be 4,778 (2,641 counted on sample rookeries and 2,137 estimated on the other rookeries); the estimated mortality rate for late August was 3.01% (SE = 0.06%). The estimate of the total number of pups born on St. Paul Island in 2000 is 158,736 (SE = 17,284); the standard error accounts for

Table 6.-- Number of pups alive at the time of marking, standard deviation (SD), numbers of dead pups, total pups born, mortality rate, idle males, harem males and the ratio of pups alive at marking to harem males, on sample rookeries of St. Paul Island, Alaska, in 2000.

Sample Rookery	Pups alive at marking	SD	Dead pups*	Total pups born	Mortality rate (%)	Idle males	Harem males	Ratio pups/males
Kitovi	6,266	485.5	146	6,412	2.28	273	187	33.51
Gorbach	13,486	49.0	462	13,948	3.31	978	273	49.40
Vostochni	27,302	453.0	674	27,976	2.41	1,161	793	34.43
Polovina	2,826	78.5	67	2,893	2.32	309	71	39.80
Little Zapadni	14,459	201.0	459	14,918	3.08	383	233	62.06
Zapadni	20,846	143.0	833	21,679	3.84	975	390	53.45
Sample total	85,185	714.4	2,641	87,826	3.01	4,079	1,947	43.75

\* Includes dead pups taken for necropsies from Vostochni (33) and Zapadni (1).



variance in the estimation of both live and dead pups (York and Towell 1996). The approximate 95% confidence interval of pups born in 2000 was 116,445 - 201,027. It was computed by multiplying the standard error of the estimate of total pups deviation of the jackknife ratio of pups to breeding males (e.g., York and Kozloff 1987) by 2.4469 the 97.5 percentile of Student's *t*-distribution with 6 degrees of freedom; i.e.,  $20,176 \pm 2.4469 \times 17,284$ ). The median bootstrapped estimate of the total number of pups born (159,644) is similar to the above; however, the bootstrapped standard error (10,180) was smaller, as was the bootstrapped 95% confidence interval (146,839- 182,212) based on 2,000 replications of the estimation process.

The above total does not include the pups on Sea Lion Rock. The last direct census of fur seal pups on Sea Lion Rock (1994) estimated 12,891 pups born (12,589 = live, 302 = dead). If we add this number to the St. Paul estimate calculated above, total pup production on St. Paul Island was 171,627; this value is comparable to years when the St. Paul Island census included Sea Lion Rock.

The estimated number of pups born and their 95% confidence intervals for St. Paul Island, 1970-2000, are shown in Figure 7. The total estimated number of pups born in 2000 (not including Sea Lion Rock) is 11.4% less and was not significantly different ( $P = 0.14$ ) from estimated pup production in 1998 (179,149). Appendix Table B-3 summarizes pup production and mortality excluding Sea Lion Rock since 1973.

The number of pups born and the number of harem bulls at different rookeries on St. Paul Island are significantly correlated (correlation = 0.922, Fig. 8). The slope of the regression line with a zero intercept is 41.393 (SE = 4.365), representing an estimate of the ratio of pups to breeding males.

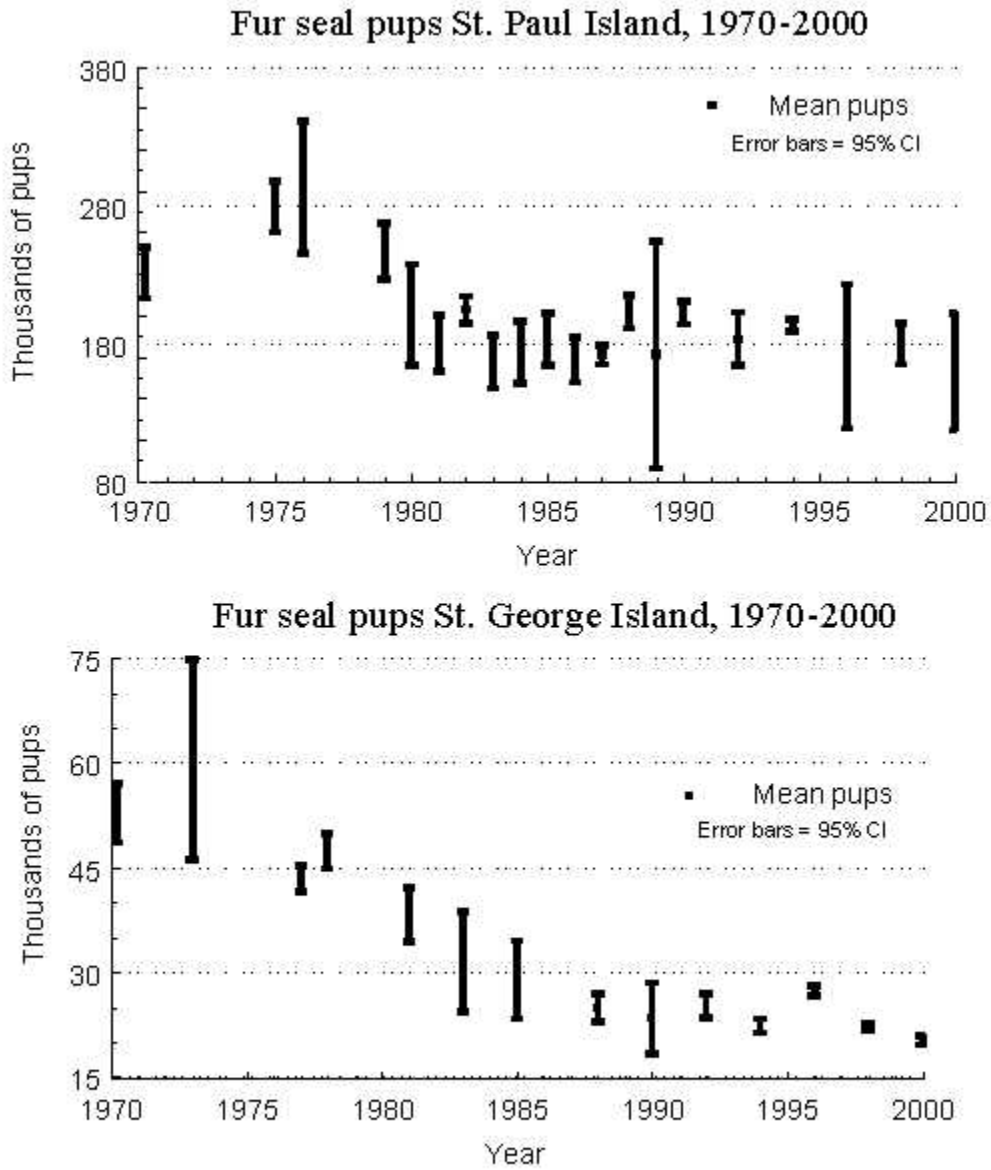


Figure 7.-- Numbers of pups born on St. Paul and St. George Islands, Alaska, in 1970-2000.

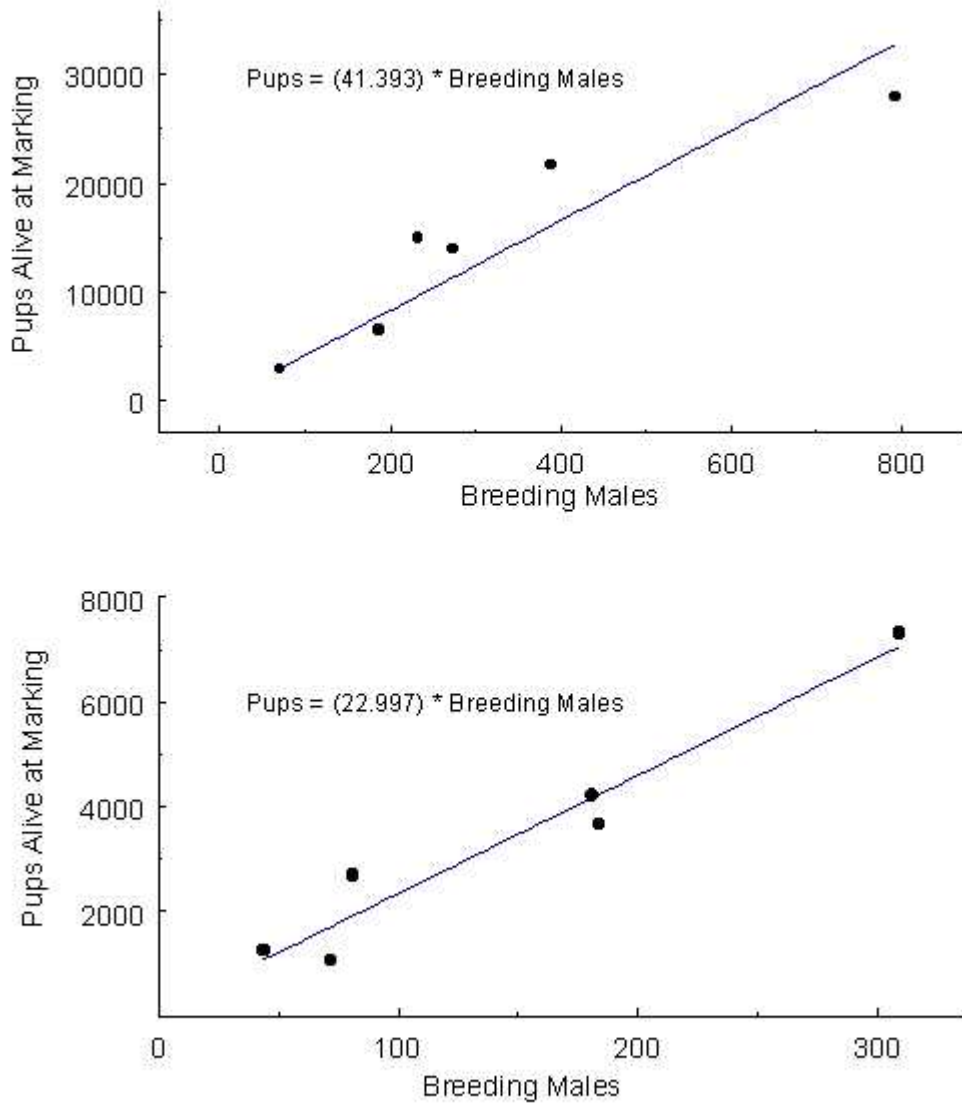


Figure 8.-- Pups born versus number of breeding males on St. Paul Island (top) and St. George Island (bottom), Alaska, in 2000.

