



NOAA Technical Memorandum NMFS-AFSC-174

Fur Seal Investigations, 2004-2005

by
J. W. Testa (editor)

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

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National Marine Mammal Laboratory
Alaska Fisheries Science Center
c/o Biological Sciences
University of Alaska Anchorage
3211 Providence Drive
Anchorage AK 99508
www.afsc.noaa.gov

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ABSTRACT

Researchers from the Alaska Fisheries Science Center's 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 estimate of the total stock for the Pribilof Islands population in 2004 was ~756,000. The approximate total stock size for the United States was 823,000 northern fur seals.

In 2004 and 2005, 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 2004 yielded totals of 1,403 territorial male seals with females and 6,928 idle adult male seals; in 2005, 1,466 and 7,860 were counted in those categories, respectively. On St. George Island in 2004, a total of 321 territorial males with females and 1,344 idle adult males were counted; 273 and 1,266 were counted in those categories in 2005. On St. Paul Island, 493 and 479 sub-adult male seals were harvested in 2004 and 2005, respectively. On St. George Island, 123 and 139 sub-adult male seals were taken in the two harvest years, respectively.

In 2004, the number of pups born and the mortality rates of fur seals were assessed on St. Paul and St. George Islands. The estimate for the total number of pups born was 122,825 (SE = 1290) on St. Paul Island (excluding Sea Lion Rock) and 16,878 (SE = 271) on St. George Island. Pup mortality from birth to late August was 3.3% on St. Paul Island and 2.5% on St. George Island. The annual rate of decline on St. Paul Island was 6.00% (SE = 0.70%, P = 0.01) and

4.56% (SE = 0.43%, P = 0.01) on St. George Island from 1998 to 2004. The rate of decline on the Pribilof Islands (excluding Sea Lion Rock) was 5.83% (SE = 0.53%, P = 0.01) since 1998.

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. Both male and female pups on St. George Island were significantly ($P < 0.01$) longer and heavier than those on St. Paul Island. The sex ratio in 2002 was significantly ($P < 0.016$) skewed toward males on both St. Paul Island (54.2:45.8) and St. George Island (54.9:45.1).

Pup production on San Miguel Island, California, was estimated at 1,238 and 1,628 in 2004 and 2005, respectively. There was no evidence of a trend in recent estimates, but early season pup mortality in 2004 (34.5%) and 2005 (30.4%) was higher than any of the previous 7 years (4.4-27.4%). Pup weights conformed to the long-term average at San Miguel Island. Pup production remained below the 1997 production levels by more than 23% in Adams Cove and by more than 19% at Castle Rock in 2005.

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INTRODUCTION

by

J. Ward Testa

The northern fur seal (*Callorhinus ursinus*) population in the Pribilof Islands Archipelago (on St. Paul and St. George Islands, Figs. 1-3) constitutes approximately 55% of the world population. Smaller breeding colonies are located on the Kuril and Commander Islands in Russia, Bogoslof Island (Fig. 4) in the southeastern Bering Sea, and San Miguel Island (Fig. 5) off California. The rookeries at San Miguel and Bogoslof Islands probably originated in the late 1950s (DeLong 1982) and 1980 (R.R. Ream, pers. comm.), respectively.

Northern fur seals were placed under international management in 1911 under the Treaty for the Preservation and Protection of Fur Seals and Sea Otters between the United States, Russia, Japan, and Great Britain after over a century of commercial exploitation (Gentry 1998). The major population concentration on the Pribilof Islands has been monitored since that time, primarily by counting of territorial adult males and newborn pups on the rookeries. The population grew rapidly from 1911 (possibly 5-8%/year) until the late 1930s, and remained at high levels throughout the 1940s and 1950s. Japan abrogated the convention in 1941, and a new convention was signed in 1957 that called for commercial harvest of adult female fur seals to reduce population size and, according to theory, maximize productivity of the population for commercial harvest. The population declined under that harvest from 1958-68, but productivity did not increase. After a brief rebound in the early 1970s, the population declined further. At St. Paul Island the population fluctuated for two decades at 35-45% of its peak numbers, while the smaller population at nearby St. George has declined at a more or less steady rate to less than

30% of the peak. Commercial harvesting of fur seals was discontinued on St. George Island in 1973 and on St. Paul Island in 1984, but a small subsistence harvest continues on both islands. There is no subsistence or commercial harvest on the remaining U.S. rookeries.

Northern fur seals were designated as depleted in 1988 under the Marine Mammal Protection Act. This report is part of an ongoing effort by the Alaska Fisheries Science Center's National Marine Mammal Laboratory (NMML), to monitor the status of northern fur seals on U.S. rookeries and disseminate that information. Research by the NMML on northern fur seals in 2004 and 2005 was conducted under Marine Mammal Protection Act Permit Nos. 782-1455 and 782-1708-00.

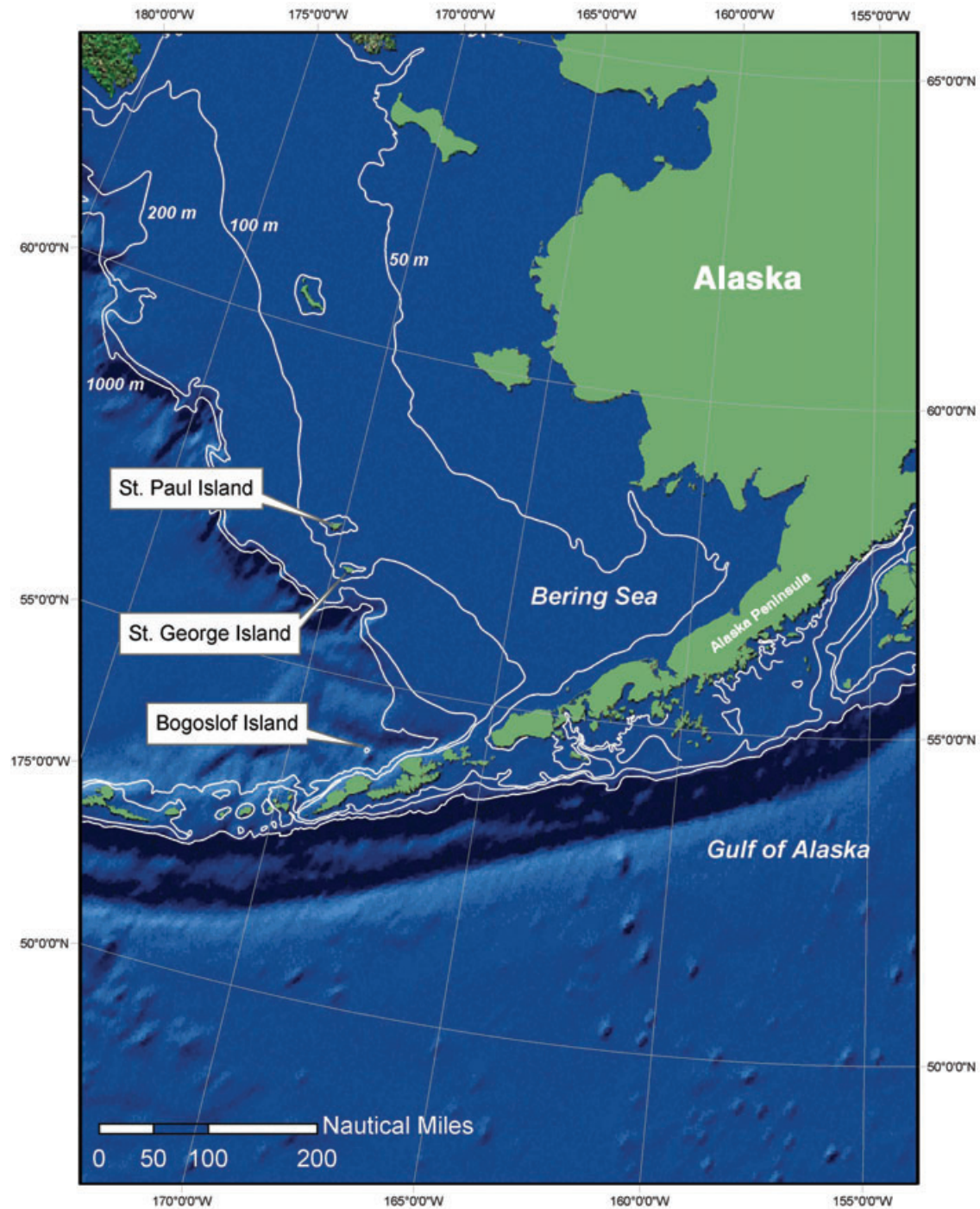


Figure 1.-- Location of the three northern fur seal breeding areas within U.S. Alaskan waters.

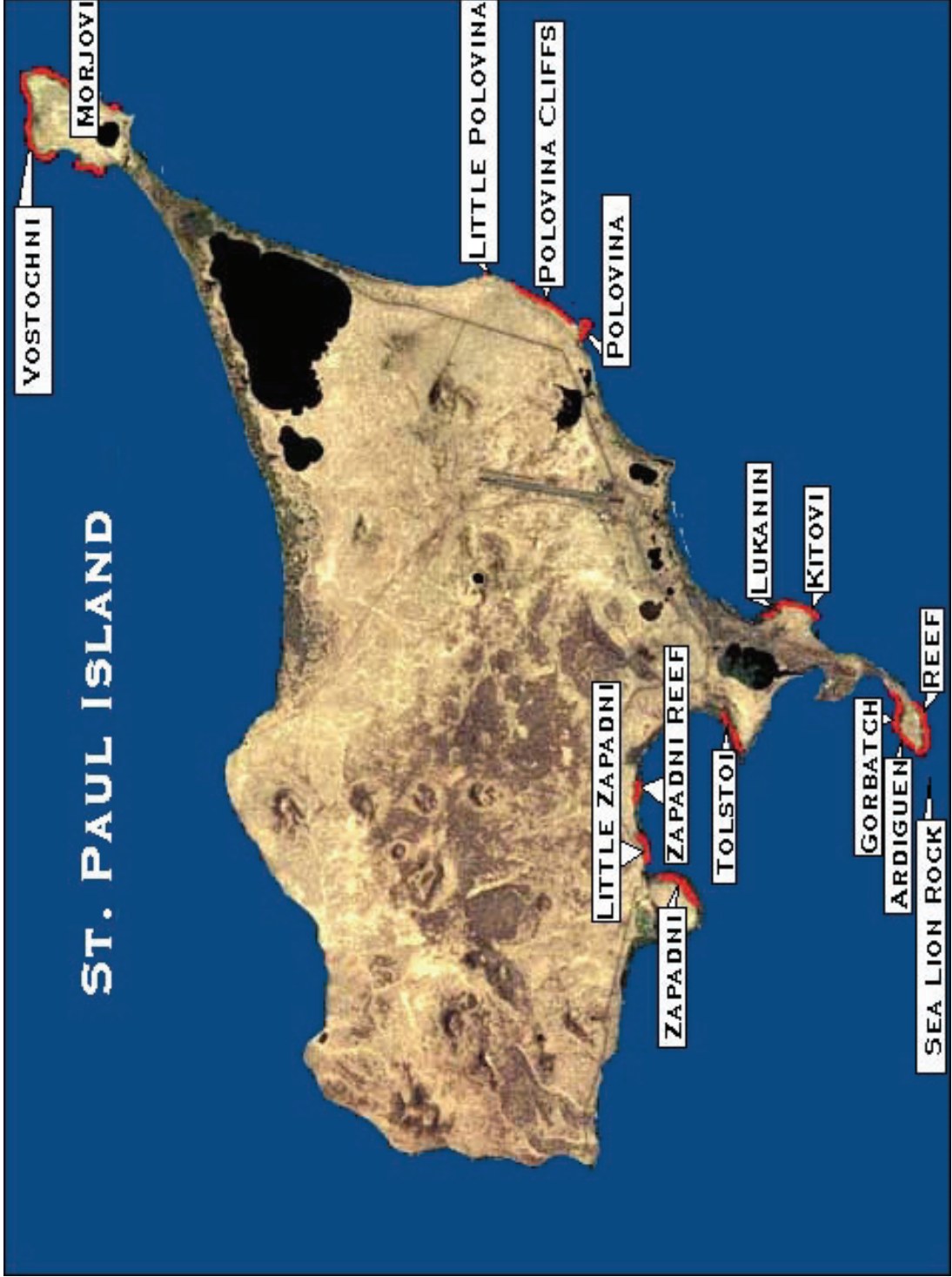


Figure 2.-- Location of northern fur seal rookeries on St. Paul Island, Alaska.

