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Fur Seal Investigations, 2002-2003

by
J. W. Testa (editor)

U.S. DEPARTMENT OF COMMERCE
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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 2002 was about 848,000 fur seals. The approximate total stock size for the United States, which includes the Pribilof, Bogoslof, and San Miguel Island populations, was about 880,000 fur seals.

In 2002 and 2003, 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 2002 yielded totals of 3,669 territorial male seals with females and 7,887 idle adult male seals; in 2003, 3,652 and 7,572 were counted in the those categories, respectively. On St. George Island in 2002, a total of 899 territorial males with females and 1,265 idle adult males were counted; 716 and 1,158 were counted in those categories in 2003. On St. Paul Island, 647 and 522 sub-adult male seals were harvested in 2002 and 2003, respectively. On St. George Island, 202 and 132 sub-adult male seals were taken in the two harvest years, respectively.

In 2002, 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 in 2002 was 145,716 (SE = 1,629) on St. Paul Island (excluding Sea Lion Rock) and 17,593 (SE = 527) on St. George Island. Pup mortality to late August was 3.3% on St. Paul Island and 3.0% on St. George

Island. During 1998-2002, the annual rate of decline in numbers of pups born was 5.12% (SE = 0.26, P = 0.03) on St. Paul Island and 5.44% (SE = 0.72, P = 0.08) on St. George Island. The rate of decline at both islands combined was 5.2% (SE = 0.19, P = 0.02). Pup production in 2002 was the lowest since 1919 on St. Paul and the lowest since 1916 on St. George, when both populations were rapidly increasing.

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 ($P < 0.05$) longer and heavier than those on St. Paul Island. The sex ratio in 2002 was significantly ($P < 0.05$) skewed toward males on St. Paul Island (58:42) but not on St. George Island (52:48).

After 3 years of increasing pup production on San Miguel Island, California, following the 1998 decline, production declined slightly in 2002. This may have resulted from the 2002-2003 El Niño or from poor recruitment from the 1997 cohort. The combination of a decrease in pup births and a significant decrease in pup growth in 2002 suggests that the mild El Niño conditions had a moderate impact on northern fur seals at San Miguel Island. In 2003, pup production increased at the Adams Cove rookery (Castle Rock rookery was not counted) and pup weights returned to the long-term average, indicating that foraging conditions for adults in the population had improved. Pup production remained below the 1997 production levels by more than 39% in Adams Cove in 2003, and by more than 25% at Castle Rock in 2002.

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INTRODUCTION

by

J. Ward Testa

The northern fur seal population in the Pribilof Islands Archipelago (on St. Paul and St. George Islands) constitutes roughly 70% of the world's population (Figs. 1-3) with an estimated 919,000 northern fur seals in 2000 (York et al. 2002). Smaller breeding colonies are located on the Kuril Islands in Japan, the Commander Islands in Russia, Bogoslof Island in the southeastern Bering Sea (Fig. 4), and San Miguel Island off California (Fig. 5). The rookeries at Bogoslof and San Miguel probably originated in 1982 and the late 1950s, respectively.

Northern fur seals (*Callorhinus ursinus*) 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 and over-exploitation. The major population concentration on the Pribilof Islands has been monitored since that time, primarily by counts 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 which 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 of adult females from 1958 to 1968, but productivity did not increase and, 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 its peak abundance. 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 National Marine Fisheries Service, National Marine Mammal Laboratory, to monitor the status of northern fur seals on U.S. rookeries and disseminate that information. Research by the National Marine Mammal Laboratory on northern fur seals in 2000 and 2001 was conducted under Marine Mammal Permit Nos. 782-1455 and 782-1708-00.

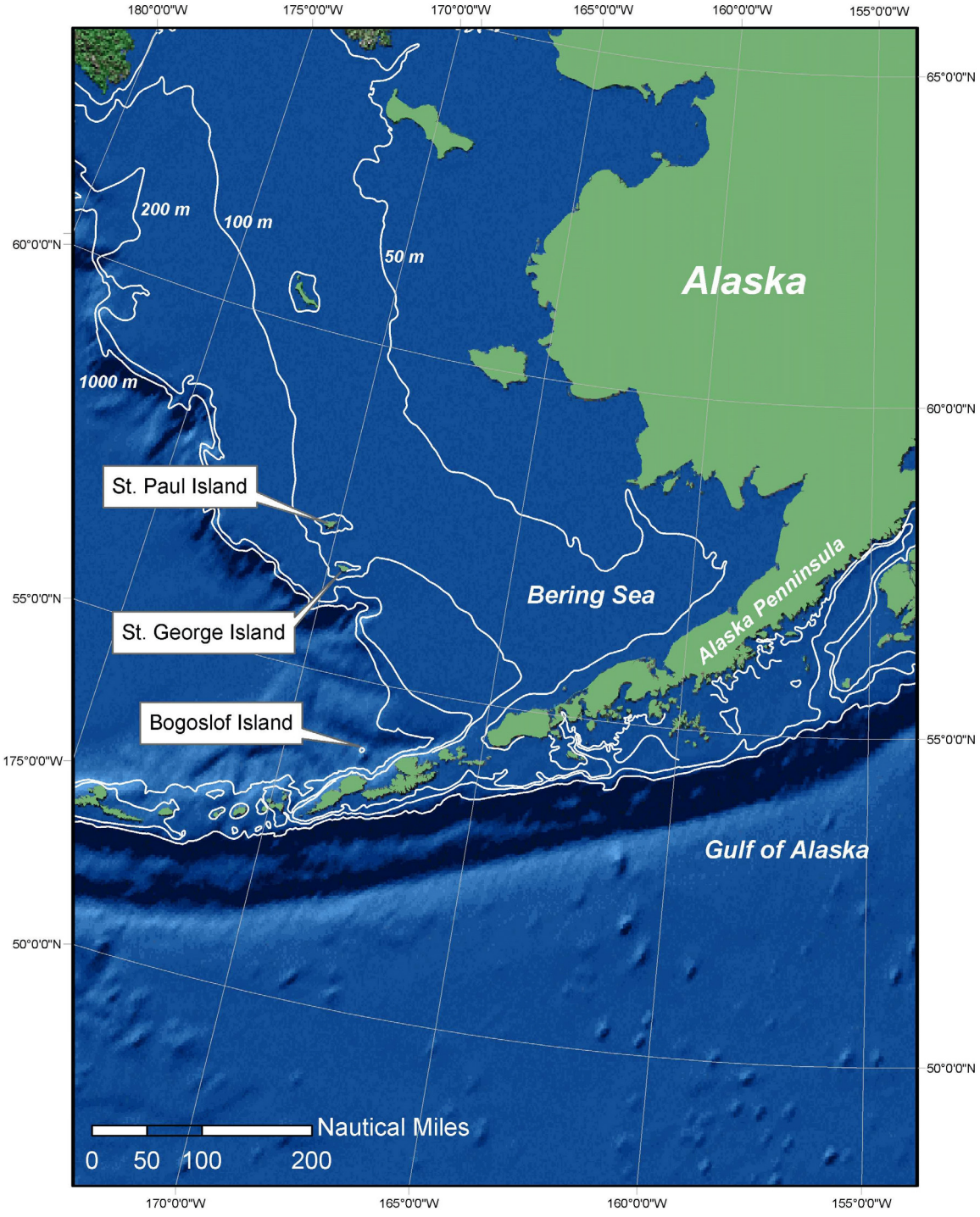

Figure 1. -- Location of the three northern fur seal breeding areas within U.S. waters.

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.

