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Fur Seal Investigations, 1999

by
B. W. Robson (editor)

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
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September 2001

ABSTRACT

Researchers from the National Marine Mammal Laboratory conduct field investigations on the population status of northern fur seals (*Callorhinus ursinus*) annually on the Pribilof Islands and on Bogoslof Island in the eastern Bering Sea and on San Miguel Island located off the coast of California. The size of the Pribilof stock of northern fur seals in 1998 was estimated to be 973,000 individuals and the total population of fur seals in U. S. rookeries was estimated to be 1,004,000 individuals.

Population parameters monitored in 1999 on the Pribilof Islands included the size of the subsistence harvest and the number of adult male fur seals on both islands. A total of 3,801 harem and 7,589 idle adult male seals were counted on St. Paul Island and 1,052 harem and 916 idle adult males were counted on St. George Island. The general decrease in the count of adult males on the Pribilof Islands noted in recent years continued in 1999. The count of territorial males with females (Class 3) on St. Paul Island has declined at a rate of about 3% per year for the last 6 years. The decline between 1998 and 1999 exceeds previous declines, being about 20% for Class 3 males on St. Paul and 17% for Class 3 males on St. George.

A total of 997 sub-adult male seals were killed in the 1999 subsistence harvest on St. Paul Island between 2 July and 7 August. On St. George Island, 193 sub-adult male seals were taken in the subsistence harvest, between 6 July and 8 August.

Trends in the mass and length of fur seal pups are used as indicators of population health and have been monitored semi annually since 1989. Consistent with earlier evaluations of pup mass data, the strongest pattern was that the size of pups varied by sex: male pups were heavier and longer than female pups. The proportion of females (42.7%) was significantly different ($P < 0.001$) than 50%, (46.0% on St. Paul Island in 1999.

The northern fur seal population at San Miguel Island began its recovery in 1999 from the 1998 decline. Although pup production increased at both San Miguel colonies, they remained below the pre 1997-98 El Nino event production levels by more than 60%. The number of territorial males with females in Adams Cove increased from 74 bulls in 1998 to 106 in 1999. The total observed pup production during 1998 was 424 in Adams Cove and 194 on Castle Rock, a decline of 79.6% and 79.5%, respectively, from 1997 to 1998. The 79.6% decline in the number of northern fur seal pup births at San Miguel Island in 1998 represents the greatest decline in population growth since studies began in 1968.

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INTRODUCTION

by

Bruce W. Robson

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

The Pribilof Islands (St. Paul and St. George Islands) northern fur seal population of approximately 1 million animals is the largest among U.S. fur seal rookeries (Figs. 1-3). It comprises approximately 74% of the world's population of northern fur seals, an estimated 973,000 northern fur seals (York et al. 2000). Smaller breeding colonies are located on the Kuril Islands in Japan, the Commander Islands in Russia, Bogoslof Island in the southeastern Bering Sea, and San Miguel Island in the Channel Islands off California. Northern fur seals were designated as depleted in 1988 under the Marine Mammal Protection Act when it was determined they were below their Optimum Sustainable Population (OSP) level. Commercial harvesting of fur seals was discontinued on St. Paul Island in 1984 and on St. George Island in 1973; however, a subsistence harvest continues on both islands. There is no subsistence or commercial harvest on the remaining U.S. rookeries (Figs. 4 and 5).

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

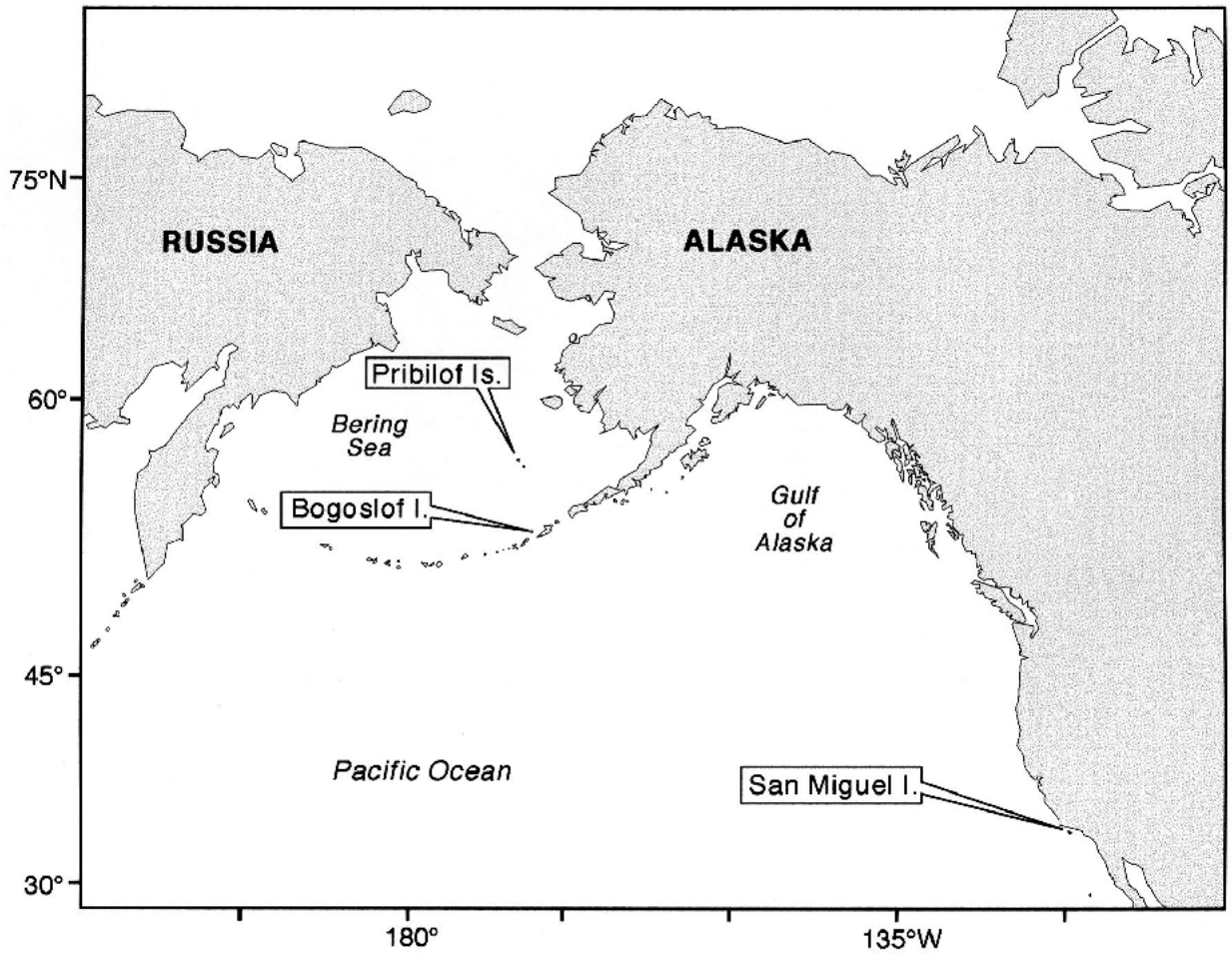

Figure 1.--Location of the three northern fur seal breeding areas within U.S. waters.