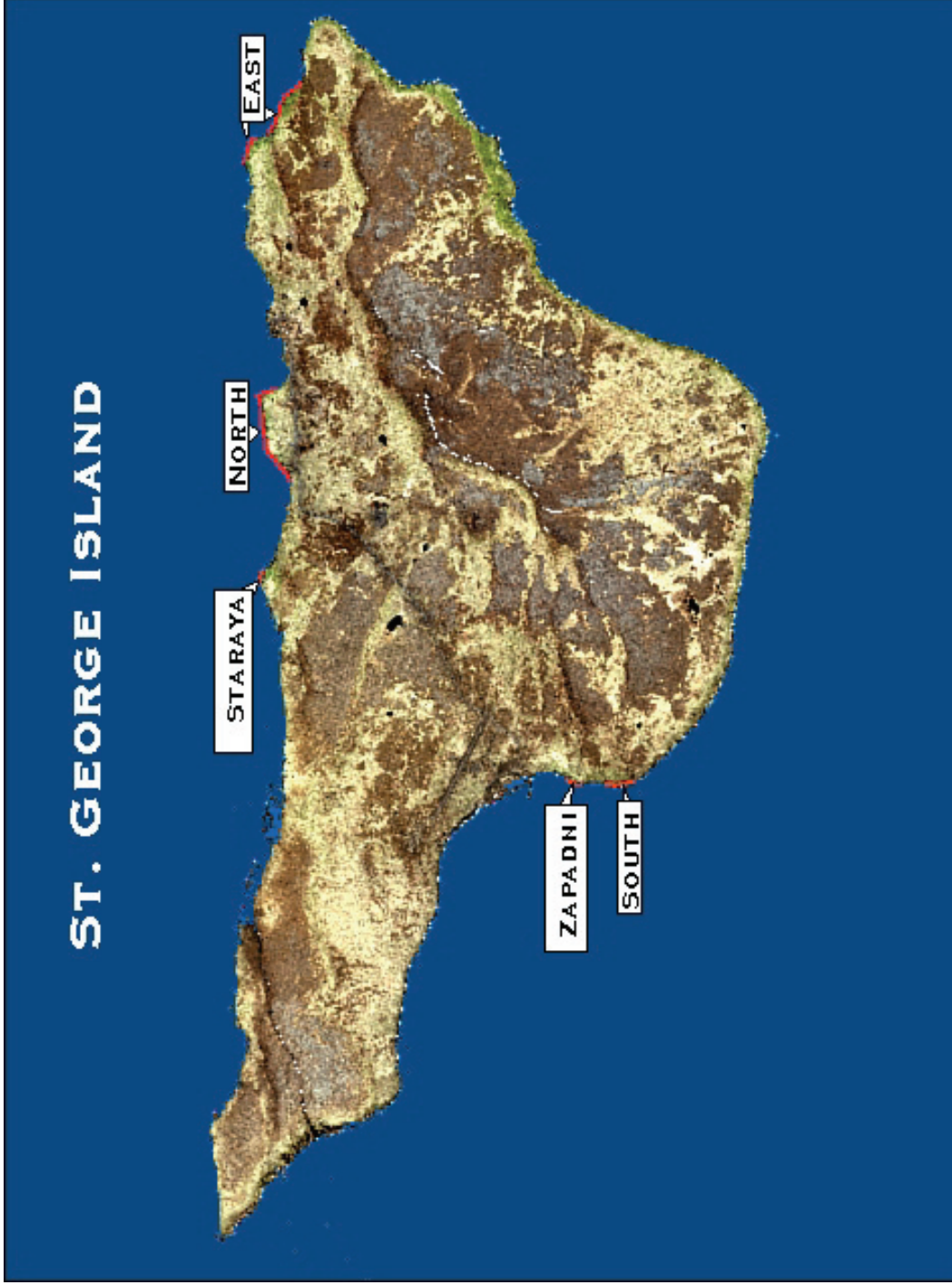


Figure 3.-- Location of northern fur seal rookeries on St. George Island, Alaska.

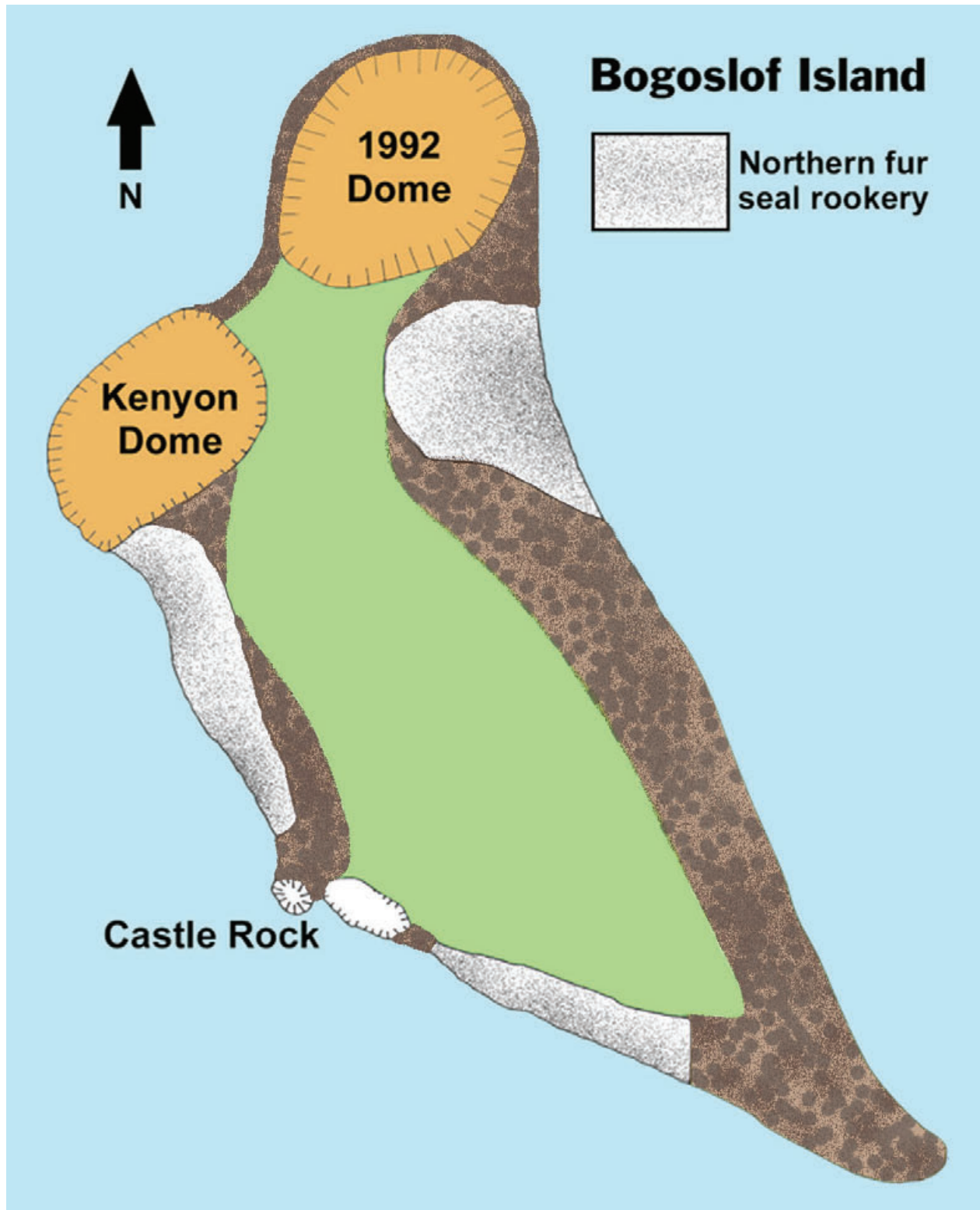


Figure 4.-- Location of northern fur seal rookeries on Bogoslof Island, Alaska.



Figure 5.-- Location of northern fur seal rookeries on San Miguel Island, California.

POPULATION ASSESSMENT OF NORTHERN FUR SEALS

ON THE PRIBILOF ISLANDS, ALASKA, 2004 - 2005

by

Rodney G. Towell, Rolf R. Ream, Charles W. Fowler, and Jeremy T. Sterling




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).

METHODS

Population characteristics monitored in 2004 included the size of the subsistence harvest, numbers of adult males and pups, 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 2005.

The subsistence harvest was monitored for the number of juveniles killed, waste, adult animals killed or injured, entanglement, hyperthermic seals, and other unusual conditions. Monitoring on St. Paul Island was conducted and reported by staff from the St. Paul Island Tribal Governments Ecosystem Conservation Office under contract with the National Marine Fisheries Service.

CLASSES OF ADULT MALES

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

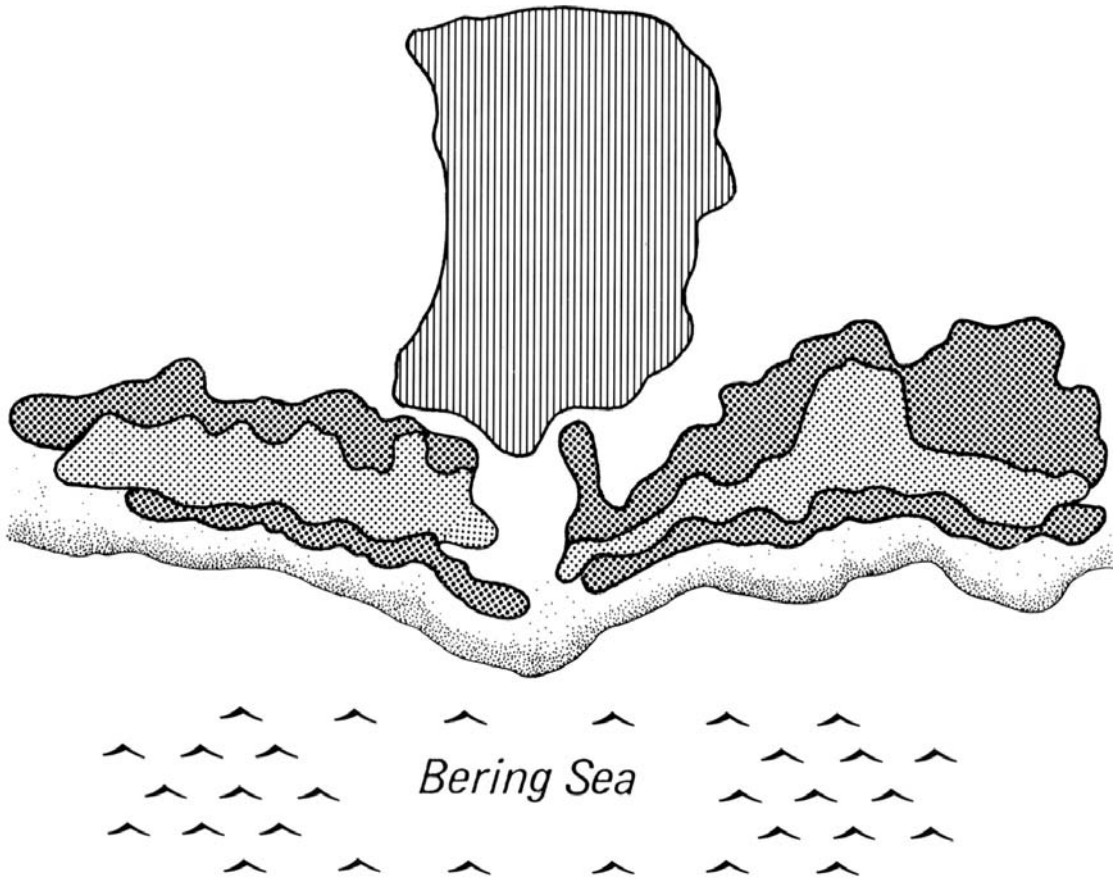


Figure 6.-- The relative location of the different classes of adult males for a typical fur seal rookery/haul-out complex.

Adult male fur seals were counted by section for each rookery (see Appendix A glossary for definitions of terms and Figure 6 for illustration of a typical fur seal rookery) on St. Paul Island from 9-14 July 2004 and 9-15 July 2005 (Appendix Tables B-1 and B-2, respectively) and on St. George Island from 9-10 July 2004 and 10-14 July 2005.

On St. Paul Island, dead fur seal pups were counted and the numbers of live pups were estimated on 13 rookeries in August 2004 using the shearing-sampling method (York and Kozloff 1987, Antonelis 1992). From 7 to 14 August, 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 in 2002. 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 counted in each section of the sampled rookery. The ratio of marked to unmarked pups was determined by two observers scanning (with the aid of binoculars when necessary) on two occasions for each rookery from 12 to 26 August. Each observer counted marked and unmarked pups independently to ensure that the entire rookery was well sampled. Each sampling day was considered an independent replicate; the variance was computed for each rookery based on these replicates (York and Kozloff 1987). The approximate 95% confidence interval (CI) of pups born was computed by multiplying the standard error (SE) of the estimate of total pups by 2.16 (the 97.5 percentile of Student's t-distribution with 13 degrees of freedom). Little Polovina rookery was not sampled due to the concern that this small rookery might be more sensitive to disturbance. We estimated the number of pups born on Little Polovina rookery from a regression of total pups born versus numbers of breeding adult males. By assuming that the pup mortality on Little Polovina rookery was equal to the observed rate on the other rookeries, we estimated the number

of dead pups as the product of that mortality rate and the estimate of total pups born. Dead pups were counted from 19 to 26 August on all sampled rookeries.

The number of pups born on St. George Island was estimated from a shearing-sampling study conducted on all rookeries from 16 to 18 August 2004 in the same manner as applied on St. Paul Island. The ratio of marked to unmarked pups on each rookery was determined by three observers from 19 to 21 August and again from 22 to 23 August. Counts of dead pups were made from 20 to 26 August 2004.

