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Fur Seal Investigations, 1995

by
E. H. Sinclair (editor)

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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ABSTRACT

Counts of adult male northern fur seals ***(Callorhinus ursinus)*** are obtained each year on St. Paul Island and semi-annually on St. George Island as a factor of population monitoring. In 1995, counts were obtained from 11 to 16 July. A total of 5,154 harem and 8,459 idle adult male seals were counted on St. Paul Island. On St. George Island a total of 1,242 harem and 1,054 idle adult males were counted. Overall, these numbers represent a decrease of 13.2% in adult male seals on the Pribilof Islands since 1994. A similar pattern occurred between 1993 and 1994.

Northern fur seal entanglement in marine debris has been studied cooperatively since the early 1980s by the National Marine Mammal Laboratory (NMML), the National Research Institute of Far Seas Fisheries of Japan, and the Aleut community of St. Paul Island. Studies conducted since 1988 indicate a decline in the rate of entanglement. There is variation in the degree of entanglement by debris type, seal age, and island. For instance, the 1995 rate of entanglement was significantly different among juvenile males on St. Paul (0.22%) and St. George Islands (0.39%), however there was no significant difference in adult male entanglement rates between the two islands. Differences are probably due to a higher incidence of entanglement in trawl net debris among juveniles on St. George Island. The overall rate of entanglement for all males was calculated as 0.18% and 0.22% for St. Paul and St. George Islands, respectively (Robson et al., this volume).

Trends in the mass and length of fur seal pups serve as indicators of population health and have been monitored semi-annually since 1989. Consistent with earlier years, studies in 1995 demonstrated that male pups are heavier and longer on average than female pups, and pups tend to be both heavier and longer on St. George Island relative to St. Paul Island. The mean mass of

both male and female pups was significantly less in 1995 than in previous years on both Islands (Towell et al., this volume).

The shearing-sampling method has been used to estimate the number of pups born on the Pribilof Islands since 1961. The technique is evaluated regularly for accuracy as new techniques or interpretations become available. Some aspects of potential biases inherent in this method; such as observer variability, subsampling, and declining probability of resighting with time; are discussed (York and Towell, p. 65-75; York and Towell, p. 77-98).

Diet records from tagged seals collected during 1960-74 were reanalyzed to determine whether prey composition differs between fur seals from St. George and St. Paul Islands. Findings support earlier research based on scat remains, that seals from St. Paul Island eat a greater percentage of fish and a lower percentage of squid in their diet than St. George Island seals, but sample sizes were too small for a rigorous statistical treatment (Perez, this volume).

Northern fur seal pups were counted (n = 1,272) on Bogoslof Island on 25 September. For the first time in the 12 years (1980-95) since this new colony established itself, the numbers of pups counted decreased. The 1995 counts were down 13.5% from 1994 (Towell and Strick, this volume).

Studies on San Miguel Island indicate that population growth slowed in 1995. The observed pup production was 2,509 which represents a 4.7% decline from 1994. Continued monitoring will determine whether the decrease in numbers is a temporary fluctuation or a long-term trend in population growth on San Miguel Island (Melin and DeLong, this volume).

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INTRODUCTION

by

Elizabeth H. Sinclair

Between 1911 and 1984, northern fur seal ***(Callorhinus ursinus)*** research was carried out 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 Island and St. George Island) fur seal population of approximately 800,000 animals is the largest among U.S. rookeries (Figs. 1-3) and comprises roughly 80% of the world's population of northern fur seals. Northern fur seals were designated as depleted in 1988 under the Marine Mammal Protection Act due to declining numbers of animals on St. George Island and a flat trend in population growth on St. Paul Island. A moratorium on commercial harvesting of fur seals was imposed on St. Paul Island in 1984 and on St. George Island in 1973 because of depressed population levels, 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. Terms specific to fur seal research are defined in Appendix A.

Research on northern fur seals in 1995 was conducted under Marine Mammal Permit **No. 837.**

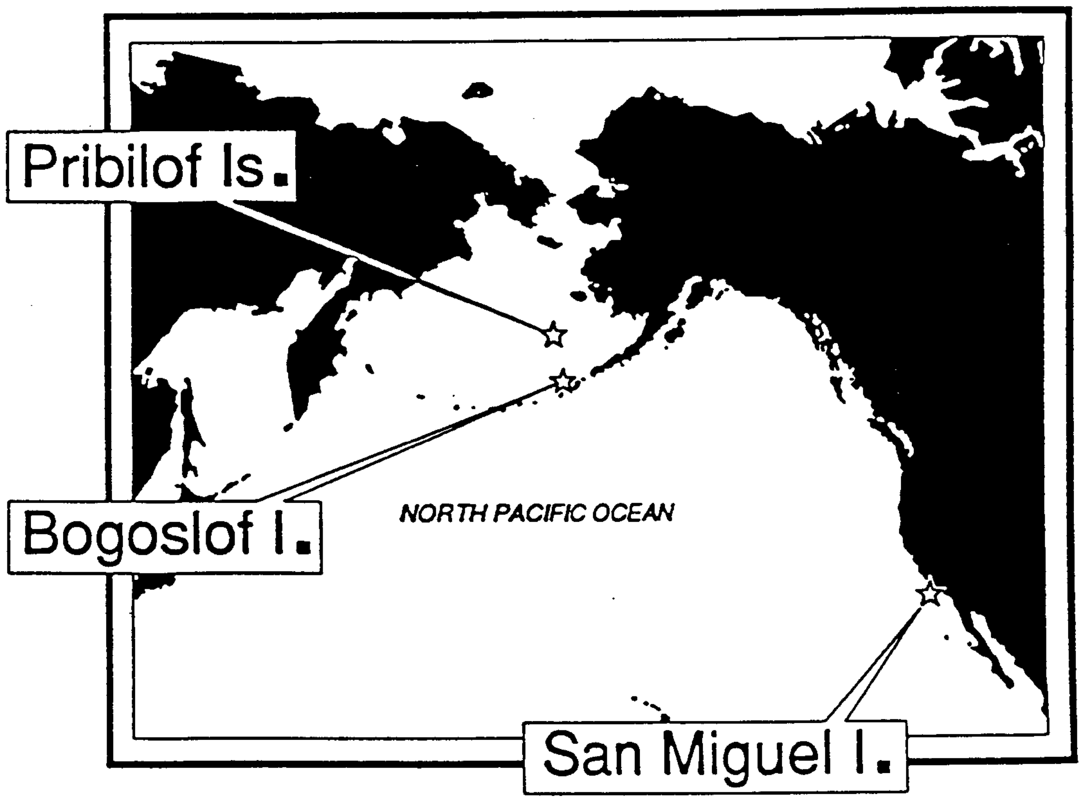


Figure 1 .--Location of the four northern fur seal breeding rookeries within U.S. waters.

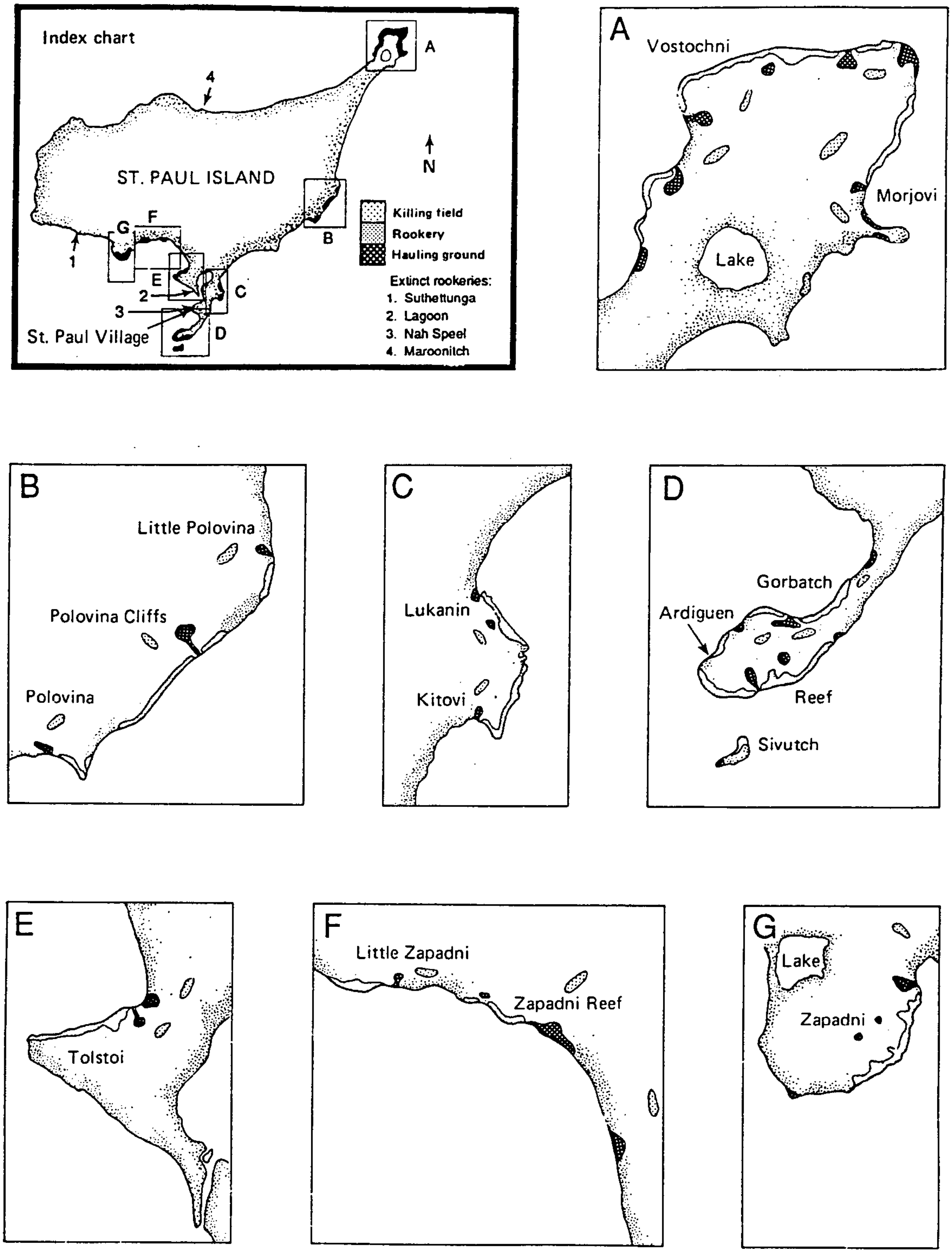


Figure 2. --Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. Paul Island, Alaska.

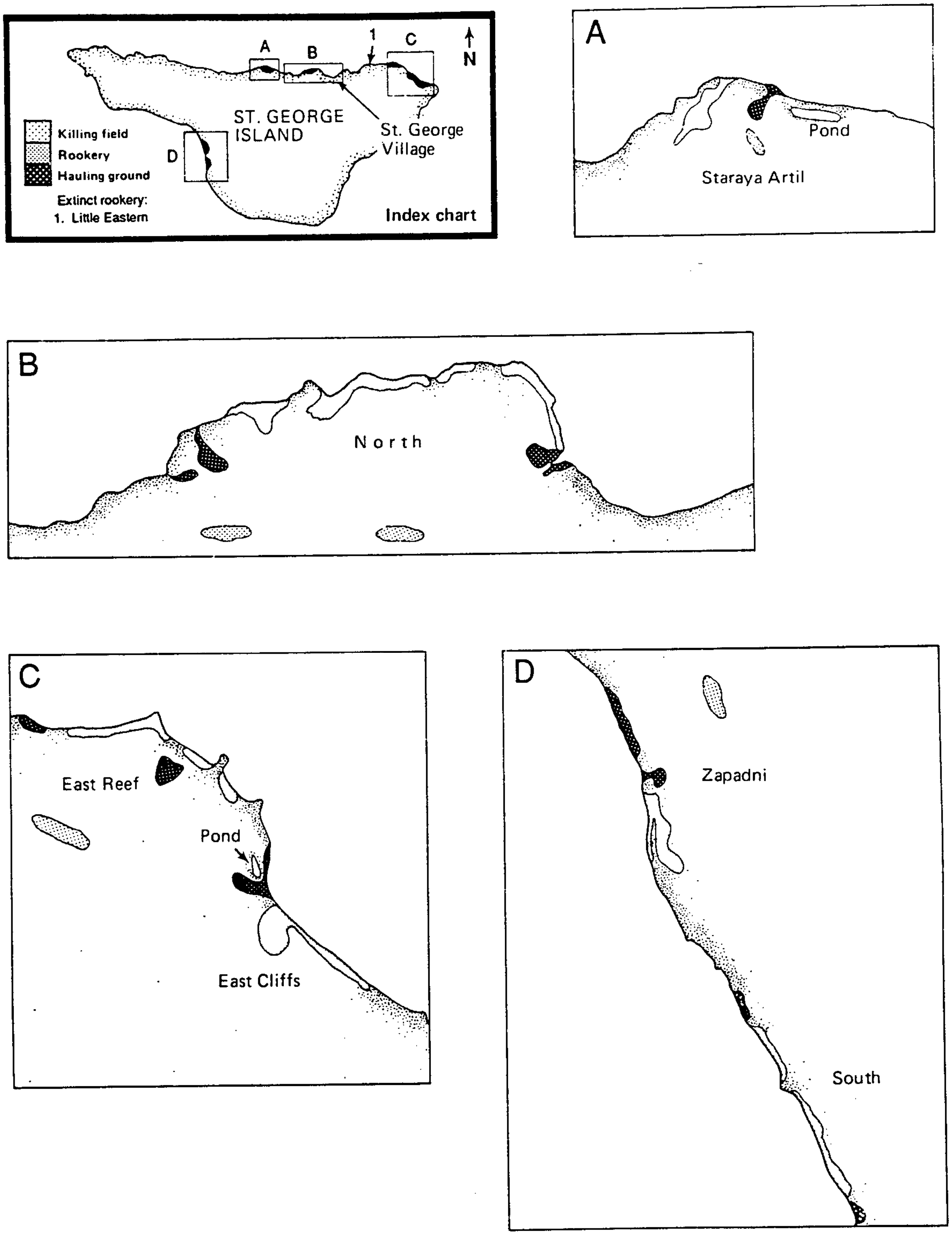


Figure 3.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. George Island, Alaska.

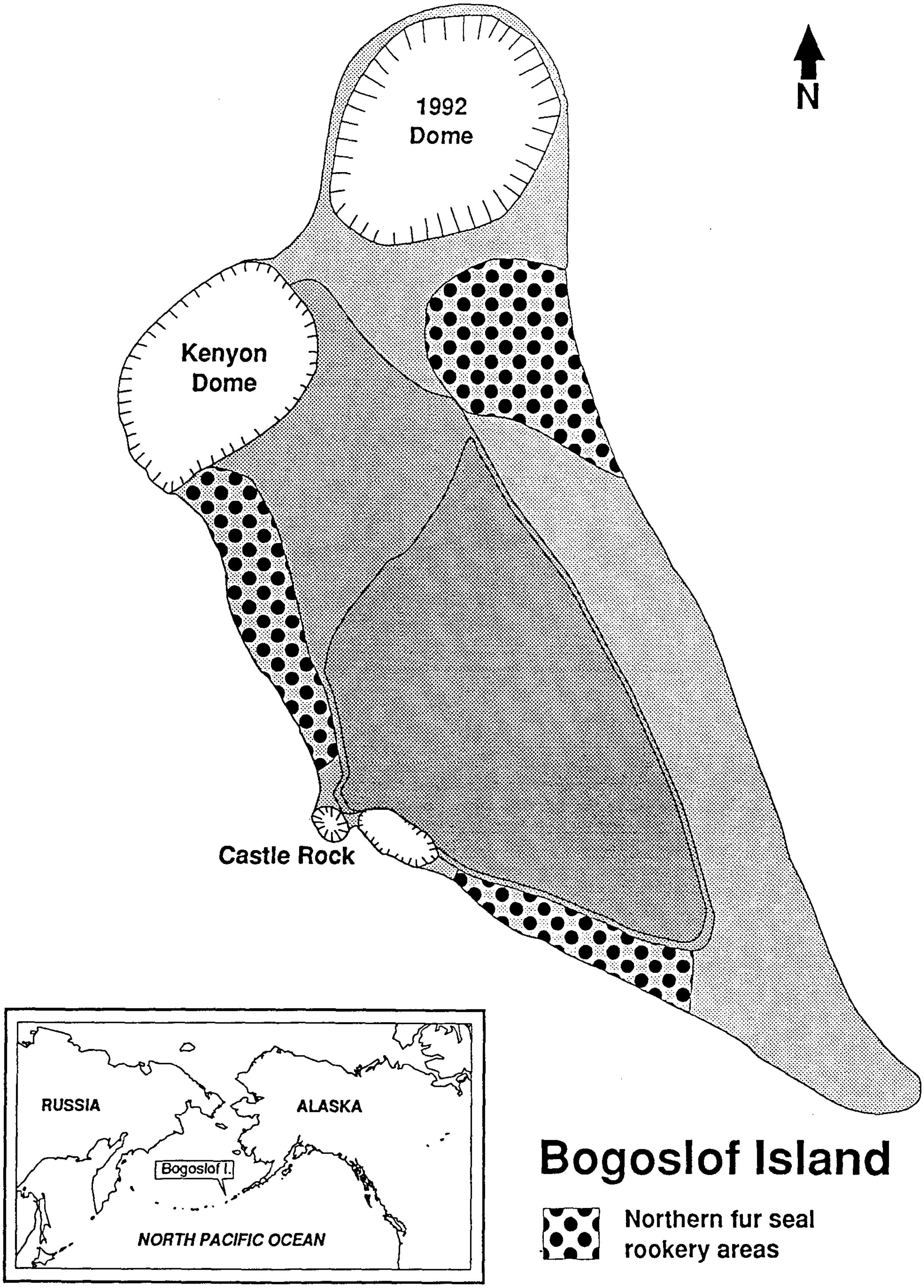


Figure 4.--Fur seal rookeries on Bogoslof Island, Alaska.

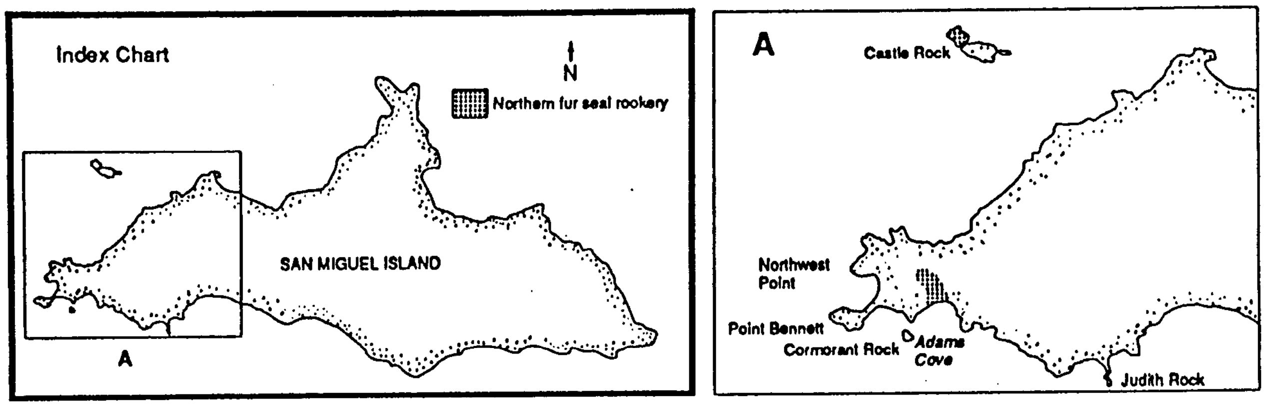


Figure 5.--Location of northern fur seal breeding colonies, San Miguel Island, California.

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

Island and Russian name	English translation	Comments and derivation of name
St. Paul Island		
Vostochni	---	From "Novoctoshni" meaning "place of recent growth"; applied to Northeast Point, which was apparently at one time an island that has since been connected to St. Paul Island by drifting sand.
Morjovi	Walrus	Historically, walruses hauled out here in summer.
Polovina	Halfway	Halfway to Northeast Point from the village.
Kitovi	Of "kit"	When whaling fleets were active in the Bering Sea between 1849 and 1856, a large right whale killed by some ship's crew drifted ashore here.
Gorbatch	Humpback	Apparently refers to the "hump like" nature of the scoria slope above the rookery.
Tolstoi	Thick	In this case, thick headland on which the rookery is located.
Zapadni	West	Western part of the island.
Lukanin	---	Named after a Russian pioneer sailor who was said to have harvested over 5,000 sea otters from St. Paul Island in 1787.
Zoltoi (hauling ground)	Golden	Named to express the metallic shimmering of the sands.
St. George Island		
Staraya Artil		Old settlement or village. There was once a settlement or village adjacent to the rookery.
Sea Lion Rock		
Sivutch	Sea lion	These animals haul out but do not breed here.

POPULATION ASSESSMENT, PRIBILOF ISLANDS, ALASKA

by

George A. Antonelis, Charles W. Fowler, David R. Cormany, and
Michael T. Williams

In accordance with provisions originally established by the Interim Convention of Conservation of North Pacific Fur Seals, the National Marine Mammal Laboratory (NMML) monitors the population status of northern fur seals on the Pribilof Islands (St. Paul and St. George Islands). This species is now listed as depleted under terms of the Marine Mammal Protection Act, and any changes in population status are of significance to its management. Data on the number of adult males present on the islands and the number of seals taken in the subsistence harvest on both St. Paul and St. George Islands are collected annually.

METHODS

National Marine Fisheries Service personnel monitor the subsistence harvest of juvenile male northern fur seals. A crew is present throughout each harvest operation and the number of seals killed is recorded and maintained as part of a permanent record.

Counts of adult males are obtained each year according to methods established early in the 1900s as documented in Antonelis (1992). In 1995, counts of adult males were obtained from 11 to 16 July. A field crew of 2 to 5 people conducted counts at rookeries or hauling grounds from vantage points (natural or constructed tripods or catwalks).

Hauling grounds are also visited to count adult males without territories. Counts are divided into three categories: adult males with territories containing females (Class 3), those occupying territories without females (Class 2), and those without territories (Class 5, see glossary in Appendix A). The last two categories are combined and reported as idle males.

RESULTS

Population Parameters

Fur Seals Harvested

In 1995,22 subsistence harvests of northern fur seals were conducted on St. Paul Island between 1 July and 8 August. Thirteen harvests were conducted on St. George Island between 30 June and 7 August. A total of 1,265 and 260 seals were killed on St. Paul Island and St. George Island, respectively (Table 2). Three female fur seals were accidentally killed in the juvenile male harvest on St. Paul (n=2) and St. George (n=l) Islands.

Living Adult Male Seals Counted

Adult male seals were counted by section for each rookery (see Appendix A for definition) on St. Paul Island from 11 to 15 July (Appendix Table B-l) A total of 5,154 harem (Class 3) and 8,459 idle (Classes 2 and 5) adult male seals (also referred to as bulls) were counted on St. Paul Island. On St. George Island a total of 1,242 harem and 1,054 idle adult males were counted from 11 to 15 July. The relative location of 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 1986 are shown in Appendix Table B-2 and the number of adult males counted by rookery for St. Paul and St. George Islands in 1995 is presented in Table 3.

The age structure of male northern fur seals on the Pribilof Island population seems to have undergone most of the expected increase in numbers following the termination of the commercial harvest on St. Paul and St. George Islands in 1984 and 1972, respectively. From 1994 to 1995, counts of harem males decreased by 9.9% on St. Paul Island, but increased by 5.5% on St. George Island. During this same period, however, the total number of adult males on the

Table 2.--Date, location, and number ofjuvenile male seals killed in subsistence harvest drives on St. Paul and St. George Islands, Alaska, in 1995.

Date	Rookery	Number Killed
1 July	Reef/Zolotoi	45
6 July	Zapadni	23
7 July	Lukanin	52
10 July	Reef	47
14 July	Lukanin	53
17 July	Polovina	58
18 July	Zapadni	44
19 July	Zap Reef	32
20 July	Lukanin	31
21 July	Kitovi*	44
22 July	Reef	42
24 July	Polovina	72
27 July	Zapadni	69
29 July	Reef	68
31 July	Zap Reef	37
1 August	Kitovi	35
2 August	Polovina	58
3 August	Lukanin	48
4 August	Big Zap	59
5 August	Reef*	88
7 August	Polovina	105
8 August	Zolotoi	13
8 August	N.E. Point	142
St. George Island		
30 June	North	24
6 July	Zapadni	24
8 July	North	16
12 July	Zapadni	30
14 July	North	26
19 July	Zapadni	15
21 July	North	18
26 July	Zapadni	14
28 July	North	17
1 August	North	22
3 August	Zapadni	17
6 August	North*	20
7 August	Zapadni	17

*1 female accidentally killed

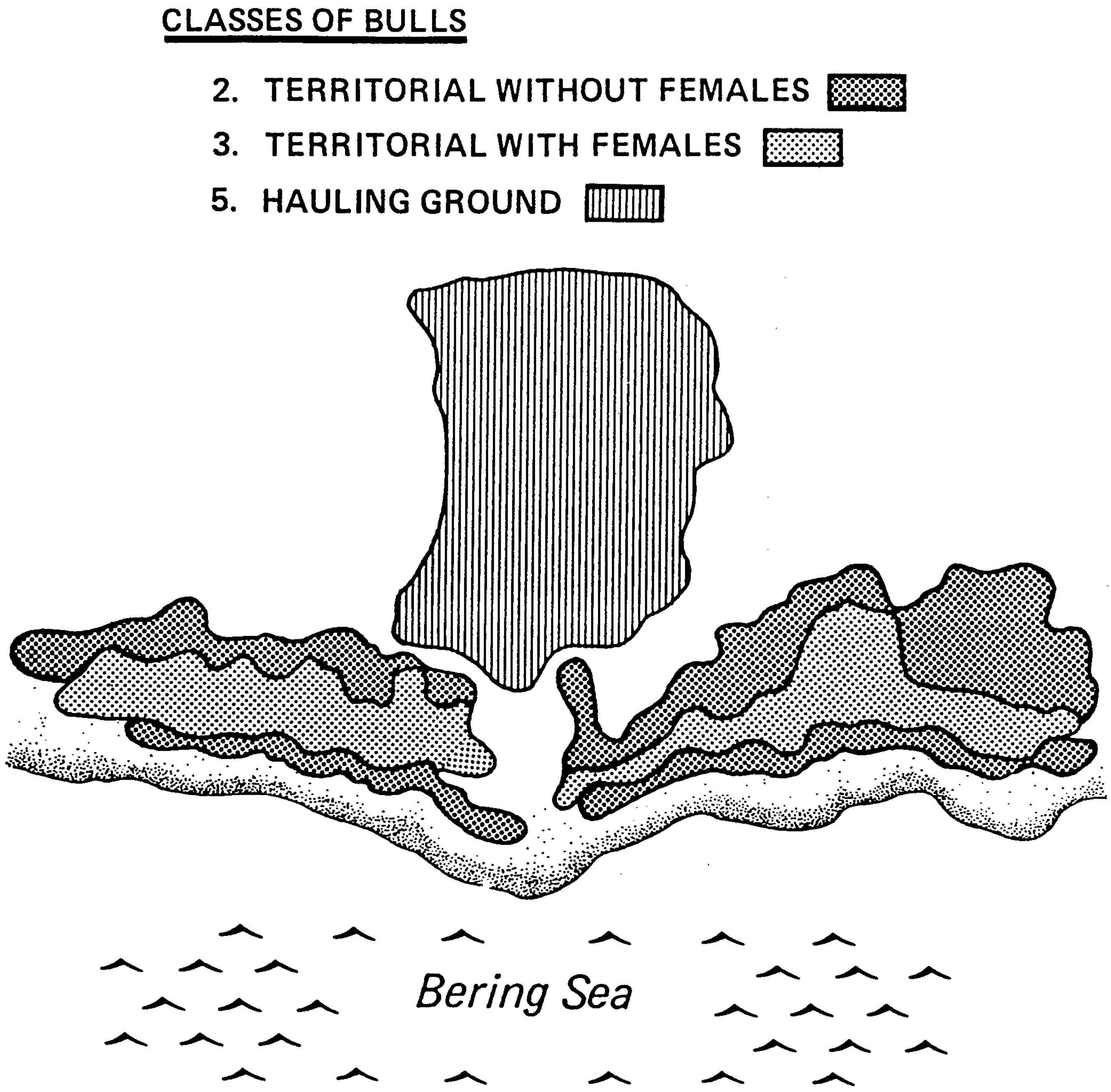


Figure 6.--The relative location of the different classes of adult males for a typical fur seal rookery.

Table 3.--Number of adult male northern fur seals counted by rookery, St. Paul Island, Alaska, July 1995.

Rookery	Date (July)	Class of Adult Male 2	3	5	Total
St. Paul Island					
Lukanin	15	47	148	149	344
Kitovi	15	85	243	324	652
Reef	11	306	706	985	1997
Gorbatch	11	271	374	879	1524
Ardiguen	11	30	58	23	111
Morjovi	16	132	380	441	953
Vostochni	16	214	914	970	2098
Little Polovina	15	9	10	192	211
Polovina	15	31	85	281	397
Polovina Cliff	15	155	596	204	955
Tolstoi	13	149	559	447	1155
Zapadni Reef	12	73	200	281	554
Little Zapadni	12	123	324	381	828
Zapadni	12	214	557	1063	1834
Island total		1839	5154	6620	13613
St. George Island					
Zapadni	11	65	136	30	231
South	11	90	234	15	339
North	15	175	457	178	810
East Reef	13-15	41	83	75	199
East Cliffs	15	139	267	85	491
Staraya Artil	13	72	65	89	226
Island total		582	1242	472	2296

Pribilof Islands decreased by 13.2%. Similar changes were also noted for counts of males from 1993 to 1994. This may reflect a decline in the numbers of adult males; however, due to the **high** degree of variability in these counts, several more years of data are needed to assess this information for possible trends.

Collection of Teeth

In 1995, tooth samples (usually upper canines) were collected from juvenile males killed in the subsistence harvest on the Pribilof Islands. Tooth samples were obtained from 191 and 30 males on St, Paul and St. George Islands, respectively. A systematic collection of tooth samples from dead fur seals of both sexes found on all rookeries was not conducted in 1995.

NORTHERN FUR SEAL ENTANGLEMENT STUDIES: ST. PAUL AND ST. GEORGE ISLANDS, 1995

by

Bruce W. Robson, Michael T. Williams, George A. Antonelis, Masashi Kiyota, Alley L. Hanson Sr., and Gary Merculief

Entanglement of northern fur seals in marine debris has been studied since the early 1980s by the National Marine Mammal Laboratory (NMML) in cooperation with the National Research Institute of Far Seas Fisheries (NRIFSF) and the Aleut community of St. Paul Island. Surveys of entanglement among subadult male fur seals were conducted in conjunction with the commercial harvest until 1985 (Scordino and Fisher 1983, Scordino 1985) and using research roundups after the cessation of the commercial harvest (Bengtson et al. 1985, Fowler 1987, Fowler and Baba 1991, Fowler et al. 1992). Adult female entanglement has been studied by Bigg (1979), Scordino and Fisher (1983), Scordino (1985), Delong et al. (1988), and Kiyota and Fowler (1994).

Incidence of entanglement in juvenile males increased from the mid-1960s to the mid-1970s reaching a peak in 1976 at 0.71% among subadult males (Fowler 1987, Fowler et al. 1992, Kiyota and Fowler 1994). Mortality resulting from entanglement in marine debris has been implicated as a contributing factor in the decline observed in the Pribilof Islands northern fur seal population during the 1970s and early 1980s (Fowler 1987). Studies from 1988 to 1992 indicate a decline in the rate of entanglement among both subadult males (Fowler and Ragen 1990, Fowler et al. 1992) and females (Kiyota and Fowler 1994) on St. Paul Island.

In 1995, in cooperation with the St. Paul and St. George Islands Traditional Councils, the NMML began a new study of juvenile and adult male fur seal entanglement using a combination of research roundups and surveys during the subsistence harvest. Surveys in conjunction with the subsistence harvests minimize the number of times seals are disturbed by conducting subsistence harvests and entanglement roundups on the same haulouts during July and early August.

The objective of this study is to determine current trends in the rate of observed on-land entanglement of northern fur seals in marine debris on St. Paul and St. George Islands. This information is being collected in order to provide: 1) a continuing index of entanglement rates, 2) a comparison of entanglement rates on St. Paul (stable population) and St. George (decreasing population) Islands, 3) a means of indirectly assessing the relative amount of entangling debris within the habitat of the fur seal, and 4) an assessment of the proportion of debris types associated with different fisheries that are impacting fur seals.

In addition to the resumption of juvenile male entanglement studies, NRIFSF researchers continued to collect information on seasonal and annual (1991-95) rates of entanglement among adult female fur seals. As in previous years, researchers continued to capture and remove debris from entangled seals encountered during other research projects.

METHODS

Harvest Surveys and Roundups of Adult and Juvenile Males

Male fur seals on hauling grounds located on St. George and St. Paul Islands were surveyed for entanglement in June, July, and August 1995. Surveys were conducted both in conjunction with the Aleut subsistence harvest and non-harvest roundups following the methods described in Bengtson et al. (1988), Fowler and Ragen (1990), and Fowler et al.

(1992). The harvest sampling protocol was adjusted to fit the logistical requirements of conducting the surveys during the subsistence harvest. Under each sampling regime, seals were prevented from escaping to the water and herded into groups by harvest or roundup crews. Seals were then released to sea in small groups or in a single file allowing observers to count and examine seals for entangling debris or scars indicating previous entanglement. Separate counts were made by different observers of the total number of male seals (all age groups) and the number of juvenile male seals of the size and age (2-4 years old) historically taken in the commercial harvest (Bengtson et al. 1988, Fowler et al. 1992). The count of adult seals was derived by subtracting the number of juveniles from the total count of all seals for a survey. Criteria for selection of juvenile males was based on overall size, pelage characteristics (color and thickness of mane, sagittal crest and chest patch) and vibrissae color and length (Scheffer 1962, C. W. Fowler pers. comm).

During subsistence harvest surveys, following the initial roundup, small groups of seals (consisting primarily of older males) were separated from the main group. These groups were released to the water and only smaller groups consisting primarily of juvenile seals were retained for the duration of the harvest. Seals released during the drive were counted and examined for entanglement upon release. Seals in the group retained for the subsistence harvest (but not killed) were counted and examined for entanglement upon release. Harvested seals were examined for entanglement and added to the final count.

When an entangled seal was sighted during release, the flow of seals to the water was stopped and the entangled seal was captured and the entangling debris removed. Information on the type of entangling debris, the extent of the wound, and the estimated age of the seal was recorded. Debris removed from entangled seals was examined to determine the type, color, weight, and size (mesh and twine size for net fragments; length and diameter of the entangling loop for other materials such as packing bands or ropes) and saved for possible future analysis. Entangled seals judged to be of harvestable size were marked by lightly shearing marks into the pelage on the shoulders indicating the island of capture and type of survey. Marking enabled observers to resight previously entangled seals during subsequent surveys (Bengtson et al. 1988, Fowler and Ragen 1990). During the period of entanglement research, juvenile male seals captured and disentangled during other research activities were also marked to indicate previous entanglement. Because some seals on haulouts are observed more than once (Fowler and Ragen 1990, Baker et al. 1995), entanglement rates of seals estimated from roundup samples (after 1985) are considered as samples taken with replacement. Samples taken during the commercial harvest (prior to 1985) in which both entangled and nonentangled seals were killed were obtained without replacement.

The overall rate of entanglement is estimated by the ratio of all (both initial and subsequent) entanglement sightings to the total of number of seals examined (Bengtson et al. 1988, Fowler et al. 1992). This estimate is subject to a slight upward bias due to the assumption that seals from which debris was removed would not have lost their debris independently (Scordino 1985).

Statistical analysis of entanglement data was preformed using a general linear model assuming a binomial response. Factors were considered statistically significant if the deviance accounted for by that factor was greater than $X^2_{df,0.95}$ (where the degrees of freedom is the number of levels of the factor -1). Factors examined in the analysis of the entanglement rate were: age (adult vs. juvenile), island (St. Paul vs. St. George), sample type (harvest vs. roundup sample) and the interaction between age and island in entanglement rate.

Entanglement Surveys of Adult Females

In 1995, island-wide surveys of entangled adult female fur seals by NRIFSF scientists were conducted on St. Paul Island using the techniques described by Kiyota and Fowler (1994). All rookeries were surveyed in conjunction with the counts of adult males from 15 to 21 July. Two study sites on Reef rookery were surveyed on 11 July, 22 July, and 1 August to detect changes in the rate of female entanglement between years and during the course of the breeding season. Locations of entangled females were recorded and attempts were made to locate and disentangle these seals using a portable blind or later in the season during pup activity and female foraging studies.

RESULTS AND DISCUSSION

Entanglement Surveys and Roundups of Adult and Juvenile Males

Nineteen subsistence harvest surveys and 15 roundups were conducted on St. Paul Island (34 total) and 47 roundups were conducted on St. George Island during late June, July and early August of 1995 (Table 4). On St. Paul Island and St. George Island, observers respectively sampled 26,883 and 15,080 seals (all age groups combined). Samples included 14,356 juveniles (2-4 years old) on St. Paul Island and 6,179 juveniles on St. George island. Sixty-five entangled juvenile and adult male seals were captured, examined, and the debris was removed during harvest surveys and roundups (39 on St. Paul Island and 26 on St. George Island).

Thirty seals with scars indicating previous entanglement were also observed during surveys (Table 4). Seventeen of these seals were adult males, some of which had fresh, open wounds suggesting that their debris was removed or lost during 1995. Due to the difficulty involved with handling adult male fur seals, they were not marked for resighting and

Table 4.--Summary of harvest surveys and roundups of juvenile and adult northern fur seal males conducted on St. Paul and St. George Islands during June, July, and August 1995, including the number of seals entangled, resighted, and observed with scars.

Date	Survey Type	Location	Total Count	Juvenile Count	Juveniles Entangled	Juveniles Resighted	Juveniles Scarred	Adults Entangled	Adults Scarred
6 Jul	H	Zapadni	1482	936	4	0	0	2	0
7 Jul	H	Lukanin	602	219	0	0	0	1	0
10 Jul	H	Reef	276	203	1	0	0	0	1
14 Jul	H	Lukanin	452	312	1	0	0	0	1
17 Jul	H	Polovina	1226	746	1	0	0	0	0
18 Jul	H	Zapadni	1998	939	0	1	1	1	2
19 Jul	H	Zapadni Reef Sands	1060	703	1	0	0	1	0
20 Jul	H	Lukanin	135	60	0	0	0	1	0
21 Jul	H	Kitovi	551	341	0	0	0	0	1
22 Jul	H	Reef	246	168	0	1	0	0	0
24 Jul	H	Polovina	1086	704	0	0	2	1	0
25 Jul	R	Little Polovina	657	159	0	0	0	1	0
25 Jul	R	Sea Lion Neck East	834	427	0	0	0	1	0
25 Jul	R	Sea Lion Neck West	478	391	1	0	0	1	0
25 Jul	R	Vostochni Sec. 14	620	321	1	0	0	1	0
25 Jul	R	Vostochni Sec. 13	321	93	0	0	0	0	0
26 Jul	R	Little Zapadni	568	201	0	0	0	0	1
26 Jul	R	Zolotoi	2101	842	2	0	0	0	3
26 Jul	R	Tolstoi Sands	802	294	0	0	0	1	0
26 Jul	R	Tolstoi Hill	573	95	0	0	0	0	0

Table 4.--cont.

Date	Survey type	Location	Total Count	Juvenile Count	Juveniles Entangled	Juveniles Resighted	Juveniles Scarred	Adults Entangled	Adults Scarred
27 Jul	H	Zapadni	1749	899	4	0	0	2	1
29 Jul	H	Reef	492	324	0	0	1	0	0
31 Jul	H	Zapadni Reef Sands	607	363	1	1	0	0	1
1 Aug	H	Kitovi	788	407	1	1	0	0	0
1 Aug	R	Sea Lion Neck East	647	360	0	0	0	0	0
1 Aug	R	Sea Lion Neck West	265	181	0	0	0	0	0
1 Aug	R	Vostochni Sec. 14	525	301	0	1	0	1	0
1 Aug	R	Vostochni Sec. 11	569	277	1	0	0	0	0
1 Aug	R	Vostochni Sec. 3	112	21	1	1	0	0	0
1 Aug	R	Northeast Point	897	351	1	0	0	1	0
2 Aug	H	Polovina	882	619	0	2	0	0	0
3 Aug	H	Lukanin	781	611	0	1	1	0	0
4 Aug	H	Zapadni	1958	1168	1	1	0	1	2
5 Aug	H	Zolotoi	543	320	0	0	0	0	0
St. Paul Totals			26883	14356	22	10	5	17	13
St. George Island									
29 Jun	R	East Cliffs-1	853	472	0	0	1	0	0
30 Jun	R	Zapadni	341	77.5	0	0	0	1	0
30 Jun	R	Zapadni	625	258	2	0	1	0	0
30 Jun	R	Northeast	421	134	0	0	0	0	1

Table 4.--cont.

Date	Survey type	Location	Total Count	Juvenile Count	Juveniles Entangled	Juveniles Resighted	Juveniles Scarred	Adults Entangled	Adults Scarred
1 Jul	R	Northcentral	273	55	0	0	1	0	0
1 Jul	R	South Reef	159	24	0	1	0	0	0
2 Jul	R	Northwest	343	156	1	0	0	1	0
2 Jul	R	Northcentral	476	140	0	0	0	0	0
6 Jul	R	East Reef	518	197	1	0	0	0	0
7 Jul	R	East Cliffs-1	748	311	3	1	1	0	0
7 Jul	R	East Cliffs-2	354	104	1	0	1	0	0
8 Jul	R	Staraya	700	210	0	0	0	0	0
11 Jul	R	South Reef	107	13.5	0	0	0	0	0
12 Jul	R	Kitasilough	44	2	0	0	0	0	0
12 Jul	R	Zapadni	176	62	0	0	0	1	0
12 Jul	R	Northcentral	183	41	0	0	0	0	0
13 Jul	R	Northwest	23	8	0	0	0	0	0
13 Jul	R	East Reef	205	97	0	0	0	0	0
14 Jul	R	East Cliffs-1	578	289	0	0	0	1	0
14 Jul	R	East Cliffs-1	151	48	0	2	0	2	0
15 Jul	R	Staraya	291	111	0	0	0	0	0
17 Jul	R	Northeast	278	151	0	0	1	0	0
19 Jul	R	Zapadni	135	94	0	0	0	0	0
20 Jul	R	Northwest	194	87	0	0	0	0	1
20 Jul	R	East Reef	243	118	0	0	0	0	0
20 Jul	R	East Cliffs-1	563	284	3	2	1	1	0
21 Jul	R	East Cliffs-1	149	66	0	0	0	0	0

Table 4.--cont.

Date	Survey type	Location	Total Count	Juvenile Count	Juveniles Entangled	Juveniles Resighted	Juveniles Scarred	Adults Entangled	Adults Scarred
22 Jul	R	Kitasilough	66	3	0	0	0	0	0
22 Jul	R	South Reef	51	15	0	0	0	0	0
24 Jul	R	Staraya	290	81	0	0	1	0	0
24 Jul	R	Northeast	274	140	0	0	0	0	0
26 Jul	R	Northcentral	280	49	0	0	0	0	0
26 Jul	R	Northwest	141	70	0	0	0	0	0
26 Jul	R	Zapadni	226	126	0	0	0	0	0
26 Jul	R	Zapadni	143	67	0	0	0	0	0
26 Jul	R	Zapadni	244	98	0	0	0	0	0
28 Jul	R	Northcentral	232	36	0	0	0	0	0
28 Jul	R	East Reef	185	64	2	0	0	0	0
29 Jul	R	East Reef	659	311	0	0	0	0	0
29 Jul	R	South Reef	157	72	0	0	0	0	0
29 Jul	R	Staraya	581	231	0	0	0	0	2
29 Jul	R	Kitasilough	62	0	0	0	0	1	0
29 Jul	R	East Cliffs-1	1075	728	3	1	0	0	0
29 Jul	R	East Cliffs-1	385	103	0	0	0	1	0
29 Jul	R	Staraya	320	154	0	0	0	0	0
1 Aug	R	Zapadni	500	194	1	0	0	0	0
2 Aug	R	Northwest	78	27	0	0	0	0	0
St. George Totals			15080	6179	17	7	8	9	4

observations of scarred adult seals were not used in calculations of the incidence of entanglement described below.

Resights of Previously Entangled Seals

Pelage marks on the shoulders proved to be easily visible during roundups and other activities. Ten juvenile males on St. Paul Island and 7 on St. George Island were observed with pelage shear marks indicating prior removal of entangling debris during 1995 (Table 4). One seal disentangled and marked during non-entanglement research activities on St. Paul Island was later observed during a roundup on St. George Island and another seal observed on St. Paul had been marked on St. George Island.

