NOAA Technical Memorandum NMFS F/NWC-190

Fur Seal Investigations, 1989

Edited by
Hiroshi Kajimura

October 1990

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

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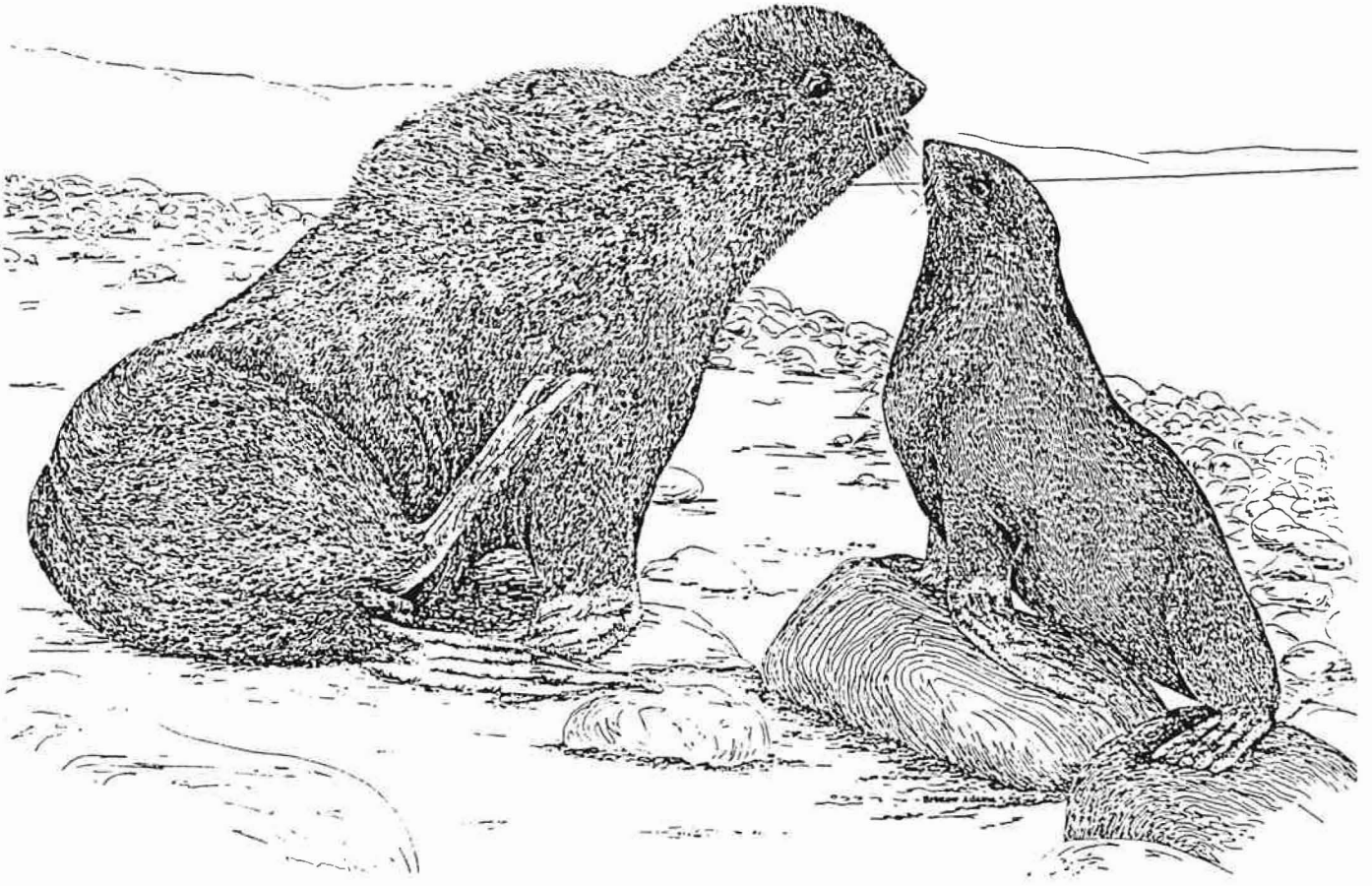

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October 1990

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ABSTRACT

Northern fur seal (Callorhinus ursinus) research in 1989 was conducted on the Pribilof Islands from 26 June through 5 September 1989. A census was conducted on Bogoslof Island on 22 July 1989. Research was carried out on San Miguel Island and nearby Castle Rock off the southern California coast intermittently from 15 July through 21 October 1989.

A total of 4,297 harem and 6,400 idle adult male seals (bulls) were counted in 1989 on St. Paul Island. Harem bull counts on St. Paul Island were 20% higher in 1989 than 1988. On St. George Island, 1,241 harem and 1,163 idle bulls were counted in 1989 indicating a decrease of 1.5% between 1988 and 1989.

The estimate of 171,534 pups born on St. Paul Island in 1989 was not significantly different from the estimate of 202,304 pups born in 1988. Pup production was not estimated for St. George Island in 1989.

A total of 4,423 pups (4,004 males, 418 females, sex of one pup was unidentified) were double tagged with modified round-post monel tags at all major rookeries on St. Paul Island to evaluate tag longevity and to estimate juvenile male mortality. Female pups were only tagged at selected study sites for long-term reproductive studies.

Samples of pups weighed during tagging operations indicate 1) that male and female pup weights are significantly different, 2) there are significant differences in average weights by

rookery ($p > 0.999$), and 3) weights of sheared pups and nonsheared pups are not highly significantly different ($p = 0.901$).

The tagged female population at East Reef rookery, St. George Island, has reached such a small size that it is questionable whether the estimates of natality and return rate calculated for this population are representative of the herd at large. The return rate (an estimate of survival rate) of previously tagged female seals was 77% ($n = 33$) of those that had returned in 1988. The natality rate (percent of those returning that suckle a pup, an estimate of pregnancy rate) was 74% ($n = 25$). Both values are similar to the results obtained from similar observations in 1988.

A census conducted on Bogoslof Island on 22 July 1989 counted 29 adult males, 132 adult females, 459 subadult males, and 99 pups.

Daily censuses were conducted between 6 July and 5 August on northern fur seals at San Miguel Island to assess abundance and population structure. A maximum of 61 adult male fur seals maintained territories containing reproductive females during the height of the breeding season. At least 749 pups were born in Adams Cove and 640 pups were born on Castle Rock. Eight adult females were captured, restrained, and instrumented with dive recorders and radio tags. On 23 September, 175 northern fur seal pups in Adams Cove were flipper tagged with pink roto tags. A second group of 175 pups were tagged on 20 and 21, October also

Juvenile male roundups were conducted during 12 to 26 July on St. Paul Island. The examination of 18,585 juvenile male fur seals (of the size range taken in the commercial harvest prior to 1985) occurred as part of entanglement studies revealing an entanglement rate of about 0.3%. Debris was removed from all entangled animals small enough to be handled safely.

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INTRODUCTION

by

Hiroshi Kajimura

The National Marine Mammal Laboratory (NMML) is responsible for collecting biological and management data on the northern fur seal (Callorhinus ursinus). This responsibility is mandated under the Fur Seal Act and the Marine Mammal Protection Act, in absence of the Fur Seal Convention which expired in 1984.

This report summarizes the research carried out by scientists from NMML at four northern fur seal breeding sites during 1989. Two of the sites are major fur seal breeding colonies consisting of about 800,000 animals and are on the Pribilof Islands (Figs. 1 and 2) in the eastern Bering Sea. The third site is a small colony of about 400 fur seals on Bogoslof Island (Fig. 3) in the southeastern Bering Sea. The fourth site is on San Miguel Island, California and nearby Castle Rock (Fig. 4) where the breeding population of northern fur seals fluctuates around 4,000 animals.

Fur seals have not been commercially harvested on the Pribilof Islands since 1984. A moratorium on commercial harvesting was first imposed on St. George Island in 1973 to permit research on the population as it reverted to its natural state. In 1985, a moratorium on the commercial harvesting of fur seals on St. Paul Island was imposed because of their decline on this Pribilof Island. Because of these moratoria, juvenile male

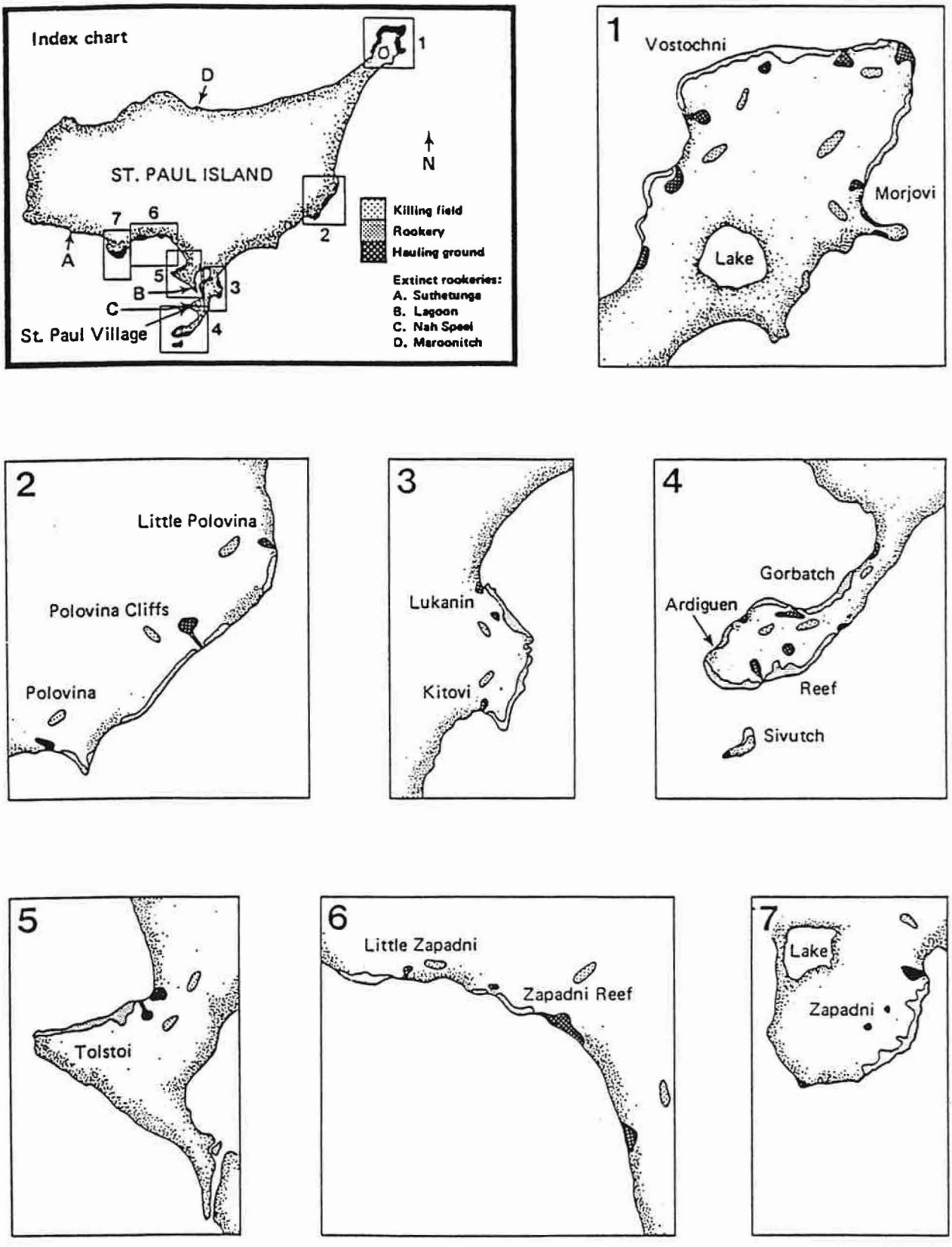

Figure 1.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. Paul Island, Alaska.

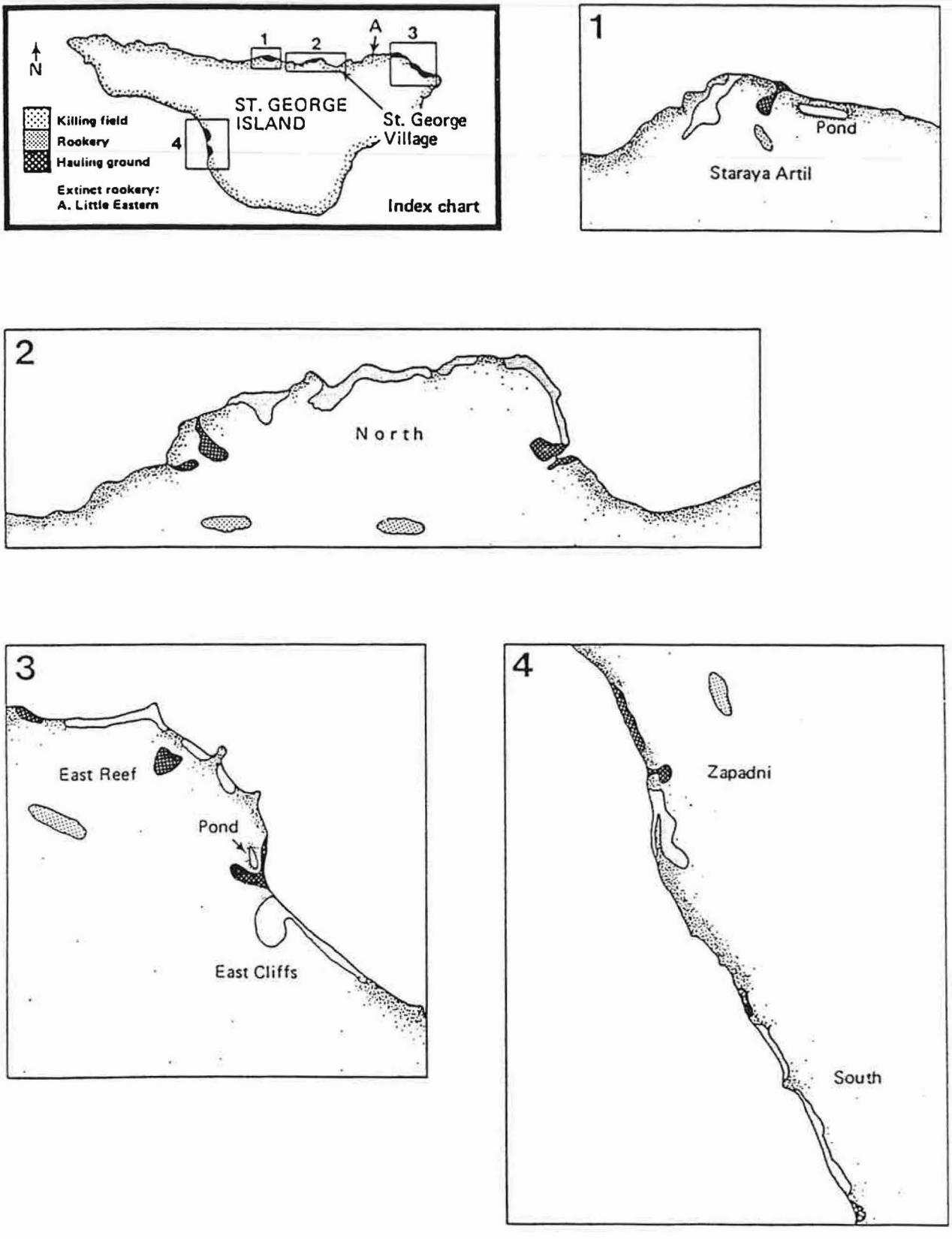

Figure 2.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. George Island, Alaska.

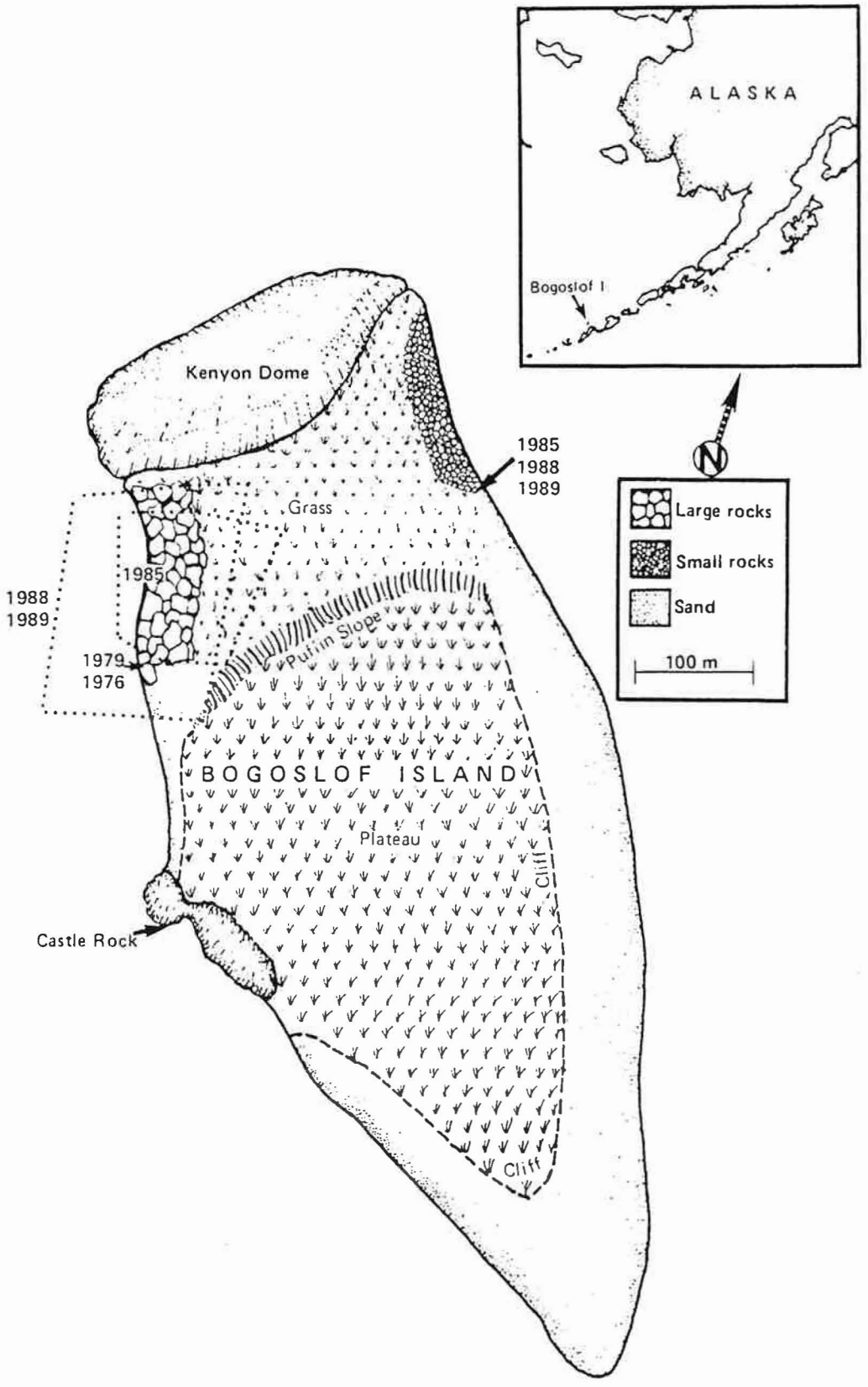

Figure 3.--Locations of fur seals as indicated by year of observations.