RESULTS AND DISCUSSION

Harvest

A total of 493 and 479 sub-adult male seals were harvested for subsistence on St. Paul Island in 2004 and 2005, respectively (Table 1). On St. George Island, 123 sub-adult male seals were taken in the subsistence harvest in 2004 and 139 were killed in 2005 (Table 2). Two females were accidentally killed in the 2004 harvest on St. George Island and included as part of the subsistence harvest (Table 2).

Adult Males Counted

The count of territorial males with females (Class 3 or harem males) on St. Paul Island decreased 10.0% between 2003 and 2004, but increased 7.0% between 2004 and 2005 (Tables 3 and 4; Appendix Table B-3). The count of harem males on St. George Island increased 6.1% between 2003 and 2004, and increased 19.1% between 2004 and 2005 (Tables 3 and 4; Appendix Table B-3). Owing to the larger size of the population on St. Paul Island, the Pribilof

Islands total for harem males decreased by 9.3% between 2003 and 2004 and increased 9.2% between 2004 and 2005.

Number of Pups Born on St. Paul Island in 2004

The estimated total number of pups alive on St. Paul Island at the time of marking in 2004 was 118,784 (SE = 1,290) (Table 5; Towell et al. 2006). The number of dead pups on all rookeries of St. Paul Island was estimated to be 4,041 (Appendix Table B-5): 4,039 counted on sampled rookeries and 2 estimated on Little Polovina rookery (Towell et al. 2006). The estimated mortality rate for late August was 3.3% (Table 6). The total number of pups born on St. Paul Island in 2004 was estimated at 122,825 (SE = 1,290; 95% CI = $\pm 2,786$). The standard error accounts for variance in the estimation of both live and dead pups (York and Towell 1996).

The above total does not include the pups on Sea Lion Rock. Sea Lion Rock was not sampled in 2004 due to logistical difficulties. The last estimate of pup production on Sea Lion Rock was 8,262 in 2002.

The number of pups born and the number of harem bulls at different rookeries on St. Paul Island are significantly correlated (correlation = 0.944, Fig. 7). The slope of the regression line with a zero intercept is 34.60 (SE = 2.43), representing an estimate of the ratio of pups to breeding males.

Number of Pups Born on St. George Island in 2004

Estimated total number of pups alive on St. George Island at the time of marking was 16,461 (SE = 238.9, Table 8) (Towell et al. 2006). The total number of dead pups was 417

Table 1.-- Date, location, and number of sub-adult male northern fur seals killed in subsistence harvest drives on St. Paul Island, Alaska, in 2004 and 2005.

2004			2005		
Date	Rookery	Number killed	Date	Rookery	Number killed
July 16	Zapadni	62	July 16	Gorbatch	59
July 17	Reef/Gorbatch	56	July 25	Zapadni	48
July 24	Polovina	73	July 26	Polovina	65
August 3	Reef/Gorbatch	75	August 5	Zapadni	69
August 6*	Zapadni	108	August 6	Polovina	55
August 7	Zoltoi	119	August 8	Gorbatch	48
			August 9	Polovina	89
			August 10	Lukanin	46

* Includes 2 accidental fatalities.

Table 2.-- Date, location, and number of sub-adult male northern fur seals killed in subsistence harvest drives on St. George Island, Alaska, in 2004 and 2005.

2004			2005		
Date	Rookery	Number killed*	Date	Rookery	Number killed
July 13	North	13	July 6	North	19
July 18	Zapadni	12	July 12	Zapadni	12
July 21	North	20	July 20	North	19
July 25	Zapadni	18	July 28	Zapadni	15
July 29	North	26	July 29	North	16
August 3	North	21	August 3	Zapadni	15
August 6	North	13	August 4	North	13
			August 8	Zapadni	30

* Includes 2 females in total for 2004.

Table 3.-- Number of adult male northern fur seals counted by rookery and behavior class (2 = territorial without females, 3 = territorial with females, 5 = non-territorial on hauling grounds), Pribilof Islands, Alaska, July 2004.

Rookery	Date (July)	Class of adult male *			Total
		2	3	5	
<u>St. Paul Island</u>					
Lukanin	9	39	90	113	242
Kitovi	9	112	129	185	426
Reef	11	166	394	343	903
Gorbatch	11	92	237	475	804
Ardiguen	11	16	39	22	77
Morjovi	14	103	281	329	713
Vostochni	14	177	742	452	1,371
Polovina	10	37	69	253	359
Little Polovina	10	0	2	235	237
Polovina Cliffs	10	145	283	151	579
Tolstoi	9	199	317	318	834
Zapadni Reef	12	58	141	142	341
Little Zapadni	12	91	238	107	436
Zapadni	12	168	324	499	991
Island total		1,403	3,286	3,642	8,313
<u>St. George Island</u>					
South	9	69	184	82	335
North	10	134	247	235	616
East Reef	9	19	59	60	138
East Cliffs	9	51	156	79	286
Staraya Artil	10	22	39	46	107
Zapadni	9	26	75	82	183
Island total		321	760	584	1,665

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

Table 4.-- Number of adult male northern fur seals counted by rookery and behavior class (2 = territorial without females, 3 = territorial with females, 5 = non-territorial on hauling grounds), Pribilof Islands, Alaska, July 2005.

Rookery	Date (July)	Class of adult male *			Total
		2	3	5	
<u>St. Paul Island</u>					
Lukanin	9	55	105	165	325
Kitovi	9	91	157	226	474
Reef	11	182	441	464	1,087
Gorbatch	11/15	139	259	592	990
Ardiguen	11	18	54	3	75
Morjovi	12	109	296	425	830
Vostochni	12/15	200	724	550	1,474
Polovina	10	31	73	174	278
Little Polovina	10	3	3	236	242
Polovina Cliffs	10	129	307	130	566
Tolstoi	9	157	305	441	903
Zapadni Reef	14	52	167	179	398
Little Zapadni	14	101	241	269	611
Zapadni	13/14	199	383	491	1,073
Island total		1,466	3,515	4,345	9,326
<u>St. George Island</u>					
South	11	53	188	38	279
North	13	87	340	88	515
East Reef	12	20	60	29	109
East Cliffs	12	68	188	59	315
Staraya Artil	10	20	48	101	169
Zapadni	11/14	25	81	46	152
Island total		273	905	361	1,539

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

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 and standard error (SE), on sampled rookeries of St. Paul Island, Alaska, 2004. Sea Lion Rock was not sampled due to logistical difficulties.

Rookery	Sheared	E1	E2	Mean	SE
Lukanin	339	3,169	2,817	2,993	176.0
Kitovi	548	4,752	4,849	4,800	48.5
Reef	1,656	14,770	15,755	15,262	492.5
Gorbatch	1,147	9,473	9,665	9,569	96.0
Ardiquen	152	1,054	1,262	1,158	104.0
Morjovi	1,089	8,958	8,604	8,781	177.0
Vostochni	2,407	19,309	18,436	18,872	436.5
Polovina	287	2,619	2,403	2,511	108.0
Polovina Cliffs	1,375	11,392	10,386	10,889	503.0
Tolstoi	1,768	12,585	13,706	13,146	560.5
Zapadni Reef	588	4,671	5,162	4,916	245.5
Little Zapadni	1,293	10,225	9,817	10,021	204.0
Zapadni	1,912	15,117	16,481	15,799	682.0
Sea Lion Rock	n/a	n/a	n/a	n/a	n/a
Total	14,561	118,094	119,343	118,717	1,290

Table 6.-- Number of pups alive at the time of marking, standard error (SE), 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 sampled rookeries of St. Paul Island, Alaska, 2004. Sea Lion Rock was not sampled due to logistical difficulties.

Sample Rookery	Pups alive at marking	SE	Dead pups*	Total pups born	Mortality rate (%)	Harem males	Ratio pups/males
Lukanin	2,993	176.0	102	3,095	3.3	90	34.39
Kitovi	4,800	48.5	111	4,911	2.3	129	38.07
Reef	15,262	492.5	456	15,718	2.9	394	39.89
Gorbatch	9,569	96.0	417	9,986	4.2	237	42.14
Ardiguen	1,158	104.0	38	1,196	3.2	39	30.67
Morjovi	8,781	177.0	237	9,018	2.6	281	32.09
Vostochni	18,872	436.5	618	19,490	3.2	742	26.27
Polovina	2,511	108.0	70	2,581	2.7	69	37.41
Little Polovina	67	4.9	2	69	2.9	2	34.50
Polovina Cliffs	10,889	503.0	177	11,066	1.6	283	39.10
Tolstoi	13,146	560.5	639	13,785	4.6	317	43.49
Zapadni Reef	4,916	245.5	171	5,087	3.4	141	36.08
Little Zapadni	10,021	204.0	418	10,439	4.0	238	43.86
Zapadni	15,799	682.0	585	16,384	3.6	324	50.57
Sea Lion Rock	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	118,784	1,289.8	4,041	122,825	3.3	3,286	37.38

* Includes dead pups taken for necropsies from Vostochni (36), Reef (62), Morjovi (1), Kitovi (1) and Polovina Cliffs (1).

(Appendix Table B-7) and the estimated mortality rate was 2.5% (Table 9) (Towell et al. 2006). The total number of pups born on St. George Island was 16,878 (SE = 271, 95% CI = \pm 585).

The 2004 estimate of pups born on St. George Island was not significantly different than the estimate of pups born in 2002 ($P = 0.12$) but was significantly less than the estimate of pups born in 2000 ($P < 0.01$). The number of pups born and the number of harem males on St. George Island rookeries were highly correlated ($y = 21.89x$, $r^2 = 0.99$; Fig. 7). The intercept of the regression line was not significantly different from zero ($P = 0.62$) and was not included in the regression equation.

Trends in Numbers of Pups

The total estimated number of pups born on St. Paul Island in 2004 (not including Sea Lion Rock) was 15.7% less than in 2002 (Fig. 8; $P < 0.01$; Towell et al. 2006). Appendix Table B-3 summarizes pup production and mortality excluding Sea Lion Rock since 1977. On St. Paul Island, estimated numbers of fur seal pups born in 2002 were 8.2% less than in 2000 (Appendix Table B-3). On St. George Island there was a 12.8% decrease between 2000 and 2002 and a 4.1% decrease between 2002 and 2004. Since 2002, pup production remains below estimated pup production of 1919 on St. Paul Island and below the estimated pup production of 1916 on St. George Island, when the northern fur seal population was increasing at about 8% per year as it was recovering from a pelagic harvest that ended in the early 20th century.

Pup production on the Pribilof Islands has been declining since 1998 at an annual rate of 6.00% (SE = 0.70%, $P = 0.01$) on St. Paul Island and 4.56% (SE = 0.43%, $P = 0.01$) on St. George Island to 2004 (Towell et al. 2006). The overall rate of decline on the Pribilof Islands

(excluding Sea Lion Rock) was 5.83% (SE = 0.53%, P = 0.01) from 1998-2004 (Towell et al. 2006).

Table 7.-- Number of pups sheared, number of pups estimated to be alive at the time of marking (E1 and E2), mean number alive (Mean) and the standard error of the mean (SE), for St. George Island, Alaska, 2004.

Rookery	Sheared	E1	E2	Mean	SE
South	362	3,704	3,844	3,774	70
North	589	5,324	5,274	5,299	25
East Reef	86	970	860	915	55
East Cliffs	333	3,253	3,357	3,305	52
Staraya Artil	120	842	1,106	974	132
Zapadni	240	2,025	2,362	2,194	168
Total	1,730	16,118	16,803	16,461	239

Table 8.-- Number of pups alive at the time of marking, standard error (SE), number of dead pups, total pups born, mortality rate, harem males, and the ratio of pups alive at marking to harem males for St. George Island, Alaska, 2004.