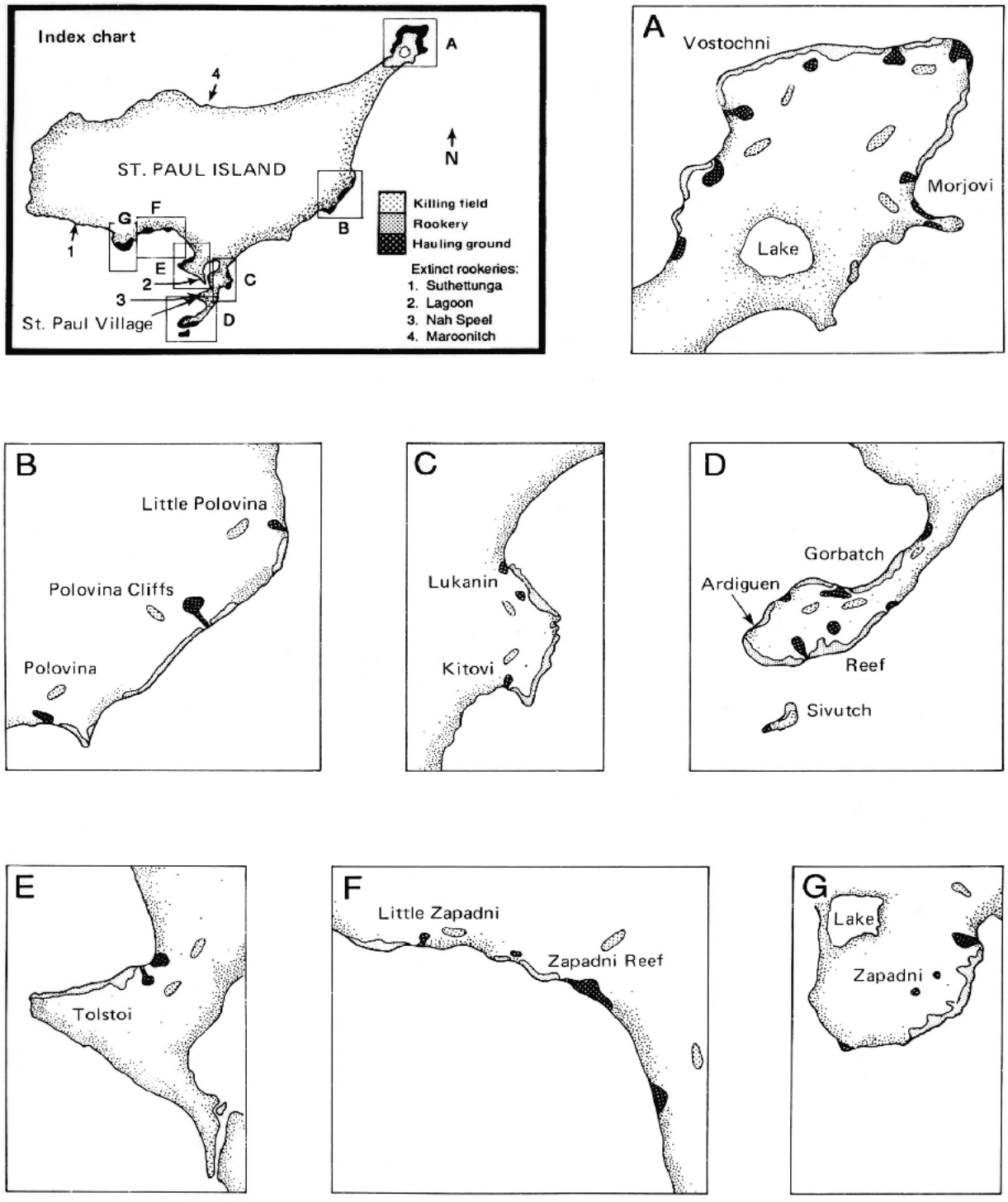

Figure 2.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. Paul Island, Alaska.

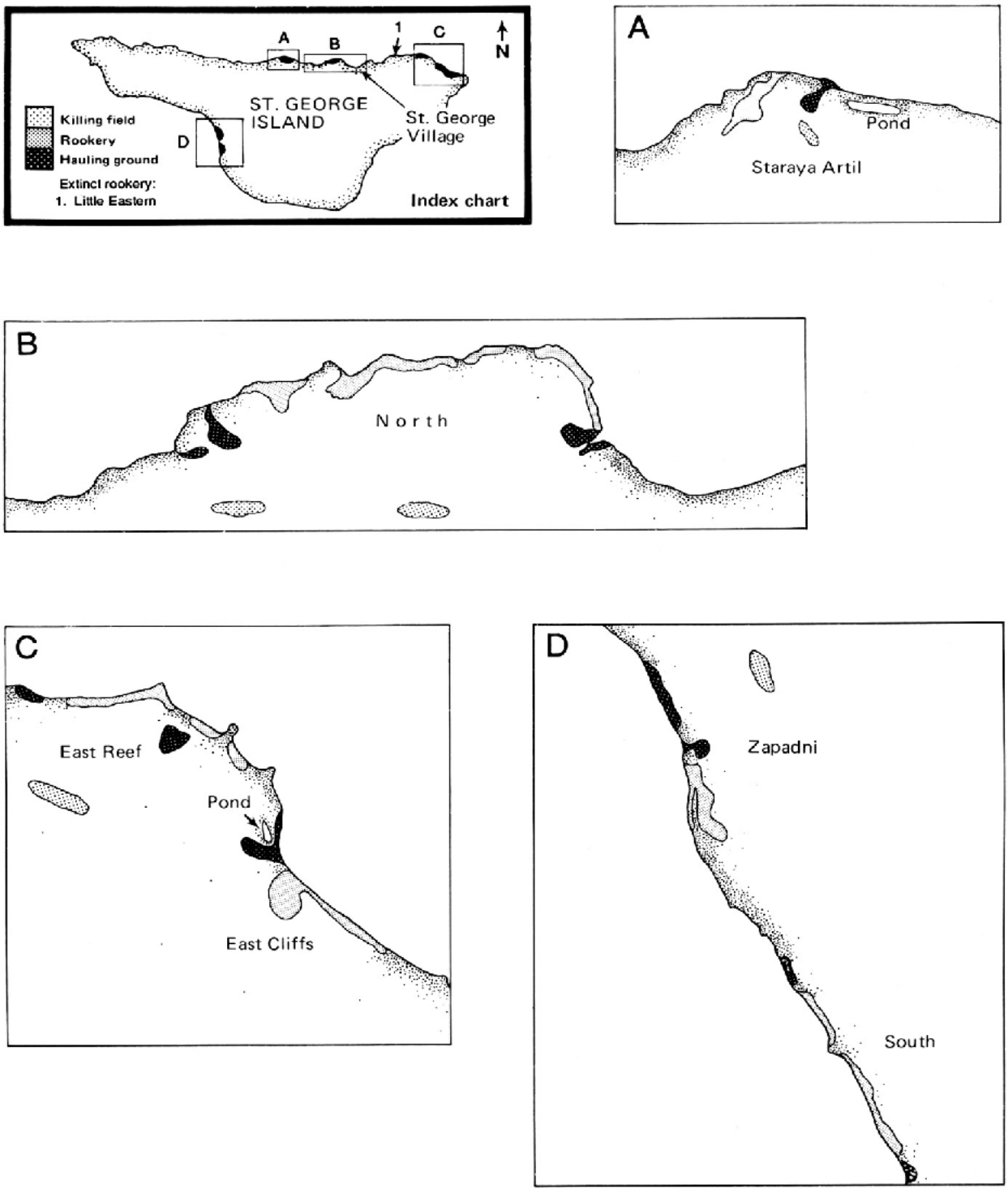

Figure 3.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. George Island, Alaska.

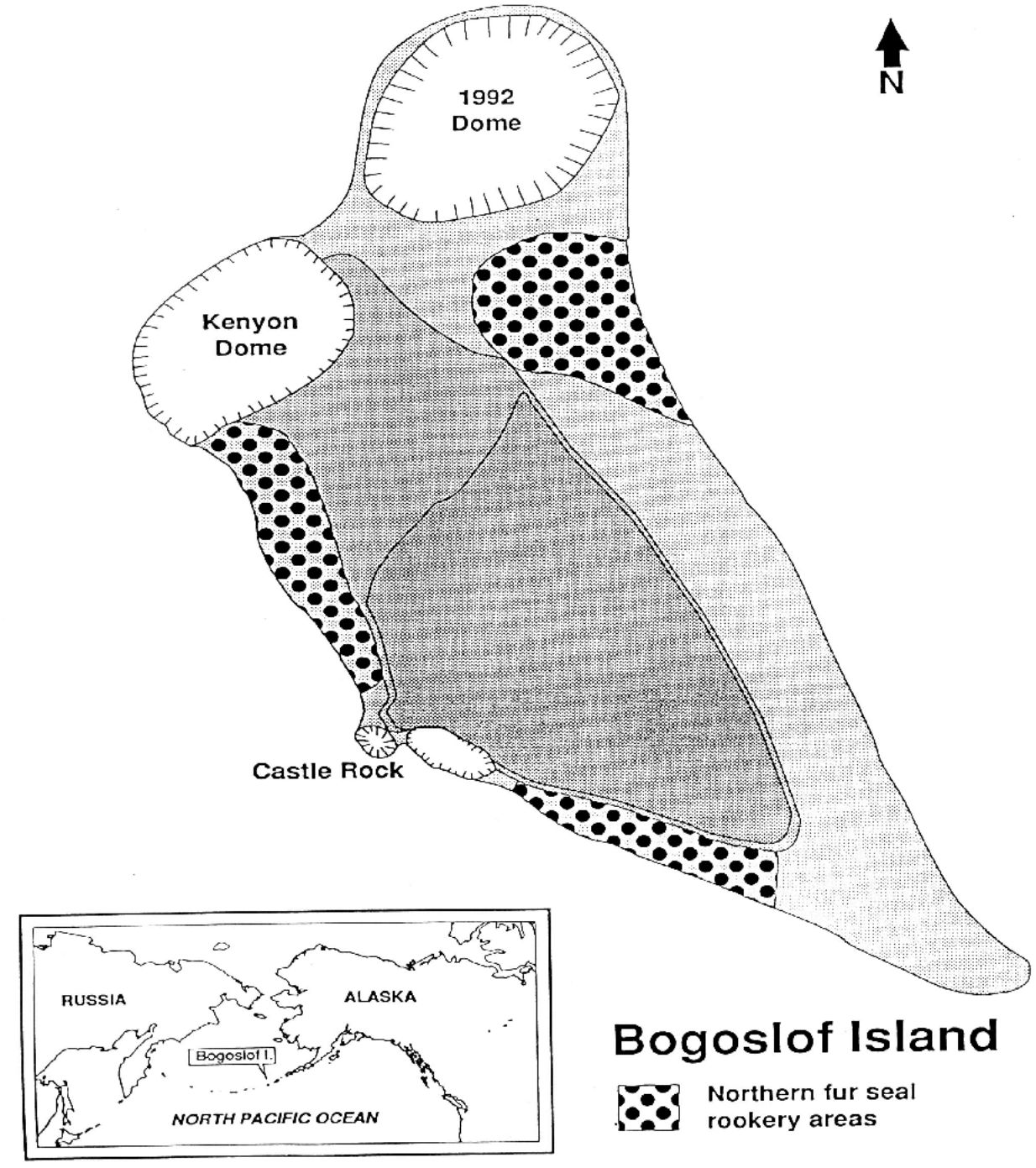

Figure 4.--Fur seal rookeries on Bogoslof Island, Alaska.