Number of Pups Born on St. George Island in 2000

The number of pups born on St. George Island was estimated from a shearing-sampling study conducted on all rookeries. The most recent estimate of pup production prior to this study was obtained in 1998. From 10 to 14 August, a total of 2,284 pups were shear-marked on St. George Island; the total number sheared on each rookery was approximately 10% of the total number estimated on the rookery in 1998. These marks were allocated proportionally within each rookery according to the fraction of harem bulls counted in 2000 (Appendix Table B-6). The ratio of marked to unmarked pups on each rookery was determined by two researchers on two occasions: once from 15 to 17 August and again from 18 to 23 August. A third sampling was done on Staraya Artil rookery on 23 August. A summary by rookery of the number of pups sheared, the estimated mean number of pups alive at the time of marking, and the standard error of the estimate is given in Table 7. Two researchers independently obtained counts of marked and unmarked pups over the entire area of the rookeries. Each sampling day was considered an independent replicate from which the variance was computed for each rookery. Counts of dead pups were made from 15 to 17 August 2000. The estimate of the number alive was calculated similarly to the method described for St. George Island for 1994 (York and Towell 1996) with the ratio of marked to unmarked pups determined by two researchers only. The estimated total number of pups alive on St. George Island at the time of marking was 19,421 (SE = 271, Table 8). The total number of dead pups was 756 (Appendix Table B-7) and the estimated mortality rate was 3.75%. The total number of pups born on St. George Island was 20,176 and the 95%

Table 7.-- Number of pups sheared, number of pups estimated to be alive at the time of marking (E1, E2 and E3), mean number alive (Mean), and the standard error of the mean (SE) for St. George Island, Alaska, in 2000.

Rookery	Sheared	E1	E2	E3	Mean	SE
South	480	3,918	4,124		4,021	103.0
North	788	7,088	6,902		6,995	93.0
East Reef	136	966	1,113		1,040	73.5
East Cliffs	339	3,435	3,690		3,563	127.5
Staraya Artil	198	1,149	1,231	1,265	1,215	48.7
Zapadni	337	2,760	2,413		2,587	173.5

Table 8.-- Number of pups alive at the time of marking, standard deviation (SD), number of dead pups, total pups born, mortality rate, idle males, harem males, and the ratio of pups alive at marking to harem males for St. George Island, Alaska, in 2000.

Rookery	Pups alive at marking	SD	Dead pups	Total pups born	Mortality rate (%)	Idle males	Harem males	Ratio pups/males
South	4,021	103.0	191	4,212	4.53	186	181	22.22
North	6,995	93.0	311	7,306	4.26	405	309	22.64
East Reef	1,040	73.5	24	1,064	2.26	128	72	14.44
East Cliffs	3,563	127.5	96	3,659	2.62	279	184	19.36
Staraya Artil	1,215	48.7	34	1,249	2.72	113	44	27.61
Zapadni	2,587	173.5	100	2,687	3.72	189	81	31.94
Island total	19,421	270.9	756	20,177	3.75	1,300	871	22.30

confidence interval was 19,513 - 20,839 (i.e.,  $20,176 \pm 2.447 \times 271$ ). The bootstrapped median estimate was similar (20,254); the standard error (381) and 95% confidence interval (19,518 - 20,980) were somewhat larger.

The 2000 estimate of pups born on St. George Island was significantly less ( $P < 0.01$ ) than the number of pups born in 1998; the estimate was also significantly less ( $P < 0.01$ ) than the estimate of the number of pups born in 1996. The 1996 estimate of the number of pups born on St. George Island was the highest since 1985, when over 28,000 pups were born (Fig. 7).

The number of pups born and the number of harem males on St. George Island rookeries are highly correlated (Fig. 8). When the number of pups born are regressed on the number of males, the value of  $R^2$  is about 0.98. The intercept of the regression line is not significantly different from zero ( $P = 0.14$ ) and was not included in the regression equation; the slope of the regression line is 22.997 ( $SE = 1.287$ ), representing the ratio of pups to breeding males.

### Trends in Numbers of Pups

On St. Paul Island, pup numbers declined 11.4% since the 1998 census. This decline was not statistically significant as the standard error for this year's estimate was quite high. However, this year's point estimate is the smallest pup production figure recorded since 1921. Pup production may be consistently declining at a small rate: since 1990, pup numbers have decreased yearly by 1.9% ( $SE = 0.59\%$ ,  $P = 0.03$ ) as determined by a linear regression of the logarithm of population size on time.

On St. George, pup numbers declined 8.7% since 1998. This decline was statistically significant ( $P < 0.001$ ). This year's estimate is the smallest since 1917. However, there is no indication of a statistically significant decline since 1990, as on St. Paul Island. When data are combined for the two islands, since St. Paul Island numbers dominate those from St. George Island, there is evidence of a small, but statistically significant ( $P < 0.01$ ) decline since 1990 of 1.8% ( $SE = 0.45$ ).

The following negative exponential model of pup production describes the trajectory on each island:

$$P(y) = \alpha_0 + \alpha_1 2^{-(y-1975)/\gamma} + e \quad \text{where,}$$

$P(y)$  is the number of pups born in year  $y$ ,

$y$  is the year, from 1975 to 2000 for St. Paul Island and from 1973 to 2000 for St.

George Island;

$\alpha_0$  is the asymptotic size of the population after the decrease has occurred;

$\alpha_1$  is the total decrease in the size of the population between 1973 and 1975 and the time the population approaches  $\alpha_0$ ;

$\gamma$  is the half-life; that is, the time required for the population to lose half of the difference between the current and asymptotic population;

$e$  is an error term, assumed to be normally distributed with mean 0.

The models appear to fit both data sets fairly well (Fig. 9). There are important differences, however, between the St. George Island and St. Paul Island models: 1) the decrease occurred more rapidly on St. Paul Island (note that the half life parameter for St. George Island is about



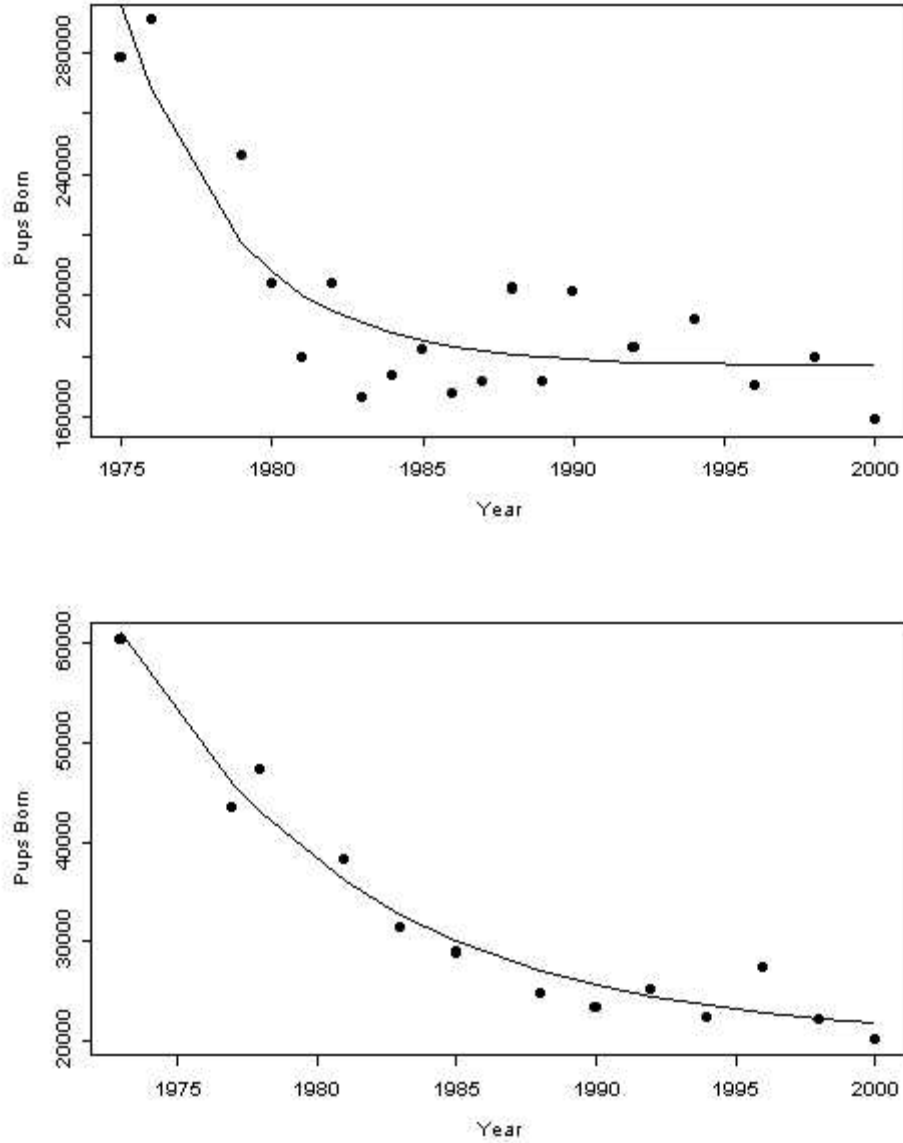


Figure 9.-- Points on the figures above represent the numbers of pups born on St. Paul Island (top) and St. George Island (bottom), Alaska. The line represents the fitted negative exponential model.