Rookery	Pups alive at marking	SE	Dead pups	Total pups born	Mortality rate (%)	Harem males	Ratio pups/males
South	3,774	70.0	134	3,908	3.4	184	21.24
North	5,299	25.0	98	5,397	1.8	247	21.85
East Reef	915	55.0	20	935	2.1	59	15.85
East Cliffs	3,305	52.0	72	3,377	2.1	156	21.65
Staraya Artil	974	132.0	27	1,001	2.7	39	25.67
Zapadni	2,194	168.5	66	2,260	2.9	75	31.13
Total	16,461	238.9	417	16,878	2.5	760	22.21

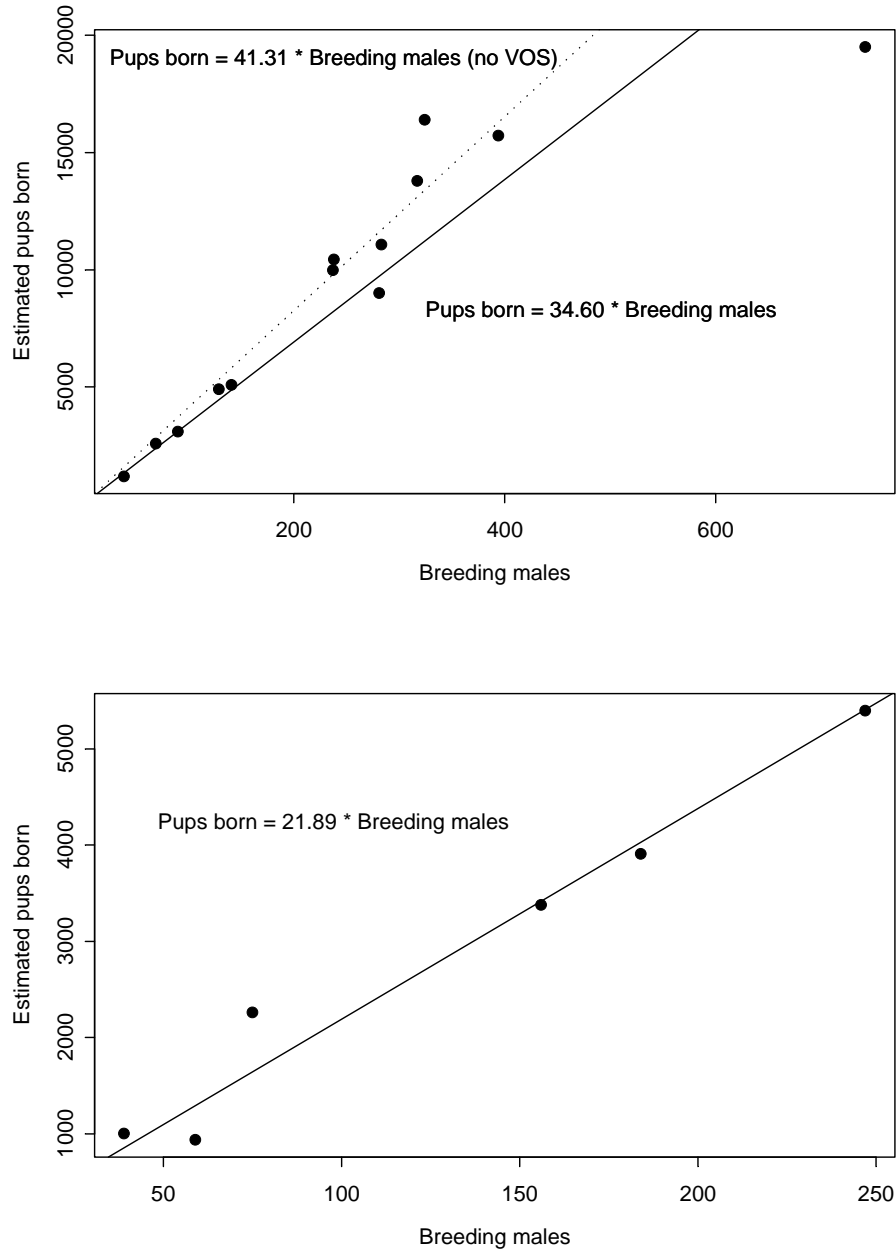


Figure 7.-- Pups born versus number of breeding males on St. Paul Island (top) and St. George Island (bottom), Alaska, 2004. Solid regression lines are shown for both locations; dotted line in top graph is regression excluding outlier (Vostochoi rookery) at far right.

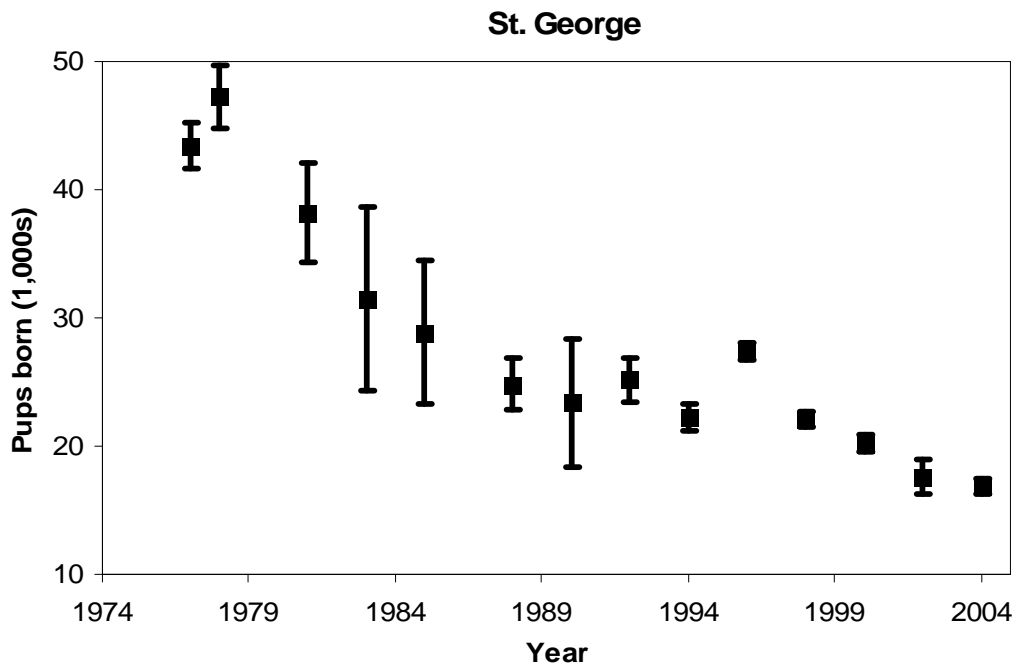
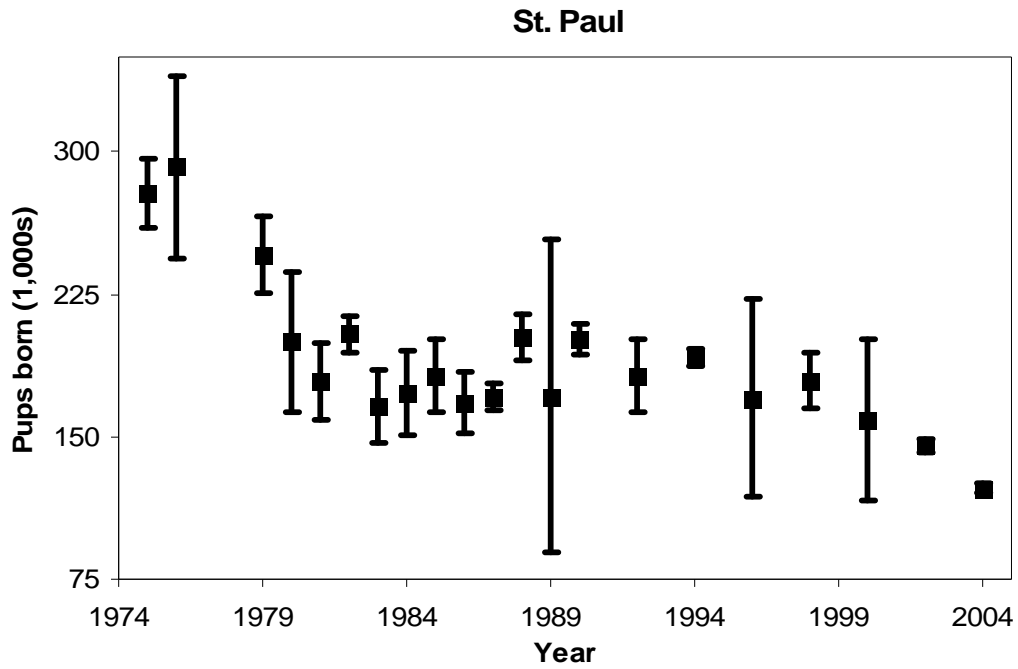


Figure 8.-- Estimated number of pups born (\pm 95% confidence intervals) on St. Paul and St. George Islands, Alaska, 1975-2004.

Estimate of Total Stock Size

Rough estimates of the total fur seal abundance have been presented in the past (Loughlin et al. 1994). These were calculated by multiplying the average number of pups born over the past three censuses by a correction factor of 4.47 (See Table 9 for the calculation method). That correction factor was derived from estimates of survival and fecundity (Loughlin et al. 1994) using data collected at sea during 1958-74. Its application here rests on the assumption that these vital rates were still valid. Since we cannot verify this assumption, the estimate must be viewed as a rough approximation. The estimate of the total stock for the Pribilof Islands population in 2004 (Table 9) was about 756,000 fur seals. The total stock size for the United States, which includes the Pribilof, Bogoslof, and San Miguel Islands, was approximately 823,000 fur seals.

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

Tooth samples (usually canines) were collected from dead fur seals older than pups whenever possible. Additionally, sample rookeries and adjacent beaches of St. Paul Island and all rookeries of St. George Island were surveyed for dead fur seals older than pups during August 2004. Tooth samples were collected from 154 fur seals: 132 on St. Paul Island and 22 on St. George Island. Appendix Table B-8 summarizes the number of dead male and female fur seals from which teeth were collected from 1970 to 2004.

Table 9.-- Details of the computation of stock size estimates of fur seals in U.S. rookeries in 2004. Separate columns are given for the Pribilof (St. George and St. Paul Islands, including Sea Lion Rock) and non-Pribilof populations (San Miguel and Bogoslof Islands).

Formula	San Miguel and		Component
	Pribilof Islands	Bogoslof Islands ²	
Average for 2000, 2002, 2004 ¹	168,902	14,926	Pups
(Pups) × (0.5)	84,451	7,463	Yearlings
(Yearlings) × (0.8)	67,561	5,970	Age 2 year
(2-year old females) × (0.86)/2	29,051	2,567	Females age 3 year
(2-year old males) × (0.8)/2	27,024	2,388	Males age 3 year
(Total pups) / (0.6)	281,503	24,877	Females 3+ years
(3-year old males × (3.6)	97,286	8,597	Males 4+ years
Total	755,778	66,788	

¹ The 2002 estimate for Sea Lion Rock was added to the St. Paul estimates of pup production for all years because it is the most current.

² The 2003, 2004, and 2005 estimates for San Miguel Island and the 2005 estimate for Bogoslof Island were used. Note that there were no data available from Castle Rock near San Miguel Island for 2003.

Table 10.-- Number of animals older than pups found dead on the Pribilof Islands from which teeth were collected during August 2004.

Rookery	Male	Female	Unknown	Total
<u>St. Paul</u>				
<u>Lukanin</u> ³	0	3	2	5
<u>Kitovi</u>	1	4	0	5
<u>Reef</u> ²	7	4	0	11
<u>Gorbatch</u>	1	7	0	8
<u>Ardiguen</u> ³	0	0	2	2
<u>Morjovi</u>	0	3	0	3
<u>Vostochni</u> ^{1,3}	1	12	2	15
<u>Polovina</u>	2	3	0	5
<u>Polovina Cliffs</u> ³	2	4	2	8
<u>Tolstoi</u> ^{1,2,3}	9	15	1	25
<u>Zapadni Reef</u> ³	1	2	1	4
<u>Little Zapadni</u>	6	15	0	21
<u>Zapadni</u> ^{1,2}	7	13	0	20
Total St. Paul	37	85	10	132
<u>St. George</u>				
South	1	2	0	3
North	3	4	1	8
East Reef	0	2	0	2
East Cliffs	4	2	0	6
Staraya Artil	0	0	0	0
Zapadni	1	2	0	3
Total St. George	9	12	0	22
Total Both Islands	46	97	11	154

¹ Females, teeth not collected. Vostochni (1), Tolstoi (2), Zapadni (2).

² Males, teeth not collected. Reef (2), Tolstoi (2), Zapadni (2)

³ Unknown, teeth not collected. Lukanin (2), Ardiguen (2), Vostochni (2), Polovina Cliffs (2), Tolstoi (1), Zapadni Reef (1).

MASS, LENGTH, AND SEX RATIOS OF NORTHERN FUR SEAL PUPS
ON THE PRIBILOF ISLANDS, 2004

by

Rodney G. Towell, Rolf R. Ream, and James R. Thomason

Mass and length measurements of northern fur seal pups on St. Paul and St. George Islands have historically been recorded in late August and 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 2004. We also report on comparisons of mass, length, and sex ratios between islands.

METHODS

Pups were sampled in mid- to late August using the techniques described by Antonelis (1992) and Robson et al. (1994). A Pesola spring scale was used to weigh pups to the nearest 0.2 kg. Lengths were measured to the nearest centimeter. We limited statistical comparisons to an analysis of variance of pup mass and length by island, sex, and rookery variables. Significant differences in mass and length by sex between islands 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 with significantly different variances. We used an exact binomial test to determine if the proportion of female pups at different islands and rookeries was significantly different from 50%.

RESULTS AND DISCUSSION

Pup Mass and Length

Pup mass (Fig. 9, Table 11) varied significantly by sex ($P < 0.01$) on St. Paul Island in 2004. Mass of male and female pups were analyzed separately because the variance for males was greater than that for females on St. Paul Island in 2004. Rookery effects on mass were significant for males ($P = 0.011$, Table 12) and females ($P = 0.031$, Table 12). The variance in pup lengths was not significantly different between males and females ($P = 0.63$); therefore, the sexes were analyzed together. Pup lengths (Fig. 10, Table 13) were significantly different by sex ($P < 0.01$) and rookeries ($P < 0.01$) on St. Paul Island (Table 14).