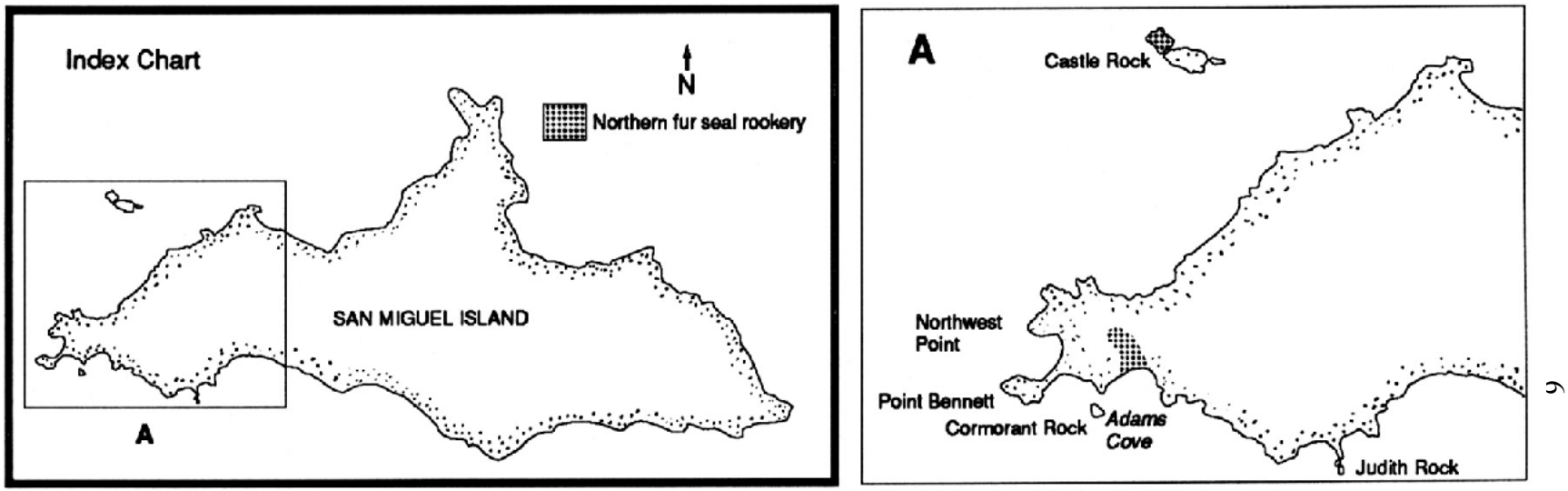

Figure 5.--Location of northern fur seal breeding colonies, San Miguel Island, California.

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POPULATION ASSESSMENT, PRIBILOF ISLANDS, ALASKA

by

Charles W. Fowler, Masashi Kiyota, David R. Cormany, Kent Sundseth

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 northern fur seal populations on the Pribilof Islands. To meet this objective, data on population size, age and sex composition, and natural mortality are collected annually following the methods described by Antonelis (1992). Population characteristics monitored in 1999 include the size of the subsistence harvest and the counts of adult males on St. Paul and St. George Islands, and counts of entangled females seen during the count of adult males.

RESULTS AND DISCUSSION

Sex Composition and Numbers of Seals Harvested

A total of 997 sub-adult male seals were harvested and three adult male fur seals were killed accidentally during the 1999 subsistence harvest on St. Paul Island between 2 July and 7 August (Table 1). At least 36 more seals, predominantly males, died as a result of falling from a cliff after the escape of a group being held for harvest on Reef Point on 31 July. No females were killed during the regular harvest routine. On St. George Island, 193 sub-adult male seals were taken in the subsistence harvest in 1999, between 6 July and 8 August (Table 2). One adult male was accidently killed.

Living Adult Male Seals Counted

Adult male seals were counted by section for each rookery (see Appendix A glossary for definitions of terms) on St. Paul Island from 9 to16 July (Appendix Table B-1). A total of 3,801 harem (Class 3) and 7,589 idle (Classes 2 and 5) adult male seals, also referred to as idle bulls, were counted on St. Paul Island. On St. George Island, a total of 1,052 harem (Class 3) and 916 idle (Classes 2 and 5) adult male seals were counted from 16 to 20 July. The relative location of the different classes of adult males is illustrated for a typical fur seal rookery-hauling ground complex on the Pribilof Islands in Figure 6. Total numbers of harem and idle bulls counted since 1972 are given in Appendix Table B-2, and the classification and number of adult males counted by rookery for St. Paul and St. George Islands are presented in Table 3.

A count of adult male fur seals was also conducted on Sea Lion Rock (Sivutch) off St. Paul Island in 1999 but the data are not included in the tables of this report to avoid confusion in comparing numbers over time. There were 86 Class 2, 405 Class 3, and 41 Class 5 males counted (i.e., 405 "harem" males, and 127 "idle" males). For comparison, there were to 32, 470, and 150, males of each Class, respectively, counted in 1979 (i.e., 182 "idle" males of Classes 2 and 5 combined). In 1990 there were 325 Class 3 males and 118 "idle" males counted.

The general decrease in the count of adult males on the Pribilof Islands noted in recent years continued in 1999 (Fig. 7). The count of territorial males with females (Class 3) on St. Paul Island has declined at a rate of about 3% per year for the last 6 years. The decline between 1998 and 1999 exceeds previous declines, being about 20% for Class 3 males on St. Paul and 17% for Class 3 males on St. George. These trends clearly mark the end of the increase in abundance of

adult males following the last commercial harvest in 1984. This increase appears to have brought the adult male population to its peak in 1992-93.

SUMMARY

During 1999, 997 sub-adult male fur seals were harvested and 39 adult male fur seal were killed accidentally during the subsistence harvest on St. Paul Island. On St. George Island, 193 sub-adult male fur seals were taken in the 1999 subsistence harvest and one adult male was killed accidently. On St. Paul Island, 3,801 harem (Class 3) and 7,589 idle (Classes 2 and 5) adult male fur seals, also referred to as bulls, were counted in mid-July. On St. George Island, a total of 1,052 harem (Class 3) and 916 idle (Classes 2 and 5) adult male seals were counted. Two out of 22,820 adult females surveyed were observed to be entangled in marine debris.

Table 1.-- Date, location, and number of subadult male seals killed in subsistence harvest drives on St. Paul Island, Alaska, in 1999.

Date	Rookery	Number killed
July 2	Reef	26
July 7	Zapadni Reef[1]	20
July 8	Polovina	35
July 10	Zapadni	12
July 14	Polovina[2]	36
July 17	Reef	40
July 21	Polovina	30
July 23	Zapadni	39
July 26	Reef	63
July 27	Polovina	35
July 28	Zapadni Reef	65
July 29	Zapadni	69
July 30	Lukanin	69
July 31	Zolotoi/Reef[3]	102
August 3	Polovina	66
August 4	Zapadni	86
August 5	Lukanin[4]	91
August 6	N.E. Point	46
August 7	Zolotoi	70

[1] one adult male accidentally struck/killed.
[2] one adult male accidentally struck/injured
[3] at least 36 seals (probably all males, and mostly juveniles) died as a result of falling over a cliff
[4] one adult male accidentally struck/killed

Table 2.-- Date, location, and number of subadult male seals killed in subsistence harvest drives on St. George Island, Alaska, in 1999.

Date	Rookery	Number killed
July 6	Northeast	11
July 10	Zapadni[1]	16
July 12	Northeast	12
July 17	Zapadni	11
July 20	Northeast	16
July 24	Zapadni	20
July 29	Northeast	25
July 31	Zapadni	11
August 3	Northeast	19
August 7	Northeast	16
August 8	Zapadni	37

[1] one adult male seal accidently struck/killed

Table 3.--Number of adult male northern fur seals counted, by rookery, Pribilof Islands, Alaska, July 1999.