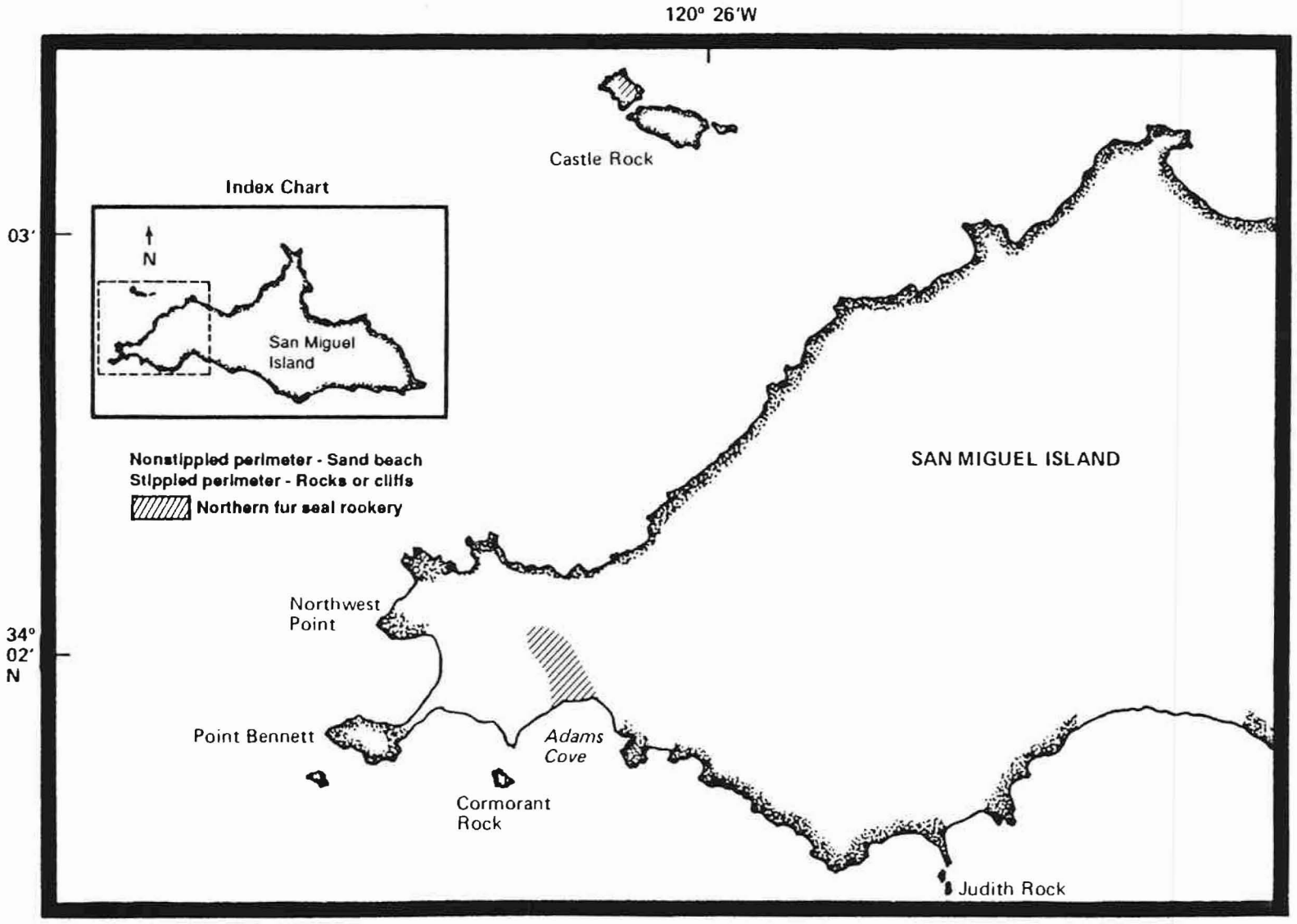

Figure 4.--Location of northern fur seal breeding colonies, San Miguel Island, California.

fur seals (primarily 2- and 3-year-olds) are now harvested only for subsistence.

Fur seals are not harvested on Sea Lion Rock (Sivutch), Bogoslof Island, or San Miguel Island and nearby Castle Rock. However, males from breeding rookeries other than those on St. Paul and St. George Islands may be subjected to subsistence harvest mortality as well since young male seals occasionally haul out at some distance from their rookeries of birth. There are four extinct rookeries on St. Paul Island (Fig. 1) and one on St. George Island (Fig. 2).

Terms having special meanings in northern fur seal research are defined in the glossary (Appendix A), and Russian names given to some of the rookeries of the Pribilof Islands following their discovery by Russian fur hunters in 1786 are translated in Table 1.

Tabular data for this report are presented as appendices. Appendix B contains the data customarily presented concerning general studies, Appendix C contains entanglement-related data, and Appendix D lists personnel involved in fur seal research in 1989.

This report summarizes the research carried out on these islands in 1989 under the authority of the Marine Mammal Permit No. 598.

Table 1.—English translations of Russian names for Pribilof Island 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" or	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	---	So 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	So 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, Elizabeth S. Sinclair, and Anne E. York

In accordance with provisions originally established under terms of the Interim Convention on Conservation of North Pacific Fur Seals, the National Marine Mammal Laboratory (NMML) has an ongoing program to monitor the population status of fur seals on the Pribilof Islands. Data on population size, age and sex composition, and natural mortality are collected annually to meet this purpose.

Population Parameters

Herd characteristics monitored on St. Paul Island in 1989 include 1) sex composition of seals harvested for food on St. Paul and St. George Islands, 2) the number of live adult males and pups, 3) pup weights and future juvenile male mortality rates through pup tagging studies and, 4) the number of dead pups and older fur seals of both sexes.

Sex Composition of Seals Harvested

A total of 1,336 subadult male seals were killed in the subsistence harvest by St. Paul Island residents in 1989. On St. George Island, 181 subadult male seals were taken in the subsistence harvest in 1989. No female fur seals were taken on either island (Table 2).

Table 2.--Date, location and number of subadult male seals killed in subsistence harvest drives on the Pribilof Islands in 1989.

Date	Rookery	Number killed
St. Paul Island		
July 10	Reef	66
July 11	Lukanin	72
July 14	Zapadni[a]	102
July 17	Polovina[b]	57
July 18	N.E. Point (eastside)	20
July 19	Reef	89
July 21	Zapadni[a]	62
July 24	Polovina[b]	71
July 26	Lukanin	55
July 27	Reef	54
July 28	Tolstoi	82
July 31	Polovina[b]	46
August 4	Reef	93
August 5	Zapadni[a]	65
August 7	N.E. Point (eastside)	126
August 8	Reef	276
	Total	1,336
St. George Island		
July 14	North	59
July 18	North	47
July 25	North	38
July 29	North	25
August 7	North	12
	Total	181

[a]Most animals are driven from Big Zapadni as opposed to Little Zapadni.

[b]Most animals are driven from "halfway point" as opposed to Big Polovina or Little Polovina.

Living Adult Male Seals Counted

A total of 4,297 harem (see glossary for definition) and 6,400 idle (class 1, 2, 4, and 5) adult male seals (bulls) were counted in 1989 on St. Paul Island from 9 to 14 July (Appendix Table B-1). On St. George Island, 1,241 harem and 1,163 idle bulls were counted from 14 to 16 July. Total numbers of harem and idle bulls counted since 1980 are given in Appendix Table B-2. Classification and number of male seals counted by rookery in 1989 are given in Table 3. The relative location of the different classes of adult males is illustrated for a typical fur seal rookery-hauling ground complex on the Pribilof Islands in Figure 5.

Harem bull counts on St. Paul Island were 20% higher in 1989 than 1988. On St. George Island, harem bull counts decreased by 1.5% between 1988 and 1989. The effects of the 1984 cessation of commercial harvesting on St Paul Island are apparent in the 70% increase in the idle male count between 1987 and 1988, and in the 100% increase between 1988 and 1989. On St. George Island, where the commercial harvest ceased in 1972, the idle male count decreased by approximately 8% between 1988 and 1989.

Number of Pups Born in 1989 at St. Paul Island

The number of pups born on St. Paul Island during 1989 was estimated according to the method developed in York and Kozloff (1987). A total of 9,931 pups were sheared on 4 sample rookeries (Ardiguen, Vostochni, Reef, and Polovina Cliffs) from 7 to 11 August. Resighting to determine the marked to unmarked ratio on the sample rookeries was done twice on each rookery from 14 to

Table 3.--Number of adult male northern fur seals counted, by rookery, St. Paul Island, Alaska, July 1989.

Rookery	Date (July)	Class of adult male[a] 2	3	5	Total
St. Paul Island					
Lukanin	9	38	106	108	252
Kitovi	9	64	223	194	481
Reef	11	92	466	632	1,190
Gorbatch	11	63	320	474	857
Ardiguin	11	20	77	7	104
Morjovi	12	51	327	348	699
Vostochni	12	98	778	668	1,544
Little Polovina	9	12	13	198	223
Polovina	9	18	39	289	346
Polovina Cliffs	9	104	345	143	592
Tolstoi	13	86	519	616	1,221
Zapadni Reef	13	20	162	318	500
Little Zapadni	13	84	332	250	666
Zapadni	14	99	590	1,306	1,995
Island total		849	4,297	5,551	10,697
St. George Island					
Zapadni	[b]	50	187	194	431
South	[b]	88	227	18	333
North	[b]	190	452	175	817
East Reef	[b]	37	54	20	111
East Cliffs	[b]	87	234	178	499
Staraya Artil	[b]	66	87	60	213
Island total		518	1,241	645	2,404

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

[b]Counts on St. George Island in 1989 were conducted between 14 July and 16 July.

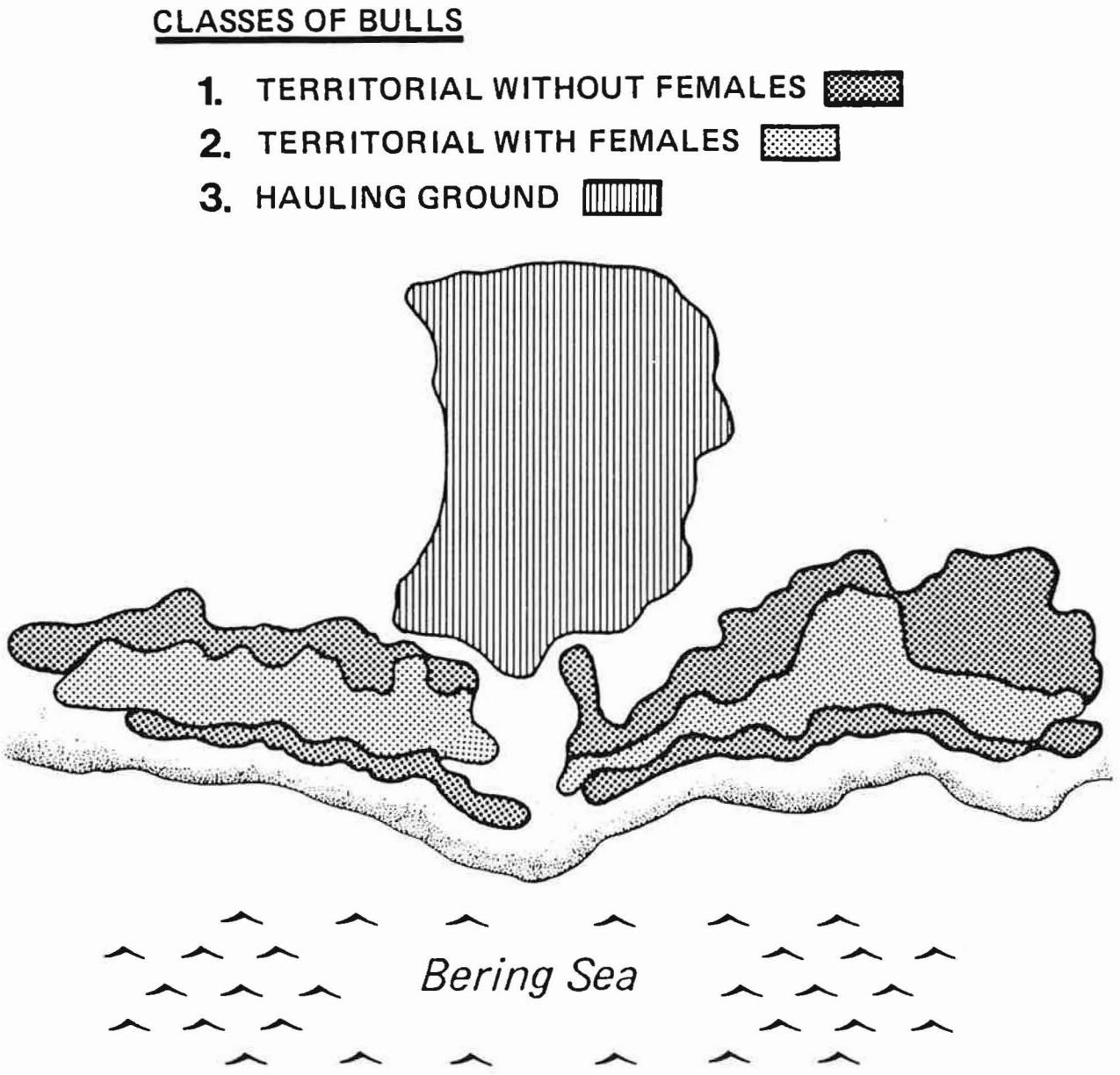

Figure 4.— General composition of a typical fur seal rookery. Class 2 as depicted here corresponds to classes 1 and 2 of Appendix A and class 5 corresponds to classes 4 and 5 of Appendix A.

20 August. The total number of pups alive at the time of sampling is estimated based on the product of the number of breeding males and the ratio of pups to breeding males on the sample rookeries (York and Kozloff 1987).

The number of pups sheared, the number of sheared animals resighted, the total number of pups sampled and the estimated number of pups alive at the time of marking for the sample rookeries are shown in Table 4. Estimates of numbers of pups born on the sample rookeries are the mean of the estimated pup numbers for the two sampling periods.

The estimate and standard error of the total number of pups born on St Paul Island for 1989 is calculated by multiplying the count of breeding males on all rookeries by the estimated ratio of pups to bulls on the sample rookeries (c.f. York and Kozloff 1987). The estimate is derived in the following way: Let

n = the number of sample rookeries,

p_i = the estimated number of pups alive at the time of sampling on rookery i,

B_i = the count of breeding males in mid-July on rookery i, and

r = the ratio of pups to males on the sampled rookeries, $r = (\Sigma P_i)/(\Sigma B_i)$.

Define r_{-i} as the ratio of pups to males on all but the ith sampled rookery:

$$r_{-i} = [(\Sigma P_j) - P_i]/[(\Sigma B_j) - B_i],$$ where the summation runs over all sample rookeries $j = 1,n$.

Table 4.--Number of northern fur seal pups sheared, number of sheared pups resighted on two sampling occasions (R_1 and R_2), total number of pups sampled on two sampling occasions (T_1 and T_2), number of pups estimated to be alive at the time of shearing (E_1 and E_2) and the mean number alive, August 1989.

Rookery	Sheared	R_1	R_2	T_1	T_2	E^*_1	E^*_2	Mean
Vostochni	4,557	565	686	3,275	3,550	26,414	23,582	24,998
Ardiguen	455	74	84	375	450	2,306	2,438	2,372
Reef	2,901	256	351	1,925	2,650	21,814	21,902	21,858
Polovina Cliffs	2,018	251	363	2,125	2,600	17,085	14,454	15,769

$^*E_i = \frac{\text{Sheared} \cdot T_i}{R_i}$ $\quad i = 1,2$

The ith pseudo-value r_i^* (Mosteller and Tukey 1977):

$$r^*_i = n\,r - (n-1)\,r_{-i}.$$

Then the jackknife estimate of the ratio of pups to adult males is the average of the pseudo-values:

$$R = (\Sigma\, r^*_i)/n.$$

The approximate variance of the jackknife ratio r is:

$$V=[\Sigma(r^*_i - R)^2]/(n)(n-1).$$

The values used to compute the jackknife estimate of the ratio of pups to breeding males on the sampled rookeries are given in Table 5. This ratio is 37.80 with an approximate standard error of 6.02.