Table 9.-- Parameter estimates from the negative exponential model fit to the number of pups from 1973 to 2000. Models were fit to estimate numbers of pup as a function of time. Estimates and standard errors of the estimates (SE) to the parameters of the model are listed below, as well as, the shear-sampling estimate, and the predictive value from the model using the data from 1973 to 2000 for St. George Island and 1975 to 2000 for St. Paul Island.

Model Parameters	St. Paul Island		St. George Island	
	Estimate	SE	Estimate	SE
$\alpha_0$	174,524	6,967	19,526	2,257
$\alpha_1$	121,918	15,352	41,443	2,697
$\gamma$	2.71	0.76	6.08	1.07
<u>Estimate Type (1000s)</u>				
Asymptotic ( $\alpha_0$ )	174,524	6,967	19,526	2,257
Shear-Sampling	158,736	17,284	20,176	271
Predicted (2000)	176,952	7,043	21,864	1,617

twice that of St. Paul Island, Table 9); 2) the expected proportion of population lost on St. Paul was 41%, much less than the loss on St. George (67%). The models predict that the eventual sizes of the St. Paul Island and St. George Island populations ( $\alpha_0$ ) are 174,500 (SE = 6967) and 19,530 (SE = 2,257), respectively. These values are not significantly different from the current population sizes (Table 9).

The linear and negative exponential models suggest two different ways of interpreting the St. Paul Island pup population trajectories. At this point, it is not clear which interpretation is more accurate. We hope that the next population assessment on St. Paul Island includes all rookeries rather than a sample of rookeries. If the standard error of the next pup production estimate is smaller (i.e., at the level that we normally expect of an estimate based on all rookeries), we may know which interpretation is more appropriate.

#### Estimate of Total Stock Size

Rough estimates of the total fur seal abundance have been presented in the past (Loughlin et al. 1994). These estimates were calculated by multiplying the average number of pups born over the past three censuses by a correction factor of 4.47 (See Table 10 for the calculation method). That correction factor was derived from estimates of survival and fecundity (Loughlin et al. 1994) from data collected at sea during 1958-74. Since it is unknown whether the vital rates used are still valid, such estimates must be viewed only as a rough approximation. The numbers presented in Table 10 do not include the Russian or Japanese rookeries. The estimate of the total stock for the Pribilof Islands population in 2000 is about 919,000 fur seals. The total stock size for the United States, which includes the Pribilof, Bogoslof, and San Miguel Island populations, is about 947,000 fur seals.

Counts of Dead Fur Seals Older Than Pups and Collection of Teeth

Tooth samples (usually canines) were collected from all dead fur seals, other than pups, whenever possible. The sample rookeries and adjacent beaches of St. Paul Island and all rookeries of St. George Island were surveyed for dead fur seals during August 2000 (Table 11). In 2000, tooth samples were collected from a total of 124 fur seals: 97 on St. Paul Island and 27 on St. George Island. Appendix Table B-8 summarizes the number of dead male and female fur seals from which teeth were collected from 1965 to 2000.

Table 10.-- Details of the computation of the estimate of the stock size of fur seals in 2000. Separate columns are given for the Pribilof (St. George, St. Paul, and Sea Lion Rock) and non-Pribilof populations (San Miguel and Bogoslof Islands).

Formula	*San Miguel and		Component
	Pribilof Islands	Bogoslof Islands	
Average for 1996, 1998, 2000	205,445	6,200	Pups
(Pups) x (0.5)	102,723	3,100	Yearlings
(Yearlings) x (0.8)	82,178	2,480	Age 2 yr
(2-yr old females) × (0.86)/2	35,337	1,066	Females age 3 yr
(2-yr old males) × (0.8)/2	32,871	992	Males age 3 yr
(Total pups) / (0.6)	342,408	10,333	Females 3+ years
(3-yr old males x (3.6)	118,336	3,571	Males 4+ years
Total	919,298	27,742	

\* The 1998, 1999, and 2000 estimates for San Miguel Island and the 1997 estimate for Bogoslof Island were used.

Table 11.-- Number of animals older than pups found dead on the Pribilof Islands from which teeth were collected during August 2000.

Rookery	Male	Female	Total
<u>St. Paul</u>			
Lukanin	0	5	5
Reef	2	7	9
Gorbatch	3	13	16
Ardiguen	0	3	3
Morjovi	3	16	19
Polovina	12	33	45
Total St. Paul	20	77	97
<u>St. George</u>			
South	1	4	5
North	2	8	10
East Reef*	0	0	0
East Cliffs	1	3	4
Staraya Artil	1	1	2
Zapadni	1	5	6
Total St. George	6	21	27
Total (both islands)	26	98	124

\* 1 Dead adult found with no teeth available.

MASS, LENGTH, AND SEX RATIOS OF NORTHERN FUR SEAL PUPS  
ON THE PRIBILOF ISLANDS, 2000 AND 2001

by

Rodney G. Towell and Rolf R. Ream

Mass and length measurements of fur seal pups on St. Paul and St. George Islands serve as an indicator of population health. Here we report average mass, average lengths and sex ratios for male and female pups from Tolstoi, Vostochni, Polovina Cliffs, and Reef rookeries on St. Paul Island and all rookeries on St. George Island in August, 2000. Only the four rookeries on St. Paul Island mentioned above were sampled in 2001. We also report on comparisons of mass, length and sex ratios between islands.

METHODS

Pups were sampled in mid-to late August following the techniques described for tagging, sexing and weighing (Antonelis 1992), and length measuring (Robson et al. 1994). A Pesola<sup>1</sup> spring scale was used to weigh pups. Mass was recorded to the nearest 0.2 kg, and lengths to the nearest centimeter. Mass and length of pups on St. Paul and St. George Islands were analyzed using analysis of variance using sex, rookery and island as factors.

Significant differences in mass and length between islands for males and females were compared using a two sample t-test for samples with variances not significantly different from one another, or a Welch modified two sample t-test (Snedecor and Cochran 1980) for samples

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

with significantly different variances. Our analysis of the sex ratios examined island and rookery differences using a two-sided exact binomial test. We used this test to determine if the proportion of female pups was significantly different from 50%.

## RESULTS

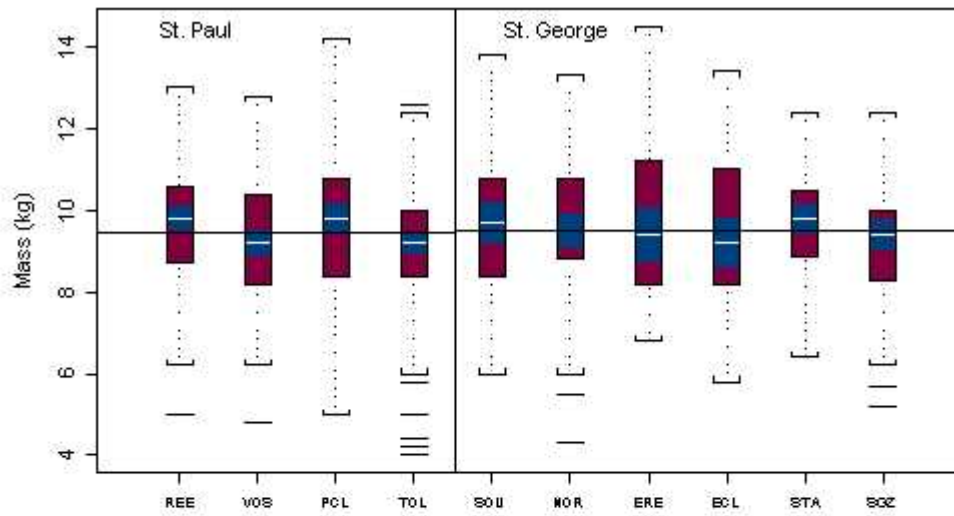
### Pup Mass and Length

Pup mass (Fig. 10, Table 11) varied significantly ( $P < 0.001$ ) by sex and rookery for St. Paul Island in 2000. Male and female pups were analyzed separately because the variance for males was greater than that for females and again rookery effects were significant ( $P = 0.004$  males,  $P = 0.002$  females, Table 12). In 2001, pup mass (Fig. 11, Table 11) varied significantly ( $P < 0.001$ ) by sex but not by rookery (Table 12, males -  $P = 0.501$ , females -  $P = 0.099$ ). Similarly, pup lengths (on St. Paul Island in 2000; Fig. 12, Table 13) were significantly different ( $P < 0.001$ ) by sex and rookery. Male and female pups were again analyzed separately and there was a significant difference in pup lengths between rookeries for each sex ( $P < 0.001$  females,  $P < 0.001$  males, Table 14). In 2000, there was no significant difference ( $P = 0.304$ ) in the variance of the length measurements for males and females on St. Paul Island so males and females were analyzed together. Pup length varied significantly by sex ( $P < 0.001$ , Table 14) and by rookery ( $P < 0.001$ , Table 14).

On St. George Island, pup mass (Fig. 10, Table 15) was also significantly different by sex ( $P < 0.001$ ). Again, male and female pups were analyzed separately due to the difference in the variances for each sex. Rookery was not a significant factor in the analysis of male mass



## Male Mass 2000



## Female Mass 2000

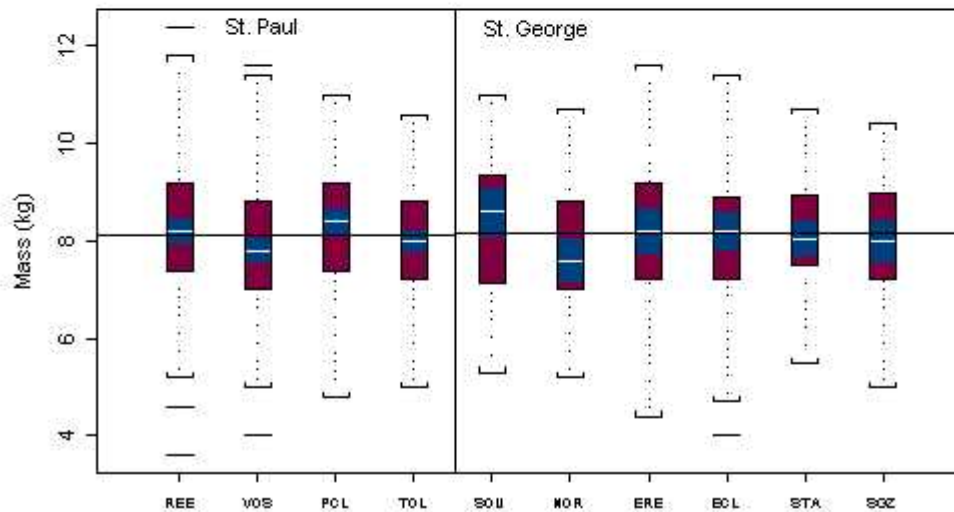


Figure 10.-- Boxplots of the median mass (white line) and 95% confidence intervals of the median mass (dark hatch) of northern fur seal pups on St. Paul and St. George Islands, Alaska, August 2000: Reef (REE), Vostochni (VOS), Polovina Cliffs (PCL), Tolstoi (TOL), South (SOU), North (NOR), East Reef (ERE), East Cliffs (ECL), Staraya Artil (STA) and St. George Zapadni (SGZ).