On St. George Island, pup mass (Fig. 9, Table 15) was also significantly different by sex ($P < 0.01$). Again, male and female pup masses were analyzed separately due to the difference in the variances for each sex. Rookery was not a significant factor in the analysis of female mass ($P = 0.411$, Table 16) or male mass ($P = 0.481$). The variance in pup lengths was not significantly different between males and females ($P = 0.22$). The analysis of variance for lengths (Fig. 10, Table 17) indicated significant differences by sex ($P < 0.01$) but not rookery ($P = 0.344$).

Mass and length were compared between islands by sex after testing for unequal variances with an F-statistic assuming normal distributions. Male (St. Paul 9.18 kg, 74.75 cm; St. George 9.56 kg, 78.09 cm) and female pups (St. Paul 7.87 kg, 71.41 cm; St. George 8.21 kg, 74.88 cm) were both heavier and longer on St. George Island than St. Paul Island ($P < 0.01$).

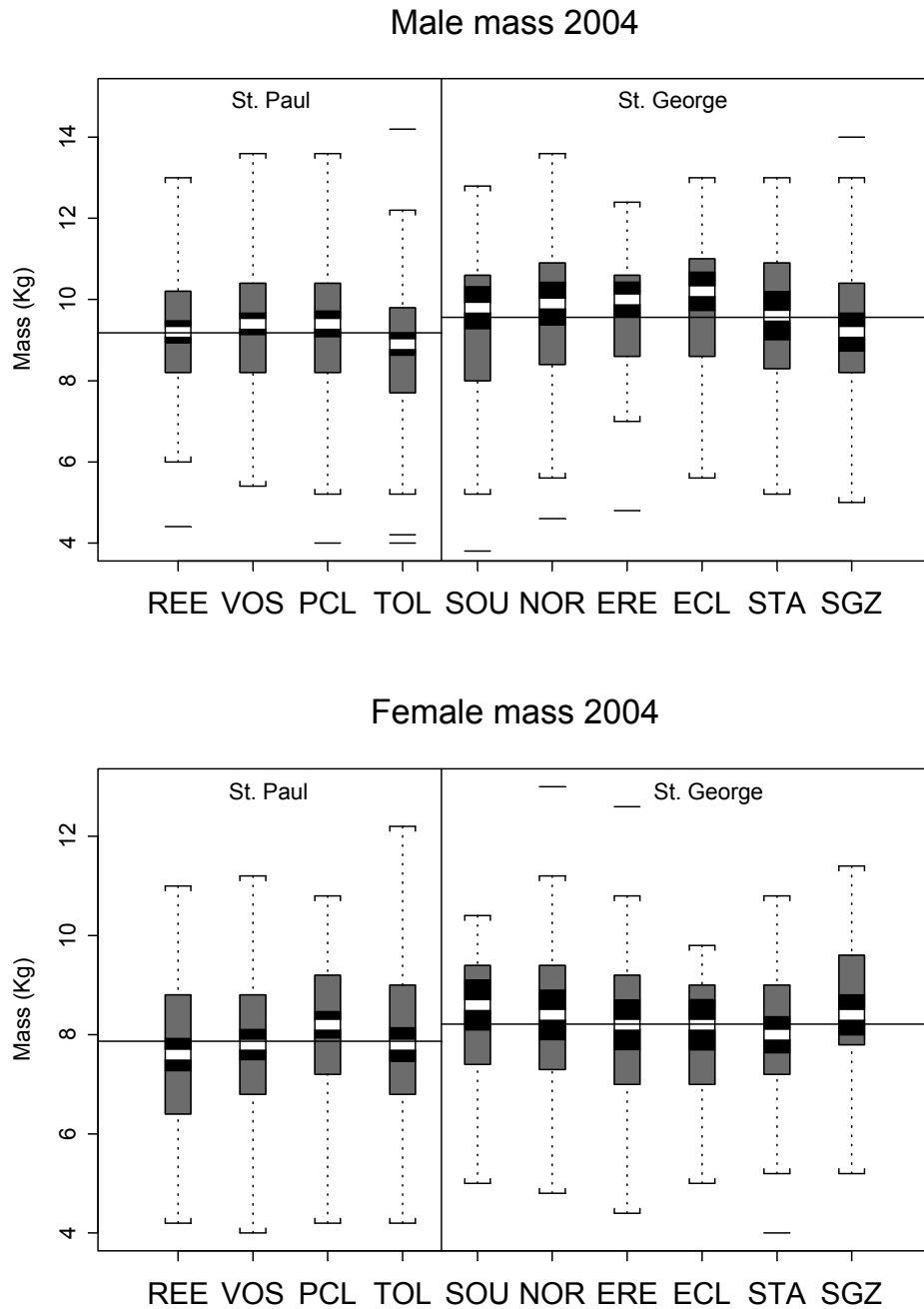


Figure 9.-- Boxplots of the median mass (white line) and its 95% confidence intervals (dark hatch) of northern fur seal pups on St. Paul and St. George Islands, Alaska, August 2004: Reef (REE), Vostochni (VOS), Polovina Cliffs (PCL), Tolstoi (TOL), South (SOU), North (NOR), East Reef (ERE), East Cliffs (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, 22-23 August 2004.

Rookery		Females	Males	Combined
Reef	kg	7.62	9.13	8.37
23 August	SD	1.54	1.54	1.71
	n	136	135	271
Vostochni	kg	7.81	9.42	8.79
23 August	SD	1.50	1.66	1.78
	n	109	173	282
Pol. Cliffs	kg	8.15	9.33	8.70
23 August	SD	1.37	1.67	1.62
	n	141	121	262
Tolstoi	kg	7.87	8.84	8.44
22 August	SD	1.66	1.66	1.72
	n	103	148	251
Combined	kg	7.87	9.18	8.58
	SD	1.52	1.65	1.72
	n	489	577	1,066

Table 12.-- Analyses of variance of mass of male and female northern fur seal pups across rookeries on St. Paul Island, Alaska, August, 2004.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Females							
Rookery	3	20.28	6.76	1,104	485	2.97	0.031
Males							
Rookery	3	30.04	10.01	1,535	573	3.74	0.011

*MSS = SS divided by df

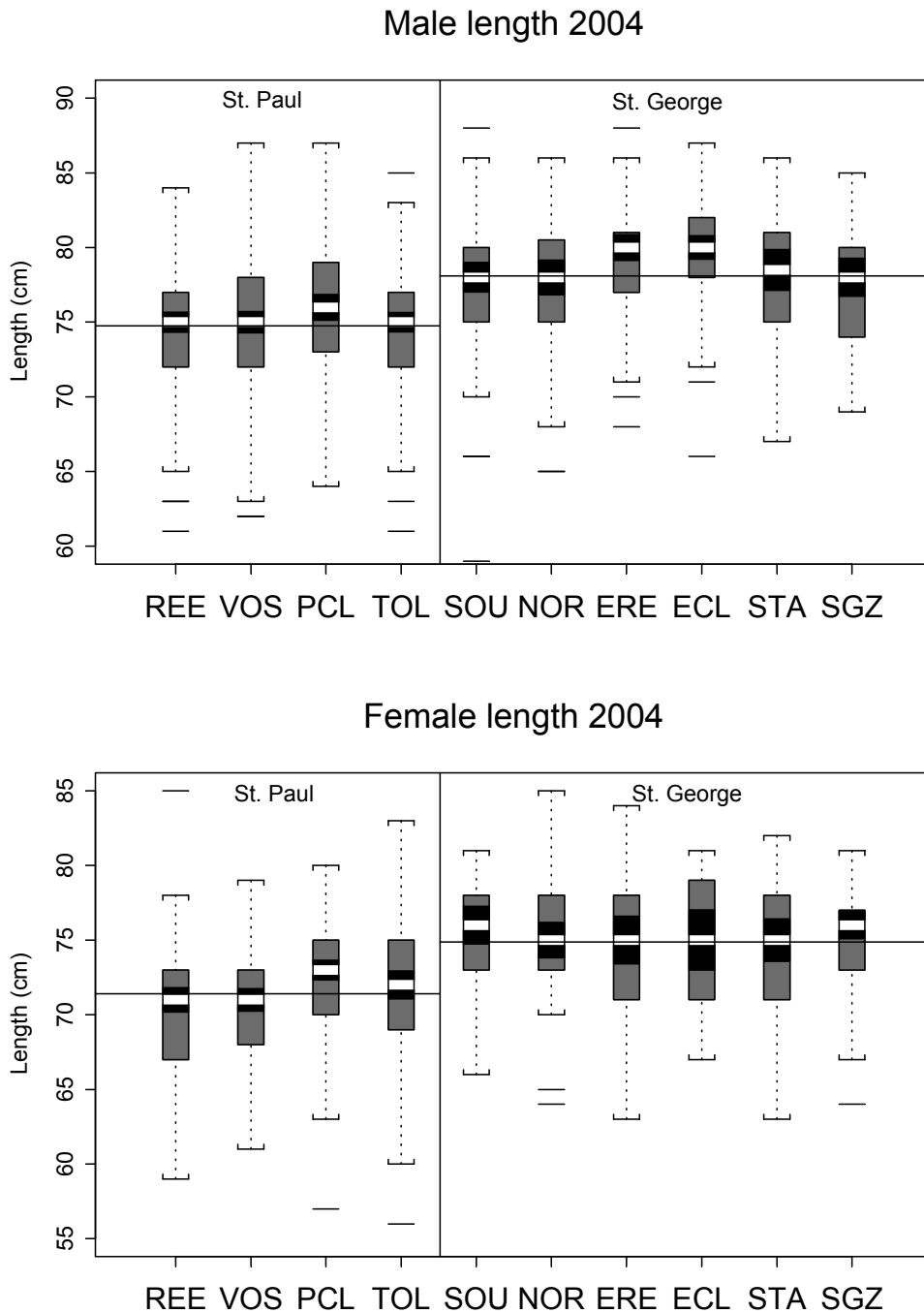


Figure 10.-- Boxplots of the median length (white line) and 95% confidence intervals of the median length (dark hatch) of northern fur seals on St. Paul and St. George Islands, Alaska, August 2004: Reef (REE), Vostochni (VOS), Polovina Cliffs (PCL), Tolstoi (TOL), South (SOU), North (NOR), East Reef (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, 22-23 August 2004.

Rookery		Females	Males	Combined
Reef	cm	70.23	74.07	72.15
23 August	SD	4.62	4.62	5.00
	n	136	136	272
Vostochni	cm	70.58	74.74	73.13
23 August	SD	3.91	4.39	4.66
	n	109	173	282
Pol. Cliffs	cm	72.79	75.78	74.17
23 August	SD	3.83	4.33	4.33
	N	141	120	261
Tolstoi	cm	71.94	74.54	73.47
22 August	SD	4.79	4.56	4.82
	n	103	148	251
Combined	cm	71.41	74.75	73.21
	SD	4.41	4.50	4.76
	n	489	577	1,066

Table 14.-- Analyses of variance of length of male and female northern fur seal pups on St. Paul Island, Alaska, August 2004.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Sex	1	2,956	2,956	21,187	1,064	152.78	< 0.01
Rookery	3	660	220	20,527	1,061	11.36	< 0.01

*MSS = Sum of squares (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, 24-26 August 2004.

Rookery		Females	Males	Combined
South	kg	8.46	9.37	9.03
25 August	SD	1.34	1.90	1.75
	n	39	63	102
North	kg	8.34	9.59	9.04
24 August	SD	1.59	1.95	1.89
	n	44	56	100
East Reef	kg	8.06	9.68	8.92
25 August	SD	1.57	1.48	1.72
	n	48	54	102
East Cliffs	kg	7.96	9.87	9.15
26 August	SD	1.32	1.59	1.75
	n	39	64	103
Staraya Artil	kg	8.06	9.55	8.72
24 August	SD	1.46	1.77	1.76
	n	60	48	108
Zapadni	kg	8.44	9.27	8.88
25 August	SD	1.42	1.74	1.65
	n	49	55	104
Combined	kg	8.21	9.56	8.95
	SD	1.46	1.74	1.75
	n	279	340	619

Table 16.-- Analyses of variance of mass of male and female northern fur seal pups across rookeries on St. George Island, Alaska, August 2004.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Females							
Rookery	5	10.8	2.2	580	273	1.01	0.411
Males							
Rookery	5	13.7	2.7	1,018	334	0.90	0.481

*MSS = Sum of squares (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, 24-26 August 2004.