Rookery	Date (July)	Class of adult male * 2	3	5	Total
St. Paul Island					
Lukanin	10	67	115	74	256
Kitovi	10	164	175	196	535
Reef	11	257	406	577	1240
Gorbatch	11	183	297	714	1194
Ardiguen	11	17	68	11	96
Morjovi	14	135	300	424	859
Vostochni	15	310	814	814	1938
Little Polovina	16	6	4	237	247
Polovina	16	37	79	365	481
Polovina Cliffs	16	174	409	217	800
Tolstoi	9	230	344	517	1091
Zapadni Reef	12	89	126	203	418
Little Zapadni	12	184	269	341	794
Zapadni	12	240	395	806	1441
Island total		2,093	3,801	5,496	11,390
St. George Island					
South	18	72	222	78	372
North	21	127	377	141	645
East Reef	16	31	80	57	168
East Cliffs	16	97	211	117	425
Staraya Artil	20	26	50	62	138
Zapadni	20	48	112	60	220
Island total		401	1,052	515	1,968

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

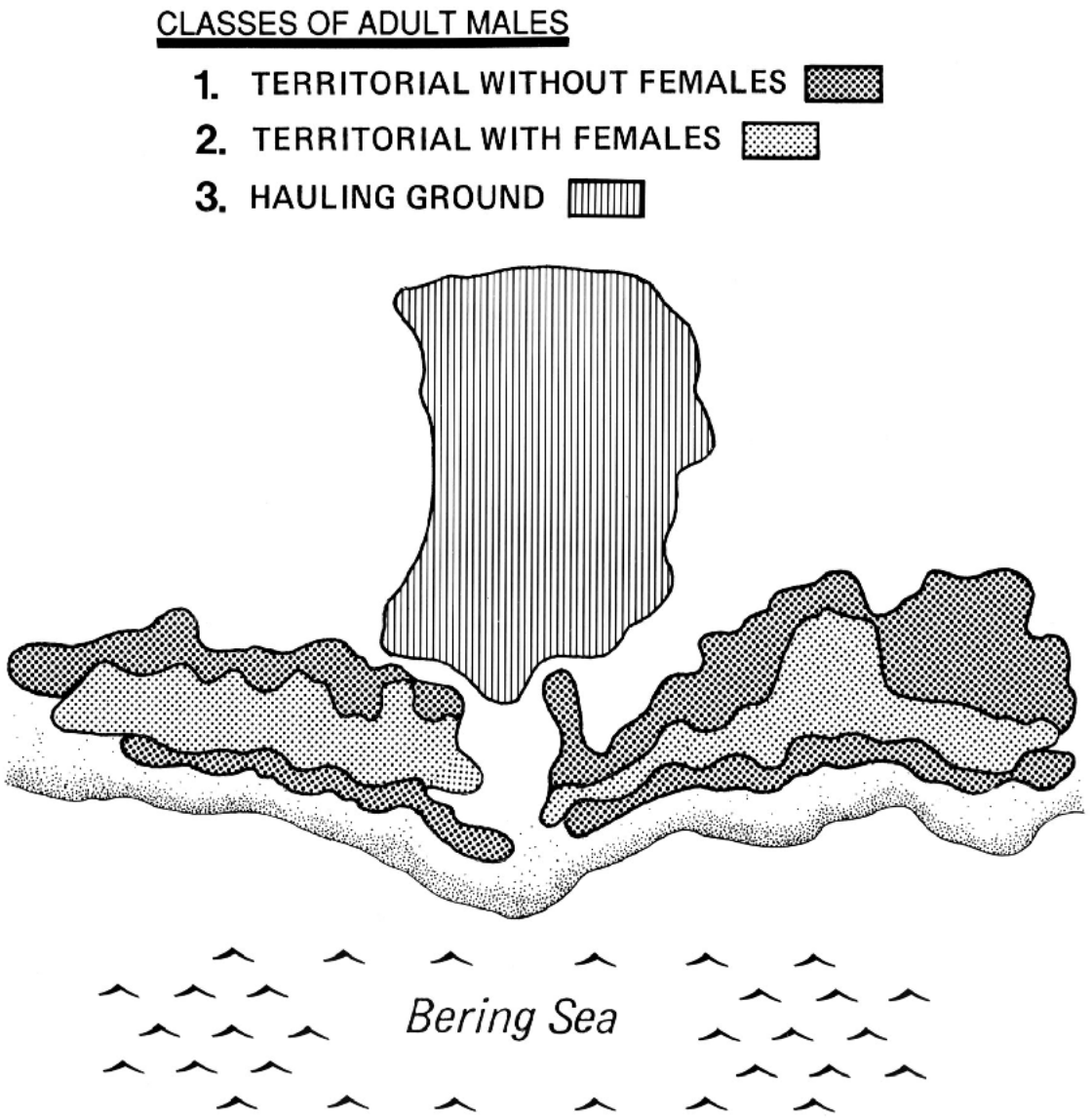

Figure 6.--The relative location of the different classes of adult males for a typical fur seal rookery.

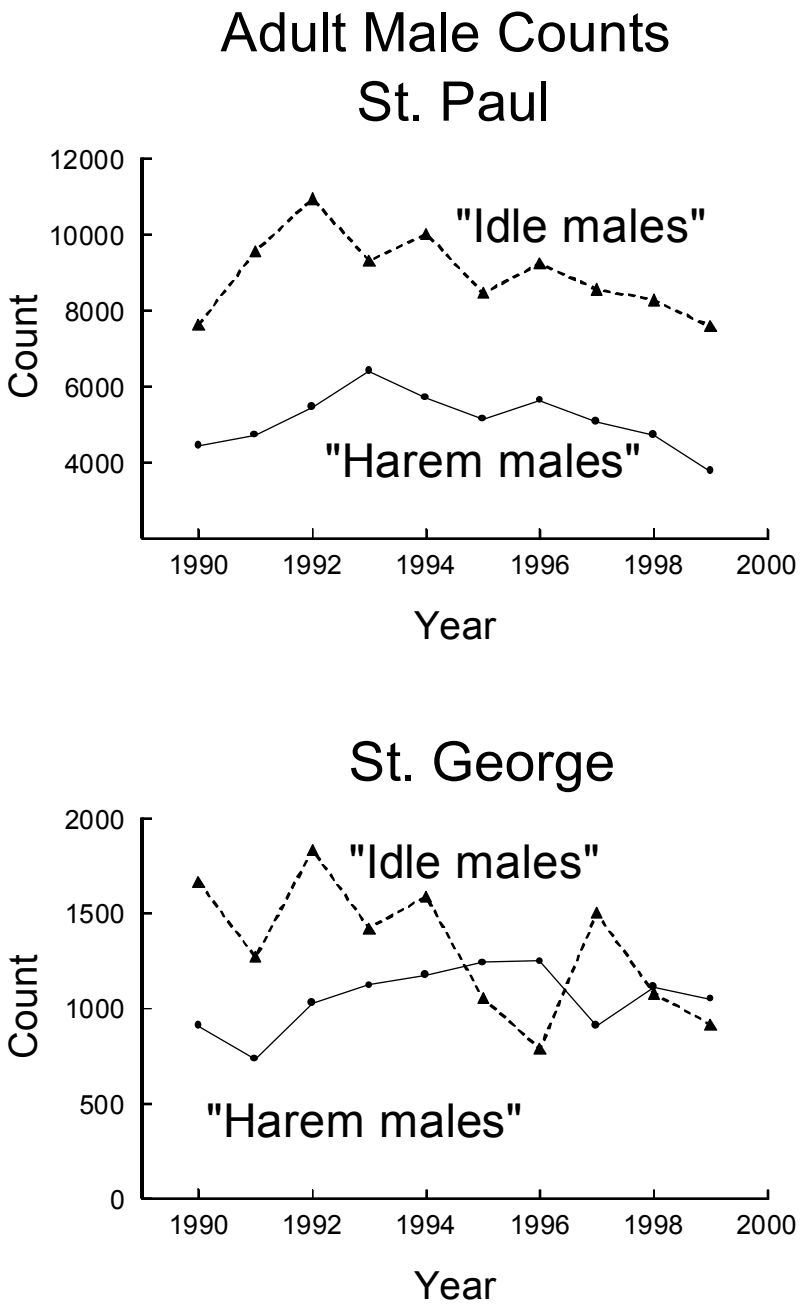

Figure 7.--Counts of adult male northern fur seals on the Pribilof Islands, Alaska, showing idle male (Classes 2 and 5) and harem male (Class 3) numbers for both islands from 1990 to 1999.

MASS, LENGTH, AND SEX RATIOS OF NORTHERN FUR SEAL PUPS ON ST. PAUL ISLAND, 1999

by

Rodney G. Towell and Anne E. York

Mass and length measurements of northern fur seal pups on St. Paul Island 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 in 1999.

METHODS

Pups were sampled in mid-to late August using the techniques described for tagging, sexing and weighing (Antonelis 1992), and length measuring (Robson et al. 1994). A Pesola spring scale was used to weigh pups. Mass was recorded to the nearest 0.2 kg, and lengths to the nearest centimeter. Variations of mass and length of pups on St. Paul Island were analyzed using analysis of variance on sex and rookery.

Our analysis of the sex ratios examined rookery differences using a 2-sided exact binomial test (Conover 1980). We used this test to determine if the proportion of female pups was significantly different from 50%.