Table 11.-- Mean mass (kg), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups weighed on St. Paul Island, Alaska, 22 - 24 August 2000 and 22 - 23 August 2001.

Rookery		2000				2001		
		Females	Males	Combined		Females	Males	Combined
Reef	kg	8.33	9.63	8.95		8.58	9.80	9.17
22 August	SD	1.45	1.47	1.59	22 August	1.19	1.47	1.46
	n	134	120	254		132	122	254
Vostochni	kg	7.87	9.38	8.61		8.19	9.61	9.00
23 August	SD	1.27	1.41	1.53	23 August	1.27	1.62	1.64
	n	148	143	291		115	157	272
Pol. Cliffs	kg	8.31	9.69	9.03		8.37	9.53	8.99
24 August	SD	1.31	1.72	1.68	23 August	1.44	1.68	1.68
	n	125	136	261		136	158	294
Tolstoi	kg	8.00	9.06	8.54		8.25	9.54	8.94
23 August	SD	1.16	1.65	1.52	22 August	1.49	1.64	1.70
	n	135	137	272		127	148	275
Combined	kg	8.12	9.43	8.77		8.35	9.61	9.02
	SD	1.31	1.58	1.59		1.36	1.61	1.62
	n	542	536	1078		510	585	1095

Table 12.--Analyses of variance of mass of male and female northern fur seal pups on St. Paul Island, Alaska, August 2000 and 2001, across rookeries.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
2000							
Females							
Rookery	3	26.5	8.8	968	539	4.9	0.002
Males							
Rookery	3	32.7	10.9	1,306	532	4.4	0.004
2001							
Females							
Rookery	3	11.6	3.9	929	506	2.1	0.099
Males							
Rookery	3	6.2	2.1	1509	580	0.8	0.501

\*MSS = SS divided by df

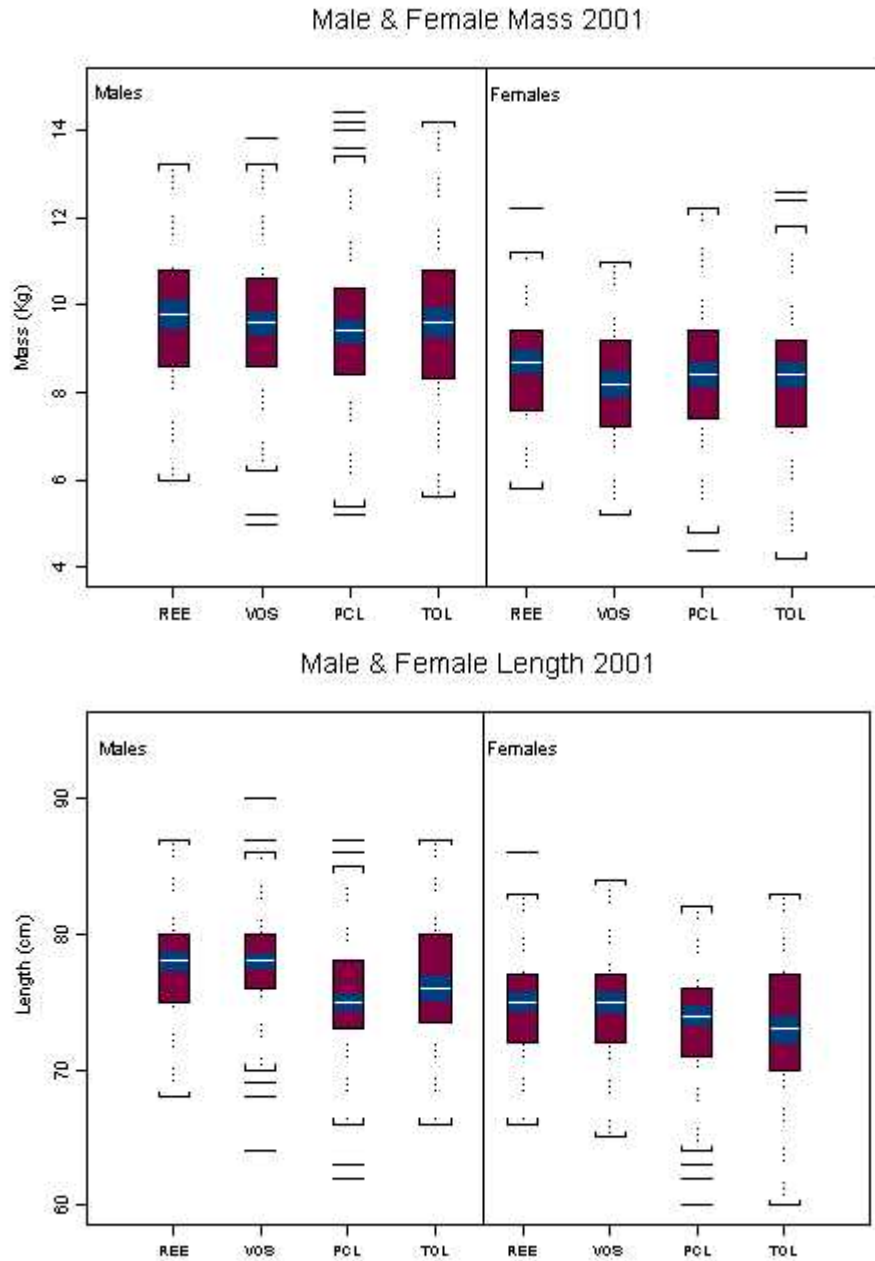


Figure 11.— Boxplots of the median mass (top panel, white line) and 95% confidence intervals of the median mass (dark hatch) of northern fur seal pups on St. Paul Island, Alaska, August 2001. Bottom panel is boxplots of the median length (white line) and 95% confidence intervals of the median length (dark hatch) of northern fur seal pups on St. Paul Island, Alaska, 2001. Rookery codes are Reef(REE), Vostochni (VOS), Polovina Cliffs (PCL), and Tolstoi (TOL).

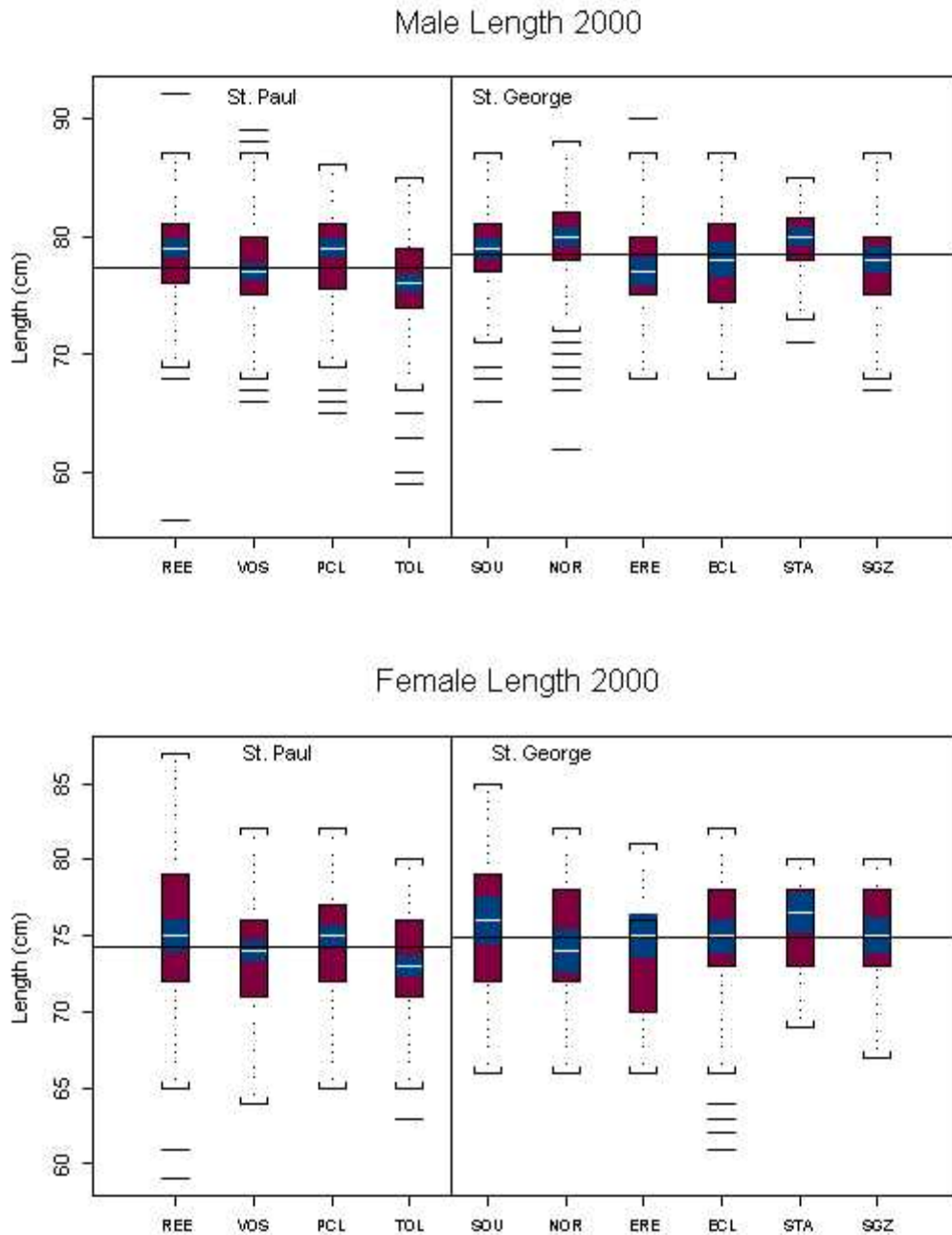


Figure 12.-- Boxplots of the median length (white line) and 95% confidence intervals of the median length (dark hatch) of northern fur seals on St. Paul and St. George Islands, Alaska, August 2000: Reef (REE), Vostochni (VOS), Polovina Cliffs (PCL), Tolstoi (TOL), South (SOU), North (NOR), East Reef (ERE), East Cliffs (ECL), Staraya Artil (STA) and St. George Zapadni (SGZ).