Pup production on all rookeries is estimated from the product of the ratio of pups to breeding males (37.803) and the count of breeding males on all rookeries (4,297). This value (162,438) is added to the total count of dead pups (9,096) for the estimate of total pups born (171,534). The estimated standard deviation (25,867) is the product of the standard deviation of the ratio (6.0197) and the total number of breeding males (4,297). An approximate 95% confidence interval for the number of pups born on St. Paul Island in 1989 is 171,534 $\pm$ (3.182) (25,867) or 171,534 $\pm$ 82,307, (3.182 is the 97.5 percentile of Student's t distribution with 3 df). This estimate is not significantly different from the estimated 171,600 pups born on St. Paul in 1987 or the 202,304 estimated for 1988. Pup mortality is estimated to be 5.3%. Numbers of pups born $\pm$ 95% confidence intervals for 1970-89 are shown in Figure 6.

Table 5.--Estimates of number of pups alive at the time of shearing for two sampling periods (E_1 and E_2), mean number of pups estimated from the two sampling periods, number of breeding males (Bulls), the ratio of the mean number of pups to breeding males (Ratio), the ratio of pups to breeding males on all but the given rookery (R-minus), and the pseudo ratio (see text for details), for four sample rookeries, St. Paul Island, Alaska, 1989.

Rookery	E_1	E_2	Mean	Bulls	Ratio	R-minus	Pseudo
Vostochni	26,414	23,582	24,998	778	32.131	45.044	20.924
Ardiguen	2,306	2,438	2,372	77	30.800	39.412	37.820
Reef	21,814	21,902	21,858	466	46.906	35.949	48.208
Polovina Cliffs	17,085	14,454	15,769	345	45.708	37.266	44.259

The jackknife estimate of the ratio of pups alive at the time of sampling to the number of breeding males is	37.803	
Its standard error is	6.0197	
An approximate 95% confidence interval is	18.648	56.957
The estimate of the total number of pups alive at the time of shearing is the product of the total number of breeding males (4,297, from Table 2, Class 3) from all rookeries with the ratio of pups to breeding males	162,438	
An approximate 95% confidence interval is	80,131	244,746
The total number of dead pups is	9,096	
Total number of pups born	171,534	
An approximate 95% confidence interval is	89,227	253,842

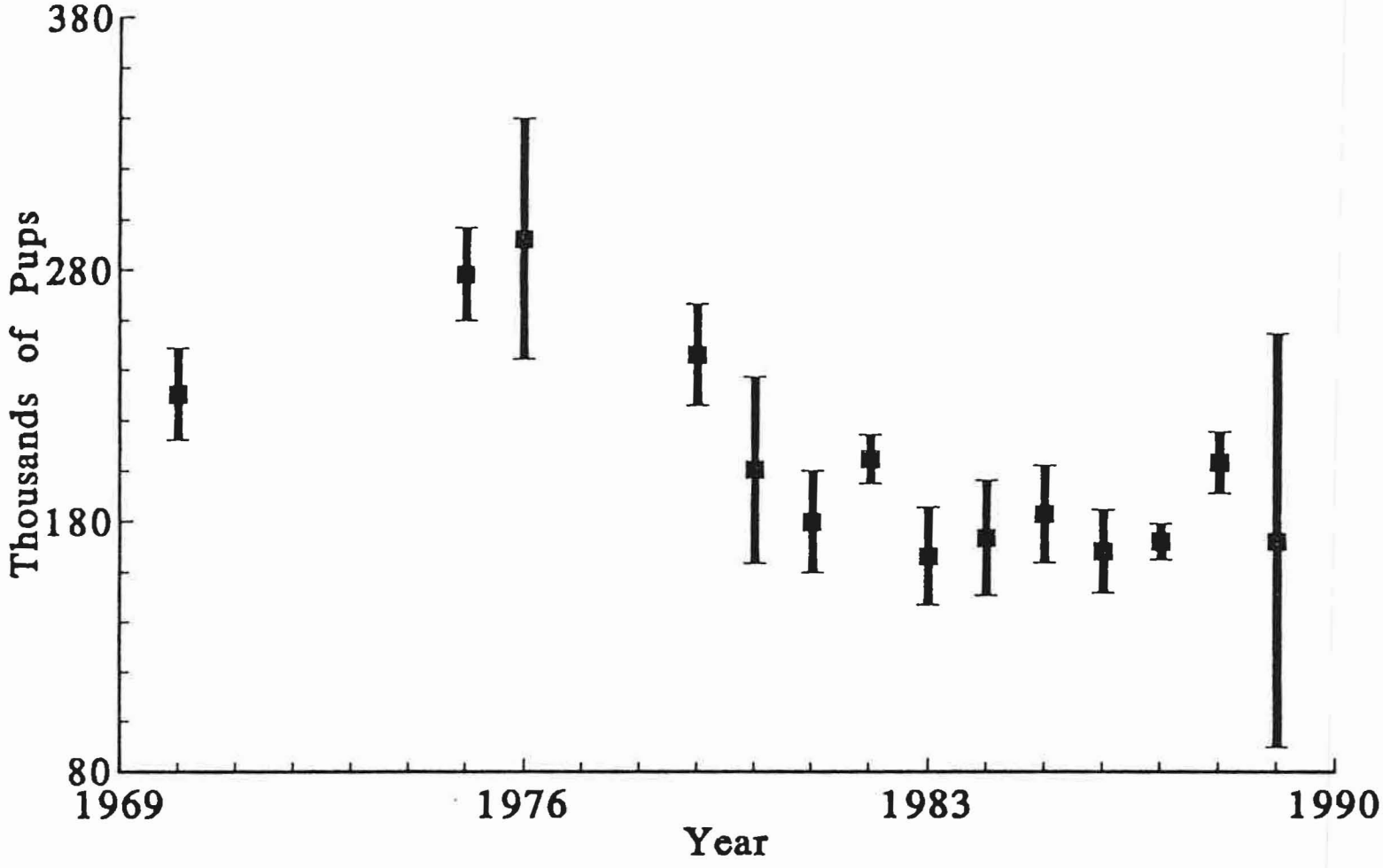

Figure 6.--Numbers of northern fur seal pups born on St. Paul Island, Alaska, 1970-89. Approximate 95% confidence intervals are shown.

The standard error of the estimated number of pups born is very high for 1989. This is caused by the high variability in the ratio of pups to breeding males among the sample rookeries, and may be the result of the cessation of the commercial harvest on St. Paul Island after 1984. Males that were 3 years old in 1985 are now joining the breeding population. If males show preference for certain rookeries over their natal rookery then the ratio of pups to breeding males may not stabilize for several years. If this is the case, a census of all rookeries will have to be done more frequently than the 5-6 year schedule that the sub-sampling procedure currently follows. All rookeries were last sampled in 1987 when the ratio of pups to harem males did not vary appreciably among rookeries (the number of breeding males accounted for approximately 98% of the variability among numbers of pups alive at the time of sampling in 1987).

Tagging Operations

A total of 4,423 pups were double tagged (number series A14837-A18931) with a modified round-post monel cattle ear tag at all major rookeries on St. Paul Island (Table 6) to evaluate tag longevity and to estimate juvenile male mortality. Tags were applied proportionally by rookery section according to the estimated number of pups present on each rookery. This was done in an effort to distribute tags randomly by sample rookery and thereby obtain an unbiased estimate of survival. A total of 4,004 male and 418 female pups (the sex of one pup was unidentified) were tagged on St. Paul Island in 1989. Female pups were only tagged at selected study sites (Polovina Cliffs

Table 6.--Number of northern fur seal pups double tagged with modifed round-post monel cattle ear tags for each rookery, St. Paul Island, Alaska, 21 August - 1 September 1989.

Rookery	Section														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Ardinguen	75	---	---	---	---	---	---	---	---	---	---	---	---	---	75
Gorbatch	166	57	39	---	---	43	---	---	---	---	---	---	---	---	305
Kitovi	37	37	23[a]	95	49	---	---	---	---	---	---	---	---	---	241
Lukanin	294	---	---	---	---	---	---	---	---	---	---	---	---	---	294
Morjovi	60[b]	---	65	54[c]	---	55	---	---	---	---	---	---	---	---	234
Polovina Cliffs	32	49	---	69	123	100	329	---	---	---	---	---	---	---	702
Polovina	49	---	---	---	---	---	---	---	---	---	---	---	---	---	49
Reef	54	89	47	75	5	91[d]	---	36	55	---	---	---	---	---	452
Tolstoi	63[e]	---	45[f]	---	128	143	102	89	---	---	---	---	---	---	570
Vostochni	35	35[g]	54	52	25	95	41	65	---	---	42	---	131	55	630
Little Zapadni	26	47	81	48	67	52	---	---	---	---	---	---	---	---	321
Zapadni	72	89	---	37	48	71	71	---	---	---	---	---	---	---	388
Zapadni Reef	65	37	60	---	---	---	---	---	---	---	---	---	---	---	162
														Total	4,423

[a]Section 4 counts are combination of section 3 and 4 on Kitovi rookery.

[b]Section 1 and 2 combined on Morjovi rookery.

[c]Section 4 and 5 were combined on Morjovi rookery.

[d]Section counts for 5 and 6 on Reef rookery were combined.

[e]Section 1 and 2 combined on Tolstoi rookery.

[f]Section 3 and 4 combined on Tolstoi rookery.

[g]These pups were tagged between sections 1 and 2 on Vostochni rookery.

and Lukanin rookeries) for long-term reproductive studies in the future.

Dead Pups Counted

From 14 to 20 August 1989, 9,096 dead fur seal pups were counted on all rookeries of St. Paul Island except Little Polovina rookery (Table 7). The numbers of dead pups counted since 1979 are given in Appendix Table B-3.

Dead Seals Older Than Pups

The rookeries and adjacent beaches of St. Paul Island, with the exception of Little Polovina rookery, were surveyed for dead seals older than pups from 14 to 20 August 1989. The count of dead seals totaled 217 animals (162 females, 55 males). Teeth were collected from all but 12 of the dead animals (9 females; 3 males). Appendix Table B-4 lists the number of dead seals older than pups counted on the Pribilof Islands since 1965.

Table 7.--Counts of dead pups by rookery sections, St. Paul, Alaska 1989.

Rookery	Date	Rookery section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Ardiguen	8/18	129	---	---	---	---	---	---	---	---	---	---	---	---	---	129
Gorbatch	8/14	256	177	173	4	20	166	---	---	---	---	---	---	---	---	796
Kitovi	8/15	58[a]	12	74	90	48	0	---	---	---	---	---	---	---	---	282
Lukanin	8/16	85	99	---	---	---	---	---	---	---	---	---	---	---	---	184
Morjovi	8/16	91[b]	46	72	39	82	57	---	---	---	---	---	---	---	---	387
Little Polovina [c]		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---[c]
Polovina Cliffs	8/16	33	41	47	73	72	92	104	---	---	---	---	---	---	---	462
Polovina	8/16	39	11	---	---	---	---	---	---	---	---	---	---	---	---	50
Reef	8/18	113	152	106	95	69	102	42	79	104	45	11	---	---	---	918
Tolstoi	8/19	124	127	119	149	188	306	285	228	---	---	---	---	---	---	1,526
Vostochni	8/17	40	11	54	56	40	162	90	106	50	22	48	96	232	92	1,099
Little Zapadni	8/20	25	118	216	300	203	182	---	---	---	---	---	---	---	---	1,044
Zapadni	8/20	120	230	380	301	251	208	213	31	---	---	---	---	---	---	1,734
Zapadni Reef	8/20	154	331	---	---	---	---	---	---	---	---	---	---	---	---	485
Total																9,096

[a]Includes 12 dead pups counted on Kitovi Amphitheater.

[b]Includes 34 dead pups counted on 2nd point south of Sea Lion Neck.

[c]No dead pup counts were made at Little Polovina rookery.

WEIGHTS AND SEX RATIOS OF NORTHERN FUR SEAL PUPS 1989

by

Anne E. York and George A. Antonelis

Samples of pups were weighed during the tagging operations on St. Paul Island during late August 1989 (approximately 1 week after shearing-sampling studies were completed) on all rookeries except Little Polovina. In contrast to tagging operations conducted during 1987 and 1988, only male pups were tagged, except on special study sites for future reproductive studies. We report average weights for males and females for each rookery studied and sex ratios among pups.

Groups of pups were surrounded on the rookeries and sexed; all males were tagged and all females were marked by clipping a small amount of hair from the rump. Random samples of approximately 10% of the males and 10% of the females were weighed, except on Tolstoi rookery where all pups that were captured were weighed.

A spring scale was attached to a bucket with a burlap bottom; the tare was checked before each group of pups were weighed. Each pup selected for weighing was put into the bucket and weighed to the nearest 1/4 kg. To avoid fatigue, weighers were usually replaced after each group.

Variations of weights of nonsheared pups were analyzed using two-way analysis of variance (sex and rookery). On those rookeries where shearing was done, a separate three-way analysis of variance (sex, rookery, and shearing status) was done.

Results and Discussion

Sample sizes, mean weights, and standard deviations for each rookery by sex and shearing status (sheared or not sheared) are shown in Table 8. Mean weight and 95% confidence intervals by rookery for male and female pups that were not sheared are shown in Figure 7; Mean weight and 95% confidence intervals by sex and rookery for both sheared and nonsheared animals on those rookeries where shearing-sampling studies were done are shown in Figure 8.

Pup Weights

The analysis of variance of the weights over sex and rookery is presented in Table 9 for the nonsheared animals over all rookeries sampled. A three-way analysis of variance of the weights over sex, rookery, and shearing status is presented in Table 10 for those rookeries on which shearing was done. In Tables 9 and 10, each factor is screened for its importance by computing the mean sum of squares due to that factor within the minimal model containing the factor. For example, the sum of squares due to the factor sex is the reduction in sum of squares by adding the factor sex after the correction for the mean; the sum of squares due to any three-way interaction is the reduction in sum of squares from the model containing all the single factors and two-way interactions of the same variables.

Analysis of variance of weights (Tables 9 and 10) indicate the following: 1) male and female weights are significantly different ($p > 0.999$); 2) there are significant differences in average weights by rookery ($p > 0.999$, in Table 7, $p = 0.956$

Table 8.-- Sample size (N), mean weight ($\bar{x}$), and standard deviation (SD) of sheared (S) and nonsheared (NS) northern fur seal pups weighed at the time of tagging, 21-28 August 1989, St. Paul Island, Alaska.

Rookery		Females		Males		Dates
		NS	S	NS	S	
Lukanin	N	59	0	61	0	27 Aug.
	$\bar{x}$	7.750	-	9.406	-	
	SD	1.541	-	1.625	-	
Kitovi	N	38	0	52	0	27 Aug.
	$\bar{x}$	8.658	-	10.111	-	
	SD	1.281	-	1.508	-	
Reef	N	29	7	39	11	21 Aug.
	$\bar{x}$	7.845	7.500	8.910	8.409	
	SD	1.402	0.791	1.773	1.865	
Gorbatch	N	50	0	61	0	25 Aug.
	$\bar{x}$	7.565	-	9.348	-	
	SD	1.581	-	1.805	-	
Ardiguen	N	29	10	36	14	25 Aug.
	$\bar{x}$	7.845	7.325	9.243	9.946	
	SD	1.189	1.688	1.776	1.838	
Morjovi	N	49	0	49	0	23 Aug.
	$\bar{x}$	8.260	-	10.107	-	
	SD	1.499	-	1.702	-	
Vostochni	N	62	23	71	27	22-23 Aug.
	$\bar{x}$	8.190	8.030	9.842	8.833	
	SD	1.282	1.339	1.696	1.886	
Polovina	N	47	0	49	0	24 Aug.
	$\bar{x}$	7.745	-	9.327	-	
	SD	1.753	-	1.876	-	
Polovina Cl.	N	75	14	91	13	24 Aug.
	$\bar{x}$	8.143	8.286	9.245	8.827	
	SD	1.240	1.712	1.803	1.900	
Tolstoi	N	509	0	637	0	29 Aug.
	$\bar{x}$	8.285	-	9.502	-	
	SD	1.469	-	1.820	-	
Zapadni Reef	N	50	0	48	0	28 Aug.
	$\bar{x}$	8.030	-	9.276	-	
	SD	1.469	-	1.844	-	
L. Zapadni	N	55	0	69	0	28 Aug.
	$\bar{x}$	7.514	-	9.348	-	
	SD	1.548	-	1.783	-	
Zapadni	N	50	0	57	0	26 Aug.
	$\bar{x}$	8.325	-	9.904	-	
	SD	1.597	-	2.010	-	
Combined	N	1102	54	1320	65	
	$\bar{x}$	8.126	7.897	9.507	9.000	
	SD	1.482	1.466	1.804	1.904	