In previous studies of entanglement among juvenile male northern fur seals, samples of entangled and control animals were tagged to assess the survival and subsequent resighting of entangled seals within seasons and between years. This information was incorporated into the calculation of the rate of entanglement assuming a 50% survival rate of entangled seals (if debris was left on) between years (Fowler and Baba 1991). In the current study, no tags were applied to entangled seals captured during surveys and nonentangled control seals were not tagged for use in comparing estimates of survival between entangled and nonentangled seals. By using pelage marks to resight previously entangled seals, our methods will not detect seals released from debris in previous years. Therefore, current methods will slightly underestimate the entanglement rate in comparison with previous methods and may be better understood as an index of the minimum rate of entanglement among juvenile male fur seals.

In entanglement studies conducted from 1985 to 1992, the resighted fraction of the overall mean entanglement rate has been close to 25% for both control and entangled samples (Fowler et al. 1993). During 1995, the resighted fraction of the number of entangled juvenile seals for both islands combined was 3 1.5 % implying similar resighting rates between study methods.

Incidence of Entanglement.

During subsistence harvest surveys and roundups on St. Paul Island, 22 juvenile and 17 adult entangled fur seals were observed and the type of debris was determined. Seventeen juvenile and 9 adult male entangled seals were observed on St. George Island. Data on all observations of entanglement used to calculate the rate of entanglement are presented in Table 5. In situations where it was not possible to capture an entangled seal, age and debris information was recorded. An additional 19 male seals, 6 female seals, 5 seals of unknown sex, and approximately 20 pups were captured and disentangled during other research activities from late June through November (Table 6).

As in previous years, entangling debris consisted primarily of pieces of trawl net, plastic packing bands and loops of synthetic or natural twine (Table 7). No seals were observed entangled in monofilament gillnet during the entanglement surveys in 1995. Differences in the relative percentage of entangling debris were observed between islands and age groups of seals (Fig. 7). Adult males entangled in packing bands were observed more often than juveniles on both islands. Trawl net comprised the largest proportion of entangling debris observed on juveniles on both islands (47.6% and 47.1% on St. Paul and St. George Island, respectively), followed by packing bands on St. Paul Island (38.1%). Fewer packing bands were observed on juveniles on St. George (11.8%); however, greater numbers of seals entangled in loops of twine (29.4%) were observed. More entanglement in packing bands was observed on St. Paul Island (44.7%) relative to St. George Island (19.2%) for all age groups combined.

Table 5.-- Adult and juvenile male northern fur seals observed entangled during harvest surveys and roundups on St. Paul and St. George Islands during June, July, and August of 1995 including a description of the debris and the wound on each seal.

			Description of Debris					
Date	Location	Disentangled[1] Y/N	Debris Type	Weight	Mesh Size	Twine Size	Tightness[2]	Wound (degrees)
St. Paul Juveniles								
6 Jul	Zapadni	Y	Packing band	1.7	24.7	9.0	T	0
6 Jul	Zapadni	Y	Trawl net	886.0	19.5	5.0	VT	200
6 Jul	Zapadni	Y	Trawl net	560.0	23.0	4.0	T	0
6 Jul	Zapadni	N	Unidentified[3]	-	-	-	-	-
10 Jul	Reef	Y	Trawl net	151.0	21.0	2.0	T	0
14 Jul	Lukanin	Y	Packing band	-	-	-	VT	180
17 Jul	Polovina	Y	Trawl net	122.0	22.5	2.0	T	0
19 Jul	Zapadni Reef Sands	Y	Packing band	1.9	22.2	1.2	VT	0
25 Jul	Sea Lion Neck West	Y	Synthetic twine	10.6	23.0	5.0	VT	360
25 Jul	Vostochni Sec. 14	Y	Battery strap	34.8	51.0	6.0	L	0
26 Jul	Zolotoi	Y	Packing band	1.9	22.0	1.2	T	0
26 Jul	Zolotoi	Y	Trawl net	97.5	19.0	2.0	T	0
27 Jul	Zapadni	Y	Packing band	2.2	23.5	1.0	VT	360
27 Jul	Zapadni	Y	Trawl net	560.0	28.5	2.0	T	0
27 Jul	Zapadni	Y	Trawl net	133.0	20.0	2.0	T	0
27 Jul	Zapadni	Y	Synthetic twine	1.3	22.5	2.0	VT	360
31 Jul	Zapadni Reef Sands	Y	Trawl net	321.0	23.5	0.3	T	0

Table 5.--cont.

Date	Location	Disentangled[1] Y/N	Description of Debris					
			Debris Type	Weight	Mesh Size	Twine Size	Tightness[2]	Wound (degrees)
1 Aug	Kitovi	Y	Trawl net	18.2	21.0	5.0	T	0
1 Aug	Northeast Point	Y	Packing band	2.0	39.0	4.0		0
1 Aug	Vostochni Sec. 11	Y	Packing band	2.2	22.0	1.6	T	0
1 Aug	Vostochni Sec. 3	Y	Trawl net	502.0	23.0	3.0	T	0
4 Aug	Zapadni	Y	Packing band	-	-	-	VT	360
St. Paul Adults								
6 Jul	Zapadni	Y	Packing band	2.5	26.5	9.0	VT	360
6 Jul	Zapadni	Y	Synthetic twine	-	-	-	VT	360
7 Jul	Lukanin	Y	Trawl net	331.0	22.0	4.0	VT	360
18 Jul	Zapadni	N	Trawl net	-	-	-	-	-
19 Jul	Zapadni Reef Sands	Y	Packing band	4.2	28.5	1.2	VT	360
20 Jul	Lukanin	Y	Packing band	-	-	-	VT	360
24 Jul	Polovina	Y	Packing band	1.3	20.0	9.0	VT	360
25 Jul	Little Polovina	Y	Packing band	1.7	35.0	6.0	L	0
25 Jul	Sea Lion Neck West	Y	Packing band	3.8	36.0	4.0	VT	360
25 Jul	Sea Lion Neck East	N	Trawl net	-	-	-	VT	360
25 Jul	Vostochni Sec. 14	Y	Packing band	-	-	-	VT	360
26 Jul	Tolstoi Hill	N	Trawl net	-	-	-	-	-
27 Jul	Zapadni	Y	Trawl net	98.0	N.A.	3.0	VT	360
27 Jul	Zapadni	Y	Synthetic twine	-	-	-	VT	360
1 Aug	Northeast Point	Y	Packing band	0.5	29.5	0.5	L	0

Table 5 .--cont.

			Description of Debris					
Date	Location	Disentangled[1] Y/N	Debris Type	Weight	Mesh Size	Twine Size	Tightness[2]	Wound (degrees)
1 Aug	Vostochni Sec. 14	Y	Packing band	-	-	-	T	90
4 Aug	Zapadni	Y	Synthetic twine	13.5	49.5	5.0	VT	360
St. George Juveniles								
30 Jun	Zapadni	Y	Trawl net	2.6	-	2	L	0
30 Jun	Zapadni	Y	Synthetic twine	19.1	37	3	VT	360
2 Jul	Northwest	Y	Trawl net	6.6	22.0	1.2	VT	360
6 Jul	East Reef	Y	Packing band	-	-	-	VT	360
7 Jul	East Cliffs 1	Y	Synthetic twine	5.5	32.5	3.0	T	300
7 Jul	East Cliffs 1	Y	Plastic pipe	11.6	12	19	VT	360
7 Jul	East Cliffs 1	Y	Trawl net	19.3	14.5	1.5	VT	340
7 Jul	East Cliffs 2	Y	Synthetic twine	2.9	24.5	5.0	-	0
21 Jul	East Cliffs 1	Y	Trawl net	132.0	27	2	VT	360
21 Jul	East Cliffs 1	Y	Trawl net	49.0	20	5	L	0
21 Jul	East Cliffs 1	Y	Strapping band[4]	1.2	22.5	13	L	0
28 Jul	East Reef	Y	Synthetic twine	1.8	24	4	T	360
28 Jul	East Reef	Y	Trawl net	2.5	18	1.8	VT	90
29 Jul	East Cliffs 1	Y	Synthetic twine	2.2	23	2.5	VT	360
29 Jul	East Cliffs 1	Y	Packing band	1.0	22.5	7	T	0
29 Jul	East Cliffs 1	Y	Trawl net	1240	23	2.7	L	0
1 Aug	Zapadni	Y	Trawl net	39.7	23	3	VT	270

Table 5.--cont.

Date	Location	Disentangled[1] Y/N	Description of Debris: Debris Type	Weight	Mesh Size	Twine Size	Tightness[2]	Wound (degrees)
St. George Adults								
30 Jun	Zapadni	Y	Packing band	1.4	38.5	7.0	L	360
2 Jul	Northwest	Y	Packing band	2.4	31.5	11	L	0
12 Jul	Zapadni	Y	Trawl net	35	27	3	L	0
14 Jul	East Cliffs 1	Y	Nylon webbing	45.3	35	9	VT	360
14 Jul	East Cliffs 2	Y	Synthetic twine	43.6	29.5	9	VT	0
14 Jul	East Cliffs 2	Y	Trawl net	933	29	2	T	0
21 Jul	East Cliffs 1	Y	Packing band	1.5	32.5	5	L	50
29 Jul	East Cliffs 2	Y	Trawl net	61.2	6	1	L	360
29 Jul	Kitasilough	N	Trawl net	-	-	-	-	-

[1]Whether debris was removed (yes or no).

[2]L = loose, T = tight, VT = very tight.

[3]Debris not identified.

[4]Fiber-based strapping material similar to packaging tape.

Table 6.-- Entangled seals observed during entanglement surveys and other research activities from which debris was removed during the field season 1995.

					Description of Debris						
Date	Location	Sex	Age Group[1]	Activity[2]	Disentangled Y/N[3]	Debris Type	Weight	Mesh Size	Twine Size	Tightness[4]	Wound (degrees)
St. Paul Island											
12 Jul	Zapadni	M	Juvenile	Bull counts	Y	Trawl net	20	23.0	3.0	-	0
12 Jul	Zapadni	M	Juvenile	Bull counts	Y	Packing band	-	-	-	VT	360
15 Jul	Vostochni	U	Unknown	Bull counts	Y	Trawl net	296.0	21.0	5.0	-	-
15 Jul	Tolstoi	M	Juvenile	Foraging studies	Y	Packing band	-	-	-	VT	360
17 Jul	Polovina	F	Unknown	Harvest survey	Y	Trawl net	63.5	UNK	7.0	T	0
30 Aug	Reef	F	Unknown	Pup Mortality	Y	Trawl net	51.3	25.0	2.0	-	-
2 Sep	Zapadni	M	Juvenile	Scat collection	Y	Packing band	1.1	23.0	6.0	VT	360
3 Sep	Reef	U	Pup	Misc.	Y	Hemp twine	6.9	25.2	6.0	T	0
3 Sep	Reef	M	Juvenile	Misc.	Y	Trawl net	118.0	22.0	6.0	L	0
3-Sep	Reef	F	Unknown	Misc.	Y	Trawl net	98.3	19.0	3.0	T	90
Fall	Tolstoi	M	Juvenile	Foraging studies	Y	Plastic laundry box	52.3	12.5	-	T	0
Fall	Unknown	U	Pup	Pup activity	Y	Rubber band	4.4	21.0	1.4	-	-
Fall	Unknown	U	Pup	Pup activity	Y	Rubber band	7.3	18.5	1.5	-	-
Fall	Unknown	U	Pup	Pup activity	Y	Rubber band	12.3	21.0	2.0	-	-
Fall	Unknown	U	Pup	Pup activity	Y	Raingear material	7.1	19.5	3.8	-	-
Fall	Reef	M	Juvenile	Pup activity	Y	Packing band	-	-	-	-	-
Fall	Reef	M	Juvenile	Pup activity	Y	Packing band	-	-	-	-	-

Table 6. --cont.

Date	Location	Sex	Age Group[1]	Activity[2]	Description of Debris: Disentangled Y/N[3]	Description of Debris: Debris Type	Weight	Mesh Size	Twine Size	Tightness[4]	Wound (degrees)
Fall	Reef	M	Juvenile	Pup activity	Y	Unidentified	-	-	-	-	-
Fall	Reef	F	Unknown	Pup activity	Y	Unidentified	-	-	-	-	-
St. George Island											
2 Jul	Northwest	M	Juvenile	Roundups	Y	Trawl net	6.6	22.0	1.2	VT	360
14 Jul	East Cliffs2	M	Adult	Roundups	Y	Synthetic twine	43.6	29.5	9	VT	360
28 Jul	Northeast	M	Juvenile	Roundups	Y	Trawl net	8.2	-	3.0	T	360
28 Jul	East Reef	M	Juvenile	Roundups	Y	Trawl net	2.5	18	1.8	VT	90
1 Aug	Northeast	M	Juvenile	Roundups	Y	Trawl net	40.4	12	2.2	VT	300
6 Aug	North	U	Juvenile	Misc.	Y	Packing band	1.6	21.5	9	-	0
7 Aug	Zapadni	U	Juvenile	Misc.	Y	Cotton twine	7.2	22.5	4.2	VT	90
10 Aug	Zapadni	M	Juvenile	Misc.	Y	Packing band	1.4	22	6	VT	360
11 Aug	East Reef	M	Adult	Misc.	Y	Trawl net	250	21.5	2.4	VT	360
14 Aug	South	F	Unknown	Shearing samp.	Y	Trawl net	322	24	2.7	-	0
14 Aug	South	F	Unknown	Shearing samp.	Y	Packing band	-	-	-	VT	360
6 Sep	East Reef	M	Juvenile	Foraging studies	Y	Trawl net	109.5	21.5	3.5	T	0
6 Oct	East Cliffs	M	Juvenile	Foraging studies	Y	Trawl net	38.0	22	4.2	VT	180
16 Oct	East Cliffs	M	Juvenile	Foraging studies	Y	Bait bag	22.1	24	2.9	VT	360

Table 6.--cont.

Date	Location	Sex	Age Group[1]	Activity[2]	Description of Debris: Disentangled Y/N[3]	Debris Type	Weight	Mesh Size	Twine Size	Tightness[4]	Wound (degrees)
Fall	East Cliffs	U	Unknown	Foraging studies	Y	Trawl net	215.0	22.5	4.0	-	-
Fall	East Cliffs	U	Unknown	Foraging studies	Y	Trawl net	166.0	23.0	3.0	-	-

[1]Only pups for which debris was saved are included. Total numbers of pups disentangled were estimated by researchers conducting pup activity studies.

[2]Seals observed during roundups or harvest surveys were not included in calculations of the incidence of entanglement.

[3]Whether debris was removed (yes or no).

[4]L= loose, T= tight, VT= very tight.

Table 7.--Number of adult and juvenile male northern fur seals observed during 1985 in frequently occurring types of debris and percent entangled on St. Paul and St. George Islands.

Island/Age	Type of Debris								
	Trawl Net		Packing Band		Twine		Misc.		
	No.	%	No.	%	No.	%	No.	%	Total
St. Paul/Juvenile	10	47.6	8	38.1	2	9.5	1	4.8	21[1]
St. George/Juvenile	8	47.1	2	11.8	5	29.4	2	11.8	17
St. Paul/Adult	5	29.4	9	52.9	3	17.6	0	-	17
St. George/Adult	4	44.4	3	33.3	1	11.1	1	11.1	9
St. Paul Total	15	39.5	17	44.7	5	13.2	1	2.6	38
St. George Total	12	46.2	5	19.2	6	23.1	3	11.5	26

‘The debris on entangled seal observed on 6 July on Zapadni rookery, St. Paul Island, was not identified and was not included in debris composition.

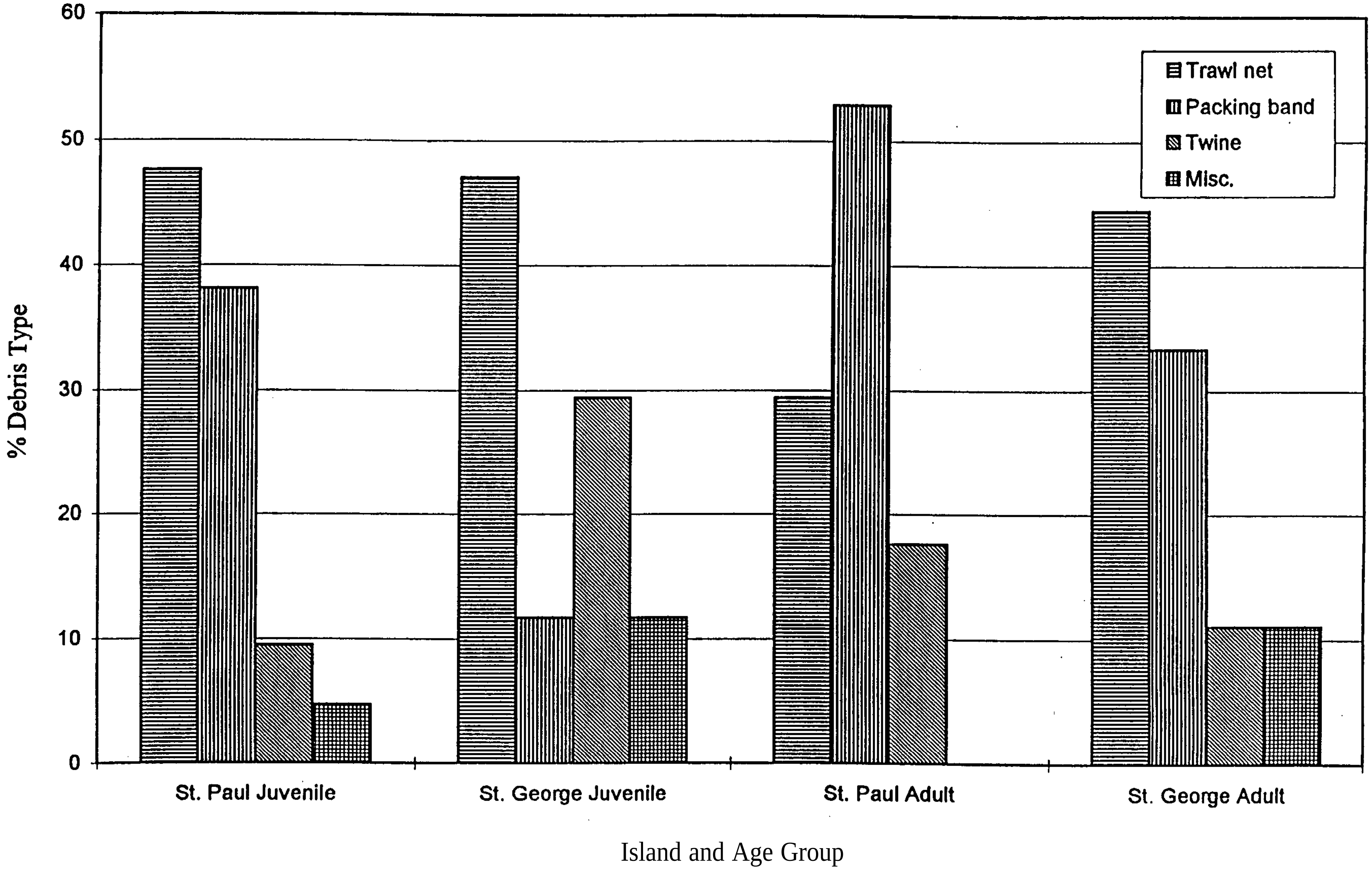


Figure 7.--Composition of entangling debris observed on adult and juvenile northern fur seals on St. Paul and St. George Islands.

ratio of all entanglement sightings (initial and subsequent sightings for juveniles) to the total number of animals observed in each age group. The rate of entanglement for juvenile males was calculated as 0.22% (32/14,356) on St. Paul Island and 0.39% (24/6,179) on St. George Island. Among adult males, the rate of entanglement was calculated as 0.14% (17/12,527) on St. Paul Island and 0.12% (11/8,901) on St. George Island. The overall rate of entanglement for all males was calculated as 0.18% (49/26,883) and 0.22% (33/15,080) for St. Paul and St. George Island, respectively.

Statistical analysis indicated that there was interaction between the age of a seal and the island on which the survey was conducted (P=O.O8); therefore, an independent analysis was performed for adult and juvenile rates of entanglement (Table 8). The rate of entanglement among juvenile males was significantly different (P=O.O43) between St. Paul (0.22%) and St. George Island (0.39%); however, there was no significant difference in adult male entanglement rates (P=O.469) between the two islands. No difference was detected between harvest and roundup sampling methods on St. Paul Island testing for sample type (P=O.69) or interaction between age and sample type (P=O.O9). For both islands, a significant difference (P<O. 10) in the age-specific (adult vs. juvenile) rate of entanglement (St. Paul, P= 0.09; St. George, P=0.0002) suggests differential entanglement or survival rates by age group. The higher level of significance observed on St. George Island is most likely tied to the high entanglement rate observed among juvenile males, although differential survival based on the type of entanglement debris may be a factor.

The incidence of entanglement among juvenile males on St. Paul Island is within the range of entanglement rates observed from 1988 to 1992 (Table 9; Fig. 8). Fowler et al. (1993) attributed decline in the rate of entanglement on St. Paul Island from a mean rate of

Table 8.--Results of statistical analysis of adult and juvenile male northern fur seal entanglement rates on St. Paul and St. George Islands, 1995.

Factor	df	Deviance	Residual df	Residual Deviance	Pr(Chi)
Effects of age and island on entanglement rate					
Null			160	172.12	
Age	1	12.57	159	159.55	0.0004
Island	1	1.54	158	158.01	0.214
Age x Island	1	3.06	157	154.95	0.08
Effects of island for juveniles					
Null			79	98.03	
Island	1	4.08	78	93.95	0.043
Effects of island for adults					
Null			80	61.52	
Island	1	0.52	79	61.0	0.469
Effect of age and sample type (St. Paul only)					
Null			67	65.54	
Age	1	2.86	66	62.68	0.091
Sample type	1	0.15	65	62.53	0.694
Age x Sample type	1	0.01	64	62.52	0.914
Effect of age within each island					
Null (St. Paul)			67	65.54	
Age (St. Paul)	1	2.86	66	62.68	0.091
Null (St. George)			92	105.94	
Age (St. George)	1	13.67	91	92.27	0.0002

Table 9.--The percentage ofjuvenile male northern fur seals from St. Paul Island, Alaska, entangled in marine debris as recorded from 1967 to 1984 during the commercial harvest (data from Kozloff et al. 1986) and from 1985 to 1992 during roundups (data updated from Fowler et al. 1993).

Year	Percent Entangled	
	St. Paul Island	St. George Island
1967	0.15	--
1968	0.16	--
1969	0.20	--
1970	0.28	--
1971	0.41	--
1972	0.43	--
1973	0.48	--
1974	0.58	--
1975	0.71	--
1976	0.42	--
1977	0.35	--
1978	0.46	--
1979	0.40	--
1980	0.49	--
1981	0.43	--
1982	0.41	--
1983	0.43	--
1984	0.39	--
1985	0.45	--
1986	0.42	--
1987	--	--
1988	0.28	--
1989	0.29	--
1990	0.32	--
1991	0.21	--
1992	0.29	--
1993	--	--
1994	--	--
1995	0.22	0.39

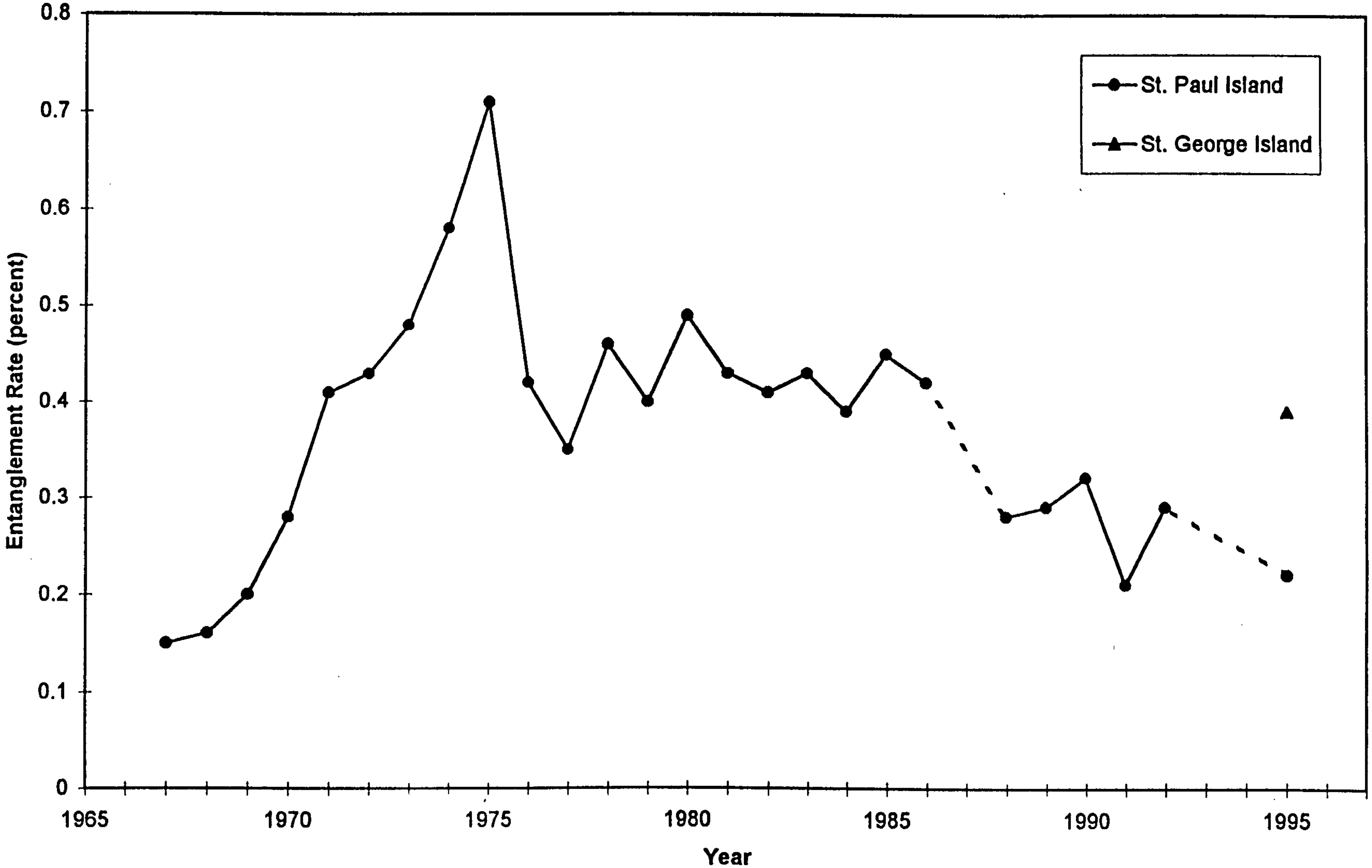


Figure 8.--The percentage ofjuvenile male northern fir seals found entangled in entanglement surveys.

0.4% between 1976 and 1985 to current levels to a reduction in the fraction of seals entangled in trawl net fragments (Table 10). Figure 9 shows the composition of debris types expressed as the observed percent of the incidence of entanglement among juvenile males for each Island in 1995. The higher entanglement rate among juvenile males on St. George Island (0.39%), reflects a higher incidence of trawl net fragments in this age group. Continued research is necessary to determine whether trends in the incidence of entanglement and debris composition persist through time indicating possible differences in the types of marine debris encountered by seals from each Island's population.

Adult Female Entanglement

Three entangled and 8 scarred (evidence of previous entanglement) adult female fur seals 'were observed during female entanglement surveys on St. Paul Island (Table 11). The rate of entanglement among females was calculated at 0.010 % for entangled females, 0.028 % for scarred females and 0.038% for the two categories combined. The 1995 data show an decrease in the observed rate of entangled and entangled and scared females combined from 1994 levels; however, the rate is comparable to that observed in 1992 and 1993 (Table 11) (Kiyota and Fowler 1994, Kiyota unpublished data). In contrast to previous years, the observed incidence of entanglement among females at Reef Rookery decreased as the breeding season progressed (Table 12).

Table l0.-- Debris found on juvenile male northern fur- seals from St. Paul and St. George Islands, Alaska, 198l-95, expressed as the incidence of entanglement (observed percent) among juvenile males entangled by debris catagory (data for 198 l-9 1 from Fowler and Ragen 1990, Fowler and Baba 1991, and Fowler et al. 1992).

Year	Trawl Net Fragments	Packing Bands	Cord, Rope, and String	Monofilament Net Fragments	Misc. Items	Entanglement Rate	Sample Size
St. Paul Island							
1981	0.29	0.08	0.04	0.00	0.03	0.43	102
1982	0.24	0.10	0.04	0.01	0.01	0.41	102
1983	0.30	0.07	0.02	0.01	0.03	0.43	112
1984	0.22	0.09	0.05	0.02	0.01	0.39	87
1985	0.31	0.05	0.07	0.01	0.01	0.45	76
1986	0.27	0.06	0.07	0.01	0.01	0.42	70
1988	0.15	0.07	0.05	0.00	0.01	0.28	53
1989	0.12	0.10	0.06	0.02	0.01	0.29	47
1990	0.11	0.11	0.07	0.01	0.03	0.32	71
1991	0.06	0.08	0.06	0.01	0.00	0.21	38
1992	0.14	0.07	0.05	0.01	0.03	0.29	40
1995	0.11	0.08	0.02	0.00	0.01	0.22	22
St.George Island							
1995	0.18	0.05	0.11	0.00	0.05	0.39	17

Figure 9.--Composition of entangling debris observed on juvenile male northern fur seals expressed as a percent of the entanglement rate.

Table 11-- Observed incidence and rate of female entanglement on St. Paul Island based on surveys of all major rookeries.

Year	Number			Rate (%)		
	Counted	Entangled	Scarred	Entangled	Scarred	Ent+Scar
1991	16009	3	7	0.019	0.044	0.062
1992	25089	3	6	0.012	0.024	0.036
1993	31638	3	11	0.009	0.035	0.044
1994	30269	7	10	0.023	0.033	0.056
1995	29109	3	8	0.010	0.028	0.038

Table 12.--Incidence of entanglement among females at Reef Rookery during July and early August, 1992-95.

Date	Count	Entangled	Scarred	Ent (%)	Ent+Scar (%)
7/11/92	4687	0	1	0	0.021
7/22/92	2811	1	1	0.036	0.071
8/2/92	2561	0	4	0	0.156
7/13/93	3528	0	1	0	0.028
7/23/93	2594	0	1	0	0.039
8/2/93	2152	0	1	0	0.046
7/21/94	4279	1	1	0.023	0.047
7/31/94	3350	0	0	0	0
8/10/94	2278	1	3	0.044	0.176
7/11/95	3026	0	2	0.0	0.066
7/22/95	3028	0	2	0.0	0.066
8/1/95	2152	1	0	0.046	0.046

MASS, LENGTH, AND SEX RATIOS OF NORTHERN FUR SEAL PUPS ON ST. PAUL AND ST. GEORGE ISLANDS, 1995

by

Rodney G. Towell, George A. Antonelis, Anne E. York, and Bruce W. Robson

Trends in the mass and length of fur seal pups serve as indicators of population health between years and locations. Here we report average mass, lengths, and sex ratios from male and female pups from Tolstoi, Vostochni, Polovina, and Reef rookeries on St. Paul Island and all rookeries on St. George Island in 1995. We also report on comparisons of mass, length and sex ratios between islands and years in which the sampling was done in the same time frame.

METHODS

Pups were randomly 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 Salter hanging dial 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 and St. George Islands were analyzed using analysis of variance on sex and rookery. We limit statistical comparisons to information collected on similar dates (24 to 29 August) during the breeding season; between islands in 1994 and 1995; between 1992, 1994, and 1995 at St. Paul Island; and between 1994 and 1995 on St. George Island.

RESULTS AND DISCUSSION

Pup Mass and Length

Mean mass, length, and 95% confidence intervals by rookery for male and female northern fur seal pups are illustrated in Figures 10 and 11 for St. Paul Island with sample sizes, mean mass, mean length, and standard deviations for each rookery by sex shown in Appendix Tables C-l and C-3. The analysis of variance of the mass by sex and rookery on St. Paul Island in 1995 indicated that there was a significant interaction between the sex and rookery term ($P = 0.003$, Table 13a). The interaction may be attributed to the small difference between males and females on Reef rookery compared to the difference in the other sample rookeries. Male and female pups were analyzed separately and there was a significant difference between rookeries for both males and females ($P < 0.001$, Table 13b). The significant interaction between sex and rookery also was present in the length analysis of pups on St. Paul Island in 1995 ($P = 0.014$, Table 14a). Males and females were again analyzed separately and there was a significant difference between rookeries for each ($P = 0.036$ females, $P < 0.001$ males Table 14b).

Mean mass, length, and 95% confidence intervals by rookery for male and female northern fur seal pups are illustrated in Figures 12 and 13 for St. George Island with sample sizes, mean mass, mean length, and standard deviations for each rookery by sex and year shown in Appendix Tables C-2 and C-4. The analysis of variance of mass indicated that there was a significant difference between sexes ($P < 0.001$, Table 15) and rookeries ($P = 0.001$, Table 15) in 1995. The analysis of variance for lengths for all sample years also indicated significant differences by sex ($P < 0.001$, Table 16) and by rookery ($P = 0.001$, Table 16).

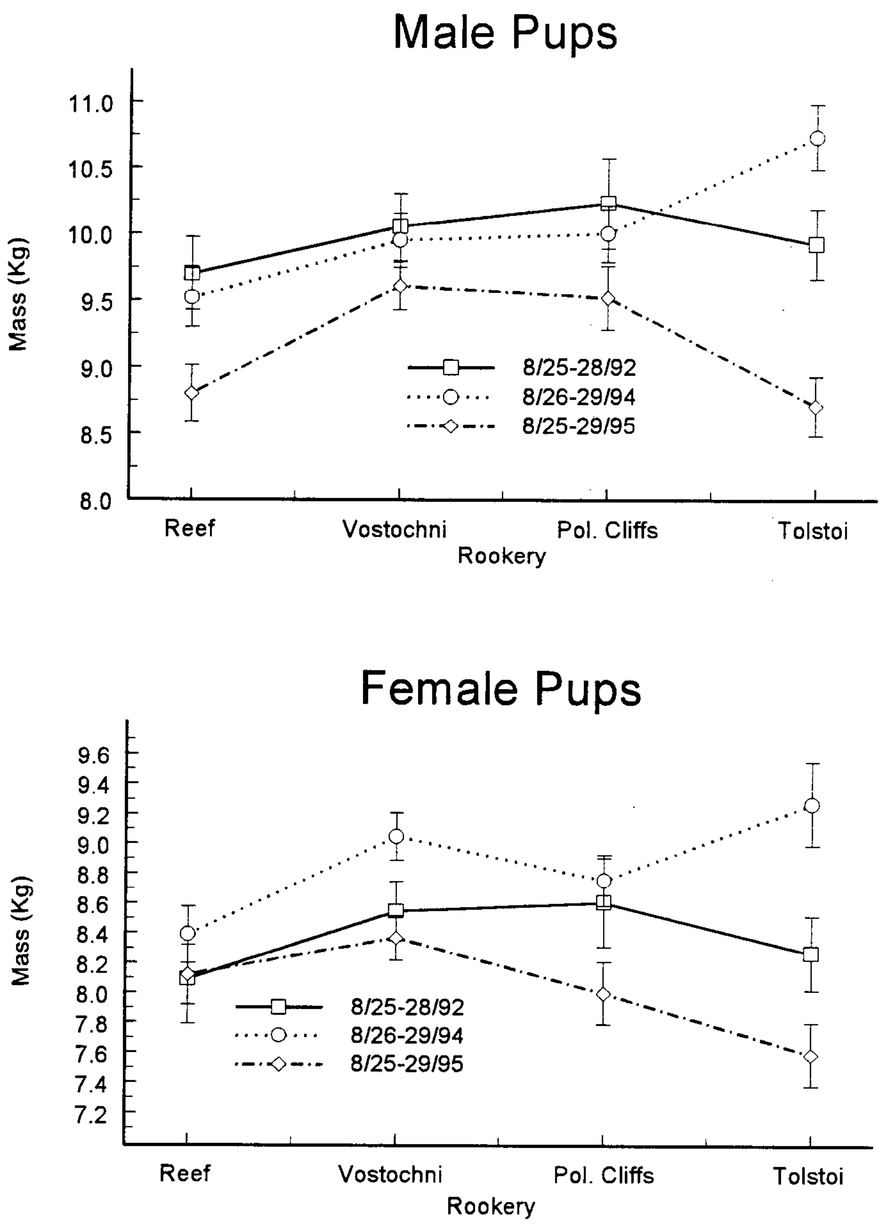


Figure 10.--Mean mass with 95% confidence intervals of northern fur seal pups weighed during August 1992, 1994, and 1995, St. Paul Island, Alaska.

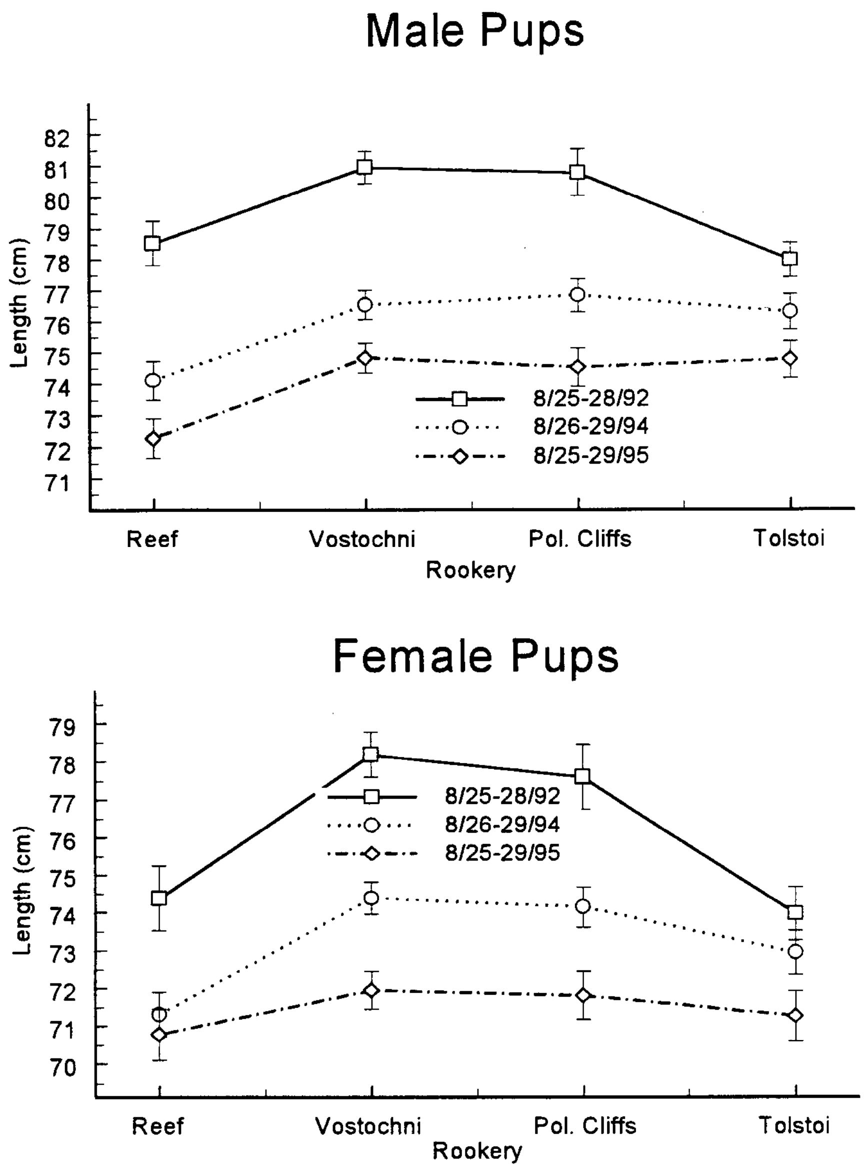


Figure 11 .--Mean length with 95% confidence intervals of northern fur seal pups weighed during August 1992, 1994, and 1995, St. Paul Island, Alaska.

Table 13a.--Analysis of variance of mass of northern fur seal pups on St. Paul Island, Alaska, August 1995, by sex (Sx) and rookery (R).

Factor	df	SS due to factor	MSS*	Residual	df	F	p
Sex	1	591.3	591.3	4962	1875	234.6	1.000
Rookeries	3	215.1	71.7	4747	1872	28.4	1.000
Sx x R	3	35.5	11.8	4711	1869	4.7	0.997

Table 13b.--Analysis of variance of mass of northern fur seal pups on St. Paul Island, Alaska, August 1995, by sex on rookery.

Factor	df	SS due to factor	MSS*	Residual	df	F	p
Females							
Rookeries	3	74.74	24.91	1702.2	843	12.3	1.000
Males							
Rookeries	3	175.85	58.62	3009.5	1026	19.98	1.000

*MSS = SS divided by df

Table 14a.--Analysis of variance of length of northern fur seal pups on St. Paul Island, Alaska, August 1995, by sex (Sx) and rookery (R).

Factor	df	SS due to factor	MSS*	Residual	df	F	p
Sex	1	3083.3	3083.3	41615	1878	143.5	1.000
Rookeries	3	1161.7	387.2	40453	1875	18.0	1.000
Sx x R	3	228.6	76.2	40225	1872	3.5	0.986

Table 14b.--Analysis of variance of length of northern fur seal pups on St. Paul Island, Alaska, August 1995, by sex on rookery.

Factor	df	SS due to factor	MSS*	Residual	df	F	p
Females							
Rookeries	3	173.58	57.86	17045	844	2.86	0.964
Males							
Rookeries	3	1216.6	405.5	23179	1028	17.98	1.000

*MSS = SS divided by df

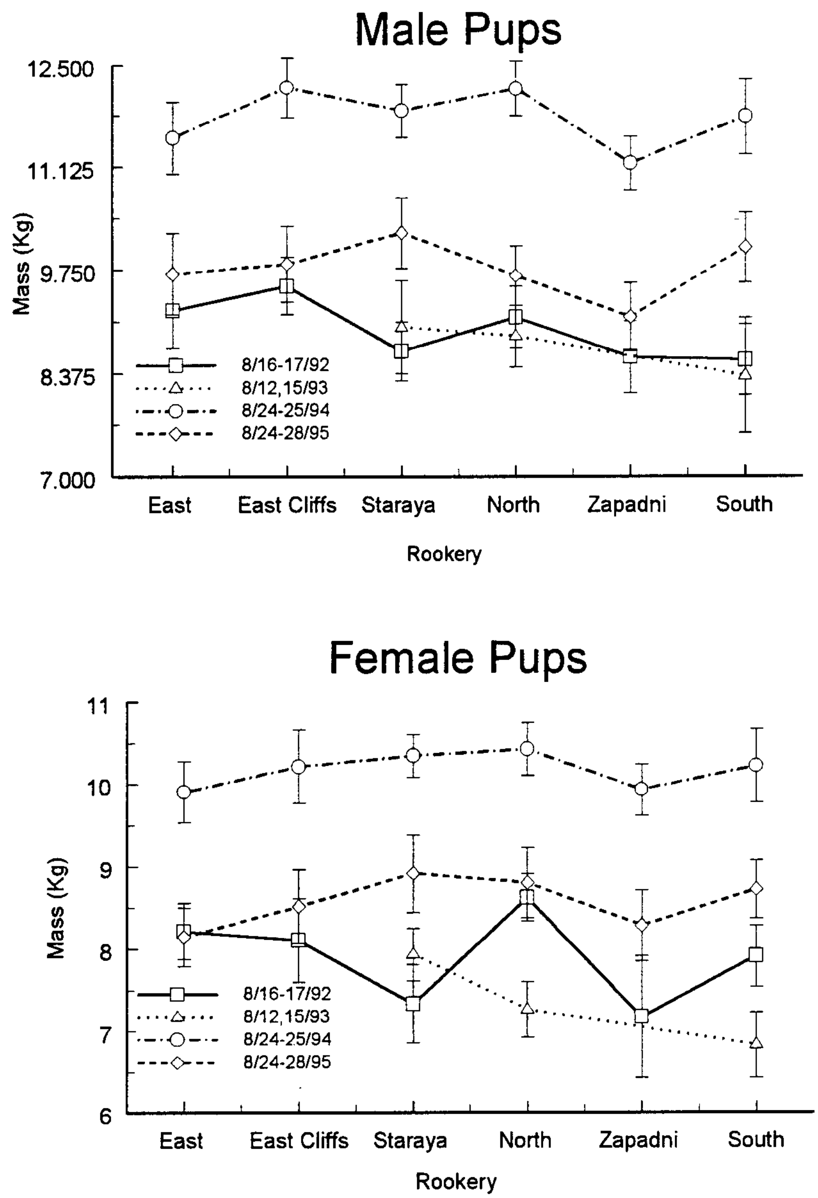


Figure 12.--Mean mass with 95% confidence intervals of northern fur seal pups measured during August 1992-95, St. George Island, Alaska.