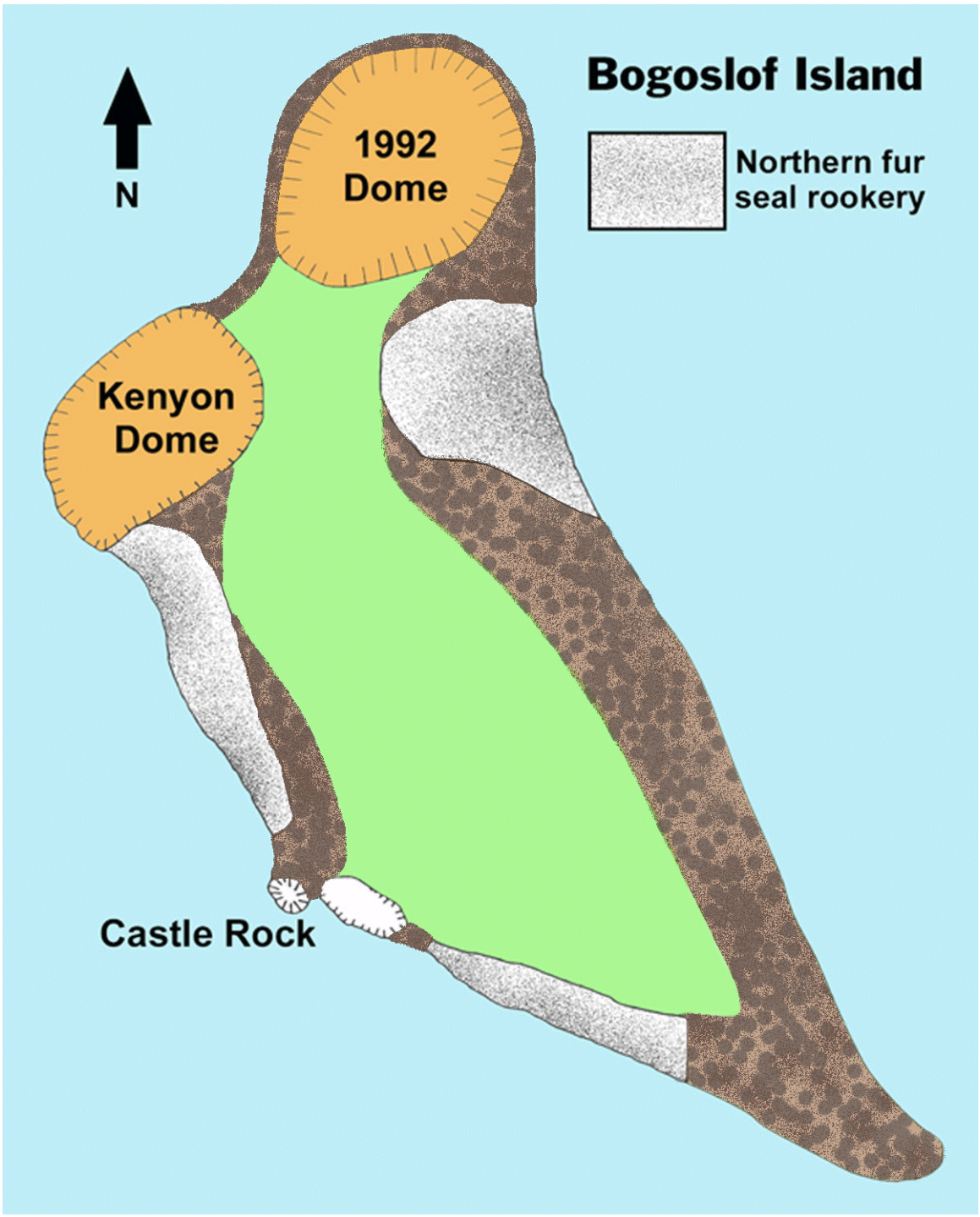

Figure 4 .-- Fur seal rookeries on Bogoslof Island, Alaska.

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

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POPULATION ASSESSMENT OF NORTHERN FUR SEALS ON THE PRIBILOF ISLANDS, ALASKA, 2002-2003

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).

METHODS

Population characteristics monitored in 2002 include the size of the 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 2003.

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

Adult male fur seals were counted by section for each rookery (see Appendix A for definitions of terms and Figure 6 for illustration of a typical fur seal rookery) on St. Paul Island from 9 to14 July 2002 and 2003 (Appendix Tables B-1 and B-2) and on St. George Island from 14 to 15 July 2002 and from 8 to 9 July 2003.

On St. Paul Island, dead fur seal pups were counted and the numbers of live pups were estimated on 13 rookeries in August 2002 using the shearing-sampling method (York and Kozloff 1987, Antonelis 1992). From 7 to 12 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 (either 1998 or 2000). 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 13 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 from which the variance was computed for each rookery (York and Kozloff 1987). Little Polovina rookery was not sampled due to concern that this small rookery might be more sensitive to any disturbance. We estimated the number of pups born on Little Polovina rookery from a regression of total pups born on numbers of breeding adult males (harem males). We assumed that the pup mortality on Little Polovina rookery was equal to the observed rate on the other rookeries and estimated the number of dead pups as the product of that mortality rate and the estimate of total pups born. Dead pups were counted on all sampled rookeries from 17 to 26 August. Dead pups were

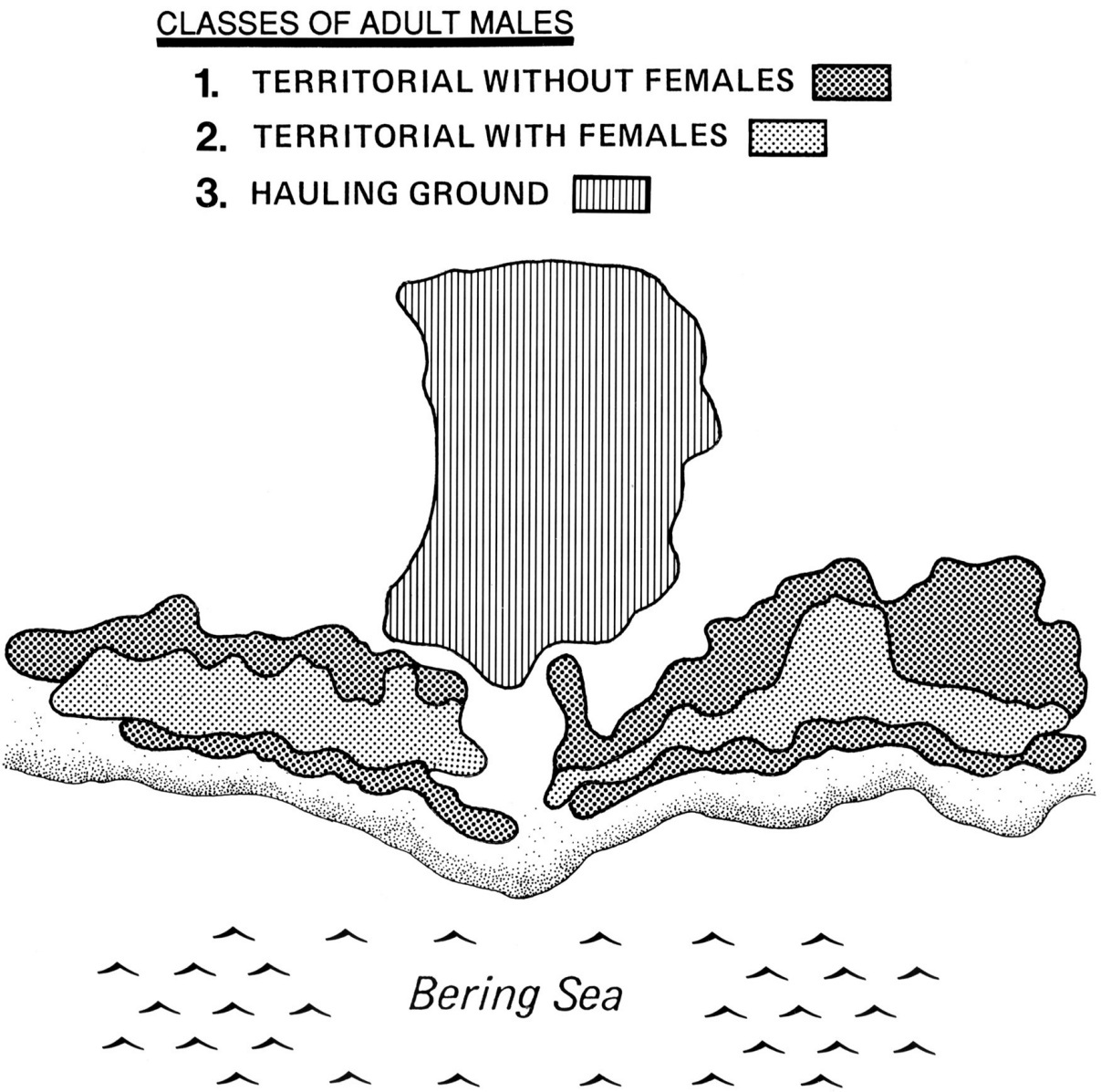

Figure 6.-- The relative location of the different classes of adult males for a typical fur seal rookery/haulout complex.

counted on Sea Lion Rock at the time of shearing due to the logistics of placing personnel on the rookery.

The number of pups born on St. George Island was estimated from a shearing-sampling study conducted on all rookeries from 13 to 15 August 2002, in the same manner as applied on St. Paul Island. The ratio of marked to unmarked pups on each rookery was determined by two observers from 16 to 18 August and again from 19 to 21 August. A third sampling was done on Staraya Artil rookery on 22 August and South rookery on 25 August. Counts of dead pups were made from 16 to 18 August 2002.

RESULTS AND DISCUSSION

Harvest

A total of 647 and 522 sub-adult male seals were harvested for subsistence on St. Paul Island in 2002 and 2003, respectively (Table 1). Two females were killed accidentally during the 2002 harvest on St. Paul Island. On St. George Island, 202 sub-adult male seals were taken in the subsistence harvest in 2002 and 132 were killed in 2003 (Table 2). One female was accidentally killed in the 2002 harvest on St. George Island.

Adult Males Counted

A total of 3,669 harem (Class 3) and 7,887 idle (Classes 2 and 5) adult male seals, also referred to as bulls, were counted on St. Paul Island in 2002 (Table 3). In 2003 on St. Paul Island, 3,652 harem males and 7,572 idle males were counted (Table 4). On St. George Island, a

total of 899 harem (Class 3) and 1,265 idle (Classes 2 and 5) bulls were counted (Table 3). In 2003, 716 harem and 1,158 idle bulls were counted on St. George Island (Table 4). Total numbers of harem and idle bulls counted since 1975 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 in 2003 are presented in Tables 3 and 4.

The count of territorial males with females (Class 3 or harem males) on St. Paul Island increased 8.3% between 2001 and 2002, and was essentially unchanged between 2002 and 2003. The count of harem males on St. George Island increased 6.6% between 2001 and 2002, and decreased 20.4% between 2002 and 2003. Owing to the larger size of the population on St. Paul Island, the Pribilof Island total for harem males increased by 7.9% between 2001 and 2002 and decreased 4.4% between 2002 and 2003.

Number of Pups Born on St. Paul Island in 2002

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 rookery are given in Table 5. The estimate for the total number of pups alive on St. Paul Island at the time of marking in 2002 was 140,924 with an estimated standard error of 1,629. Numbers of dead pups counted by section are given in Appendix Table B-5. The number of dead pups was estimated to be 4,792 (4,790 counted on sampled rookeries and 2 estimated on Little Polovina rookery); the estimated mortality rate for late August was 3.3% (Table 6). The estimate of the total number of pups born on St. Paul Island in 2002 was 145,716 (SE = 1,629, 95% confidence interval of ± 3,519, or 142,197 - 149,235). The standard error accounts for variance in the estimation of both live and

Table 1.-- Date, location, and number of sub-adult male seals killed in subsistence harvest drives on St. Paul Island, Alaska, in 2002 and 2003.