RESULTS AND DISCUSSION

Pup Mass and Length

Pup mass (Fig. 8, Table 4) varied significantly ($P < 0.001$) by sex and rookery for St. Paul Island. Male and female pups were analyzed separately since the variance for males was greater than that for females and again rookery effects were significant ($P < 0.001$ males, $P =$

0.004 females, Table 6). Similarly, pup lengths (Fig. 8, Table 5) were significantly different ($P < 0.001$, Table 7) by sex and rookery on St. Paul Island in 1999.

Sex Ratios

The fractions of females (Table 8) for each rookery were tested using an exact binomial test. The fraction of females were significantly different than 50% for Vostochni (35.0%, $P < 0.001$) and Tolstoi (40.9%, $P = 0.003$) rookeries. The fraction of females was significantly different than 50% for St. Paul Island (42.7%, $P < 0.001$).

SUMMARY

Consistent with earlier evaluations of pup mass data (York and Antonelis 1990, York and Towell 1993, Towell et. al. 1996, and 1997), the strongest pattern was that the size of pups varied by sex: male pups were heavier and longer than female pups. The proportion of females (42.7%) was significantly different ($P < 0.001$) than 50% on St. Paul Island in 1999.

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 protocol for measuring length is very subjective and the process should be more closely examined.

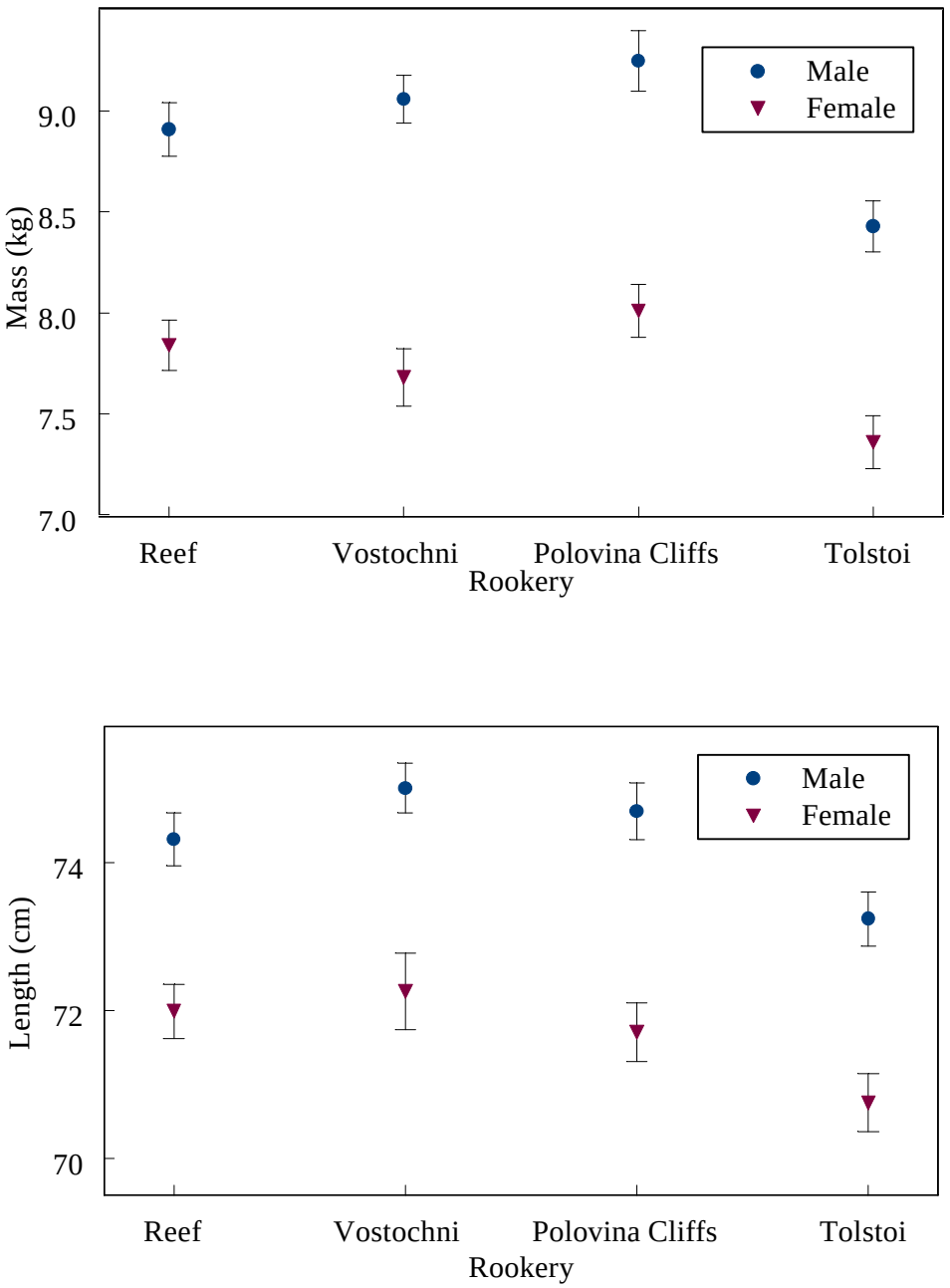

Figure 8.– Mean mass (top) and mean length (bottom) with 95% confidence intervals of northern fur seal pups measured during August 1999, St. Paul Island, Alaska.

Table 4.-- Mean mass (kg), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups weighed on St. Paul Island, Alaska, 24 - 25 August, 1999.

Rookery		Females	Males	Combined
Reef	kg	7.84	8.91	8.41
25 August	SD	1.46	1.62	1.63
	n	134	149	283
Vostochni	kg	7.68	9.06	8.57
24 August	SD	1.34	1.54	1.61
	n	90	167	257
Pol. Cliffs	kg	8.01	9.25	8.66
25 August	SD	1.46	1.74	1.73
	n	123	137	260
Tolstoi	kg	7.36	8.43	7.99
24 August	SD	1.40	1.63	1.63
	n	115	166	281
Combined	kg	7.73	8.89	8.40
	SD	1.44	1.65	1.67
	n	462	619	1081

Table 5.-- Mean length (cm), standard deviation (SD), and sample sizes (n) of male and female northern fur seal pups measured on St. Paul Island, Alaska, 24 - 25 August, 1999.

Rookery		Females	Males	Combined
Reef	cm	71.99	74.32	73.21
25 August	SD	4.27	4.37	4.47
	n	134	149	283
Vostochni	cm	72.26	75.01	74.05
24 August	SD	4.89	4.36	4.73
	n	90	167	257
Pol. Cliffs	cm	71.71	74.70	73.28
25 August	SD	4.38	4.52	4.69
	n	123	137	260
Tolstoi	cm	70.75	73.24	72.22
24 August	SD	4.22	4.71	4.67
	n	115	166	281
Combined	cm	71.66	74.30	73.17
	SD	4.44	4.53	4.68
	n	462	619	1081

Table 6.--Analyses of variance of mass of male and female northern fur seal pups on St. Paul Island, Alaska, August 1999, across rookeries.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Females							
Rookery	3	27.3	9.1	927	458	4.5	0.004
Males							
Rookery	3	58.4	19.4	1634	615	7.3	0.000

*MSS = SS divided by df

Table 7.--Analyses of variance of length of male and female northern fur seal pups on St. Paul Island, Alaska, August 1999, across rookeries.

Factor	df	SS due to factor	MSS*	Residual	df	F	P
Sex	1	1850.3	1850.3	21776	1079	93.0	0.000
Rookery	3	417.8	139.3	21359	1076	7.0	0.000
Sex x Rookery	3	17.1	5.7	21341	1073	0.3	0.835

*MSS = SS divided by df

Table 8.--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 Island, Alaska, August 1999. The fraction of females is significantly less than 50% (P = 0.95) for bold items.

Rookery	Females	Total	Fraction
St. Paul			
Reef	134	283	0.473
Vostochni	**90**	**257**	**0.350**
Polovina Cliffs	123	260	0.473
Tolstoi	**115**	**281**	**0.409**
Total	**462**	**1081**	**0.427**

Table 9.--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 1992-98.

	St. Paul			St. George		
Year	Females	Total	Fraction	Females	Total	Fraction
1992	494	1,118	0.442	291	634	0.459
1994	926	1,926	0.481	430	886	0.485
1995	939	2,040	0.460	294	653	0.450
1996	520	1,149	0.453	331	749	0.442
1997	495	1,020	0.485	311	639	0.487
1998	506	1,100	0.460	344	745	0.462

THE STATUS OF THE NORTHERN FUR SEAL POPULATION AT SAN MIGUEL ISLAND, CALIFORNIA, FOLLOWING THE 1997-1998 EL NIÑO EVENT

by

Sharon R. Melin and Robert L. DeLong

Population monitoring 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 San Miguel Island cool during the summer months when northern fur seals pup and breed on the island. 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 associated with El Niño events in 1983 and 1998 (DeLong and Antonelis 1991, Melin and DeLong, 1999). 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 at San Miguel Island move farther north and deeper in the water column (Arntz et al. 1991) and thereby become difficult for animals to obtain. Consequently, fur seals are in poor physical and nutritional condition during these El Niño environmental conditions and the population experiences reduced reproductive success and high pup and adult mortality (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 where they impact the population growth of fur seals at San Miguel, they

play an influential role in the dynamics of this population (DeLong and Antonelis 1991, Melin and DeLong 1994, Melin et al. 1996).