Rookery		Females	Males	Combined
South	cm	75.05	77.37	76.48
25 August	SD	3.45	5.03	4.61
	n	39	63	102
North	cm	75.39	77.43	76.53
24 August	SD	4.19	4.87	4.68
	n	44	56	100
East Reef	cm	74.31	79.02	76.80
25 August	SD	4.65	3.90	4.86
	n	48	54	102
East Cliffs	cm	74.82	79.39	77.66
26 August	SD	4.06	3.76	4.45
	n	39	64	103
Staraya Artil	cm	74.88	77.94	76.24
24 August	SD	4.54	4.57	4.78
	n	60	48	108
Zapadni	cm	74.90	77.27	76.15
25 August	SD	3.79	4.13	4.13
	n	49	55	104
Combined	cm	74.88	78.09	76.64
	SD	4.15	4.45	4.60
	n	279	340	619

Table 18.-- Analyses of variance of length of male and female northern fur seal pups across rookeries on St. George Island, Alaska, August 2004.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Sex	1	1,572	1,572	11,507	617	84.41	<0.01
Rookery	5	105	21	11,402	612	1.13	0.34

*MSS = Sum of square (SS) divided by df

Sex Ratios

The proportions of pups that were females differs significantly from 50% on two of the four sample rookeries on St. Paul Island in 2004 (Table 19). Two of six sample rookeries on St. George Island had a fraction of females significantly different than 50%. The fraction of total females for both islands was significantly different than 50%: 45.8% for St. Paul Island ($P = 0.007\%$) and 45.1% for St. George Island ($P = 0.016$). The observed proportions were not significantly different ($P = 0.764$) between the two islands.

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 strongest pattern was that the size of pups varied by sex; male pups were heavier and longer than female pups. After controlling for sex, both male and female pups on St. George Island were significantly longer and heavier than those on St. Paul Island. The proportion of females was significantly different than 50% on St. Paul Island (45.8%, Table 20) and also on St. George Island (45.1%, Table 20) in 2004. 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 measurement technique. The protocol for taking length measurements is subjective and the process should be more closely examined.

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 2004. The fraction of females is significantly less than 50% ($P = 0.05$) for bold items.

Rookery	Females	Total	Fraction
<u>St. Paul</u>			
Reef	136	272	0.500
Vostochni	109	282	0.387
Polovina Cliffs	141	262	0.538
Tolstoi	103	251	0.410
Total	489	1,067	0.458
<u>St. George</u>			
South	39	102	0.382
North	44	100	0.440
East Reef	48	102	0.471
East Cliffs	39	103	0.379
Staraya Artil	60	108	0.556
Zapadni	49	104	0.471
Total	279	619	0.451

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 1992-2004. Bold numbers indicate the fraction of females significantly different than 50%.

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	--	--	--
2002	424	1016	0.417	300	627	0.478
2004	489	1,067	0.458	279	619	0.451

THE STATUS OF THE NORTHERN FUR SEAL POPULATION
AT SAN MIGUEL ISLAND, CALIFORNIA, 2004 AND 2005

by

Sharon R. Melin, Anthony J. Orr, and Robert L. DeLong

Demographic studies of the northern fur seal population at San Miguel Island, California (34° 01'N, 120° 26'W), have been conducted since the discovery of the colony in 1968. The population originated from the Pribilof Islands and Russian populations during the late 1950s or early 1960s (DeLong 1982). The environment around San Miguel Island is influenced by the California Current and coastal upwelling, which produces fog and wind conditions that keep the island cool during summer months when northern fur seals return to pup and breed. It is this characteristic of the environment that makes San Miguel Island habitable for this species, which is adapted to a colder climate than that found along most of the southern California coast (DeLong 1982).

The northern fur seal population has thrived at San Miguel Island except for two severe declines during 1983 and 1998 that were associated with El Niño events (DeLong and Antonelis 1991, Melin and DeLong 2000). El Niño events cause changes in marine communities by altering the sea level height, sea surface temperature, thermocline depth, current flow patterns, and upwelling strength of marine ecosystems (Norton et al. 1985, Arntz et al. 1991). In response to these changes in oceanographic conditions, prey species of fur seals move farther north and deeper in the water column (Arntz et al. 1991) and thereby become difficult for fur seals to obtain. Consequently, fur seals at San Miguel Island are in poor condition during El Niño events and the population experiences reduced reproductive success and high mortality of pups and

adults (DeLong and Antonelis 1991, Melin and DeLong 1994, Melin et al. 1996, Melin and DeLong 2000). Because El Niño events occur periodically along the California coast and impact the population growth of fur seals at San Miguel Island, they play an influential role in the dynamics of this population (DeLong and Antonelis 1991, Melin and DeLong 1994, Melin et al. 1996).

In 1999, after almost two decades of a warm water regime, the California Current shifted into a cold water regime (Hayward et al. 1999) which persisted through 2005 (Goericke et al. 2005). The cooler sea surface temperatures, shallower thermocline, and strong coastal upwelling associated with the regime shift is expected to create a favorable foraging environment for northern fur seals at San Miguel Island that will result in higher survival and natality rates. However, forces occurring on interannual cycles such as El Niño events may mitigate the advantages of a cold water regime on northern fur seals at San Miguel Island (Venrick et al. 2003). Here, we present the results of the 2004 and 2005 population monitoring studies at San Miguel Island and discuss the long-term effects of the 1997-1998 and 2002-2003 El Niño events on the population growth indices.

METHODS

Census

Censuses were conducted at two colonies of fur seals at San Miguel Island: Adams Cove on the mainland and Castle Rock located offshore (Fig. 5). The Castle Rock colony was only visited once each year, in late July, to conduct a census of live pups. Between 25 May and

20 July, daily censuses of territorial bulls were conducted at Adams Cove and were used as an index of the maximum number of breeding bulls for each year.

Counts of live and dead pups were used as an index of the number of pups born at the Castle Rock and Adams Cove colonies. Total births each year was the sum of the number of live pups counted at the census and the cumulative number of dead pups counted up to the time of the live pup census. Live pup censuses were conducted during late July and early August in Adams Cove and at Castle Rock. Dates of the censuses were determined by the frequency of births observed during daily surveys in the Adams Cove colony. When no births were documented over 3 days, pupping was considered complete and the live pup census was conducted. In Adams Cove, the live pup census was conducted on 30 July 2004 and 26 July 2005. The live pup census was conducted on 28 July 2004 and 24 July 2005 at Castle Rock. In Adams Cove, the live pup counts were conducted from a mobile blind by two observers using binoculars. At Castle Rock, pups were counted by two observers counting small groups of pups in each territory of the colony. At both colonies, each observer conducted two counts of each group of pups before comparing the counts of the group between observers. If the difference between the counts of an individual observer or between the two observers was greater than 5%, the count was repeated. The mean of an observer's counts was used as an estimate for each group of pups. The mean number of pups for the colony was calculated from the group estimates for each observer.

Fur seal pup mortality surveys were conducted between June and October in Adams Cove in 2004 and 2005. Each dead pup was counted, removed from the territory, and then stacked away from the survey area to minimize the possibility of recounting the same pup during the season. The total number of dead pups was 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 conducted at the time of the live pup count (28 July 2004, 24 July 2005). Pup mortality at Castle Rock was a minimum estimate of pup mortality because only one survey was conducted and carcasses that decomposed or disappeared were not accounted for. However, the surveys were conducted in the same manner each year thus the counts provided a relative measure of pup mortality at Castle Rock.

Tagging and Pup Condition

Between four and six surveys of tagged breeding animals were conducted between July and August in 2004 and 2005 from a mobile blind, which was moved through the colony at least once a week. Tag numbers and reproductive status were recorded for each individual.

Between 100 and 300 northern fur seal pups have been flipper-tagged annually in Adams Cove during September or October since 1975. At the time of tagging, pups were 3-4 months old. Tags were placed on each foreflipper of each pup. Pups were weighed, sexed, measured, and released. We used pup weight at the time of tagging as an index of pup condition. To account for differences in annual average pup weights due to different weighing dates among years, we used a linear regression to estimate pup weights on 1 October for each year. We compared the long-term average between 1975 and 2003 to weights in 2004 and 2005. We excluded El Niño years (1983, 1992, 1993, 1997, 1998, and 2002) from the calculation of the long-term average because pups born in 2004 and 2005 were not affected by El Niño conditions.

RESULTS

Census

The maximum number of territorial bulls counted in Adams Cove was 127 in 2004 and 117 in 2005, representing a decline of 7.9% between the two years (Table 21). The maximum number of territorial bulls fluctuated between 1997 and 2005, with annual increases ranging from 2.2% to 32.8% and declines between 7.9% and 45.5%. The decline between 1997 and 1998 was the greatest decline (45.5%) observed; the highest increase occurred between 2001 and 2002 (32.8%). Even with increases in four years since 1997, the number of territorial bulls in 2005 remained 53.8% below the number observed in 1997, when the population was at its highest recorded level.

Table 21.-- Maximum number of territorial northern fur seal bulls at San Miguel Island, California, 1997-2005.

Year	Maximum number of territorial bulls	Annual percent change in maximum number of territorial bulls	Percent change from maximum number of territorial bulls in 1997
1997	253		
1998	138	-45.5	-45.5
1999	141	2.2	-44.3
2000	108	-23.4	-57.3
2001	119	10.2	-53.0
2002	158	32.8	-37.5
2003	184	16.5	-27.3
2004	127	-31.0	-49.8
2005	117	-7.9	-53.8

Table 22.--Summary of pup counts of northern fur seals at Adams Cove and Castle Rock during 1997-2005. Mortality rates are based on observed mortality, which is likely underestimated. Standard error about the mean is in parentheses. A dash (-) preceding the percent change indicates a decline.

Colony/Year	Mean number of live pups	Early season pup mortality ¹	Total births	Percent change			Early season pup mortality rate	Late season pup mortality ²	Total pup mortality	Season pup mortality rate ³
				Annual percent change in total births	from births in 1997	from births in 1997				
Adams Cove										
1997	1759 (6.7)	368	2127				27.3	488	856	40.2
1998	308 (1.3)	116	424	-80.1	-80.1	-80.1	27.4	113	229	54.0
1999	604 (3.4)	169	773	82.0	-63.7	-63.7	21.8	26	195	25.2
2000	963 (4.5)	107	1070	38.4	-49.7	-49.7	10.0	35	142	13.3
2001	1227 (9.0)	57	1284	20.0	-39.6	-39.6	4.4	8	65	5.1
2002	1127 (1.2)	81	1208	-5.9	-43.2	-43.2	6.7	83	164	13.4
2003	1083 (2.8)	257	1340	6.8	-39.3	-39.3	19.2	36	293	21.9
2004	811 (3.5)	427	1238	-7.6	-41.8	-41.8	34.5	204	631	51.0
2005	1133 (14.1)	495	1628	31.5	-23.5	-23.5	30.4	298	793	48.7

Table 22.-- Continued.

Colony/Year	Mean number of live pups	Early season pup mortality ¹	Total births	Annual percent change in total births	Percent change from births in 1997			Late season pup mortality ²	Total pup mortality	Season pup mortality rate ³
					Early season pup mortality rate	Early season pup mortality rate	Early season pup mortality rate			
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					
2002	718 (2.0)	21	739	-1.6	-25.4					
2003	---	---	---	---	---					
2004	804 (4.2)	21	825	---	-16.8					
2005	783 (3.5)	18	801	-2.9	-19.2					

¹Number of dead pups counted up to the time of the live pup census.

²Number of dead pups counted after the live pup census.

³Rate calculated based on total number of dead pups in early and late season dead pup counts.

The mean number of live pups counted in Adams Cove increased 31.5% between 2004 and 2005 (Table 22). Early pup mortality (to 2 months of age) declined slightly from 34.5% in 2004 to 30.4% in 2005 and total pup mortality declined from 51% to 48.7% between the two years (Table 22). In 2004, the mean number of live pups counted at Castle Rock was 804. In 2005, a mean of 783 pups was counted (Table 22). A decrease in pup births (2.9%) occurred between 2004 and 2005. Early pup mortality was 21 pups in 2004 (2.5%) and 18 pups in 2005 (2.2%).

Total births at Adams Cove and Castle Rock remained depressed from the historical highs in 1997. The 2005 total births were 23.5% below 1997 at Adams Cove and 19.2% at Castle Rock (Table 22). Between 1997 and 2005, the highest total pup mortality occurred in 1998 (54.0%) but high mortality also occurred in 1997 (40.2%), 2004 (51.0%) and 2005 (48.7%). The lowest pup mortality occurred in 2001 (5.1%) (Table 22). At Castle Rock, the highest early pup mortality occurred in 2001 (5.7%) but high mortality was also recorded in 1997 (5.1%) and 1998 (4.4%). Lowest pup mortality at Castle Rock occurred in 2000 and 2005 (2.2%).

Tagging and Pup Condition

Forty-two female and 86 male northern fur seals, flipper-tagged as pups, were identified during 2004; 74 adult females and 86 males were identified in 2005. The females were between 4 and 16 years old. Twenty-two females between 4 and 12 years old were observed with pups. The males ranged between 2 and 12 years of age. Eleven territorial males were between 9 and 11 years old.

The distribution of sightings by age was bimodal for females and unimodal for males (Fig. 11). Females showed peaks at 4 and 5 years (41%) and 10 and 11 years (28%). Males

showed a peak at 3 and 4 years (60%). Few females (3.5%) and males (0.6%) were older than 12 years of age. No tagged animals from the 1997 cohort were observed (Fig. 12). The low percentages of females and males observed at 7 and 8 years old coincides with the near total mortality of the 1997 cohort due to El Niño conditions in 1997, and low numbers of animals recruited from the 1998 cohort.