2002			2003		
Date	Rookery	Number killed	Date	Rookery	Number killed
July 3	Zapadni	39	June 25	Polovina	29
July 16	Polovina	43	June 28	Zapadni	26
July 17	Lukanin	32	July 9	Zapadni	34
July 20	Zapadni	36	July 16	Polovina	51
July 22	Polovina	60	July 18	Zapadni	46
July 23	Zapadni	56	July 25	Gorbatch	42
July 25	Lukanin	17	August 5	Polovina	80
July 26	Zapadni	44	August 6	Lukanin	96
July 31	Gorbatch	41	August 9	Zoltoi	118
August 2	Polovina	55			
August 6	Zapadni	52			
August 8	Kitovi	48			
August 9*	Polovina	52			
August 10	Zoltoi	74			

* Includes 2 females killed.

Table 2.-- Date, location, and number of sub-adult male seals killed in subsistence harvest drives on St. George Island, Alaska, in 2002 and 2003.

2002			2003		
Date	Rookery	Number killed	Date	Rookery	Number killed
July 2	North	12	July 8	North	13
July 8	North	25	July 11	Zapadni	8
July 11	Zapadni	19	July 15	North	10
July 15	North	6	July 17	Zapadni	4
July 17	Zapadni	15	July 19	North	16
July 20	North	15	July 23	Zapadni	5
July 22	Zapadni	12	July 25	North	16
July 24	North	21	July 27	Zapadni	9
July 27	Zapadni	15	July 29	North	7
July 31	North	15	August 1	Zapadni	8
August 4	Zapadni	8	August 3	North	15
August 8*	Zapadni	40	August 6	Zapadni	21

* Includes 1 female struck and killed.

Table 3.-- Number of adult male northern fur seals counted, by rookery, Pribilof Islands, Alaska, July 2002.

Rookery	Date (July)	Class of adult male* 2	3	5	Total
St. Paul Island					
Lukanin	9	66	110	200	376
Kitovi	9	152	162	332	646
Reef	10	268	476	497	1,241
Gorbatch	10	155	291	907	1,353
Ardiguen	10	28	53	9	90
Morjovi	13	113	269	471	853
Vostochni	14	257	782	722	1,761
Polovina	11	63	52	319	434
Little Polovina	11	1	2	264	267
Polovina Cliffs	11	158	321	153	632
Tolstoi	9	260	354	653	1,267
Zapadni Reef	11	95	139	304	538
Little Zapadni	11	133	217	235	585
Zapadni	12	237	441	825	1,503
Island total		1,986	3,669	5,891	11,546
St. George Island					
South	14	61	212	73	346
North	15	107	306	310	723
East Reef	14	23	66	83	172
East Cliffs	14	41	182	239	462
Staraya Artil	14	25	43	91	159
Zapadni	14	30	90	182	302
Island total		287	899	978	2,164

* 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 2003.

Rookery	Date (July)	Class of adult male* 2	3	5	Total
St. Paul Island					
Lukanin	9	61	91	117	269
Kitovi	9	110	155	160	425
Reef	11	250	503	512	1,265
Gorbatch	11	137	272	708	1,117
Ardiguen	11	13	52	7	72
Morjovi	10	174	296	602	1,072
Vostochni	10	303	606	871	1,780
Polovina	14	39	84	316	439
Little Polovina	14	1	2	96	99
Polovina Cliffs	14	143	374	261	778
Tolstoi	9	221	341	329	891
Zapadni Reef	12	86	154	344	584
Little Zapadni	13	135	286	441	862
Zapadni	13	195	436	940	1,571
Island total		1,868	3,652	5,704	11,224
St. George Island					
South	8	65	183	94	342
North	9	139	220	278	637
East Reef	8	20	52	45	117
East Cliffs	8	67	141	239	447
Staraya Artil	9	26	41	81	148
Zapadni	8	36	79	68	183
Island total		353	716	805	1,874

* See Glossary 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 (mean) and standard error (SE), on sample rookeries of St. Paul Island, Alaska, 2002.

Rookery	Sheared	E1	E2	Mean	SE
Lukanin	446	3,304	3,121	3,212	91.50
Kitovi	652	5,110	5,519	5,314	204.50
Reef	2,004	17,296	14,441	15,868	1,427.50
Gorbatch	1,435	11,150	11,466	11,308	158.00
Ardiquen	199	1,514	1,366	1,440	74.00
Morjovi	1,254	10,376	10,570	10,473	97.00
Vostochni	2,845	23,501	24,056	23,778	277.50
Polovina	304	2,894	2,652	2,773	121.00
Polovina Cliffs	1,603	13,806	13,072	13,439	367.00
Tolstoi	2,390	16,499	17,416	16,958	458.50
Zapadni Reef	668	5,556	5,212	5,384	172.00
Little Zapadni	1,519	12,068	12,485	12,276	208.50
Zapadni	2,161	18,756	18,501	18,628	127.50
Sea Lion Rock	835	8,289	7,907	8,098	191.00

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, 2002.

Sample Rookery	Pups alive at marking	SD	Dead pups*	Total pups born	Mortality rate (%)	Harem males	Ratio pups/males
Lukanin	3,212	91.5	145	3,357	4.3	110	30.5
Kitovi	5,314	204.5	151	5,465	2.8	162	33.7
Reef	15,868	1,427.5	544	16,412	3.3	476	34.5
Gorbatch	11,308	158.0	476	11,784	4.0	291	40.5
Ardiguen	1,440	74.0	57	1,497	3.8	53	28.2
Morjovi	10,473	97.0	257	10,730	2.4	269	39.9
Vostochni	23,778	277.5	693	24,471	2.8	782	31.3
Polovina	2,773	121.0	101	2,874	3.5	52	55.3
Little Polovina	73	4.2	2	75	2.7	2	37.5
Polovina Cliffs	13,439	367.0	277	13,716	2.0	321	42.7
Tolstoi	16,958	458.5	709	17,667	4.0	354	49.9
Zapadni Reef	5,384	172.0	203	5,587	3.6	139	40.2
Little Zapadni	12,276	208.5	440	12,716	3.5	217	58.6
Zapadni	18,628	127.5	737	19,365	3.8	441	43.9
Total (excl. SLR)	140,924	1,629.0	4,792	145,716	3.3	3,669	39.7
Sea Lion Rock	8,098	191.0	164	8,262	2.0		
Total (incl. SLR)	149,022	1,640.2	4,956	153,978	3.2		

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

dead pups (York and Towell 1996). The approximate 95% confidence interval of pups born was computed by multiplying the standard error of the estimate of total pups by 2.16 (the 97.5 percentile of Student's t-distribution with 13 degrees of freedom).

The above total does not include the pups on Sea Lion Rock. On Sea Lion Rock, we estimated 8,098 (SE = 191) pups to be alive at the time of shearing. At that time, 164 dead pups were counted, resulting in an estimate of 8,262 pups born on Sea Lion Rock in 2002.

If we add this number to the St. Paul estimate calculated above, total pup production on St. Paul Island was 153,978.

The number of pups born and the number of harem bulls at different rookeries on St. Paul Island are significantly correlated (correlation = 0.964, Fig. 7). The slope of the regression line with a zero intercept is 37.61 (SE = 2.09), representing an estimate of the ratio of pups to breeding males.

Number of Pups Born on St. George Island in 2002

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. The estimated total number of pups alive on St. George Island at the time of marking was 17,060 (SE = 526.6, 95% confidence interval of ± 1,289, or 15,771 - 18,349, Table 8). The estimated mortality rate was 3.0% (533 dead pups, Appendix Table B-7). The 2002 estimate of pups born on St. George Island was significantly less ($P < 0.01$) than the number of pups born in both 1998 and 2000. 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.

The number of pups born and the number of harem males on St. George Island rookeries are highly correlated ($y = 19.49x$, $r^2 = 0.98$; Fig. 7). The intercept of the regression line is not significantly different from zero ($P = 0.38$) and was not included in the regression equation.

Trends in Numbers of Pups

The estimated number of pups born and their 95% confidence intervals for St. Paul Island, 1975-2002, are shown in Figure 8. The total estimated number of pups born in 2002 (not including Sea Lion Rock) is 8.2% less than in 2000 (158,763) but was not significantly different ($P = 0.23$) due to the high variance of the 2000 estimate. Appendix Table B-3 summarizes pup production and mortality excluding Sea Lion Rock since 1975. On St. Paul Island, estimated numbers of fur seal pups born in 2000 were 11.4% less than in 1998 and the number born in 2002 was 8.2% less than in 2000 (Table B-3). On St. George Island this compares to an 8.7% decrease between 1998 and 2000 and a 12.8% decrease between 2000 and 2002. Estimated pup production has now declined below the 1919 level on St. Paul Island and below the 1916 level on St. George Island; during those years, 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.

Since the standard errors of the estimates of pups born varied widely, we estimated the recent annual rate of decline with a weighted regression of the logarithm of numbers of pups born on year, with weights equal to the inverse of the standard error of the logarithm (via the delta method, Casella and Berger 2002) of the annual pup estimate. During 1998-2002, the annual rate of decline on St. Paul Island was 5.12% (SE = 0.26%, P = 0.03) and 5.44% (SE = 0.72%,

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, 2002.

Rookery	Sheared	E1	E2	Live	SE
South	424	3,467	3,570	3,518	51.5
North	740	6,199	6,163	6,181	18.0
East Reef	105	775	812	794	18.5
East Cliffs	362	3,167	3,082	3,124	42.5
Staraya Artil	120	1,240	1,082	1,161	79.0
Zapadni	273	2,037	2,526	2,282	244.5

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, 2002.