Table 13.-- Mean length (cm), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups measured on St. Paul Island, Alaska, 22 - 24 August 2000 and 22 - 23 August 2001.

Rookery		2000				2001		
		Females	Males	Combined		Females	Males	Combined
Reef	kg	75.65	78.46	76.98		74.59	77.77	76.12
22 August	SD	4.77	3.64	4.84	22 August	4.43	3.64	3.94
	n	134	120	254		132	122	254
Vostochni	kg	73.71	77.55	75.59		74.69	78.02	76.61
23 August	SD	3.91	4.35	4.55	23 August	3.86	4.14	4.35
	n	149	143	292		115	157	272
Pol. Cliffs	kg	74.45	77.90	76.25		73.45	75.43	74.51
24 August	SD	3.44	4.15	4.19	23 August	4.43	4.71	4.68
	n	125	136	261		136	158	294
Tolstoi	kg	73.39	75.86	74.64		73.21	76.43	74.95
23 August	SD	3.31	4.75	4.28	22 August	4.88	4.64	5.01
	n	135	137	272		127	148	275
Combined	kg	73.96	77.41	75.84		73.96	76.87	75.52
	SD	4.26	4.53	4.60		4.26	4.46	4.60
	n	543	536	1079		510	585	1095

Table 14.--Analyses of variance of length of male and female northern fur seal pups on St. Paul Island, Alaska, August 2000 and 2001.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
2000							
Females							
Rookery	3	409.2	136.4	8,222	539	8.9	0.000
Males							
Rookery	3	495.6	165.2	10,492	532	8.4	0.000
2001 Males and Females							
Sex	2	2294	1147	20842	1093	62.5	0.000
Rookery	3	795	397	20047	1090	14.4	0.000
Sex × Rookery	3	86	43	19961	1087	1.6	0.197

\*MSS = SS divided by df

Table 15.-- Mean mass (kg), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups weighed on St. George Island, Alaska, 23-25 August 2000.

Rookery		Females	Males	Combined
South	kg	8.33	9.69	9.02
24 August	SD	1.36	1.86	1.76
	n	56	58	114
North	kg	7.89	9.53	8.83
25 August	SD	1.30	1.83	1.81
	n	46	63	109
East Reef	kg	8.25	9.73	9.02
23 August	SD	1.47	1.78	1.79
	n	49	54	103
East Cliffs	kg	8.09	9.46	8.78
23 August	SD	1.52	1.84	1.82
	n	55	56	111
Staraya Artil	kg	8.17	9.69	9.08
23 August	SD	1.15	1.39	1.49
	n	40	60	100
Zapadni	kg	8.06	9.02	8.59
24 August	SD	1.29	1.49	1.48
	n	46	57	103
Combined	kg	8.14	9.52	8.89
	SD	1.36	1.71	1.70
	n	292	348	640



( $P = 0.231$ , Table 16) or female mass ( $P = 0.658$ ). The analysis of variance for lengths (Fig. 12, Table 17) indicated significant differences ( $P < 0.050$ ) by sex and rookery. Separate analyses for males and females were conducted and there were significant differences between rookeries for males ( $P = 0.042$ , Table 18) but not for females ( $P = 0.207$ , Table 18).

Mass and length were compared between islands for each sex in 2000. The variances of the mass for males and females between islands were not significantly different ( $P = 0.104$  and  $P = 0.458$ , respectively). There was not a significant difference between St. George Island and St. Paul Island for the mass of male pups ( $P = 0.440$ ) or female pups ( $P = 0.839$ ). The variances of the lengths for each sex by island were not significantly different (males,  $P = 0.563$ ; females,  $P = 0.822$ ). Male (St. Paul 77.41 cm, St. George 78.38 cm) and female (St. Paul 74.28 cm, St. George 74.87 cm) pups were longer on St. George Island than St. Paul Island (males,  $P = 0.002$ ; females,  $P = 0.041$ ).

### Sex Ratios

The fractions of females (Table 19) for each rookery and island were tested using an exact binomial test. The fraction of females were not significantly different than 50% for any of the sample rookeries on St. Paul Island in 2000 and only Vostochni's fraction of females was significantly different ( $P = 0.012$ ) than 50% in 2001. None of the rookeries on St. George Island had a fraction of females significantly different than 50%. The fraction of females was not significantly different than 50% for St. Paul Island (50.3%) but was significantly different for St. George Island (45.6%,  $P = 0.030$ ) in 2000. The fraction of females was significantly different ( $P = 0.025$ ) than 50% for St. Paul Island in 2001. These proportions on the two islands were not significantly different ( $P = 0.059$ ) in 2000. The overall fraction of females (48.6%) for both islands combined was not significantly different than 50% ( $P = 0.247$ ) in 2000.

Table 16.--Analyses of variance of mass of male and female northern fur seal pups on St. George Island, Alaska, August 2000, across rookery.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Females							
Rookery	5	6.1	1.2	532	286	0.7	0.658
Males							
Rookery	5	20.1	4.0	996	342	1.4	0.231

\*MSS = SS divided by df

Table 17.-- Mean length (cm), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups measured on St. George Island, Alaska, 23 - 25 August, 2000.

Rookery		Females	Males	Combined
South	cm	75.54	78.76	77.18
24 August	SD	4.19	4.53	4.64
	n	56	58	114
North	cm	74.63	78.98	77.15
25 August	SD	3.73	4.90	4.92
	n	46	63	109
East Reef	cm	73.93	77.33	75.72
23 August	SD	3.95	4.52	4.57
	n	49	54	103
East Cliffs	cm	74.56	77.84	76.22
23 August	SD	4.87	4.58	4.98
	n	55	56	111
Staraya Artil	cm	75.83	79.55	78.06
23 August	SD	2.90	3.25	3.60
	n	40	60	100
Zapadni	cm	74.83	77.61	76.37
24 August	SD	3.20	4.21	4.02
	n	46	57	103
Combined	cm	74.87	78.38	76.78
	SD	3.94	4.40	4.55
	n	292	348	640

Table 18.--Analyses of variance of length of male and female northern fur seal pups on St. George Island, Alaska, August 2000, across rookery.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Females							
Rookery	5	111.7	22.3	4,411	286	1.4	0.207
Males							
Rookery	5	222.4	44.5	6,508	342	2.3	0.042

\*MSS = SS divided by df

Table 19.--Numbers of female pups, total number of pups, and fraction (that are female) of northern fur seal pups sampled during pup weighing on St. Paul and St. George Islands, Alaska, August 2000 and 2001. The fraction of females is significantly less than 50% ( $P = 0.95$ ) for bold items.

Rookery	2000			2001		
	Females	Total	Fraction	Females	Total	Fraction
<u>St. Paul</u>						
Reef	134	254	0.528	132	254	0.526
Vostochni	149	292	0.510	<b>115</b>	<b>272</b>	<b>0.423</b>
Polovina Cliffs	125	261	0.479	136	294	0.463
Tolstoi	135	272	0.496	127	275	0.462
Total	543	1079	0.503	<b>510</b>	<b>1095</b>	<b>0.466</b>
<u>St. George</u>						
South	56	114	0.491			
North	46	109	0.422			
East Reef	49	103	0.476			
East Cliffs	55	111	0.495			
Staraya Artil	10	100	0.400			
Zapadni	46	103	0.447			
Total	<b>292</b>	<b>640</b>	<b>0.456</b>			

## DISCUSSION

Consistent with earlier evaluations of pup mass data (York and Antonelis 1990, York and Towell 1993, Towell et al. 1996, and Towell et al. 1997), the size of pups varied by sex: male pups were heavier and longer than female pups. Both male and female pups were significantly longer ( $P = 0.002$ ,  $P = 0.041$ ) on St. George Island than on St. Paul Island in 2000. The proportion of females was significantly less ( $P = 0.030$ ) than 50% on St. George Island (45.6%, Table 20) but not on St. Paul Island (50.3%, Table 20) in 2000. On St. Paul Island in 2001, the proportion of females was significantly less ( $P = 0.025$ ) than 50% (46.6%, Table 20).

These differences in mass and length may reflect the influence of environmental variability on the condition of pups and their mothers. Undetected biases in sampling techniques may also be responsible for the differences detected in this study. The large difference in length measurements between islands may be attributed to the technique of individual measurers. On St. George Island two measurers did about half the number of pups on each rookery; St. Paul Island measurers were rotated more frequently. The protocol for taking length measurements is very subjective and the process must be more closely examined.

Table 20.--Numbers of female pups, total number of pups, and fraction (that are female) of live northern fur seals pups captured during weighing operations on St. Paul and St. George Islands, Alaska, for the years 1992-2001.