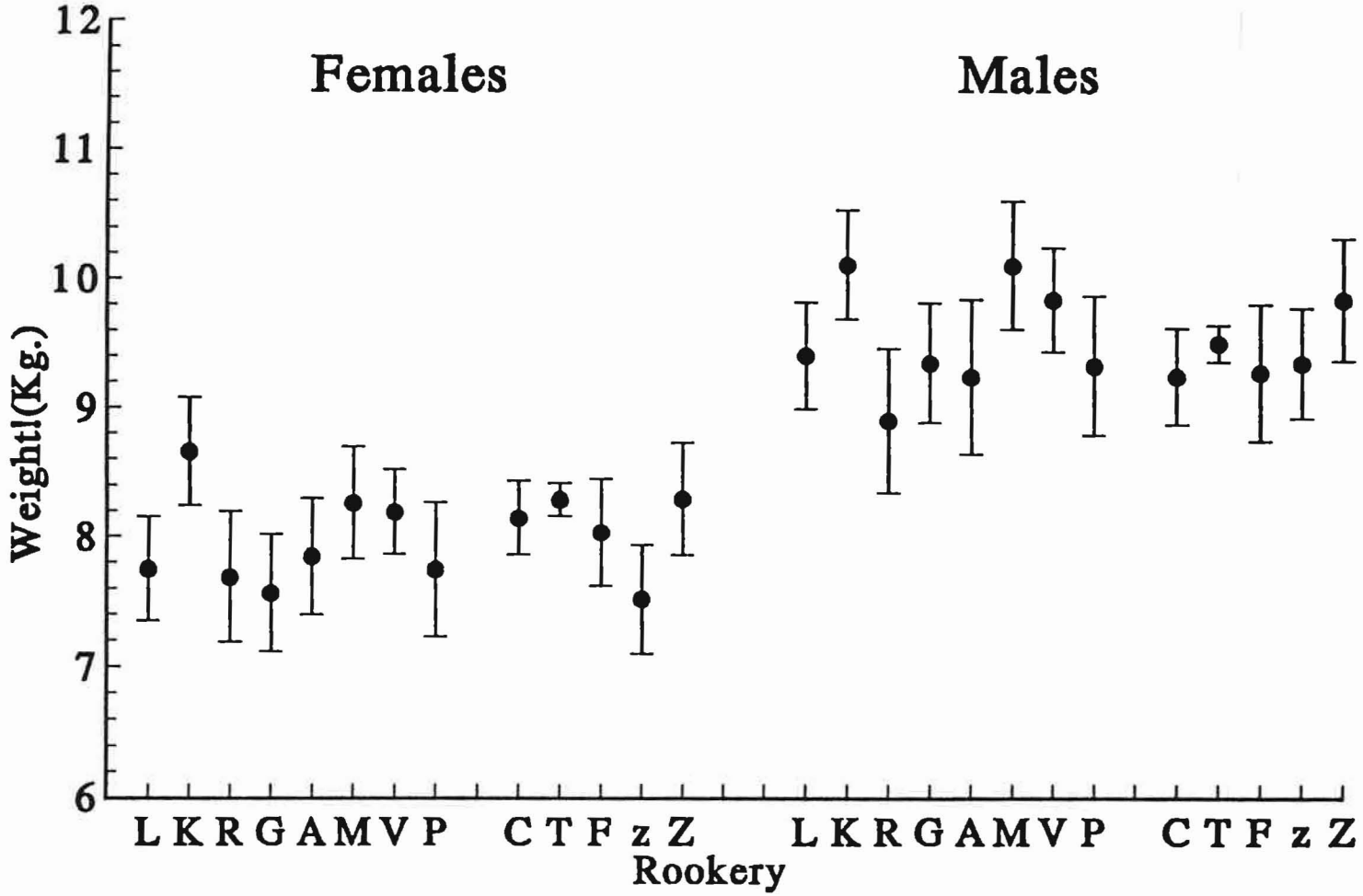

Figure 7.--Mean weights with 95% confidence intervals of northern fur seal pups weighed during tagging operations, August 1989, St. Paul Island, Alaska: Lukanin (L), Kitovi (K), Reef (R), Gorbatch (G), Ardiguen (A), Morjovi (M), Vostochni (V), Polovina (P), Polivin Cliffs (C), Tolstoi (T), Zapadni Reef (F), Little Zapadni (z), and Zapadni (Z).

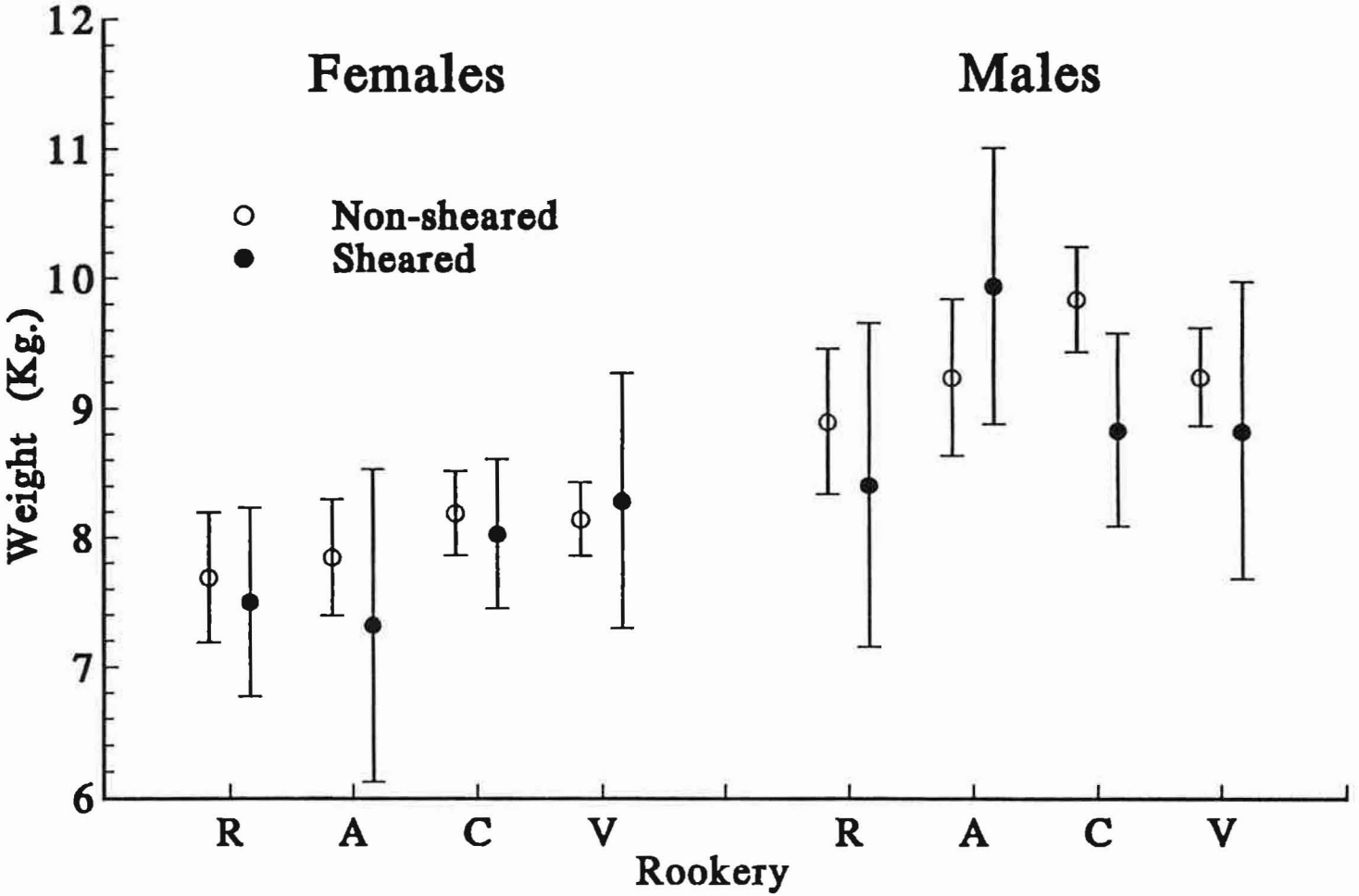

Figure 8.--Mean weights with 95% confidence intervals of northern fur seal pups weighed during tagging operations, August 1989, St. Paul Island, Alaska: Reef (R), Ardiguen (A), Polovina Cliffs (C), and Vostochni (V).

Table 9.--Analysis of variance of weights of nonsheared northern fur seal pups on sex and rookery for data collected during August 1989.

Source	Sum Squares	df	MSS	F	p
Total	7,857.9	2,421			
Sex	1,146.0	1	1,146.00	419.78	>0.999
Rookeries	131.8	12	10.98	4.02	>0.999
Rook.Sex	35.8	12	2.98	1.09	0.638
Residual	6,544.3	2,396	2.73		

Table 10.--Analysis of variance of pup weights on sex, rookery, and shearing status for data collected during August 1989 on rookeries where shearing took place.

Source	Sum of Squares	df	MSS	F	p
Total	1,632.29	550			
Sex	215.63	1	215.60	215.60	>0.999
Rookeries	20.79	3	6.93	2.74	0.957
Shearing	8.56	1	8.56	3.38	0.934
Sex.Rook	10.04	3	3.01	1.19	0.686
Rook.Shear	8.65	3	2.88	1.14	0.714
Sex.Shear	1.71	1	1.71	0.68	0.589
Sex.Shear.Rook	13.10	3	4.36	1.73	0.839
Residual	1,353.80	535	2.53		

Table 9); 3) there are no statistically significant two-way or three-way interactions; and, 4) weights of sheared pups and nonsheared pups are not significantly different ($p = 0.901$).

In order to compare the weights for 1989 with the 1987 and 1988 values, a separate analysis was carried out for the nonsheared animals (Table 11). The sampling of pup weights during the 3 years were not the same; numbers of animals weighed in the previous years were not necessarily proportional to the population size on the rookery and neither tagging nor shearing-sampling studies were conducted on all rookeries each year. Therefore, mean weights for St. Paul Island were calculated for males and females for 1989 using the same method as in 1987 and 1988 (York and Antonelis 1990) and were compared to the previously calculated means for 1987 and 1988. These estimated means are the weighted sums of the means for each sampled rookery (Ardiguen and Little Polovina rookeries were excluded because data were not obtained there in all 3 years); the means were weighted using the fraction of breeding bulls contributed by that rookery to the total number of breeding bulls on the island (excluding Little Polovina and Ardiguen rookeries). These fractions are considered representative of the size of the pup population on each rookery and are independent of the weight data. The variance of the weighted mean is estimated as the sum of the product of the squared weights with the variances of the mean weights from each rookeries.

The calculations were carried out in the following way: Let B_1, B_2, ... B_{12} be the 1989 bull counts on the 12 rookeries where

Table 11.-- Fraction of breeding males contributed by each rookery to total breeding male numbers on St. Paul Island (excluding Little Polovina and Ardiguen rookeries) for 1989.

Rookery	1989
Lukanin	0.025
Kitovi	0.053
Reef	0.111
Gorbatch	0.076
Morjovi	0.078
Vostochni	0.185
Polovina	0.009
Polovina Cliffs	0.082
Tolstoi	0.123
Zapadni Reef	0.039
Little Zapadni	0.079
Zapadni	0.140

Table 12.-- Estimated mean weights (with standard deviations) for female and male pups for 1987, 1988, and 1989.

	Estimated mean weights		
	1987	1988	1989
Females	8.518	8.057	8.087
SD	0.077	0.057	0.063
Males	9.811	9.531	9.577
SD	0.091	0.061	0.072

weighing studies were conducted all 3 years (1987-89). Let $W_{i,j}$ be the corresponding mean weight of nonsheared animals on rookery i, i = 1, 12 for sex j (j = 1 for females, 2 for males) from Table 8. Let $V_{i,j}$ be the variance for $W_{i,j}$; $V_{i,j}$ is calculated as the square of the standard deviation (in Table 8) divided by the sample size (from Table 8). For example, $V(1,1) = 1.541^2/59$. For each rookery, i, the fraction of bulls (f) contributed by that rookery is computed as

$$f_i = B_i \; / \; \sum_{i=1}^{12} B_i .$$

Then, the weighted mean (M) for sex j is

$$M_j = \sum_{i=1}^{12} f_i \; W_{i,j},$$

with variance

$$S^2_j = \sum_{i=1}^{12} f^2_i \; V_{i,j}.$$

Significant differences between two means can be assessed by comparing the difference in the two means divided by the square root of the sum of the two corresponding variances to a Student's t distribution with 12 degrees of freedom.

The weights and the estimated mean weight of a St. Paul Island pup and its standard error for each sex for 1987, 1988 and 1989 are shown in Table 11 and 12. Females were 0.43 kg heavier in 1987 than in 1989 (t = 4.35, p = 0.999), while males were 0.23 kg heavier (t = 2.01, p = 0.933). The weights for 1988 were not

significantly different from the 1989 weights ($t = 0.375$, $p = 0.285$ for females; $t = 0.548$, $p = 0.405$ for males).

Sex Ratios

Sex-ratio information by rookery and shearing status is summarized in Table 13. An analysis of the sex ratios was conducted by analyzing the fraction of male fur seals in each year, rookery, and shear-status combination. The analysis was carried out using the General Linear Interactive Modelling (GLIM) program assuming that the fraction of males in each section was a binomial random variable; the logit of the fraction of males [$\log(p/(1-p))$] was modelled as a linear function of rookery and shearing status. The results from that analysis (Table 14) can essentially be interpreted like an analysis of variance except that the significance of a factor is judged by comparing the mean deviance (total deviance divided by the degrees of freedom of the factor) with a chi-square random variable over its degrees of freedom (1968 CRC Handbook Table V.2).

When all categories are considered simultaneously, the additions of the shearing or rookery terms do not reduce the deviance significantly ($p = 0.95$). That is, one does not reject the null hypothesis that there is no significant difference in the fraction of males among the rookeries nor is there a difference in sex ratio between the sheared and nonsheared animals. If only the nonsheared animals are considered, there is a difference among rookeries at $p = 0.91$. Males comprised 53.4% of the nonsheared animals and 56.7% of the sheared animals

Table 13.--Numbers of pups (Males), total number of pups (Total), and fraction (Fract.) of males captured during tagging operations on St. Paul Island, Alaska, 21-30 August 1989. The fraction of males is in significantly greater numbers than 50% (p=0.95) for shaded items.

Rookery	Nonsheared animals			Sheared animals		
	Males	Total	Fract.	Males	Total	Fract.
Lukanin	152	294	0.517	-	-	-
Kitovi	241	433	0.557	-	-	-
Reef	377	683	0.551	71	129	0.550
Gorbatch	302	531	0.569	4	5	0.800
Ardiguen	53	103	0.515	22	34	0.647
Morjovi	233	462	0.504	1	1	1.000
Vostochni	472	913	0.517	158	279	0.566
Polovina	49	96	0.510	-	-	-
Polovina Cl.	378	775	0.488	56	103	0.544
Tolstoi	637	1,146	0.556	-	-	-
Zapadni Reef	162	322	0.503	-	-	-
L. Zapadni	321	581	0.553	-	-	-
Zapadni	383	702	0.546	-	-	-
Total	3,760	7,041	0.534	312	551	0.567

Table 14.--Analysis of deviance for dependence of sex-ratio on shearing status and rookeries. p-values are 1/100 the percentile from χ_{df} table.

Factor	df	Deviance	p
Rookeries(R)	12	17.17	0.912
Shearing (S)	1	3.80	0.534
R.S	5	3.81	0.844

(Table 13); based on the Klopper-Pearson test, both of these numbers are significantly greater ($p = 0.95$) than 50%. Among the nonsheared animals, the fraction of males was significantly greater ($p = 0.95$) than 50% on Kitovi, Reef, Gorbatch, Tolstoi, Little Zapadni, and Zapadni rookeries; these items are highlighted in Table 13. The fraction of males was not significantly different from 50% on the other rookeries. These results are similar to data taken in 1987 and 1988, for which averaged over the 2 years, males comprised 53.3% (52.8% in 1988 and 54.5% in 1987) of the nonsheared tagged animals. On the other hand, a significantly ($p = 0.99$) higher percentage (63.3%) of the sheared animals that were subsequently weighed (68.1% in 1988 and 60.8% in 1987) were males.

Summary

Consistent with data from 1987 and 1988, the only clear pattern of how weights of pups vary is by sex: males outweigh females. On most rookeries, the mean weight of sheared pups is less than that of the nonsheared pups but not always, and not always significantly less. Comparing the data taken in 1989 with that of 1987 and 1988, the pattern of differences among rookeries is not consistent across years. The average weight of pups on St. Paul Island was not significantly different from 1988, but was significantly less than the 1987 samples.

The ratio of males to females among nonsheared animals was not significantly different from data taken in 1987 and 1988. However, among the sheared animals, the ratio of males to females was lower for 1989 than for 1987 and 1988.

BEHAVIOR AND BIOLOGY OF NORTHERN FUR SEALS, ST. GEORGE ISLAND

by

Roger L. Gentry and Camille A. Goebel-Diaz

Field research was conducted from 26 June to 17 August. This field research focused on 1) observing tagged fur seal females for return and natality rates, 2) counting the total number of adult male fur seals on the island, 3) counting marine mammals other than fur seals around the island, 4) deploying satellite transmitters and Time-Temperature-Depth Recorders (TTDRs) on foraging female fur seals, and 5) removing entangling debris from juvenile male fur seals.

This report discusses items 1 and 4 above; item 2 was discussed in a previous section (see page 8). New flipper tags were applied to three females on which the old tags had become unreadable. No other tags were applied. Entangling debris was removed from eight juvenile male fur seals on East Reef, East Cliffs, and Zapadni hauling grounds.

Natality and Return Rates

In 1984, 104 adult female fur seals at East Reef rookery were double tagged with green Riese tags. They were also given a hot brand on the head as a check against double tag loss, and to facilitate recognition and observation of tagged females. Observations have been conducted each year since 1984 to determine the number of females that return (an index of survival rate), and the number that suckle young (an index of pregnancy

rate). Since 1984, other females have been marked by hot iron branding, or with Allflex or white Riese tags. These animals are observed each year with the head-branded females providing our most reliable results.

Tagged females were observed daily from a blind in the center of East Reef rookery, from 5 m high observation towers at either end of the rookery, or from the ground. Tags were read using a 60 power spotting scope. Data on tagged individuals, including whether the female was seen suckling a pup, were recorded on history cards for each female.

In collating data at the end of the season, females were scored as nonsuckling if they were seen on fewer than 6 days throughout the season, or on six or more days without suckling a pup.

Return rate.

Thirty-three of the females branded in 1988 were seen in 1989 (33/43 = 0.77 return rate). To compare this value to previous estimates (see Gentry and Goebel-Diaz 1990) return rate is expressed as its reciprocal, failure to return. The value for 1989, 0.23 failure to return, is almost identical to the 1988 value (0.22), but represents a poorer return when compared to returns for 1987 (0.08) or for 1986 (0.17).

Natality rate.