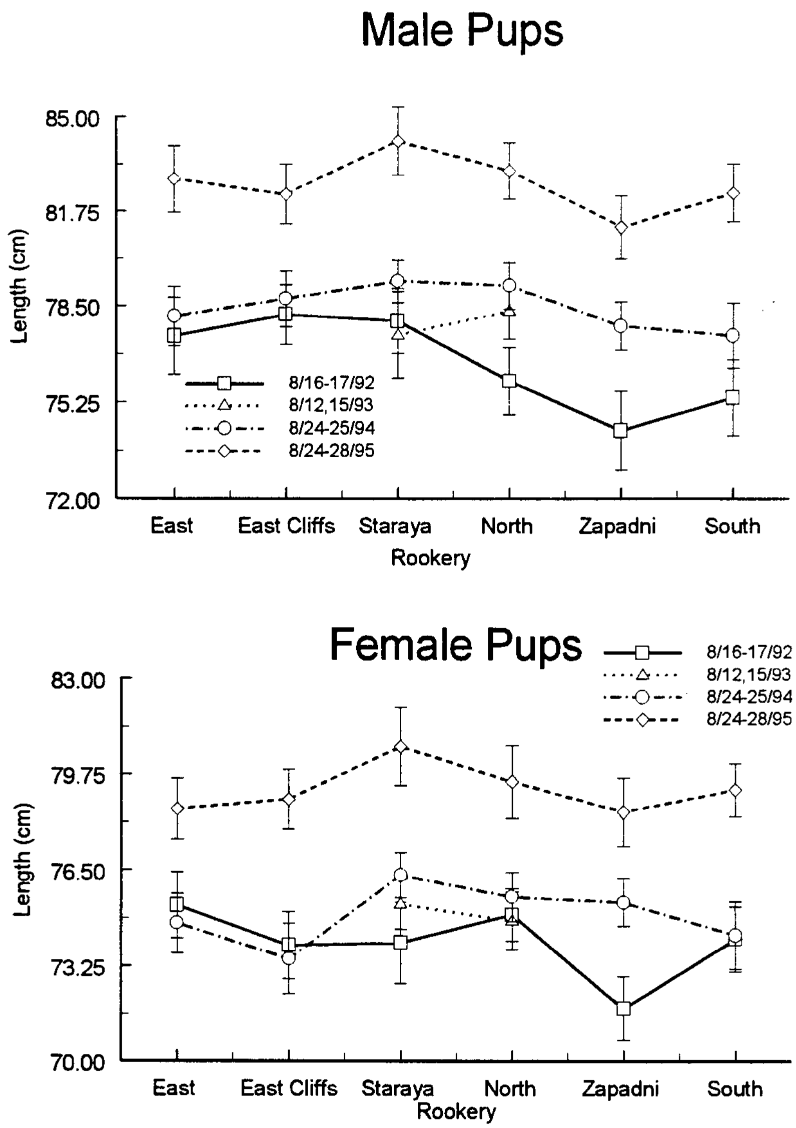


Figure 13 .--Mean length with 95% confidence intervals of northern fur seal pups measured during August 1992-95, St. George Island, Alaska.

Table 15.--Analysis of variance of the effects of sex and rookery on the mass of northern fur seal pups weighed on St. George Island, Alaska, 24-28 August 1995.

Factor	df	SS due to factor	MSS*	Residual	df	F	p
Sex	1	217.45	217.45	1826.13	650	79.19	1.000
Rookeries	5	57.71	11.54	1768.41	645	4.20	0.999
Sx x R	5	11.08	2.22	1757.33	640	0.81	0.455

Table 16.--Analysis of variance of the effects of sex and rookery on the length of northern fur seal pups weighed on St. George Island, Alaska, 24-28 August 1995.

Factor	df	SS due to factor	MSS*	Residual	df	F	p
Sex	1	1820.12	1820.12	10931.4	651	111.4	1.000
Rookeries	5	425.57	85.11	10505.9	646	5.21	0.999
Sx x R	5	36.27	7.25	10469.6	641	0.44	0.182

*MSS = SS divided by df

A separate analysis was conducted to compare the mass and length of pups with similar sample dates, within 3 to 5 days, between islands in 1994 and 1995, and between years (1992, 1994, and 1995) on St. Paul Island. The proportion of pups sampled on each rookery was not the same for all years of data collection. Therefore, mean mass for all pups on St. Paul Island was calculated for males and females for 1992 and 1994 by weighting sums of the means for each sampled rookery on the basis of the pup production of that rookery. For each sampled rookery in 1995, the sums of means were weighted by the harem bull count for that rookery since pup production numbers were not available. This was done for each island by weighting the mean according to the fraction of pups, or bulls, that were contributed by that rookery to the total number of pups born, or harem bulls present, on St. George Island and the total number of pups, or harem bulls counted, for rookeries sampled on St. Paul Island. These fractions are considered representative of the size of the pup population, or harem bull population, on each rookery and are independent of the mass data. The variance of the weighted mean was estimated as the sum of the product of the squared weight with the variances of the mean mass from each rookery.

The calculations were determined in the following manner: Let B_1, B_2, . . . B_4 be the 1995 harem bull counts on the four St. Paul rookeries where studies were conducted during 1995. Let $W_{i,j}$ be the corresponding mean mass of pups on rookery I, I = 1, 4 for sex j (j = 1 for females, 2 for males) from Appendix Table C-l. Let $V_{i,j}$ be the variance for $W_{i,j}$; $V_{i,j}$ is calculated as the square of the standard deviation (Appendix Tables C-l and C-2) divided by the sample size (Appendix Tables C-l and C-2). For example, for females in 1995 the calculation was $V(l, 1) = (1 .33)^2/169$. For each rookery, I, the fraction of pups or harem bulls (f_i) contributed by that rookery is computed as:

$$f_i = B_i \Big/ \sum_{i=1}^{4} B_i .$$

Then the weighted mean (M) for sex j is

$$M_j = \sum_{i=1}^{4} f_i \, W_{i,j} ,$$

with variance:

$$S^2_j = \sum_{i=1}^{4} f_i \, V_{i,j} .$$

Similar calculations were made for lengths of pups on St. Paul Island and for mass and length of pups on St. George Island. B_i is replaced by P_i = number of pups (on a given rookery I) for 1992 and 1994 on both islands. Pair-wise significant differences among the means were assessed using Tukey's Honest Significant Difference Test (Neter et al. 1990), q (5,df,.95). The first parameter, 5, represents the number of comparisons made within sex by year and island. Degrees of freedom were determined to be the total number of sample points (pups) in all years minus the number of parameters estimated (df = 2,965 females; df = 3,444 males; the test statistic is equal to 4 significant digits, 3.8577, for all categories) minus 1.

The weighting factors (f_i in the above equations) are shown for 1992, 1994, and 1995 in Appendix Table C-5 for St. Paul and St. George Islands. The estimated mean mass of pups and standard error for each sex for 1992-95 from St. Paul Island and for 1994 and 1995 from St. George Island are presented in Table 17. The estimated mean length of pups and standard error for each sex for 1992-95 from St. Paul Island and 1994-95 from St. George Island are

Table 17.--Estimated mean mass (kg) (with its standard error) for northern fur seal female and male pups, St. Paul Island, Alaska, 1992-95 and St. George Island, Alaska, 24-29 August 1994-95.

	St. Paul			St. George	
	1992	1994	1995	1994	1995
Females	8.90	8.38	8.06	10.25	8.64
SE	0.065	0.054	0.049	0.084	0.101
Males	9.97	10.07	9.20	11.91	9.75
SE	0.070	0.057	0.054	0.095	0.105

Table 18.--Estimated mean length (cm) (with its standard error) for northern fur seal female and male pups, St. Paul Island, Alaska, 1992-95 and St. George Island, Alaska, 24-29 August 1994-95.

	St. Paul			St. George	
	1992	1994	1995	1994	1995
Females	76.11	73.21	71.50	75.00	79.21
SE	0.185	0.138	0.155	0.225	0.275
Males	79.59	75.95	74.11	78.60	82.65
SE	0.158	0.141	0.147	0.208	0.243

shown in Table 18. The calculated t-statistics for each year comparison are summarized for mass (Appendix Table C-6) and length (Appendix Table C-7). The mass of male pups was significantly ($P < 0.01$) lighter on St. George Island in 1995 than on St. George Island in 1994. Male pups were significantly lighter ($P < 0.01$) in 1995 than in 1992 and 1994 on St. Paul Island. Female pups were also significantly lighter ($P < 0.01$) on St. George Island in 1995 than on St. George Island in 1994. However, female pups were significantly heavier on St. George Island in 1995 than on St. Paul Island in 1995 ($P < 0.01$). Female pups on St. Paul Island were significantly lighter (P<O.Ol) in 1995 than 1992 and 1994. The lengths of males and females on St. Paul Island were significantly less in 1995 than in 1992 and 1994 on St. Paul Island ($P < 0.01$). The lengths of males and females on St. George Island in 1995 were significantly greater than in 1994 on St. George Island and in 1992, 1994, and 1995 on St. Paul Island ($P < 0.01$).

Sex Ratios

The fractions of live female fur seal pups sampled on St. Paul and St. George Island are summarized by rookery in Table 19. An analysis of the sex ratios by rookery was conducted by using a General Linear Model (S-Plus) program assuming that the fraction of females in each rookery was a binomial random variable. The logit of the fraction of females [log(p/(l-p)] was modelled as a linear function of rookery and year of sample. The results from that analysis (Table 20) can be interpreted like an analysis of variance except that the significance of a factor is judged by comparing the total sum of squares explained by that factor with a chi-square random variable with degrees of freedom equal to the degrees of freedom of that factor.

Table lg.--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 1995. The fraction of females is significantly less than 50% (p =.95) for **bold items.**

	1995		
Rookery	Females	Total	Fraction
Reef	**169**	**439**	**0.385**
Vostochni	345	721	0.479
Pol. Cliffs	187	372	0.503
Tolstoi	238	508	0.469
Total	**939**	**2040**	**0.460**
East Reef	51	102	0.500
East Cliffs	**33**	**100**	**0.330**
Staraya Artil	54	108	0.500
North	**45**	**111**	**0.405**
Zapadni	**45**	**111**	**0.405**
South	66	121	0.545
Total	**294**	**653**	**0.450**

Table 20.--Analysis of deviance for dependence of sex-ratio on rookery and year sampled of northern fur seal pups on the Pribilof Islands, Alaska, 1992-95. Fraction of females modeled as a general linear model with binomial errors and logit link functions. The "reduction in deviance" is the amount the residuals are reduced when the given factor is entered into the model in order of significance; the deviance is the weighted residual sum of squares for the model.

Factor	df	Deviance	df	Deviance reduction	P
St. Paul					
Grand Mean	11	22.576			
Year	9	18.075	2	4.501	0.105
Rookery	6	12.886	3	5.189	0.158
Rky * Year	0	0.000	6	12.886	0.045
St. George					
Grand Mean	17	32.694			
Rookeries	12	13.453	5	19.242	0.002
Year	10	11.173	2	2.280	0.320
Rky * Year	0	0.000	10	11.173	0.344

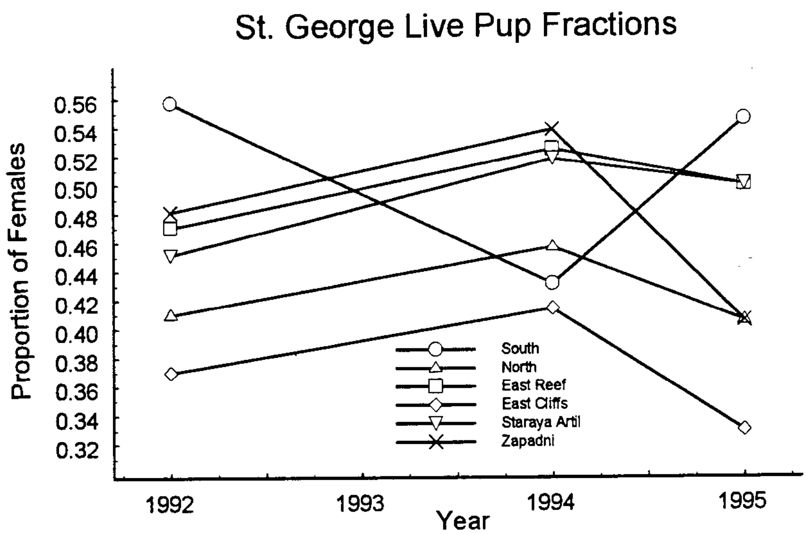
When all categories are considered simultaneously in the sex ratio analysis, the interaction between year and rookery term for St. Paul Island reduces the deviance significantly ($P = 0.045$). Rookery becomes a significant factor ($P = 0.077$) when Tolstoi is not included in the analysis while the interaction between rookery and year is still significant ($P = 0.064$).

On St. George Island, there is no significant difference in the fraction of females between rookeries for 1992, 1994, and 1995 ($P = 0.320$). The percentage of female pups (45.0 %) in 1995 was significantly different than 50% ($P < 0.01$). The addition of the rookery term for St. George Island reduces the deviance significantly ($P = 0.002$). Plots of live pup sex ratios for 1992, 1994, and 1995, Figure 14, show the ratios by year versus rookery for St. Paul and St. George Islands.

The fraction of females (all rookeries combined) sampled in 1992, 1994, and 1995 on St. Paul Island and St. George Island are presented in Table 21. The ordering of frequency for females on St. Paul (SP) and St. George (SG) Islands is shown below. A line joins groups whose sex ratios were not significantly different from each other. Only live pup data was used for both islands. There were no significant differences in the fraction of live female pups between islands or years:

SP92 < SG95 < SG92 < SP95 < SP94 < SG94

Differences between two frequencies were assessed by comparing the difference in the two frequencies divided by the square root of the sum of the two corresponding variances to a Student's t distribution with degrees of freedom equal to the sum of the sample size in each group minus 2 (Fleiss 1973).



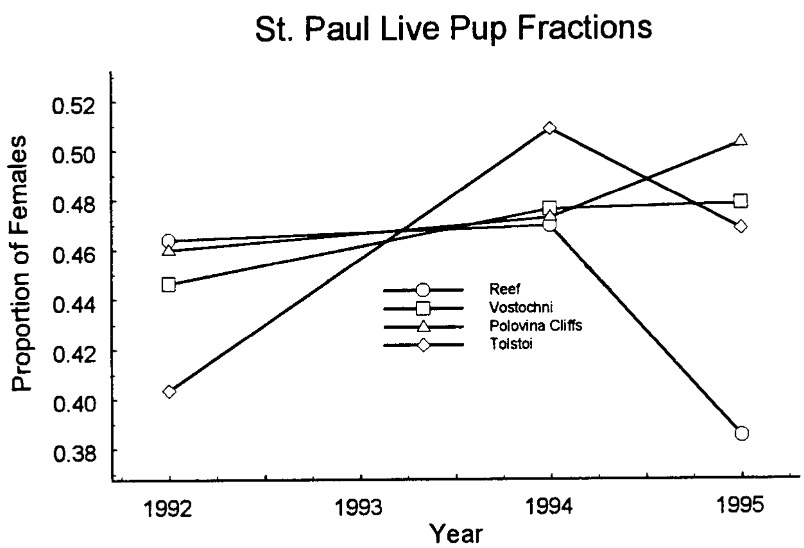


Figure 14.--Fraction of live female pups on the Pribilof Islands, Alaska, 1992, 1994 and 1995.

Table 21 .--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 Island, and separate samples on St. George Island, Alaska for the years 1992-95.

Year	St. Paul			St. George		
	Females	Total	Fraction	Females	Total	Fraction
1992	494	1118	0.442	291	634	0.459
1994	926	1926	0.481	430	886	0.485
1995	939	2040	0.460	294	653	0.450

SUMMARY

Consistent with earlier evaluations of pup mass data (York and Antonelis 1990, York and Towel1 1993, Antonelis et. al. 1994, and Towel1 et. al. 1996), the only clear pattern of how size of pups varied by sex: males outweighed females and male pups are longer than female pups. On St. Paul Island the mass of male pups in 1995 was significantly less than in 1992 and 1994. The length of male and female pups was significantly less on St. Paul Island in 1995 than on St, George Island in 1992, 1994, and 1995. The mass of male pups on St. George Island in 1995 was significantly greater than males on St. Paul Island in 1995. The mass of female pups on St. Paul Island in 1995 was significantly less than female pups on St. Paul and St. George Islands in 1994. Male and female pups on St. George Island in 1995 were significantly longer than male and female pups on St. Paul Island in 1995. There were no significant differences in the sex ratio of live pups between years or islands. However, the sex ratio of females was significantly less than 50% : 46% on St. Paul Island and 45 % on St. George Island, for both islands in 1995. These differences in mass, length, and sex ratio may reflect variability in the environmental influences on the condition of pups and their mothers. Undetected biases in sampling techniques may also be responsible of the differences detected in this study. Future studies will be designed to minimize possible sources of biases due to methodology and explore the combined use of length and mass to create indices of pup condition.

SOURCES OF VARIABILITY IN THE RESAMPLING PROCESS FOR THE POPULATION ESTIMATE OF NORTHERN FUR SEALS, SOUTH ROOKERY, 1995

by

Anne E. York and Rodney G. Towell

The "shearing-sampling" method is a mark-recapture procedure designed to estimate the number of northern fur seal pups born on a rookery during a particular breeding season. It has been used on the Pribilof Islands since 1961. The development of the shearing-sampling method is described in Chapman and Johnson 1968, the method applied to sub-samples of rookeries is discussed by York and Kozloff (1987). Protocols for marking and guidelines for resampling to determine the ratio of marked to unmarked animals are discussed in Antonelis (1992).

The purpose of our study was to determine the variability of sighting patterns among individual observers, to see if the observed numbers of marked animals changed over time, and to determine if certain groups of animals (e.g., males vs. females and heavy vs. average vs. light weight) were resighted more often. Resampling on most rookeries is done while walking through the rookeries. Our study was done on South Rookery on St. George Island because all pups can be seen from the cliff top and observations could be made frequently without disturbing the rookery.

METHODS

Two-hundred eighty-six pups were marked by shearing on South Rookery, St. George Island, on 14 August 1995 between l0:25 and 18: 15 hours. All pups were weighed using a hanging dial scale accurate to the nearest 0.2 kg. Thirty pups were "marked" individual marks--

15 males and 15 females and within each sex, 5 heavy, 5 average, and 5 light pups were marked, based on the distribution of mass during the previous year.

Pups were resighted by 2-6 observers using binoculars during 15 August - 3 1 August. Observations were usually made in the morning between 10:00 and 12:00 and in the afternoon between 18:00 and 21:00. As discussed in York and Kozloff (1987) and Antonelis (1992), observers counted groups of 25 pups and recorded the number of sheared animals on a tally counter; after they completed each count, they wrote that number in a waterproof notebook. If any of the 30 individually marked animals were seen in the group of 25 animals, they were counted as non-sheared and their identification mark was written in parentheses next to the count for the group in which they appeared. On the day of weighing operations on South Rookery (28 August 1995), we obtained resamples of marked animals from two observers who traveled through the rookery on foot (i.e., “normal” on the ground resampling as opposed to from the cliff) before pups were rounded up for weighing; during the weighing operations, we attempted to recapture and reweigh as many of the 30 marked animals as possible.

At the beginning of the resampling effort, observers were given basic instruction on the principles of resampling. They were told that the main purpose of the effort is to obtain unbiased estimates of the fraction of marked animals on the rookery and that it is important that all pups, regardless of whether it had a mark or not, appear in the sample with the same probability. Several techniques for sampling were explained to them: 1) sampling in the vicinity of a stationary object; 2) sampling across an imaginary transect defined by two objects; or 3), if pups were active, sampling pups moving past a fixed object. On the mornings of 22 and 23 of August, observers were instructed to sample only those pups whose rumps were the first feature that appeared in the field of their binoculars; they were instructed to then check the head and see if the pup was marked or unmarked. After 23 August, observers used whatever techniques they thought reasonable.

In order to assess the importance of possible explanatory variables on the number of sheared animals in the samples, we modeled the mean per group of 25 animals as a linear model on date, observer, section of the rookery, and time of day. Similarly, to assess the effects of size and sex of the animals and time of day (a.m. or p.m.) and seasonality on sighting probability, we modeled the total number of individually marked animals seen as a general linear model with Poisson errors, adjusted for amount of effort. We modeled these observations as functions of time of day, sex and size of individuals, and 3 time periods; Period 1, 15 - 19 Aug.; Period 2,20 - 25 Aug.; and Period 3,26 - 3 1 Aug.

We calculated the autocorrelation among successive observations for each observer because autocorrelated observations could cause an underestimation of the variance of the population estimate.

RESULTS

The mean length and mass of sheared animals was similar to that of the individually marked animals (Tables 22 and 23). Nineteen (10 F and 9 M) of the specially marked animals were remeasured at the time of weighing operations on 28 August; they had gained an average of 1.43 kg (SE = 0.32 kg) and 4.31 cm (SE = 0.51 cm). There was no significant difference ($P = 0.98$ mass, $P = 0.37$ length) between males and females. Among sheared animals, males outnumbered females 54% to 46%. This ratio was not significantly different from 1: 1 ($P = 0.17$).

The mean number of marked animals per sample of 25 pups varied by observer, rookery section, and by day (Table 24). There was no significant time of day effect ($P = 0.13$). One observer (Fig. 15, Observer 2) consistently had a lower mean count than the other observers

Table 22.-- Sample sizes (n), mean mass (kg), mean length (cm), and standard deviations (SD) of male and female northern fur seal pups sheared on South rookery on St. George Island, Alaska, 14 August 1995.

Section		Females	Males	Combined
1	n	32	48	80
	kg.	7.36	8.52	8.06
	SD	1.22	1.22	1.34
	cm.	73.56	76.48	75.31
	SD	4.56	3.55	4.21
2	n	62	52	114
	kg.	7.64	9.38	8.43
	SD	1.06	1.61	1.59
	cm.	75.27	79.13	77.03
	SD	3.97	3.79	4.33
3	n	37	55	92
	kg.	7.88	8.87	8.47
	SD	1.08	1.45	1.39
	cm.	75.35	77.88	76.86
Combined	n	131	155	286
	kg.	7.64	8.93	8.34
	SD	1.11	1.48	1.47
	cm.	74.87	77.87	76.50
	SD	4.03	4.13	4.34

Table 23. -- Sample sizes (n), mean mass (kg), mean length (cm), and standard deviations (SD) of male and female northern fur seal pups specially marked on South rookery on St. George Island, Alaska, 14 August 1995.

Size		Females	Males	Combined
Small	n	5	5	10
	kg.	6.44	6.68	6.56
	SD	0.33	0.46	0.40
	cm.	70.90	70.80	70.85
	SD	3.66	2.63	3.98
Medium	n	5	5	10
	kg.	7.24	8.02	7.63
	SD	0.55	0.65	0.70
	cm.	73.20	76.50	74.85
	SD	1.96	3.28	3.08
Large	n	5	5	10
	kg.	9.46	11.12	10.29
	SD	0.71	1.17	1.27
	cm.	81.00	80.60	80.80
	SD	4.84	3.49	3.01
Combined	n	15	15	30
	kg.	7.71	8.61	8.16
	SD	1.42	2.07	1.80
	cm.	75.03	75.97	75.50
	SD	5.62	5.08	5.29

Table 24.--Single factor analyses of variance assessing the effects of time of day, section, observers, and day on the mean number of sheared pups seen in samples of 25 pups on South rookery, St. George Island, Alaska during 15-3 1 August 1996.

Factor	df	Deviance	Residual df	Residual Deviance	F	Pr(F)
AM-PM	1	0.2005	325	29.0898	2.2403	0.1354
Section	2	0.5316	324	28.7587	2.9948	0.0514
Section=1	1	0.4550	325	28.8354	5.1279	0.0242
Observer	5	1.7847	321	27.5056	4.1656	0.0011
Day	16	3.7298	310	25.5606	2.8272	0.0003

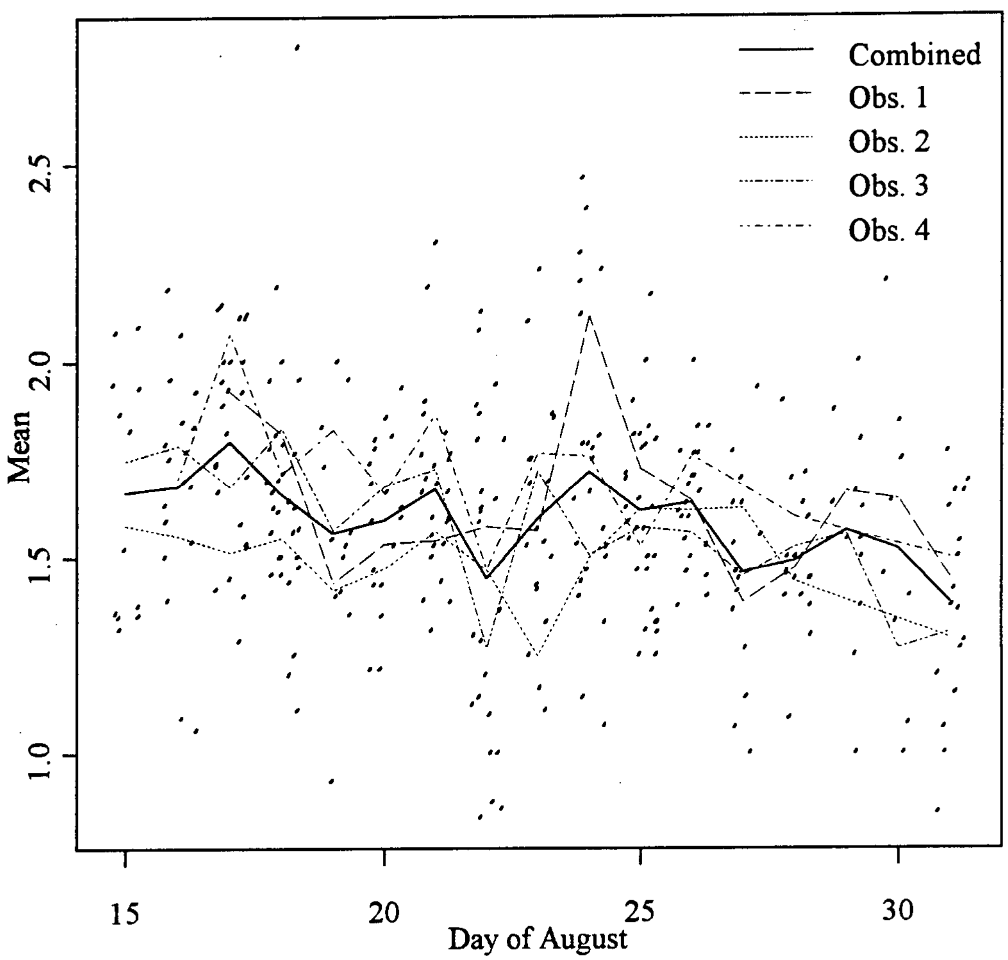


Figure 15.--Mean number of marked animals for each observer. Dots are mean number of marked animals observed on each section at each sampling day and time (morning and evening). The lines are the mean number for each observer on each day for the entire rookery.

(P < .OOO5). The average level of difference between Observer 2 and the other observers translated into a difference in the estimate of total number of pups of about 375 animals (approximately 8.8%). The mean count varied by section of the rookery: Section 1 had a larger number of marked animals than Section 2 or 3. There was a statistically significant decrease in the mean count over time (P <0.0003) for all observers except Observer 2, who showed a significant increase in the mean number of marked animals over time. Overall, there was a decrease in the mean numbers of marked animals which translated into an increase in total pup estimate of about 5.2% (Standard Error (SE) = 1.9%, 95% CI = 1.4% - 9.0%) per week.

One observer (Observer 3) showed significant (P < 0.05) autocorrelation between successive observations; none of the other observers showed this pattern. Observer 3's observations after a lag of 2 were not significantly correlated.

The total number of individually marked animals that were observed during the course of the sighting observations (Fig. 16) varied significantly by sex and size of the pups and time period (Table 25a, 25b, and 25c). Females were more likely than males to be observed (P = 0.02) and small pups more likely than large pups (P = 0.02). The number of pups seen decreased significantly between time Periods 1 and 2 but not between Periods 2 and 3. There was no significant effect of time of day (P = 0.42), nor were there statistically significant two-, three-, or four-way interactions among the factors (P > 0.15 in all cases).

DISCUSSION

Variability among observers determining the marked-unmarked ratio of northern fur seal pups can be quite high and is taken into account in calculating the variance of the total pup estimate under the design proposed in York and Towel1 (1996). However, their design does not account for autocorrelation of observations. We recommend that this be determined for each

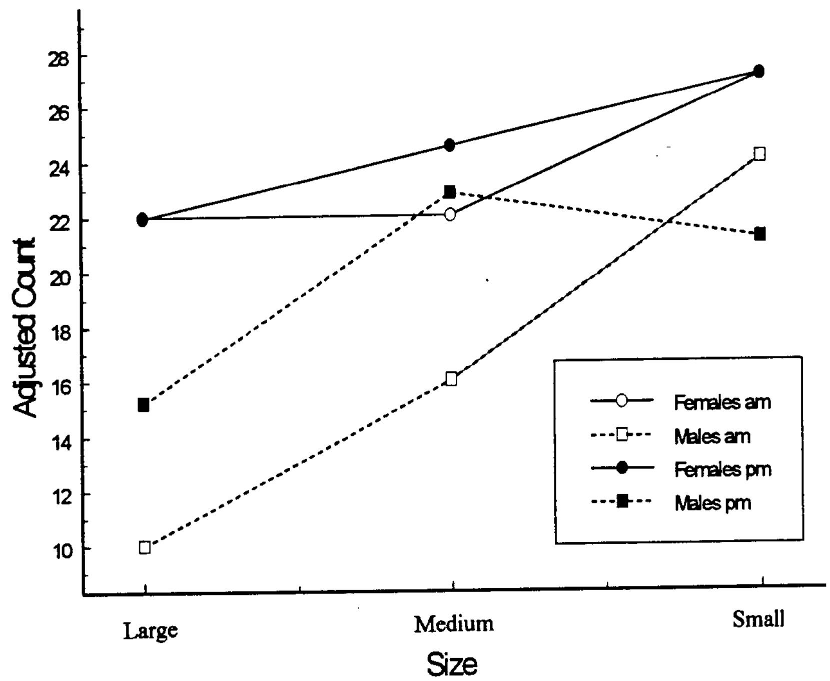


Figure 16--Numbers of specially marked animals observed during resighting experiments. Numbers were adjusted for an 18% higher level of effort during the afternoon.

Table 25a.--Numbers of individually marked pups on South rookery, St. George Island, observed in samples of sheared pups 15-3 1 August 1995. Numbers are categorized by sex and size of the pups and time of day and period in which the observations were made. Period 1 corresponds to 15-19 August, Period 2 to 20-25 August, and Period 3 to 26-3 1 August. Effort is the total number of observer sessions for the given period- time of day combination.

	AM							PM						
		Large		Medium		Small			Large		Medium		Small	
Period	Effort	F	M	F	M	F	M	Effort	F	M	F	M	F	M
1	13	9	2	6	7	4	4	17	13	12	11	10	13	9
2	22	9	6	12	6	12	10	25	8	4	9	9	16	10
3	14	4	2	4	3	8	10	14	5	2	9	8	3	6

Table 25b. Analyis of variance of most parsimonius model fit to the data in Table 25a.

Component	df Deviance	Resid. df	Residual Deviance	Pr(Chi)
Null		35	61.0130	
Sex	1 17.018	34	43.9950	0.0000
Size	2 5.622	32	38.3730	0.0600
Time period	2 9.35	30	29.0230	0.0090

Table 25c Parameter estimates of model described in Table 25b

Component	Value	SE	t
Intercept	-0.6284	0.1483	-4.2364
Sex	-0.2751	0.1211	-2.2719
Size=Medium	0.2126	0.1543	1.3779
Size=Small	0.3514	0.1497	2.3470
Period 2	-0.3741	0.1368	-2.7348
Period 3	-0.4069	0.1592	-2.5562

observer and be taken into account when calculating the variance of the total pup estimate. Observer variability was not the only important factor that we found. The results from studying the individually marked animals indicated a lower resighting probability between Periods 1 and 2, but not between Periods 2 and 3, and are similar to the results obtained for the sheared animals. Besides detecting the differences over time, the study on individually marked animals confirms that there are effects of sex and size on the frequency at which individuals were resighted.

A decline in the mean number of marked animals detected in the sample over time was found and that decline could have a substantial effect on the estimate of pup abundance. The decline could be caused by increased movement among pups who spend more time in the water as they grow or by an immigration of unmarked pups, even only temporarily onto the study site. Another possible reason for the decline is that pups with their mothers have a higher probability of being marked. Once the mothers of the marked pups went on a feeding trip, (within 4 days after marking the pup), the pup had a higher probability of being in the water and not observed. These results on declining mean number of sheared animals will be used to improve the methodologies employed in estimating pup abundance.

CAN WE RETURN TO ESTIMATING NUMBERS OF NORTHERN FUR SEALS FROM SUBSAMPLES OF ROOKERIES?

by

Anne E. York and Rodney G. Towel1

The "shearing-sampling" method is a mark-recapture procedure designed to estimate the number of northern fur seal pups present on a rookery during a particular breeding season. It has been used on the Pribilof Islands since 1961. The development of the shearing-sampling method is described in Chapman and Johnson (1968); subsequent development of the method was applied to sub-samples of rookeries by York and Kozloff 1987, and development of a new experimental design wherein observers work in pairs was used by York and Towel1 (1996).

When rookeries are subsampled, the estimate and standard error of the total number of pups present at the time of marking on St Paul Island is obtained by multiplying the count of breeding males on all rookeries by an estimated ratio of pups to bulls on the sample rookeries (York and Kozloff 1987). York and Kozloff (1987) investigated three types of ratio estimates (raw ratio, regression estimates, and jackknife ratios) over two sampling plans (simple random and stratified random based on the rookery size) over a range of sample sizes (2 rookeries - 14 = all rookeries). Based on the accuracy, variability, and the coverage properties of confidence intervals of estimates for the given sampling plans and estimation methods from data collected on all rookeries during the 1965, 1970, and 1975 field seasons, they found that the jackknife ratio estimate from 4 rookeries (1 large, 1 medium size, and 2 small) produced essentially unbiased estimates, tolerable variance on the estimate, and confidence intervals with nominal coverage properties. The high quality of the ratio estimates was due to the very high correlation between numbers of breeding males and numbers of pups within a given year (r^2 ranged from 0.96 to 0.99 over 13 different years). The subsampling procedure was used for 1980-89, except in 1987 when all rookeries were censused. A critical assumption for obtaining valid estimates of numbers of pups using this method is that the ratio of pups to breeding males be approximately the same on all rookeries. Thus, an important component of the sampling design was that this assumption be verified by conducting a census on all rookeries approximately every 6 years. A complete census was scheduled in 1986, but was not done due to logistic difficulties. The complete census in 1987 validated the constant ratio assumption. The confidence interval for total number of pups born in 1989 was very large, and it was decided to census all rookeries in 1990 to verify that the ratio of pups to numbers of breeding bulls was approximately constant across the rookeries. Fur seal researchers suspected that the constant ratio assumption might not be valid since an inspection of the ratios on the individual rookeries in 1989 indicated a much lower ratio on Vostochni Rookery--perhaps due to a differential success in establishing territories by younger breeding males following the cessation of the commercial harvest after 1984. A full census in 1990 confirmed a smaller ratio of pups to bulls on Vostochni rookery. Censuses were conducted on all rookeries in 1992 and 1994. The purpose of this report is to determine if we can again return to subsampling. York and Towel1 (1996) showed that if all rookeries were censused, it was possible to estimate the population size and its variance from only one visit to each rookery with the sampling team. Here, we investigate the quality of pup estimates based on one resampling visit to each rookery instead of the usual two visits under a sub-sampling procedure. In addition, we also investigate how well we can estimate total pup abundance (versus pups alive at the time of resampling) if we estimate the number of dead pups from counts on the sample rookeries.

METHODS

We conducted several bootstrap simulations based on the 1994 pup data to determine the quality of an estimate of number of pups under a subsampling procedure. We attempted to determine what would happen if we estimated the number of live pups from subsampling, if we estimated the number of live pups from only one resampling visit to the rookeries instead of the usual two visits, and if we estimated the total number of pups born from one or two visits to each sampled rookeries.

In two simulation experiments, we estimated the distribution of the total number of pups alive at the time of sampling using stratified random samples which had one or two small, medium, and large rookeries, respectively. As in York and Kozloff (1987), we calculated the ratio of pups to breeding males for each sampling scheme in three ways: a regression passing through the origin, a ratio, and a jackknife ratio estimate. In Simulation 1, we assumed that each sampled rookery would be visited twice and that the estimated number of live pups on each sampled rookery was normally distributed with mean equal to the observed estimate in 1994 and standard error equal to the empirical standard error calculated from the two censuses (York and Towel1 1996). In Simulation 2, we assumed that samplers would visit each sampled rookery once and that the estimated number of live pups on each sampled rookery was normally distributed with mean equal to the observed estimate of the first census in 1994 and standard error equal to the theoretical hypergeometric-based standard error for that census (York and Towel1 1996). In Simulations 3 and 4, we estimated the number of live pups as in Simulations 1 and 2, respectively, and estimated the number of dead pups on all rookeries by applying the mortality rate (m) on the sampled rookeries to the entire island. Thus, if D_s, A_s, and T_s are the total number of dead, live, and total pups on the sampled rookeries, and B_s is the total number of bulls on the sampled rookeries, then the estimate of total number of live pups is r B, where r is either a simple or jackknife ratio, or a regression estimate based on the ratio of pups to breeding males on the sample rookeries and B is the total number of bulls on all rookeries. Since $A_s + D_s = T_s$ and $m = D_s/T_s$ then T, total pups on all rookeries can be estimated from the following:

$$T = A + D = A + m\,T, \text{ and therefore, } T = A/(1-m) = r\,B\,/\,(1-m). \quad (1)$$

The uncorrected estimate of T is in Equation 1. Since A and m are random variables, we computed a corrected estimate of T and standard error of T using the delta-method:

$$\hat{T} = \frac{A}{1-m} + \frac{A}{(1-m)^3}\,Var[1-m]$$

$$Var[\hat{T}] = \left(\frac{A}{1-m}\right)^2 \left(\frac{Var[A]}{A^2} + \frac{Var[1-m]}{(1-m)^2}\right)$$

We ran 2,000 bootstrap samples for each simulation. For each bootstrapped sample, we calculated the estimates of live pups and total pups, their standard error, and an estimated 95% confidence intervals about each estimate. Boxplots are a graphical device that can be used to easily compare a number of distributions. For each simulation experiment, we compared the sampling plans and estimation methods by examining the boxplots which displayed the range, median, and interquartile range (the interquartile range excludes the lower 25% and upper 25% of observations) of the estimates, standard errors, and coefficients of variation (CVs). We calculated the fraction of nominal 95% confidence intervals which contained the “true” estimate based on the census of all rookeries (Table 26).

Table 26.-- Number of live northern fur seal pups estimated during first resample, standard error, mean of live pups estimated from two resamples, standard error, pups counted, total pups born and harem bulls counted on St. Paul Island, Alaska, 1994.

Rookery	Pups Alive 1 Resample	SE	Mean Alive 2 Resamples	SE (Mean)	Dead	Total Pups Born	Harem Bulls
Lukanin	3,544	294.8	3,635	90.8	245	3,880	158
Kitovi	6,347	380.0	6,337	10.4	174	6,511	244
Reef	21,063	913.4	21,441	377.9	1,088	22,529	811
Gorbatch	14,543	749.2	14,702	159.1	779	15,481	477
Ardiguen	2,260	283.2	2,418	157.6	85	2,503	109
Morjovi	13,460	776.8	13,156	304.3	362	13,518	297
Vostochni	25,221	903.1	27,020	1,799.8	1,026	28,046	861
Polovina	2,221	229.5	2,304	82.8	54	2,358	85
Polovina Cliffs	15,891	592.9	16,225	334.4	380	16,605	589
Tolstoi	24,472	1,135.3	24,595	122.5	1,152	25,747	633
Zapadni Reef	7,063	405.0	7,273	210.1	386	7,659	232
Little Zapadni	15,863	773.2	16,267	404.2	996	17,263	530
Zapadni	28,559	1,384.2	28,068	491.0	1,431	29,499	674
Total	180,507	2,738.0	18,344	2,028.7	8,158	191,599	5,700

RESULTS

We estimated the distribution of the total number of pups alive at the time of sampling for 13 rookeries of St. Paul Island using stratified bootstrapped random samples which had one or two small, medium, and large rookeries (raw data in Table 26). We excluded Little Polovina and Sea Lion Rock rookeries from the simulations since we have not done shearing-sampling estimates on Little Polovina since 1984 and logistical difficulties make two visits to Sea Lion Rock very unlikely. To report these results in a concise manner, we will refer to a sampling plan with three numbers, ijk, where I denotes the number of large rookeries, j the number of medium size rookeries, and k the number of small rookeries. Thus, in plan 211, two large, one medium, and one small rookery were sampled.

Numbers of live pups are significantly correlated with numbers of breeding males (Fig. 17), but $r^2 = 0.89$ is smaller than in previous years when r^2 ranged from 0.96 to 0.99 (York and Kozloff 1987). The boxplot of estimates of live pups (Fig. 18) shows a large range of possible estimates for each sampling plan, the boxes indicate the interquartile ranges, and the lines within the boxes; the interquartile ranges, medians, and estimated 95% confidence intervals are also given in Tables 27 and 28. The vertical lines spanning the boxes in Figure 19 pass through the “true” values, the estimated number of live pups on all rookeries given two resamples (183,44 1, Fig. 18) and the first resample (180,507, Fig. 18). The nearer the vertical line is to the median, the less biased the estimate. Sampling plan 211 exhibits positive bias and plan 122 negative bias with less bias for two resamples. The distribution of standard errors (Fig. 19) tends to range from very low (1,673) to 30,000 - 35,000 for plan 222 to 50,000 - 60,000 for plan 112. The sampling plan used during the 1980s (112) produced the largest range in the estimate and standard error among those examined. Although the interquartile ranges for CVs (Fig. 20) seem

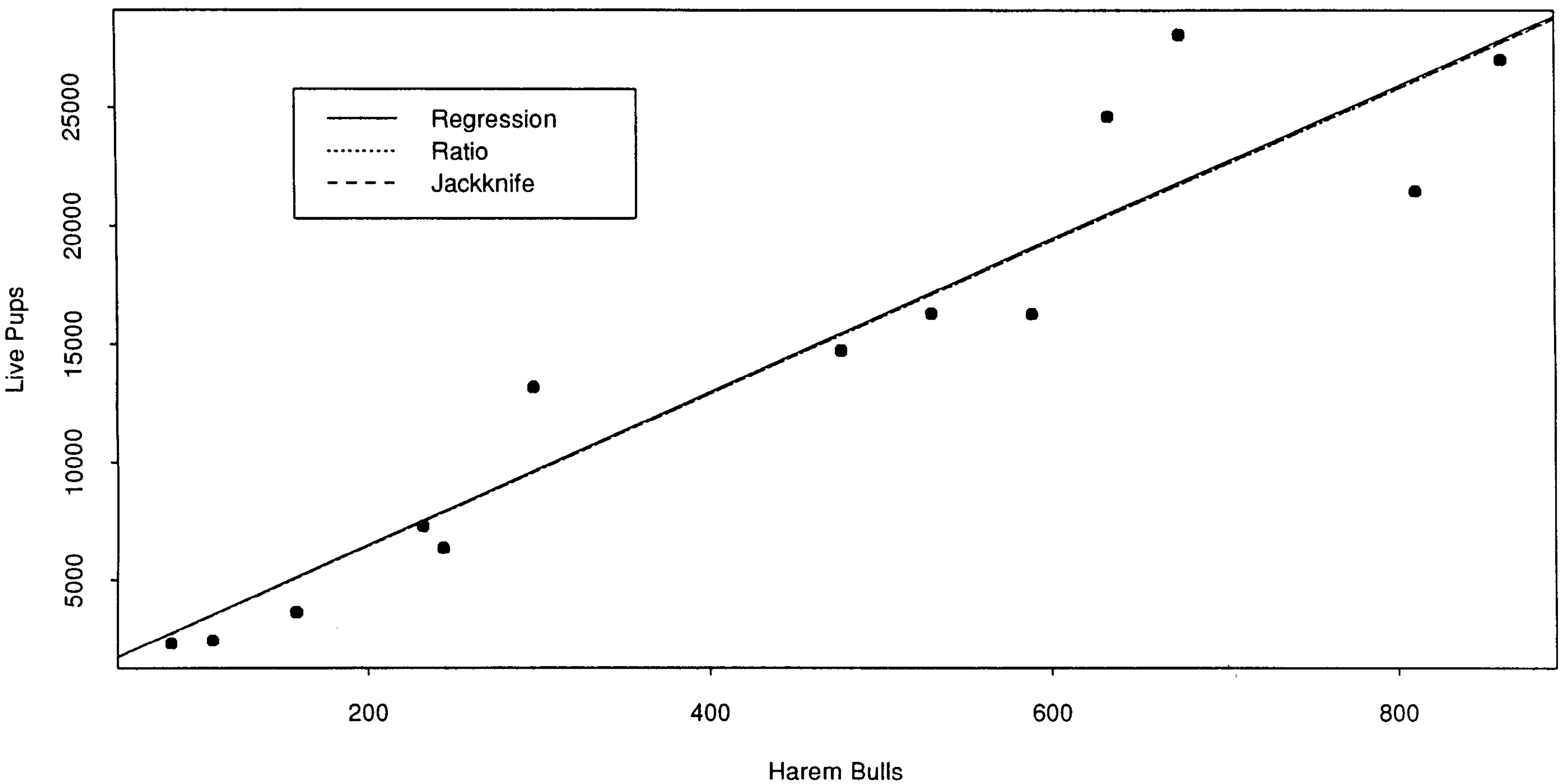


Figure 17.--Number of northern fur seal pups alive at the time of sampling versus the number of harem bull fur seals for the rookeries of St. Paul Island, Alaska, 1994. The slope of the lines are the regression (32.34, SE= 1.64) ratio (32.18, SE= 1.91) and jackknife (32.19, SE= 1.97) estimates based on the census of all rookeries.