Year	St. Paul			St. George		
	Females	Total	Fraction	Females	Total	Fraction
1992	494	1118	0.442	291	634	0.459
1994	926	1926	0.481	430	886	0.485
1995	939	2040	0.460	294	653	0.450
1996	520	1149	0.453	331	749	0.442
1997	495	1020	0.485	311	639	0.487
1998	506	1100	0.460	344	745	0.462
1999	462	1081	0.427	--	--	--
2000	543	1079	0.503	292	640	0.456
2001	510	1095	0.466			

THE STATUS OF THE NORTHERN FUR SEAL POPULATION  
AT SAN MIGUEL ISLAND, CALIFORNIA, IN 2000 AND 2001

by

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Population monitoring studies of the northern fur seal population at San Miguel Island, California, have been conducted since the discovery of the colony in 1968. In 1997, the population reached its highest production since population studies began (2,127 pups born; Melin and DeLong 2000). Between July 1997 and May 1998, a severe El Niño event along the coast of California (Lynn et al. 1998) coincided with high pup mortality in 1997 and 1998 and an 80% decline in pup production in 1998 (424 pups born). These changes are believed to be the result of poor foraging conditions for adult females (Melin and DeLong 2000). In 1999, cool sea surface temperatures, a shallow thermocline, and strong coastal upwelling resulted in high ocean productivity along the California coast (Hayward et al. 1999). The improved conditions in 1999 likely enhanced prey availability for northern fur seals; the population began to recover from the 1998 decline. However, pup production in 1999 was still 64% below the pre-El Niño levels observed in 1997 (Melin and DeLong 2001). This paper presents the results of the 2000 and 2001 population monitoring studies at San Miguel Island and discusses the continuing recovery of the population after the 1997-98 El Niño event.

## METHODS

### Study Site

San Miguel Island, California (34.03°N, 120.44°W), is the southernmost breeding colony of northern fur seals (Fig. 1). Northern fur seal colonies are located at Adams Cove on San



Miguel Island and on Castle Rock, an offshore island located approximately 2.2 km north of San Miguel Island (Fig. 5).

#### Live Pup Census and Pup Mortality

The live pup census were conducted in late July and early August of 2000 and 2001 after pupping was completed at the Adams Cove and Castle Rock colonies. We defined the end of pupping as the date after which no births were observed for three or more consecutive days in Adams Cove. In Adams Cove, the live pup census was conducted from a mobile blind by two observers using binoculars to count groups of pups. At Castle Rock, the census was conducted from bluffs overlooking populated areas. For both colonies, the mean number of pups and standard error about the mean were calculated from the total counts of the observers.

Pup mortality surveys were conducted between June and October in Adams Cove. Each dead pup was counted, removed from the territory, and then stacked away from the survey area to minimize the possibility of counting the same pup twice during the season. The total dead pup count is equal to the sum of the dead pups counted and stacked by each observer. Observed pup mortality at Castle Rock was obtained from one survey at the time of the live pup count.

#### Pup Tagging and Condition Indices

In October 2000 and 2001, northern fur seal pups approximately 4 months old were tagged on each foreflipper with pink plastic roto tags in Adams Cove. The sex and weight of each pup were recorded and the pup was released. Effort to sight animals tagged between 1985 and 2000 was conducted between July and October in 2000 and 2001 in Adams Cove. Three to four surveys for tagged animals were conducted each year using a mobile blind to approach animals and binoculars and spotting scopes (15× to 45×) to read tag numbers.

## RESULTS

Live Pup Census and Pup Mortality

The total pup production for the San Miguel Island fur seal population (Adams Cove and Castle Rock colonies) was 1,646 in 2000 and 2,035 in 2001. More than 60% of the fur seal production at San Miguel Island occurred in the Adams Cove colony in 2000 and 2001. The mean total pup production in Adams Cove was 1,070 (SE = 4.5) in 2000 and 1,284 (SE = 9.0) in 2001. Pup production increased 38.4% between 1999 and 2000, and increased 20.0% between 2000 and 2001 (Table 21). The production continued to increase in 2000 and 2001 from the 80.1% decline that occurred in 1998 due to El Niño conditions (Table 21). However, the pup production was 49.7% lower in 2000 and 39.6% lower in 2001 than production in 1997, when the colony reached its highest recorded production (2,127) (Table 21).

The observed early season pup mortality rate for the Adams Cove colony was 10% in 2000 and 4.4% in 2001. The early season pup mortality declined from a mean of 25.5% between 1997 and 1999 ( $n = 3$ , S.E. = 1.9%) to 10.0% in 2000 and 4.4% in 2001 (Table 21). The observed mortality rate from birth to four months of age was also lower in 2000 (13.3%) and 2001 (5.1%) compared to mortality rates between 1997 and 1999 (range: 25.2 - 54.0%) (Table 21).

At Castle Rock, mean total pup production was 576 (SE = 4.2) in 2000 and 751 (SE = 4.5) in 2001 (Table 21). Pup production increased 85.8% between 1999 and 2000 and 30.4% between 2000 and 2001 (Table 21). Pup production continued to recover from the 79.5% El Niño decline, but production was 41.9% and 24.2% below 1997 production in 2000 and 2001, respectively (Table 21). No observed mortality rates were calculated for Castle Rock because the

Table 21.--Summary of live and dead pup counts of northern fur seals at Adams Cove 1997-2001 and Castle Rock 1997-2001. Mortality rates are based on observed mortality and are underestimates of the total mortality. Standard Error about the mean is in parentheses. A (-) preceding the percent change indicates a decline.

Colony/Year	Mean number of live pups <sup>1</sup>	Early season pup mortality <sup>2</sup>	Total production	Annual percent change in total production	Percent change from total production in 1997	Early season pup mortality rate	Late-season pup mortality <sup>3</sup>	Season pup mortality rate <sup>4</sup>
Adams Cove								
1997	1759 (6.7)	368	2127			27.3	488	40.2
1998	308 (1.3)	116	424	-80.1	-80.1	27.4	113	54.0
1999	604 (3.4)	169	773	82.0	-63.7	21.8	26	25.2
2000	963 (4.5)	107	1070	38.4	-49.7	10.0	35	13.3
2001	1227 (9.0)	57	1284	20.0	-39.6	4.4	8	5.1
Castle Rock								
1997	940 (5.4)	51	991					
1998	194 (1.2)	9	203	-79.5	-79.5			
1999	299 (1.8)	11	310	52.7	-68.7			
2000	563 (4.2)	13	576	85.8	-41.9			
2001	708 (4.5)	43	751	30.4	-24.2			

<sup>1</sup> The standard error about the mean was calculated using the sum of the standard deviations from the two independent counts for each group of pups. The sum of the standard deviations was divided by the square root of the total number of pup groups to obtain the standard error.

<sup>2</sup> Number of dead pups counted up to the time of the live pup census.

<sup>3</sup> Number of dead pups counted after the live pup census.

<sup>4</sup> Rate calculated based on total number of dead pups in early and late-season dead pup counts.

dead pups counted at the time of the survey were not representative of the total mortality during the season.

#### Pup Weight

The mean weight of male fur seal pups was 11.5 kg in 2000 ( $n = 105$ ,  $SE = 0.19$  kg) and 2001 ( $n = 138$ ,  $S.E = 0.16$  kg) (Table 22). The mean weights of male pups were different for the 5 years between 1997 and 2001 (ANOVA,  $P < 0.001$ ). However, the yearly differences were attributed to low weights in 1997 ( $n = 75$ ,  $\bar{x} = 6.3$  kg,  $SE = 0.13$  kg) and 1998 ( $n = 78$ ,  $\bar{x} = 8.6$  kg,  $SE = 0.21$ ) during El Niño conditions (ANOVA, Bonferroni post-hoc test,  $P < 0.001$  in both years) (Table 22).

The mean weight of 4-month-old female fur seal pups was 10.2 kg in 2000 ( $n = 95$ ,  $SE = 0.15$  kg) and 10.4 kg in 2001 ( $n = 147$ ,  $SE = 0.12$ ) (Table 22). Similar to the weights of male pups, the mean weights of female pups were different for the 5 years due to low weights in 1997 ( $n = 79$ ,  $\bar{x} = 5.9$  kg,  $SE = 0.12$  kg) and 1998 ( $n = 85$ ,  $\bar{x} = 8.0$  kg,  $SE = 0.21$  kg) (ANOVA, Bonferroni post-hoc test,  $P < 0.001$ ) (Table 22).

#### Tag Resight Effort

In 2001, 80 adult female and 56 male northern fur seals were individually identified from flipper tags (Table 23). The age of females ranged from 2 to 16 years, and 45% of the sighted females were observed with pups (Table 23). Tagged males ranged from 3 to 11 years of age and tagged territorial males were 7 to 11 years old. No 4-year-old tagged individuals were observed for either sex in 2001, indicating poor survival of the 1997 cohort due to El Niño conditions in late 1997 and 1998.

Table 22.-- Mean weights and standard error (SE) about the mean of 4-month-old northern fur seal pups at Adams Cove, San Miguel Island, California, between 1997 and 2001.

Year	Males			Females		
	n	Mean (kg)	SE	n	Mean (kg)	SE
1997	75	6.3	0.13	79	5.9	0.12
1998	78	8.6	0.21	85	8.0	0.21
1999	78	11.3	0.20	81	10.4	0.20
2000	105	11.5	0.19	95	10.2	0.15
2001	138	11.5	0.16	147	10.4	0.12

## DISCUSSION

The northern fur seal population at San Miguel Island in 2000 and 2001 continued to recover from the 1998 decline. Even though pup production increased at the two colonies over the 2 years, both colonies in 2001 remained below the 1997 production levels by more than 24%. Other signs of population in 2000 and 2001 recovery included good condition of 4-month-old pups and reduced late-season pup mortality.