From July 1997 through May 1998, one of the most severe El Niño events in recorded history affected the coastal waters of California (Lynn et al. 1998). Although the event began to wane in May 1998, it continued to impact fur seals at San Miguel Island throughout the 1998 pupping and breeding season. Based upon oceanographic indices, the 1997-98 El Niño event was similar to the 1982-83 El Niño event (Norton et al. 1985, Lynn et al. 1998). The sea surface temperatures ranged from 2° to 5° C warmer than normal, the thermocline deepened, and prey species were distributed farther north (Lynn et al. 1998). These changes in the foraging environment of northern fur seals at San Miguel Island resulted in a 60% decline in 1983 and an 80% decline in 1998 in the number of pups born (DeLong and Antonelis 1991, Melin and DeLong 2000). In 1999, a dramatic shift in the oceanic and atmospheric conditions produced a La Niña event characterized by cool sea surface temperatures, a shallow thermocline, and strong coastal upwelling conditions along the California coast (Hayward et al. 1999).

This paper presents the results of the 1999 population monitoring studies at San Miguel Island including the timing of reproductive events during the breeding season and estimates of pup production, pup mortality and pup condition. The results are compared to 1996, a 'normal' year, and 1997 and 1998, the El Niño years, to provide a context for the magnitude of and recovery from the 1997-98 El Niño event on the fur seals at San Miguel Island.

METHODS

Surveys of Adults

Surveys of territorial adult male fur seals were conducted at the Adams Cove colony during the breeding season from 1996 through 1999. Surveys were conducted from two blinds overlooking the Adams Cove colony (approximately 20 m above and 40 to 300 m horizontal

distance from the breeding animals) every 1 to 3 days. Counts of territorial adult males were conducted using a 15-45 × zoom scope and 10 × 50 binoculars.

Live Pup Census and Pup Mortality

The live pup census was conducted on 6 August at Adams Cove and 7 August at Castle Rock, when most of the pupping was completed. These dates are subjective but are based upon the frequency of births observed during daily surveys. When no births occur for several days, most of the pupping is considered completed and the live pup census is conducted. The live pup census was conducted from a mobile blind by two observers using binoculars to count groups of pups. The mean number of pups and standard error about the mean was calculated from the total counts of the two observers.

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

Pup Tagging and Condition Indices

Northern fur seal pups were tagged with pink plastic roto tags in Adams Cove in September and October of 1996 through 1999. Tags with the same number were placed on both foreflippers of each pup. The sex and weight of each pup was recorded and the pup was released.

RESULTS

Surveys of Adults

Four territorial northern fur seal bulls were present at the beginning of the season on 19 May 1999. The maximum number of territorial bulls in Adams Cove was 106 on 11 July 1999; 63.2% held territories with females (Table 10). This is similar to the number of territorial

bulls present in 1998 but the number of territorial bulls remained below the numbers recorded in 1996 and 1997.

The first adult female arrived on 1 June, and the first pup was born on 12 June in 1999 (Table 10). The onset of pupping occurred on a similar date in 1998 (13 June) but occurred earlier in 1996 and 1997.

Live Pup Census and Pup Mortality

The total pup production in Adams Cove was 773 in 1999, an increase of 82% from 1998, but 64% below the total pup births in 1997 (Table 11). The observed early-season mortality rate (22%) remained high in 1999 and was similar to the rates in 1997 (17%) and 1998 (27%), but higher than 1996 (10%). However, the observed mortality rate for the entire season was lower in 1999 (25%) compared to 1997 (40%) and 1998 (54%) (no data are available for 1996) indicating lower late-season pup mortality in 1999 (Table 11).

The Castle Rock colony also experienced a significant decline in 1998 (80%) but showed signs of recovery in 1999 (Table 11). The mean number of live pups counted was 299 in 1999 and total production was 310 pups, a 53% increase from 1998 (Table 11). No observed mortality rates were calculated for Castle Rock because the dead pups counted at the time of the survey is not representative of the total mortality during the season.

The total pup production for the San Miguel Island fur seal population (Adams Cove and Castle Rock colonies) was 1,083 in 1999, a 73% increase from 1998 but 65% below 1997 pup production.

Pup Weights

A total of 300, 154, 163, and 159 pups were tagged and weighed in 1996, 1997, 1998, and 1999, respectively (Table 12). The mean weights of both sexes were different for the four years (ANOVA, $P < 0.001$ for both sexes). However, weights of female pups (mean = 10.4 kg) in 1999 were similar to weights of female pups in 1996, and the yearly differences for female pups were attributed to the extremely low weights in 1997 and 1998 (ANOVA, Bonferroni post-

hoc test, $P < 0.001$ in both years). Weights of male pups (mean = 11.3 kg) in 1999 were significantly higher than weights of male pups in 1997 and 1998 , but significantly lower than weights of male pups in 1996 (ANOVA, Bonferroni post-hoc test, $P < 0.001$).

Tag Resight Effort

Fifty-five (55) adult female and 26 male northern fur seals were individually identified from flipper tags (Table 13). The age of females ranged from 3 to 14 years, and 24% of the sighted females had pups (Table 13). Tagged males ranged from 3 to 11 years of age and tagged territorial males were 7 to 11 years old.

DISCUSSION

The northern fur seal population at San Miguel Island began its recovery from the 1998 decline in 1999. Although pup production increased at both colonies, both remained below the 1997 production levels by more than 60%. Melin and DeLong (1999) 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 low pup production and low number of territorial bulls in 1999 suggest that indeed, adult mortality occurred during the 1997-98 El Niño event. Continued monitoring of pup production and the number of territorial bulls will provide data to assess the magnitude of the adult mortality and the long-term population effects of the 1997-98 El Niño event.

Other signs of population recovery included the cessation of the pupping season at the end of July compared to the protracted season ending after 6 August in 1998 (Melin and DeLong 2000), an improvement in the condition of 4-month-old pups, and reduced late-season pup mortality. Northern fur seal pups were in good condition in 1999, although male pup weights were below pre-El Niño weights. Male pups consume up to 61% more energy than female pups (Costa and Gentry 1986); therefore the slow recovery of male pups to pre-El Niño condition may reflect an adult female population that is still recovering from a lower nutritional status caused by

reduced prey availability during the El Niño. However, the return of female pup weights to pre-El Niño levels, the substantial increase in male pup weights, and the decline in late-season pup mortality (25.2% in 1999 compared to 40.2% and 54.0% in 1997 and 1998, respectively), suggest that adult females were able to maintain lactation throughout the lactation period. This provides indirect evidence that foraging conditions for northern fur seals improved significantly in 1999 from conditions in 1998, and that the decline in the population growth observed in 1998 was associated with the 1997-98 El Niño conditions. Melin and DeLong (1999), discuss the probable causes for the pattern of population changes from 1996 through 1998 as related to the timing of the El Niño event relative to the timing of reproductive events in the life cycle of northern fur seals.

The 80% decline in total pup production of both colonies in 1998 reduced the northern fur seal population to levels equal to those observed 14 years before (DeLong and Antonelis 1991), and exemplified 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 slow population growth for 7 years (Melin and DeLong 1994). In 1999, the northern fur seal population again began a slow recovery from a dramatic decline brought about by the 1997/98 El Niño event. The results presented here indicate that adult female and male mortality occurred during the 1997-98 El Niño event, and when combined with the probable loss of the 1997 cohort and most of the 1998 cohort, suggest that the growth rate of the San Miguel Island northern fur seal population will remain depressed for several years.

Table 10.--Maximum number of territorial northern fur seal bulls and the date of the onset of pupping from 1996 through 1999 at San Miguel Island, California. Percent of territorial bulls with females in their territory is in parentheses.

Year	Date of first birth	Maximum number of territorial bulls
1996	9 June	204 (79.4)
1997	4 June	250 (56.8)
1998	13 June	112 (66.1)
1999	12 June	106 (63.2)

Table 11.--Summary of live and dead pup counts of northern fur seals at Adams Cove 1996-99 and Castle Rock 1997-99. Mortality rates are based on observed mortality and are underestimates of the total mortality. Standard Error about the mean is in parentheses. A (!) preceding the percent change indicates a decline.