Rookery	Pups alive at marking	SD	Dead pups	Total pups born	Mortality rate (%)	Harem males	Ratio pups/males
South	3,518	51.5	173	3,691	4.7	212	17.4
North	6,181	18.0	167	6,348	2.6	306	20.7
East Reef	794	18.5	11	805	1.4	66	12.2
East Cliffs	3,124	42.5	82	3,206	2.6	182	17.6
Staraya Artil	1,161	79.0	19	1,180	1.6	43	27.4
Zapadni	2,282	244.5	81	2,363	3.4	90	26.3
Island total	17,060	526.6	533	17,593	3.0	899	19.6

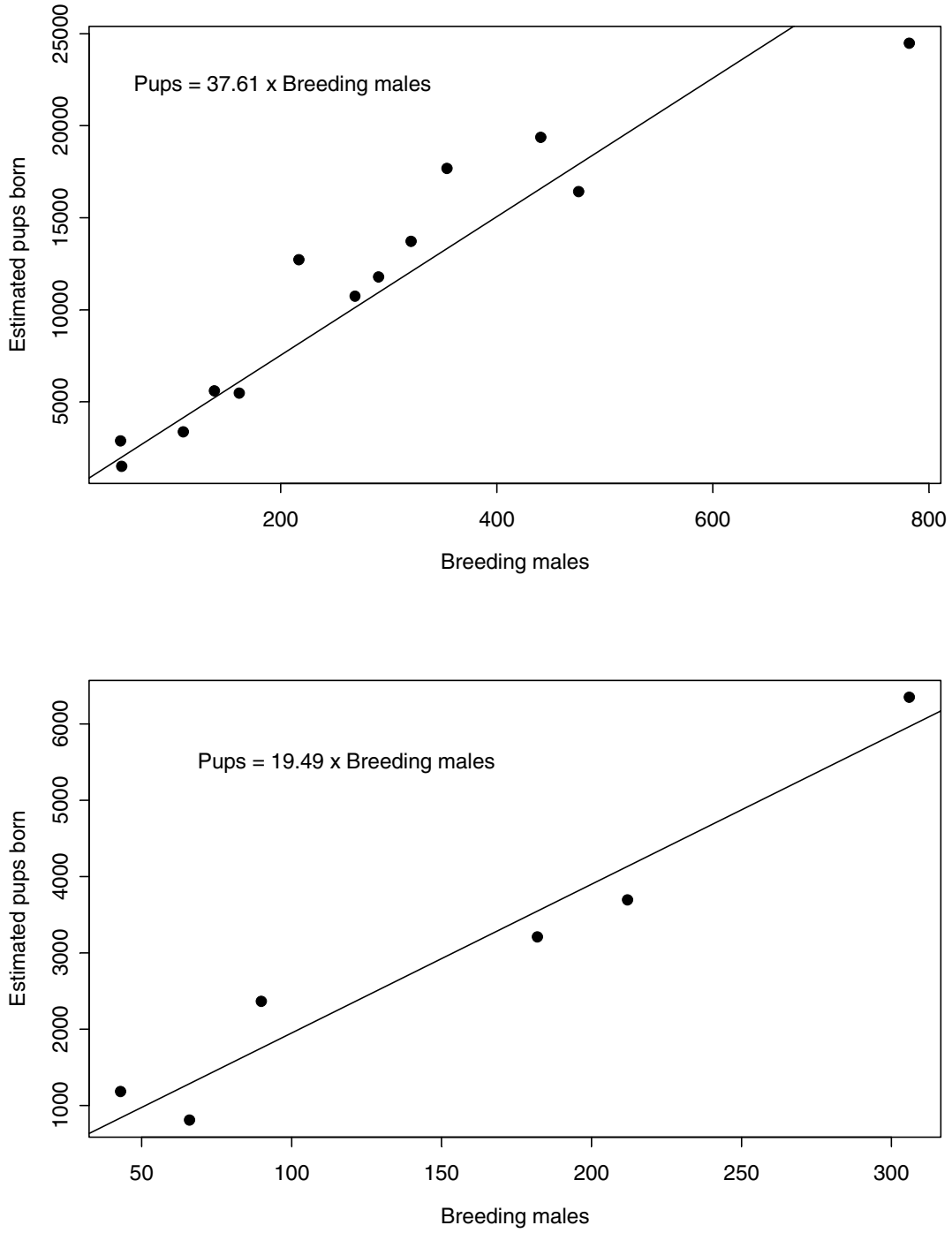

Figure 7. -- Pups born versus number of breeding males on St. Paul Island (top) and St. George Island (bottom), Alaska, 2002. Solid regression lines are shown for both locations.

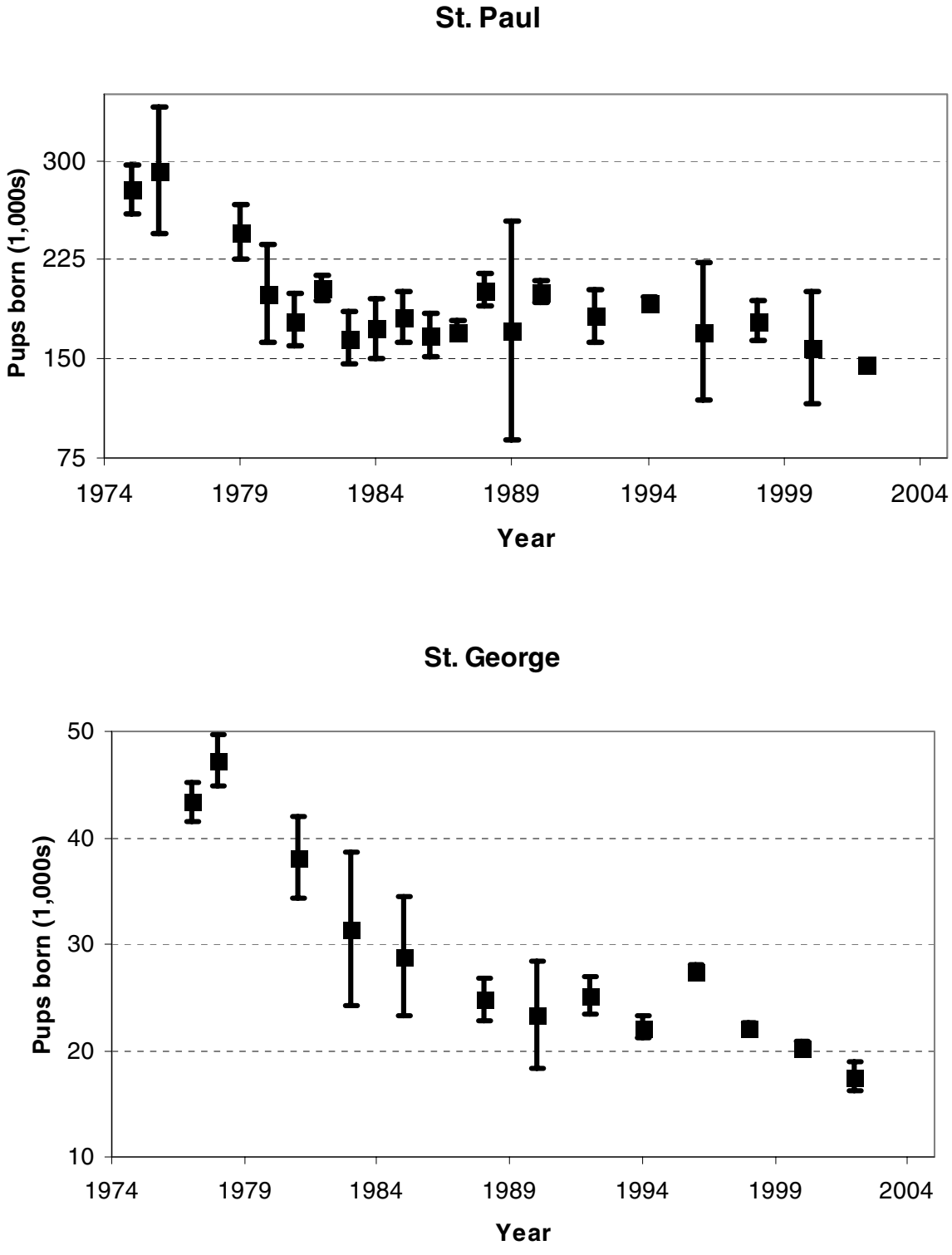

Figure 8 -- Estimated number of pups born and 95% confidence intervals (error bars) on St. Paul and St. George Islands, Alaska, 1975-2003.

P = 0.08) on St. George Island. The rate of decline on the Pribilof Islands (excluding Sea Lion Rock) was 5.20% (SE = 0.19%, P = 0.02).

The 2002 estimate of pup numbers on Sea Lion rock declined by approximately 36% from the 1994 estimate of 12,891 (SE = 989.3) and 19% from the 1990 estimate of 10,207 (SE = 528). This compares to declines of about 24% and 28% over the same periods on the St. Paul main island. Thus, it is difficult to determine if the changes on the mainland of St. Paul are different than on Sea Lion Rock, but the proportion of total pup production on St Paul that took place on Sea Lion Rock in those years has varied only slightly (range = 4.8-6.3%).

Estimate of Total Stock Size

Crude 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 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. Therefore, a strong assumption built into the estimate is that these vital rates are still valid. Since we cannot verify these assumptions, the estimate must be viewed only as a rough approximation. The numbers presented in Table 9 do not include the rookeries in Russian or Japanese waters**.** The estimate of the total stock for the Pribilof Islands population in 2002 is about 848,000 fur seals. The total stock size for the United States, which includes the Pribilof, Bogoslof, and San Miguel Island populations, is about 880,000 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 older than pups during August 2002 (Table 10). In 2002, tooth samples were collected from a total of 173 fur seals: 144 on St. Paul Island and 29 on St. George Island (3 dead adults were found with no teeth present). Appendix Table B-8 summarizes the number of dead male and female fur seals from which teeth were collected from 1965 to 2002.

Table 9.-- Details of the computation of the estimate of the stock size of fur seals in 2002.

Separate columns are given for the Pribilof (St. George and St. Paul Islands, and Sea Lion Rock) and non-Pribilof populations (San Miguel and Bogoslof Islands).