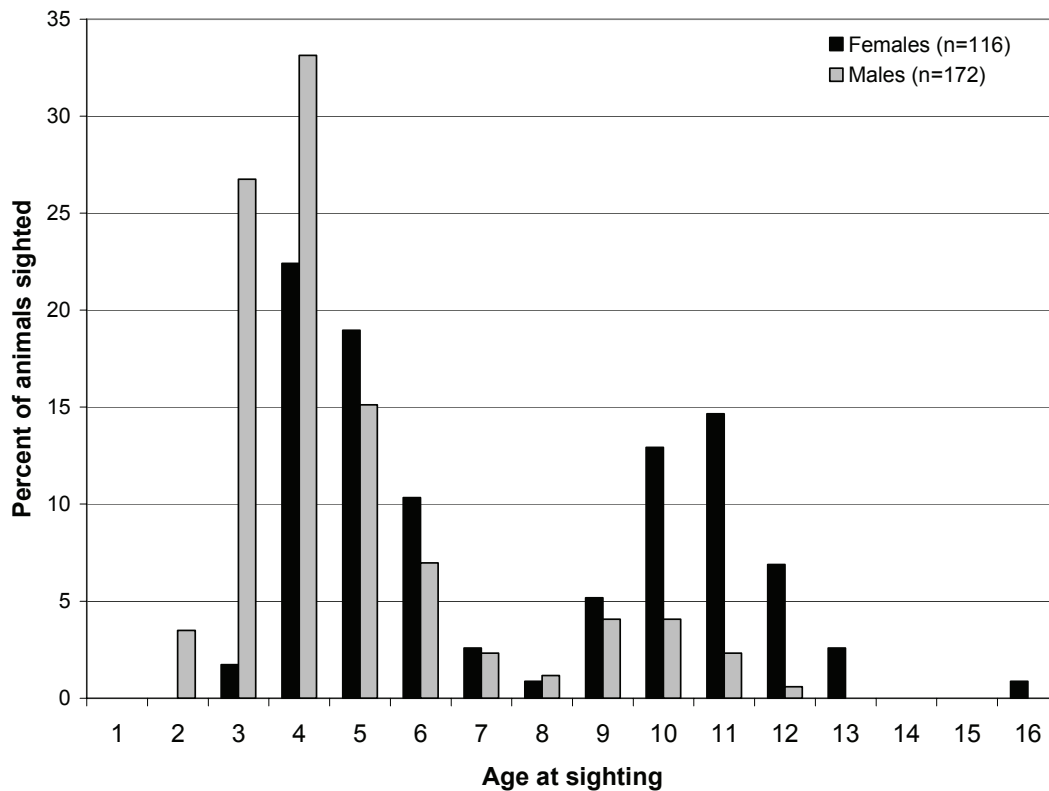


Figure 11.--Percentage of tagged northern fur seals sighted in 2004 and 2005 by age. Animals were tagged as pups at Adams Cove, San Miguel Island, California, between 1990 and 2004.

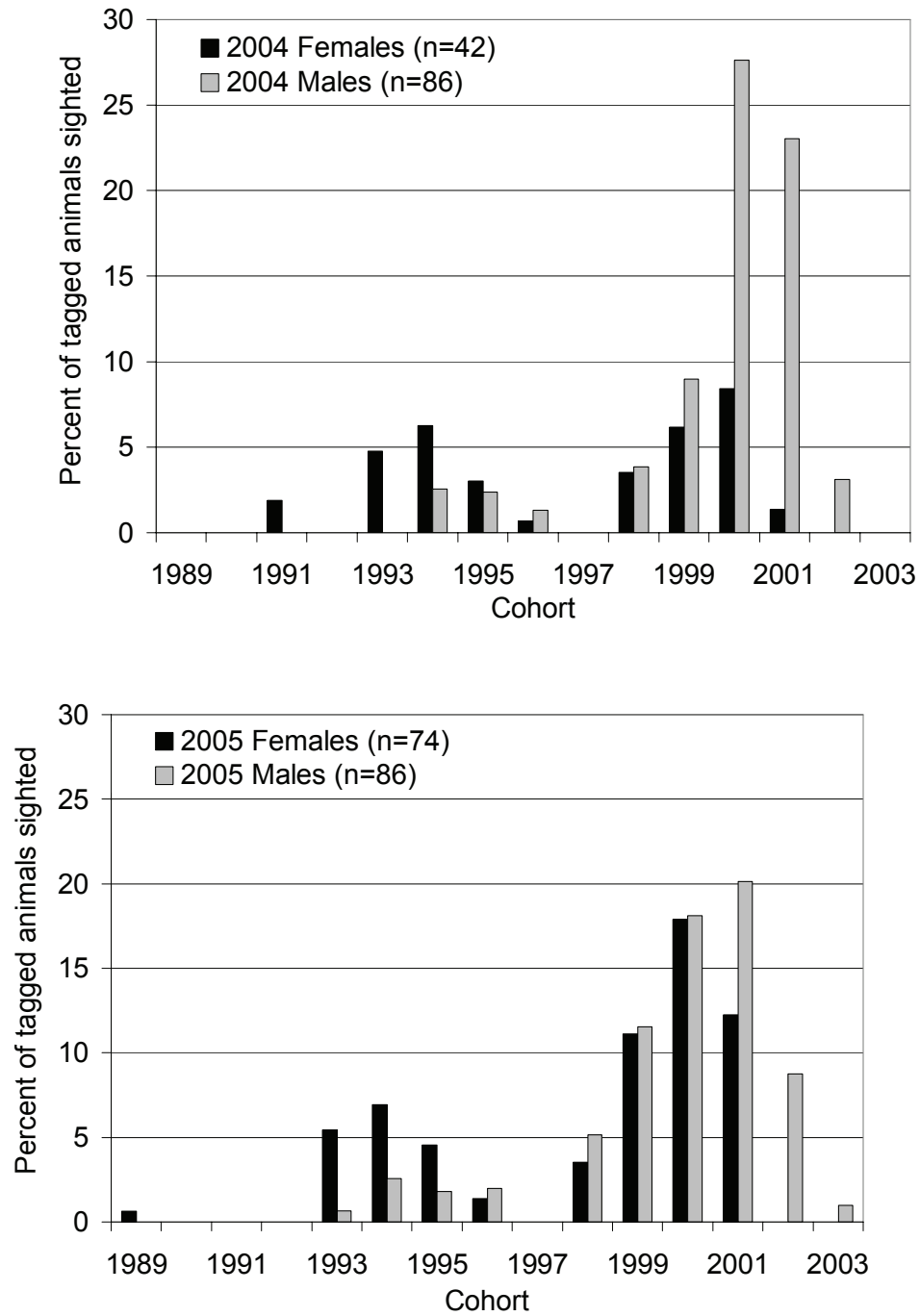


Figure 12.--Percentage of tagged northern fur seals sighted in 2004 and 2005 by cohort. Animals were tagged as pups at Adams Cove, San Miguel Island, California, between 1990 and 2004.

During 2004 and 2005, we tagged 200 3-month-old northern fur seals. Their mean weights were within the bounds of the long-term average weights of female and male pups (Table 23).

DISCUSSION

The residual effects of the 1997-1998 El Niño, such as low survival of the 1997 and 1998 cohorts and adult mortality, appear to be mitigating the positive effects of a cooler California Current system on northern fur seals at San Miguel Island. The northern fur seal population at San Miguel Island showed conflicting signs in status indices in 2004 and 2005. The number of territorial bulls declined in 2004 (31%) and continued to decline in 2005 (7.9%). Pup births declined in 2004 (7.6%) but rebounded in 2005 (31.5%). Pup mortality to 3 months of age was high in 2004 (51.0%) and remained high in 2005 (48.7%). Yet, pups that survived to 3 months of age appeared to be in good condition in the two years, with pup weights similar to the long-term average.

The contrasting trends in the indices may reflect a population recovering from adult, juvenile, and pup mortality in 1997 and 1998 due to the 1997-1998 El Niño event and other factors currently influencing the survival of fur seals in the California Current ecosystem.

Table 23.-- Mean weights of northern fur seal pups at Adams Cove, San Miguel Island, California, in 2004 and 2005 compared to the long-term mean between 1975 and 2003. The observed mean is the mean weight on the weighing date. The predicted mean is the estimated weight on 1 October.

	Year	Date	n	Observed mean	S.E.	Predicted mean	CI
Females	2004	17 Oct	104	12.3	0.2	11.0	10.7-11.3
	2005	21 Oct	105	12.1	0.2	10.4	10.1-10.7
	1975-2003		3,014			10.7	10.2-11.2
Males	2004	17 Oct	96	13.7	0.2	12.2	12.0-12.6
	2005	21 Oct	95	13.5	0.2	11.7	11.4-12.0
	1975-2003		3,117			12.0	11.5-12.5

Interpretation of sighting data relative to age-specific mortality is complicated by high tag loss for northern fur seals. The low percentage of older animals represented in the tagged animal population may represent high tag loss after 11 years of age for females and 6 years of age for males. Double-tagging studies of northern fur seals were conducted in the Pribilof Islands, Alaska, to estimate tag loss and these studies confirmed that tag loss was significant with 67% of the pups losing one tag and 3% losing both tags by 3 years of age (Scheffer et al. 1984). Although the studies were based on a different tag type than was used in our study, tag loss has been identified (but not quantified) as a problem with the pink roto tags that were used at San Miguel Island. Thus, adult mortality may be positively biased due to tag loss for older animals. However, the abrupt decline in the number of territorial bulls and the slow recovery of total births (i.e., fewer reproductive females in the population) after the 1997-1998 El Niño suggests that adult mortality did occur in 1997 and 1998 (Melin and DeLong 2000, Melin et al. 2005). In addition to adult mortality, no tagged animals from the 1997 cohort have been observed, and the low percentages of 7- and 8-year olds coincide with lower pup and yearling survival for the 1997 and 1998 cohorts. Thus, the 1997 and 1998 cohorts did not have significant recruitment into the population, which is likely to affect the age distribution of the population and its recovery.

The 2002-2003 El Niño appears to have had a short-term effect on the northern fur seal population at San Miguel Island. This is likely because the event was mild and was offset by an influx of cold water from the North Pacific Ocean (Venrick et al. 2003). Total births declined in 2002 (-5.9%) but fully recovered in 2003 (6.8%). The cause of the decline in pup births in 2004 (7.6%) is unknown.

In recent years, other sources, besides El Niño, have been identified as causes of mortality of northern fur seals at San Miguel Island. Environmental toxins, such as domoic acid, that have been prevalent in the California Current over the past 5 years have caused significant mortality of California sea lions that consumed contaminated fish (Scholin et al. 2000, Lefebvre et al. 2002, Silvagni et al. 2005). Although mostly documented as a cause of mortality for California sea lions, mortality of northern fur seals from domoic acid toxicity has also been reported (Silvagni et al. 2005). Additional research is needed to determine the potential affect of this source of mortality on the population growth of northern fur seals at San Miguel Island.

Hookworm disease was first described in San Miguel northern fur seal population in 1996 (Lyons et al. 1997). In 2000, 95% of the dead pups less than one month old had hookworm infections (Lyons et al. 2001). Much of the mortality in 2004 and 2005 occurred during the first 6 weeks of life and was likely due to this disease. We anticipate that the high mortality will continue until the population mounts an immune response to the parasite, perhaps several generations into the future. Thus, in addition to El Niño events that occur periodically along the California coast, environmental toxins and disease may play influential roles in the dynamics of the northern fur seal population at San Miguel Island.

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The fur seal research team extends its special thanks to the communities of St. George Island and St. Paul Island who continuously support our research efforts. We are especially appreciative of the participation of youths from the stewardship program which have become integral to our field work on the Pribilof Islands. The Channel Islands National Park Service provided logistical support for field operations on San Miguel Island. The bulk of our work on the Pribilof and Channel Islands would not be possible without the assistance of numerous volunteers and employees from affiliated universities and institutions (Appendix C). The quality of this report was greatly improved by Gary Duker and James Lee, technical editors at the Alaska Fisheries Science Center.

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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.
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.
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.'