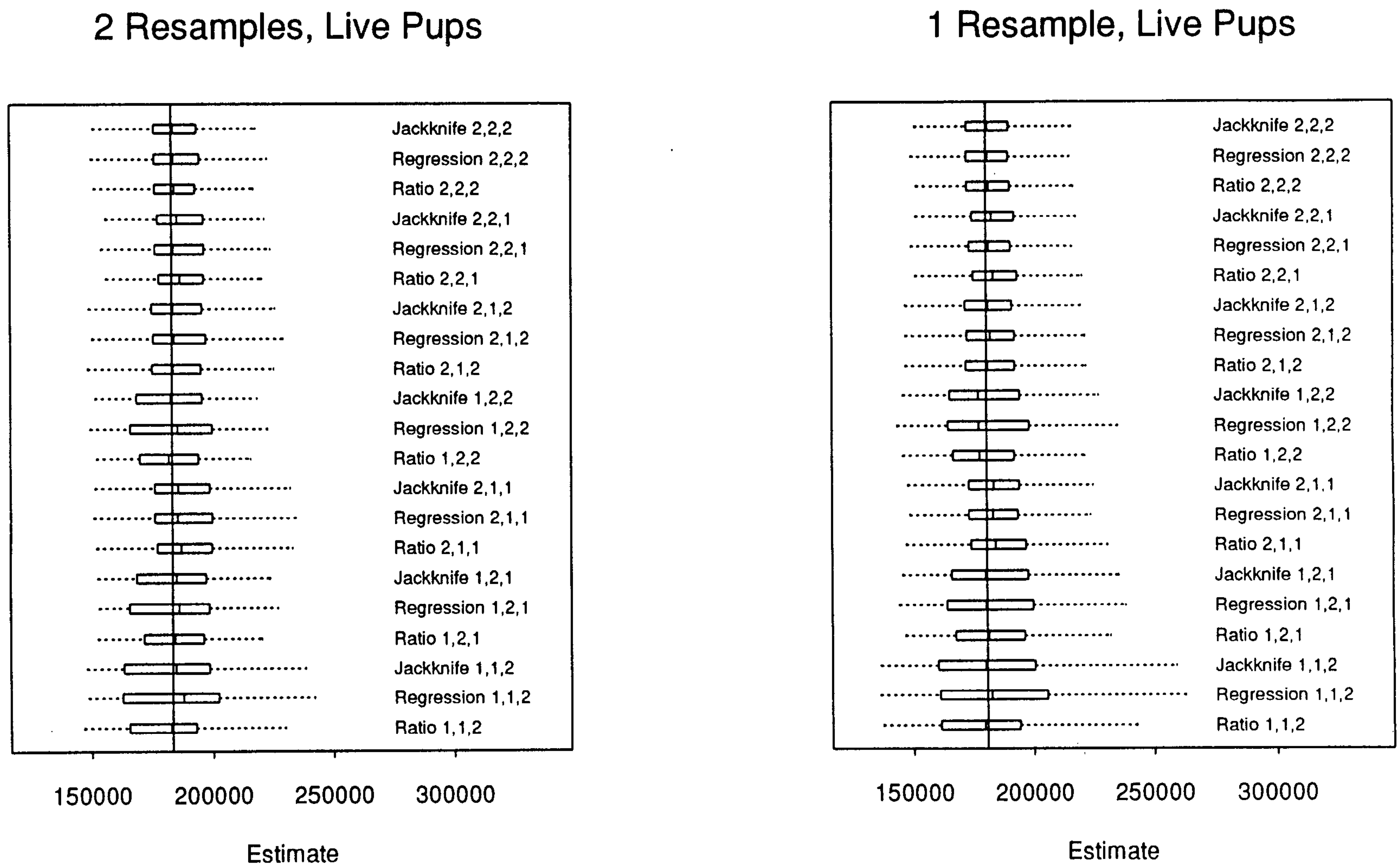


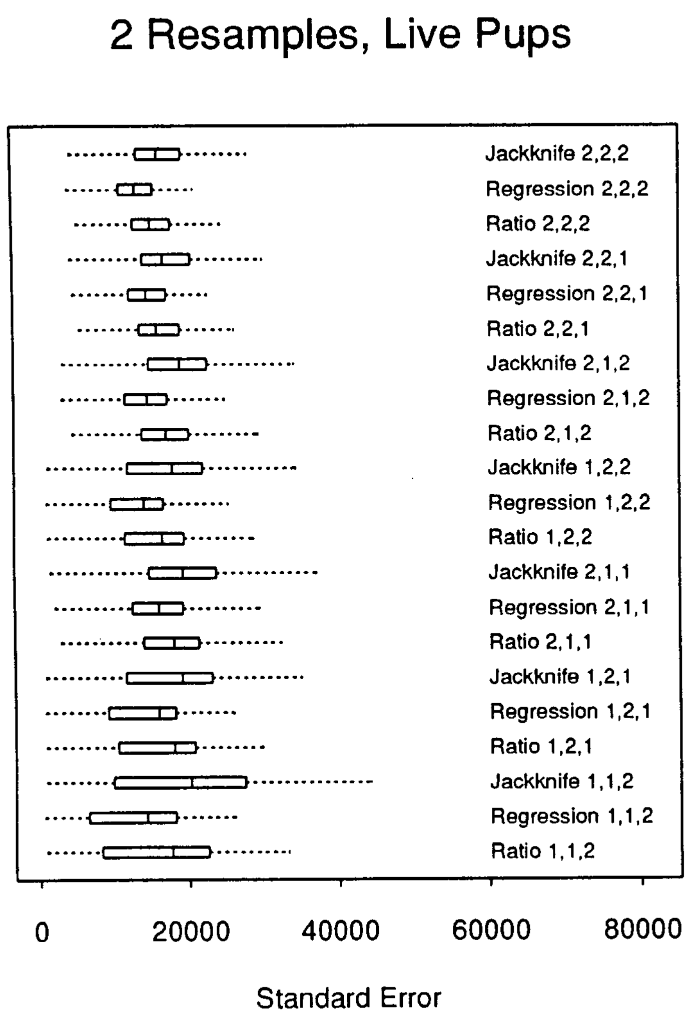
Figure 18.--Boxplots of 2,000 bootstrapped estimates of live northern fur seal pups based on data collected in 1994. For each sampling plan and estimation method, plots display the range, median and interquartile range (excludes the lower 25% and upper 25% of observations) of the estimate of live pups. The vertical line is the “true” estimate based on all rookeries in Table 26.

Table 27.-- Simulation 1. Estimation of number of live pups with two subsampling visits. Summary statistics of the distribution 2,000 bootstrap estimates of the total number of northern fur seal pups alive at the time of sampling on the rookeries of St. Paul Island, Alaska, for several sampling plans based on data collected on all rookeries in 1994. Qu 2.5, Qu 25, Qu 75, and Qu 97.5 are the 2.5%, 25%, 75%, and 97.5% quantiles of the estimated number of pups; Qu 2.5 can be considered as a lower confidence bound of a 95% confidence interval, etc. Mean is the mean, SD the standard deviation, and CV, the coefficient of variation = l00*SD/Mean of the 2,000 bootstrap estimates. "True number of live pups" = 183,44 1.

	Qu 2.5	Qu 25.0	Qu 75.0	Qu 97.5	Mean	SD	CV
2 Large, 1 Medium , 1 Small Rky.							
Ratio	160,471	177,064	199,614	226,486	188,553	16,266	8.63
Regression	160,950	176,037	199,766	229,670	188,772	17,729	9.39
Jackknife	160,601	176,231	198,782	227,954	188,290	16,758	8.90
1 Large, 2 Medium , 1 Small Rky.							
Ratio	157,118	171,549	196,222	214,499	184,254	16,260	8.82
Regression	156,233	165,585	198,534	218,644	184,453	18,932	10.26
Jackknife	156,551	168,532	197,085	216,435	184,145	17,508	9.51
1 Large, 1 Medium , 2 Small Rky.							
Ratio	151,746	165,392	193,170	219,458	181,417	18,635	10.27
Regression	152,315	162,804	202,322	231,189	186,167	23,256	12.49
Jackknife	151,934	163,252	198,488	226,620	183,691	21,443	11.67
1 Large, 2 Medium , 2 Small Rky.							
Ratio	156,444	170,134	194,212	208,518	182,205	15,085	8.28
Regression	156,364	166,072	199,822	216,279	184,409	18,497	10.03
Jackknife	156,381	168,591	195,826	211,286	182,846	16,366	8.95
2 Large, 1 Medium , 2 Small Rky.							
Ratio	159,573	175,289	195,436	219,003	185,466	14,654	7.90
Regression	160,795	175,689	197,265	226,499	187,484	16,731	8.92
Jackknife	160,012	175,094	195,655	221,533	185,879	15,282	8.22
2 Large, 2 Medium , 1 Small Rky.							
Ratio	163,180	177,954	196,479	215,181	187,437	13,124	7.00
Regression	162,440	176,382	196,658	219,107	186,702	14,640	7.84
Jackknife	163,159	177,483	196,495	216,474	187,065	13,515	7.22
2 Large, 2 Medium , 2 Small Rky.							
Ratio	162,641	176,390	193,167	210,820	184,963	12,094	6.54
Regression	162,205	176,182	194,963	216,824	185,894	13,883	7.47
Jackknife	162,571	176,147	193,772	212,379	185,073	12,510	6.76

Table 28.-- Simulation 2. Estimation of number of live pups with one subsampling visit. Summary statistics of the distribution 2,000 bootstrap estimates of the total number of northern fur seal pups alive at the time of sampling on the rookeries of St. Paul Island, Alaska, for several sampling plans based on data collected on all rookeries in 1994. Qu 2.5, Qu 25, Qu 75, and Q 97.5 are the 2.5%, 25%, 75%, and 97.5% quantiles of the estimated number of pups; Qu 2.5 can be considered as a lower confidence bound of a 95% confidence interval, etc. Mean is the mean, SD the standard deviation, and CV, the coefficient of variation = l00*SD/Mean of the 2,000 bootstrap estimates. "True" number of live pups" = 180,507.

	Qu 2.5	Qu 25.0	Qu 75.0	Qu 97.5	Mean	SD	CV
2 Large, 1 Medium , 1 Small Rky.							
Ratio	154,970	173,886	196,655	227,549	185,593	17,894	9.64
Regression	155,161	172,972	193,371	231,553	185,066	19,137	10.34
Jackknife	155,061	172,923	194,082	229,045	184,921	18,230	9.86
1 Large, 2 Medium , 1 Small Rky.							
Ratio	153,408	167,377	196,018	217,724	182,589	18,262	10.00
Regression	151,832	163,728	199,728	222,885	182,475	21,221	11.63
Jackknife	152,592	165,678	197,726	220,610	182,293	19,623	10.76
1 Large, 1 Medium , 2 Small Rky.							
Ratio	146,803	161,019	193,989	225,616	179,670	21,518	11.98
Regression	147,377	160,888	205,466	239,518	184,669	26,743	14.48
Jackknife	147,061	160,221	200,273	234,257	181,994	24,673	13.56
1 Large, 2 Medium , 2 Small Rky.							
Ratio	152,883	166,484	191,898	211,576	179,539	16,457	9.17
Regression	152,351	164,328	198,005	220,382	181,351	20,258	11.17
Jackknife	152,780	165,185	194,158	214,921	179,984	17,870	9.93
2 Large, 1 Medium , 2 Small Rky.							
Ratio	155,096	171,905	192,142	220,357	182,426	15,988	8.76
Regression	155,876	172,274	192,106	228,456	183,987	18,267	9.93
Jackknife	155,385	171,744	191,183	223,119	182,608	16,643	9.11
2 Large, 2 Medium , 1 Small Rky.							
Ratio	158,417	175,120	193,381	216,247	184,487	14,103	7.64
Regression	158,046	173,421	190,619	218,808	183,256	15,372	8.39
Jackknife	158,335	174,608	192,207	216,837	183,926	14,388	7.82
2 Large, 2 Medium , 2 Small Rky.							
Ratio	157,825	172,592	190,479	211,340	182,143	13,476	7.40
Regression	157,691	172,360	189,670	217,883	182,429	15,443	8.47
Jackknife	157,992	172,366	189,917	212,930	182,050	13,907	7.64



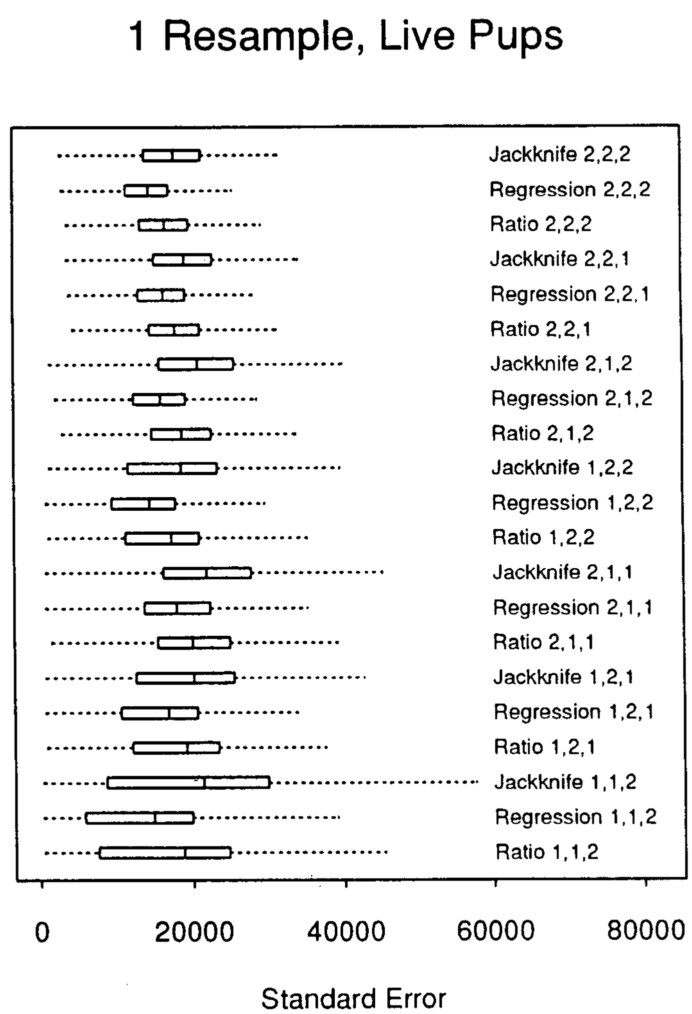


Figure 19.--Boxplots of 2,000 bootstrapped standard error estimates of live northern fur seal pups based on data collected in 1994. For each sampling plan and estimation methods plots display the range, median and interquartile range (excludes the lower 25% and upper 25% of observations) of the standard errors of the live pup estimates.

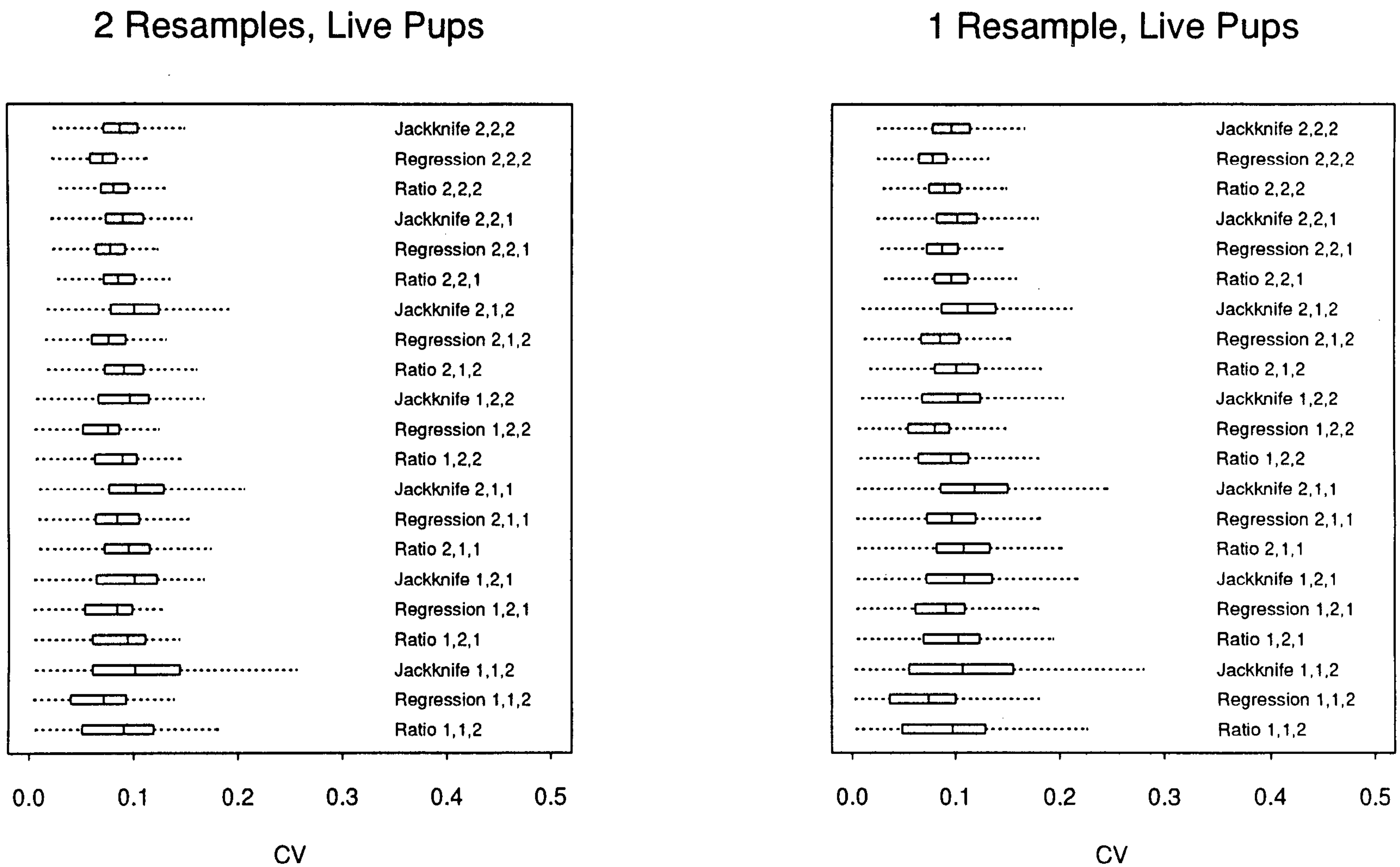


Figure 20.--Boxplots of 2,000 bootstrapped CVs of estimates of live northern fur seal pups based on data collected in 1994. For each sampling plan and estimation method, plots display the range, median and interquartile range (excludes the lower 25% and upper 25% of observations) of the CVs of the live pup estimate.

to lie within a tolerable range (5 - 15%) they are about twice the size as when all rookeries are censused. The range of the CVs is quite large for the jackknife estimate under sampling plans 112, 211, and 212, and even larger if there is only one resample. The actual coverage rate of the nominal 95% confidence interval (Fig. 21) is less than 95% for two resamples except for plans 221 and 222. Using only one resample, the coverage is less than 95% for all sampling plans, but plans 221 and 222 are near 95% for the jackknife and raw ratio estimates. The regression estimate has worse coverage properties than the jackknife or the raw ratio estimates. In the case of one resample, the jackknife estimator performs slightly better than the raw ratio. Both are preferred to the regression estimate.

The medians, the interquartile ranges, and estimated 95% confidence intervals of mortality rate (Table 29) indicate low variability in the estimated mortality rate. The boxplot of estimates of total pups (Fig. 22) shows a large range of possible estimates for each sampling plan; the vertical lines spanning the boxes in Figure 22 pass through the “true” values, the estimated number of total pups on all rookeries given two resamples (191,599, Fig. 22) and the first resample (188,665, Fig. 22). Sampling plan 211 exhibits positive bias and plan 122 negative bias with less bias for two resamples. The interquartile ranges, medians, and estimated 95% confidence intervals also given in Tables 30 and 3 1. The distribution of standard errors (Fig. 23) tends to range from very low (near 2,000) to 35,600 for plan 222 and to 60,000 for plan 112.

Based on the above, we examined in greater detail the results from sampling plan 222 and 221 to estimate total pups assuming two resampling visits using the raw ratio and the jackknife ratio estimates. In all cases, the uncorrected estimate was less biased than the corrected estimate. For both estimators, the bias under plan 222 was less than under plan 22 1. Under 222, the 95% confidence interval for the bias for the uncorrected jackknife estimate was (-22065, 30871)

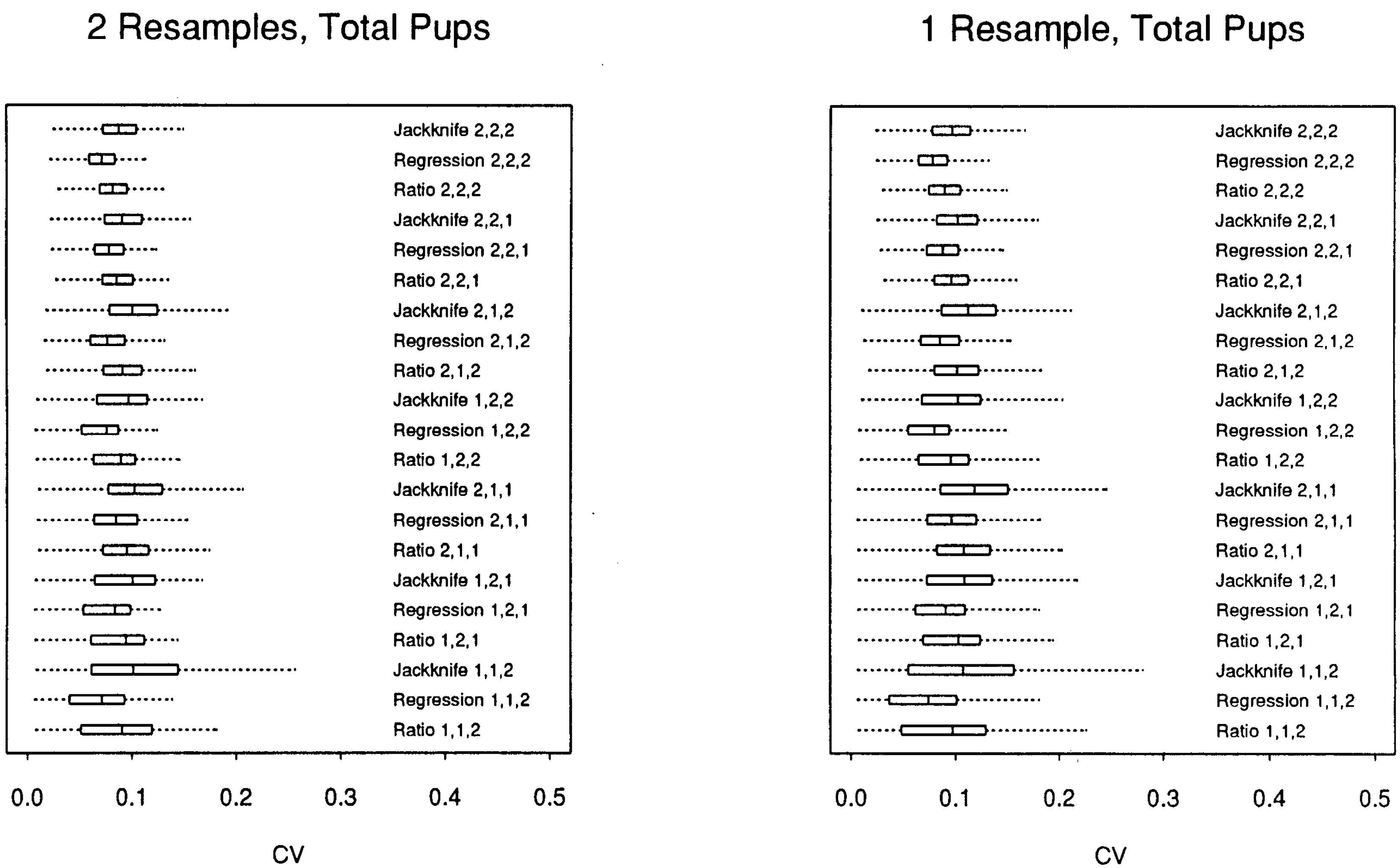
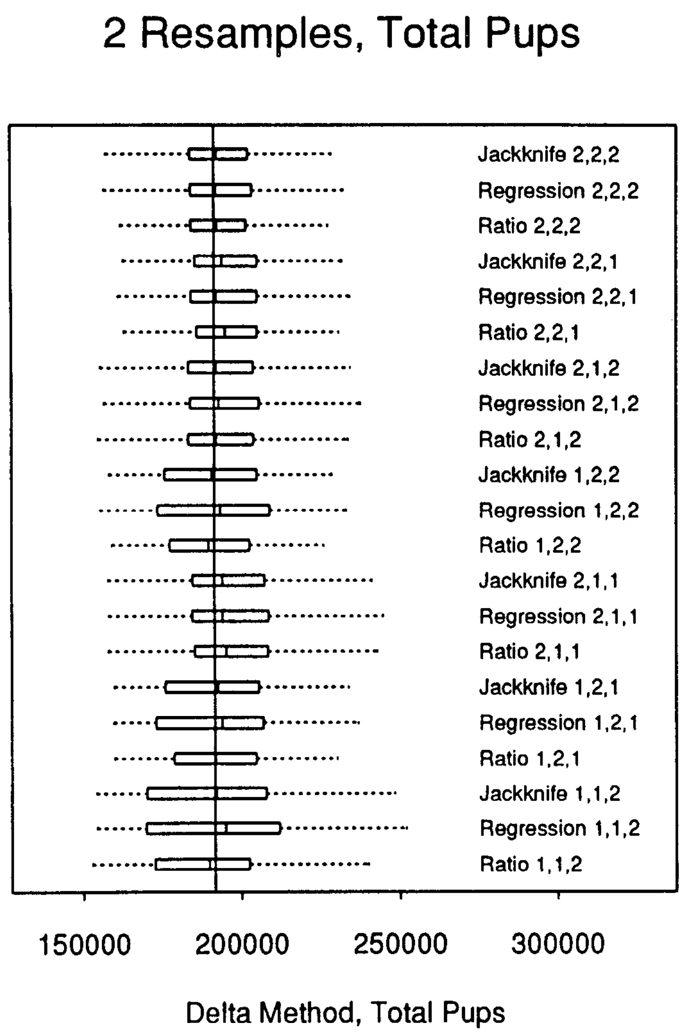


Figure 21 .--Fraction of nominal 95% confidence intervals which contain the “true” estimate of live northern fur seal pups based on the census of all rookeries. For each sampling plan and estimation method, 2,000 bootstrapped confidence intervals were calculated.

Table 29. Estimation of number of live pups with 2 subsampling vistits. Summary statistics for the distribution of 2,000 bootstrap estimates of the mortality rate of northern fur seal pups at the time of sampling on the rookeries of St. Paul Island, Alaska; several sampling plans based on data collected on all rookeries in 1994 were used. Qu 2.5, Qu 25, Qu 75, and Qu 97.5 are the 2.5%, 25%, 75%, and 97.5% quantiles of the estimated mortality rate of pups; Qu 2.5 can be considered as a lower confidence bound of a 95% confidence interval. Mean is the mean, SD the standard deviation, and CV, the coefficient of variation = l00*SD/Mean of the 2,000 bootstrap estimates.



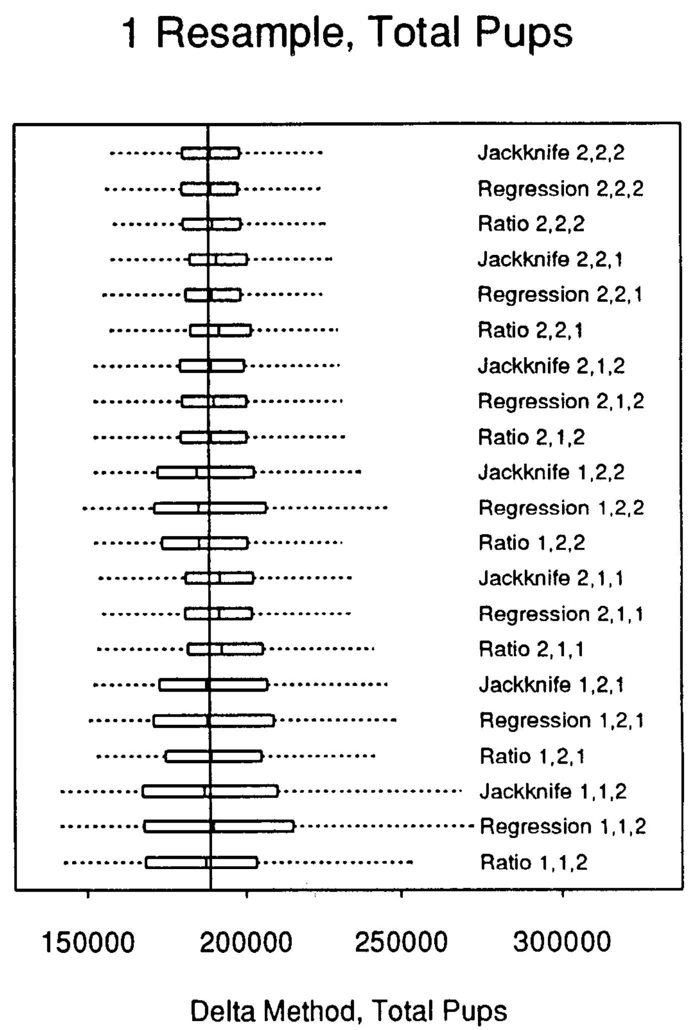


Figure 22.--Boxplots of 2,000 bootstrapped estimates of northern fur seal pups born based on data collected in 1994. For each sampling plan and estimation method, plots display the range, median and interquartile range (excludes the lower 25% and upper 25% of observations) of the estimate of pups born. The vertical line is the “true” estimate based on all rookeries in Table 26.

Table 30.-- Simulation 3. Estimation of number of pups born based on two subsampling visits. Summary statistics of the distribution of 2,000 bootstrap estimates of the total number of northern fur seal pups born on the rookeries of St. Paul Island, Alaska, for several sampling plans based on data collected on all rookeries in 1994. Qu 2.5, Qu 25, Qu 75, and Qu 97.5 are the 2.5%, 25%, 75%, and 97.5% quantiles of the estimated number of pups; Qu 2.5 can be considered as a lower confidence bound of a 95% confidence interval, etc. Mean is the mean, SD the standard deviation, and CV, the coefficient of variation = l00*SD/Mean of the 2,000 bootstrap estimates. "True number of pups born" = 191,599.

	Qu 2.5	Qu 25.0	Qu 75.0	Qu 97.5	Mean	SD	CV
2 Large, 1 Medium , 1 Small Rky.							
Ratio	167,525	185,358	208,379	236,569	197,054	17,049	8.65
Regression	167,777	184,406	208,608	240,121	197,285	18,611	9.43
Jackknife	167,823	184,601	207,316	238,206	196,780	17,579	8.93
1 Large, 2 Medium , 1 Small Rky.							
Ratio	163,874	178,699	204,720	224,459	192,293	17,057	8.87
Regression	162,972	173,039	207,050	228,862	192,507	19,917	10.35
Jackknife	163,473	175,814	205,589	226,824	192,182	18,392	9.57
1 Large, 1 Medium , 2 Small Rky.							
Ratio	157,745	172,578	202,515	229,123	189,460	19,526	10.31
Regression	158,453	169,797	211,936	241,206	194,428	24,414	12.56
Jackknife	158,033	170,200	207,753	236,748	191,838	22,498	11.73
1 Large, 2 Medium , 2 Small Rky.							
Ratio	163,095	177,410	202,689	218,304	190,155	15,826	8.32
Regression	162,992	173,648	209,070	226,356	192,461	19,448	10.10
Jackknife	163,047	175,916	204,955	221,393	190,826	17,187	9.01
2 Large, 1 Medium , 2 Small Rky.							
Ratio	166,707	183,478	203,986	229,134	193,819	15,353	7.92
Regression	167,877	184,074	205,663	236,495	195,931	17,558	8.96
Jackknife	167,030	183,411	204,011	231,785	194,251	16,023	8.25
2 Large, 2 Medium , 1 Small Rky.							
Ratio	170,059	186,016	205,138	225,097	195,783	13,764	7.03
Regression	169,422	184,322	205,050	229,202	195,019	15,387	7.89
Jackknife	170,059	185,490	205,087	226,609	195,396	14,184	7.26
2 Large, 2 Medium , 2 Small Rky.							
Ratio	169,624	184,244	201,710	220,662	193,196	12,659	6.55
Regression	169,214	184,136	203,433	227,153	194,170	14,557	7.50
Jackknife	169,534	184,038	202,171	222,470	193,311	13,101	6.78

Table 3 1 .-- Simulation 4. Estimation of number of pups born based on one subsampling visit. Summary statistics of the distribution 2,000 bootstrap estimates of the total number of northern fur seal pups born on the rookeries of St. Paul Island, Alaska, for several sampling plans based on data collected on all rookeries in 1994. Qu 2.5, Qu 25, Qu 75, and Q 97.5 are the 2.5%, 25%, 75%, and 97.5% quantiles of the estimated number of pups; Qu 2.5 can be considered as a lower confidence bound of a 95% confidence interval, etc. Mean is the mean, SD the standard deviation, and CV, the coefficient of variation = lOO*SD/Mean of the 2,000 bootstrap estimates. "True number pups born" = 188,665.

	Qu 2.5	Qu 25.0	Qu 75.0	Qu 97.5	Mean	SD	CV
2 Large, 1 Medium , 1 Small Rky.							
Ratio	161,789	181,772	205,663	237,460	194,111	18,685	9.63
Regression	162,005	181,015	202,196	241,913	193,566	20,048	10.36
Jackknife	161,754	181,106	202,455	239,397	193,411	19,068	9.86
1 Large, 2 Medium , 1 Small Rky.							
Ratio	160,702	174,645	204,993	227,587	190,715	19,076	10.00
Regression	158,904	170,958	208,896	232,967	190,606	22,260	11.68
Jackknife	160,209	172,870	206,771	230,812	190,410	20,544	10.79
1 Large, 1 Medium , 2 Small Rky.							
Ratio	153,689	168,255	203,388	234,565	187,788	22,415	11.94
Regression	154,095	167,859	215,273	249,557	193,022	27,955	14.48
Jackknife	153,777	167,518	210,111	243,863	190,223	25,769	13.55
1 Large, 2 Medium , 2 Small Rky.							
Ratio	159,757	173,746	200,670	221,287	187,516	17,207	9.18
Regression	159,057	171,458	206,717	230,198	189,417	21,251	11.22
Jackknife	159,585	172,342	202,955	224,737	187,984	18,715	9.96
2 Large, 1 Medium , 2 Small Rky.							
Ratio	162,168	179,683	200,711	230,006	190,765	16,699	8.75
Regression	162,734	180,213	200,679	238,510	192,402	19,139	9.95
Jackknife	162,482	179,484	199,907	233,316	190,957	17,409	9.12
2 Large, 2 Medium , 1 Small Rky.							
Ratio	165,396	182,910	202,075	226,045	192,833	14,706	7.63
Regression	165,095	181,509	198,909	228,942	191,551	16,087	8.40
Jackknife	165,388	182,703	200,886	226,469	192,248	15,022	7.81
2 Large, 2 Medium , 2 Small Rky.							
Ratio	164,994	180,627	198,874	220,994	190,369	14,069	7.39
Regression	164,613	180,186	197,920	227,998	190,672	16,177	8.48
Jackknife	165,020	180,455	198,401	222,697	190,273	14,535	7.64

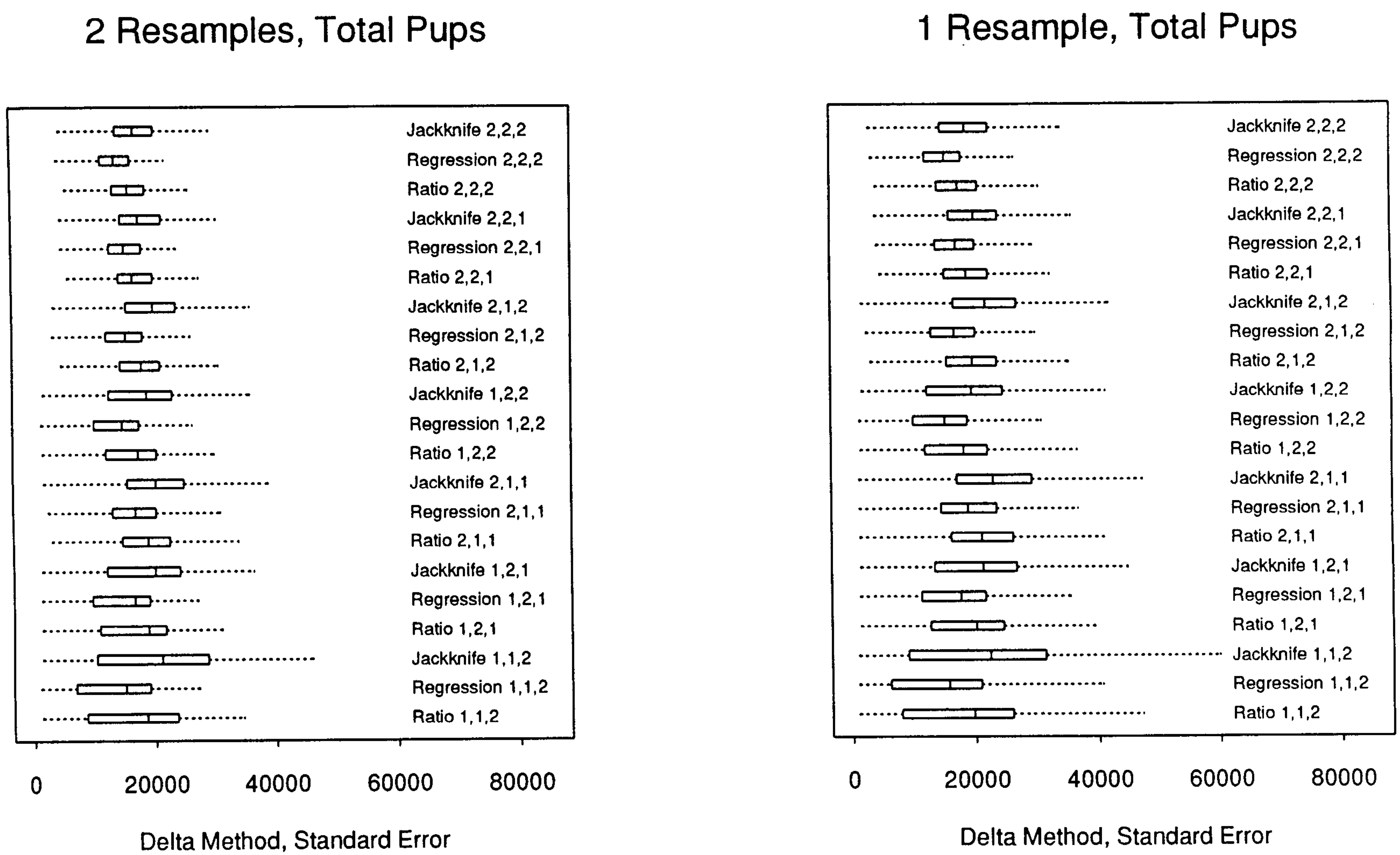


Figure 23.--Boxplots of 2,000 bootstrapped standard error estimates of northern fur seal pups born based on data collected in 1994. For each sampling plan and estimation method plots display the range, median and interquartile range (excludes the lower 25% and upper 25% of observations) of the standard errors of live pup estimates.

compared to (-2 1540, 35010) under 221. Similarly for the uncorrected ratio estimate the 95% confidence intervals for the bias were (-21975, 29062) vs. (-21539, 33497). The distribution of the standard errors of the estimates under both sampling plans similar. The half-widths of the 95% confidence intervals for both sampling plans and both estimators are quite wide: under 222, the median half width is 43,639 for the jackknife and the 40,835 for the raw ratio; under 221, the median half width is 48,949 for the jackknife and the 46,248 for the raw ratio. Under 222, the interquartile ranges are (36,122, 52,296) and (34,564, 48,055) for the jackknife and ratio respectively and under 221 they are even wider: (40,818, 59,405) and (39,633, 55,323).

DISCUSSION

Of the sampling plans that we have considered, only plans 222 and 221 using the raw ratio or jackknife ratio estimator, provide reasonable estimates with reliable variance and confidence intervals close to their nominal level. It is possible to obtain estimates of total pups with dead pups counts only on the sample rookeries, provided that dead pup counts on study areas are not significantly higher than in recent years. It is clearly not prudent to drop the number of resampling visits to one. The disadvantage of subsampling now is that the probability of obtaining confidence intervals with half widths greater than 40,000 is larger than 0.5 and that the probability that the confidence interval half-width is wider than 60,000 is about 0.25 (Table 32). Under sampling plans 222 and 221, we would on average have to shear approximately 8,953 or 8,513 animals, compared to 19,160 if the census takes place on all rookeries (Table 33). Estimates with smaller variance could be obtained by conducting shearing-sampling on more rookeries; a small gain in precision is probably possible if we made more than two resampling visits to each rookery.

Table 32.-- Descriptive statistics of half widths of the estimated 95% confidence intervals for the total number of northern fur seal pups born for sampling plans 222 (2 large, 2 medium, and 2 small rookeries) and 221 (2 large, 2 medium and 1 small rookery) with the jackknife and raw ratio estimators. Qu 2.5, Qu 25, Qu 50, Qu 75, and Qu 97.5 are the 2.5%, 25%, 50%, 75% and 97.5% quantiles of the estimated half widths of 95% confidence intervals of total pups born; Qu 2.5 can be considered as a lower confidence bound of the half width of the 95% confidence interval.

Sampling Plan	Estimation Method	Qu 2.5	Qu 25	Qu 50	Qu 75	Qu 97.5
2 lg, 2 md, 2 sm	Jackknife	16,550	36,122	43,639	52,296	65,437
	Ratio	15,462	34,564	40,835	48,055	58,622
2 lg, 2 md, 1 sm	Jackknife	19,487	40,818	48,948	59,405	75,529
	Ratio	17,996	39,633	46,249	55,323	68,093

Table 33 .-- Approximate number of northern fur seal pups to shear under the stratified random sampling plans for the rookeries on St. Paul Island, Alaska.

Sampling Plan (Rookeries)	Average Pups to Shear 10% of Total Pups
2 Large, 2 Medium, 2 Small	8953
2 Large, 2 Medium, 1 Small	8513
2 Large, 1 Medium, 2 Small	7444
1 Large, 2 Medium, 2 Small	6425
2 Large, 1 Medium, 1 Small	7005
1 Large, 2 Medium, 1 Small	5985
1 Large, 1 Medium, 2 Small	4916

DATA ON THE DIET OF NORTHERN FUR SEALS *(CALLORHINUS URSINUS)* WITH TAGS IDENTIFYING ISLAND OF ORIGIN COLLECTED BY THE UNITED STATES AND CANADA DURING 1958-74 IN THE NORTH PACIFIC AND BERING SEA

by

Michael A. Perez

A study of the diet of northern fur seals *(Callorhinus ursinus)* in recent years (1987-90) based on scat analysis, has suggested a difference in feeding habits between adult females from St. George and St. Paul Islands (Pribilof Islands, Alaska) in the eastern Bering Sea (Antonelis et al. 1997). Antonelis et al. (1997) have suggested that these seals feed in oceanographically different zones and utilize a different prey base with some overlap. The diet of not-them fur seals based on collections made between 1958 and 1974 over pelagic waters of the eastern Bering Sea and eastern North Pacific Ocean has been summarized by Kajimura (1984) and Perez and Bigg (1986). Sinclair et al. (1994) summarized the pelagic collections relative to the current diet of northern fur seals in the eastern Bering Sea. However, to date, there have been no studies specifically reporting stomach contents analyses from these collections on the basis of tagged or marked animals indicating their island of origin (most northern fur seals usually return to their birth island rookery every summer). Consequently, the historical database was reexamined in this report to determine whether significant differences in diet composition occurred among juvenile, adult, or lactating female fur seals relative to island of origin. All of the diet data for northern fur seals with tags or markings collected pelagically during 1958-74 in all areas (Appendix Table D-l) were reexamined. Several tables summarizing the diet composition of these animals from St. George and St. Paul Islands during 1960-74 in the eastern Bering Sea, and during 1958-72 in Washington are also presented to provide anecdotal information for future research.