Formula	Pribilof Islands	San Miguel and Bogoslof Islands[2]	Component
Average for 1998, 2000, 2002[1]	189,424	7,180	Pups
(Pups) x (0.5)	94,712	3,590	Yearlings
(Yearlings) x (0.8)	75,770	2,872	Age 2 yr
(2-yr old females) x (0.86)/2	32,581	1,235	Females age 3 yr
(2-yr old males) x (0.8)/2	30,308	1,149	Males age 3 yr
(Total pups) / (0.6)	315,707	11,967	Females 3+ years
(3-yr old males x (3.6)	109,108	4,136	Males 4+ years
Total	847,610	32,129	

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

[2] The 2001, 2002 and 2003 estimates for San Miguel Island and the 1997 estimate for Bogoslof Island were used. Note that there were no data available from Castle Rock of 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 2002.

Rookery	Male	Female	Unknown	Total
St. Paul				
Lukanin	1	0	1	2
Kitovi	1	2	0	3
Reef	6	13	0	19
Gorbatch	1	14	0	15
Ardiguen	0	0	0	0
Morjovi	0	5	0	5
Vostochni	5	15	0	20
Polovina	0	5	0	5
Polovina Cliffs	1	3	0	4
Tolstoi	3	24	0	27
Zapadni Reef	1	2	0	3
Little Zapadni	5	13	0	18
Zapadni	12	11	0	23
Total St. Paul	36	107	1	144
St. George				
South	0	5	0	5
North[1]	4	8	2	14
East Reef	1	0	1	2
East Cliffs[2]	0	2	2	4
Staraya Artil[3]	1	3	1	5
Zapadni	0	1	1	2
Total St. George	6	19	7	32
Total both Islands	42	126	8	176

[1] One skull of unknown sex, 1 male with no teeth and 1 unknown sex with no teeth.
[2] One skull of unknown sex collected and 1 unknown sex with no teeth.
[3] One skull of unknown sex.

MASS, LENGTH, AND SEX RATIOS OF NORTHERN FUR SEAL PUPS ON THE PRIBILOF ISLANDS, 2002

by

Rodney G. Towell and Rolf R. Ream

Mass and length measurements of fur seal pups on St. Paul and St. George Islands have 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 2002. 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 data 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 ($P < 0.001$) by sex and rookery on St. Paul Island in 2002. Male and female pups were analyzed separately because the variance for males was greater than that for females, and rookery effects were significant only for males ($P = 0.003$, Table 12). Similarly, pup lengths (Fig. 10, Table 13) were significantly different ($P < 0.001$) by sex on St. Paul Island, and between rookeries for each sex analyzed separately ($P < 0.015$ females, $P < 0.001$ males, Table 14).

On St. George Island, pup mass (Fig. 9, Table 15) was also significantly different ($P < 0.001$) by sex. 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 female mass ($P = 0.097$, Table 16) or male mass ($P = 0.679$). The analysis of variance for lengths (Fig. 10, Table 17) indicated significant differences ($P < 0.001$) by sex and rookery. Separate analyses for males and females (Table 18) revealed significant differences between rookeries for females ($P = 0.034$), but not for males ($P = 0.172$).

Mass and length were compared between islands by sex after testing for unequal variances with an F-statistic assuming normal distributions. Male and female (St. Paul 7.82 kg., St. George 8.29 kg.) pups were both heavier and longer on St. George Island than St. Paul Island ($P < 0.001$).

Sex Ratios

The proportions of pups that were females were significantly different than 50% for all of the sample rookeries on St. Paul Island in 2002 (Table 19). None of the rookeries on St. George Island had a fraction of females significantly different than 50%. The fraction of total females was 41.7% for St. Paul Island ($P < 0.001\%$) but was not significantly different from 50% for St. George Island (47.8%, $P = 0.299$). The observed proportions were also significantly different ($P = 0.015$) 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 (41.7%, Table 20) but not on St. George Island in 2002. 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. On St. George Island, two measurers did about half the number of pups on each rookery; St. Paul measurers were rotated more frequently. The

protocol for taking length measurements is subjective and the process should be more closely examined.

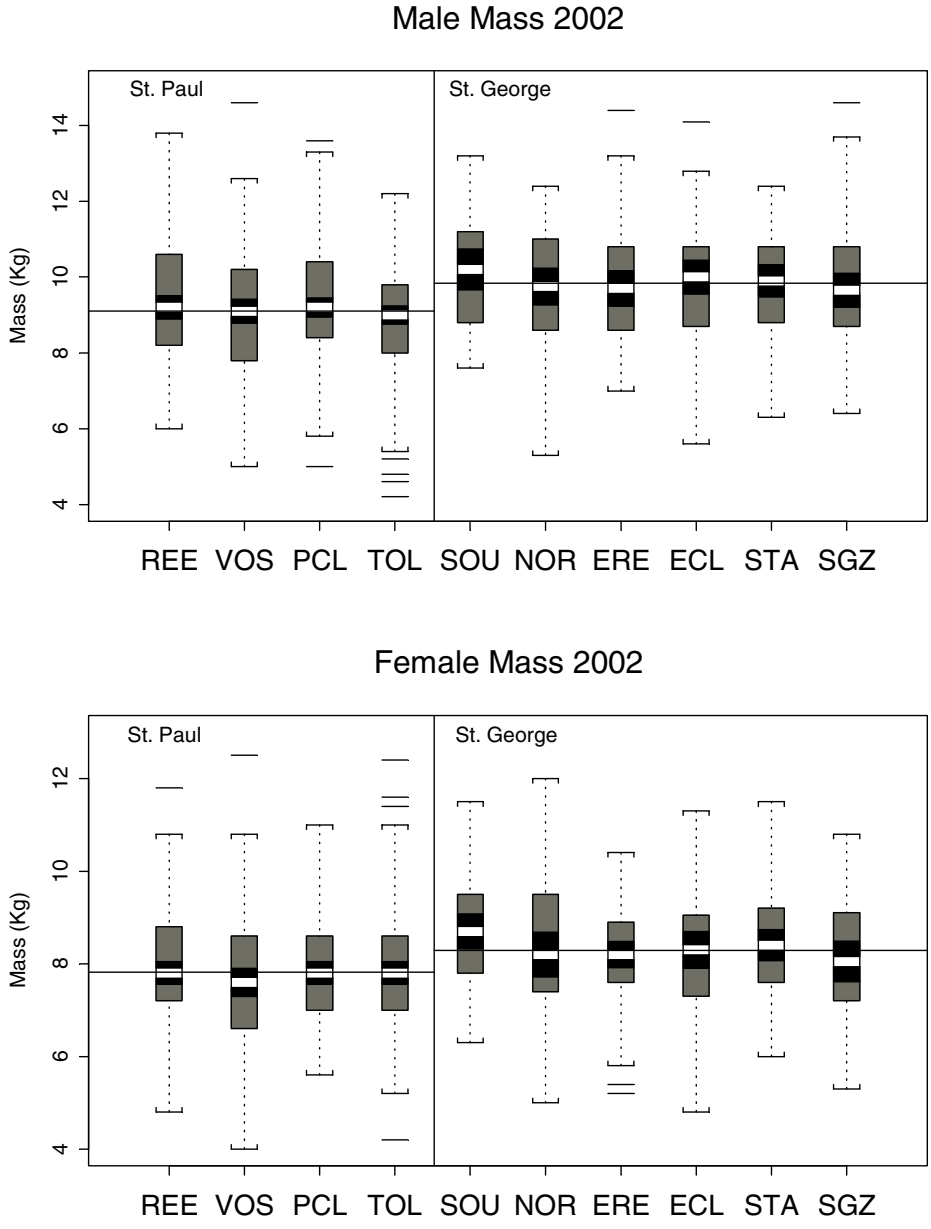

Figure 9.-- Boxplots of the median mass (white line) and its 95% confidence intervals (dark hatch) of northern fur seal pups on St. Paul and St. George Islands, Alaska, August 2002: Reef (REE), Vostochni (VOS), Polovina Cliffs (PCL), Tolstoi (TOL), South (SOU), North (NOR), East Reef (ERE), East Cliffs (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, August 24 - 25, 2002.

Rookery		Females	Males	Combined
Reef	kg	7.93	9.33	8.75
25 August	SD	1.32	1.54	1.61
	n	106	150	256
Vostochni	kg	7.70	8.98	8.44
24 August	SD	1.47	1.63	1.68
	n	106	145	251
Pol. Cliffs	kg	7.80	9.34	8.71
25 August	SD	1.21	1.49	1.57
	n	105	153	258
Tolstoi	kg	7.85	8.78	8.39
24 August	SD	1.43	1.53	1.56
	n	107	144	251
Combined	kg	7.82	9.11	8.57
	SD	1.36	1.56	1.61
	n	424	592	1016

Table 12.-- Analyses of variance of mass of male and female northern fur seal pups on St. Paul Island, Alaska, August 2002, across rookeries.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Females							
Rookery	3	2.8	0.94	775	423	0.51	0.673
Males							
Rookery	3	33.2	11.06	1409	588	4.62	0.003