The 80% decline in total pup production in 1998 reduced the northern fur seal population at San Miguel Island to levels observed following the 1983 El Niño (DeLong and Antonelis 1991). In that year, the population suffered a 60.3% decline from the previous year. Higher adult and pup mortality in 1983 resulted in slow population growth for 7 years (Melin and DeLong 1994). The results presented here indicate that 4 years later, the northern fur seal population at San Miguel Island is still recovering from the 1997-98 El Niño event. Melin and DeLong (2000) suggest that adult mortality may have occurred during the 1997-98 El Niño event based on the unusually low numbers of adult females ashore during the 1998 breeding season. The low pup production in 2000 and 2001 also supports this contention. In addition, the lack of observations of tagged individuals suggests that the 1997 cohort suffered significant mortality. The reduced number of adult females in the population after 1998 and the loss of most of the 1997 cohort suggest that fur seal pup production at San Miguel Island may remain depressed for several more years.

Table 23.--Number of tagged northern fur seals sighted at Adams Cove, San Miguel Island, California, from May through August 2001.

Cohort	Age	Females			Males		
		Number tagged	Number sighted	Number sighted with pups	Number tagged	Number sighted	Number Territorial
1985	16	87	2	1	113	0	
1986	15	100	0		99	0	
1987	14	56	1	1	43	0	
1988	13	192	3	1	195	0	
1989	12	160	3	2	192	0	
1990	11	86	3	2	113	3	3
1991	10	158	5	1	143	1	1
1992	9	163	2	1	136	3	3
1993	8	147	15	9	152	2	1
1994	7	143	16	8	157	9	2
1995	6	132	10	6	168	18	
1996	5	147	7	4	153	14	
1997	4	79	0		75	0	
1998	3	85	6	0	78	6	
1999	2	81	7	0	78	0	
Total			80	36		56	10

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Class 4 (territorial with females)	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 grounds)	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.
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 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 several 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 where they haul out.

Vibrissae  
(facial whiskers)

To determine the relative age structure of females in a population, the color of their 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 adults and pups counted by rookery, size class, and rookery section during population assessment.

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Table B-1.--Number of adult male northern fur seals counted, by class<sup>a</sup> and rookery section, St. Paul Island, Alaska, 8-18 July 2000. A dash indicates no section.

Rookery and class of male	Section														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
<b>Lukanin</b>															
2	26	6	-	-	-	-	-	-	-	-	-	-	-	-	32
3	50	48	-	-	-	-	-	-	-	-	-	-	-	-	98
5	53	12	-	-	-	-	-	-	-	-	-	-	-	-	65
<b>Kitovi<sup>b</sup></b>															
2	8 (7)	13	29	21	23	-	-	-	-	-	-	-	-	-	101
3	17 (22)	19	48	41	40	-	-	-	-	-	-	-	-	-	187
5	(26)	2	7	9	128	-	-	-	-	-	-	-	-	-	172
<b>Reef<sup>c</sup></b>															
2	27	24	37	20	8	30	8	25	19	12	2	-	-	-	212
3	25	77	49	32	32	58	0	46	28	28	5	-	-	-	380
5	18	37	28	31	129	24	11	26	17	130	105	-	-	-	556
<b>Gorbatch</b>															
2	53	30	31	7	26	37	-	-	-	-	-	-	-	-	184
3	72	52	46	10	40	53	-	-	-	-	-	-	-	-	273
5	623	22	14	99	16	20	-	-	-	-	-	-	-	-	794
<b>Ardiguen</b>															
2	22	-	-	-	-	-	-	-	-	-	-	-	-	-	22
3	43	-	-	-	-	-	-	-	-	-	-	-	-	-	43
5	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7
<b>Morjovi<sup>d</sup></b>															
2	11 (13)	29	19	10	29	15	-	-	-	-	-	-	-	-	126
3	36 (32)	53	50	19	78	42	-	-	-	-	-	-	-	-	310
5	224 (23)	19	44	10	14	65	-	-	-	-	-	-	-	-	399
<b>Vostochni</b>															
2	21	14	8	18	17	32	12	20	5	8	8	17	27	23	230
3	52	27	50	59	50	81	48	54	28	20	39	60	150	75	793
5	7	15	9	76	95	31	20	7	61	3	2	234	210	161	931
<b>Little Polovina</b>															
2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
3	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5
5	241	-	-	-	-	-	-	-	-	-	-	-	-	-	241
<b>Polovina</b>															
2	20	10	-	-	-	-	-	-	-	-	-	-	-	-	30
3	41	30	-	-	-	-	-	-	-	-	-	-	-	-	71
5	206	73	-	-	-	-	-	-	-	-	-	-	-	-	279
<b>Polovina Cliffs</b>															
2	5	84	9	10	16	32	33	-	-	-	-	-	-	-	189
3	32	30	26	46	51	84	99	-	-	-	-	-	-	-	368
5	48	14	6	11	18	24	26	-	-	-	-	-	-	-	147
<b>Tolstoi</b>															
2	23	14	8	29	41	29	34	36	-	-	-	-	-	-	214
3	40	32	33	52	53	70	47	51	-	-	-	-	-	-	378
5	13	9	12	14	18	18	23	350	-	-	-	-	-	-	457
<b>Zapadni Reef</b>															
2	49	18	-	-	-	-	-	-	-	-	-	-	-	-	67
3	89	28	-	-	-	-	-	-	-	-	-	-	-	-	117
5	37	145	-	-	-	-	-	-	-	-	-	-	-	-	182
<b>Little Zapadni</b>															
2	11	32	29	33	13	14	-	-	-	-	-	-	-	-	132
3	11	34	46	51	38	53	-	-	-	-	-	-	-	-	233
5	11	23	25	20	28	144	-	-	-	-	-	-	-	-	251
<b>Zapadni<sup>d</sup></b>															
2	13	22	35	38	37	31	32	12	-	-	-	-	-	-	220
3	31	49	51	53	56	79	58	13	-	-	-	-	-	-	390
5	6 (74)	13	26	25	27	47	27	510	-	-	-	-	-	-	755

<sup>a</sup> See Glossary for a description of the classes of adult male seals.

<sup>b</sup> Numbers in parentheses are the adult males counted in Kitovi Amphitheater.

<sup>c</sup> Numbers in parentheses are the adult males counted on the second point south of Sea Lion Neck.

<sup>d</sup> Numbers in parentheses are the adult males counted on Zapadni Point Reef.



Table B-2.--Number of adult male northern fur seals counted, by class<sup>a</sup> and rookery section, St. Paul Island, Alaska, 8-12 July 2001. A dash indicates no section.

Rookery and class of male	Section														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
<b>Lukanin</b>															
2	39	15	-	-	-	-	-	-	-	-	-	-	-	-	54
3	58	31	-	-	-	-	-	-	-	-	-	-	-	-	89
5	90	9	-	-	-	-	-	-	-	-	-	-	-	-	99
<b>Kitovi<sup>b</sup></b>															
2	10(4)	16	23	14	17	-	-	-	-	-	-	-	-	-	84
3	11(13)	24	36	40	34	-	-	-	-	-	-	-	-	-	158
5	(36)	36	0	8	127	-	-	-	-	-	-	-	-	-	178
<b>Reef<sup>c</sup></b>															
2	29	22	18	16	21	34	7	12	20	8	1	-	-	-	188
3	33	73	52	42	60	58	1	53	35	28	3	-	-	-	438
5	13	17	17	51	146	7	39	22	176	241	16	-	-	-	745
<b>Gorbatch</b>															
2	36	25	38	16	24	33	-	-	-	-	-	-	-	-	172
3	67	53	50	16	43	33	-	-	-	-	-	-	-	-	262
5	630	17	51	127	11	14	-	-	-	-	-	-	-	-	850
<b>Ardiguen</b>															
2	11	-	-	-	-	-	-	-	-	-	-	-	-	-	11
3	53	-	-	-	-	-	-	-	-	-	-	-	-	-	53
5	12	-	-	-	-	-	-	-	-	-	-	-	-	-	12
<b>Morjovi<sup>d</sup></b>															
2	13 (15)	16	16	13	24	20	-	-	-	-	-	-	-	-	117
3	26 (28)	35	49	29	62	31	-	-	-	-	-	-	-	-	260
5	329 (11)	13	48	18	5	76	-	-	-	-	-	-	-	-	500
<b>Vostochni</b>															
2	9	2	5	14	9	32	19	22	31	9	6	23	26	22	229
3	39	14	42	48	24	91	51	48	66	14	21	68	130	84	740
5	26	16	7	49	133	31	18	6	25	41	2	139	100	239	832
<b>Little Polovina</b>															
2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
5	193	-	-	-	-	-	-	-	-	-	-	-	-	-	193
<b>Polovina</b>															
2	32	17	-	-	-	-	-	-	-	-	-	-	-	-	49
3	21	13	-	-	-	-	-	-	-	-	-	-	-	-	34
5	151	24	-	-	-	-	-	-	-	-	-	-	-	-	175
<b>Polovina Cliffs</b>															
2	24	10	7	16	22	32	32	-	-	-	-	-	-	-	143
3	41	20	29	49	36	53	73	-	-	-	-	-	-	-	301
5	31	4	7	2	3	7	5	-	-	-	-	-	-	-	59
<b>Tolstoi</b>															
2	17	13	21	17	26	45	39	36	-	-	-	-	-	-	214
3	33	21	43	44	46	68	54	52	-	-	-	-	-	-	361
5	0	1	7	0	17	20	18	578	-	-	-	-	-	-	641
<b>Zapadni Reef</b>															
2	41	13	-	-	-	-	-	-	-	-	-	-	-	-	54
3	77	25	-	-	-	-	-	-	-	-	-	-	-	-	102
5	79	128	-	-	-	-	-	-	-	-	-	-	-	-	207
<b>Little Zapadni</b>															
2	8	11	27	20	22	28	-	-	-	-	-	-	-	-	116
3	12	29	55	49	39	30	-	-	-	-	-	-	-	-	214
5	11	19	27	21	17	121	-	-	-	-	-	-	-	-	216
<b>Zapadni<sup>d</sup></b>															
2	15	27	36	26	27	31	30	6	-	-	-	-	-	-	198
3	26	44	50	56	64	58	63	13	-	-	-	-	-	-	374
5	5 (88)	14	17	31	16	35	18	611	-	-	-	-	-	-	835

<sup>a</sup> See Glossary for a description of the classes of a adult male seals.