Colony/Year	Mean number of live pups[1]	Early-season pup mortality[2]	Total production	Percent Change in Total Production	Early-season pup mortality rate	Late-season pup mortality[3]	Season pup mortality rate[4]
Adams Cove							
1996	1808 (3.90)	201	2009		10.0		
1997	1759 (5.05)	368	2127	5.6	17.3	488	40.2
1998	308 (0.86)	116	424	-80.1	27.4	113	54.0
1999	604 (0.86)	169	773	82.0	21.7	26	25.2
Castle Rock							
1997	940 (3.50)	51	991				
1998	194 (0.76)	9	203	-79.5			
1999	299 (0.76)	11	310	52.7			

[1] The standard error about the mean was calculated using the sum of the standard deviations from the two independent counts for each group of pups. The sum of the standard deviations was divided by the square root of the total number of pup groups to obtain the standard error.
[2] Number of dead pups counted up to the time of the live pup census.
[3] Number of dead pups counted after the live pup census.
[4] Rate calculated based on total number of dead pups in early and late-season dead pup counts.

Table 12.-- Mean weights and standard error (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
1996	153	11.8	0.14	147	10.6	0.13
1997	75	6.3	0.13	79	5.9	0.12
1998	78	8.6	0.21	85	8.0	0.21
1999	78	11.3	0.20	81	10.4	0.20

Table 13.--Number of tagged northern fur seals sighted at Adams Cove, San Miguel Island, California, from May through August 1999.

		Females			Males		
Cohort	Age	Number tagged	Number sighted	Number sighted with pups	Number tagged	Number sighted	Number Territorial
1985	14	87	1	0	113	0	0
1986	13	100	1	0	99	0	0
1987	12	56	1	0	43	1	0
1988	11	192	1	1	195	1	1
1989	10	160	3	1	192	2	2
1990	9	86	4	1	113	2	3
1991	8	158	12	4	143	1	0
1992	7	163	3	0	136	2	1
1993	6	147	10	3	152	1	0
1994	5	143	12	2	157	4	0
1995	4	132	5	0	168	8	0
1996	3	147	2	1	153	4	0
Total		1,571	55	13	1,664	26	7

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CITATIONS

Antonelis, G. A. 1992. Northern fur seal research techniques manual. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-214, 47 p.

Arntz, W., W.G. Pearcy, and F. Trillmich. 1991. Biological consequences of the 1982-83 El Niño in the Eastern Pacific, p. 22-44. *In* F. Trillmich and K. Ono (editors). Pinnipeds and El Niño: Responses to environmental stress. Springer-Verlag, New York.

Conover, W.J. 1980. Practical nonparametric statistics. John Wiley and Sons. New York.

Costa, D.P., and R.L. Gentry. 1986. Free-ranging energetics of northern fur seals, p. 79-101. *In* R.L. Gentry and G.L. Kooyman (editors). Fur seals: Maternal strategies on land and at sea. Princeton University Press. Princeton, New Jersey.

DeLong, R.L. 1982. Population biology of northern fur seals at San Miguel Island, California. Ph.D. Dissertation. University of California, Berkeley, California. 185 p.

DeLong, R.L., and G.A. Antonelis. 1991. Impact of the 1982-83 El Niño on the northern fur seal population at San Miguel Island, California, p. 75-83. *In* F. Trillmich and K. Ono (editors), Pinnipeds and El Niño: Responses to Environmental Stress. Springer-Verlag, New York.

Hayward, T.L., T.R. Baumgartner, D.M. Checkley, R. Durazo, G. Gaxiola-Castro, K.D. Hyrenbach, A.W. Mantyla, M.M. Mullin, T. Murphree, F.B. Schwing, P.E. Smith, and M.J. Tegner. The state of the California Current, 1998-1999: Transition to cool-water conditions. Calif. Coop. Oceanic Fish. Invest. Rep. 40: 29-62.

Lynn, R.J., T. Baumgartner, J. Garcia, C.A. Collins, T.L. Hayward, K.D. Hyrenbach, A.W. Mantyla, T. Murphree, A. Shankle, F.B. Schwing, K.M. Sakuma, and M.J. Tegner. 1998. The state of the California Current, 1997-1998: Transition to El Niño conditions. Calif. Coop. Oceanic Fish. Invest. Rep. 39: 25-49.

Melin, S.R. and R.L. DeLong. 1994. Population monitoring of northern fur seals on San Miguel Island, California, p. 137-142. *In* Sinclair, E.H. (editor), Fur Seal Investigations, 1992. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-45.

Melin, S.R., R.L. DeLong and J.R. Thomason. 1996. Population monitoring studies of northern fur seals at San Miguel Island, California, p. 87-102. *In* Sinclair, E.H. (editor), Fur Seal Investigations, 1994. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-69.

Melin, S.R. and R.L. DeLong. 2000. Population monitoring studies of northern fur seals at San Miguel Island, California, p. 41-52. *In* B. W. Robson (editor), Fur Seal Investigations, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-113.

Norton, J., D. McLain, R. Brainard, and D. Husby. 1985. The 1982-83 El Niño event off Baja and Alta California and its ocean climate context, p 44-72. *In* Wooster, W.S. and D. L. Fluharty (editors), El Niño North: Niño effects in the Eastern Subarctic Pacific Ocean. Washington Sea Grant, Seattle, Washington.

Robson, B. W., G. A. Antonelis, and J. L. Laake. 1994. Assessment of measurement error in weights and lengths of northern fur seal pups in 1992, p. 34-45. *In* E. H. Sinclair (editor), Fur seal investigations, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-46.

Sinclair, E.H. and B.W. Robson. 1999. Fur seal investigations, 1997. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-106, 111p.

Towell, R. G., G. A. Antonelis, A. E. York, B. W. Robson, and M. T. Williams. 1996. Mass, length, and sexratios of northern fur seal pups on St. Paul and St. George Islands, 1992-1994, p. 47-70. *In* E. H. Sinclair (editor), Fur seal investigations, 1994. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-69.

Towell, R. G., G. A. Antonelis, A. E. York, and B. W. Robson. 1997. Mass, length, and sex ratios of northern fur seal pups on St. Paul and St. George Islands, 1995, p. 45-64. *In* E. H. Sinclair (editor), Fur seal investigations, 1995. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-86.

York A. E., and G. A. Antonelis. 1990. Weights and sex ratios of northern fur seal pups, 1989, p. 22-32. *In* E. H. Sinclair (editor), Fur seal investigations, 1991. U.S. Dep. Commer. NOAA Tech. Memo. NMFS F/NWC-190.

York A. E., and R. G. Towell. 1993. Weights and sex ratios of northern fur seal pups, 1990, p. 38-60. *In* E. H. Sinclair (editor), Fur seal investigations, 1991. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-24.

York, A. E., R. G. Towell, R. R. Ream, J. D. Baker, and B. W. Robson. 2000. Population assessment, Pribilof Islands, Alaska, p. 7-26. *In* B. W. Robson. (editor), Fur Seal Investigations, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-113.

APPENDIX A

Glossary

The terms defined below are used in 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 usedas 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.
Drive	The act of surrounding and moving groups of seals from one location to another.
Hauling ground	An area, usually near a rookery, on which nonbreeding seals congregate. See "Rookery."
Haul out	The act of seals moving from the sea onto shore at either a rookery or hauling ground.
Kleptogyny	The act of an adult male seal (primarily Classes 1, 2, or 3) seizing an adult female from another male's territory.
Known-age	Refers to a seal whose age is known because the animal bears an inscribed tag or other type of mark.
Marked	Describes a seal that has been marked by attaching an inscribed metal or plastic tag to one or more of its flippers, by hair clipping, or by bleaching.
Mark recoveries	Recovery (sighting) of a seal that has been marked by one of several methods. See "Marked."
Rookery	An area on which breeding seals congregate. See 'Hauling ground."
Roundup	Biologists surround and herd juvenile male fur seals close to the location where they haul out.
Vibrissae (facial whiskers)	To determine the relative age structure of females in a population, the color of their whiskers are used. Facial vibrissae are black at birth and remain black through age 3 years; become mixed (black and white) at ages 4 and 5 years; and by age 7, the vibrissae usually are entirely white.

APPENDIX B

Tabulations of northern fur seal adults and pups counted by rookery, size class, and rookery section during population assessment.