*MSS = SS divided by df

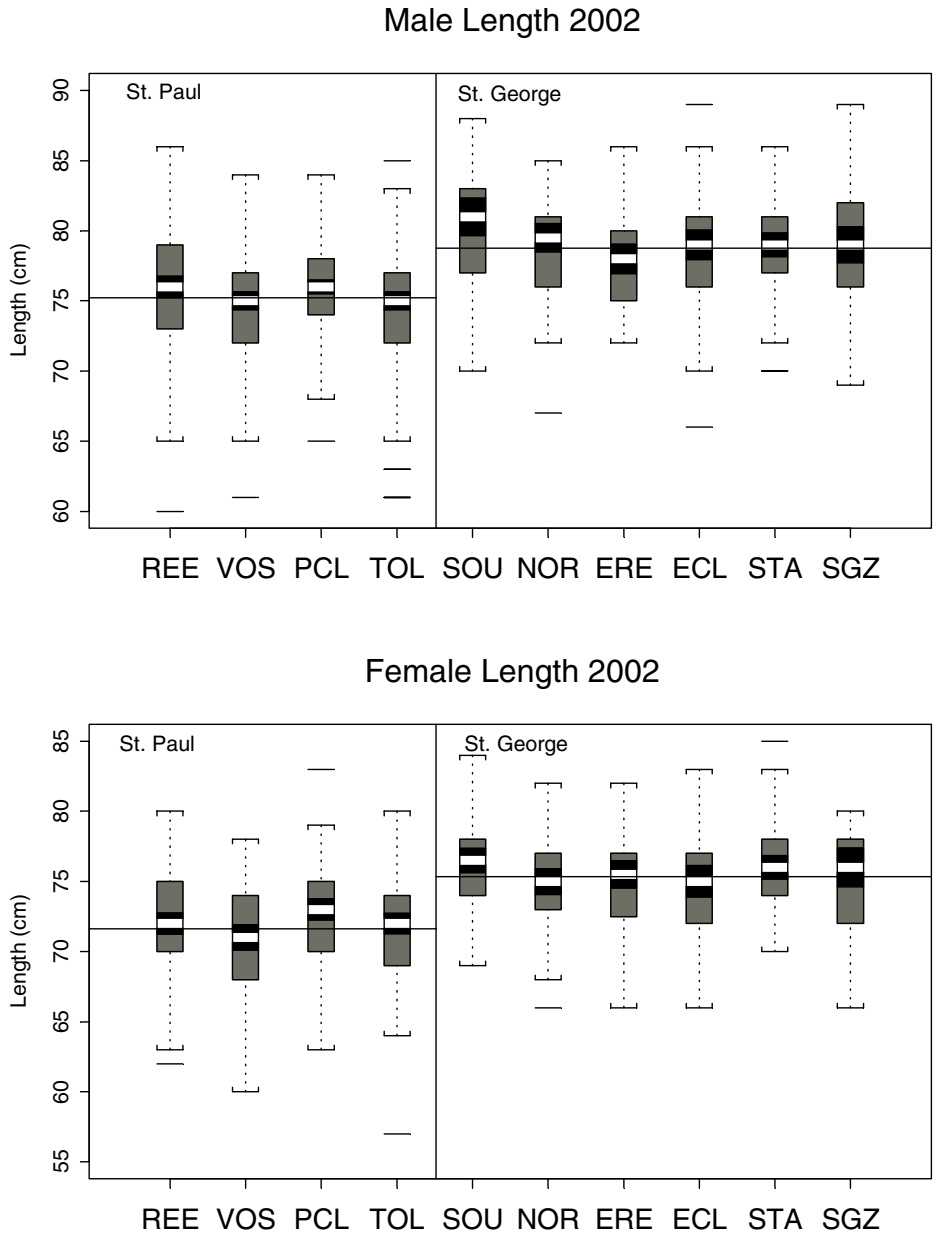

Figure 10.-- Boxplots of the median length (white line) and 95% confidence intervals of the median length (dark hatch) of northern fur seals on St. Paul and St. George Islands, Alaska, August 2002: Reef (REE), Vostochni (VOS), Polovina Cliffs (PCL),Tolstoi (TOL), South (SOU), North (NOR), East Reef (ERE), 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, August 24 - 25 2002.

Rookery		Females	Males	Combined
Reef	kg	72.00	75.92	74.30
25 August	SD	3.75	4.34	4.53
	n	106	150	256
Vostochni	kg	70.69	74.57	72.93
24 August	SD	3.94	4.31	4.57
	n	106	145	251
Pol. Cliffs	kg	72.27	76.08	74.48
25 August	SD	3.57	3.54	3.99
	n	105	153	258
Tolstoi	kg	71.51	74.37	73.15
24 August	SD	3.92	4.42	4.44
	n	107	144	251
Combined	kg	71.62	75.23	73.72
	SD	3.83	4.22	4.43
	n	424	592	1016

Table 14.-- Analyses of variance of length of male and female northern fur seal pups on St. Paul Island, Alaska, August 2002.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Females							
Rookery	3	152.3	50.8	6,065	420	3.51	0.015
Males							
Rookery	3	333.1	111.0	10,172	588	6.42	0.000

*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, 22-23 August 2002.

Rookery		Females	Males	Combined
South	kg	8.73	10.15	9.43
23 August	SD	1.16	1.37	1.45
	n	50	49	99
North	kg	8.21	9.69	9.04
23 August	SD	1.45	1.59	1.69
	n	47	60	107
East Reef	kg	8.18	9.81	9.02
22 August	SD	1.12	1.50	1.55
	n	52	55	107
East Cliffs	kg	8.13	9.93	9.09
22 August	SD	1.38	1.60	1.75
	n	48	55	103
Staraya Artil	kg	8.41	9.78	9.07
22 August	SD	1.09	1.48	1.46
	n	57	54	111
Zapadni	kg	8.07	9.73	8.97
23 August	SD	1.28	1.72	1.74
	n	46	54	100
Combined	kg	8.29	9.84	9.10
	SD	1.26	1.54	1.61
	n	300	327	627

Table 16.-- Analyses of variance of mass of male and female northern fur seal pups on St. George Island, Alaska, August 2002 across rookery.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Females							
Rookery	5	14.6	2.9	457	294	1.9	0.097
Males							
Rookery	5	7.5	1.5	770	321	0.6	0.679

*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, 22-23 August 2002.

Rookery		Females	Males	Combined
South	cm	76.42	79.94	78.16
23 August	SD	3.28	4.10	4.09
	n	50	49	99
North	cm	74.94	78.78	77.09
23 August	SD	3.42	3.71	4.05
	n	47	60	107
East Reef	cm	74.98	77.84	76.45
22 August	SD	3.52	3.50	3.78
	n	52	55	107
East Cliffs	cm	74.42	78.51	76.60
22 August	SD	3.99	3.99	4.47
	n	48	55	103
Staraya Artil	cm	76.07	78.79	77.40
22 August	SD	3.25	3.63	3.69
	n	57	54	111
Zapadni	cm	75.07	78.76	77.06
23 August	SD	3.35	4.48	4.39
	n	46	54	100
Combined	cm	75.34	78.75	77.12
	SD	3.51	3.92	4.10
	n	300	327	627

Table 18.-- Analyses of variance of length of male and female northern fur seal pups on St. George Island, Alaska, August 2002 across rookery.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Females							
Rookery	5	147.4	29.5	3,542	294	2.44	0.034
Males							
Rookery	5	118.5	23.7	4,892	321	1.56	0.172

*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 2002. The fraction of females is significantly less than 50% (P = 0.05) for bold items.

Rookery	Females	Total	Fraction
St. Paul			
Reef	**106**	**256**	**0.414**
Vostochni	**106**	**251**	**0.422**
Polovina Cliffs	**105**	**258**	**0.407**
Tolstoi	**107**	**251**	**0.426**
Total	**424**	**1016**	**0.417**
St. George			
South	50	99	0.505
North	47	107	0.439
East Reef	52	107	0.486
East Cliffs	48	103	0.466
Staraya Artil	57	111	0.514
Zapadni	46	100	0.46
Total	300	627	0.478

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 1992-2002.

	St. Paul			St. George		
Year	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

THE STATUS OF THE NORTHERN FUR SEAL POPULATION AT SAN MIGUEL ISLAND, CALIFORNIA, 2002-2003

by

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

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 and Russian Islands populations during the late 1950s or early 1960s (DeLong 1982). The environment around San Miguel Island is influenced by the California Current upwelling system, which produces fog and wind conditions that keep the island cool during the 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 they play an influential role in the dynamics of this population (DeLong and Antonelis 1991, Melin and DeLong 1994, Melin et al. 1996).

Between July 1997 and May 1998, one of the most severe El Niño events in recorded history affected the coastal waters off California (Lynn et al. 1998). Changes in the marine environment of northern fur seals at San Miguel Island resulted in an 80% decline in pup production in 1998 (Melin and DeLong 2000). In 1999, after almost two decades of a warm water regime in the California Current, the California Current shifted into a cold water regime (Hayward et al.1999). The cooler sea surface temperatures, shallower thermocline, and strong coastal upwelling associated with the regime shift should create a more favorable foraging environment for northern fur seals at San Miguel Island over the next decade and the population should experience higher survival and natality rates. However, between April 2002 and April 2003, a mild El Niño event occurred in the California Current (Venrick et al. 2003) and northern fur seals at San Miguel Island were again impacted by poor foraging conditions associated with the event. Here, we present the results of the 2002 and 2003 population monitoring studies at San Miguel Island. Although the population has continued to increase, it still remains 39% below the 1997 pup production and thus, has not yet recovered from the 1998 decline. In addition, the mild 2002-2003 El Niño negatively impacted the population, as indicated by lower pup weights at 4 months of age and lower pup production in 2002.

METHODS

Territorial Bull Count

The number of territorial bulls with females present over the breeding season was determined from daily surveys of the Adams Cove colony (Fig. 5). Each territorial bull associated with females was counted and the maximum daily count was used as an index of the maximum number of breeding bulls for the season.

Pup Production

Indices of pup production included censuses of live and dead pups during the breeding season at two colonies at San Miguel Island, California (Fig. 5). Live pup censuses were conducted in late July and early August in Adams Cove in 2002 and 2003 and at Castle Rock in 2002. Dates of the surveys were determined by the frequency of births observed during daily surveys in the Adams Cove colony. When no births were documented over several days, pupping was considered complete and the live pup census was conducted. In Adams Cove on the San Miguel Island mainland, the live pup counts were conducted from a mobile blind by two observers using binoculars to count groups of pups. At Castle Rock, an offshore rock, pups were counted by two observers counting small groups of pups in each territory of the colony. The mean number of pups and standard error about the mean were calculated from the counts of the two observers for each colony.