For the 1989 population of head-branded females, 25 were seen suckling a pup (25/34 = 0.74 suckling rate). The 1989 value compares to 0.93, 0.85, and 0.84 for 1986-88, respectively. That is, the value in 1989 decreased compared to previous years.

Tag loss rate.

Twelve percent of head-branded females from 1989 lost a single tag (4/34 or 12%). This value is lower than the 21.4% observed in 1988, but is greater than the 5 and 7.4% reported for 1986 and 1987, respectively. One female (1/34 = 3%) lost two tags.

The sample size for both natality and tag loss rate was 34, not 33 as calculated for return rate. This discrepancy reflects the inclusion of female 2119 which was suckling at the start of 1989, and which had two tags on her 1989 return, but which did not survive the 1989 season (died on land).

Discussion

After 5 years, the tagged population at East Reef rookery has reached such a small size that it is questionable whether the estimates of natalilty and return rate calculated for it are representative of the herd at large. For example, does the apparent decrease in natality rate in 1989 reflect a change in the herd, aging in the marked population, or observational error. In such a small population, the failure of observers to see only one or two females that are actually present introduces large errors into the estimates. This problem is exacerbated by the fact that the Riese tags with which the animals are identified are now so badly worn that positive identification in some cases is impossible. For these reasons, we have not statistically compared the 1989 results against previous results.

Tag returns offer the only means of estimating survival and pregnancy rates without sacrificing animals; they are therefore

valuable management tools. If these estimates are to be made in future seasons, these head-banded females should all be retagged and the size of the marked population should be increased.

Satellite Transmitters

The long-term goal of this project is to develop a system for monitoring fur seal foraging relative to the subarctic-subpolar front in the North Pacific Ocean, and thereby measure how fur seals interact with the high seas squid driftnet fishery that operates along the front. The system is being developed at St. George Island because some fur seals there must cross a shelf break front (the front between Bering Sea shelf water and the Bering Sea and Alaska Stream water) to feed in the deep waters of the Bering Sea, and because instruments can be reliably retrieved in case of malfunction.

The goals for the 1989 season were to determine 1) whether Toyocom 0.5 watt satellite transmitters broadcasting every 45 seconds (with no saltwater switch) would reliably report positions for fur seals foraging at sea; 2) whether females were capable of carrying both the satellite tag and an electronic Time-Temperature-Depth Recorder, 3) whether the front could be identified by instruments; and 4) whether map coordinates could be assigned to different thermal structures of the water column by comparing the time bases of the TTDR and the satellite tags.

Reliability

Two satellite tags were deployed, once each. The first was deployed for 6 days. During that time four locations of excellent signal quality were received while the female was on

shore, and four locations were received while she was at sea. Of the latter, one was of excellent quality, two were of acceptable quality, and one was unacceptable. The antenna of one instrument was broken off when the female returned to shore.

The second instrument was deployed for 7 days. Twenty locations (15 at NQ $\geq$ 1) were recorded before the female left land. Of five locations recorded while the female was at sea, one was of excellent quality, and two were of acceptable quality. Six more locations of excellent quality were recorded at the island on the females return from sea. The instrument was returned to shore with the waterproof covering around the antenna broken off.

Load

The combined satellite and TTDR instruments weighed 350 g in air, less than half the mass of mechanical Time-Temperature-Depth Recorders used previously. The durations at sea, 6 and 7 days, are well within the range of trip durations of uninstrumented females. Therefore, the combined instruments were not too massive or large in cross section for females to carry.

Identification of front

Software is not available for analyzing the temperature data, but the records contain data with which to answer the questions about temperatur breaks. Two satellite locations were on the shelf, two were on the slope, and two were in deep water. Therefore, one or perhaps both females crossed the front, which occurs over the continental slope.

Map coordinates

Too few locations were received to assign map coordinates to all dives. However, the locations of at least a few dives on both records can be determined closely. Even without data analysis, it is clear that the dive pattern formerly referred to as "shallow" diving (e.g., <100 m, see Kozloff 1986) occurs over water that is more than 1,000 m deep.

Discussion

From the standpoint of encumbering animals with instruments, these initial trials demonstrated that northern fur seal females are fully capable of carrying the combined satellite tag and TTDR without adversely affecting their swimming performance. The surfacing characteristics of fur seals at sea are not conducive to plotting locations using the present transmission schedule. Improvements are needed in either the transmission frequency or the design of the instrument or antenna.

CENSUS OF NORTHERN FUR SEALS ON BOGOSLOF ISLAND

by

Richard Merrick

A survey of fur seal abundance on Bogoslof Island (Fig. 3) was conducted on 22 July 1989 as part of the Joint U.S.-U.S.S.R. Marine Mammal Research Cruise in the Kuril and Aleutian Islands. Soviet and U.S. biologists counted 29 adult territorial males, 132 adult females, 459 subadult males, and 99 pups (93 alive and 6 dead). Territories were observed on both sides of the island. The number of subadult males has increased by 144% (from 188 animals) since the survey on 2 August 1988. The area occupied by northern fur seals has expanded into much of the beach area north of Castle Rock, which was formerly occupied by northern sea lions (Eumetopias jubatus), and on to the western edge of the island plateau.

Six net entangled animals were observed--two males, two females, and two animals of unknown sex. Seven tagged females were observed with blue Riese or Roto tags. Females identified with Reise tags 2019 and 2050 were tagged as adults on Bogoslof Island in 1985, and the female with Roto tag 13?? was tagged as a pup at East rookery on St. George Island in 1982.

POPULATION AND BEHAVIORAL STUDIES, SAN MIGUEL ISLAND, CALIFORNIA

(Adams Cove and Castle Rock)

by

Robert L. DeLong

The 1989 field season on San Miguel Island extended from 6 July through 5 August, with subsequent trips being made in September and October for pup tagging. A maximum of 61 adult male fur seals maintained territories containing reproductive females during the height of the breeding season. At least 749 pups were born in Adams Cove and 640 pups on Castle Rock. The number of pups born in Adams Cove has changed little over the past 3 years but the number of births increased by 28% between 1988 and 1989 at Castle Rock. Corresponding with the increased numbers of births on Castle Rock is the occupation by fur seals of habitat used by California sea lions (Zalophus californianus) in past years.

In a collaborative study with Dr. B. Stewart, Sea World Research Institute, we conducted a diving-foraging study with eight adult female fur seals. Eight microprocessor-controlled dive recorders were attached to the dorsal pelage along with a radio transmitter tag. All eight recorders were recovered after one or more trips to sea. Six dive records contained between 1,275 and 2,772 dives for each animal. The mean dive depth averaged 24 m.

The colon contents from seven of the eight animals with dive recorders were obtained by enema. The material obtained was

washed and identifiable prey hard parts were recovered from the fecal material. Northern anchovy (Engraulis mordax) was the predominant prey identified.

As in 1988, 175 fur seal pups were double-tagged with pink roto tags during late September and another group of 175 were tagged in late October as part of a study to determine the effect of pup age at the time of tagging and pup survival. Tag numbers and data on individual animals are listed in Appendix Table B-5.

On 7 December 1989 while reading tags on subadult male fur seals in western Adams Cove, an apparent hybrid fur seal x sea lion was observed. The animal was among the juvenile fur seals and looked like a fur seal except that his head was very large compared to a fur seal. This hybrid male had coarse pelage and pelage extending down onto the foreflippers to form a V pattern. On 8 December we captured the animal, obtained a blood sample for genetics analysis and tagged him with pink roto tags, numbers C521 and C522.

ENTANGLEMENT STUDIES, JUVENILE MALE ROUNDUPS[1]

ST PAUL ISLAND, ALASKA

by

Charles W. Fowler and Timothy J. Ragen

Introduction

Northern fur seals become entangled in plastic debris and scraps of fish nets during the time they spend at sea. Such entanglement, especially in scraps of fishing net, has been seen as a source of mortality for this species and has been the focus of research related to finding explanations for recent declines in the population on the Pribilof Islands (Fowler 1987). A number of recent studies conducted by the National Marine Mammal Laboratory have focused on the effects of entanglement in marine debris on northern fur seals (e.g., see Fowler et al. in press).

For experimental work in the field, juvenile males (aged 2 to 5 years) from St. Paul Island, Alaska, comprise the component of the population most readily studied. Entanglement among these males is studied during roundups (a research procedure described in Fowler et al. in press) wherein animals are grouped together on or near haul-out areas adjacent to breeding rookeries. This report is the compilation and presentation of the results of 1989 field research on entanglement and its effects on male northern fur seals.

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[1]Research reported herein was partially funded by the National Marine Fisheries Service Marine Entanglement Research Program, James Coe, Program Manager.

Results

Roundups

A total of 65 roundups were completed during studies on St. Paul Island during July 1989 (Appendix Table C-1). During these roundups, 18,565 male seals judged to be of the size historically taken in the commercial harvest (approximately 105 to 125 cm in total length) were examined for debris. (Unless indicated otherwise, data in this report apply to seals of this size.) Among these, the entangled animals were counted. As will be explained below, about 25% of the total counts (unentangled and entangled) were repeated sightings. The total count and the count of entangled animals are used to estimate the entanglement rate for comparison with rates observed in the commercial harvest prior to 1985. All entangled seals small enough to safely handle were captured and the debris removed. In all, 43 entangled subadult male seals judged to be of harvestable size were captured, the debris was removed, then they were double tagged with numbered orange Allflex tags bearing the address of the National Marine Mammal Laboratory (Appendix Table C-2). Tags were placed on the inner trailing (or posterior) edge of the front flipper, near the hairline, according to standard practice for this species (Gentry and Holt 1982). For each entangled seal, and following procedures from previous years, two unentangled controls were also tagged to compare rates of return in succeeding years (Appendix Table C-2). This resulted in the tagging of 86 similarly sized seals with no debris entangling them in addition to the disentangled animals that were tagged.

Seals Resighted from Previous Year's Tagging

All seals, regardless of size, were examined for tags during roundups. As shown in Appendix Table C-3, seals tagged in previous years were resighted along with seals tagged during the 1989 season. As in previous years, some of the resighted seals were seen on more than one occasion during the 1989 season. Of the resighted tagged seals for which the tags were read, 68 were from the application of Allflex tags in 1985, 1986, and 1988 during earlier phases of research to evaluate the mortality of young male seals in small debris. Fifty-nine of the 68 were seals tagged in previous years as controls and 9 were entangled when tagged in previous years. Of the 9 seals resighted after having been tagged as entangled, 4 had lost their entangling debris. Three pieces of debris that were lost had been noted at their first sighting as being small (0-150 g in estimated weight) and one was medium (150-500 g). Three additional tags from previous years (2 orange Allflex and 1 white Allflex) were sighted but not read; none of these animals were entangled at the time of the resighting.

Entangeled Seals and Entanglement Rate

Forty-seven (the 43 seals mentioned above and 4 that were judged to be larger than historically harvested) entangled juvenile male seals encountered in the 1989 roundups were examined to remove and determine the nature of their entangling debris. Information noted included: the size and kind of the debris, the extent of any wounds, and how tightly the debris was

lodged on the animal (Appendix Table C-4). The tags applied are summarized in Appendix Tables C-2 and C-4.

Of the 47 entangled seals examined, 18 (38.3%) carried fragments of trawl webbing, 15 (31.9%) plastic packing bands, and 9 (19.1%) string, small line or cords. The remainder were entangled in miscellaneous material. The overall entanglement rate is estimated by the ratio of all (both initial and all subsequent) entanglement sightings to the total number of seals examined (thus including the resightings in both cases, i.e., a sampling with replacement design, Bengtson et al. 1988; Fowler et al. in press). In 1989 this included the resighting of animals from which the debris was removed during the same season. In all, there were 56 sightings including the 43 from 1989 of entangled seals of harvestable size which were either newly encountered or resighted seals from which debris had been removed. The entanglement rate for 1989 was thus 0.302% (56/18,565). This rate of entanglement is less than the observed rate of about 0.4% between 1976 and 1985 (Fig. 9).

Appendix Table C-5 shows that the majority of the reduction can be attributed to a reduction in the rate of entanglement in trawl webbing. Historically the rate of entanglement in trawl webbing has been 0.27%. In 1988 that rate dropped to 0.15%, a reduction to about 56% of earlier levels. In 1989 this rate remained low at 0.12%.

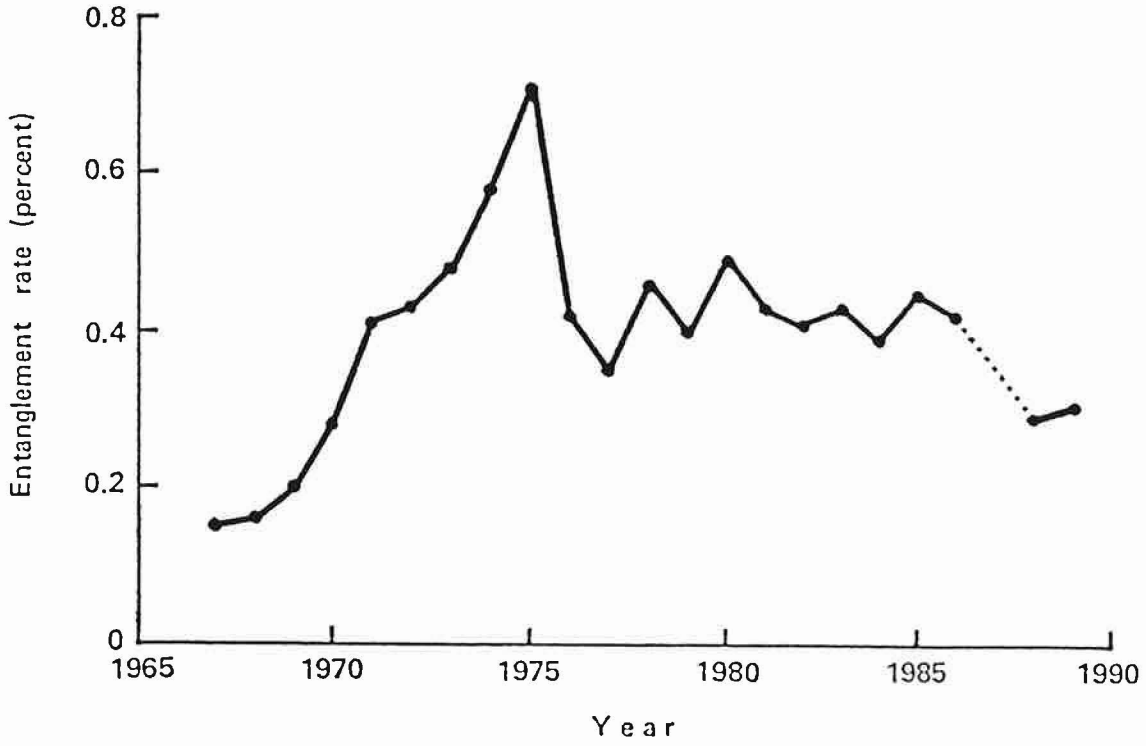

Figure 9.--The percentage of juvenile male seals found entangled in commercial harvest from 1967 to 1984 and in research roundups from 1985 to 1989 on St. Paul Island, Alaska.

Relative Rate of Resighting and Survival Estimates

The record of tags applied to juvenile males during entanglement studies for each year since 1985 is presented in Appendix Table C-6. No samples were collected in 1987. A total of 156 tagged seals judged to be of harvestable size were tagged and released in 1988; 52 of these were entangled. In 1989, 20 (19.2%) of these seals originally tagged as controls were resighted. Five (9.6%) of the seals tagged as entangled animals in 1988 were resighted in 1989. This implies a resighting rate of seals tagged as entangled in previous years of 50% of the rate for controls (9.6/19.2 = 0.5). Although not significantly different from a ratio of 1.0 (Chi-square test, $p > 0.05$), the change in ratio between the years 1988 and 1989 is consistent with the survival rate (about 0.5) estimated for the effects of entanglement in small debris (Fowler et al. in press).

In 1989, 32 seals were resighted after being tagged as part of a group of 279 controls in 1986. Four were resighted out of a group of 128 animals tagged as entangled in 1986. These represent 11.5 and 3.1%, of their respective groups and resighting rates that are significantly different (Chi-square test, $p < 0.05$).

No entangled animals from 1985 were resighted in 1989; however, eight controls were resighted. This is a significant change from the original ratio of tagged entangled to controls for that year (Appendix Table C-6).

The data, as reviewed above, for relative resighting rates of seals tagged in 1985, 1986, and 1988 and seen in 1989, are

shown in Figure 10 along with the data from previous work reported in Fowler et al. (in press). As described above and as can be seen in Figure 10, recent data are consistent with the results of earlier work. The cumulative data continue to show estimated annual survival of 0.5 independent of other causes for seals entangled in small debris.

Characteristics of Debris

Because the debris was removed from the entangled seals in 1989, it was possible to directly determine weights of the debris. With these data the size frequency distribution of the fragments of trawl webbing found as debris on seals can be determined as shown in Figure 11 for the weights and in Figure 12 for mesh sizes. Specific weights and mesh sizes are listed in Appendix Table C-4. These distributions are similar to those seen for debris from entangled northern fur seals in previous studies (Fowler 1987). This is shown in Appendix Table C-7 where slightly over 70% of the debris found on seals seen entangled for the first time are between 0 and 150 g. About 20 and 10% fall between 150 and 500 g and over 500 g respectively. Of the seals entangled in debris of these size categories, however, the rates of return differ markedly. As seen in Appendix Table C-8, roughly half as many seals seen entangled in medium-sized debris return to be seen when compared to seals in the smaller debris. A further reduction of the return rate is seen in comparing the resightings of seals in heavy (over 500 g) debris compared to debris of the intermediate category.