METHODS

Except as discussed later, the 1958-74 pelagic database was reanalyzed using only tagged or marked animals (Table 34). For the purposes of this study, the terms “tagged” and “marked” will be considered equivalent, and no further distinction will be made between the two cases in the presentation of data.

lnformation concerning the metal tag series used to mark pups, yearlings and 2-year olds between 1941 and 1972 by the United States (Pribilof Islands) and the U.S.S.R. (Commander Islands) can be found in North Pacific Fur Seal Commission (1962, 1969, 1971, 1975), Marine Mammal Biological Laboratory (1971) Marine Mammal Division (1974), and Roppel et al. (1963). Most tagged seals were also marked by branding or marking flippers to aid identification when metal tags were unreadable or were similar to other types of tag series. Pups from the Pribilof Islands were not tagged, but only marked, during 1969-74.

Data groups were chosen to compare the diets between tagged seals from St. George and St. Paul Islands feeding in the eastern Bering Sea and Washington. There were too few data in the 1958-74 pelagic database to compare diets of tagged seals collected in other areas. The months and years selected in a specific analysis were those times when data from food stomachs were available for each of the groups being compared in that analysis; for some analyses, due to low sample sizes, all of the available data in all years were combined. It was also necessary to combine data for all ages within reproductive status groups because of low sample size.

The limited data on diet composition for tagged lactating females in the eastern Bering Sea, tagged pregnant females in Washington, and tagged juvenile male and female fur seals in the eastern Bering Sea and Washington were summarized. The summaries of diet for the different

Table 34.--Number of northern fur seals with tags identifying island of origin collected pelagically during 1958-74 (all years pooled). The number of seals with food (including trace remains) are given in parentheses. Pribilof Islands (Alaska): St. George = St. George Island, St. Paul = St. Paul Island; Commander Islands (Russia): Bering = Bering Island, Medny = Medny Island. Dashes indicate months in areas when no collections were made.

Month/ Island	California	Oregon	Washington	British Columbia	Gulf of Alaska	Western Alaska	Eastern Bering Sea
November							
St. George	-	-	0	-	-	-	-
St. Paul	-	-	0	-	-	-	-
Bering	-	-	0	-	-	-	-
Medny	-	-	0	-	-	-	-
December							
St. George	0	-	0	-	-	-	-
St. Paul	0	-	3(2)	-	-	-	-
Bering	0	-	0	-	-	-	-
Medny	0	-	0	-	-	-	-
January							
St. George	2	0	3(3)	0	-	-	-
St. Paul	6(5)	0	13(9)	2(1)	-	-	-
Bering	0	-	1(1)	0	-	-	-
Medny	0	-	0	0	-	-	-
February							
St. George	4(2)	-	4(2)	1	0	-	-
St. Paul	17(11)	-	10(5)	4(2)	0	-	-
Bering	0	-	1(1)	0	0	-	-
Medny	0	-	0	0	0	-	-
March							
St. George	3(2)	0	8(5)	2(2)	0	-	-
St. Paul	15(10)	2(2)	40(19)	2(1)	7(5)	-	-
Bering	0	0	1(1)	0	0	-	-
Medny	0	0	2	0	0	-	-
April							
St. George	1	1	15(6)	0	0	-	-
St. Paul	7(4)	2(2)	56(23)	3	5(3)	-	-
Bering	0	0	0	0	0	-	-
Medny	0	0	1(1)	0	0	-	-
May							
St. George	3(2)	0	8(4)	0	1	0	-
St. Paul	2(2)	0	33(15)	4(1)	10(8)	1	-
Bering	0	0	1(1)	0	0	0	-
Medny	0	0	1(1)	0	0	0	-
June							
St. George	0	-	1(1)	0	0	1(1)	0
St. Paul	5(4)	-	1(1)	3(3)	21(7)	13(6)	5(4)
Bering	0	-	0	0	0	0	0
Medny	0	-	0	0	0	0	0
July							
St. George	-	-	-	0	1	0	7(2)
St. Paul	-	-	-	0	5(3)	2(2)	43(23)
Bering	-	-	-	0	0	0	0
Medny	-	-	-	0	0	0	0

Table 34.--Continued.

Month/ Island	California	Oregon	Washington	British Columbia	Gulf of Alaska	Western Alaska	Eastern Bering Sea
August							
St. George	-	-	-	-	-	2	8 (5)
St. Paul	-	-	-	-	-	4 (1)	53 (28)
Bering	-	-	-	-	-	0	2
Medny	-	-	-	-	-	0	0
September							
St. George	-	-	-	-	-	0	2 (1)
St. Paul	-	-	-	-	-	0	14 (7)
Bering	-	-	-	-	-	0	0
Medny	-	-	-	-	-	0	0
October							
St. George	-	-	-	-	-	0	0
St. Paul	-	-	-	-	-	0	0
Bering	-	-	-	-	-	0	0
Medny	-	-	-	-	-	0	1
Months combined							
St. George	13 (6)	1	39 (21)	3 (2)	2	3 (1)	17 (8)
St. Paul	52 (36)	4 (4)	156 (74)	19 (8)	48 (26)	20 (9)	115 (62)
Bering	0	0	4 (4)	0	0	0	2
Medny	0	0	4 (2)	0	0	0	1
Total number of seals collected:							
Empty	1,027	49	2,628	415	1,389	384	1,813
Food/trace	2,578	118	2,941	464	1,321	438	2,839
Tagged	65	5	203	22	50	23	135
Total percent tagged:							
Collected	1.8	3.0	3.6	2.5	1.8	2.8	2.7
Food/trace	1.2	2.4	1.8	1.1	1.0	1.2	1.4

data groups were presented in respective pairs of tables: 1) a tabulation of stomach contents for each group by frequency of occurrence, volume, and count of individual identifiable specimens of prey species; and 2) the composition of the total diet of each group by percentage and rank of each prey species.

Relative importance of diet proportions of prey species in the present study was calculated by each of three computational methods which have been used in previous diet research on northern fur seals: 1) percent prevalence or frequency of occurrence (e.g., Perez and Bigg 1980; Sinclair et al. 1994), 2) percent biomass indicated by volume (e.g., Perez and Bigg 1980; Kajimura 1984), and 3) percent modified volume (trace occurrences are excluded in this method; Perez and Bigg 1986). Each of these three methods yield different results and have their inherent biases and limitations which were discussed, with respect to northern fur seal biology, by Bigg and Perez (1985). In the present study it has been necessary to calculate diet importance by each of the three methods to provide comparability with both previous studies based on stomach contents and current research studies based on scat collections (which provide data on prevalence, count of individual prey specimens, and biomass from prey size estimates). Due to incomplete data records, diet proportions and ranks of prey species based on the numerical count (number of individual identifiable specimens of each prey) data were not calculated in the present report. This limits the use of this analysis in terms of a direct comparison with current diet analyses which rely on numerical proportions. Numerical data has been tabulated in Appendix Table D-l and summarized for each analytical group for reference purposes.

The proportions (percentages) of prey species calculated by each computational method were assigned numerical ranks in descending order (by rounded integer percentage value) to denote relative importance in diet composition. Trace occurrences (including percentages

<0.05%) were assigned the lowest rank. These ranks were averaged for ties; thus, the sum of the assigned ranks will equal T(T+1)/2 where ***T*** is the total number of categories of prey taxa.

As stated above, the data groups presented in this study represent tagged **animals**. However, one analysis was done on the diets ofjuvenile male and female northern fur seals (ages l-3 years) and lactating females (age 24 years), regardless of tags (i.e., including untagged animals), in the eastern Bering Sea. For this particular analysis only data for seals of each of the three groups collected during the first 6 hours of daylight following sunrise on the same calendar dates were included. Lactating females have a higher average daily feeding rate than non-lactating, adult females (Perez and Mooney 1986) because they feed throughout the day, primarily on juvenile walleye pollock ***(Theragra chalcogramma)*** and gonatid squid (Gonatidae), in the eastern Bering Sea (Perez 1995; Sinclair et al. 1994; Antonelis et al. 1997). Non-lactating adult female fur seals in the eastern Bering Sea do not feed throughout the day (Perez 1995), and juvenile fur seals probably do not feed in the daytime either based on the higher proportion of empty and trace stomachs found in seals collected in afternoon hours (juvenile fur seals do not exhibit daytime feeding in Washington; Perez 1995). Bigg and Fawcett (1985) indicated that digestion of Pacific herring ***(Clupea pallasi)*** and squid ***(Loligo opalescens)*** can be expected within 4-12 hours of consumption. An exploratory examination of the data showed that 75% of trace and empty stomachs were collected in the hours later than 6 hours after sunrise. Therefore, only data collected in the morning (<6 hours after sunrise) were included in the analysis of the pooled tagged and untagged sample. It was necessary to eliminate cases representing daytime feeding to avoid a possible bias in favor of daytime prey selection by lactating females. A 3X2 contingency table using the chi-square statistic (Zar 1984) was also used in this particular analysis to test for a significant difference in the prevalence of fish or squid in the diet among the three in the diet among the three groups of fur seals (juvenile males, juvenile females, and lactating females; regardless of tags).

RESULTS AND DISCUSSION

A complete list of stomach contents for all tagged seals collected during 1958-74 is given in Appendix Table D-l. A total of 503 (2.7%) of the 18,404 northern fur seals collected pelagically by the United States and Canada during 1958-74 were tagged, but only 263 (1.4%) of these seals had food or trace remains in their stomachs (Table 34).

Two analyses have been presented to compare diets between tagged fur seals from St. George and St. Paul Islands collected in the eastern Bering Sea: 1) northern fur seals (any age; both sexes) collected during June-September in 1960-74 (Tables 35 and 36), and 2) only lactating females during the months of July-August in 1963 and July and September in 1973 (Tables 37 and 38). Fur seals from both islands were collected in similar localities in the eastern Bering Sea during 1960-74 (Figs. 24 and 25). In the first analysis, Gonatid squid species (including ***Berryteuthis magister)*** and capelin ***(Mallotus villosus)*** were the primary foods of fur seals from St. George Island, but fish species (including walleye pollock and capelin) were also important to seals from St. Paul Island in addition to the gonatid squid ***Gonatopsis borealis*** (Table 36). Gonatid squid species were the principal food items of the lactating females from St. George Island, but walleye pollock and gonatid squids were the chief foods of the lactating females from St. Paul Island (Table 38). These results support the findings of recent studies (Antonelis et al. 1997) based on scat analysis that determined St. George Island female fur seals prey on squids more heavily than St. Paul Island female fur seals do. This report also supports findings of Sinclair et al. (1994) based on analysis of scats and stomach contents that determined capelin was historically predominant in the diet of northern fur seals but dropped from the diet by the 1980s.

Table 35.--Stomach contents[1] of all northern fur seals[2] (N; trace occurrences in parentheses) with tags indicating origin from St. George and St. Paul Islands collected pelagically in the eastern Bering Sea during the months of June-September in 1960-74 by the United States and Canada.

	St. George Island			St. Paul Island		
Prey Species	*N*	Volume (cc)	Count[3]	*N*	Volume (cc)	Count[3]
FISH:						
Pacific herring (*Clupea pallasi*)	0	-	-	2	3,100	20
Salmonidae	0	-	-	1	460	1
Capelin (*Mallotus villosus*)	2	698	170	12 (1)	3,897	702
Osmeridae	0	-	-	1 (1)	Trace	2
Deepsea smelts (Bathylagidae)	0	-	-	1	231	73
Walleye pollock (*Theragra chalcogramma*)	1	160	34	11 (3)	9,215	90
Gadidae	0	-	-	4	1,168	269
Atka mackerel (*Pleurogrammus monopterygiuus*)	0	-	-	4	1,051	7
Cyclopteridae	0	-	-	1	71	1
Pacific sand lance (*Ammodytes hexapterus*)	0	-	-	1	27	46
Greenland halibut (*Reinhardtius hippoglossoides*)	0	-	-	3 (1)	144	34
Pleuronectidae	0	-	-	1	185	5
Unidentified fish	0	-	-	8 (7)	290	8
Subtotal (fish)	3	858	204	41 (9)	19,839	1,258
CEPHALOPODS:						
Gonatus sp.	3 (2)	11	11	13 (10)	70	52
Berryteuthis magister	2	2,335	32	8 (2)	1,028	69
Gonatopsis borealis	2 (1)	16	5	11	2,037	249
Gonatidae	6 (6)	Trace	128	25 (20)	211	694
Unidentified squid	0	-	-	3 (3)	Trace	4
Subtotal (cephalopods)	7 (4)	2,362	176	34 (18)	3,346	1,068
TOTAL	8 (3)	3,220	380	62 (22)	23,185	2,327
No. stomachs collected	17			115		

[1] Miscellaneous items including bird remnants are not included.

[2] Seals of both sexes at any age or reproductive condition were included.

[3] The numerical count of the number of identifiable prey specimens. This number should be considered a minimum because it was not always recorded. Therefore, it has not been used to rank diet importance of prey species.

Table 36.--Comparison of diet between northern fur seals from St. George and St. Paul Islands collected in the eastern Bering Sea during the months of July-September in 1960-74 by percentage and rank (in parentheses[1]) of prey species using three methods of ranking relative importance of diet.

	Diet Importance Ranking Methods					
	Percent Frequency		Percent Volume		Modified Volume[2]	
Prey Species	St. George	St. Paul	St. George	St. Paul	St. George	St. Paul
FISH:						
Pacific herring	-	3.23 (12)	-	13.37 (3)	-	10.62 (4.5)
Salmonidae	-	1.61 (15.5)	-	1.98 (8)	-	1.58 (7)
Capelin	25.00 (4)	19.35 (3)	21.68 (2)	16.81 (2)	40.68 (2)	13.36 (3)
Osmeridae	-	1.61 (15.5)	-	Trace (17.5)	-	Trace
Deepsea smelts	-	1.61 (15.5)	-	1.00 (11)	-	0.79 (9)
Walleye pollock	12.50 (6)	17.74 (4.5)	4.97 (3)	39.75 (1)	9.32 (3)	35.59 (1)
Gadidae	-	6.45 (8.5)	-	5.04 (5)	-	Trace
Atka mackerel	-	6.45 (8.5)	-	4.53 (6)	-	3.60 (6)
Cyclopteridae	-	1.61 (15.5)	-	0.31 (15)	-	Trace
Pacific sand lance	-	1.61 (15.5)	-	0.12 (15)	-	Trace
Greenland halibut	-	4.84 (10.5)	-	0.62 (11)	-	1.13 (9)
Pleuronectidae	-	1.61 (15.5)	-	0.80 (11)	-	Trace
Unidentified fish	-	12.90 (6.5)	-	1.25 (11)	-	-
Subtotal (fish)	37.50	66.13	26.65	85.57	50.00	66.67
CEPHALOPODS:						
Gonatus sp.	37.50 (2)	20.97 (2)	0.34 (4.5)	0.30 (15)	Trace	0.74 (9)
Berryteuthis magister	25.00 (4)	12.90 (6.5)	75.52 (1)	4.43 (7)	50.00 (1)	10.93 (4.5)
Gonatopsis borealis	25.00 (4)	17.74 (4.5)	0.50 (4.5)	8.79 (4)	Trace	21.66 (2)
Gonatidae	75.00 (1)	40.32 (1)	Trace (6.5)	0.91 (11)	Trace	Trace
Unidentified squid	-	4.84 (10.5)	Trace (6.5)	Trace (17.5)	-	-
Subtotal (cephalopods)	87.50	54.84	73.35	14.43	50.00	33.33
TOTAL	-	-	100.00	100.00	100.00	100.00
No. stomachs collected	17	115				
No. stomachs food	8	62				
No. stomachs trace	3	22				

[1] Ranks were averaged for ties.

[2] Unidentified categories are either eliminated (unidentified fish and squid categories) or allocated among known categories in the modified volume method (see Bigg and Perez 1985); trace occurrences are also excluded in this method.

Table 37.--Stomach contents[1] of lactating female northern fir seals (N; trace occurrences in parentheses) from St. George and St. Paul Islands collected pelagically in the eastern Bering Sea during the months of July-August in 1963 and July and September in 1973 by the United States and Canada.

	St. George Island			St. Paul Island		
Prey Species	*N*	Volume (cc)	Count[2]	*N*	Volume (cc)	Count[2]
FISH:						
Salmonidae	0	-	-	1	460	1
Capelin (*Mallotus villosus*)	1	518	110	1	291	137
Osmeridae	0	-	-	1 (1)	Trace	2
Walleye pollock (*Theragra chalcogramma*)	1	160	34	3	4,680	13
Gadidae	0	-	-	2	319	89
Atka mackerel (*Pleurogrammus monopterygiuus*)	0	-	-	1	665	4
Pacific sand lance (*Ammodytes hexapterus*)	0	-	-	1	27	46
Greenland halibut (*Reinhardtius hippoglossoides*)	0	-	-	1 (1)	Trace	5
Unidentified fish	0	-	-	1 (1)	Trace	1
Subtotal (fish)	2	678	144	9	6,442	298
CEPHALOPODS:						
Gonatus sp.	2 (1)	11	6	5 (3)	24	19
Berryteuthis magister	1	1,025	17	3	147	11
Gonatopsis borealis	2 (1)	16	5	4	399	55
Gonatidae	4 (4)	Trace	90	7 (5)	48	173
Subtotal (cephalopods)	4 (2)	1,052	118	8 (2)	618	258
TOTAL	4 (1)	1,730	262	12 (1)	7,060	556
No. stomachs collected	4			18		

1 Miscellaneous items including bird remnants are not included.

2 The numerical count of the number of identifiable prey specimens. This number should be considered a minimum because it was not always recorded. Therefore, it has not been used to rank diet importance of prey species.

Table 38.--Comparison of diet between lactating northern fur seals from St. George and St. Paul Islands collected in the eastern Bering Sea during the months of July-August in 1963 and July and September in 1973 by percentage and rank (in parentheses') of prey species using three methods of ranking relative importance of diet.

	Diet Importance Ranking Methods					
	Percent Frequency		Percent Volume		Modified Volume[2]	
Prey Species	St. George	St. Paul	St. George	St. Paul	St. George	St. Paul
FISH:						
Salmonidae	-	8.33 (10)	-	6.52 (3)	-	4.30 (5)
Capelin	25.00 (5)	8.33 (10)	29.94 (2)	4.12 (6)	38.20 (2)	2.72 (6)
Osmeridae	-	8.33 (10)	-	Trace (12)	-	Trace
Walleye pollock	25.00 (5)	25.00 (4.5)	9.25 (3)	66.29 (1)	11.80 (3)	46.76 (1)
Gadidae	-	16.67 (6)	-	4.52 (5)	-	Trace
Atka mackerel	-	8.33 (10)	-	9.42 (2)	-	6.22 (4)
Pacific sand lance	-	8.33 (10)	-	0.38 (9.5)	-	Trace
Greenland halibut	-	8.33 (10)	-	Trace (12)	-	Trace
Unidentified fish	-	8.33 (10)	-	Trace (12)	-	Trace
Subtotal (fish)	50.00	75.00	39.19	91.25	50.00	60.00
CEPHALOPODS:						
Gonatus sp.	50.00 (2.5)	41.67 (2)	0.64 (4.5)	0.34 (9.5)	0.52 (4.5)	1.68 (7)
Berryteuthis magister	25.00 (5)	25.00 (4.5)	59.25 (1)	2.08 (7)	48.72 (1)	10.32 (3)
Gonatopsis borealis	50.00 (2.5)	33.33 (3)	0.92 (4.5)	5.65 (4)	0.76 (4.5)	28.00 (2)
Gonatidae	100.00 (1)	58.33 (1)	Trace (6)	0.68 (8)	Trace	Trace
Subtotal (cephalopods)	100.00	66.67	60.81	8.75	50.00	40.00
TOTAL	-	-	100.00	100.00	100.00	100.00
No. stomachs collected	4	18				
No. stomachs food	4	12				
No. stomachs trace	1	1				

[1] Ranks were averaged for ties.

[2] Unidentified categories are either eliminated (unidentified fish and squid categories) or allocated among known categories in the modified volume method (see Bigg and Perez 1985); trace occurrences are also excluded in this method.

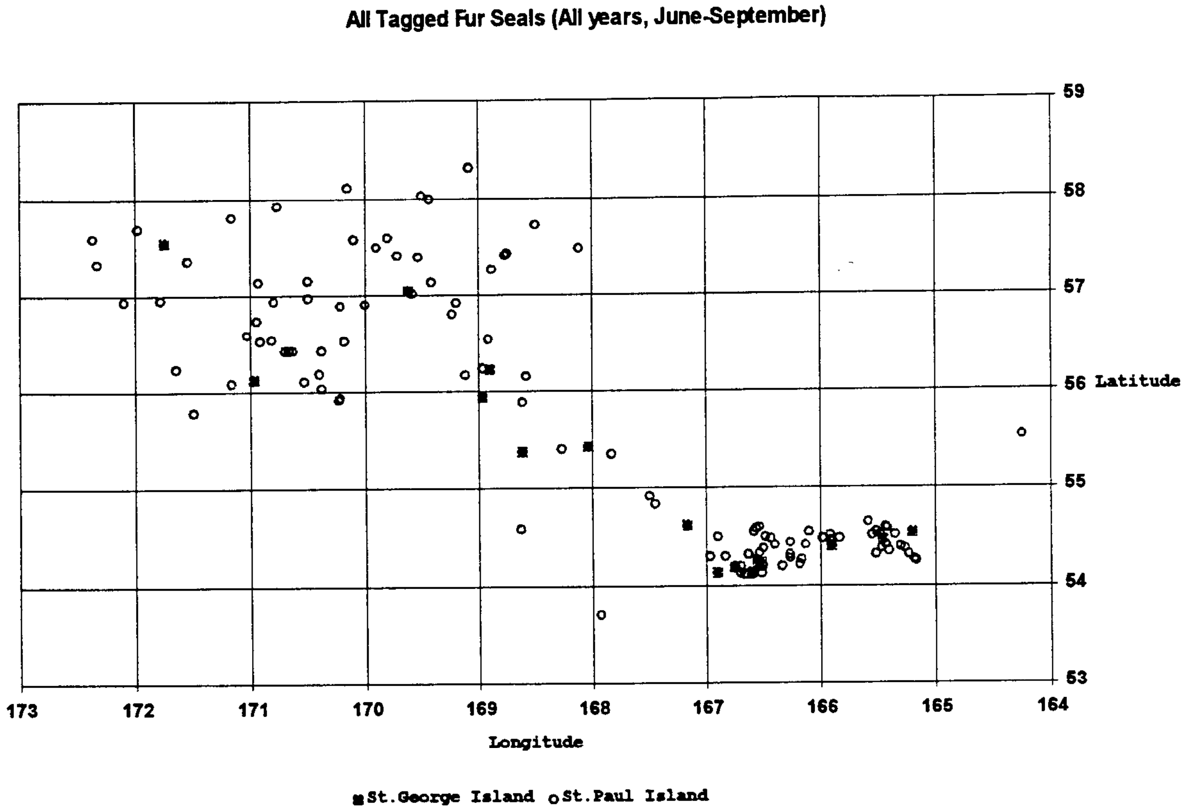


Figure 24.--Locations in the Bering Sea during 1960-74 (June-September) where northern fur seals (both sexes, all ages and reproductive status) with tags indicating island of origin (Pribilof Islands population) were collected pelagically by the United States and Canada.

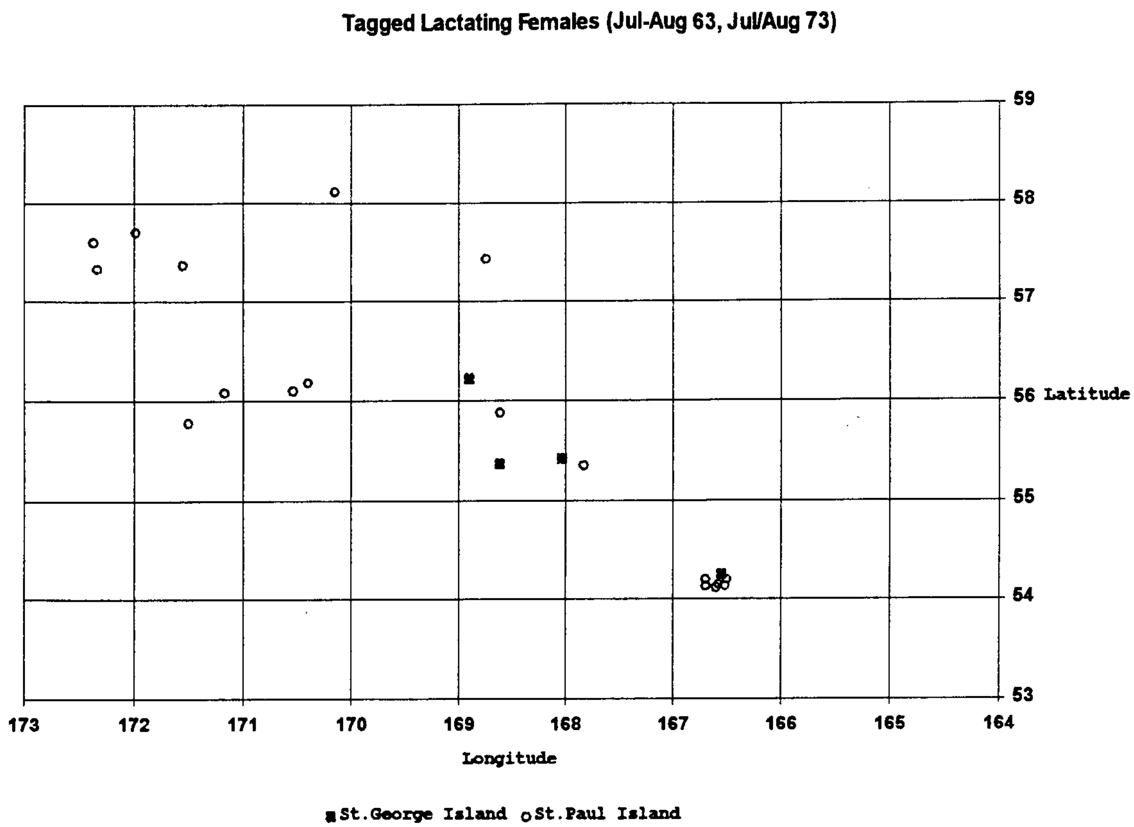


Figure 25.--Locations in the Bering Sea during July-August 1963 and July and September 1973 where lactating female northern fur seals with tags indicating island of origin (Pribilof Islands population) were collected pelagically by the United States and Canada.

Two analyses were prepared to compare diets between tagged fur seals from St. George and St. Paul Islands collected in Washington: 1) pregnant tagged northern fur seals collected during January (1968 and 1972), February (1968) and March (1970 and 1972) (Tables 39 and 40); and 2) juvenile fur seals (ages l-3 years; both sexes combined) collected during March (1958), April (1958, 1962, and 1971), and May (1972) (Tables 41 and 42). A third analysis was done to compare diets between tagged male and female juvenile fur seals (ages 1-3 yr) from only St. Paul Island collected in Washington during April (196 1) and May (196 1 and 1972) (Tables 43 and 44). Northern anchovy *(Engraulis mordax)*, Pacific herring (St. George seals only) and coho salmon ***(Oncorhynchus kisutch)*** (St. Paul seals only) were the principal foods of pregnant females (Table 40). Gonatid squid species (especially ***Berryteuthis magister),*** Pacific herring, northern anchovy (St. George seals only), and ***Onychoteuthis*** sp. (almost certainly 0. ***borealijaponica)*** were the chief prey items ofjuvenile fur seals (Table 42). ***Onychoteuthis*** sp. was identified in only one juvenile male stomach (Table 43); and the identified species of gonatid squids were different for males and females, but each species occurred in only one stomach (Table 43). The importance of these species (Tables 42 and 44) was biased by low sample sizes. Fur seals from both islands, including juvenile fur seals of either sex, were collected in similar localities in Washington during 1960-74 (Figs. 26-28).

An analysis was run comparing diets among tagged juvenile male, juvenile female, and lactating female fur seals from St. Paul Island collected in the eastern Bering Sea during July and August 1963 (Tables 45 and 46). Similarly an analysis was prepared for all seals (regardless of tags) of these three categories collected during the first 6 hours of daylight in the eastern Bering Sea during July-September 1960-74 (Tables 47 and 48). The purpose of this latter analysis was to illustrate the extent of comparable information in the historic pelagic database. Tagged seals

Table 39.--Stomach contents[1] of pregnant female northern fur seals (N; trace occurrences in parentheses) from St. George and St. Paul Islands collected pelagically in Washington during the months of January (1968, 1972), February (1968), and March (1970, 1972) by the United States and Canada.

Prey Species	St. George Island *N*	Volume (cc)	Count[2]	St. Paul Island *N*	Volume (cc)	Count[2]
FISH:						
Clupeidae	0	-	-	1(1)	Trace	1
Pacific herring (*Clupea pallasi*)	1	2,510	12	-	-	-
Northern anchovy (*Engraulis mordax*)	2	235	14	1	35	3
Coho salmon (*Oncorhynchus kisutch*)	0	-	-	1	315	1
Unidentified salmon (*Oncorhynchus* spp.)	1	18	2	-	-	-
Salmonidae	1	90	3	1(1)	Trace	1
Unidentified fish	1(1)	Trace	1	1(1)	Trace	1
TOTAL	6(1)	2,853	32	4(3)	350	7
No. stomachs collected	7			5		

1 Miscellaneous items including bird remnants are not included.

2 The numerical count of the number of identifiable prey specimens. This number should be considered a minimum because it was not always recorded. Therefore, it has not been used to rank diet importance of prey species.

Table 40.--Comparison of diet between pregnant northern fur seals from St. George and St. Paul Islands collected in Washington during the months of January (1968, 1972), February (1968), and March (1970, 1972) by percentage and rank (in parentheses') of prey species using three methods of ranking relative importance of diet.

	Diet Importance Ranking Methods					
	Percent Frequency		Percent Volume		Modified Volume[2]	
Prey Species	St. George	St. Paul	St. George	St. Paul	St. George	St. Paul
FISH:						
Clupeidae	-	25.00 (3)	-	Trace (4)	-	-
Pacific herring	16.67 (3.5)	-	87.98 (1)	-	87.98 (1)	-
Northern anchovy	33.33 (1)	25.00 (3)	8.24 (2)	10.00 (2)	8.24 (2)	10.00 (2)
Coho salmon	-	25.00 (3)	-	90.00 (1)	-	90.00 (1)
Unidentified salmon	16.67 (3.5)	-	0.63 (4)	-	-	-
Salmonidae	16.67 (3.5)	25.00 (3)	3.15 (3)	Trace (4)	3.79 (3)	-
Unidentified fish	16.67 (3.5)	25.00 (3)	Trace (5)	Trace (4)	-	-
TOTAL	-	-	100.00	100.00	100.00	100.00
No. stomachs collected	7	5				
No. stomachs food	6	4				
No. stomachs trace	1	3				

[1] **Ranks were averaged for ties.**

[2] Unidentified categories are either eliminated (unidentified fish and squid categories) or allocated among known categories in the modified volume method (see Bigg and Perez 1985); trace occurrences are also excluded in this method.

Table 41.--Stomach contents' ofjuvenile (ages l-3 years) northern fur seals (*N;* trace occurrences in parentheses) from St. George and St. Paul Islands collected pelagically in Washington during the months of March (1958), April (1958, 1962, 1971), and May (1972) by the United States and Canada.

Prey Species	St. George Island *N*	St. George Island Volume (cc)	St. George Island Count[2]	St. Paul Island *N*	St. Paul Island Volume (cc)	St. Paul Island Count[2]
FISH:						
Pacific herring (*Clupea pallasi*)	1	430	4	1	244	7
Northern anchovy (*Engraulis mordax*)	1	415	16	0	-	-
Deepsea smelts (Bathylagidae)	0	-	-	1 (1)	Trace	1
Unidentified fish	2 (2)	Trace	2	4 (3)	3	4
Subtotal (fish)	4 (2)	845	22	5 (4)	247	12
CEPHALOPODS:						
Onychoteuthis sp.	1 (1)	Trace	11	1	285	3
Octopoteuthis sp.	0	-	-	1 (1)	Trace	1
Gonatus sp.	0	-	-	1 (1)	Trace	1
Berryteuthis magister	0	-	-	1	375	18
Gonatopsis borealis	0	-	-	1	190	9
Gonatidae	1	30	11	3 (3)	Trace	93
Unidentified squid	1 (1)	Trace	1	2 (1)	9	9
Subtotal (cephalopods)	2 (1)	30	23	5 (2)	859	134
TOTAL	5 (2)	875	45	7 (3)	1,106	146
No. stomachs collected	16			10		

1 Miscellaneous items including bird remnants are not included.

2 The numerical count of the number of identifiable prey specimens. This number should be considered a minimum because it was not always recorded. Therefore, it has not been used to rank diet importance of prey species.

Table 42.--Comparison of diet between juvenile (ages l-3 years) northern fur seals from St. George and St. Paul Islands collected in Washington during the months of March (1958), April (1958, 1962, 1971), and May (1972) by percentage and rank (in parentheses') of prey species using three methods of ranking relative importance of diet.

	Diet Importance Ranking Methods					
	Percent Frequency		Percent Volume		Modified Volume[2]	
Prey Species	St. George	St. Paul	St. George	St. Paul	St. George	St. Paul
FISH:						
Pacific herring	20.00 (4)	14.29 (7)	49.14 (1)	22.06 (3)	33.93 (1)	25.00 (2.5)
Northern anchovy	20.00 (4)	-	47.43 (2)	-	32.74 (3)	-
Deepsea smelts	-	14.29 (7)	-	Trace (8.5)	-	Trace
Unidentified fish	40.00 (1)	57.14 (1)	Trace (5)	0.27 (6)	-	-
Subtotal (fish)	80.00	71.43	96.57	22.33	66.67	25.00
CEPHALOPODS:						
Onychoteuthis sp.	20.00 (4)	14.29 (7)	Trace (5)	25.77 (2)	Trace	25.15 (2.5)
Octopoteuthis sp.	-	14.29 (7)	-	Trace (8.5)	-	Trace
Gonatus sp.	-	14.29 (7)	-	Trace (8.5)	-	Trace
Berryteuthis magister	-	14.29 (7)	-	33.91 (1)	-	33.09 (1)
Gonatopsis borealis	-	14.29 (7)	-	17.18 (4)	-	16.76 (4)
Gonatidae	20.00 (4)	42.86 (2)	3.43 (3)	Trace (8.5)	33.33 (2)	-
Unidentified squid	20.00 (4)	28.57 (3)	Trace (5)	0.81 (5)	-	-
Subtotal (cephalopods)	40.00	71.43	3.43	77.67	33.33	75.00
TOTAL	-	-	100.00	100.00	100.00	100.00
No. stomachs collected	16	10				
No. stomachs food	5	7				
No. stomachs trace	2	3				

[1] Ranks were averaged for ties.

[2] Unidentified categories are either eliminated (unidentified fish and squid categories) or allocated among known categories in the modified volume method (see Bigg and Perez 1985); trace occurrences are also excluded in this method.

Table 43 .--Stomach contents[1] of tagged male and female juvenile (ages l-3 years) northern fur seals (N; trace occurrences in parentheses) from St. Paul Island collected pelagically in Washington during the months of April (196 1) and May (196 1, 1972) by the United States and Canada.

	Males			Females		
Prey Species	*N*	Volume (cc)	Count[2]	*N*	Volume (cc)	Count[2]
FISH:						
Pacific herring (*Clupea pallasi*)	2	389	6	1	370	5
Deepsea smelts (Bathylagidae)	0	-	-	1(1)	Trace	1
Unidentified fish	1(1)	Trace	1	1(1)	Trace	1
Subtotal (fish)	3(1)	389	7	3(2)	370	7
CEPHALOPODS:						
Onychoteuthis sp.	1	285	3	-	-	-
Octopoteuthis sp.	0	-	-	1(1)	Trace	1
Gonatus sp.	1(1)	Trace	1	-	-	-
Berryteuthis magister	0	-	-	1	375	18
Gonatopsis borealis	1	190	9	-	-	-
Gonatidae	1(1)	Trace	53	1(1)	Trace	39
Subtotal (cephalopods)	1	475	66	1	375	58
TOTAL	3	864	73	3(1)	745	65
No. stomachs collected	6			10		

1 Miscellaneous items including bird remnants are not included.

2 The numerical count of the number of identifiable prey specimens. This number should be considered a minimum because it was not always recorded. Therefore, it has not been used to rank diet importance of prey species.

Table 44.--Comparison of diet between tagged male and female juvenile (ages l-3 years) northern fur seals from St. Paul Island collected in Washington during the months of April (1961) and May (1961, 1972) by percentage and rank (in parentheses[1]) of prey species using three methods of ranking relative importance of diet.

	Diet Importance Ranking Methods					
	Percent Frequency		Percent Volume		Modified Volume[2]	
Prey Species	Males	Females	Males	Females	Males	Females
FISH:						
Pacific herring	66.67 (1)	33.33 (3.5)	45.02 (1)	49.66 (1.5)	66.67 (1)	50.00 (1.5)
Deepsea smelts	-	33.33 (3.5)	-	Trace (4.5)	-	Trace
Unidentified fish	33.33 (4)	33.33 (3.5)	Trace (5)	Trace (4.5)	-	-
Subtotal (fish)	100.00	100.00	45.02	49.66	66.67	50.00
CEPHALOPODS:						
Onychoteuthis sp.	33.33 (4)	-	32.99 (2)	-	20.00 (2)	-
Octopoteuthis sp.	-	33.33 (3.5)	-	Trace (4.5)	-	Trace
Gonatus sp.	33.33 (4)	-	Trace (5)	-	Trace	-
Berryteuthis magister	-	33.33 (3.5)	-	50.34 (1.5)	-	50.00 (1.5)
Gonatopsis borealis	33.33 (4)	-	21.99 (3)	-	13.33 (3)	-
Gonatidae	33.33 (4)	33.33 (3.5)	Trace (5)	Trace (4.5)	-	-
Subtotal (cephalopods)	33.33	33.33	54.98	50.34	33.33	50.00
TOTAL	-	-	100.00	100.00	100.00	100.00
No. stomachs collected	6	10				
No. stomachs food	3	3				
No. stomachs trace	0	1				

[1] Ranks were averaged for ties.

[2] Unidentified categories are either eliminated (unidentified fish and squid categories) or allocated among known categories in the modified volume method (see Bigg and Perez 1985); trace occurrences are also excluded in this method.

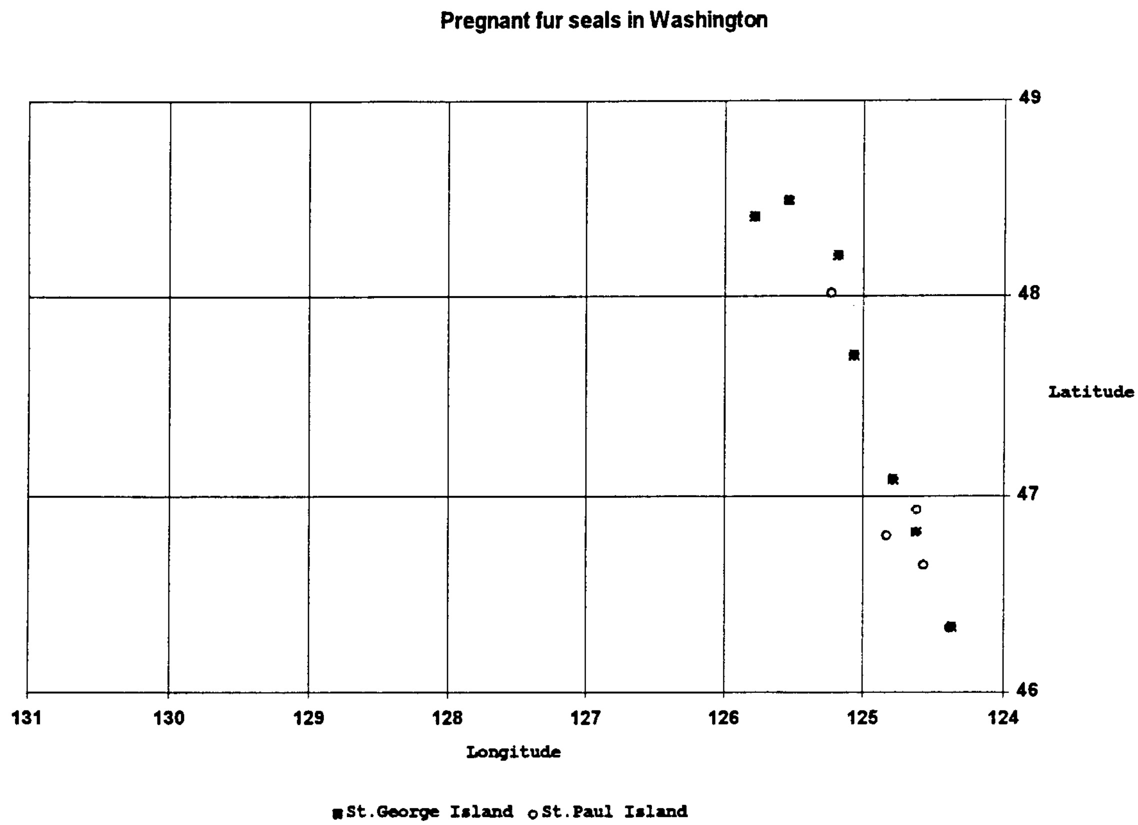


Figure 26.--Locations in Washington during January (1968, 1972), February (1968), and March (1970, 1972) where pregnant female northern fur seals with tags indicating island of origin (Pribilof Islands population) were collected pelagically by the United States and Canada.

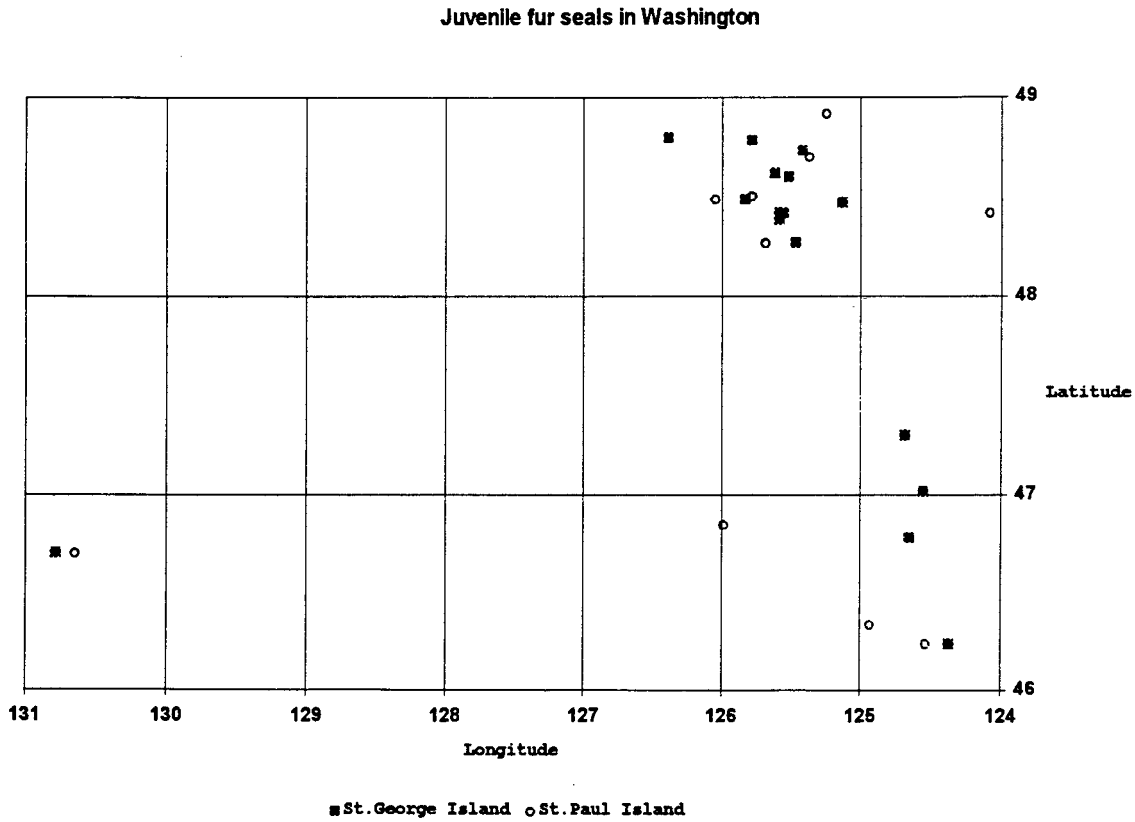


Figure 27.--Locations in Washington during March (1958), April (1958, 1962, 1971), and May (1972) where juvenile (ages l-3 yr) northern fur seals with tags indicating island of origin (Pribilof Islands population) were collected pelagically by the United States and Canada.