Fur seal pup mortality surveys were conducted between June and October in Adams Cove. Each dead pup was counted, removed from the territory and stacked away from the survey area to minimize the possibility of counting the same pup twice. 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

Northern fur seal pups were tagged in each foreflipper with pink Jumbo Plastic Rototags (Dalton Supplies, Ltd., United Kingdom) in Adams Cove in October 2002 and 2003. Each pup was weighed, sexed, and measured before release.

RESULTS

Territorial Bull Count

The maximum number of territorial bulls with females in Adams Cove was 94 in 2002 and 109 in 2003. This continues an increasing trend over the past 4 years, but the latest count remains 24.8% below 145 territorial bulls recorded during 1997.

Pup Production

In 2002, the live pup survey for northern fur seals was conducted on 1 August in Adams Cove and 28 July at the Castle Rock colony. A mean of 1,127 fur seal pups was counted at Adams Cove and a mean of 718 pups was counted at Castle Rock (Table 21). Total production (live + dead pups) at Adams Cove was 1,208 and at Castle Rock, total production was 739. Pup mortality in 2002 increased 152% from 2001. The low production and high pup mortality resulted in a 5.9% decline in total production for the Adams Cove colony in 2002. At Castle

Rock, total production also declined 1.6% from 2001. The total production of both colonies was 1,947, a 4.3% decrease from 2001.

In 2003, the live pup survey for northern fur seals was conducted on 1 August in Adams Cove. Weather conditions precluded a survey at Castle Rock. A mean of 1,083 fur seal pups was counted at Adams Cove and total production was 1,290, a 6.8% increase from 2002 (Table 21). Pup mortality increased 47% from 2002 and 271% from 2001. Total production at the Adams Cove colony in 2003 was 39.3% below the 1997 pup production, indicating that the population still has not recovered from the El Niño event in 1998

Pup Condition

Weights of 4-month-old pups were different for female and male pups in 2002 and 2003 compared to the long-term average (ANOVA, females, $P = 0.001$; males, $P < 0.001$) (Table 22). The difference was due to lower weights in 2002 for both sexes (Bonferroni post-hoc test, females, $P = 0.001$; males, $P < 0.001$).

Resighting of tagged fur seals

Forty-two (42) adult female and 85 adult male northern fur seals were individually identified from flipper tags. The age of females ranged from 2 to 13 years. Nine females observed with pups were between 4 and 11 years old. Tagged males ranged from 2 to 10 years of age. Six territorial males were 10 or 11 years old. As in previous years, no animals were resighted from the 1997 cohort.

DISCUSSION

The northern fur seal population at San Miguel Island began its recovery from the decline associated with the1998 El Niño event in 1999. In 2003, pup production remained 39% below that in 1997, indicating that the population has not recovered from the 1998 decline. Melin and DeLong (2000) suggested that adult mortality may have occurred during the 1997-98 El Niño event based on the low numbers of territorial bulls and adult females ashore during the 1998 breeding season. The continued low pup production and low number of territorial bulls in both 2002 and 2003 supports that conclusion. Furthermore, no tagged individuals from the 1997 cohort have been resighted, suggesting that the cohort suffered total or near-total mortality. The loss of that cohort would likely dampen the rate of recovery during the period when they would be expected to recruit to the adult breeding population (i.e., 2002-2004).

After 3 years of increasing pup production following the 1998 decline, production declined in 2002. The slight decline in 2002 may have resulted from the 2002-2003 El Niño, or from poor recruitment from the 1997 cohort. It is difficult to tease apart the effects of the event on pup production because the production had not yet recovered from the 1997-98 El Niño. However, the combination of a decrease in pup births and a significant decrease in pup growth in 2002 suggests that the recent mild El Niño conditions had a moderate impact on northern fur seals at San Miguel Island. In 2003, pup production increased and pup weights returned to the long-term average, indicating that foraging conditions for adults in the population had improved.

The 80% decline in total pup production at San Miguel Island during the 1997-98 El Niño reduced the northern fur seal population to levels equal to those observed 14 years before (DeLong and Antonelis 1991), and highlighted the importance of El Niño events in the dynamics

of the fur seal population at San Miguel Island. The population suffered one other significant decline of 60.3% in 1983, also related to an El Niño event (DeLong and Antonelis 1991). Adult mortality and high pup mortality in 1983 resulted in a 7-year recovery period characterized by rapid growth (Melin and DeLong 1994). In 1999, the northern fur seal population again began a recovery from the dramatic decline brought about by the 1997-98 El Niño event. The results presented here indicate that the population is still recovering 5 years later. Furthermore, although the California Current has shifted to a cold regime, El Niño events continue to occur and impede the population growth of northern fur seals at San Miguel Island.

Table 21.--Summary of live and dead pup counts of northern fur seals at Adams Cove 1997-2003 and Castle Rock 1997-2002. Mortality rates are based on observed mortality, which is likely underestimated. Standard error about the mean is in parentheses. A (−) preceding the percent change indicates a decline.

Colony/Year	Mean number of live pups	Early season pup mortality[1]	Total production	Annual percent change in total production	Percent change from total production in 1997	Early season pup mortality rate	Late-season pup mortality[2]	Season pup mortality rate[3]
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
2002	1127 (1.2)	81	1208	-5.9	-43.2	6.7	83	13.4
2003	1083 (0.3)	207	1290	6.8	-39.3	16.0	34	18.7
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	---	---	---	---	---			

[1] Number of dead pups counted up to the time of the live pup census.
[2] Number of dead pups counted after the live pup census.
[3] Rate calculated based on total number of dead pups in early and late-season dead pup counts.

Table 22.-- Mean weights and standard errors (SE) of 4-month-old northern fur seal pups at Adams Cove, San Miguel Island, California.

	Males			Females		
Year	n	Mean (kg)	SE	n	Mean (kg)	SE
2002	160	10.7	0.21	139	9.8	0.19
2003	102	11.8	0.26	98	10.8	0.23
1975-2001	2,360	11.9	0.05	2,322	10.5	0.05

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APPENDIX A

Glossary

The terms defined below are used in the chapters of this report on fur seal research and management on the Pribilof Islands, Bogoslof Island, San Miguel Island, and Castle Rock.

Bachelor	Young male seals aged 2-5 years

Classification of adult male fur seals

Class 1 (shoreline)	Full-grown males apparently attached to "territories" spaced along the water's edge at intervals of 10-15 m. Most of these animals are wet or partly wet, and some acquire harems of one to four females between 10 and 20 July. They would then be called harem males (Class 3). Class 1 males should not be confused with Class 2 animals, which have definite territories, whereas the shoreline males appear to be attached to such sites but may not be in all cases.
Class 2 (territorial without females)	Full-grown males that have no females, but are actively defending territories. Most of these animals are located on the inland fringe of a rookery: some are between Class 1 (shoreline) and Class 3 (territorial with females) males, and a few are completely surrounded by Class 3 males and their harems.
Class 3 (territorial with females)	Full-grown males actively defending territories and females. Most Class 3 males and their harems combine to form a compact mass of animals. Isolated individuals, usually with small harems, may be observed at each end of a rookery, on sandy beaches, and in corridors leading to inland hauling grounds. Some territorial males have as few as one or two females. Should these females beabsent during counts, their pups are used as a basis for putting the adult male into Class 3 rather than Class 2.

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.

Page

Table B-1. – Number of adult male northern fur seals counted, by class[a] and rookery section, St. Paul Island, Alaska, 9-14 July 2002. A dash indicates no section.

Rookery and class of male	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Lukanin															
2	38	28	-	-	-	-	-	-	-	-	-	-	-	-	66
3	59	51	-	-	-	-	-	-	-	-	-	-	-	-	110
5	181	19	-	-	-	-	-	-	-	-	-	-	-	-	200
Kitovi[b]															
2	(15)9	9	30	46	43	-	-	-	-	-	-	-	-	-	152
3	(14)13	16	39	38	42	-	-	-	-	-	-	-	-	-	162
5	(98)10	5	7	8	204	-	-	-	-	-	-	-	-	-	332
Reef															
2	20	44	22	20	42	28	10	34	25	20	3	-	-	-	268
3	40	75	50	38	97	59	0	54	31	27	5	-	-	-	476
5	16	26	49	58	158	56	8	19	9	52	46	-	-	-	497
Gorbatch															
2	41	15	28	5	26	40	-	-	-	-	-	-	-	-	155
3	77	59	61	5	39	50	-	-	-	-	-	-	-	-	291
5	649	23	71	116	26	22	-	-	-	-	-	-	-	-	907
Ardiguin															
2	28	-	-	-	-	-	-	-	-	-	-	-	-	-	28
3	53	-	-	-	-	-	-	-	-	-	-	-	-	-	53
5	9	-	-	-	-	-	-	-	-	-	-	-	-	-	9
Morjovi[c]															
2	(14)15	17	18	12	22	15	-	-	-	-	-	-	-	-	113
3	(25)37	41	42	26	64	34	-	-	-	-	-	-	-	-	269
5	(16)298	11	48	31	19	48	-	-	-	-	-	-	-	-	471
Vostochni															
2	14	11	10	21	9	38	15	18	11	6	10	15	50	29	257
3	45	21	41	68	36	105	52	50	28	17	30	50	147	92	782
5	10	30	24	29	70	37	18	14	35	7	6	116	170	156	722
Little Polovina															
2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
5	264	-	-	-	-	-	-	-	-	-	-	-	-	-	264
Polovina															
2	34	29	-	-	-	-	-	-	-	-	-	-	-	-	63
3	24	28	-	-	-	-	-	-	-	-	-	-	-	-	52
5	292	27	-	-	-	-	-	-	-	-	-	-	-	-	319
Polovina Cliffs															
2	27	14	11	18	21	44	23	-	-	-	-	-	-	-	158
3	50	27	25	51	45	60	63	-	-	-	-	-	-	-	321
5	52	4	10	11	9	33	34	-	-	-	-	-	-	-	153
Tolstoi															
2	32	18	21	23	37	38	55	36	-	-	-	-	-	-	260
3	27	28	42	48	47	62	54	46	-	-	-	-	-	-	354
5	3	4	6	8	15	32	45	540	-	-	-	-	-	-	653
Zapadni Reef															
2	74	21	-	-	-	-	-	-	-	-	-	-	-	-	95
3	109	30	-	-	-	-	-	-	-	-	-	-	-	-	139
5	147	157	-	-	-	-	-	-	-	-	-	-	-	-	304
Little Zapadni															
2	4	13	22	34	27	33	-	-	-	-	-	-	-	-	133
3	10	39	38	40	40	50	-	-	-	-	-	-	-	-	217
5	10	13	17	17	21	157	-	-	-	-	-	-	-	-	235
Zapadni															
2	28	15	32	23	36	68	28	7	-	-	-	-	-	-	237
3	22	48	65	50	51	117	73	15	-	-	-	-	-	-	441
5	(123)7	11	19	33	39	22	39	532	-	-	-	-	-	-	825

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

[b] Numbers in parenthesis are the adult males counted in Kitovi Ampitheater.