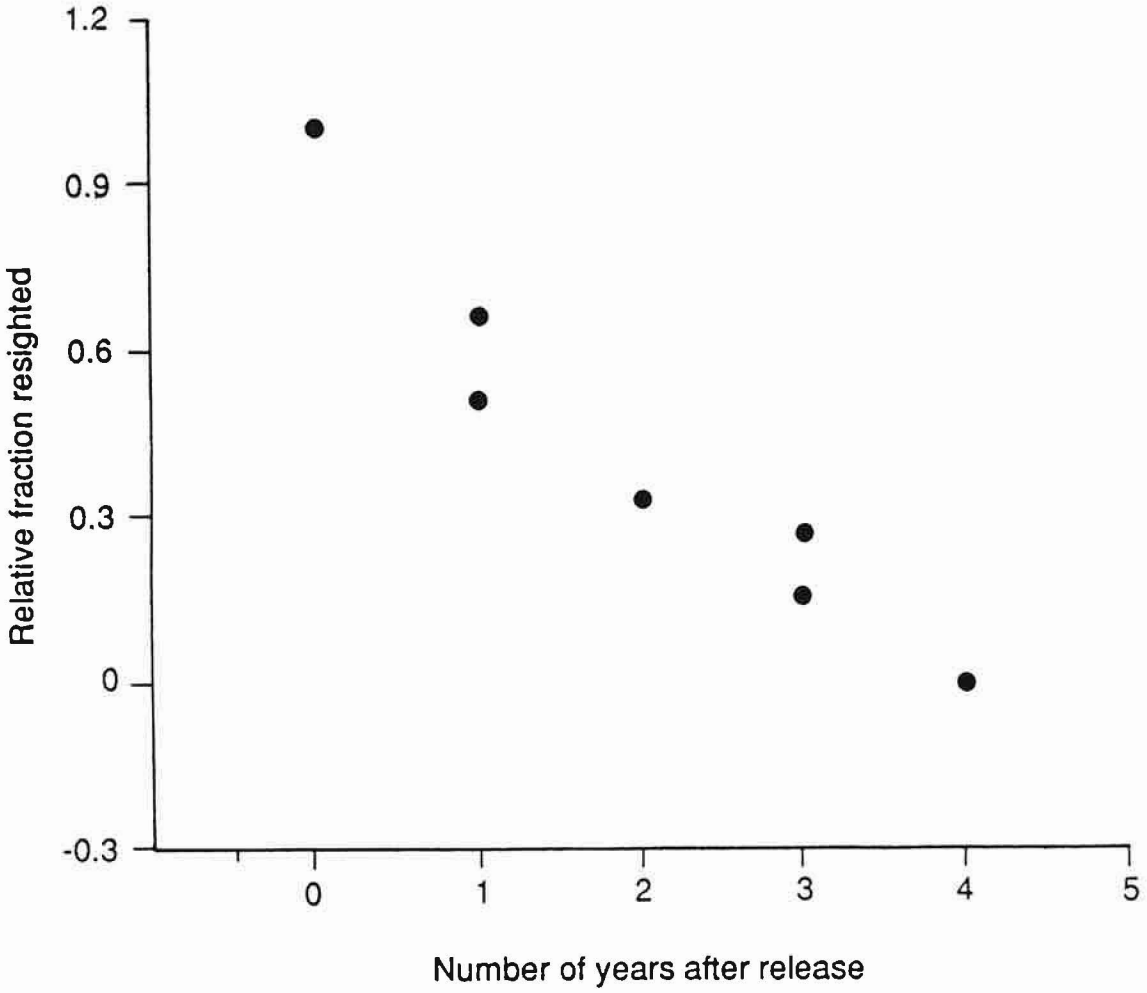

Figure 10.--Relative rates of return for entangled and control, juvenile male fur seals (nonentangled) for varying time intervals (updated from Fowler et al., in press, with the data from this report). Each data point is the fraction of entangled seals that returned divided by the fraction of controls that returned for the corresponding time interval (for example, there are two data points for 1 year representing the 1985-86 and 1988, 1989 intervals).

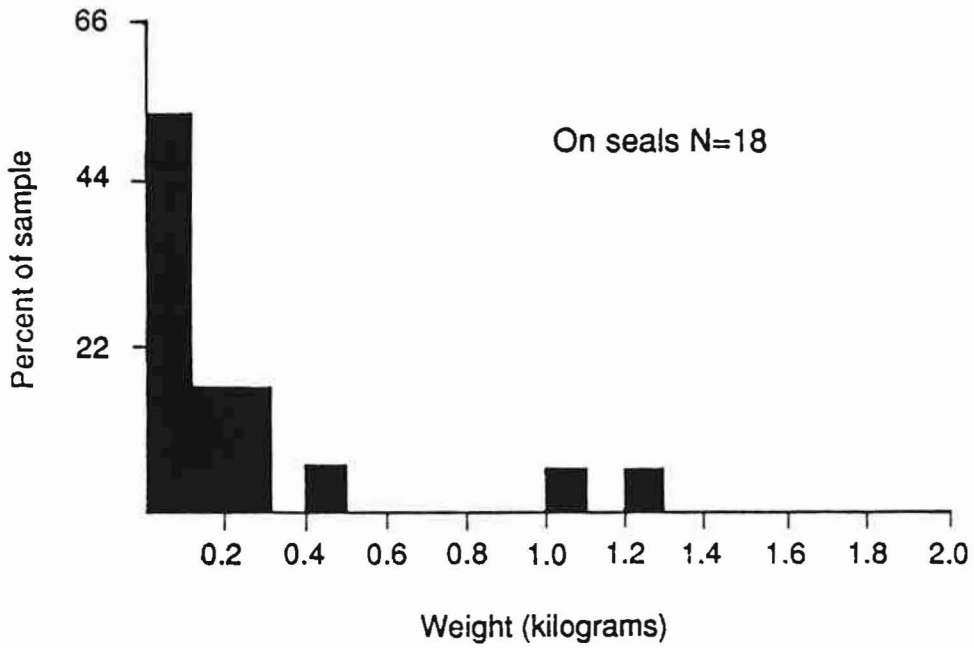

Figure 11.--Size frequency distribution of trawl net debris found on entangled juvenile male northern fur seals, July 1989, St. Paul Island, Alaska.

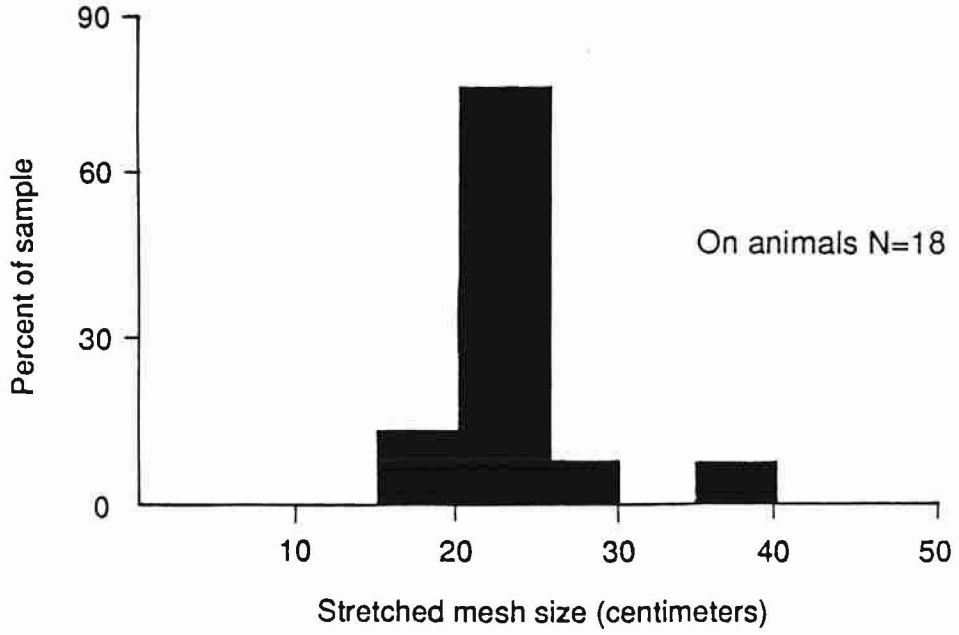

Figure 12.--Size frequency distribution of trawl net debris found on entangled juvenile male northern fur seals, July 1989, St. Paul Island, Alaska (size measured a length of stretched mesh of trawl net fragments).

Within-season Resighting Rate

The fraction of seals tagged as entangled seals (from which the debris was removed in 1989) and resighted in the same field season continues to be about the same as for controls. As seen in Appendix Table C-9, this fraction is close to 25% for the effort expended in roundups for the years shown. There is no statistically significant difference in the rates of resighting between the two groups (Chi-square = 0.805).

Summary

The 1989 results of entanglement research through roundups of juvenile males showed:

1) A continued reduction of the overall entanglement rate from about 0.4% through 1986 to about 0.3% in 1988 and 1989.
2) Entanglement in trawl webbing in 1989 continued to be about half of entanglement levels observed for this kind of debris in previous years (prior to 1988).
3) The 1989 rate of resighting for animals tagged in 1986 indicated that entangled animals were seen at a rate that was significantly less than the rate at which controls were resighted.
4) Data for relative return rates in research on entangled seals continue to produce estimated survival attributable to entanglement caused mortality (i.e., independent of natural causes of mortality) of about 0.5 per year.

5) There is further evidence from the 1989 studies that the rate of return of seals entangled in heavier debris is less than for seals in smaller debris, implying an even greater mortality among seals entangled in large debris.

ACKNOWLEDGMENTS

Research on the Pribilof Islands in 1989 was completed with the cooperation and assistance of Vyacheslov Melovidof, Gregory Fratis, Patrick Kozloff, John R. Merculief, the City of St. Paul, the Indian Reorganization Act (I.R.A.) Council, the Tanadgusix Corporation (TDX), and Steve Zimmerman (NMFS).

Research on San Miguel Island, California, was completed with the cooperation of the staff of the Channel Islands National Monument, National Park Service, Ventura, California, and the U.S. Navy Public Works Department, Pacific Missile Range Headquarters, Point Magu, California.

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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.
Check mark	A notch, slit, hole, or other mark made on a seal flipper when a tag is applied to ensure recognition of an animal if the animal should lose its tag.

Classifications of adult male fur seals

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

APPENDIX B

Tabulations of northern fur seal data collected on the Pribilof Islands and Bogoslof Island, Alaska, and on San Miguel Island, California during 1989.

Table B-1.--Number of adult male northern fur seals counted, by class[a] and rookery section, St. Paul Island, Alaska, 9-14 July 1989. A dash indicates no numbered sections.

Rookery and class of male	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Lukanin															
2	19	19	-	-	-	-	-	-	-	-	-	-	-	-	38
3	54	52	-	-	-	-	-	-	-	-	-	-	-	-	106
5	100	8	-	-	-	-	-	-	-	-	-	-	-	-	108
Kitovi[b]															
2	7(5)	2	21	14	15	-	-	-	-	-	-	-	-	-	64
3	40(19)	10	42	66	46	-	-	-	-	-	-	-	-	-	223
5	12(37)	12	0	0	133	-	-	-	-	-	-	-	-	-	194
Reef															
2	18	11	6	7	4	9	10	4	9	11	3	-	-	-	92
3	42	73	74	42	49	52	16	45	48	29	4	-	-	-	466
5	8	21	44	27	224	18	87	56	10	101	36	-	-	-	632
Gorbatch															
2	23	15	7	0	3	15	-	-	-	-	-	-	-	-	63
3	97	67	68	0	17	71	-	-	-	-	-	-	-	-	320
5	266	9	8	116	58	17	-	-	-	-	-	-	-	-	474
Ardiguen															
2	20	-	-	-	-	-	-	-	-	-	-	-	-	-	20
3	77	-	-	-	-	-	-	-	-	-	-	-	-	-	77
5	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Morjovi[c]															
2	2(9)	9	8	10	5	8	-	-	-	-	-	-	-	-	51
3	36(27)	40	60	33	96	35	-	-	-	-	-	-	-	-	327
5	125(11)	1	66	24	12	109	-	-	-	-	-	-	-	-	348
Vostochni															
2	4	2	6	7	4	8	16	16	14	3	5	10	13	6	105
3	39	12	45	47	29	96	57	85	48	22	37	54	140	67	778
5	16	0	9	89	103	36	34	18	37	61	0	94	92	79	668
Little Polovina															
2	6	6	-	-	-	-	-	-	-	-	-	-	-	-	12
3	4	9	-	-	-	-	-	-	-	-	-	-	-	-	13
5	76	122	-	-	-	-	-	-	-	-	-	-	-	-	198
Polovina															
2	16	2	-	-	-	-	-	-	-	-	-	-	-	-	18
3	28	11	-	-	-	-	-	-	-	-	-	-	-	-	39
5	195	94	-	-	-	-	-	-	-	-	-	-	-	-	289
Polovina Cliffs															
2	11	10	2	15	23	23	20	-	-	-	-	-	-	-	104
3	32	28	31	46	56	60	92	-	-	-	-	-	-	-	345
5	6	10	1	24	7	31	64	-	-	-	-	-	-	-	143
Tolstoi															
2	8	4	9	12	13	17	15	8	-	-	-	-	-	-	86
3	62	87	66	53	78	64	63	46	-	-	-	-	-	-	519
5	4	17	7	3	26	43	32	484	-	-	-	-	-	-	616
Zapadni Reef															
2	15	5	-	-	-	-	-	-	-	-	-	-	-	-	20
3	98	34	-	-	-	-	-	-	-	-	-	-	-	-	132
5	109	209	-	-	-	-	-	-	-	-	-	-	-	-	318
Little Zapadni															
2	3	17	15	18	10	21	-	-	-	-	-	-	-	-	84
3	11	40	72	78	67	64	-	-	-	-	-	-	-	-	332
5	29	10	15	20	8	168	-	-	-	-	-	-	-	-	250
Zapadni[d]															
2	14(0)	14	11	17	16	17	8	2	-	-	-	-	-	-	99
3	56(0)	112	103	86	63	76	76	18	-	-	-	-	-	-	590
5	27(261)	56	57	49	411	49	38	358	-	-	-	-	-	-	1306

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

Table B-2.--Number of harem and idle male northern fur seals counted in mid-July, Pribilof Islands, Alaska, 1980-89. A dash indicates no data.

Year	St. Paul Island		St. George Island		Total	
	Harem.	Idle	Harem	Idle	Harem	Idle
1980	5,490	4,248	1,563	1,795	7,053	6,043
1981	5,120	4,003	1,472	1,646	6,592	5,649
1982	5,767	4,009	1,410	1,319	7,177	5,328
1983	4,827	4,242	-	-	-	-
1984	4,803	3,977	1,473	1,452	6,276	5,429
1985	4,372	3,363	1,286	1,601	5,658	4,964
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

Table B-3.--Number of dead northern fur seal pups counted, by rookery, Pribilof Islands, Alaska, 1979-89.[a] A dash indicates no data.

Island and rookery	Year										
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
St. Paul Island											
Morjovi	269	508	346	348	274	336	247	441	336	423	387
Vostochni	573	932	889	837	747	973	604	891	738	959	1,099
Little Polovina	28	77	41	49	46	14	29	19	-	-	-
Polovina Cliffs	433	627	463	570	438	397	367	591	536	451	462
Polovina	85	127	89	97	79	75	56	67	47	53	50
Ardiguen	31	76	38	49	33	46	6	75	114	63	129
Gorbatch	260	699	379	399	414	522	371	578	697	487	796
Reef	651	790	623	654	649	411	624	778	827	727	918
Kitovi	171	256	187	269	223	142	211	429	288	307	282
Lukanin	132	206	102	139	171	104	149	214	182	204	184
Tolstoi	1,645	1,488	1,547	1,332	1,178	1,407	919	1,062	1,368	1,314	1,526
Little Zapadni	637	645	377	779	562	580	485	815	878	820	1,044
Zapadni Reef	161	243	266	276	258	301	197	390	334	384	485
Zapadni	1,368	1,185	1,451	1,503	925	807	1,001	1,417	1,306	1,069	1,734
Counted total	6,444	7,859	6,798	7,301	5,997	6,115	5,266	7,767	7,651	7,261	9,096
Estimated oversight 5%[b]	322	393	340	365	300	306	263	388	383	363	455
Total	6,766	8,252	7,138	7,666	6,297	6,421	5,529	8,155	8,034	7,624	9,551
St. George Island											
North	774	949	810	649	367	-	317	-	-	534	-
Zapadni	277	350	186	190	124	-	134	-	-	152	-
South	186	197	177	110	111	-	128	-	-	152	-
East Reef	104	121	74	56	25	-	22	-	-	12	-
East Cliffs	285	284	402	340	128	-	106	-	-	246	-
Staraya Artil	565	484	376	315	148	-	99	-	-	111	-
Counted total	2,191	2,385	2,025	1,660	903	-	806	-	-	1,212	-
Estimated oversight 5%[b]	110	119	101	83	45	-	40	-	-	61	-
Total	2,301	2,504	2,126	1,743	948	-	846	-	-	1,273	-

Table B-3.--Continued

Island and rookery	Year										
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Pribilof Islands											
counted total	8,635	10,244	8,823	8,961	6,900	-	6,072	-	-	8,833	-
Estimated oversight 5%[b]	432	512	441	448	345	-	303	-	-	422	-
Total	9,067	10,756	9,264	9,409	7,245	-	6,421	-	-	9,275	-

[a]The dead pups are counted after 15 August each year; most mortality has occurred by that date.

[b]As established by survey conducted in 1960: C. E. Abegglen, A. Y. Roppel, and F. Wilke. 1960. Alaska fur seal investigations, Pribilof Island, Alaska. Unpubl. manuscr., 165 p. Natl. Mar. Mammal Lab., Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way N.E., Seattle, WA 98115.

Table B-4.--Number of dead northern fur seals counted that were older than pups, Pribilof Islands, Alaska, 1965-89. A dash indicates no data.