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Table B-1.--Number of adult male northern fur seals counted, by class and rookery section, St. Paul Island, Alaska, 9-16 July 1999.....47

Table B-2.--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 Islands, Alaska, 1972-99.....48

Table B-1. – Number of adult male northern fur seals counted, by class[a] and rookery section, St. Paul Island, Alaska, 9-16 July, 1999. 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	29	-	-	-	-	-	-	-	-	-	-	-	-	67
3	53	62	-	-	-	-	-	-	-	-	-	-	-	-	115
5	68	6	-	-	-	-	-	-	-	-	-	-	-	-	74
Kitovi[b]															
2	(7)23	10	32	52	40	-	-	-	-	-	-	-	-	-	164
3	(12)31	5	38	45	44	-	-	-	-	-	-	-	-	-	175
5	(8)3	1	6	13	165	-	-	-	-	-	-	-	-	-	196
Reef															
2	34	26	40	15	26	40	9	24	19	23	1	-	-	-	257
3	45	60	53	38	38	69	2	43	31	23	4	-	-	-	406
5	20	53	47	34	134	16	34	27	28	87	97	-	-	-	577
Gorbatch															
2	63	18	33	6	26	37	-	-	-	-	-	-	-	-	183
3	92	50	52	4	34	65	-	-	-	-	-	-	-	-	297
5	448	43	44	150	10	19	-	-	-	-	-	-	-	-	714
Ardiguin															
2	17	-	-	-	-	-	-	-	-	-	-	-	-	-	17
3	68	-	-	-	-	-	-	-	-	-	-	-	-	-	68
5	11	-	-	-	-	-	-	-	-	-	-	-	-	-	11
Morjovi[c]															
2	(12)23	16	24	15	29	16	-	-	-	-	-	-	-	-	135
3	(34)24	33	45	33	66	31	-	-	-	-	-	-	-	-	266
5	(11)188	35	33	17	37	103	-	-	-	-	-	-	-	-	424
Vostochni															
2	23	13	12	24	12	44	21	18	26	12	18	20	37	30	310
3	46	25	37	67	47	91	58	60	29	24	44	59	144	83	814
5	34	8	21	52	101	37	20	11	26	17	3	34	246	204	814
Little Polovina															
2	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6
3	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4
5	237	-	-	-	-	-	-	-	-	-	-	-	-	-	237
Polovina															
2	18	19	-	-	-	-	-	-	-	-	-	-	-	-	37
3	51	28	-	-	-	-	-	-	-	-	-	-	-	-	79
5	313	52	-	-	-	-	-	-	-	-	-	-	-	-	365
Polovina Cliffs															
2	22	13	8	20	24	44	43	-	-	-	-	-	-	-	174
3	52	28	26	54	46	90	113	-	-	-	-	-	-	-	409
5	55	17	18	15	43	46	23	-	-	-	-	-	-	-	217
Tolstoi															
2	28	20	13	33	24	40	45	27	-	-	-	-	-	-	230
3	34	25	44	48	47	74	45	27	-	-	-	-	-	-	344
5	3	7	18	23	30	58	35	343	-	-	-	-	-	-	517
Zapadni Reef															
2	71	18	-	-	-	-	-	-	-	-	-	-	-	-	89
3	100	26	-	-	-	-	-	-	-	-	-	-	-	-	126
5	51	152	-	-	-	-	-	-	-	-	-	-	-	-	203
Little Zapadni															
2	9	26	30	35	48	36	-	-	-	-	-	-	-	-	184
3	16	29	55	53	64	52	-	-	-	-	-	-	-	-	269
5	29	23	19	44	31	195	-	-	-	-	-	-	-	-	341
Zapadni															
2	24	40	21	34	49	23	42	7	-	-	-	-	-	-	240
3	35	43	72	45	59	88	40	13	-	-	-	-	-	-	395
5	175	21	26	43	55	41	23	422	-	-	-	-	-	-	806

[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 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 Islands, Alaska, 1972-99. 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
1972	3,738	2,384	--	--	--	22,649	1,153	328	--	--	--	2,484
1973	4,906	2,550	--	--	--	9,908	875	375	60,385	--	6	2,661
1974	4,563	1,782	--	--	--	--	822	481	--	--	--	1,353
1975	5,018	3,535	278,261	8,620	14	20,625	877	1,427	--	--	--	3,289
1976	5,324	4,041	291,000	11,108	2	23,676	1,093	996	--	--	--	2,289
1977	6,457	3,845	--	--	--	14,083	1,610	899	43,407	748	6	1,208
1978	6,496	3,908	--	--	--	8,073	1,590	1,220	47,248	1,009	6	2,518
1979	6,242	4,457	245,932	9,464	14	6,444	1,716	1,942	--	--	--	2,191
1980	5,490	4,248	203,825	11,672	4	7,859	1,563	1,795	--	--	--	2,385
1981	5,120	4,003	179,444	5,876	4	6,798	1,472	1,646	38,152	1,581	6	2,025
1982	5,767	4,009	203,581	3,482	4	7,301	1,410	1,319	--	--	--	1,600
1983	4,827	4,242	165,941	6,034	4	5,997	--	--	31,440	2,930	6	903
1984	4,803	3,977	173,274	8,117	5	6,115	1,473	1,452	--	--	--	--
1985	4,372	3,363	182,258	7,997	7	5,266	1,268	1,601	28,869	2,297	6	806
1986	4,603	1,865	167,656	5,086	4	7,771	1,394	1,342	--	--	--	--
1987	3,636	1,892	171,610	3,218	13	7,757	1,303	1,283	--	--	--	--
1988	3,585	3,201	202,229	3,751	4	7,272	1,259	1,258	24,820	827	6	1,212
1989	4,297	6,400	171,534	25,867	4	9,096	1,241	1,163	--	--	--	--
1990	4,430	7,629	201,305	3,724	13	9,128	909	1,666	23,397	2,054	6	928
1991	4,729	9,453	--	--	--	--	736	1,271	--	--	--	--
1992	5,460	10,940	182,437	8,918	13	8,525	1,029	1,834	25,160	707	6	806
1993	6,405	9,301	--	--	--	--	1,123	1,422	--	--	--	--
1994	5,715	10,014	192,104	2,029	13	8,180	1,179	1,481	22,244	410	6	788
1995	5,154	8,459	--	--	--	--	1,242	1,054	--	--	--	--
1996	5,643	9,239	170,125	21,244	6	6,837*	1,248	790	27,385	294	6	719
1997	5,064	8,560	--	--	--	--	910	1,474	--	--	--	--
1998	4,762	8,396	179,149	6,193	7	5,058*	1,116	1,084	22,090	222	6	452
1999	3,801	7,589	--	--	--	--	1,052	916	--	--	--	--

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

APPENDIX C

Scientific staff engaged in northern fur seal
field research in 1999

National Marine Mammal Laboratory
Douglas P. DeMaster, Director
Thomas R. Loughlin, Leader, Alaska Ecosystem Program
Elizabeth H. Sinclair, Northern Fur Seal Program

Name	Affiliation
Employees	
Robert Caruso	NMML
Robert Delong	NMML
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Appendix C.-- continued

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WPI - Wildlife Pathology International

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AFSC-

122 SEASE, J. L., W. P. TAYLOR, T. R. LOUGHLIN, and K. W. PITCHER. 2001. Aerial and land-based surveys of Steller sea lions (Eumetopias jubatus) in Alaska, June and July 1999 and 2000, 52 p. NTIS No. PB2001-107277.

121 BRITT, L. L., and M. H. MARTIN. 2001. Data report: 1999 Gulf of Alaska bottom trawl survey, 249 p. NTIS No. PB2001-105324

120 LAUTH, R. R. 2001. The 2000 Pacific west coast upper continental slope trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and length composition, 284 p. NTIS No. PB2001-105327.

119 FERRERO, R. C., HILL, D. P. DEMASTER, P. S. HILL, M. M. MUTO, and A. L. LOPEZ. 2000. Alaska marine mammal stock assessments, 2000, 191p. NTIS No. PB2001-102015.

118 WILSON, C. D., M. A. GUTTORMSEN, K. COOKE, M. W. SAUNDERS, and R. KIESER. 2000. Echo integration-trawl survey of Pacific hake, Merluccius productus, off the Pacific coast of the United States and Canada during July-August, 1998, 103 p. NTIS No. PB2000-108482.

117 ORR, J. W., M. A. BROWN, and D. C. BAKER. 2000. Guide to rockfishes (Scorpaenidae) of the genera Sebastes, Sebastolobus, and Adelosebastes of the northeast Pacific Ocean, second edition, 47 p. NTIS No. PB2001-100757.

116 WION, D. A., and R. A. MCCONNAUGHEY (editors). 2000. Mobile fishing gear effects on benthic habitats: A bibliography, 163 p. NTIS No. PB2000-108106.

115 LAUTH, R. R. 2000. The 1999 Pacific west coast upper continental slope trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and length composition, 287 p. NTIS No. PB2000-106004.

114 SHAW, F. R., M. E. WILKINS, K. L. WEINBERG, M. ZIMMERMANN, and R. R. LAUTH. 2000. The 1998 Pacific west coast bottom trawl survey of groundfish resources: Estimates of distribution, abundance, and length and age composition, 138 p. + Appendices. NTIS No. PB2000-105410.

113 ROBSON, B. W. (editor). 2000. Fur seal investigations, 1998, 101 p. NTIS No. PB2000-104258.

112 YANG, M-S., and M. W. NELSON. 2000. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990, 1993, and 1996, 174 p. NTIS No. PB2000-103403.

111 BUSBY, M. S., A. C. MATARESE, and K. L. MEIR. 2000. Annual, seasonal, and diel composition of larval and juvenile fishes collected by dip-net in Clam Bay, Puget Sound, Washington, from 1985 to 1995, 36 p. NTIS No. PB2000-103424.

110 HILL, P. S., and D. P. DEMASTER. 1999. Alaska marine mammal stock assessments, 1999, 166 p. NTIS PB2000-102844.

109 FOWLER, C. W., and M. A. PEREZ. 1999. Constructing species frequency distributions - a step toward systemic management, 59 p. NTIS No. PB2000-102552.