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 (rounded average of two counts), by class^a and rookery section, St. Paul Island, Alaska, 9-14 July, 2004. 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	
<u>Lukanin</u>															
2	21	18	-	-	-	-	-	-	-	-	-	-	-	-	39
3	44	46	-	-	-	-	-	-	-	-	-	-	-	-	90
5	92	21	-	-	-	-	-	-	-	-	-	-	-	-	113
<u>Kitovi^b</u>															
2	(10)10	11	24	26	31	-	-	-	-	-	-	-	-	-	112
3	(8)12	20	30	31	28	-	-	-	-	-	-	-	-	-	129
5	(43)4	8	12	3	115	-	-	-	-	-	-	-	-	-	185
<u>Reef</u>															
2	16	24	28	18	20	17	2	16	14	11	0	-	-	-	166
3	34	50	46	31	59	64	1	52	29	23	5	-	-	-	394
5	5	12	28	43	68	11	21	10	8	66	71	-	-	-	343
<u>Gorbatch</u>															
2	30	20	1	9	11	21	-	-	-	-	-	-	-	-	92
3	69	48	29	11	32	48	-	-	-	-	-	-	-	-	237
5	331	23	11	71	18	21	-	-	-	-	-	-	-	-	475
<u>Ardiguin</u>															
2	16	-	-	-	-	-	-	-	-	-	-	-	-	-	16
3	39	-	-	-	-	-	-	-	-	-	-	-	-	-	39
5	22	-	-	-	-	-	-	-	-	-	-	-	-	-	22
<u>Morjovi^c</u>															
2	(15)30	12	17	7	17	5	-	-	-	-	-	-	-	-	103
3	(41)25	47	53	25	61	29	-	-	-	-	-	-	-	-	281
5	(12)162	16	17	1	11	110	-	-	-	-	-	-	-	-	329
<u>Vostochni</u>															
2	8	5	7	7	7	36	13	8	12	7	6	17	26	18	177
3	42	26	43	49	40	88	53	47	26	20	19	54	137	98	742
5	16	24	13	21	61	44	9	19	12	15	1	35	68	114	452
<u>Little Polovina</u>															
2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0
3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
5	235	-	-	-	-	-	-	-	-	-	-	-	-	-	235
<u>Polovina</u>															
2	27	10	-	-	-	-	-	-	-	-	-	-	-	-	37
3	43	26	-	-	-	-	-	-	-	-	-	-	-	-	69
5	168	85	-	-	-	-	-	-	-	-	-	-	-	-	253
<u>Polovina Cliffs</u>															
2	21	14	6	17	19	27	41	-	-	-	-	-	-	-	145
3	35	17	18	44	39	58	72	-	-	-	-	-	-	-	283
5	81	17	6	8	11	18	10	-	-	-	-	-	-	-	151
<u>Tolstoi</u>															
2	17	22	19	27	24	37	32	21	-	-	-	-	-	-	199
3	35	29	30	49	36	60	44	34	-	-	-	-	-	-	317
5	20	6	4	17	13	14	17	227	-	-	-	-	-	-	318
<u>Zapadni Reef</u>															
2	48	10	-	-	-	-	-	-	-	-	-	-	-	-	58
3	103	38	-	-	-	-	-	-	-	-	-	-	-	-	141
5	44	98	-	-	-	-	-	-	-	-	-	-	-	-	142
<u>Little Zapadni</u>															
2	5	10	22	18	17	19	-	-	-	-	-	-	-	-	91
3	13	36	47	51	40	51	-	-	-	-	-	-	-	-	238
5	13	24	17	19	15	19	-	-	-	-	-	-	-	-	107
<u>Zapadni^d</u>															
2	20	18	29	23	25	19	23	11	-	-	-	-	-	-	168
3	21	29	50	41	45	55	68	15	-	-	-	-	-	-	324
5	(68)4	6	18	31	19	33	40	280	-	-	-	-	-	-	499

^a Class 2 = territorial adult male without female; class 3 = territorial adult male with female; class 5 = non-territorial adult male.

^b Numbers in parenthesis are the adult males counted in Kitovi Amphitheater.

^c Numbers in parenthesis are the adult males counted on the second point south of Sea Lion Neck.

^d Numbers in parenthesis are the adult males counted on Zapadni Point Reef.

Table B-2. --Number of adult male northern fur seals counted (rounded average of two counts), by class^a and rookery section, St. Paul Island, Alaska, 9-15 July, 2005. 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	
Lukanin															
2	38	17	-	-	-	-	-	-	-	-	-	-	-	-	55
3	51	54	-	-	-	-	-	-	-	-	-	-	-	-	105
5	148	17	-	-	-	-	-	-	-	-	-	-	-	-	165
Kitovi^b															
2	(6)8	15	12	20	30	-	-	-	-	-	-	-	-	-	91
3	(8)15	27	37	43	27	-	-	-	-	-	-	-	-	-	157
5	(33)0	10	8	8	167	-	-	-	-	-	-	-	-	-	226
Reef															
2	22	31	24	11	19	21	3	27	16	8	0	-	-	-	182
3	35	64	46	32	57	64	1	70	36	29	7	-	-	-	441
5	21	27	15	41	107	7	28	13	3	112	90	-	-	-	464
Gorbatch															
2	40	14	37	7	17	24	-	-	-	-	-	-	-	-	139
3	70	42	58	9	39	41	-	-	-	-	-	-	-	-	259
5	377	2	33	155	11	14	-	-	-	-	-	-	-	-	592
Ardiguin															
2	18	-	-	-	-	-	-	-	-	-	-	-	-	-	18
3	54	-	-	-	-	-	-	-	-	-	-	-	-	-	54
5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Morjovi^c															
2	(9)8	21	18	17	22	14	-	-	-	-	-	-	-	-	109
3	(34)37	55	47	26	58	39	-	-	-	-	-	-	-	-	296
5	(13)295	32	6	14	15	50	-	-	-	-	-	-	-	-	425
Vostochni															
2	12	6	10	8	14	21	13	14	8	5	11	22	35	21	200
3	35	21	28	62	41	77	40	39	25	27	24	50	163	92	724
5	31	8	8	25	85	31	8	4	30	10	6	41	97	166	550
Little Polovina															
2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
5	236	-	-	-	-	-	-	-	-	-	-	-	-	-	236
Polovina															
2	21	10	-	-	-	-	-	-	-	-	-	-	-	-	31
3	43	30	-	-	-	-	-	-	-	-	-	-	-	-	73
5	146	28	-	-	-	-	-	-	-	-	-	-	-	-	174
Polovina Cliffs															
2	20	7	8	16	14	38	26	-	-	-	-	-	-	-	129
3	48	27	20	51	39	58	64	-	-	-	-	-	-	-	307
5	72	12	14	7	5	7	13	-	-	-	-	-	-	-	130
Tolstoi															
2	13	18	18	5	18	23	26	36	-	-	-	-	-	-	157
3	27	28	31	39	44	65	43	28	-	-	-	-	-	-	305
5	2	0	8	25	6	39	17	344	-	-	-	-	-	-	441
Zapadni Reef															
2	42	10	-	-	-	-	-	-	-	-	-	-	-	-	52
3	128	39	-	-	-	-	-	-	-	-	-	-	-	-	167
5	53	126	-	-	-	-	-	-	-	-	-	-	-	-	179
Little Zapadni															
2	8	11	22	16	19	25	-	-	-	-	-	-	-	-	101
3	19	34	44	46	41	57	-	-	-	-	-	-	-	-	241
5	31	21	9	13	12	183	-	-	-	-	-	-	-	-	269
Zapadni^d															
2	16	21	28	30	26	35	31	12	-	-	-	-	-	-	199
3	24	37	55	50	58	70	64	25	-	-	-	-	-	-	383
5	(65)6	8	12	8	9	24	49	310	-	-	-	-	-	-	491

^a Class 2 = territorial adult male without female; class 3 = territorial adult male with female; class 5 = non-territorial adult male.

^b Numbers in parenthesis are the adult males counted in Kitovi Amphitheater.

^c Numbers in parenthesis are the adult males counted on the second point south of Sea Lion Neck.

^d Numbers in parenthesis 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, 1977-2005. 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
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	--	--	--	--
2002	3,669	7,877	145,716	1,629	13	4,790	899	1,265	17,593	527	6	533
2003	3,652	7,572	--	--	--	--	716	1,158	--	--	--	--
2004	3,286	5,027	122,825	1,290	13	4,041	760	905	16,878	239	6	417
2005	3,515	5,811	--	--	--	--	905	634	--	--	--	--

* 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, 2004. Section 0 corresponds to 2nd Point South on Morjovi and Kitovi Amphitheater.

Rookery	Section														Total	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13		14
Lukanin	170	169														339
Kitovi	31	51	82	126	134	124										548
Reef*	144	208	192	128	250	272	216	126	102	18						1,656
Gorbatch	312	246	147	57	144	241										1,147
Ardiguen	152															152
Morjovi	153	106	181	203	100	229	117									1,089
Vostochni	141	73	140	159	136	293	147	176	74	70	68	148	457	325		2,407
Polovina	184	103														287
Little Polovina																
Polovina Cliffs	171	84	89	214	191	282	344									1,375
Tolstoi	184	161	170	280	202	334	246	191								1,768
Zapadni Reef	442	146														588
Little Zapadni	70	182	258	275	224	284										1,293
Zapadni	127	175	297	241	258	327	362	125								1,912
Total																14,561

*Section 7 was combined with Section 6.

Table B-5.-- Number of dead northern fur seal pups counted by section on the sampled rookeries of St. Paul Island, Alaska, 2004.

Rookery	Date	Section														Total			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14		necropsies		
Lukanin	8/26	47	55																102
Kitovi ¹	8/19	(2)9	11	28	27	33												1	111
Reef	8/26	61	73	54	20	42	34	5	53	30	21	1						62	456
Gorbatch	8/21	123	79	96	15	67	37												417
Ardiguen	8/21	38																	38
Morjovi ²	8/19	(20)36	35	37	16	56	36											1	237
Vostochni	8/24	20	11	28	28	33	62	22	33	13	18	14	50	175	75			36	618
Polovina	8/25	44	26																70
Polovina Cliffs	8/25	29	14	9	25	30	45	24										1	177
Tolstoi	8/22	37	45	64	65	76	129	110	113										639
Zapadni Reef	8/20	36	135																171
Little Zapadni	8/21	21	61	69	111	56	100												418
Zapadni	8/20	11	49	77	93	90	139	95	31										585
Total																			4,039

¹ Numbers in parenthesis are for Kitovi Amphitheater.

² Numbers in parenthesis are for 2nd point south of Sea Lion Neck.

Table B-6.-- Number of northern fur seal pups sheared on each rookery of St. George Island, Alaska, 2004.

Rookery	Section					Total
	1	2	3	4	5	
South	105	126	131			362
North	127	112	191	104	55	589
East Reef	86					86
East Cliffs	208	125				333
Staraya Artil	120					120
Zapadni ¹	45	110	85			240
Total						1,730

Table B-7.-- Number of dead northern fur seal pups counted by section on the rookeries of St. George Island, Alaska, 2004.

Rookery	Date	Section					Total
		1	2	3	4	5	
South	8/20	37	56	41			134
North	8/24	17	20	38	18	5	98
East Reef	8/20	20					20
East Cliffs	8/20(26)	58	14				72
Staraya Artil*	8/24	27					27
Zapadni	8/20	16	30	20			66
Total							417

* Dead pups were not counted by section on Staraya Artil.

Table B-8.-- Number of dead northern fur seals counted that were older than pup, Pribilof Islands, Alaska, 1970-2004. 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
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	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 ^c	6	19 ^d	90	242
1996	20 ^e	92 ^e	3	20 ^f	23	112 ^f
1998 ^g	-	-	-	-	-	-
2000	20	77	26	98	46	175
2002 ^h	36	107	6	19	42	126
2004 ⁱ	37	85	9	12	46	97

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

^b Includes 10 dead adult fur seals of unknown sex.

^c Includes 16 dead adult fur seals of unknown sex.

^d Includes 2 dead adult fur seals of unknown sex.

^e Counts made only on the 6 sample rookeries where dead pups were counted.

^f Includes 16 dead adult fur seals of unknown sex.

^g A total of 108 dead adults were counted on St. Paul Island and 34 dead adults were counted on St. George Island.

^h Does not include 8 dead adults that were unidentifiable, had no teeth and both.

ⁱ Does not include 11 dead adults that were not sexually identifiable.

APPENDIX C

Scientific staff engaged in northern fur seal
field research in 2004-2005

National Marine Mammal Laboratory
John L. Bengtson, Director
Tom Gelatt, Leader, Alaska Ecosystem Program
Rolf R. Ream, Northern Fur Seal Task

<u>Employees</u>	<u>Affiliation</u>
Kate Call	NMML
Bob Caruso	NMML
Robert DeLong	NMML
Brian Fadely	NMML
Charles Fowler	NMML
Harriet Huber	NMML
Sharon Melin	NMML
Anthony Orr	NMML
Andrea Gemmer Pecharich	NMML
Rolf Ream	NMML
Erin Siek	NMML
Jen Sloth	NMML
Jeremy Sterling	NMML
Jim Thomason	NMML
Rod Towell	NMML
Anne York	NMML
Tonya Zeppelin	NMML
Heather Ziel	NMML

Research Associates and Cooperators

Aquilina Lestenkof	TGSP
David Cormany	NMFSJ
Karin Holser	PISP
Masashi Kiyota	NRIFSF
John Wayne Melovidov	PISP
John R. Melovidov	PISP
Mark Rukovishnikoff	PISP
William Shane	PISP
Terry Spraker	WPI
Candace Stepetin	PISP
Kent Sundseth	NMFS/USFWS
Andrew Zacharof	PISP
Phillip Zavadil	TGSP

Affiliation Code

NMFS - National Marine Fisheries Service

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

NMML - National Marine Mammal Laboratory

NRIFSF - National Research Institute of Far Seas Fisheries, Shimizu, Japan

PISP - Pribilof Island Stewardship Program

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

UCD - University of California, Davis

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

WPI - Wildlife Pathology International

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