Year	St. Paul Island		St. George Island		Total	
	Males	Females	Males	Females	Males	Females
1965	158	-	-	-	158	-
1966	181	172	41	55	222	227
1967	108	157	41	28	149	185
1968	98	141	33	22	131	163
1969	94	141	22	29	116	170
1970	52	124	4	53	56	177
1971	39	91	5	37	44	128
1972	46	111	22	30	68	141
1973	61	65	7	30	68	95
1974	33	30	4	15	37	45
1975	92	99	-	-	92	99
1976	46	64	-	-	46	64
1977	60	69	-	-	60	69
1978	57	87	-	-	57	87
1979	56	66	-[a]	-[a]	56	66
1980	102	117	14	65	116	182
1981	44	83	12	61	56	144
1982	47	117	-	-	47	117
1983	57	66	-	-	57	66
1984	66	72	-	-	66	72
1985	5	34	17	35	22	69
1986	24	67	-	-	24	67
1987	20	90[b]	-	-	20	99[b]
1988	56	112	21	29	77	141
1989	55	162	-	-	55	162

[a]A total of 70 dead fur seals of both sexes that were older than pups were counted on the rookeries of St. George Island.

[b]Includes 10 dead fur seals of unknown sex.

Table B-5.--Northern fur seal pups tagged with pink roto tags, San Miguel Island, California, 1989.

Month	Left tag	Right tag	Sex	Weight(kg)	Sample*
September					
22	A000901	A000901	F	12.0	
22	A000902	A000902	F	10.5	
22	A000903	A000903	M	10.5	
22	A000904	A000904	M	14.0	
22	A000905	A000905	M	14.0	
22	A000906	A000906	F	10.0	
22	A000907	A000907	M	13.0	
22	A000908	A000908	M	15.5	
22	A000909	A000909	F	11.5	
22	A000910	A000910	F	14.0	
22	A000911	A000911	F	10.5	
22	A000912	A000912	F	11.5	
22	A000913	A000913	M	11.5	
22	A000914	A000914	M	17.5	
22	A000915	A000915	F	7.5	
22	A000916	A000916	M	8.0	
22	A000917	A000917	M	12.0	
22	A000918	A000918	F	10.0	
22	A000919	A000919	M	13.5	
22	A000920	A000920	M	17.0	
22	A000921	A000921	M	14.0	
22	A000922	A000922	F	16.0	
22	A000923	A000923	F	10.5	
22	A000924	A000924	F	10.0	
22	A000925	A000925	F	14.5	
22	A000926	A000926	M	12.0	
22	A000927	A000927	M	16.5	
22	A000928	A000928	M	15.0	
22	A000929	A000929	M	16.0	
22	A000930	A000930	M	10.0	
22	A000931	A000931	F	9.5	
22	A000932	A000932	F	11.0	
22	A000933	A000933	M	12.0	
22	A000934	A000934	F	16.5	
22	A000935	A000935	M	13.0	
22	A000936	A000936	F	11.0	
22	A000937	A000937	M	17.5	
22	A000938	A000938	F	12.5	
22	A000939	A000939	F	9.0	
22	A000940	A000940	F	11.0	
22	A000941	A000941	F	11.5	
22	A000942	A000942	M	12.0	
22	A000943	A000943	F	12.0	
22	A000944	A000944	F	10.5	
22	A000945	A000945	F	11.5	
22	A000946	A000946	M	12.0	

Table B-5.--Continued.

Month	Left tag	Right tag	Sex	Weight(kg)	Sample*
September					
22	A000947	A000947	M	15.0	
22	A000948	A000948	F	11.0	
22	A000949	A000949	F	11.0	
22	A000950	A000950	F	9.0	
22	A000951	A000951	F	6.5	
22	A000952	A000952	F	13.5	
22	A000953	A000953	M	16.0	
22	A000954	A000954	M	14.0	
22	A000955	A000955	F	8.0	
22	A000956	A000956	M	9.5	
22	A000957	A000957	M	14.5	
22	A000958	A000958	M	13.0	
22	A000959	A000959	M	12.5	
22	A000960	A000960	F	11.5	
22	A000961	A000961	M	13.0	
22	A000962	A000962	F	8.5	
22	A000963	A000963	M	13.5	
22	A000964	A000964	M	12.0	
22	A000965	A000965	F	6.0	
22	A000966	A000966	F	12.0	
22	A000967	A000967	F	11.5	
22	A000968	A000968	F	10.5	
22	A000969	A000969	M	17.0	
22	A000970	A000970	F	8.5	
22	A000971	A000971	M	11.0	
22	A000972	A000972	M	11.5	
22	A000973	A000973	M	11.5	
22	A000974	A000974	M	14.0	
22	A000975	A000975	F	9.0	
22	A000976	A000976	M	14.0	
22	A000977	A000977	F	11.5	
22	A000978	A000978	F	11.0	
22	A000979	A000979	M	11.5	
22	A000980	A000980	F	8.5	
22	A000981	A000981	M	11.5	
22	A000982	A000982	F	10.0	
22	A000983	A000983	F	11.5	
22	A000984	A000984	M	15.5	
22	A000985	A000985	M	9.0	
22	A000986	A000986	F	9.0	
22	A000987	A000987	F	9.5	
22	A000988	A000988	F	14.0	
22	A000989	A000989	M	11.0	
22	A000990	A000990	M	7.5	
22	A000991	A000991	M	18.5	
22	A000992	A000992	M	15.5	

Table B-5.--Continued.

Month	Left tag	Right tag	Sex	Weight(kg)	Sample*
September					
22	A000993	A000993	F	9.5	
22	A000994	A000994	M	16.5	
22	A000995	A000995	F	11.0	
22	A000996	A000996	M	16.0	
22	A000997	A000997	M	13.0	
22	A000998	A000998	F	12.0	
22	A000999	A000999	F	9.0	
22	A001000	A001000	M	12.0	
22	A001001	A001001	M	10.5	
22	A001002	A001002	F	11.5	
22	A001003	A001003	F	11.5	
22	A001004	A001004	M	13.5	
22	A001005	A001005	M	14.5	
22	A001006	A001006	F	12.0	
22	A001007	A001007	M	10.0	
22	A001008	A001008	F	10.0	
22	A001010	A001010	M	11.5	
22	A001011	A001011	M	14.0	
22	A001012	A001012	M	13.5	
22	A001013	A001013	M	17.5	
22	A001014	A001014	M	11.5	
22	A001015	A001015	M	14.0	
22	A001016	A001016	M	9.5	
22	A001017	A001017	M	9.5	
22	A001018	A001018	F	9.0	
22	A001019	A001019	F	9.0	
22	A001020	A001020	M	12.5	
22	A001021	A001021	M	11.5	
22	A001022	A001022	F	11.5	
22	A001023	A001023	M	12.5	
22	A001024	A001024	M	14.0	
22	A001025	A001025	M	7.5	
22	A001009	A001009	F	12.5	
23	A001026	A001026	M	10.5	02
23	A001027	A001027	M	17.5	02
23	A001028	A001028	F	9.5	02
23	A001029	A001029	M	14.0	02
23	A001030	A001030	M	13.5	02
23	A001031	A001031	M	11.0	02
23	A001032	A001032	F	10.5	02
23	A001033	A001033	M	11.0	02
23	A001034	A001034	M	11.5	02
23	A001035	A001035	F	12.0	02
23	A001036	A001036	F	9.0	02
23	A001037	A001037	F	11.5	02
23	A001038	A001038	F	9.5	02

Table B-5.--Continued.

Month	Left tag	Right tag	Sex	Weight(kg)	Sample*
September					
23	A001039	A001039	M	11.0	02
23	A001040	A001040	M	10.0	02
23	A001041	A001041	M	14.5	02
23	A001042	A001042	F	11.5	02
23	A001043	A001043	M	12.5	02
23	A001044	A001044	F	10.0	02
23	A001045	A001045	F	9.0	02
23	A001046	A001046	M	11.0	02
23	A001047	A001047	M	10.0	02
23	A001048	A001048	M	13.0	02
23	A001049	A001049	F	9.0	02
23	A001050	A001050	M	12.5	02
23	A001051	A001051	M	14.5	02
23	A001052	A001052	M	14.5	02
23	A001053	A001053	M	11.0	02
23	A001054	A001054	M	12.0	02
23	A001055	A001055	F	8.5	02
23	A001056	A001056	M	14.5	02
23	A001057	A001057	M	13.5	02
23	A001058	A001058	M	12.0	02
23	A001059	A001059	M	10.5	02
23	A001060	A001060	M	10.0	02
23	A001061	A001061	M	14.0	02
23	A001062	A001062	F	11.5	02
23	A001063	A001063	F	8.5	02
23	A001064	A001064	M	10.0	02
23	A001065	A001065	F	12.0	02
23	A001066	A001066	F	14.5	02
23	A001067	A001067	F	11.0	02
23	A001068	A001068	M	10.0	02
23	A001069	A001069	F	11.0	02
23	A001070	A001070	F	10.5	02
23	A001071	A001071	F	9.0	02
23	A001072	A001072	F	11.0	02
23	A001073	A001073	M	11.0	02
23	A001074	A001074	F	10.0	02
23	A001075	A001075	M	10.5	02
October					
20	A001076	A001076	M	12.0	
20	A001077	A001077	F	14.0	
20	A001078	A001078	F	12.0	
20	A001079	A001079	M	17.5	
20	A001080	A001080	M	16.5	
20	A001081	A001081	F	13.0	
20	A001082	A001082	M	12.0	

Table B-5.--Continued.

Month	Left tag	Right tag	Sex	Weight(kg)	Sample*
October					
20	A001083	A001083	F	15.0	
20	A001084	A001084	M	16.0	
20	A001085	A001085	M	19.0	
20	A001086	A001086	M	17.0	
20	A001086	A001086	M	17.0	
20	A001087	A001087	F	12.0	
20	A001088	A001088	F	12.0	
20	A001089	A001089	F	17.5	
20	A001090	A001090	F	13.0	
20	A001091	A001091	F	14.0	
20	A001092	A001092	M	14.0	
20	A001093	A001093	F	14.5	
20	A001094	A001094	M	15.0	
20	A001095	A001095	M	18.0	
20	A001096	A001096	M	12.0	
20	A001097	A001097	F	13.0	
20	A001098	A001098	F	12.5	
20	A001099	A001099	F	12.5	
20	A001100	A001100	M	16.0	
20	A001101	A001101	F	13.5	
20	A001102	A001102	F	14.0	
20	A001103	A001103	M	16.0	
20	A001104	A001104	M	13.5	
20	A001105	A001105	F	15.0	
20	A001106	A001106	M	16.0	
20	A001107	A001107	F	14.0	
20	A001108	A001108	F	11.0	
20	A001109	A001109	F	12.5	
20	A001110	A001110	F	16.5	
20	A001111	A001111	M	14.0	
20	A001112	A001112	M	22.5	
20	A001113	A001113	M	17.5	
20	A001114	A001114	M	15.0	
20	A001115	A001115	F	16.5	
20	A001116	A001116	F	13.5	
20	A001117	A001117	M	11.5	
20	A001118	A001118	M	10.0	
20	A001119	A001119	F	13.0	
20	A001120	A001120	M	17.0	
20	A001121	A001121	M	15.0	
20	A001122	A001122	F	14.5	
20	A001123	A001123	M	14.0	
20	A001124	A001124	M	16.5	
20	A001125	A001125	M	13.5	
20	A001126	A001126	M	15.0	
20	A001127	A001127	F	15.5	

Table B-5.--Continued.

Month	Left tag	Right tag	Sex	Weight(kg)	Sample*
October					
20	A001128	A001128	M	16.0	
20	A001129	A001129	F	12.5	
20	A001130	A001130	M	13.0	
20	A001131	A001131	M	13.5	
20	A001132	A001132	M	13.0	
20	A001133	A001133	F	12.0	
20	A001134	A001134	M	16.0	
20	A001135	A001135	M	19.0	
20	A001136	A001136	F	13.5	
20	A001137	A001137	M	12.5	
20	A001138	A001138	F	13.5	
20	A001139	A001139	F	16.0	
20	A001140	A001140	M	13.0	
20	A001141	A001141	M	14.0	
20	A001142	A001142	M	14.0	
20	A001143	A001143	M	14.5	
20	A001144	A001144	M	16.0	
20	A001145	A001145	M	15.5	
20	A001146	A001146	M	17.5	
20	A001147	A001147	F	13.0	
20	A001148	A001148	M	14.5	
20	A001149	A001149	M	15.5	
20	A001150	A001150	F	15.0	
20	A001151	A001151	F	10.0	
20	A001152	A001152	F	13.0	
20	A001153	A001153	M	14.0	
20	A001154	A001154	F	15.0	
20	A001155	A001155	M	12.5	
20	A001156	A001156	M	12.5	
20	A001157	A001157	M	11.0	
20	A001158	A001158	M	14.0	
20	A001159	A001159	M	16.5	
20	A001160	A001160	F	11.0	
20	A001161	A001161	M	12.5	
20	A001162	A001162	F	12.0	
20	A001163	A001163	F	12.5	
20	A001164	A001164	F	13.5	
20	A001165	A001165	F	15.0	
20	A001166	A001166	M	15.0	
20	A001167	A001167	F	10.5	
20	A001168	A001168	M	15.5	
20	A001169	A001169	M	16.5	
20	A001170	A001170	M	14.0	
20	A001170	A001170	M	14.0	
20	A001171	A001171	F	15.5	
20	A001172	A001172	F	14.5	

Table B-5.--Continued.

Month	Left tag	Right tag	Sex	Weight(kg)	Sample*
October					
20	A001173	A001173	M	14.5	
20	A001174	A001174	M	15.0	
20	A001175	A001175	M	13.0	
20	A001176	A001176	M	13.5	
20	A001177	A001177	F	13.0	
20	A001178	A001178	M	16.5	
20	A001179	A001179	F	12.5	
20	A001180	A001180	M	19.0	
20	A001181	A001181	M	16.5	
20	A001182	A001182	M	17.5	
20	A001183	A001183	F	12.0	
20	A001184	A001184	M	18.0	
20	A001185	A001185	M	15.0	
20	A001186	A001186	M	13.0	
20	A001187	A001187	F	14.0	
20	A001188	A001188	F	13.0	
20	A001189	A001189	F	12.5	
20	A001190	A001190	M	17.5	
20	A001191	A001191	F	9.5	
20	A001192	A001192	F	13.0	
20	A001193	A001193	F	15.0	
20	A001194	A001194	F	14.0	
20	A001195	A001195	F	13.5	
20	A001196	A001196	F	13.5	
20	A001197	A001197	F	13.5	
20	A001198	A001198	M	16.5	
20	A001199	A001199	M	16.0	
20	A001200	A001200	F	13.0	
20	C000801	C000801	M	16.0	02
20	C000802	C000802	M	13.0	02
20	C000803	C000803	M	14.0	02
20	C000804	C000804	M	15.0	02
20	C000805	C000805	M	15.5	02
20	C000806	C000806	F	15.0	02
20	C000807	C000807	F	13.0	02
20	C000808	C000808	F	15.0	02
20	C000809	C000809	F	14.5	02
20	C000810	C000810	F	11.5	02
20	C000811	C000811	F	12.5	02
20	C000812	C000812	F	14.5	02
20	C000813	C000813	M	17.0	02
20	C000814	C000814	M	16.0	02
20	C000815	C000815	M	12.5	02
20	C000816	C000816	M	13.0	02
20	C000817	C000817	F	12.5	02
20	C000818	C000818	M	13.0	02

Table B-5.--Continued.

Month	Left tag	Right tag	Sex	Weight(kg)	Sample*
October					
20	C000819	C000819	M	13.5	02
20	C000820	C000820	F	15.0	02
20	C000821	C000821	F	15.0	02
20	C000822	C000822	F	10.0	02
20	C000823	C000823	M	16.0	02
20	C000824	C000824	F	13.5	02
20	C000825	C000825	M	15.0	02
20	C000826	C000826	M	13.5	02
20	C000827	C000827	F	16.5	02
20	C000828	C000828	M	14.0	02
20	C000829	C000829	M	16.0	02
20	C000830	C000830	F	12.5	02
20	C000831	C000831	M	13.5	02
20	C000832	C000832	M	18.0	02
20	C000833	C000833	M	14.0	02
20	C000834	C000834	M	12.0	02
20	C000835	C000835	F	13.0	02
20	C000836	C000836	M	17.5	02
20	C000837	C000837	M	16.0	02
20	C000838	C000838	F	12.5	02
20	C000839	C000839	M	17.5	02
20	C000840	C000840	F	13.0	02
20	C000841	C000841	M	13.5	02
20	C000842	C000842	F	13.0	02
20	C000843	C000843	F	15.5	02
20	C000844	C000844	M	15.0	02
20	C000845	C000845	F	13.0	02
20	C000846	C000846	M	19.0	02
20	C000847	C000847	F	11.5	02
20	C000848	C000848	F	14.5	02
20	C000849	C000849	M	12.5	02
20	C000850	C000850	M	13.0	02
20	C000851	C000851	M	11.0	06
20	C000852	C000852	F	13.0	06

*02 = rectal swabs; 06 = blood

APPENDIX C

Tabulations of northern fur seal entanglement data.

APPENDIX C (Continued)

Table C-1.--Summary of roundups of juvenile (subadult) males conducted on St. Paul Island, Alaska, 1989.