<sup>b</sup> Numbers in parentheses are the adult males counted in Kitovi Amphitheater.

<sup>c</sup> Numbers in parentheses are the adult males counted on the second point south of Sea Lion Neck.

<sup>d</sup> Numbers in parentheses are the adult males counted on Zapadni Point Reef.

Table B-3.--Number of harem and idle males, pups born, number of rookeries sampled, standard deviation (SD) of the number of pups born, and the number of dead pups on the Pribilof Island, Alaska, 1973-2001. A dash indicates no data.

Year	St. Paul					St. George						
	Harem Bulls	Idle Bulls	Pups Born	SD	Rookeries Sampled (n)	Dead Pups	Harem Bulls	Idle Bulls	Pups Born	SD	Rookeries Sampled	Dead Pups
1973	4,906	2,550	--	--	--	9,908	875	375	60,385	--	6	2,661
1974	4,563	1,782	--	--	--	--	822	481	--	--	--	1,353
1975	5,018	3,535	278,261	8,620	14	20,625	877	1,427	--	--	--	3,289
1976	5,324	4,041	291,000	11,108	2	23,676	1,093	996	--	--	--	2,289
1977	6,457	3,845	--	--	--	14,083	1,610	899	43,407	748	6	1,208
1978	6,496	3,908	--	--	--	8,073	1,590	1,220	47,248	1,009	6	2,518
1979	6,242	4,457	245,932	9,464	14	6,444	1,716	1,942	--	--	--	2,191
1980	5,490	4,248	203,825	11,672	4	7,859	1,563	1,795	--	--	--	2,385
1981	5,120	4,003	179,444	5,876	4	6,798	1,472	1,646	38,152	1,581	6	2,025
1982	5,767	4,009	203,581	3,482	4	7,301	1,410	1,319	--	--	--	1,600
1983	4,827	4,242	165,941	6,034	4	5,997	--	--	31,440	2,930	6	903
1984	4,803	3,977	173,274	8,117	5	6,115	1,473	1,452	--	--	--	--
1985	4,372	3,363	182,258	7,997	7	5,266	1,268	1,601	28,869	2,297	6	806
1986	4,603	1,865	167,656	5,086	4	7,771	1,394	1,342	--	--	--	--
1987	3,636	1,892	171,610	3,218	13	7,757	1,303	1,283	--	--	--	--
1988	3,585	3,201	202,229	3,751	4	7,272	1,259	1,258	24,820	827	6	1,212
1989	4,297	6,400	171,534	25,867	4	9,096	1,241	1,163	--	--	--	--
1990	4,430	7,629	201,305	3,724	13	9,128	909	1,666	23,397	2,054	6	928
1991	4,729	9,453	--	--	--	--	736	1,271	--	--	--	--
1992	5,460	10,940	182,437	8,918	13	8,525	1,029	1,834	25,160	707	6	806
1993	6,405	9,301	--	--	--	--	1,123	1,422	--	--	--	--
1994	5,715	10,014	192,104	2,029	13	8,180	1,179	1,481	22,244	410	6	788
1995	5,154	8,459	--	--	--	--	1,242	1,054	--	--	--	--
1996	5,643	9,239	170,125	21,244	6	6,837*	1,248	790	27,385	294	6	719
1997	5,064	8,560	--	--	--	--	910	1,474	--	--	--	--
1998	4,762	8,396	179,149	6,193	7	5,058*	1,116	1,084	22,090	222	6	452
1999	3,767	7,589	--	--	--	--	1,052	916	--	--	--	--
2000	3,646	6,998	158,736	17,284	6	4,778*	871	1,300	20,176	271	6	756
2001	3,388	7,174	--	--	--	--	843	1,596	--	--	--	--

\* Dead pups for the entire island are estimated from the mortality rate on sampled rookeries.

Table B-4.-- Number of northern fur seal pups sheared on each sampled rookery of St. Paul Island, Alaska, in 2000.

Rookery	Section														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Kitovi	135	70	179	157	144										685
Gorbatch	358	259	261	57	207	272									1,414
Vostochni	198	100	171	220	176	296	212	209	108	72	147	237	261	528	2,935
Polovina	158	123													281
Little Zapadni	69	231	314	350	270	354									1,588
Zapadni	205	303	326	318	338	463	351	66							2,370
Total															9,273

Table B-5.-- Number of dead northern fur seal pups counted by section on the sampled rookeries of St. Paul Island, Alaska, in 2000.

Rookery	Date	Section														necropsies	Total		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14				
Kitovi <sup>1</sup>	8/21	14	11	46	32	43													146
Gorbatch	8/19	151	73	139	13	59	27												462
Vostochni <sup>2</sup>	8/18	28	3	41	45	34	86	47	41	18	6	25	36	170	61		33		674
Polovina <sup>3</sup>	8/18	43	24																67
Little Zapadni <sup>4</sup>	8/19	21	51	78	94	96	119												459
Zapadni <sup>5</sup>	8/20	20	88	132	139	112	182	108	51									1	833
Total																			2641

<sup>1</sup> Total includes 3 sheared animals.  
<sup>2</sup> Total includes 3 sheared animals.  
<sup>3</sup> Total includes 5 sheared animals.  
<sup>4</sup> Total includes 16 sheared animals.  
<sup>5</sup> Total includes 11 sheared animals.

Table B-6.-- Number of northern fur seal pups sheared on each rookery of St. George Island, Alaska, in 2000.

Rookery	Section					Total
	1	2	3	4	5	
South	148	167	166			481
North	110	191	262	122	103	788
East Reef	136					136
East Cliffs	218	122				340
Staraya Artil*	201					201
Zapadni*	246		92			338
Total						2,284

\* Sections 1 and 2 were treated as one section for the allocation of shear marks.

Table B-7.-- Number of dead northern fur seal pups counted by section on the rookeries of St. George Island, Alaska, in 2000. Numbers in parenthesis are counts of dead sheared pups. These numbers are included in the section totals.

Rookery	Date	Section					Total
		1	2	3	4	5	
South	8/17	50	93(1)	48			191
North <sup>1</sup>	8/16	43	75	114		79	311
East Reef	8/15	24					24
East Cliffs	8/15	73(1)	23				96
Staraya Artil <sup>2</sup>	8/17	34(3)					34
Zapadni <sup>3</sup>	8/17	100(1)					100
Total							756

<sup>1</sup> Dead pup counts were combined for Sections 4 and 5.

<sup>2</sup> Dead pups were not counted by section on Staraya Artil.

<sup>3</sup> Dead pups were not counted by section.

Table B-8.-- Number of dead northern fur seals counted that were older than pup, Pribilof Islands, Alaska, 1965-2000. Teeth (usually canines) were collected from most of these seals. 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	- <sup>a</sup>	- <sup>a</sup>	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 <sup>b</sup>	-	-	20	99
1988	56	112	21	29	77	141
1989	55	162	-	-	55	162
1990	97	151	13	31	110	182
1992	97	265	7	19	104	284
1994	84	223 <sup>c</sup>	6	19 <sup>d</sup>	90	242
1996	20 <sup>e</sup>	92 <sup>e</sup>	3	20 <sup>f</sup>	23	112 <sup>f</sup>
1998 <sup>g</sup>	-	-	-	-	-	-
2000	20	77	26	98	46	175

<sup>a</sup> A total of 70 dead adult fur seals of both sexes were counted on the rookeries of St. George Island.

<sup>b</sup> Includes 10 dead adult fur seals of unknown sex.

<sup>c</sup> Includes 16 dead adult fur seals of unknown sex.

<sup>d</sup> Includes 2 dead adult fur seals of unknown sex.

<sup>e</sup> Counts made only on the 6 sample rookeries where dead pups were counted.

<sup>f</sup> Includes 16 dead adult fur seals of unknown sex.

<sup>g</sup> A total of 108 dead adults were counted on St. Paul Island and 34 dead adults were counted on St. George Island.

## APPENDIX C

Scientific staff engaged in northern fur seal  
field research in 2000-2001

National Marine Mammal Laboratory  
Douglas P. DeMaster, Director  
Thomas R. Loughlin, Leader, Alaska Ecosystem Program  
Rolf R. Ream, Northern Fur Seal Task

Name	Affiliation
<u>Employees</u>	
Kate Call	NMML
Robert Caruso	NMML
Robert Delong	NMML
Charles Fowler	NMML
Sharon Melin	NMML
Rolf Ream	NMML
Bruce Robson	NMML
Elizabeth Sinclair	NMML
Jeremy Sterling	NMML
Jim Thomason	NMML
Rod Towell	NMML
Anne York	NMML
Tonya Zeppelin	NMML
<u>Research Associates and Cooperators</u>	
Kimberlee Beckman	UAF
Ivan Blokhin	TINRO
Aquilina Lestenkof Bourdukofsky	TGSP



David Cormany	NMFSJ
Karen Holzer	PISP
Joanne Mellish	TA&M
Sean Oliver	SA
Peter Shaughnessy	CSIRO
Kent Sundseth	NMFS/USFWS
Terry Spraker	WPI
Michael T. Williams	LGL
Phillip Zavadil	TGSP

Appendix C.-- continued

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Affiliation Code

CSIRO - Commonwealth Scientific & Industrial Research Organization

LGL - LGL Associates, Anchorage, AK

NMFS - National Marine Fisheries Service

NMFSJ - National Marine Fisheries Service Regional Office, Juneau, Alaska

NMML - National Marine Mammal Laboratory

PISP - Pribilof Island Stewardship Program

SA - Seattle Aquarium

TA&M - Texas A&M University

TGSP - Tribal Government of St. Paul, St. Paul Island, Alaska

UAF - University of Alaska, Fairbanks

USFWS - U. S. Fish and Wildlife Service, Alaska Maritime Wildlife Refuge, Homer, Alaska

TINRO - Pacific Research Institute of Marine Fisheries and Oceanography, Russia

WPI - Wildlife Pathology International

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