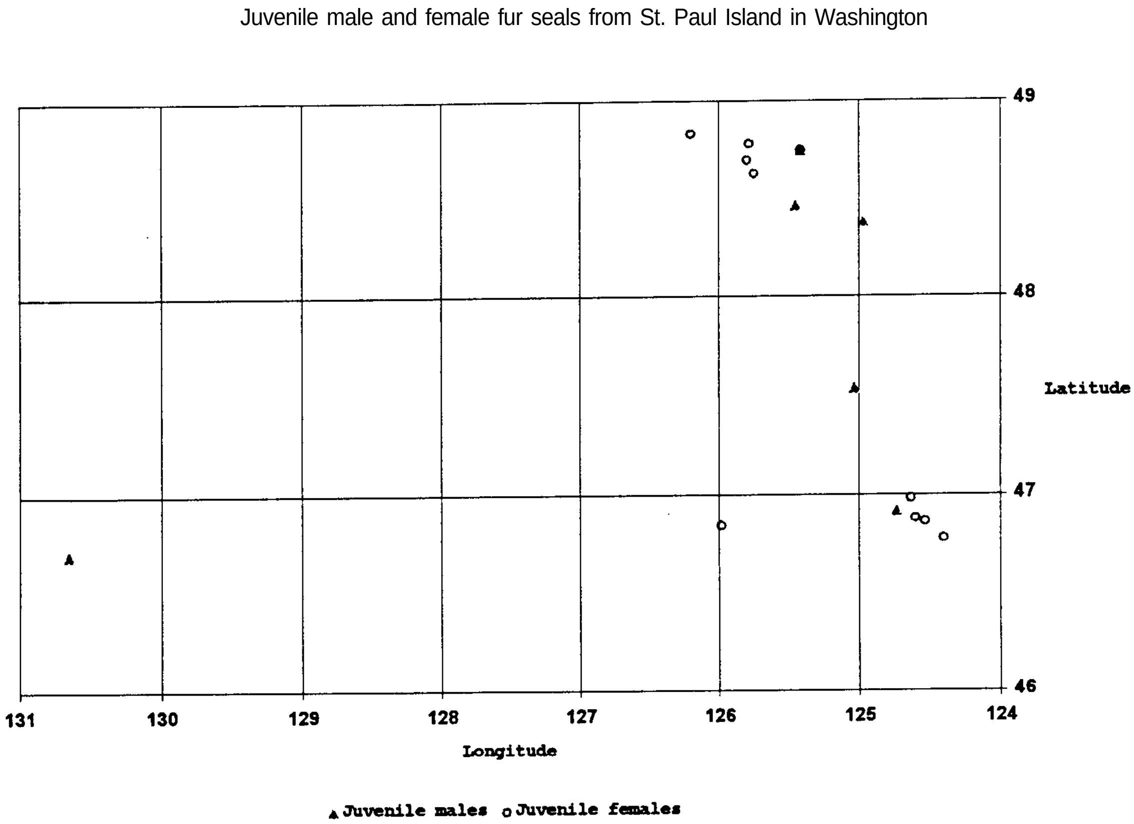


Figure 28.--Locations in Washington during the months of April (1961) and May (1961, 1972) where juvenile (ages l-3 yr) male and female northern fur seals from St. Paul Island were collected pelagically by the United States and Canada.

Table 45.--Stomach contents[1] (*N*, trace occurrences in parentheses) of tagged juvenile (ages l-3 years) northern fur seals, by sex, and tagged lactating female (ages 24 years) northern fur seals from St. Paul Island collected pelagically in the eastern Bering Sea during July and August 1963 by the United States and Canada.

	Juvenile Males			Juvenile Females			Lactating Females		
Prey Species	*N*	Volume (cc)	Count[2]	*N*	Volume (cc)	Count[2]	*N*	Volume (cc)	Count[2]
FISH:									
Capelin (*Mallotus villosus*)	0	-	-	1	185	35	1	291	137
Walleye pollock (*Theragra chalcogramma*)	1(1)	Trace	1	0	-	-	0	-	-
Gadidae	0	-	-	0	-	-	1	19	6
Atka mackerel (*Pleurogrammus monopterygius*)	0	-	-	0	-	-	1	665	4
Pacific sand lance (*Ammodytes hexapterus*)	0	-	-	0	-	-	1	27	46
Pleuronectidae	0	-	-	1	185	5	0	-	-
Unidentified fish	1(1)	Trace	1	0	-	-	0	-	-
Subtotal (fish)	2(2)	Trace	2	1	370	40	4	1,002	193
CEPHALOPODS:									
Gonatus sp.	1(1)	Trace	1	0	-	-	3(3)	24	12
Berryteuthis magister	1	374	44	0	-	-	2(1)	118	5
Gonatopsis borealis	1	201	22	1	Trace	1	3	313	27
Unidentified Gonatidae	3(2)	Trace	63	1(1)	165	11	5	48	114
Subtotal (cephalopods)	3(2)	575	130	2(1)	165	12	6(1)	503	158
TOTAL	4(3)	575	132	3(1)	535	52	7(1)	1,505	351
No. stomachs collected	5			4			12		

1 Miscellaneous items including bird remnants are not included.

The numerical count of the number of identifiable prey specimens. This number should be considered a minimum because it was not always recorded. Therefore, it has not been used to rank diet importance of prey species.

Table 46.--Comparison of diet between tagged juvenile (ages l-3 years) northern fur seals, by sex, and tagged lactating female (ages 24 years) northern fur seals from St. Paul Island collected pelagically in the eastern Bering Sea during July and August 1963 by percentage and rank (in parentheses[1]) of prey species using three methods of ranking relative importance of diet.

	Diet Importance Ranking Methods								
	Percent Frequency			Percent Volume			Modified Volume[2]		
Prey Species	Juvenile Males	Juvenile Females	Lactating Females	Juvenile Males	Juvenile Females	Lactating Females	Juvenile Males	Juvenile Females	Lactating Females
FISH:									
Capelin	-	33.33 (2.5)	14.29 (6.5)	-	34.58 (1.5)	19.34 (3)	-	25.00 (2.5)	12.91 (4)
Walleye pollock	25.00 (4)	-	-	Trace (4.5)	-	-	Trace	-	-
Gadidae	-	-	14.29 (6.5)	-	-	1.26 (8)	-	-	0.84 (6.5)
Atka mackerel	-	-	14.29 (6.5)	-	-	44.19 (1)	-	-	29.50 (2)
Pacific sand lance	-	-	14.29 (6.5)	-	-	1.79 (6.5)	-	-	1.20 (6.5)
Pleuronectidae	-	33.33 (2.5)	-	-	34.58 (1.5)	-	-	25.00 (2.5)	-
Unidentified fish	25.00 (4)	-	-	Trace (4.5)	-	-	-	-	-
Subtotal (fish)	50.00	33.33	57.14	Trace	69.16	66.58	Trace	50.00	44.44
CEPHALOPODS:									
Gonatus sp.	25.00 (4)	-	42.86 (2.5)	Trace (4.5)	-	1.59 (6.5)	Trace	-	2.93 (5)
Berryteuthis magister	25.00 (4)	-	28.57 (4)	65.04 (1)	-	7.84 (4)	65.04 (1)	-	14.41 (3)
Gonatopsis borealis	25.00 (4)	33.33 (2.5)	42.86 (2.5)	34.96 (2)	30.84 (3)	20.80 (2)	34.96 (2)	50.00 (1)	38.22 (1)
Gonatidae	75.00 (1)	33.33 (2.5)	71.43 (1)	Trace (4.5)	Trace (4)	3.19 (5)	-	-	-
Subtotal (cephalopods)	75.00	66.67	85.71	100.00	30.84	33.42	100.00	50.00	55.56
TOTAL	-	-	-	100.00	100.00	100.00	100.00	100.00	100.00
No. stomachs collected	5	4	12						
No. stomachs food	4	3	7						
No. stomachs trace	3	1	1						

[1] Ranks were averaged for ties.

[2] Unidentified categories are either eliminated (unidentified fish and squid categories) or allocated among known categories in the modified volume method (see Bigg and Perez 1985); trace occurrences are also excluded in this method.

Table 47.--Stomach contents[1] (*N*, trace occurrences in parentheses) of all juvenile (ages l-3 years) northern fur seals, by sex, and lactating female (ages 24 years) northern fur seals collected pelagically in the eastern Bering Sea during the first 6 hours of daylight on the same collection dates[2] in July-September 1960-74 by the United States and Canada.

Prey Species	Juvenile Males			Juvenile Females			Lactating Females		
	N	Volume (cc)	Count[3]	*N*	Volume (cc)	Count[3]	*N*	Volume (cc)	Count[3]
FISH:									
Pink salmon (*Oncorhynchus gorbuscha*)	0	-	-	0	-	-	1	770	1
Chum salmon (*Oncorhynchus keta*)	0	-	-	0	-	-	1	4,215	4
Unidentified salmon (*Oncorhynchus* spp.)	0	-	-	0	-	-	1(1)	Trace	1
Salmonidae	1	400	1	0	-	-	0	-	-
Capelin (*Mallotus villosus*)	4	1,581	226	3	77	33	46(3)	22,734	4,866
Osmeridae	0	-	-	1(1)	Trace	1	0	-	-
Deepsea smelts (Bathylagidae)	11(1)	4,062	947	5	390	145	52(8)	11,597	3,258
Lanternfishes (Myctophidae)	0	-	-	0	-	-	1	10	1
Walleye pollock (*Theragra chalcogramma*)	2(2)	Trace	2	1	35	2	22(3)	12,771	1,197
Gadidae	11(7)	289	47	6	1,895	264	30(10)	8,185	983
Atka mackerel (*Pleurogrammus monopterygius*)	1(1)	Trace	1	1(1)	Trace	1	7(1)	962	50
Pacific sand lance (*Ammodytes hexapterus*)	1	112	6	2	578	236	5(2)	1.011	568
Greenland halibut (*Reinhardtius hippoglossoides*)	1	84	9	3(1)	121	35	13(3)	563	63
Pleuronectidae	0	-	-	1	6	1	1(1)	Trace	1
Unidentified fish	2(2)	Trace	2	3(2)	152	3	24(23)	290	118
Subtotal (fish)	29(10)	6,528	1,241	19(3)	3,254	721	176(41)	63,108	11,111
CEPHALOPODS:									
Gonatus sp.	16(14)	43	38	14(11)	128	41	120(85)	2,252	355
Berryteuthis magister	8	2,074	35	4	1,032	25	87(8)	62,224	1,031
Gonatopsis borealis	16(2)	2,166	167	9	1,599	107	118(9)	23,305	1,431
Gonatidae	27(25)	196	494	24(21)	117	423	192(161)	2,744	4,748
Unidentified squid	1(1)	Trace	1	1(1)	Trace	1	3(3)	Trace	76
Subtotal (cephalopods)	30(14)	4,479	735	26(12)	2,876	597	211(75)	90,525	7,641
TOTAL	41(17)	11,007	1,976	33(10)	6,130	1,318	273(74)	153,633	18,752
No. stomachs collected	44			42			306		

[1] Miscellaneous items including bird remnants are not included.

[2] All seals were included, regardless of tag status, when male and female juvenile seals of both sexes were collected on the same days as lactating females were collected. The following months and years were included: July (1960, 1962, 1963, 1964, 1968, 1973), August (1962, 1963, 1964, 1968, 1973, 1974), and September (1963, 1964, 1973). Only stomach contents collected during the first six hours of daylight after sunrise were included in an attempt to provide similarly digested stomach contents data (information on digestion states were not recorded during 1958-74).

[3] The numerical count of the number of identifiable prey specimens. This number should be considered a minimum because it was not always recorded. Therefore, it has not been used to rank diet importance of prey species.

Table 48.--Comparison of diet among juvenile (ages l-3 years) northern fur seals, by sex, and lactating female (ages 24 years) northern fur seals collected pelagically in the eastern Bering Sea during the first 6 hours of daylight on the same collection dates’ in July-September 1960-74 by percentage and rank (in parentheses*) of prey species using three methods of ranking relative importance of diet.

	Diet Importance Ranking Methods								
	Percent Frequency			Percent Volume			Modified Volume[3]		
Prey Species	Juvenile Males	Juvenile Females	Lactating Females	Juvenile Males	Juvenile Females	Lactating Females	Juvenile Males	Juvenile Females	Lactating Females
FISH:									
Pink salmon	-	-	0.37 (16)	-	-	0.50 (13)	-	-	-
Chum salmon	-	-	0.37 (16)	-	-	2.74 (7)	-	-	-
Unidentified salmon	-	-	0.37 (16)	-	-	Trace (16.5)	-	-	-
Salmonidae	2.44 (12)	-	-	3.63 (5)	-	-	3.33 (5)	-	3.99 (6)
Capelin	9.76 (7)	9.09 (8)	16.85 (6)	14.36 (4)	1.26 (10.5)	14.80 (3)	13.15 (4)	1.32 (8)	18.19 (2)
Osmeridae	-	3.03 (13)	-	-	Trace (14)	-	-	-	-
Deepsea smelts	26.83 (4.5)	15.15 (5)	19.05 (5)	36.90 (1)	6.36 (5)	7.55 (4.5)	33.78 (1)	6.71 (5)	9.28 (5)
Lanternfishes	-	-	0.37 (16)	-	-	0.01 (16.5)	-	-	-
Walleye pollock	4.88 (8.5)	3.03 (13)	8.06 (9)	Trace (12.5)	0.57 (10.5)	8.31 (4.5)	-	-	-
Gadidae	26.83 (4.5)	18.18 (4)	10.99 (7)	2.63 (6)	30.91 (1)	5.33 (6)	2.40 (6)	33.10 (1)	16.77 (3)
Atka mackerel	2.44 (12)	3.03 (13)	2.56 (11)	Trace (12.5)	Trace (14)	0.63 (10)	Trace	Trace	0.77 (8)
Pacific sand lance	2.44 (12)	6.06 (10)	1.83 (12)	1.02 (8.5)	9.43 (4)	0.66 (10)	0.93 (7.5)	9.94 (4)	0.81 (8)
Greenland halibut	2.44 (12)	9.09 (8)	4.76 (10)	0.76 (8.5)	1.97 (7.5)	0.37 (13)	0.70 (7.5)	2.18 (6.5)	Trace
Pleuronectidae	-	3.03 (13)	0.37 (16)	-	0.10 (12)	Trace (16.5)	-	-	-
Unidentified fish	4.88 (8.5)	9.09 (8)	8.79 (8)	Trace (12.5)	2.48 (7.5)	0.19 (13)	-	-	-
Subtotal (fish)	70.73	57.58	64.47	59.31	53.08	41.08	54.29	53.33	49.82
CEPHALOPODS:									
Gonatus sp.	39.02 (2.5)	42.42 (2)	43.96 (2)	0.39 (10)	2.09 (7.5)	1.47 (10)	0.46 (9)	2.17 (6.5)	1.29 (8)
Berryteuthis magister	19.51 (6)	12.12 (6)	31.87 (4)	18.84 (3)	16.84 (3)	40.50 (1)	22.14 (3)	17.46 (3)	35.57 (1)
Gonatopsis borealis	39.02 (2.5)	27.27 (3)	43.22 (3)	19.68 (2)	26.08 (2)	15.17 (2)	23.12 (2)	27.05 (2)	13.32 (4)
Gonatidae	65.85 (1)	72.73 (1)	70.33 (1)	1.78 (7)	1.91 (7.5)	1.79 (8)	-	-	-
Unidentified squid	2.44 (12)	3.03 (13)	1.10 (13)	Trace (12.5)	Trace (14)	Trace (16.5)	-	-	-
Subtotal (cephalopods)	73.17	78.79	77.29	40.69	46.92	58.92	45.71	46.67	50.18
TOTAL	-	-	-	100.00	100.00	100.00	100.00	100.00	100.00
No. stomachs collected	44	42	306						
No. stomachs food	41	33	273						
No. stomachs trace	17	10	74						

Table 48.--Continued.

[1] All seals were included, regardless of tags status, when male and female juvenile seals of both sexes were collected on the same days as lactating females were collected. The following months and years were included: July (1960, 1962, 1963, 1964, 1968, 1973), August (1962, 1963, 1964, 1968, 1973, 1974), and September (1963, 1964, 1973). Only stomach contents collected during the first 6 hours of daylight after sunrise were included in an attempt to provide similarly digested stomach contents data (information on digestion states were not recorded during 1958-74).

[2] Ranks were averaged for ties.

[3] Unidentified categories are either eliminated (unidentified fish and squid categories) or allocated among known categories in the modified volume method (see Bigg and Perez 1985); trace occurrences are also excluded in this method. Salmon and gadid categories were pooled to calculate modified volume in this table.

primarily fed on gonatid squid species, but capelin, Atka mackerel (Pleurogrammus monopterygius) (lactating seals only), and flounders (Pleuronectidae) (‘juvenile females only) were also important diet items of tagged seals (Table 46). However, when untagged seals were included in the analysis (Table 47) gonatid squids (especially ***Gonatopsis borealis*** and ***Beryteuthis magister)*** were the principal food items, in addition to deepsea smelts (Bathylagidae), capelin, and gadid fishes (mainly walleye pollock) (Table 48). These prey species were important to each of the three northern fur seal groups (Table 48) and any differences in ranks of importance were primarily due to individual feeding behavior and differences in digestion of stomach contents attributed to the different feeding (and collection) times of fur seals in the early morning hours. Juvenile fur seals and lactating female fur seals were collected in similar localities in the eastern Bering Sea during 1960-74 (Figs. 29 and 30).

The collection sites may not be the locations where the seals fed; some lactating females may have been collected in localities along their return transit route to the Pribilof Islands from their feeding locations. This could be one explanation for differences in importance of prey species among the different seal groups, in addition to different times of collection during the day (quantity of stomach contents would be affected by variable digestion rates), opportunistic feeding habits of individual seals (biased by low sample sizes), and possible different prey selection.

Statistical analyses of the diet composition data in Tables 35-48 were not performed because of 1) lack of information on digestion states of food eaten, 2) incomplete information with which to reconstruct diets to reflect quantities actually eaten, and 3) low sample sizes. Data were not recorded during 1958-74 on digestion states of the stomach contents (except for some Canadian collections). Likewise, the number (count data) of individual specimens for each prey taxon eaten by each fur seal was frequently not estimated; the size of individual specimens was

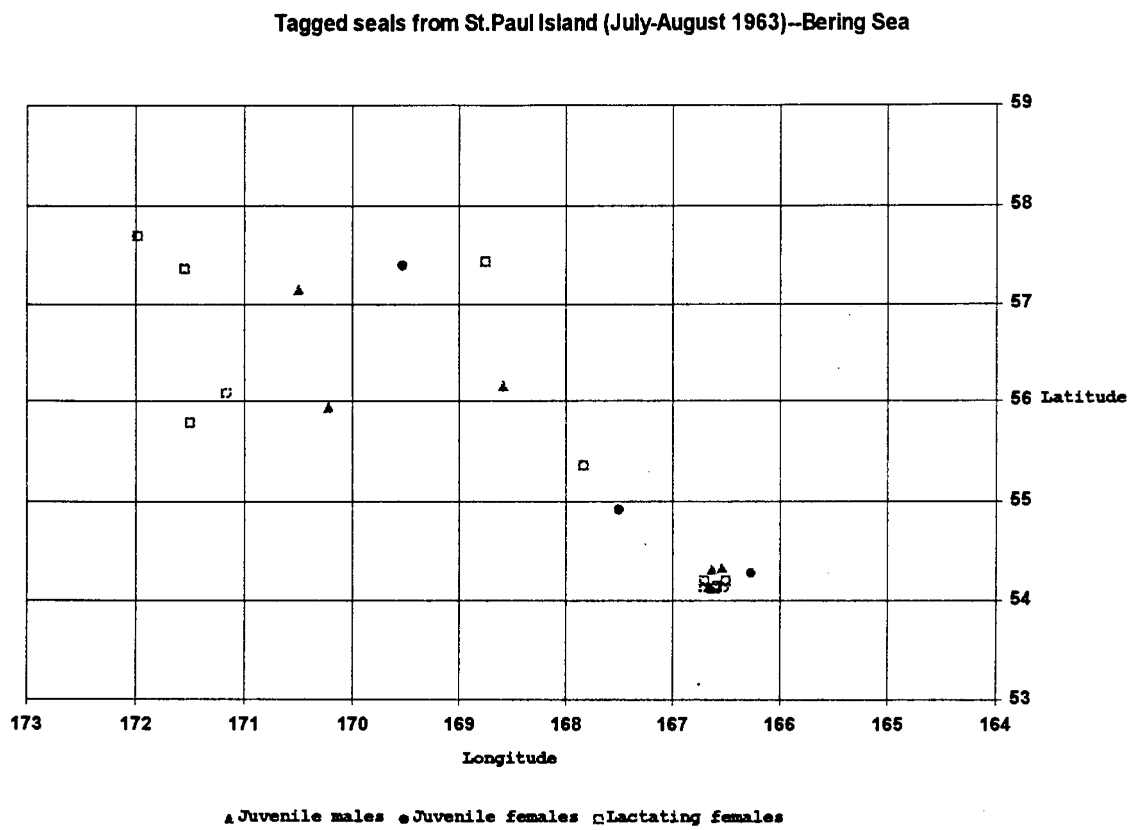


Figure 29.--Locations in the Bering Sea during July and August 1963 where tagged juvenile (ages l-3 years) northern fur seals, by sex, and tagged lactating female (ages 24 years) northern fur seals from St. Paul Island (Pribilof Islands) were collected pelagically by the United States and Canada.

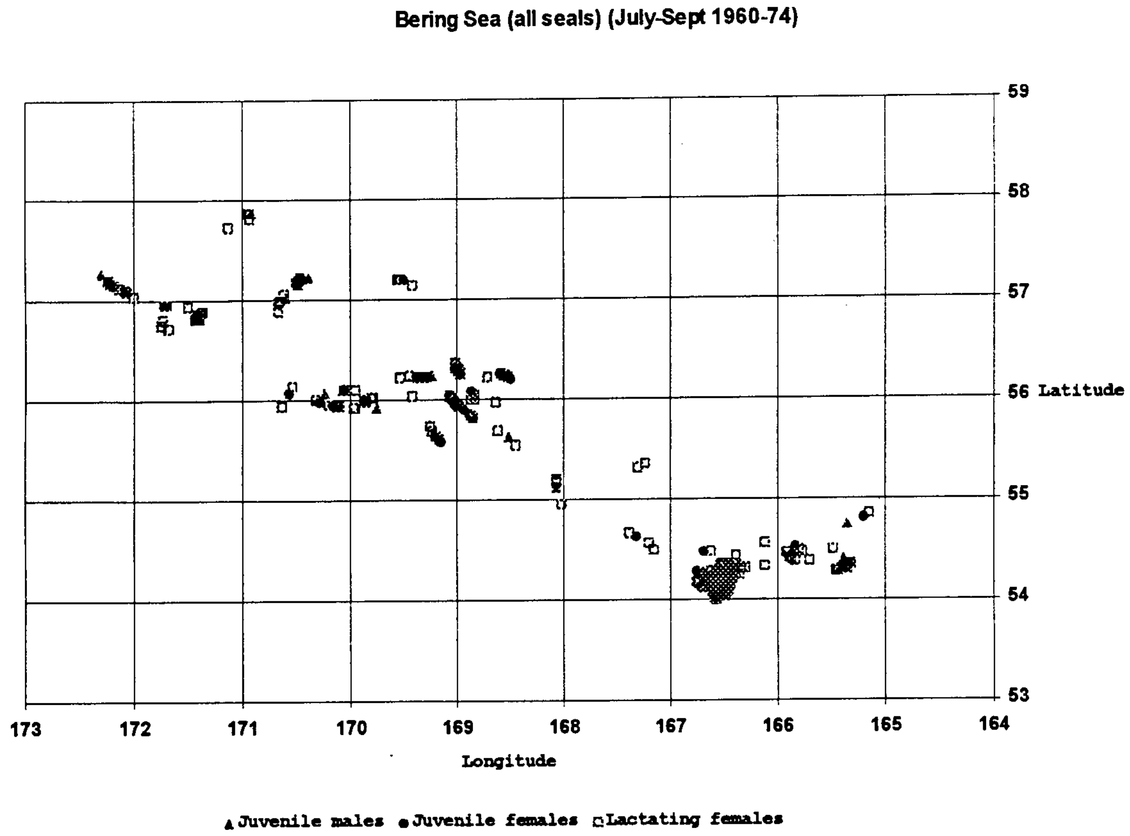


Figure 30.--Locations in the eastern Bering Sea where all juvenile (ages 1-3 years) northern fur seals, by sex, and lactating female (ages >4 years) northern fur seals were collected pelagically during the first six hours of daylight on the same collection dates in July-September 1960-74 by the United States and Canada.

rarely recorded. Therefore, it is not possible to backcalculate or reconstruct the meal size for a particular seal using the volumetric or count data. Due to this situation it is not possible to assume that the variance of the diet among groups to be compared would be similar or could be transformed to approximate a normal distribution, thereby restricting the use of standard statistical methods.

Furthermore, the sample sizes (number of seals with food) of at least one of the groups listed in each of Tables 35-48 was less than 40. Using plots of cumulative Brillouin diversity indices (for the number of prey eaten) by the number of fur seal stomachs added to the data pool (and also bootstrap analyses of the variance and mean of total volume of stomach contents), Perez (1984) found that a sample size greater than 40 is necessary to assess the general diet of northern fur seals within a region during the same time period using the 1958-74 pelagic database. For smaller samples, the likelihood of any fur seal stomach in the sample containing the same prey in similar proportions as the other seal stomachs in the sample is probably low, especially since most seal stomachs contain usually only one food type.

Somerton (1991) also suggested that reasonably large sample sizes (>50 stomachs with prey per sample) are necessary to estimate parameters for testing differences in diets using a nonparametric MANOVA method. In this method, gravimetric (or presumably volumetric) proportions, and their variances and covariances, for each prey taxon are calculated, and a measure of the statistical difference between samples is then calculated and tested for significance. However, this method can only be applied to cases in which the two diet samples lack mutually exclusive prey components. Because gravimetric or volumetric data are used in this method, trace occurrences must be eliminated prior to analyses because they are zero proportions; alternatively, unrelated taxa can be pooled to higher levels to remove the restriction on trace occurrences. This constraint arises because computation of one of the parameters requires inversion of a variance-covariance matrix which is singular and therefore not invertible when a prey category is completely absent from one of the samples. This constraint further reduces the sample sizes of available data from the 1958-74 pelagic fur seal database if similar statistical methods were used to detect diet differences.

Sample sizes were also too low to perform valid 2X2 and 3X2 contingency table tests on the presence of fish or squid in the diet. The chi-square statistic in these tests is only an approximation and it is not recommended for small samples (Zar 1984). More than 20% of the cells in contingency tables constructed from the data in Tables 35-46 would have expected values less than five, and some cells have an expected value less than 1. However, 3X2 table tests on the data in Table 47 did not show any significant difference in the proportion of food stomachs (including traces) with fish or squid among juvenile males, juvenile females and lactating females (regardless of tags).

The data in Appendix Table D-l can only provide indicative information with respect to fur seal population feeding habits. Any differences ascribed to these limited data may only reflect individual variability in feeding habits among seals which usually feed opportunistically on a single prey species at any particular time (Kajimura 1984); whereas, 80% of the diet of the northern fur seal population in a region typically consists of only three prey species (Perez and Bigg 1986).

For the reasons stated above the 1958-74 pelagic database of the United States and Canada indicates support for but lacks sufficient sample sizes to statistically test the hypotheses that northern fur seals from St. George and St. Paul Islands may either utilize a different prey base in the same feeding area or feed in oceanographically different zones. Therefore, additional data must be obtained in future research, usually new and/or current methods, specifically designed to address these hypotheses.

CENSUS OF NORTHERN FUR SEAL PUPS ON BOGOSLOF ISLAND, ALASKA, 1995

by

Rodney G. Towel1 and J. Michael Strick

Northern fur seal, ***Callorhinus ursinus,*** pups on Bogoslof Island, Alaska, were counted on 25 September 1995. A total of 1,272 live pups were counted on all beaches. Non-pup fur seals were not counted due to time constraints.

METHODS

Northern fur seal pups were counted directly while walking next to or through all rookeries on the island. The distribution of rookeries on Bogoslof Island are shown in Figure 4. Pups are very mobile this late in the season, which made counting problematical. Counters moved down the rookery separating and counting small pods of pups which were driven back toward the direction from which the counters had come. In this way, double-counting of individuals was minimized. Independent counts were made by two observers and averaged for each of the three rookery areas. Total number of live pups is the sum of the mean counts from each rookery.

RESULTS

A total of 229 live pups were counted on the south rookery, 170 live pups on the northeast rookery, and 873 live pups on the northwest rookery. Dead pups were not counted due to time constraints. The rookery area on the northeast side of the island extended farther north in 1995 than in 1993 (Ream and Towel1 1994). This is likely due to the increased mobility of the pups late in the season.

The live pup count in 1995 represents a 13.6% decrease (200 individuals) from the live pup count in 1994 (Piatt and Goley 1996). The live pup count in 1995 should be considered a minimum estimate of pup production since dead pups were not counted and some pups could have been missed. On St. Paul Island, pups spend approximately 30% of their time in the water during this time of the year (J. Baker, pers. comm.). Large numbers of pups in the water may have been missed. Pup counts for Bogoslof Island since 1980 are listed in Table 49 and graphically represented in Figure 31.

Other Observations

The counts of northern fur seal pups were done late in the season. The distribution of animals was wider than when the counts were done in 1993, as adults and pups were more spread out along the beaches. Steller sea lion, ***Eumetopias jubatus,*** pups, juveniles, and adults were observed on Bogoslof Island but were not counted. Prior to landing on Bogoslof Island, 8 adult harbor seals ***Phoca vitulina*** were observed hauled out on the east side of the island.

Table 49.-- Count of northern fur seal pups on Bogoslof Island, Alaska, since 1980. Pups were present in 1986 but were not counted.

Year	Date	Pups
1980	20 July	2
1982	7 July	3
1983	11 Aug.	13
1984	31 Aug.	14
1985	18 Aug.	9
1986	2 Aug.	present
1988	2 Aug.	80
1989	22 July	99
1990	24 July	181
1993	23 Aug.	890
1994	18 Aug.	1472
1995	25 Sept.	1272

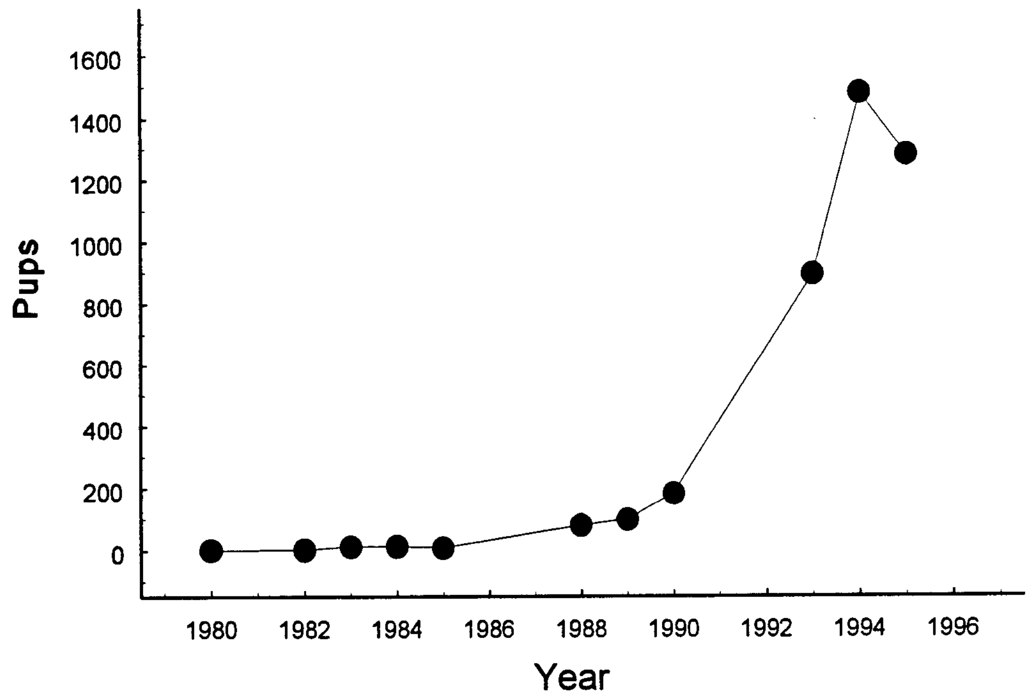


Figure 3 1 .-- The number of northern fur seal pups, ***Callorhinus ursinus,*** observed on Bogoslof Island, Alaska, 1980-95.

POPULATION MONITORING STUDIES OF NORTHERN FUR SEALS AT SAN MIGUEL ISLAND, CALIFORNIA

by

Sharon R. Melin and Robert L. DeLong

The northern fur seal population at San Miguel Island California (34° 01'N, 120° 26'W) was discovered in 1968. Because the population was discovered while very small (only 100 females, 28 pups, and 1 territorial bull in 1968) the growth of this population has provided an opportunity to study the population dynamics of a growing population.

Population monitoring studies of the northern fur seal population at Adams Cove Rookery have been conducted since the discovery of the colony. In general, the population has grown steadily with one severe decline probably resulting from high adult mortality during the 1982-83 El Niño (DeLong and Antonelis 1991). Since 1984, the population has grown steadily and, in 199 1, fully recovered to pre-El Niño levels (Melin and DeLong 1994). The 1992-93 El Niño conditions resulted in reduced pup production in 1992 but the population recovered in 1993 and increased in 1994 (Melin et al. 1996).

This paper presents the results of the 1995 population monitoring studies at San Miguel Island. The studies continued to focus on estimates of pup production, mortality and general health of pups and survival and reproductive status of tagged animals.

METHODS

Observations and Census of Adults

Daily observations of territorial northern fur seal bulls (Classes 2 and 3) at Adams Cove, San Miguel Island were conducted every 1 to 3 days from 30 May through 26 July

1995. Observations were conducted using a 60 mm zoom scope and 10 X 50 binoculars from two blinds overlooking the Adams Cove rookery (approximately 20 m above and 40 to 300 m horizontal distance from the breeding animals).

The number of territorial bulls with females at Castle Rock was determined from photographs obtained from an aerial survey on 11 July 1995. Surveys were flown at an altitude of 500 ft and photos were taken using a 200 mm lens.

Live Pup Census and Pup Mortality

Live pup counts were conducted on 27 July at Adams Cove and 1 August at Castle Rock. The live pup census was conducted by two observers using binoculars and counting groups of pups at both rookeries. The mean number of pups at each rookery was calculated from the total counts of the two observers. The standard error (SE) about the mean was calculated using the sum of the variances from the two independent counts for each group of pups.

Three fur seal pup mortality surveys, one each in June, July, and August, were conducted in Adams Cove. In June, pups were not collected from within the breeding groups because of the potential for disturbance to newborn pups and pregnant females. During the July and August surveys, pups were collected from the entire fur seal rookery. 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. At Castle Rock, dead pups were counted once during the live pup census. The total dead pup count at each rookery is the sum of the dead pups counted by each observer at each rookery.

Pup Tagging and Growth

A total of 300 northern fur seal pups were tagged with pink plastic roto tags in Adams

Cove on 5 and 6 October. Tags with the same number were placed on both foreflippers of each pup. Each pup was sexed, weighed, and measured (length and girth) and released.

Resight Effort

Efforts to resight tagged juvenile and idle adult male northern fur seals at San Miguel Island were conducted every 1 to 3 days throughout the breeding season. Resight efforts for tagged females and territorial males were conducted on 10 and 31 July. Tagged individuals were identified by reading tags on the foreflippers using binoculars or a 60 mm zoom scope. The tag numbers, association and reproductive status (with or without pup, territorial or non-territorial) were recorded.

RESULTS

Observation and Census of Adults

Territorial northern fur males arrived before 30 May and the maximum number of territorial males with females, 104, occurred on 13 July. An additional 50 males held territories without females on the same date. At Castle Rock, 48 territorial bulls with females were counted from aerial photographs. Males holding territory without females were not possible to distinguish from idle males, therefore this class was not counted at Castle Rock.

Pup Census

The mean count of live fur seal pups was 1,577 pups at Adams Cove on 26 July (Table 50). Eighty-nine dead pups were counted in Adams Cove throughout the season producing an observed mortality rate of 5.3 % for this rookery.

At Castle Rock, a mean of 795 live fur seal pups was counted and 48 dead pups were counted (Table 50). This represents a 9.7% decline from the 1994 count at Castle Rock reported in Melin et al. (1996). The observed mortality rate was 5.7 % at Castle Rock.

Table 50.--Northern fur seal pup counts at Adams Cove and Castle Rock, San Miguel Island and total for San Miguel Island 1995. Number live and dead is the minimum number of pups in the population.

Location	Date[1]	Mean Number Live	SE	Number Dead[2]	Total	% Mortality[3]
Adams Cove	26 Jul	1577	0.17	86	1666	5.2
Castle Rock	1 Aug	795	0.19	48	843	5.7
Total		2372	0.15	134	2509	5.3

[1] Date of live pup count
[2] Number of dead pups is a cumulative count over the season, beginning at the end of June; does not include mortalities early in the season.
[3] Should be used only as an index of pup mortality

For the San Miguel Island population, the observed fur seal pup production in 1995 was 2,509 which represents a 4.7% decline from the 1994 production reported in Melin et al. (1996). The observed mortality rate for the population at San Miguel Island was 5.5 % (Table 50).

Pup Growth

In 1995, the mean weights of male (11.9 kg) fur seal pups were similar to the weights of males in 1994 (11.6 kg) (ANOVA p=O.112) (Table 51). The mean length (79.5 cm) and girth (57.9 cm) of male pups were greater in 1995 than male pups in 1994 (lengths ANOVA=.OOO; girths ANOVA=.OOl).

The mean weight of female pups in 1995 (10.8 kg) was greater than that for females in 1994 (10.2 kg) (ANOVA p=.004) (Table 51). The mean length of females in 1995 (73.2 cm) was about 3 cm less than females in 1994 (ANOVA p= .000) but the average girth (56.3 cm) was greater than females in 1994 (ANOVA p= .000).

Resight Effort

Forty-two adult female and 128 male individuals were identified throughout the season. The age groups of females ranged from 4 to 15 years and for males from 3 to 11 years (Table 52). Of the 18 females sighted with pups, 7 (38.9%) were 7 years of age. The remaining females with pups represented age groups 6 years old and 9 to 15 years old.

Of the 128 males identified, 10 were territorial with females (Table 52). The age groups of territorial males ranged from 6 to 11 years of age and the average age was 8.6 years (SE=0.538). For comparison to the Pribilof population, we calculated the mean age of territorial males at the Pribilof Islands from Table 50 in Johnson (1968). The mean age of 405 males was 10.9 years (SE=0.096).

Table 5 1 .--Length, girth and weight of northern fur seal pups at 3 months of age at Adams Cove, San Miguel Island in 1994 and 1995. P-value is derived from a one-way Analysis of Variance by years.

Sex	n	Mean Length (cm)	p-value	Mean Girth (cm)	p-value	Mean Weight (kg)	p-value
Females							
1994	144	76.7 (0.32)		53.7 (0.36)		10.2 (0.14)	
1995	132	73.2 (0.33)	0.000	56.3 (0.34)	0.000	10.8 (0.15)	0.004
Males							
1994	156	78.6 (0.32)		56.2 (0.37)		11.6 (0.17)	
1995	168	79.5 (0.36)	0.000	57.9 (0.34)	0.001	11.9 (0.15)	0.112

Table 52.--Number of tagged northern fur seals sighted at Adams Cove, San Miguel Island, California from May through August 1995.

	Females				Males			
Cohort	n	Number Sighted	Percent of Cohort Sighted	Number With Pups	n	Number Sighted	Percent of Cohort Sighted	Number of Territorial Males
1980	119	1	0.8	1	81	0	----	-
1981	105	1	1.0	1	107	0	----	-
1984	51	2	3.9	-	48	1	2.1	2
1985	43	3	7.0	1	57	4	7.0	1
1986	51	2	3.9	1	48	2	4.2	2
1987	56	4	7.1	2	43	5	11.6	2
1988	192	12	6.3	7	195	25	12.8	2
1989	159	5	3.1	1	195	37	19.0	1
1990	85	4	4.7	2	114	19	16.7	-
1991	159	8	5.0	2	142	29	20.4	-
1992	163	0	---	-	136	6	4.4	-
Total		42		18		128		10

DISCUSSION

The indices of population growth traditionally monitored at San Miguel Island, territorial bull and pup counts, have provided good indicators of the population trends over the past 25 years. In 1995, the number of territorial bulls increased from 97 bulls in 1994 to 104 in 1995, indicating that new males continue to be recruited into the breeding population.

The 4.7% decline in production at San Miguel Island was primarily due to the 9.7% decline in observed pup production at Castle Rock in 1995. This decline follows a year in which the highest count on record was observed at Castle Rock (see Melin et al. 1996). Continued monitoring of the Castle Rock population will aid in the interpretation of whether the decline is a temporary fluctuation or a long-term trend in population growth.

The slowing of growth of the Adams Cove population observed in 1995 either reflects a lower recruitment rate of females or reduced natality rates. A lower recruitment rate in 1995 may be caused by lower survival of juveniles from the 1989, 1990, and 1991 cohorts during the 1992 and 1993 El Niño conditions in the north Pacific. We have not measured natality rates at San Miguel Island, thus while reduced natality is a possible explanation for the lower production in 1995, we have no data to support or refute this possibility. It is also possible that high pup mortality prior to the live pup count could result in slowed growth, but the observed pup mortality in Adams Cove (5.2%) in 1995 was lower than the 1994 mortality rate (7.1%) reported by Melin et al. (1996) and the condition of pups at 3 months of age indicated that pups were in good health in 1995, making, this explanation unlikely. It seems most probable that the decrease in the number of pups born in 1995 at both Adams Cove and Castle Rock is due to lower recruitment of females and that the slowed growth is temporary. If this is true, we expect that 1996 and 1997 pup production will also be depressed due to lower recruitment of females from the 1989 through 1991 cohorts. Population monitoring studies will be continued to determine if these trends occur in the population growth at San Miguel Island.

Because of the small sample size of known-age individuals at San Miguel Island, information on survival and age of first reproduction is lacking. However age distribution data for reproductive females (Table 52) suggests that females first reproductive at 4 years of age may continue to produce pups until at least 15 years of age. Additional data need to be collected to accurately describe the age distribution of reproductive females at San Miguel Island and to compare these data with those from the Pribilof Islands population.

The mean age of territorial males with females at San Miguel Island (8.6 years) is less than the 10.9 years calculated from Johnson (1968) for the Pribilof Islands population. DeLong (1982) suggested that males at San Miguel Island were holding territories at a younger age because of the lack of older males in the growing population. Our data suggests that males are still successfully establishing territories at a younger age at San Miguel Island. The older age groups may, however, be under-represented in the San Miguel data because the pink plastic roto tags used to identify individuals are often lost or the numbers are worn off on older individuals. If the older age groups are under-represented, the mean age at San Miguel may be closer to the age reported for male fur seals on the Pribilof Islands.

The results of the 1995 monitoring studies suggest that the growth of the northern fur seal population at San Miguel Island slowed in 1995. Population monitoring studies in the next few years will determine if the slowed growth is a temporary fluctuation or a long-term trend.

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APPENDIX A

Glossary

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

Bachelor	Young male seals of age 2-5 years.

<u>Classifications of adult male fur seals</u>

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

Class 4 (back fringe)	Full- and partly grown males on the inland fringe of a rookery. A few animals too young and too small to include in the count may be found here. Though some Class 4 males may appear to be holding territories, most will flee when approached or when prodded with a pole.
Class 5 (hauling ground)	The hauling grounds contain males from May to late July and a mixture of males and females from then on. The counts include males that obviously are adults and all others that have a mane and the body conformation of an adult. Males included in this count are approximately 7 years of age and older. Prior to 1966, Class 3 males were called harem bulls, and Classes 1,2,4, and 5 were collectively called idle bulls. From 1966 through 1974, the adult male seals were classified into five groups (Classes 1, 2, 3, 4, and 5). Beginning in 1975, Classes 1 and 2 were combined and designated as Class. 2, Class 3 remained the same, and Classes 4 and 5 were combined and designated as Class 5.
Drive	The act of surrounding and moving groups of seals from one location to another.
Hauling ground	An area, usually near a rookery, on which nonbreeding seals congregate. See Rookery.
Haul out	The act of seals moving from the sea onto shore at either a rookery or hauling ground.
Kleptogyny	The act of an adult male seal (primarily Classes 1, 2, or 3) seizing an adult female from another male's territory.
Known-age	Refers to a seal whose age is known because the animal bears an inscribed tag or other type of mark.

Marked	Describes a seal that has been marked by 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 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 years, the vibrissae usually are entirely white.

APPENDIX B

Tabulations of adult male northern fur seals counted by rookery, size class, and rookery section.