[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, 9-14 July, 2003. A dash indicates no section.

Rookery and class of male	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Lukanin															
2	41	20	-	-	-	-	-	-	-	-	-	-	-	-	61
3	44	47	-	-	-	-	-	-	-	-	-	-	-	-	91
5	93	24	-	-	-	-	-	-	-	-	-	-	-	-	117
Kitovi[b]															
2	(10)10	8	32	30	20	-	-	-	-	-	-	-	-	-	110
3	(11)12	22	38	34	38	-	-	-	-	-	-	-	-	-	155
5	(48)5	13	16	22	56	-	-	-	-	-	-	-	-	-	160
Reef															
2	16	24	27	26	41	26	6	32	26	22	4	-	-	-	250
3	36	70	48	39	60	90	1	68	42	44	5	-	-	-	503
5	33	56	38	38	126	32	15	50	36	42	46	-	-	-	512
Gorbatch															
2	42	19	26	10	14	26	-	-	-	-	-	-	-	-	137
3	69	50	65	9	37	42	-	-	-	-	-	-	-	-	272
5	415	48	83	82	48	32	-	-	-	-	-	-	-	-	708
Ardiguin															
2	13	-	-	-	-	-	-	-	-	-	-	-	-	-	13
3	52	-	-	-	-	-	-	-	-	-	-	-	-	-	52
5	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Morjovi[c]															
2	(14)30	24	32	16	38	20	-	-	-	-	-	-	-	-	174
3	(37)44	40	49	32	56	38	-	-	-	-	-	-	-	-	296
5	(72)228	32	58	19	48	145	-	-	-	-	-	-	-	-	602
Vostochni															
2	20	16	11	20	17	48	26	18	13	8	13	20	53	20	303
3	38	24	27	47	27	85	30	46	22	17	25	46	106	66	606
5	34	40	16	76	108	63	32	21	40	37	8	95	160	141	871
Little Polovina															
2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
5	96	-	-	-	-	-	-	-	-	-	-	-	-	-	96
Polovina															
2	25	14	-	-	-	-	-	-	-	-	-	-	-	-	39
3	49	35	-	-	-	-	-	-	-	-	-	-	-	-	84
5	252	64	-	-	-	-	-	-	-	-	-	-	-	-	316
Polovina Cliffs															
2	15	8	11	21	14	24	50	-	-	-	-	-	-	-	143
3	50	30	26	60	51	58	99	-	-	-	-	-	-	-	374
5	112	14	14	20	25	30	46	-	-	-	-	-	-	-	261
Tolstoi															
2	32	20	4	22	32	40	39	32	-	-	-	-	-	-	221
3	34	28	26	56	46	60	46	45	-	-	-	-	-	-	341
5	6	24	3	5	30	26	29	206	-	-	-	-	-	-	329
Zapadni Reef															
2	74	12	-	-	-	-	-	-	-	-	-	-	-	-	86
3	126	28	-	-	-	-	-	-	-	-	-	-	-	-	154
5	104	240	-	-	-	-	-	-	-	-	-	-	-	-	344
Little Zapadni															
2	8	14	26	28	25	34	-	-	-	-	-	-	-	-	135
3	20	50	60	54	47	55	-	-	-	-	-	-	-	-	286
5	50	29	37	40	48	237	-	-	-	-	-	-	-	-	441
Zapadni[d]															
2	18	25	36	22	29	28	26	11	-	-	-	-	-	-	195
3	34	34	62	65	64	86	68	23	-	-	-	-	-	-	436
5	(185)14	24	22	32	32	48	48	535	-	-	-	-	-	-	940

[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 Ampitheater.

[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, 1975-2003. A dash indicates no data.

	St. Paul						St. George					
Year	Harem Bulls	Idle Bulls	Pups Born	SD	Rookeries Sampled (n)	Dead Pups	Harem Bulls	Idle Bulls	Pups Born	SD	Rookeries Sampled	Dead Pups
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	--	--	--	--
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	--	--	--	--

* 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 2002.

	Section															
Rookery	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Lukanin		231	215													446
Kitovi	52	58	62	157	154	169										652
Reef		174	336	211	158	319	261	0	255	144	124	22				2,004
Gorbatch		384	289	307	26	188	241									1,435
Ardiguen		199														199
Morjovi	113	180	182	189	119	310	161									1,254
Vostochni		160	71	146	255	137	382	188	180	105	65	109	185	334	528	2,845
Polovina		159	145													304
Little Polovina		0	0													0
Polovina Cliffs		257	127	120	262	223	303	311								1,603
Tolstoi		175	185	276	315	322	411	359	347							2,390
Zapadni Reef		521	147													668
Little Zapadni		75	266	275	297	247	359									1,519
Zapadni		108	234	320	247	252	566	362	72							2,161
Sea Lion Rock		835														835
Total																18,315

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

Table B-5.-- Number of dead northern fur seal pups counted by section on the sampled rookeries of St. Paul Island, Alaska, 2002.

		Section															
Rookery	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	necropsies	Total
Lukanin	8/20	62	83														145
Kitovi[1]	8/26	(1)17	9	41	56	27											151
Reef	8/20	45	111	41	37	66	66	4	76	56	12	2				28	544
Gorbatch	8/21	134	86	123	21	47	65										476
Ardiguen	8/21	57															57
Morjovi[2]	8/21	(16)43	39	35	19	77	28										257
Vostochni	8/17	29	10	23	44	57	87	33	41	27	4	17	65	157	68	31	693
Polovina	8/22	71	30														101
Polovina Cliffs	8/22	43	14	17	45		95	63									277
Tolstoi	8/18	48	43	77	72	115	132	130	92								709
Zapadni Reef	8/18	43	160														203
Little Zapadni	8/19	23	58	71	101	103	84										440
Zapadni	8/23	51	67	124	133	101	140	90	31								737
Total w/o SLR																	4,790
Sea Lion Rock	8/9	164															164
Total																	4,954

[1] Numbers in parenthesis are for Kitovi Amphitheater.

[2] Numbers in parenthesis are for second point south of Sea Lion Neck.

Table B-6.-- Number of northern fur seal pups sheared on each rookery of St. George Island, Alaska, 2002.

Rookery	Section					Total
	1	2	3	4	5	
South	106	169	149			424
North	152	168	213	111	96	740
East Reef	105					105
East Cliffs	224	138				362
Staraya Artil	96	24				120
Zapadni*		209	64			273
Total						2,024

* 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, 2002.

Rookery	Date	Section 1	2	3	4	5	Total
South	8/18	55	75	43			173
North	8/17	29	36	57	23	22	167
East Reef	8/16	11					11
East Cliffs	8/16	59	23				82
Staraya Artil*	8/17	19					19
Zapadni	8/18	24	33	24			81
Total							533

*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, 1965-2002. Teeth (usually canines) were collected from most of these seals. A dash indicates no data.

	St. Paul Island		St. George Island		Total	
Year	Males	Females	Males	Females	Males	Females
1965	158	-	-	-	158	-
1966	181	172	41	55	222	227
1967	108	157	41	28	149	185
1968	98	141	33	22	131	163
1969	94	141	22	29	116	170
1970	52	124	4	53	56	177
1971	39	91	5	37	44	128
1972	46	111	22	30	68	141
1973	61	65	7	30	68	95
1974	33	30	4	15	37	45
1975	92	99	-	-	92	99
1976	46	64	-	-	46	64
1977	60	69	-	-	60	69
1978	57	87	-	-	57	87
1979	56	66	-[a]	-[a]	56	66
1980	102	117	14	65	116	182
1981	44	83	12	61	56	144
1982	47	117	-	-	47	117
1983	57	66	-	-	57	66
1984	66	72	-	-	66	72
1985	5	34	17	35	22	69
1986	24	67	-	-	24	67
1987	20	90[b]	-	-	20	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

[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 mode 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.

APPENDIX C

Scientific staff engaged in northern fur seal
field research in 2002-2003

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

Name	Affiliation
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Robert DeLong	NMML
Brian Fadely	NMML
Charles Fowler	NMML
Sharon Melin	NMML
Anthony Orr	NMML
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Jeremy Sterling	NMML
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Jim Thomason	NMML
Rod Towell	NMML
Anne York	NMML
Tonya Zeppelin	NMML

Research Associates and Cooperators

Aquilina Lestenkof	TGSP
Patience Browne	UCD
David Cormany	NMFSJ
Tamra Faris	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
Lou Taylor	PISP
Andrew Fratis	PISP
Phillip Zavadil	TGSP

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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