Table B-1.--Number of adult male northern fur seals counted, by class[a] and rookery section, St. Paul Island, Alaska, 11-15 July 1995. 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	19	28	-	-	-	-	-	-	-	-	-	-	-	-	47
3	74	74	-	-	-	-	-	-	-	-	-	-	-	-	148
5	110	39	-	-	-	-	-	-	-	-	-	-	-	-	149
Kitovi[b]															
2	12(13)	6	15	15	24	-	-	-	-	-	-	-	-	-	85
3	45(14)	12	58	45	69	-	-	-	-	-	-	-	-	-	243
5	32(89)	7	21	13	162	-	-	-	-	-	-	-	-	-	324
Reef															
2	62	39	46	23	24	30	11	21	25	20	5	-	-	-	306
3	138	80	83	73	66	95	2	77	51	39	2	-	-	-	706
5	124	27	75	64	189	43	59	144	26	101	133	-	-	-	985
Gorbatch															
2	65	58	40	0	57	51	-	-	-	-	-	-	-	-	271
3	111	55	89	0	63	56	-	-	-	-	-	-	-	-	374
5	579	15	35	227	0	23	-	-	-	-	-	-	-	-	879
Ardiguen															
2	30	-	-	-	-	-	-	-	-	-	-	-	-	-	30
3	58	-	-	-	-	-	-	-	-	-	-	-	-	-	58
5	23	-	-	-	-	-	-	-	-	-	-	-	-	-	23
Morjovi[c]															
2	9(11)	24	25	15	27	21	-	-	-	-	-	-	-	-	132
3	61(24)	60	65	39	79	52	-	-	-	-	-	-	-	-	380
5	174(19)	22	82	12	12	120	-	-	-	-	-	-	-	-	441
Vostochni															
2	18	4	9	8	8	26	11	17	14	5	8	34	33	19	214
3	63	35	47	60	45	132	45	69	42	37	33	53	172	81	914
5	36	19	81	19	145	67	22	27	126	0	5	5	225	193	970
Little Polovina															
2	9	-	-	-	-	-	-	-	-	-	-	-	-	-	9
3	10	-	-	-	-	-	-	-	-	-	-	-	-	-	10
5	192	-	-	-	-	-	-	-	-	-	-	-	-	-	192
Polovina															
2	26	5	-	-	-	-	-	-	-	-	-	-	-	-	31
3	66	19	-	-	-	-	-	-	-	-	-	-	-	-	85
5	178	103	-	-	-	-	-	-	-	-	-	-	-	-	281
Polovina Cliffs															
2	26	16	17	12	14	27	43	-	-	-	-	-	-	-	155
3	54	46	50	65	80	136	165	-	-	-	-	-	-	-	596
5	27	23	28	19	21	28	58	-	-	-	-	-	-	-	204
Tolstoi															
2	15	10	13	18	31	20	26	16	-	-	-	-	-	-	149
3	53	48	65	66	109	65	88	65	-	-	-	-	-	-	559
5	13	12	23	34	27	51	92	195	-	-	-	-	-	-	447
Zapadni Reef															
2	62	11	-	-	-	-	-	-	-	-	-	-	-	-	73
3	138	62	-	-	-	-	-	-	-	-	-	-	-	-	200
5	124	157	-	-	-	-	-	-	-	-	-	-	-	-	281
Little Zapadni															
2	6	18	26	27	28	18	-	-	-	-	-	-	-	-	123
3	12	56	83	66	48	59	-	-	-	-	-	-	-	-	324
5	31	21	27	39	60	203	-	-	-	-	-	-	-	-	381
Zapadni[d]															
2	26(0)	27	24	35	31	41	19	11	-	-	-	-	-	-	214
3	59(0)	73	90	79	75	85	80	16	-	-	-	-	-	-	557
5	8(167)	43	38	38	110	52	39	568	-	-	-	-	-	-	1063

[a] See Glossary for a description of the classes of adult males seals.
[b] Numbers in parentheses are the adult males counted in Kitovi Amphitheater.
[c] Numbers in parentheses are the adult males counted on the second point south of Sea Lion Neck.
[d] Numbers in parentheses are the adult males counted on Zapadni Point Reef.

Appendix Table B-2.--Number of harem and idle male northern fur seals counted in mid-July, Pribilof Islands, Alaska, 1986-95.

Year	St. Paul Island		St. George Island		Total	
	Harem	Idle	Harem	Idle	Harem	Idle
1986	4,603	1,865	1,394	1,342	5,997	3,207
1987	3,636	1,892	1,303	1,283	4,939	3,175
1988	3,585	3,201	1,259	1,258	4,844	4,459
1989	4,297	6,400	1,241	1,163	5,538	7,563
1990	4,430	7,632	909	1,666	5,339	9,298
1991	4,729	9,543	736	1,271	5,465	10,814
1992	5,460	10,940	1,028	1,834	6,488	12,774
1993	6,405	9,301	1,123	1,422	7,528	10,723
1994	5,715	10,014	1,174	1,590	6,889	11,436
1995	5,154	8,459	1,242	1,054	6,396	9,513

APPENDIX C

Mean mass, length, and 95 % confidence intervals by rookery and date for northern fur seal pups.

Appendix Table C-l .--Sample sizes (n), mean mass (kg.), and standard deviation (SD) of male and female northern fur seal pups weighed on St. Paul Island, Alaska, 25 - 29 August 1995.

Rookery		Females	Males	Combined
Reef	kg.	8.12	8.80	8.53
27 August	SD	1.33	1.76	1.64
	n	169	269	438
Vostochni	kg.	8.37	9.61	9.04
26, 28 August	SD	1.31	1.66	1.63
	n	280	329	609
Pol. Cliffs	kg.	8.00	9.52	8.76
29 August	SD	1.47	1.69	1.76
	n	187	185	372
Tolstoi	kg.	7.59	8.71	8.19
25 August	SD	1.57	1.74	1.75
	n	211	247	458
Combined	kg.	8.04	9.17	8.66
	SD	1.45	1.76	1.72
	n	847	1030	1877

Appendix Table C-2.--Sample sizes (n), mean mass (kg.), and standard deviation (SD) of male and female northern fur seal pups weighed on St. George Island, Alaska, 24, 25, 27 and 28 of August 1995.

Rookery		Females	Males	Combined
East	kg.	8.15	9.70	8.92
24 August	SD	1.26	1.92	1.80
	n	51	51	102
East Cliffs	kg.	8.52	9.83	9.40
24 August	SD	1.26	2.06	1.93
	n	33	67	100
Staraya Artil	kg.	8.92	10.24	9.58
28 August	SD	1.72	1.73	1.84
	n	54	54	108
North	kg.	8.81	9.67	9.33
25 August	SD	1.40	1.60	1.58
	n	44	66	110
Zapadni	kg.	8.29	9.12	8.78
27 August	SD	1.43	1.84	1.73
	n	45	66	111
South	kg.	8.73	10.04	9.33
28 August	SD	1.45	1.68	1.68
	n	66	55	121
Combined	kg.	8.58	9.75	9.22
	SD	1.46	1.83	1.77
	n	293	359	652

Appendix Table C-3 .--Sample sizes (n), mean length (cm.), and standard deviation (SD) of male and female northern fur seal pups weighed on St. Paul Island, Alaska 25 - 29 August 1995.

Rookery		Females	Males	Combined
Reef	cm.	70.79	72.29	71.71
27 August	SD	4.50	5.31	5.06
	n	169	270	439
Vostochni	cm.	71.96	74.84	73.52
26, 28 August	SD	4.20	4.45	4.56
	n	280	329	609
Pol. Cliffs	cm.	71.82	74.54	73.17
29 August	SD	4.37	4.21	4.50
	n	187	185	372
Tolstoi	cm.	71.28	74.77	73.16
25 August	SD	4.95	4.86	5.20
	n	212	248	460
Combined	cm.	71.53	74.10	72.94
	SD	4.51	4.86	4.88
	n	848	1032	1880

Appendix Table C-4.--Sample sizes (n), mean length (cm.), and standard deviation (SD) of male and female northern fur seal pups weighed on St. George Island, Alaska 24,25,27 and 28 August 1995.

Rookery		Females	Males	Combined
East	cm.	78.57	82.85	80.71
24 August	SD	3.68	4.06	4.42
	n	51	51	102
East Cliffs	cm.	78.91	82.34	81.21
24 August	SD	2.84	4.28	4.18
	n	33	67	100
Staraya Artil	cm.	80.69	84.17	82.43
28 August	SD	4.88	4.27	4.89
	n	54	54	108
North	cm.	79.50	83.14	81.67
25 August	SD	4.11	3.92	4.37
	n	45	66	111
Zapadni	cm.	78.48	81.19	80.09
27 August	SD	3.84	4.45	4.40
	n	45	66	111
South	cm.	79.23	82.37	80.66
28 August	SD	3.61	3.72	3.97
	n	66	55	121
Combined	cm.	79.27	82.63	81.12
	SD	3.96	4.20	4.42
	n	294	359	653

Appendix Table C-5.--Fraction of northern fur seal pups contributed by each sample rookery to total number of pups born on St. Paul Island and St. George Island, Alaska, for 1992, 1994 and 1995.

Rookery	Fraction		
St. Paul	1992	1994	1995
Reef	0.238	0.242	0.254
Vostochni	0.328	0.302	0.329
Polovina Cliffs	0.178	0.179	0.215
Tolstoi	0.256	0.277	0.202
St. George			
East Reef		0.046	0.067
East Cliffs		0.194	0.215
North		0.379	0.368
Staraya Artil		0.077	0.052
Zapadni		0.169	0.110
South		0.135	0.188

Appendix Table C-6.--Calculated t-statistics for comparison between years of mean mass of northern fur seals on St. Paul Island and St. George Island, Alaska. Significantly different years are in bold text.

	St. Paul		St. George	
	1994	1995	1994	1995
Females				
SP92	**-6.15**	**-10.32**	**12.71**	-2.16
SP94		**-4.38**	**18.73**	2.27
SP95			**22.52**	**5.17**
SG94				**-12.25**
Males				
SP92	1.11	**-8.70**	**16.44**	-1.74
SP94		**-11.08**	**16.61**	-2.68
SP95			**24.80**	**4.66**
SG94				**-15.25**

Appendix Table C-7.--Calculated t-statistics for comparison between years of mean length of northern fur seals on St. Paul Island and St. George Island, Alaska. Significantly different years are in bold text.

	St. Paul		St. George	
	1994	1995	1994	1995
Females				
SP92	**-12.56**	**-19.10**	-3.81	**9.35**
SP94		**-8.24**	**6.78**	**19.50**
SP95			**12.81**	**24.42**
SG94				**11.84**
Males				
SP92	**-17.19**	**-25.39**	-3.79	**10.56**
SP94		**-9.03**	**10.54**	**23.84**
SP95			**17.63**	**30.07**
SG94				**12.66**

APPENDIX D

Appendix Table D- 1 .--Northern fur seals with tags indicating island of origin, including stomach contents, that were collected in the North Pacific and eastern Bering Sea by the United States and Canada during 1958-74 by location where seals were collected pelagically.'

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents Volume[3]	Prey Species
		St. George Island (Pribilof Islands)			
California:					
J 04415	23 Jan 1961 (1345 hr)	33°44'N 120°43'W	4 yr F	Empty	
I 07252	9 Jan 1961 (1520 hr)	38°38'N 123°41'W	5 yr F	Empty	
J 06043	25 Feb 1961 (1100 hr)	36°12'N 122°29'W	4 yr F	Empty	
O 07748	21 Feb 1966 (1410 hr)	37°01'N 122°38'W	4 yr F	Empty	
O 01245	23 Feb 1966 (1100 hr)	38°00'N 123°36'W	4 yr F	Trace (1)	Unidentified fish
O 01915	21 Feb 1966 (0925 hr)	36°55'N 122°34'W	4 yr F	95 cc (3)	Northern anchovy
O 07260	6 Mar 1966 (1515 hr)	35°58'N 122°07'W	4 yr F	Empty	
P 02700	5 Mar 1966 (0730 hr)	36°39'N 122°09'W	3 yr M	75 cc (5)	Northern anchovy
L 04044	3 Mar 1966 (1400 hr)	37°18'N 123°05'W	7 yr F (Preg.)	40 cc (16)	Northern anchovy
same				Trace (5)	*Loligo opalescens*
N 05075	28 Apr 1964 (0850 hr)	37°54'N 123°18'W	3 yr F	Empty	
N 02054	20 May 1965 (1336 hr)	37°35'N 123°08'W	4 yr F	Empty	
N 03347	27 May 1964 (1430 hr)	40°43'N 124°41'W	3 yr F	Trace (1)	Unidentified fish
Q 00526	26 May 1965 (0830 hr)	36°34'N 122°25'W	1 yr M	1,391 cc (6)	Pacific whiting
same				14 cc (4)	*Sebastes* sp.
same				Trace (3)	*Loligo opalescens*
Oregon:					
K 06323	9 Apr 1959 (1000 hr)	43°53'N 124°54'W	1 yr F	Empty	
Washington:					
K 06278	8 Jan 1968 (1305 hr)	48°12'N 125°11'W	10 yr F (Preg.)	90 cc (3)	Salmonidae
O 05424	15 Jan 1972 (1145 hr)	48°29'N 125°32'W	10 yr F (Preg.)	2,510 cc (12)	Pacific herring
M 05613	25 Jan 1972 (1600 hr)	48°24'N 125°47'W	12 yr F (Preg.)	18 cc (2)	*Oncorhynchus* sp.
S 00764	25 Feb 1969 (1446 hr)	47°18'N 124°41'W	3 yr M	Empty	
P 00700	18 Feb 1969 (1012 hr)	47°43'N 125°01'W	6 yr F	Empty	
Q 01218	9 Feb 1968 (1435 hr)	47°10'N 124°41'W	4 yr F	Trace (1)	Unidentified fish
K 05169	9 Feb 1968 (1135 hr)	47°05'N 124°47'W	10 yr F (Preg.)	10 cc (5)	Northern anchovy
N 04454	12 Mar 1962 (1620 hr)	48°48'N 126°23'W	1 yr M	Empty	
O 03737	30 Mar 1966 (0900 hr)	48°19'N 125°24'W	4 yr F	Empty	
S 01135	27 Mar 1972 (1528 hr)	46°49'N 124°37'W	6 yr F (Preg.)	Empty	
J 06279	14 Mar 1958 (1227 hr)	48°25'N 125°35'W	1 yr F	Trace	Unidentified fish
N 05439	27 Mar 1969 (0918 hr)	46°33'N 124°31'W	8 yr F	475 cc (1)	Salmonidae[4]
L 05183	26 Mar 1969 (0751 hr)	46°40'N 124°31'W	10 yr F	656 cc (36)	Northern anchovy
same				34 cc (5)	Capelin
same				Trace (2)	*Onychoteuthis* sp.
N 05249	25 Mar 1970 (0908 hr)	46°20'N 124°22'W	9 yr F (Preg.)	225 cc (9)	Northern anchovy
K 08477	16 Mar 1972 (1505 hr)	47°42'N 125°04'W	14 yr F (Preg.)	Trace (1)	Unidentified fish
K 06381	2 Apr 1959 (1415 hr)	48°28'N 125°08'W	1 yr M	Empty	
L 05254	7 Apr 1961 (1200 hr)	48°16'N 125°28'W	2 yr M	Empty	
J 07454	17 Apr 1961 (1050 hr)	46°39'N 124°32'W	4 yr M	Empty	
M 04939	26 Apr 1961 (1030 hr)	48°47'N 125°47'W	1 yr F	Empty	

Appendix Table D-1.--Continued.

Location/ Tag[2]	Date andTime Seal Collected	Location	Age and Sex (Condition)	Stomach Contents Volume[3]	Prey Species
		St. George Island (continued)			
Washington (continued):					
N 00086	11 Apr 1962 (1745 hr)	48°29'N 125°50'W	1 yr F	Empty	
O 09282	22 Apr 1965 (1330 hr)	47°01'N 124°33'W	3 yr F	Empty	
N 08490	1 Apr 1967 (1410 hr)	46°43'N 124°42'W	6 yr F (Preg.)	Empty	
T 02237	5 Apr 1968 (0815 hr)	48°36'N 125°31'W	1 yr F	Empty	
T 01524	4 Apr 1971 (1217 hr)	46°51'N 124°47'W	4 yr M	Empty	
J 03452	27 Apr 1958 (0910 hr)	48°23'N 125°35'W	1 yr F	430 cc (4)	Pacific herring
N 05951	12 Apr 1962 (0855 hr)	48°44'N 125°25'W	1 yr F	Trace	Unidentified squid
same				Trace	Unidentified fish
N 07126	8 Apr 1965 (1415 hr)	48°27'N 124°58'W	4 yr M	Trace (1)	Unidentified fish
same				Trace (3)	*Loligo opalescens*
N 03371	24 Apr 1965 (1045 hr)	48°32'N 125°17'W	4 yr F	Trace (3)	*Loligo opalescens*
J 09300	3 Apr 1970 (1542 hr)	46°27'N 124°23'W	13 yr F	Trace (1)	Unidentified fish
Marked	23 Apr 1971 (0734 hr)	46°14'N 124°22'W	2 yr F	415 cc (16)	Northern anchovy
K 05382	15 May 1960 (1100 hr)	48°37'N 125°37'W	2 yr M	Empty	
K 06517	29 May 1961 (1750 hr)	48°25'N 125°33'W	3 yr F	Empty	
O 07064	15 May 1967 (1615 hr)	48°48'N 126°14'W	5 yr F	Empty	
Marked	21 May 1971 (1250 hr)	46°47'N 124°39'W	1 yr M	Empty	
J 00896	22 May 1959 (0945 hr)	48°45'N 125°42'W	2 yr F	215 cc	Pacific herring
O 07029	22 May 1969 (1915 hr)	47°12'N 129°42'W	7 yr F (Preg.)	Trace (1)	Unidentified squid
S 00627	25 May 1970 (0830 hr)	47°32'N 128°41'W	4 yr F	Trace (1)	Myctophidae
same				36 cc (1)	Pacific saury
same				Trace (1)	Unidentified fish
same				128 cc (9)	*Onychoteuthis* sp.
same				Trace (1)	*Abraliopsis* sp.
same				Trace (16)	Gonatidae
same				128 cc (15)	*Berryteuthis magister*
same				73 cc (1)	*Gonatopsis borealis*
Marked	6 May 1972 (0740 hr)	46°42'N 130°47'W	3 yr F	Trace (11)	*Onychoteuthis* sp.
same				30 cc (11)	Gonatidae
L 03266	3 Jun 1961 (1505 hr)	48°42'N 125°38'W	2 yr F	Trace	Unidentified fish
British Columbia:					
K 04245	1 Feb 1959 (9999 hr)	50°33'N 126°49'W	1 yr F	Empty	
M 09097	2 Mar 1961 (0900 hr)	52°50'N 128°25'W	1 yr M	249 cc (20)	Unidentified squid
same				1 cc (1)	Unidentified fish
M 00402	7 Mar 1961 (1310 hr)	50°47'N 125°38'W	1 yr F	Trace (1)	Unidentified squid
Gulf of Alaska:					
J 07668	26 May 1968 (0855 hr)	56°37'N 151°46'W	11 yr F (Preg.)	Empty	
K 03359	1 Jul 1963 (1845 hr)	58°01'N 149°40'W	5 yr F	Empty	
Western Alaska:					
P 00947	17 Jun 1968 (1705 hr)	53°41'N 164°27'W	5 yr M	Trace (1)	*Gonatopsis borealis*
M 08707	30 Aug 1962 (1610 hr)	53°51'N 164°36'W	2 yr F	Empty	
L 08985	13 Aug 1962 (1740 hr)	53°46'N 164°32'W	3 yr F	Empty	

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents Volume[3]	Prey Species
		St. George Island (continued)			
Eastern Bering Sea:					
J 06234	13 Jul 1962 (1010 hr)	54°32'N 165°12'W	5 yr F	Empty	
K 01315	31 Jul 1963 (1051 hr)	54°11'N 166°45'W	5 yr F	Empty	
K 09585	6 Jul 1963 (1315 hr)	54°37'N 167°10'W	5 yr F (Preg.)	Empty	
Marked	29 Jul 1973 (1232 hr)	56°07'N 170°58'W	4 yr F	Empty	
Marked	30 Jul 1974 (0810 hr)	57°02'N 169°37'W	4 yr F	Empty	
I 05168	27 Jul 1963 (1125 hr)	55°22'N 168°37'W	7 yr F (Lact.)	Trace (6)	Gonatidae
N 07100	21 Jul 1973 (0755 hr)	55°25'N 168°02'W	12 yr F (Lact.)	160 cc (34)	Walleye pollock
same				Trace (3)	Gonatidae
M 00165	29 Aug 1963 (0845 hr)	57°33'N 171°45'W	3 yr F	Empty	
K 06172	12 Aug 1963 (1320 hr)	54°12'N 166°32'W	5 yr F	Empty	
Q 01642	2 Aug 1968 (1623 hr)	54°24'N 165°54'W	4 yr F	Empty	
J 05565	11 Aug 1962 (0920 hr)	54°28'N 165°27'W	5 yr F	180 cc (60)	Capelin
M 10962	5 Aug 1963 (1055 hr)	54°08'N 166°36'W	3 yr F	Trace (3)	Gonatidae
L 01011	5 Aug 1963 (1150 hr)	54°14'N 166°31'W	4 yr F	Trace (35)	Gonatidae
same				Trace (5)	*Gonatus* sp.
J 03662	9 Aug 1963 (0840 hr)	54°15'N 166°33'W	6 yr F (Lact.)	518 cc (110)	Capelin
same				Trace (17)	Gonatidae
same				11 cc (4)	*Gonatus* sp.
same				16 cc (4)	*Gonatopsis borealis*
N 03375	20 Aug 1964 (0845 hr)	55°56'N 168°58'W	3 yr M	1,310 cc (15)	*Berryteuthis magister*
M 06511	14 Sep 1962 (0855 hr)	54°08'N 166°54'W	2 yr M	Empty	
O 08080	1 Sep 1973 (1350 hr)	56°13'N 168°54'W	11 yr F (Lact.)	Trace (64)	Gonatidae
same				Trace (2)	*Gonatus* sp.
same				1,025 cc (17)	*Berryteuthis magister*
same				Trace (1)	*Gonatopsis borealis*
		St. Paul Island (Pribilof Islands)			
California:					
C 04506	25 Jan 1959 (1705 hr)	35°47'N 122°08'W	10 yr F (Preg.)	Empty	
I 34419	9 Jan 1961 (1010 hr)	38°24'N 123°32'W	5 yr F	168 cc (6)	Northern anchovy
same				72 cc (3)	*Loligo opalescens*
same				Trace (49)	*Onychoteuthis* sp.
same				Trace (1)	Gonatidae
E 11064	23 Jan 1961 (1120 hr)	33°45'N 120°37'W	9 yr F (Preg.)	Trace (6)	Unidentified squid
same				35 cc (45)	*Onychoteuthis* sp.
same				Trace (6)	Gonatidae
same				Trace (12)	*Gonatopsis borealis*
B 11958	18 Jan 1961 (1330 hr)	35°14'N 122°07'W	13 yr F (Preg.)	Trace (10)	Unidentified squid
same				Trace (4)	*Onychoteuthis* sp.
same				Trace (4)	Gonatidae
B 00055	22 Jan 1961 (0710 hr)	34°23'N 121°08'W	13 yr F (Preg.)	325 cc (52)	Blue lanternfish
same				150 cc (3)	Pacific saury
same				5 cc (1)	Unidentified fish
same				Trace (1)	*Loligo opalescens*
same				Trace (5)	*Onychoteuthis* sp.
same				20 cc (2)	Gonatidae
K 11858	22 Jan 1966 (1300 hr)	36°50'N 122°33'W	8 yr F (Preg.)	Trace (1)	Unidentified squid
(H)38090	22 Feb 1959 (1240 hr)	37°45'N 123°26'W	4 yr F	Empty	
(H)48050	13 Feb 1959 (1550 hr)	35°44'N 122°08'W	4 yr F	Empty	
G 03954	13 Feb 1959 (1500 hr)	35°47'N 122°11'W	5 yr F	Empty	

Appendix Table D-l .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents: Volume[3]	Stomach Contents: Prey Species
		St. Paul Island (continued)			
California (continued):					
G 04384	1 Feb 1959 (1540 hr)	34°44'N 121°51'W	5 yr F	Empty	
(H)22100	15 Feb 1961 (1150 hr)	36°13'N 122°18'W	6 yr F (Preg.)	Empty	
N 49042	21 Feb 1966 (1505 hr)	37°20'N 124°42'W	5 yr F	Empty	
A 05946	21 Feb 1958 (0900 hr)	37°09'N 124°18'W	11 yr F (Preg.)	944 cc (20)	Pacific saury
same				236 cc (10)	Unidentified squid
(H)31857	22 Feb 1959 (1130 hr)	37°46'N 123°26'W	4 yr F	35 cc (1)	Northern anchovy
same				Trace (4)	Unidentified squid
(H)29937	9 Feb 1961 (1620 hr)	35°23'N 121°51'W	6 yr F (Preg.)	Trace (1)	Unidentified squid
E 13080	5 Feb 1961 (0950 hr)	34°37'N 121°04'W	9 yr F (Preg.)	700 cc (47)	Northern anchovy
O 39262	23 Feb 1966 (1230 hr)	38°00'N 123°41'W	4 yr F	1,515 cc (79)	Northern anchovy
O 42454	21 Feb 1966 (1445 hr)	37°01'N 122°39'W	4 yr F	90 cc (6)	Northern anchovy
same				Trace (7)	*Loligo opalescens*
N 17124	17 Feb 1966 (1720 hr)	36°22'N 122°18'W	5 yr F	30 cc (1)	Northern anchovy[5]
N 45611	18 Feb 1966 (1210 hr)	36°27'N 122°31'W	5 yr F	Trace (1)	Unidentified fish
M 45367	17 Feb 1966 (1100 hr)	35°54'N 122°09'W	6 yr F (Preg.)	875 cc (37)	Northern anchovy
same				Trace (1)	*Loligo opalescens*
J 24567	18 Feb 1966 (0850 hr)	36°23'N 122°28'W	9 yr F (Preg.)	150 cc (12)	Northern anchovy
same				Trace (1)	Gonatidae
(G)	8 Feb 1966 (1315 hr)	35°26'N 121°20'W	12 yr F (Preg.)	Trace (1)	Northern anchovy
A 00176	3 Mar 1958 (1542 hr)	37°09'N 122°47'W	11 yr F (Preg.)	Empty	
(H)48155	21 Mar 1959 (1721 hr)	41°15'N 125°14'W	4 yr F	Empty	
F 02958	5 Mar 1959 (1410 hr)	37°15'N 123°20'W	6 yr F	Empty	
K 11572	19 Mar 1961 (1150 hr)	36°54'N 123°28'W	3 yr F	Empty	
K 24143	20 Mar 1961 (1710 hr)	36°54'N 123°43'W	3 yr F	Empty	
J 40511	17 Mar 1959 (1032 hr)	41°09'N 125°32'W	2 yr F	91 cc (2)	Pacific saury
same				39 cc (15)	Unidentified squid
G 07848	18 Mar 1959 (0900 hr)	41°44'N 125°51'W	5 yr F	150 cc (1)	Unidentified fish
same				Trace (11)	Unidentified squid
E 14904	23 Mar 1959 (1030 hr)	36°44'N 122°51'W	7 yr F	800 cc (78)	Northern anchovy
same				200 cc (2)	Pacific whiting
O 33480	9 Mar 1966 (1400 hr)	34°49'N 121°39'W	4 yr F	15 cc (1)	Pacific whiting
same				15 cc	Unidentified fish
O 45563	5 Mar 1966 (0930 hr)	36°39'N 122°26'W	4 yr F	520 cc (26)	Northern anchovy
same				Trace (1)	Pacific whiting
same				Trace (1)	Gonatidae
N 43625	5 Mar 1966 (1515 hr)	36°28'N 122°30'W	5 yr F (Preg.)	Trace (1)	Unidentified fish
same				Trace (1)	*O. borealijaponica*
M 53665	8 Mar 1966 (1240 hr)	35°18'N 121°45'W	6 yr F (Preg.)	Trace (1)	Unidentified fish
L 42511	5 Mar 1966 (1515 hr)	36°28'N 122°30'W	7 yr F (Preg.)	1,707 cc (170)	Northern anchovy
same				53 cc (1)	Pacific whiting
L 41250	25 Mar 1966 (1000 hr)	37°39'N 123°07'W	7 yr F (Preg.)	140 cc (1)	Pacific whiting
same				Trace (1)	Unidentified fish
same				Trace (1)	*Abraliopsis* sp.
J 25852	25 Mar 1966 (1343 hr)	37°45'N 123°10'W	9 yr F (Preg.)	Trace (1)	Unidentified fish
N 29091	24 Apr 1964 (1630 hr)	37°21'N 122°53'W	3 yr M	Empty	
N 42708	27 Apr 1964 (0925 hr)	37°47'N 123°19'W	3 yr M	Empty	
G 06777	17 Apr 1965 (1335 hr)	37°40'N 122°57'W	11 yr F (Preg.)	Empty	
G 07981	4 Apr 1959 (1645 hr)	38°07'N 123°49'W	5 yr F	Trace (1)	Pacific whiting
(F/G)	2 Apr 1961 (1615 hr)	39°13'N 123°59'W	8 yr F (Preg.)	Trace (1)	Unidentified fish
N 45379	19 Apr 1964 (0910 hr)	37°15'N 122°58'W	3 yr F	5 cc (6)	*Loligo opalescens*
E 07931	19 Apr 1964 (1020 hr)	37°16'N 123°04'W	12 yr F (Preg.)	1,075 cc (7)	Pacific whiting
M 58449	27 May 1964 (1002 hr)	40°41'N 124°40'W	4 yr F	Trace (1)	Unidentified fish
same				Trace (1)	Gonatidae
M 53030	15 May 1964 (0950 hr)	40°46'N 124°34'W	4 yr F	40 cc (2)	Pacific whiting
same				Trace (1)	*Loligo opalescens*
same				Trace (3)	*Gonatus* sp.

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents	
				Volume[3]	Prey Species
		St. Paul Island (continued)			
California (continued):					
M 42476	19 Jun 1965 (1315 hr)	36°32'N 122°22'W	5 yr F	Empty	
O 14782	23 Jun 1965 (0840 hr)	37°06'N 122°52'W	3 yr F	Trace (1)	Pacific whiting
same				Trace (2)	*Sebastes* sp.
same				1,130 cc (58)	*Loligo opalescens*
O 12883	2 Jun 1965 (0930 hr)	36°36'N 122°23'W	3 yr F	51 cc (1)	Northern anchovy
same				412 cc (10)	*Sebastes* sp.
same				Trace (1)	Unidentified fish
same				52 cc (1)	*Loligo opalescens*
N 47932	23 Jun 1965 (1035 hr)	37°06'N 123°03'W	4 yr F	Trace (1)	Unidentified fish
same				7 cc (1)	*Loligo opalescens*
same				Trace (1)	Gonatidae
N 10587	3 Jun 1965 (1010 hr)	37°01'N 123°19'W	4 yr F	9 cc (3)	Pacific saury
same				28 cc (1)	Jack mackerel
same				Trace (1)	Unidentified fish
same				Trace (1)	Unidentified squid
same				55 cc (5)	*Loligo opalescens*
same				Trace (1)	*O. borealijaponica*
same				Trace (1)	*Abraliopsis* sp.
Oregon:					
J 45659	19 Mar 1959 (1305 hr)	44°46'N 124°55'W	2 yr M	Trace (1)	Unidentified squid
G 05354	19 Mar 1959 (0915 hr)	44°35'N 124°50'W	5 yr F	Trace (2)	Unidentified squid
J 26677	14 Apr 1958 (1300 hr)	43°23'N 124°40'W	1 yr F	Trace (2)	Unidentified squid
O 50752	10 Apr 1964 (1232 hr)	42°27'N 125°00'W	3 yr F	Trace (2)	Unidentified squid
Washington:					
N 34720	19 Dec 1967 (1320 hr)	46°28'N 124°35'W	6 yr F	Empty	
E 00230	15 Dec 1967 (1437 hr)	47°27'N 124°51'W	15 yr F (Preg.)	Trace (1)	Unidentified fish
L 48281	17 Dec 1973 (1135 hr)	48°28'N 125°47'W	14 yr F (Preg.)	Trace	Unidentified fish
same				Trace (15)	*Loligo opalescens*
J 25447	31 Jan 1967 (0805 hr)	46°50'N 124°36'W	10 yr F (Preg.)	Empty	
T 05239	30 Jan 1968 (1140 hr)	46°53'N 124°36'W	1 yr F	Empty	
R 06963	27 Jan 1971 (1306 hr)	48°32'N 125°37'W	6 yr F	Empty	
T 07149	18 Jan 1972 (1440 hr)	48°35'N 125°36'W	5 yr F	Empty	
P 07523	21 Jan 1967 (1230 hr)	48°28'N 124°50'W	4 yr F	Trace (1)	*Loligo opalescens*
N 15698	31 Jan 1967 (0910 hr)	46°54'N 124°33'W	6 yr F (Preg.)	40 cc (4)	Northern anchovy
N 47833	13 Jan 1967 (0855 hr)	48°29'N 124°56'W	6 yr F (Preg.)	75 cc (4)	Pacific herring
same				300 cc (1)	*Oncorhynchus* sp.
same				900 cc (3)	Coho salmon
same				225 cc (11)	*Loligo opalescens* [6]
2S 30805	12 Jan 1968 (1005 hr)	48°28'N 124°46'W	4 yr M	902 cc (2)	Coho salmon [7]
same				48 cc (19)	Eulachon
N 18317	30 Jan 1968 (1445 hr)	46°56'N 124°37'W	7 yr F (Preg.)	35 cc (3)	Northern anchovy
same				315 cc (1)	Coho salmon [8]
T 10073	24 Jan 1971 (1127 hr)	48°54'N 126°08'W	4 yr F	94 cc (2)	Pacific herring
same				94 cc (9)	*Loligo opalescens*
N 22512	11 Jan 1971 (1352 hr)	48°36'N 125°40'W	10 yr F (Preg.)	2,095 cc (21)	Pacific herring [9]
L 39203	9 Jan 1971 (1035 hr)	48°38'N 125°49'W	12 yr F (Preg.)	1,257 cc (11)	Pacific herring
same				13 cc (13)	*Loligo opalescens*
E 08743	14 Jan 1971 (1312 hr)	48°35'N 125°51'W	19 yr F (Preg.)	Trace (2)	*Loligo opalescens*
J 36013	15 Feb 1958 (1025 hr)	48°45'N 125°25'W	1 yr M	Empty	
J 22781	23 Feb 1958 (1415 hr)	48°45'N 125°25'W	1 yr F	Empty	
U 11867	20 Feb 1969 (1700 hr)	48°28'N 125°27'W	1 yr M	Empty	

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents Volume[3]	Prey Species
		St. Paul Island (continued)			
Washington (continued):					
Q 18777	13 Feb 1970 (1512 hr)	48°38'N 126°05'W	6 yr F (Preg.)	Empty	
R 00611	17 Feb 1971 (1405 hr)	48°16'N 125°38'W	6 yr F	Empty	
O 22438	16 Feb 1968 (1525 hr)	48°01'N 125°14'W	6 yr F (Preg.)	Trace (1)	Salmonidae
P 19408	25 Feb 1969 (1611 hr)	47°12'N 124°49'W	6 yr F	Trace (6)	Unidentified squid
O 27775	14 Feb 1969 (0832 hr)	46°14'N 124°25'W	7 yr F (Preg.)	136 cc (10)	Northern anchovy
same				544 cc (1)	*Sebastes* sp.
same				Trace (1)	*Gonatus* sp.
J 22698	6 Feb 1969 (1000 hr)	46°16'N 124°35'W	12 yr F (Preg.)	840 cc (2)	*Sebastes* sp.
N 20745	17 Feb 1972 (1102 hr)	48°49'N 126°26'W	11 yr F (Preg.)	1,715 cc (10)	Pacific herring
J 29184	20 Mar 1958 (1615 hr)	48°25'N 124°05'W	1 yr M	Empty	
M 17542	23 Mar 1961 (1430 hr)	48°25'N 124°35'W	1 yr F	Empty	
CS 02080	28 Mar 1961 (1110 hr)	46°11'N 124°43'W	12 yr F (Preg.)	Empty	
N 34030	28 Mar 1962 (1100 hr)	48°47'N 126°11'W	1 yr M	Empty	
M 37584	28 Mar 1962 (1230 hr)	48°41'N 126°27'W	2 yr M	Empty	
L 46272	12 Mar 1962 (1040 hr)	48°45'N 126°09'W	3 yr M	Empty	
K 14082	28 Mar 1962 (1415 hr)	48°41'N 126°28'W	4 yr F	Empty	
Q 15013	21 Mar 1966 (1600 hr)	48°22'N 125°26'W	2 yr M	Empty	
R 04712	23 Mar 1966 (1310 hr)	48°20'N 125°25'W	1 yr F	Empty	
T 10500	25 Mar 1968 (1340 hr)	48°36'N 125°31'W	1 yr M	Empty	
T 07035	30 Mar 1968 (1130 hr)	48°19'N 125°21'W	1 yr M	Empty	
Q 10656	28 Mar 1968 (1035 hr)	48°11'N 125°22'W	4 yr F	Empty	
U 10876	24 Mar 1969 (0835 hr)	46°17'N 124°33'W	1 yr M	Empty	
U 10344	11 Mar 1969 (1420 hr)	47°27'N 124°44'W	1 yr F	Empty	
R 09345	8 Mar 1969 (1605 hr)	46°35'N 124°44'W	4 yr F	Empty	
O 38210	26 Mar 1969 (0941 hr)	46°38'N 124°29'W	7 yr F	Empty	
N 40118	8 Mar 1969 (1455 hr)	46°37'N 124°45'W	8 yr F (Preg.)	Empty	
M 50006	9 Mar 1969 (1510 hr)	46°44'N 124°51'W	9 yr F (Preg.)	Empty	
L 34898	24 Mar 1969 (1415 hr)	46°42'N 124°36'W	10 yr F (Preg.)	Empty	
O 30011	18 Mar 1970 (1424 hr)	46°48'N 124°50'W	8 yr F (Preg.)	Empty	
N 42832	17 Mar 1971 (1420 hr)	47°08'N 124°52'W	10 yr F	Empty	
J 21191	20 Mar 1958 (0915 hr)	48°55'N 125°15'W	1 yr M	244 cc (7)	Pacific herring
same				3 cc	Unidentified fish
L 37719	17 Mar 1960 (0840 hr)	47°28'N 124°43'W	1 yr M	Trace (3)	Unidentified squid
J 42454	22 Mar 1960 (0940 hr)	46°15'N 124°25'W	3 yr M	16 cc (19)	Unidentified fish
N 32188	12 Mar 1962 (1050 hr)	48°45'N 126°09'W	1 yr M	Trace	Threespine stickleback
O 15200	22 Mar 1966 (0810 hr)	48°22'N 125°14'W	4 yr F	130 cc (10)	Northern anchovy
U 10498	25 Mar 1969 (1145 hr)	47°18'N 124°42'W	1 yr F	Trace (1)	Unidentified fish
(R)	8 Mar 1969 (1001 hr)	46°40'N 124°42'W	4 yr F	Trace (1)	Unidentified fish
same				Trace (1)	*Onychoteuthis* sp.
P 15421	13 Mar 1969 (0850 hr)	46°51'N 124°32'W	6 yr F (Preg.)	82 cc (34)	Northern anchovy
same				738 cc (6)	Capelin
N 23418	11 Mar 1969 (1635 hr)	47°30'N 124°45'W	8 yr F (Preg.)	Trace (1)	Unidentified fish
same				Trace (1)	*Onychoteuthis* sp.
K 39948	13 Mar 1969 (0807 hr)	46°50'N 124°27'W	11 yr F (Preg.)	916 cc (44)	Northern anchovy
same				9 cc (4)	Capelin
U 03607	27 Mar 1970 (1030 hr)	46°31'N 124°24'W	2 yr F	Trace (1)	Unidentified fish
same				Trace (3)	*Loligo opalescens*
same				Trace (1)	Gonatidae
Marked	8 Mar 1970 (1210 hr)	46°59'N 124°59'W	4 yr F	Trace (11)	*Loligo opalescens*
Marked	8 Mar 1970 (1227 hr)	47°01'N 125°00'W	5 yr F	5 cc (2)	*Loligo opalescens*
R 01839	19 Mar 1970 (1800 hr)	47°29'N 124°54'W	5 yr F	Trace (1)	Unidentified squid
R 05208	27 Mar 1970 (0907 hr)	46°28'N 124°26'W	5 yr F	Trace (1)	Clupeidae
same				Trace (1)	*Loligo opalescens*
N 12796	25 Mar 1970 (1334 hr)	46°20'N 124°23'W	9 yr F (Preg.)	Trace (1)	Unidentified fish
T 12447	18 Mar 1971 (1245 hr)	47°14'N 124°46'W	4 yr F	Trace (5)	*Loligo opalescens*
same				Trace (7)	*Gonatus* sp.
Marked	20 Mar 1971 (1535 hr)	46°34'N 124°34'W	6 yr F	Trace (1)	Unidentified fish
L 14218	29 Mar 1972 (1321 hr)	46°39'N 124°34'W	13 yr F (Preg.)	Trace (1)	Clupeidae

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date andTtime Seal Collected	Location	Age and Sex (Condition)	Stomach Contents Volume[3]	Stomach Contents Prey Species
		St. Paul Island (continued)			
Washington (continued):					
J 14264	28 Apr 1958 (1350 hr)	48°16'N 125°41'W	1 yr M	Empty	
A 07310	21 Apr 1958 (1615 hr)	46°12'N 125°22'W	11 yr F (Preg.)	Empty	
J 40616	22 Apr 1959 (0930 hr)	46°56'N 124°19'W	2 yr M	Empty	
J 19397	12 Apr 1959 (1531 hr)	48°36'N 125°34'W	2 yr M	Empty	
(H)15134	14 Apr 1959 (1445 hr)	46°38'N 124°58'W	4 yr F	Empty	
E 10561	25 Apr 1959 (1435 hr)	47°39'N 125°42'W	7 yr F (Preg.)	Empty	
J 18284	26 Apr 1960 (1200 hr)	48°47'N 125°43'W	3 yr M	Empty	
K 28952	11 Apr 1960 (1640 hr)	47°15'N 124°35'W	2 yr F	Empty	
E 09536	4 Apr 1960 (1325 hr)	48°25'N 125°15'W	8 yr F (Preg.)	Empty	
E 12005	22 Apr 1960 (1200 hr)	46°56'N 124°43'W	8 yr F (Preg.)	Empty	
K 32625	19 Apr 1961 (1445 hr)	46°55'N 124°44'W	3 yr M	Empty	
M 36119	26 Apr 1961 (1015 hr)	48°47'N 125°47'W	1 yr F	Empty	
L 32936	23 Apr 1961 (1305 hr)	46°47'N 124°24'W	2 yr F	Empty	
K 21221	23 Apr 1961 (1100 hr)	46°52'N 124°32'W	3 yr F	Empty	
J 22203	21 Apr 1961 (1230 hr)	48°20'N 125°12'W	4 yr F	Empty	
J 26399	24 Apr 1961 (1300 hr)	47°21'N 124°38'W	4 yr F	Empty	
I 21601	16 Apr 1961 (1515 hr)	46°36'N 124°37'W	5 yr F	Empty	
N 12702	12 Apr 1962 (1300 hr)	48°29'N 126°03'W	1 yr F	Empty	
N 34342	15 Apr 1965 (0820 hr)	46°43'N 124°36'W	4 yr F	Empty	
M 30891	4 Apr 1967 (0900 hr)	46°22'N 124°20'W	7 yr F	Empty	
T 09367	19 Apr 1968 (1050 hr)	46°30'N 124°24'W	1 yr M	Empty	
2T 00632	1 Apr 1968 (1520 hr)	48°23'N 125°23'W	4 yr M	Empty	
T 05958	2 Apr 1968 (0815 hr)	48°33'N 126°00'W	1 yr F	Empty	
T 07988	7 Apr 1968 (1205 hr)	48°32'N 125°27'W	1 yr F	Empty	
K 17558	1 Apr 1968 (1115 hr)	48°05'N 125°18'W	10 yr F (Preg.)	Empty	
J 43127	1 Apr 1968 (1310 hr)	48°16'N 125°14'W	11 yr F (Preg.)	Empty	
K 44197	11 Apr 1969 (1549 hr)	48°24'N 126°50'W	11 yr F (Preg.)	Empty	
O 41106	13 Apr 1970 (1503 hr)	46°47'N 124°34'W	8 yr F (Preg.)	Empty	
(R)	12 Apr 1971 (0950 hr)	46°27'N 124°33'W	6 yr F	Empty	
Marked	5 Apr 1971 (1505 hr)	46°29'N 124°32'W	6 yr F (Preg.)	Empty	
Marked	28 Apr 1971 (1545 hr)	47°08'N 124°43'W	6 yr F (Preg.)	Empty	
O 19852	20 Apr 1972 (1300 hr)	48°29'N 125°53'W	10 yr F (Preg.)	Empty	
J 40000	24 Apr 1958 (1215 hr)	46°20'N 124°56'W	1 yr F	9 cc (8)	Unidentified squid
K 36086	19 Apr 1959 (0904 hr)	48°20'N 124°52'W	1 yr F	56 cc	Threespine stickleback
same				Trace	Unidentified squid
J 17484	24 Apr 1959 (1000 hr)	48°35'N 125°19'W	2 yr F	270 cc (5)	Pacific herring
same				180 cc (4)	*Loligo opalescens*
C 06306	20 Apr 1959 (1017 hr)	48°28'N 125°18'W	10 yr F (Preg.)	210 cc (1)	*Sebastes* sp.
L 45725	26 Apr 1960 (0830 hr)	48°43'N 125°29'W	1 yr M	20 cc (7)	Unidentified squid
same				5 cc (1)	Pacific herring
L 46725	22 Apr 1961 (1324 hr)	47°32'N 125°02'W	2 yr M	380 cc (4)	Pacific herring
J 20312	11 Apr 1961 (0850 hr)	48°44'N 125°30'W	4 yr M	365 cc (50)	Northern anchovy [10]
same				365 cc (86)	Eulachon
J 20229	21 Apr 1961 (1120 hr)	48°19'N 125°08'W	4 yr M	133 cc (1)	*Sebastes* sp.
same				7 cc (1)	Unidentified fish
K 29221	23 Apr 1961 (0652 hr)	46°59'N 124°38'W	3 yr F	370 cc (5)	Pacific herring
J 39457	23 Apr 1961 (1416 hr)	46°42'N 124°22'W	4 yr F	10 cc (1)	Unidentified fish
(H)36951	24 Apr 1961 (0945 hr)	48°19'N 125°11'W	6 yr F (Preg.)	202 cc (27)	Eulachon
N 34145	10 Apr 1962 (1720 hr)	48°42'N 125°22'W	1 yr M	Trace	Unidentified squid
N 10756	11 Apr 1962 (1815 hr)	48°30'N 125°47'W	1 yr M	Trace	Unidentified fish
K 42302	11 Apr 1962 (1710 hr)	48°28'N 125°50'W	4 yr M	Trace (2)	Unidentified squid
N 15941	19 Apr 1964 (1210 hr)	48°35'N 125°50'W	3 yr M	50 cc (2)	Pacific herring
same				Trace (2)	Unidentified squid
N 21639	15 Apr 1965 (0750 hr)	46°44'N 124°36'W	4 yr F	135 cc (7)	Pacific herring
P 22122	8 Apr 1966 (0935 hr)	46°25'N 129°30'W	3 yr F	Trace (24)	Unidentified squid

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents Volume[3]	Prey Species
		St. Paul Island (continued)			
Washington (continued):					
Q 06537	30 Apr 1967 (1730 hr)	48°13'N 127°10'W	3 yr F	Trace (12)	*Berryteuthis magister*
same				Trace (11)	*O. borealijaponica*
Q 19955	29 Apr 1968 (1030 hr)	48°39'N 125°44'W	4 yr F	Trace	*Oncorhynchus* sp.
L 33142	22 Apr 1968 (1305 hr)	47°06'N 124°40'W	9 yr F (Preg.)	20 cc (1)	*Oncorhynchus* sp.
M 35184	9 Apr 1969 (1340 hr)	48°22'N 126°59'W	9 yr F (Preg.)	1,480 cc (2)	*Sebastes* sp.
(F/G)	6 Apr 1969 (1550 hr)	48°37'N 125°24'W	16 yr F (Preg.)	560 cc (1)	*Oncorhynchus* sp.
N 32446	3 Apr 1970 (0850 hr)	46°23'N 124°16'W	9 yr F	290 cc (14)	Northern anchovy
U 06993	23 Apr 1971 (1415 hr)	46°14'N 124°32'W	3 yr F	Trace (1)	Unidentified fish
same				Trace (1)	Gonatidae
J 26855	17 May 1958 (1630 hr)	48°48'N 126°15'W	1 yr M	Empty	
J 37523	11 May 1960 (1715 hr)	48°38'N 125°34'W	3 yr F	Empty	
I 19869	3 May 1960 (1055 hr)	48°28'N 125°00'W	4 yr F	Empty	
L 28915	19 May 1961 (1100 hr)	48°42'N 125°48'W	2 yr F	Empty	
K 26355	29 May 1961 (1335 hr)	48°38'N 125°45'W	3 yr F	Empty	
B 09643	3 May 1961 (1505 hr)	48°18'N 124°59'W	13 yr F (Preg.)	Empty	
O 47422	14 May 1963 (1745 hr)	48°48'N 125°39'W	1 yr M	Empty	
1R 00928	9 May 1967 (2000 hr)	48°59'N 126°59'W	3 yr F	Empty	
T 09519	20 May 1969 (1000 hr)	48°39'N 125°50'W	2 yr F	Empty	
Q 24932	21 May 1969 (1700 hr)	46°57'N 130°18'W	5 yr F	Empty	
M 24407	15 May 1969 (1410 hr)	48°52'N 125°59'W	9 yr F (Preg.)	Empty	
J 44387	17 May 1970 (1724 hr)	46°29'N 128°54'W	13 yr F	Empty	
U 10073	23 May 1971 (1200 hr)	48°28'N 125°37'W	3 yr F	Empty	
Q 21264	11 May 1971 (1450 hr)	46°42'N 124°31'W	7 yr F	Empty	
Marked	14 May 1971 (1420 hr)	46°44'N 124°34'W	6 yr F (Preg.)	Empty	
Q 23096	1 May 1971 (1442 hr)	48°18'N 125°31'W	7 yr F (Preg.)	Empty	
62-242	7 May 1972 (1215 hr)	46°44'N 130°42'W	10 yr F	Empty	
Marked	3 May 1972 (1610 hr)	48°19'N 126°31'W	6 yr F (Preg.)	Empty	
J 21904	17 May 1958 (0610 hr)	48°55'N 125°45'W	1 yr M	470 cc	Pacific herring
same				15 cc (1)	*Loligo opalescens*
F 05560	2 May 1959 (1745 hr)	48°42'N 125°29'W	6 yr F (Preg.)	Trace	Unidentified fish
L 35698	7 May 1961 (0935 hr)	48°23'N 124°58'W	2 yr M	9 cc (2)	Pacific herring
M 16358	21 May 1961 (0850 hr)	48°50'N 126°12'W	1 yr F	Trace	Unidentified fish
(H)20889	19 May 1961 (0805 hr)	48°48'N 125°55'W	6 yr F	1,620 cc (24)	Pacific herring
O 42549	31 May 1964 (0615 hr)	46°31'N 124°42'W	2 yr F	748 cc (6)	Pacific whiting
same				345 cc (2)	*Berryteuthis magister*
same				57 cc (1)	*Gonatopsis borealis*
K 41754	15 May 1964 (1500 hr)	48°55'N 130°10'W	6 yr F (Preg.)	980 cc (5)	Hexagrammidae
same				10 cc (6)	Unidentified squid
U 11847	7 May 1969 (1200 hr)	48°31'N 126°34'W	1 yr F	10 cc (4)	*O. borealijaponica*
(R)	20 May 1970 (1040 hr)	46°41'N 127°13'W	5 yr F	Trace (1)	*Loligo opalescens*
same				Trace (3)	*Abraliopsis* sp.
same				Trace (18)	Gonatidae
same				Trace (4)	*Gonatus* sp.
same				55 cc (2)	*Gonatopsis borealis*
Q 15249	17 May 1970 (0932 hr)	46°27'N 128°03'W	6 yr F (Preg.)	Trace (3)	*Onychoteuthis* sp.
same				Trace (1)	Gonatidae
Marked	10 May 1971 (1345 hr)	46°29'N 124°29'W	5 yr F	Trace (1)	Unidentified fish
R 07932	14 May 1971 (1315 hr)	46°47'N 124°34'W	6 yr F (Preg.)	Trace (1)	Clupeidae [11]
same				Trace (1)	Unidentified fish
1Y 02205	7 May 1972 (1310 hr)	46°42'N 130°39'W	3 yr M	Trace (1)	Unidentified fish
same				285 cc (3)	*Onychoteuthis* sp.
same				Trace (53)	Gonatidae
same				Trace (1)	*Gonatus* sp.
same				190 cc (9)	*Gonatopsis borealis*

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents	
				Volume[3]	Prey Species
		St. Paul Island (continued)			
Washington (continued):					
Marked	14 May 1972 (0915 hr)	46°51'N 125°59'W	1 yr F	Trace (1)	Bathylagidae
same				Trace (1)	*Octopoteuthis* sp.
same				Trace (39)	Gonatidae
same				375 cc (18)	*Berryteuthis magister*
O 45142	7 May 1972 (1330 hr)	46°45'N 130°40'W	10 yr F (Preg.)	Trace (1)	*Onychoteuthis* sp.
same				Trace (7)	Gonatidae
same				Trace (1)	*Berryteuthis magister*
M 58807	1 Jun 1964 (0730 hr)	47°51'N 124°53'W	4 yr F	Trace (1)	Unidentified fish
same				Trace (1)	*Loligo opalescens*
British Columbia:					
M 23646	25 Jan 1961 (1555 hr)	51°02'N 128°39'W	1 yr M	Empty	
K 32035	28 Jan 1959 (0930 hr)	50°58'N 127°46'W	1 yr F	16 cc	Unidentified squid
same				3 cc	Unidentified fish
N 28498	11 Feb 1962 (1330 hr)	53°48'N 130°55'W	1 yr M	Empty	
N 46627	28 Feb 1962 (1540 hr)	49°16'N 126°30'W	1 yr M	Empty	
K 14206	2 Feb 1959 (0940 hr)	50°57'N 125°34'W	1 yr F	206 cc	Unidentified squid
E 11099	22 Feb 1961 (1615 hr)	53°51'N 130°54'W	9 yr F (Preg.)	Trace (1)	Unidentified fish
M 58462	5 Mar 1961 (1000 hr)	51°00'N 125°34'W	1 yr M	Empty	
M 35387	6 Mar 1961 (1000 hr)	51°00'N 125°34'W	1 yr F	Trace (1)	Unidentified squid
J 42910	6 Apr 1958 (1010 hr)	52°15'N 129°10'W	1 yr F	Empty	
J 27770	6 Apr 1958 (1035 hr)	52°15'N 129°10'W	1 yr F	Empty	
B 00055	21 Apr 1958 (1130 hr)	49°27'N 127°10'W	10 yr F (Preg.)	Empty	
CS 06681	25 May 1958 (1240 hr)	49°27'N 127°07'W	9 yr F	Empty	
E 08265	22 May 1958 (1112 hr)	49°08'N 126°34'W	6 yr F (Preg.)	Empty	
N 10491	5 May 1966 (1330 hr)	50°32'N 129°37'W	5 yr F	Empty	
R 03905	28 May 1968 (1810 hr)	53°13'N 134°35'W	3 yr F	Empty	
E 02308	28 May 1968 (1550 hr)	53°12'N 134°28'W	16 yr F (Preg.)	Trace (1)	*Berryteuthis magister*
J 49320	17 Jun 1959 (1230 hr)	51°55'N 131°05'W	2 yr M	Trace	Unidentified squid
N 31968	1 Jun 1964 (1035 hr)	50°15'N 128°50'W	3 yr F	1,530 cc (3)	*Oncorhynchus* sp.
same				270 cc (9)	*O. borealijaponica*
L 18065	1 Jun 1964 (1200 hr)	50°15'N 128°50'W	5 yr F (Preg.)	60 cc (31)	*O. borealijaponica*
Gulf of Alaska:					
J 49699	2 Mar 1958 (1100 hr)	56°55'N 135°20'W	1 yr M	Empty	
L 11882	11 Mar 1960 (1045 hr)	57°01'N 135°21'W	1 yr F	Empty	
L 15470	22 Mar 1960 (0755 hr)	57°02'N 135°12'W	1 yr M	1,025 cc (11)	Pacific herring
L 36180	22 Mar 1960 (0825 hr)	57°02'N 135°12'W	1 yr M	925 cc (41)	Pacific herring
L 47948	23 Mar 1960 (0820 hr)	57°02'N 135°12'W	1 yr M	480 cc (7)	Pacific herring
K 36675	13 Mar 1960 (0845 hr)	57°01'N 135°21'W	2 yr F	190 cc (3)	Pacific herring
A 03153	7 Mar 1960 (0855 hr)	57°00'N 135°30'W	13 yr F (Preg.)	1,715 cc (23)	Pacific herring
(H)27097	4 Apr 1958 (1300 hr)	58°00'N 138°20'W	3 yr M	Empty	
J 28942	9 Apr 1960 (0815 hr)	59°36'N 148°11'W	3 yr M	Empty	
(H)41414	3 Apr 1958 (1100 hr)	58°50'N 140°50'W	3 yr M	150 cc (9)	Capelin
same				Trace (2)	Unidentified squid

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Volume[3]	Prey Species
		St. Paul Island (continued)			
Gulf of Alaska (continued):					
CS 12714	21 Apr 1958 (1100 hr)	59°13'N 141°00'W	9 yr M	3,600 cc (13)	Walleye pollock
A 01985	27 Apr 1958 (1240 hr)	56°58'N 136°16'W	11 yr F (Preg.)	1,188 cc (12)	Pacific herring
same				12 cc (1)	Walleye pollock
E 12177	24 May 1960 (1410 hr)	58°28'N 150°40'W	8 yr F	Empty	
D 00041	21 May 1960 (1010 hr)	58°35'N 151°36'W	9 yr F (Preg.)	Empty	
B 01290	9 May 1958 (0715 hr)	58°35'N 149°16'W	10 yr F (Preg.)	2,400 cc (96)	Pacific sand lance
J 18349	19 May 1960 (0715 hr)	58°08'N 150°40'W	3 yr M	385 cc (11)	Pacific sand lance
I 31723	24 May 1960 (1430 hr)	58°28'N 150°40'W	4 yr F	5 cc (1)	Pacific sand lance
C 01369	25 May 1960 (0615 hr)	58°06'N 150°49'W	11 yr F	2,020 cc (82)	Pacific sand lance
1756	25 May 1960 (0748 hr)	58°08'N 150°44'W	19 yr F	Trace	*Sebastes* sp.
same				1,225 cc (17)	Pacific sand lance
E 03166	10 May 1960 (0810 hr)	56°55'N 151°42'W	8 yr F (Preg.)	300 cc (5)	Pacific sand lance
N 25922	28 May 1968 (1045 hr)	56°33'N 151°55'W	7 yr F (Preg.)	Trace (1)	Unidentified fish
same				35 cc (3)	*Gonatopsis borealis*
(H)	26 May 1968 (1040 hr)	56°30'N 151°49'W	13 yr F (Preg.)	630 cc (12)	Unidentified fish
same				Trace (143)	Gonatidae
same				630 cc (68)	*Berryteuthis magister*
(H)22352	8 Jun 1958 (0900 hr)	56°30'N 152°38'W	3 yr M	Empty	
K 38001	19 Jun 1962 (1315 hr)	57°55'N 150°50'W	4 yr M	Empty	
K 10238	10 Jun 1962 (1950 hr)	57°15'N 138°10'W	4 yr F	Empty	
K 46448	16 Jun 1962 (1400 hr)	58°10'N 150°30'W	4 yr F	Empty	
I 17490	17 Jun 1962 (1900 hr)	58°10'N 150°30'W	6 yr F	Empty	
62-114	1 Jun 1963 (1520 hr)	58°10'N 150°26'W	8 yr F (Preg.)	Empty	
E 12383	15 Jun 1963 (1115 hr)	58°15'N 150°30'W	11 yr F (Preg.)	Empty	
S 11104	21 Jun 1968 (0830 hr)	58°00'N 150°00'W	2 yr M	Empty	
R 00532	10 Jun 1968 (1615 hr)	59°31'N 145°48'W	3 yr M	Empty	
R 08377	17 Jun 1968 (1330 hr)	59°03'N 150°13'W	3 yr M	Empty	
Q 15457	17 Jun 1968 (1145 hr)	59°05'N 150°04'W	4 yr F	Empty	
H 08660	20 Jun 1968 (1630 hr)	58°00'N 150°23'W	13 yr F	Empty	
N 48668	21 Jun 1968 (0900 hr)	58°00'N 150°00'W	7 yr F (Preg.)	Empty	
K 15073	11 Jun 1962 (2030 hr)	58°04'N 144°55'W	4 yr F	12 cc (60)	*Loligo opalescens*
same				3 cc (4)	Unidentified squid
M 44802	16 Jun 1963 (0950 hr)	58°20'N 149°49'W	3 yr M	Trace	Unidentified fish
E 09897	15 Jun 1963 (0930 hr)	58°15'N 150°30'W	11 yr F	Trace	Unidentified fish
CS 17439	12 Jun 1963 (0850 hr)	58°25'N 150°10'W	14 yr F	378 cc (14)	Pacific sand lance
A 06024	1 Jun 1963 (1015 hr)	58°10'N 150°26'W	16 yr F (Preg.)	468 cc	Pacific sand lance
2T 00766	12 Jun 1968 (1940 hr)	58°16'N 149°29'W	3 yr M	435 cc (50)	Pacific sand lance
1S 20853	9 Jun 1968 (1010 hr)	59°32'N 140°55'W	3 yr M	505 cc (2)	*Oncorhynchus* sp.
same				135 cc (10)	Capelin
Q 23338	9 Jun 1968 (1120 hr)	59°31'N 141°05'W	4 yr M	14 cc	Capelin
R 01957	2 Jul 1968 (1240 hr)	57°01'N 152°30'W	3 yr M	Empty	
R 00206	2 Jul 1968 (1445 hr)	57°02'N 152°17'W	3 yr M	Empty	
J 48626	22 Jul 1958 (0650 hr)	57°40'N 150°30'W	1 yr F	458 cc	Capelin
same				2 cc	Unidentified squid
F 02873	24 Jul 1958 (0630 hr)	57°40'N 150°30'W	5 yr F	896 cc	Capelin
same				99 cc	*Oncorhynchus* sp.
R 05500	9 Jul 1968 (1130 hr)	59°32'N 144°35'W	3 yr F	255 cc	*Oncorhynchus* sp.
same				5 cc (6)	Unidentified squid
Western Alaska:					
H 02555	16 May 1962 (1140 hr)	54°12'N 163°32'W	7 yr F (Preg.)	Empty	

Appendix Table D-1.--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents: Volume[3]	Stomach Contents: Prey Species
		St. Paul Island (continued)			
Western Alaska (continued):					
H 09142	22 Jun 1960 (1015 hr)	54°25'N 162°23'W	5 yr F (Preg.)	Empty	
E 00029	21 Jun 1960 (1345 hr)	54°23'N 162°10'W	8 yr F (Preg.)	Empty	
C 19695	20 Jun 1960 (0855 hr)	54°03'N 162°28'W	11 yr F (Preg.)	Empty	
M 16555	19 Jun 1962 (1315 hr)	53°52'N 164°22'W	2 yr M	Empty	
L 25074	18 Jun 1962 (1715 hr)	53°55'N 164°39'W	3 yr F	Empty	
K 10190	19 Jun 1962 (1730 hr)	53°47'N 164°46'W	4 yr F	Empty	
(H)	11 Jun 1962 (1615 hr)	53°47'N 164°06'W	7 yr F (Preg.)	Empty	
K 37579	3 Jun 1962 (1430 hr)	53°52'N 164°29'W	4 yr F	Trace	Unidentified fish
K 37975	18 Jun 1962 (1150 hr)	53°49'N 164°52'W	4 yr F	Trace (7)	*Berryteuthis magister*
same				Trace (3)	Gonatidae
(H)30000	18 Jun 1962 (1405 hr)	53°52'N 164°44'W	7 yr F (Preg.)	Trace (1)	Unidentified squid
E 09386	19 Jun 1962 (1655 hr)	53°51'N 164°40'W	10 yr F (Preg.)	Trace (1)	Unidentified squid
N 44385	18 Jun 1968 (1658 hr)	53°31'N 165°40'W	7 yr F (Preg.)	200 cc (1)	Atka mackerel
M 40896	27 Jun 1968 (1130 hr)	53°44'N 164°36'W	8 yr F (Preg.)	Trace (1)	Unidentified squid
K 32444	15 Jul 1962 (0935 hr)	53°48'N 164°28'W	4 yr F	Trace (1)	*Berryteuthis magister*
S 06528	21 Jul 1968 (1025 hr)	53°43'N 165°43'W	2 yr M	Trace (1)	Capelin
M 58430	13 Aug 1962 (1505 hr)	53°48'N 164°07'W	2 yr M	Empty	
M 22414	29 Aug 1962 (1710 hr)	53°27'N 166°01'W	2 yr M	Empty	
(H)	29 Aug 1962 (1615 hr)	53°23'N 166°13'W	7 yr F (Lact.)	Empty	
K 13761	13 Aug 1962 (1030 hr)	54°04'N 164°35'W	4 yr F	19 cc (3)	Capelin
same				76 cc (1)	Atka mackerel
Eastern Bering Sea:					
K 40285	24 Jun 1962 (0945 hr)	54°12'N 166°20'W	4 yr M	Empty	
K 39927	27 Jun 1960 (0758 hr)	54°23'N 165°28'W	2 yr M	770 cc (88)	Capelin
I 20388	29 Jun 1960 (1530 hr)	54°19'N 165°14'W	4 yr F	15 cc (2)	Capelin
I 15324	29 Jun 1962 (0700 hr)	54°19'N 165°31'W	6 yr F	121 cc (10)	Capelin
same				284 cc (1)	Atka mackerel
F 06692	27 Jun 1962 (1445 hr)	54°23'N 165°16'W	9 yr F (Preg.)	Trace (1)	Capelin
J 27399	6 Jul 1960 (0945 hr)	54°16'N 165°11'W	3 yr F	Empty	
I 33593	6 Jul 1960 (0955 hr)	54°15'N 165°10'W	4 yr F	Empty	
A 07841	10 Jul 1960 (1730 hr)	55°32'N 164°15'W	13 yr F	Empty	
(H)39982	28 Jul 1960 (1045 hr)	56°54'N 170°00'W	5 yr F (Lact.)	Empty	
L 26642	27 Jul 1962 (0740 hr)	57°01'N 169°35'W	3 yr M	Empty	
(H)	13 Jul 1962 (1620 hr)	54°31'N 165°21'W	7 yr F (Preg.)	Empty	
(H)37528	27 Jul 1962 (1600 hr)	57°35'N 170°06'W	7 yr F (Lact.)	Empty	
(G)	27 Jul 1962 (0740 hr)	57°01'N 169°35'W	8 yr F (Lact.)	Empty	
L 16465	31 Jul 1963 (1325 hr)	54°31'N 165°33'W	4 yr F	Empty	
L 46869	31 Jul 1963 (1025 hr)	54°11'N 166°45'W	4 yr F	Empty	
L 41160	31 Jul 1963 (1105 hr)	54°12'N 166°45'W	4 yr F	Empty	
J 20563	31 Jul 1963 (0725 hr)	54°21'N 165°24'W	6 yr F	Empty	
K 47404	13 Jul 1963 (1325 hr)	56°14'N 168°58'W	5 yr F (Preg.)	Empty	
N 35320	19 Jul 1964 (1410 hr)	54°35'N 166°34'W	3 yr M	Empty	
M 34054	13 Jul 1964 (1215 hr)	54°36'N 166°32'W	4 yr M	Empty	
N 43912	29 Jul 1964 (1250 hr)	54°30'N 166°29'W	3 yr F	Empty	
M 42376	19 Jul 1964 (1720 hr)	54°25'N 166°24'W	4 yr F	Empty	
Q 24446	31 Jul 1968 (1845 hr)	54°28'N 165°55'W	4 yr F	Empty	
K 38678	16 Jul 1968 (1640 hr)	54°30'N 166°54'W	10 yr F	Empty	
Marked	20 Jul 1974 (1046 hr)	56°58'N 170°30'W	9 yr F (Lact.)	Empty	
C 02157	30 Jul 1960 (1645 hr)	57°56'N 170°46'W	11 yr F (Lact.)	290 cc	Unidentified fish
G 10086	14 Jul 1962 (0750 hr)	54°36'N 165°26'W	8 yr F (Preg.)	655 cc (70)	Capelin
same				35 cc (1)	Atka mackerel

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents Volume[3]	Prey Species
		St. Paul Island (continued)			
Eastern Bering Sea (continued):					
J 25342	14 Jul 1962 (0715 hr)	54°35'N 165°25'W	5 yr F (Lact.)	100 cc (30)	Capelin
same				Trace (1)	Unidentified fish
M 22878	13 Jul 1963 (0740 hr)	56°09'N 168°35'W	3 yr M	Trace (1)	Walleye pollock
same				Trace (55)	Gonatidae
same				374 cc (44)	*Berryteuthis magister*
same				201 cc (22)	*Gonatopsis borealis*
M 51809	7 Jul 1963 (0755 hr)	54°55'N 167°30'W	3 yr F	165 cc (11)	*Gonatopsis borealis*
L 18537	7 Jul 1963 (0715 hr)	54°50'N 167°27'W	4 yr F	71 cc (1)	Cyclopteridae
same				Trace (1)	*Gonatus* sp.
same				404 cc (46)	*Gonatopsis borealis*
K 12151	31 Jul 1963 (1125 hr)	54°12'N 166°45'W	5 yr F	Trace (2)	Gonatidae
J 17998	13 Jul 1963 (0915 hr)	55°47'N 171°30'W	6 yr F (Lact.)	Trace (44)	Gonatidae
same				10 cc (5)	*Gonatus* sp.
(H)29051	13 Jul 1963 (1435 hr)	56°05'N 171°10'W	8 yr F (Lact.)	665 cc (4)	Atka mackerel
(H)	31 Jul 1963 (0821 hr)	54°08'N 166°42'W	8 yr F (Lact.)	27 cc (46)	Pacific sand lance
same				Trace (24)	Gonatidae
same				14 cc (2)	*Gonatus* sp.
same				49 cc (9)	*Gonatopsis borealis*
G 01653	12 Jul 1963 (0716 hr)	55°21'N 167°50'W	9 yr F (Lact.)	291 cc (137)	Capelin
same				24 cc (3)	*Berryteuthis magister*
same				170 cc (16)	*Gonatopsis borealis*
N 17910	11 Jul 1964 (0925 hr)	54°29'N 166°26'W	3 yr M	Trace (1)	Unidentified fish
same				80 cc (55)	Gonatidae
same				120 cc (6)	*Gonatopsis borealis*
N 50016	20 Jul 1964 (1145 hr)	54°33'N 166°35'W	3 yr F	Trace (1)	Digested flesh
M 26495	29 Jul 1964 (1530 hr)	54°26'N 166°16'W	4 yr F	Trace (1)	Unidentified squid
J 23253	11 Jul 1964 (1135 hr)	54°23'N 166°30'W	7 yr F (Preg.)	Trace (1)	Unidentified fish
R 05262	31 Jul 1968 (1515 hr)	54°29'N 165°59'W	3 yr M	Trace (3)	Gonatidae
2T 00322	24 Jul 1968 (0724 hr)	54°19'N 166°16'W	3 yr M	231 cc (73)	Bathylagidae
same				46 cc (2)	*Gonatus* sp.
same				648 cc (86)	*Gonatopsis borealis*
Q 19901	31 Jul 1968 (0950 hr)	54°27'N 165°54'W	4 yr F	Trace (182)	Gonatidae
same				75 cc (8)	*Gonatopsis borealis*
Marked	24 Jul 1973 (0820 hr)	56°32'N 168°55'W	4 yr M	Trace (1)	Gonatidae
Marked	30 Jul 1973 (0840 hr)	56°11'N 170°24'W	8 yr F (Lact.)	460 cc (1)	Salmonidae [12]
same				Trace (1)	Unidentified fish
same				Trace (25)	Gonatidae
same				Trace (3)	*Gonatus* sp.
same				29 cc (6)	*Berryteuthis magister*
same				86 cc (28)	*Gonatopsis borealis*
P 13061	30 Jul 1973 (1235 hr)	56°06'N 170°32'W	10 yr F (Lact.)	1,425 cc (4)	Walleye pollock [13]
O 35135	22 Jul 1973 (1032 hr)	55°53'N 168°37'W	11 yr F (Lact.)	25 cc (1)	Walleye pollock
same				Trace (34)	Gonatidae
same				Trace (4)	*Gonatus* sp.
J 19687	31 Jul 1974 (1755 hr)	56°35'N 171°02'W	17 yr F (Lact.)	310 cc (19)	Walleye pollock
J 32161	17 Aug 1960 (1414 hr)	54°35'N 168°38'W	3 yr M	Empty	
L 14195	11 Aug 1962 (1640 hr)	54°33'N 165°31'W	3 yr F	Empty	
J 14749	11 Aug 1962 (1245 hr)	54°31'N 165°29'W	5 yr F	Empty	
(H)	30 Aug 1962 (1650 hr)	56°32'N 170°49'W	7 yr F (Lact.)	Empty	
E 01958	25 Aug 1962 (1400 hr)	54°24'N 165°18'W	10 yr F (Lact.)	Empty	
N 35210	19 Aug 1963 (1725 hr)	55°56'N 170°13'W	2 yr M	Empty	
M 14423	3 Aug 1963 (1315 hr)	54°07'N 166°39'W	3 yr F	Empty	
H 07093	30 Aug 1963 (1421 hr)	57°25'N 168°46'W	8 yr F	Empty	
K 41036	30 Aug 1963 (1435 hr)	57°26'N 168°45'W	5 yr F (Lact.)	Empty	
(H)	1 Aug 1963 (1225 hr)	54°12'N 166°42'W	8 yr F (Lact.)	Empty	
(H)	24 Aug 1963 (0926 hr)	57°22'N 171°33'W	8 yr F (Lact.)	Empty	

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents Volume[3]	Stomach Contents Prey Species
		St. Paul Island (continued)			
Eastern Bering Sea (continued):					
E 00935	5 Aug 1963 (1625 hr)	54°12'N 166°30'W	11 yr F (Lact.)	Empty	
61-008	3 Aug 1963 (1030 hr)	54°09'N 166°35'W	15 yr F (Lact.)	Empty	
N 26854	8 Aug 1964 (0955 hr)	57°30'N 169°54'W	3 yr F	Empty	
M 35465	27 Aug 1964 (1300 hr)	57°16'N 168°53'W	4 yr F	Empty	
K 32752	28 Aug 1964 (1545 hr)	57°44'N 168°30'W	6 yr F	Empty	
I 28030	8 Aug 1964 (1215 hr)	57°36'N 169°48'W	8 yr F (Lact.)	Empty	
CS 05699	9 Aug 1964 (1650 hr)	58°02'N 169°30'W	15 yr F (Lact.)	Empty	
R 00000	8 Aug 1968 (1605 hr)	54°31'N 165°55'W	3 yr M	Empty	
E 10367	9 Aug 1968 (0840 hr)	54°33'N 166°06'W	16 yr M	Empty	
M 28995	2 Aug 1968 (1345 hr)	54°29'N 165°50'W	8 yr F	Empty	
Marked	30 Aug 1974 (1645 hr)	57°25'N 169°43'W	2 yr M	Empty	
Marked	7 Aug 1974 (1455 hr)	56°48'N 169°14'W	3 yr M	Empty	
1Y 00007	1 Aug 1974 (0950 hr)	56°31'N 170°55'W	5 yr M	Empty	
Marked	3 Aug 1974 (1320 hr)	56°25'N 170°38'W	9 yr F (Lact.)	Empty	
(H)14189	6 Aug 1962 (1400 hr)	54°16'N 166°10'W	7 yr F (Lact.)	Trace	Walleye pollock
same				Trace (3)	*Berryteuthis magister*
E 02371	6 Aug 1962 (1045 hr)	54°13'N 166°11'W	10 yr F (Lact.)	Trace (1)	Walleye pollock
same				75 cc (5)	*Berryteuthis magister*
same				75 cc (5)	Gonatidae
(E)	9 Aug 1962 (1310 hr)	54°39'N 165°35'W	10 yr F (Lact.)	350 cc (2)	Walleye pollock
same				Trace	Unidentified squid
N 42258	1 Aug 1963 (1500 hr)	54°19'N 166°38'W	2 yr M	Trace	Unidentified fish
N 39440	6 Aug 1963 (1000 hr)	54°20'N 166°32'W	2 yr M	Trace	Gonatidae
N 44423	12 Aug 1963 (1600 hr)	57°09'N 170°30'W	2 yr M	Trace (7)	Gonatidae
same				Trace (1)	*Gonatus* sp.
N 46495	14 Aug 1963 (1315 hr)	54°17'N 166°16'W	2 yr F	Trace (1)	Gonatidae
M 38289	27 Aug 1963 (0915 hr)	57°24'N 169°32'W	3 yr F	185 cc (5)	Pleuronectidae
same				185 cc (35)	Capelin
L 21934	3 Aug 1963 (0725 hr)	54°07'N 166°40'W	4 yr F	48 cc (41)	Capelin
same				Trace (9)	Gonatidae
same				432 cc (5)	*Berryteuthis magister*
H 01717	1 Aug 1963 (1030 hr)	54°08'N 166°31'W	8 yr F (Lact.)	47 cc (40)	Gonatidae
same				Trace (5)	*Gonatus* sp.
same				94 cc (2)	*Berryteuthis magister*
same				94 cc (2)	*Gonatopsis borealis*
(H)33167	23 Aug 1963 (1725 hr)	57°42'N 171°59'W	8 yr F (Lact.)	19 cc (6)	Gadidae
same				1 cc (2)	Gonatidae
CS 14499	5 Aug 1963 (1042 hr)	54°07'N 166°36'W	14 yr F (Lact.)	Trace (4)	Gonatidae
O 28887	22 Aug 1964 (1350 hr)	56°44'N 170°57'W	2 yr M	10 cc (2)	Gadidae
L 26147	15 Aug 1964 (1332 hr)	56°14'N 171°39'W	5 yr F	Trace (5)	Gonatidae
K 48223	21 Aug 1964 (1140 hr)	56°02'N 170°23'W	6 yr F (Lact.)	Trace (22)	Gonatidae
same				Trace (9)	*Gonatus* sp.
same				25 cc (15)	*Gonatopsis borealis*
J 22722	28 Aug 1964 (1017 hr)	57°29'N 168°07'W	7 yr F (Lact.)	1,290 cc (7)	Pacific herring
(H)10782	8 Aug 1964 (1720 hr)	58°00'N 169°26'W	9 yr F (Lact.)	100 cc (12)	Capelin
F 01026	9 Aug 1964 (0830 hr)	58°19'N 169°05'W	11 yr F (Lact.)	767 cc (117)	Capelin
same				8 cc (2)	Greenland halibut
(F)	13 Aug 1964 (0950 hr)	57°49'N 171°10'W	11 yr F (Lact.)	1,810 cc (13)	Pacific herring
E 14967	14 Aug 1964 (1500 hr)	56°56'N 172°06'W	12 yr F (Lact.)	2,610 cc (35)	Walleye pollock
U 11633	20 Aug 1973 (0905 hr)	57°08'N 170°56'W	5 yr F (Lact.)	839 cc (178)	Gadidae [14]
same				136 cc (27)	Greenland halibut [15]
same				Trace (1)	Birds
Marked	28 Aug 1973 (1729 hr)	56°10'N 169°07'W	8 yr F (Lact.)	Trace (89)	Gonatidae
same				Trace (7)	*Gonatus* sp.
Marked	10 Aug 1974 (1650 hr)	56°53'N 170°13'W	2 yr M	Empty	
Marked	7 Aug 1974 (1645 hr)	56°55'N 169°12'W	4 yr F	Trace (1)	Unidentified fish
Marked	25 Aug 1974 (1125 hr)	56°56'N 170°48'W	4 yr F	Trace (1)	Unidentified fish

Appendix Table D- 1 .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents: Volume[3]	Stomach Contents: Prey Species
		St. Paul Island (continued)			
Eastern Bering Sea (continued):					
T 05899	26 Aug 1974 (1415 hr)	56°31'N 170°11'W	7 yr F (Lact.)	Trace (1)	Gonatidae
same				Trace (3)	*Gonatus* sp.
Marked	1 Aug 1974 (1605 hr)	56°25'N 170°23'W	9 yr F (Lact.)	900 cc (14)	Walleye pollock [16]
Q 19952	1 Aug 1974 (1405 hr)	56°25'N 170°40'W	10 yr F (Lact.)	365 cc (4)	Walleye pollock
N 49976	13 Sep 1962 (0940 hr)	54°25'N 166°08'W	1 yr M	Empty	
M 43458	30 Sep 1962 (1505 hr)	54°18'N 166°50'W	2 yr M	Empty	
I 20188	4 Sep 1962 (1305 hr)	56°25'N 170°42'W	6 yr F (Lact.)	Empty	
K 30875	5 Sep 1963 (1327 hr)	55°24'N 168°16'W	5 yr F	Empty	
I 31881	2 Sep 1963 (1111 hr)	57°08'N 169°25'W	7 yr F (Lact.)	Empty	
Marked	4 Sep 1973 (1353 hr)	56°57'N 171°47'W	4 yr F	Empty	
L 43235	5 Sep 1973 (1247 hr)	57°20'N 172°20'W	14 yr F (Lact.)	Empty	
M 55010	14 Sep 1962 (0942 hr)	54°18'N 166°58'W	2 yr F	Trace (9)	Gonatidae
same				Trace (1)	*Gonatus* sp.
K 48206	15 Sep 1962 (0750 hr)	53°43'N 167°56'W	4 yr F	67 cc (1)	Atka mackerel
same				8 cc (73)	Gonatidae
same				Trace (9)	*Gonatus* sp.
I 23119	14 Sep 1962 (1008 hr)	54°18'N 166°58'W	6 yr F (Lact.)	Trace (2)	Unidentified squid
E 07845	2 Sep 1962 (1020 hr)	54°25'N 165°26'W	10 yr F (Lact.)	845 cc (159)	Capelin
same				Trace (1)	*Berryteuthis magister*
N 34714	2 Sep 1963 (1450 hr)	55°55'N 170°14'W	2 yr M	Trace (1)	Gonatidae
N 47348	10 Sep 1973 (0902 hr)	58°07'N 170°09'W	12 yr F (Lact.)	Trace (2)	Osmeridae
same				300 cc (83)	Gadidae
same				Trace (5)	Greenland halibut
L 25442	5 Sep 1973 (1645 hr)	57°36'N 172°22'W	14 yr F (Lact.)	3,230 cc (8)	Walleye pollock
same				Empty	
		Bering Island (Commander Islands)			
Washington:					
Y 23050	24 Jan 1970 (1545 hr)	48°29'N 125°19'W	4 yr F	Trace (2)	*Loligo opalescens*
K 17884	21 Feb 1969 (1130 hr)	48°26'N 125°57'W	7 yr F	1,620 cc (3)	*Sebastes* sp.
C 01628	18 Mar 1971 (1111 hr)	47°10'N 124°50'W	1 yr F	Trace (1)	*Loligo opalescens*
same				Trace (1)	Gonatidae
X 22266	15 May 1970 (0911 hr)	46°22'N 125°05'W	3 yr F	Trace (1)	Pacific saury
same				25 cc (1)	*Onychoteuthis* sp.
same				Trace (4)	*Abraliopsis* sp.
same				Trace (5)	Gonatidae
same				Trace (3)	*Gonatus* sp.
Eastern Bering Sea:					
E 03858	28 Aug 1964 (1455 hr)	57°41'N 168°26'W	4 yr F	Empty	
HB 01287	26 Aug 1974 (1425 hr)	56°30'N 170°14'W	2 yr F	Empty	

Appendix Table D-l .--Continued.

Location/ Tag[2]	Date and Time Seal Collected	Location	Age and Sex (Condition)	Stomach Contents Volume[3]	Prey Species
		Medny Island (Commander Islands)			
Washington:					
P 25398	25 Mar 1966 (1400 hr)	46°58'N 124°47'W	2 yr M	Empty	
Y 30572	28 Mar 1968 (1320 hr)	48°03'N 125°11'W	2 yr M	Empty	
H 26981	21 Apr 1968 (0850 hr)	46°18'N 124°23'W	5 yr F	100 cc (1)	Sablefish
Y 27779	4 May 1971 (1725 hr)	46°38'N 125°35'W	5 yr F	Trace (1)	Unidentified fish
Eastern Bering Sea:					
C 29850	4 Oct 1962 (1327 hr)	54°24'N 165°08'W	2 yr F	Empty	
same				Empty	

[1] All seals with affixed metal tags or markings which could be verified with those used on the island of origin corresponding to the seal's age were included. Seals which lost their tags but were born before or during 1955 were also included because only seals from St. Paul Island were tagged before 1956.

[2] Information concerning the tag series used between 1941 and 1972 to correspond with the numbers and letters in the table can be found in North Pacific Fur Seal Commission (1962, 1969, 1971, 1975), Marine Mammal Biological Laboratory (1971), Marine Mammal Division (1974), and Roppel et al. (1963). The three tags in this table with prefixes of "61-" or "62-" were used by R. Peterson (in 1961 and 1962) who tagged adult females as well as pups on St. Paul Island; these tags were not part of the research program by the United States under the auspices of the North Pacific Fur Seal Commission. "same" indicates multiple prey items in the same seal above.

[3] The numbers in parentheses indicate the recorded number of individual specimens associated with the volume data. Specimen count data were frequently not recorded; therefore, such data should be considered incomplete and minimum values.

[4] Probably coho salmon; freshwater regenerated.

[5] The total length of this anchovy specimen was 17 cm.

[6] The dorsal mantle lengths of 3 of these 11 specimens of California market squid were 100, 110 and 150 mm.

[7] The estimated ages of these two specimens of coho salmon were l.O+ (regenerated center and no annulus yet) and 2.0+ (no annulus yet).

[8] The estimated age of this coho salmon specimen was l.O+ (no annulus yet).

[9] These specimens of herring ranged as large as 23 cm.

[10] This fur seal was collected near a small school of fish which was mostly northern anchovy, but there were also a few smelt and a few 2 yr old herring present.

[11] This specimen consisted of a single large vertebral fragment.

[12] This specimen was probably a 2 yr old chum salmon based on scale identification.

[13] The total lengths of 3 of these 4 specimens of pollock were 35.0, 35.0, and 37.0 cm.

[14] These gadid specimens were approximately 5 cm in length.

[15] One of these specimens of Greenland halibut was approximately 12 cm long, and the other 26 specimens were approximately 5 cm in length.

[16] The otoliths of these pollock specimens ranged from 7-14 mm. The lengths of the parasphenoid bones for 10 of these pollock specimens were: 2.0, 2.7, 2.7, 2.7, 2.9, 3.6, 4.3, 4.8, 5.7, and 5.7 cm.

APPENDIX E

Scientific staff engaged in northern fur seal
field research in 1995

National Marine Mammal Laboratory (NMML)
Howard W. Braham, Director
Robert V. Miller, Deputy Director
Thomas R. Loughlin, Leader, Alaska Ecosystem Program
George Antonelis, Leader, Northern Fur Seal Program

Name	Affiliation	Assignment
Employees		
Jason Baker	NMML	Life History
Robert Caruso	NMML	Population Assessment
Robert DeLong	NMML	Population Assessment
Charles Fowler	NMML	Population Dynamics
Rolf Ream	NMML	Life History
Sharon Melin	NMML	Population Assessment
Bruce Robson	NMML	Foraging Ecology
Elizabeth Sinclair	NMML	Foraging Ecology
Rod Towell	NMML	Population Dynamics
Anne York	NMML	Population Dynamics
Research Associates and Cooperators		
Aquilina Lestenkof-Bourdukofsky	PISP	Entanglement
Tim Brod	IND	Entanglement
Mary Engles	UCSC	Life History
John Fratis	TCSP	Entanglement
Chris Gburski	IND	Population Assessment
Michael Goebel	UCSC	Life History
Alfey Hanson Jr.	IRASP	Entanglement
Henry Hanson	CSP	Population Assessment
Steve Insley	SI	Entanglement
Gilbert Kashevarof	IRASG	Entanglement
Masa Kiyota	NRIFS	Population Assessment
Jason Kozloff	IRASP	Entanglement
Reggie Lekanof	CSG	Entanglement
Dimitri Lestenkof	CSG	Entanglement
Todd Lestenkof	CSG	Entanglement
Maxim Malavansky	CSG	Entanglement
Mariamna Melovidov	NMFS	Entanglement

Appendix E.--cont.

Name	Affiliation	Assignment
Robert Melovidov	TCSP	Entanglement
Grace Merculief	CSG	Entanglement
Sam Merculief	CSG	Entanglement
Isiah Shabolin	CSG	Entanglement
Terry Spraker	WPI	Pup Mortality
Mark Tetoff	TCSP	Entanglement
Richard Warner	IRASP	Entanglement
Mike Williams	NMFS	Population Assessment
Nicolai Deon Zacharof	IRASP	Entanglement
Richard Zacharof	TCSP	Entanglement

<u>Affiliation Code</u>
CSG - City of St. George, St. George Island, Alaska
CSP - City of St. Paul, St. Paul Island, Alaska
IND - Independent
IRASG - IRA Council, St. George Island, Alaska
IRASP - IRA Council, St. Paul Island, Alaska
NMFS - National Marine Fisheries Service
NMML - National Marine Mammal Laboratory
NRIFS - National Research Institute of Far Seas Fisheries, Shimizu, Japan
PISP - Pribilof Island Stewardship Program
SI - Smithsonian Institution, Washington, D.C.
TCSP - Tribal Council, St. Paul Island, Alaska
UCSC - University California at Santa Cruz
WPI - Wildlife Pathology International

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