Date (July)	Location	Total[a] in roundup	Tagged seals[b] resighted	Total seals tagged
14	Tolstoi Sands	77	0	0
14	Tolstoi Sands	133	1	0
14	Tolstoi Sands	235	1	3
14	Zapadni Reef Sands	696	4	0
15	Gorbatch	371	3	3
15	Reef North	13	0	0
15	Reef	264	2	5
15	Reef	535	1	0
15	Reef	153	1	3
15	Reef	195	2	0
15	Reef	51	0	0
15	Zapadni Reef Sands	273	3	8
15	Zoltoi Sands	494	8	9
16	Kitovi	245	4	2
16	Little Zapadni	274	5	2
16	Lukanin	280	0	0
16	Polovina	107	2	0
16	Polovina	207	0	0
16	Polovina	317	4	2
16	Zapadni	472	3	0
16	Zapadni Sands	642	5	3
18	Morjovi	742	3	12
18	Vostochni	136	1	3
18	Vostochni	387	0	1
18	Vostochni	209	1	3
19	Tolstoi	318	3	0
19	Tolstoi	328	3	3
19	Vostochni	94	2	0
19	Vostochni	130	0	6
19	Zapadni Reef Sands	214	3	1
21	Gorbatch	671	3	0
21	Reef	492	6	3
21	Reef	164	1	0
21	Zoltoi Sands	348	3	1
22	Kitovi	360	1	3
22	Reef	211	4	4
22	Reef	118	0	0
22	Reef	229	3	0
23	Little Zapadni	251	2	4
23	Lukanin	605	5	3
23	Polovina	132	1	0
23	Polovina	316	2	0
23	Polovina	227	4	7
23	Zapadni	179	1	3

Table C-1.--Continued.

Date (July)	Location	Total[a] in roundup	Tagged seals[b] resighted	Total seals tagged
23	Zapadni Sands	277	2	0
24	Tolstoi	224	3	0
24	Tolstoi	238	1	0
24	Tolstoi	303	1	3
24	Zapadni	36	1	0
24	Zapadni	86	1	0
24	Zapadni	823	4	9
24	Zapadni Reef Sands	380	0	0
25	Morjovi	40	0	0
25	Morjovi	222	3	2
25	Morjovi	776	5	5
25	Vostochni	88	1	3
25	Vostochni	109	1	0
25	Vostochni	148	1	0
25	Vostochni	249	0	6
25	Vostochni	417	1	0
26	Kitovi	187	6	0
26	Reef	79	2	0
26	Reef	212	7	0
26	Reef	300	1	1
26	Zoltoi Sands	496	3	0
Totals		18,565	140	126

[a]Seals that are judged to be of the size that were taken in the commercial harvest prior to 1985.

[b]Seals which had any kind of tag in either fore-flipper and that were successfully restrained to read the tag. Includes any that were resighted more than once this year.

Table C-2.--List of orange broad banded Allflex tags applied to northern fur seals during roundups conducted on St. Paul Island, Alaska, 1989. Entangling debris was removed from entangled seals prior to their release.

Tag number	Date (July)	Sex	Location	Entangled (e) Control (c)
1151	14	m	Tolstoi Sands	e
1152	14	m	Tolstoi Sands	c
1153	14	m	Tolstoi Sands	c
1154	14	m	Zapadni Reef Sands	e
1155	14	m	Zapadni Reef Sands	e
1156	15	m	Zoltoi Sands	e
1157	15	m	Zoltoi Sands	e
1158	15	m	Zoltoi Sands	e
1159	15	m	Zoltoi Sands	c
1160	15	m	Zoltoi Sands	c
1161	15	m	Zoltoi Sands	c
1162	15	m	Zoltoi Sands	c
1163	15	m	Zoltoi Sands	c
1164	15	m	Zoltoi Sands	c
1165	15	m	Zapadni Reef Sands	c
1166	15	m	Zapadni Reef Sands	c
1167	15	m	Zapadni Reef Sands	c
1168	15	m	Zapadni Reef Sands	c
1169	15	m	Zapadni Reef Sands	c
1170	15	m	Zapadni Reef Sands	c
1171	15	m	Zapadni Reef Sands	c
1172	15	m	Zapadni Reef Sands	c
1173	15	m	Gorbatch	e
1174	15	m	Gorbatch	c
1175	15	m	Gorbatch	c
1176	15	m	Reef	e
1177	15	m	Reef	c
1178	15	m	Reef	c
1179	15	m	Reef	c
1180	15	m	Reef	c
1181	15	m	Reef	e
1182	15	m	Reef	c
1183	15	m	Reef	c
1184	16	m	Kitovi	c
1185	16	m	Kitovi	c
1186	16	m	Polovina	e
1187	16	m	Polovina	e
1188	16	m	Little Zapadni	e
1189	16	m	Little Zapadni	e
1190	16	m	Zapadni Sands	e
1191	16	m	Zapadni Sands	c
1192	16	m	Zapadni Sands	c
1193	17	f	Zapadni Reef	f[a]

Table C-2.--Continued.

Tag number	Date (July)	Sex	Location	Entangled (e) Control (c)
1194	17	f	Zapadni Reef	f[a]
1195	18	f	Zapadni Reef	f[a]
1196	18	f	Zapadni Reef	f[a]
1197	18	m	Morjovi	e
1198	18	m	Morjovi	e
1199	18	m	Morjovi	c
1200	18	m	Morjovi	c
1201	18	m	Morjovi	c
1202	18	m	Morjovi	e
1203		(not used)		
1204	18	m	Morjovi	e
1205	18	m	Morjovi	c
1206	18	m	Morjovi	c
1207	18	m	Morjovi	c
1208	18	m	Morjovi	c
1209	18	m	Morjovi	c
1210	18	m	Vostochni	e
1211	18	m	Vostochni	e
1212	18	m	Vostochni	c
1213	18	m	Vostochni	c
1214	18	m	Vostochni Sands	e
1215	18	m	Vostochni Sands	c
1216	18	m	Vostochni Sands	c
1217	19	m	Vostochni	e
1218	19	m	Vostochni	c
1219	19	m	Vostochni	c
1220	19	m	Vostochni	c
1221	19	m	Vostochni	c
1222	19	m	Vostochni	e
1223	19	m	Tolstoi	e
1224	19	m	Tolstoi	e
1225	19	m	Tolstoi	c
1226	19	m	Tolstoi	c
1227	19	m	Zapadni Reef Sands	e
1228	20	f	Zapadni Reef	f[a]
1229	20	f	Zapadni Reef	f[a]
1230	21	m	Zoltoi Sands	e
1231	21	m	Reef	c
1232	21	m	Reef	c
1233	21	m	Reef	e
1234	22	m	Reef	e
1235	22	m	Reef	e
1236	22	m	Reef	c
1237	22	m	Reef	c
1238	22	m	Kitovi	e
1239	22	m	Kitovi	c

Table C-2.--Continued.

Tag number	Date (July)	Sex	Location	Entangled (e) Control (c)
1240	22	m	Kitovi	c
1241	23	m	Lukanin	e
1242	23	m	Lukanin	c
1243	23	m	Lukanin	c
1244	23	m	Polovina	c
1245	23	m	Polovina	c
1246	23	m	Polovina	e
1247	23	m	Polovina	c
1248	23	m	Polovina	c
1249	23	m	Polovina	c
1250	23	m	Polovina	c
1251	23	m	Little Zapadni	c
1252	23	m	Little Zapadni	c
1253	23	m	Little Zapadni	c
1254	23	m	Little Zapadni	c
1255	23	m	Zapadni	e
1256	23	m	Zapadni	c
1257	23	m	Zapadni	c
1258	24	m	Tolstoi	e
1259	24	m	Tolstoi	c
1260	24	m	Tolstoi	c
1261	24	m	Zapadni	e
1262	24	m	Zapadni	c
1263	24	m	Zapadni	c
1264	24	m	Zapadni	e
1265	24	m	Zapadni	c
1266	24	m	Zapadni	c
1267	24	m	Zapadni	c
1268	24	m	Zapadni	e
1269	24	m	Zapadni	c
1270	25	m	Morjovi	e[b]
1271	25	m	Morjovi	c
1272	25	m	Morjovi	c
1273	25	m	Morjovi	c
1274	25	m	Morjovi	e
1275	25	m	Morjovi	c
1276	25	m	Morjovi	c
1277	25	m	Morjovi	c
1278	25	m	Vostochni	e
1279	25	m	Vostochni	c
1280	25	m	Vostochni	c
1281	25	m	Vostochni	e
1282	25	m	Vostochni	c
1283	25	m	Vostochni	c
1284	25	m	Vostochni	c

Table C-2.--Continued.

Tag number	Date (July)	Sex	Location	Entangled (e) Control (c)
1285	25	m	Vostochni	c
1286	25	m	Vostochni	e
1287	26	m	Reef	e

[a]Female seal tagged for Japanese behavioral study with radio transmitters.

[b]This seal had been tagged as a control on Kitovi in 1986;no controls were tagged for this seal.

Table C-3.--List of tagged fur seals seen during July juvenile male roundup activities on St. Paul Island, 1989. Tags were seen on both fore-flippers unless noted otherwise. Entangling debris was removed from entangled seals prior to being released.

Date (July)	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
14	Tolstoi Sands	5184	Allflex	white	c	Tagged on 3 Aug. 1986 at Tolstoi.
14	Tolstoi Sands	A03430	monel		p	Tagged in 1987 as a pup.
14	Zapadni Reef Sands	0478	Allflex	orange	c	Tagged on 24 Aug. 1986 at Zapadni.
14	Zapadni Reef Sands	14	Allflex	blue	e	Tagged on 17 July 1988 at Reef with the same debris. At that time was also fit with radio. Animal was in very poor condition on the 14 July sighting.
14	Zapadni Reef Sands	54	Allflex	blue	c	Tagged on 20 July 1988 at Vostochni.
14	Zapadni Reef Sands	123	Allflex	blue	e	Tagged on 29 July 1988 at Vostochni.
15	Gorbatch	24	Allflex	blue	c	Tagged 17 July 1988 at Reef.
15	Gorbatch	0774	Allflex	orange	c	Tagged 25 Aug. 1986 at Zoltoi Sands. Both tags present, left one was read.
15	Gorbatch	1157	Allflex	orange	e[r]	Showed a rub mark on its neck.
15	Reef	5117	Allflex	white	c	Tagged on 16 Oct. 1986, on Reef.
15	Reef	18	Allflex	blue	e	Tagged on 17 July 1988 at Reef.
15	Reef	161	Allflex	blue	c	Tagged on 31 July 1988 at Kitovi.
15	Reef	22	Allflex	blue	c	Tagged on 17 July 1988 at Reef.
15	Reef	148	Allflex	blue	c	Tagged on 31 July 1988 at Tolstoi.
15	Reef	A00432	monel			Tagged in 1987 as a pup.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
15	Zapadni Reef Sands	0852	Allflex	orange	c	Tagged on 2 Oct. 1986, at Little Zapadni.
15	Zapadni Reef Sands	5178	Allflex	white	c	Tagged on 3 Aug. 1986, at Tolstoi.
15	Zapadni Reef Sands	123	Allflex	blue	e[r]	Tagged on 29 July 1988 at Vostochni. Second sighting in 1989.
15	Zoltoi Sands	0383	Allflex	orange	c	Tagged 23 July 1986 on Gorbatch. Tag not sighted on left.
15	Zoltoi Sands	A04869	monel			Tag hole in left. Tagged in 1987 as a pup.
15	Zoltoi Sands	55	Allflex	blue	c	Tagged 20 July 1988 on Vostochni.
15	Zoltoi Sands	153	Allflex	blue	c	Tagged 31 July 1988 on Tolstoi.
15	Zoltoi Sands	0173	Allflex	orange	c	Tagged 7 Aug. 1985 on Gorbatch.
15	Zoltoi Sands	0330	Allflex	orange	c	Tagged 19 July 1986 on Reef.
15	Zoltoi Sands	0604	Allflex	orange	c	Tag on right was present but not read; should have been 0605. Was tagged on Zapadni, in August of 1986.
15	Zoltoi Sands	A05358	monel			Tagged in 1987 as a pup.
16	Kitovi	88	Allflex	blue	e	Debris removed.
16	Kitovi	809	Roto	blue	n	Tag missing on right side but the post of a tag was seen.
16	Kitovi	1174	Allflex	orange	c	Only one tag read, side not noted.
16	Kitovi	A01199	monel			Tag missing on right side, tag hole seen. Tagged in 1987 as a pup.
16	Little Zapadni	60	Allflex	blue	c	Tagged 21 July 1988 on Little Zapandi.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
16	Little Zapadni	123	Allflex	blue	e[r]	Tagged on 29 July 1988 at Vostochni. Third sighting in 1989.
16	Little Zapadni	0419	Allflex	orange	c	Tagged on Little Zapadni, 27 July 1986.
16	Little Zapadni	1169	Allflex	orange	c	
16	Little Zapadni	1172	Allflex	orange	c	
16	Lukanin	143	Allflex	blue	c	Tagged 30 July 1988 on Zapadni.
16	Polovina	0071	Allflex	orange	c	Tagged 20 July 1985 on Tolstoi. No tag on left.
16	Polovina	0105	Allflex	orange	c	Tagged 27 July 1985 on Reef, section 7. No note made of tag on right.
16	Polovina	0494	Allflex	orange	c	Tagged 25 Aug. 1986 on Morjovi. Tag hole on right.
16	Polovina	0732	Allflex	orange	c	Tagged 24 Aug. 1986 on Vostochni. No note made on which side tag was observed.
16	Polovina	0954	Allflex	orange	c	Tagged 8 Oct. 1986 on Morjovi. Tag with number 0955 observed on right flipper.
16	Polovina	A02349	monel			Tagged in 1987 as a pup.
16	Zapadni	1155	Allflex	orange	e[r]	
16	Zapadni	1168	Allflex	orange	c	
16	Zapadni	5144	Allflex	white	c	Tagged at Zapadni on 1 Aug. 1986.
16	Zapadni Sands	1165	Allflex	orange	c	
16	Zapadni Sands	1171	Allflex	orange	c	
16	Zapadni Sands	A03430	monel			Tagged in 1987 as a pup.
16	Zapadni Sands	bC2249	monel			

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
18	Morjovi	0489	Allflex	orange	c	Tag seen on left side but not read. Tagged on Morjovi 25 August 1986.
18	Morjovi	A01931	Monel			Tagged in 1987 as a pup.
18	Morjovi	ME346	Monel			Tag on right with number: ME345
18	Vostochni	0370	Allflex	orange	c	Tagged on 23 July 1986 on Tolstoi.
18	Vostochni Sands	66	Allflex	blue	e	
19	Tolstoi	28	Allflex	blue	c	Tagged 18 July 1988 at Tolstoi.
19	Tolstoi	29	Allflex	blue	c	Tagged 18 July 1988 at Tolstoi.
19	Tolstoi	54	Allflex	blue	c	Tagged 20 July 1988 at Vostochni.
19	Tolstoi	0422	Allflex	orange	c	Tagged 27 July 1986 at Zapadni Reef.
19	Tolstoi	0423	Allflex	orange	e[r]	Tagged 29 July 1986 at Tolstoi.
19	Tolstoi	1170	Allflex	orange	c	
19	Tolstoi	1178	Allflex	orange	c	
19	Vostochni	1210	Allflex	orange	e[r]	
19	Vostochni	5145	Allflex	white	c	Tagged 1 Aug. 1986 on Zapadni.
19	Zapadni Reef Sands	879	Roto	blue		This number was on the bottom blade. Top blade was broken off and there was no tag on the left side.
19	Zapadni Reef Sands	MA2237	monel			The "A" was the Russian Crylic A. No tag in the left side.
21	Gorbatch	1158	Allflex	orange	e[r]	
21	Gorbatch	1175	Allflex	orange	c	
21	Gorbatch	A03919	monel			Hole in right flipper. Tagged in 1987 as a pup.
21	Reef	37	Allflex	blue	c	Tagged 19 July 1988 on Reef.
21	Reef	45	Allflex	blue	c	Tagged 19 July 1988 on Reef.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
21	Reef	88	Allflex	blue	e[r]	
21	Reef	0796	Allflex	orange	c	Tagged 24 Sept. 1986 on Reef. No tag read on right.
21	Reef	1182	Allflex	orange	c	
21	Reef	5140	Allflex	white	c	Tagged 1 Aug. 1986, Zapadni.
21	Reef	A05358	monel			Tagged in 1987 as a pup.
21	Zoltoi Sands	0354	Allflex	orange	c	Tagged 22 July 1986 on Zoltoi Sands. Hole in left flipper.
21	Zoltoi Sands	0357	Allflex	orange	c	Tagged 22 July 1986 on Zoltoi Sands. Hole on left.
21	Zoltoi Sands	7	Allflex	blue	c	Tagged 16 July 1988 on Zoltoi Sands.
22	Kitovi	0094	Allflex	orange	c	Tagged 24 July 1985 on Morjovi.
22	Reef	549	Roto	blue		Tag on right only, tear on left.
22	Reef	81	Allflex	blue	c	Tagged 25 July 1988 on Tolstoi.
22	Reef	0582	Allflex	orange	c	Tagged 5 Aug. 1986 on Reef. Tag missing on right.
22	Reef	1204	Allflex	orange	e[r]	
22	Reef	93	Allflex	blue	c	Tagged 26 July 1988 on Kitovi.
22	Reef	1168	Allflex	orange	c	
22	Reef	1182	Allflex	orange	c	
23	Little Zapadni	70	Allflex	blue	c	Tagged 22 July 1988 on Polovina; also tagged with radio tag.
23	Little Zapadni	875	Roto	blue		No note of side on which tag was read.
23	Lukanin	0513	Allflex	orange	c	Tagged 31 July 1986 on Lukanin.
23	Lukanin	A01091	monel			Tagged in 1987 as a pup.
23	Lukanin	A01453	monel			Tagged in 1987 as a pup.
23	Lukanin	A03530	monel			Tagged in 1987 as a pup.
23	Lukanin	A07313	monel			Tagged in 1987 as a pup.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
23	Polovina	0071	Allflex	orange	c	Tagged 20 July 1985 on Tolstoi. Left flipper had hole.
23	Polovina	bE2540	monel			Tag hole in left flipper.
23	Polovina	7	Allflex	blue	c	Tagged 17 July 1988 on Zapadni.
23	Polovina	64	Allflex	blue	c	Tagged 21 July 1988 on Zapadni complete with radio tag.
23	Polovina	0343	Allflex	orange	c	Tagged 22 July 1986 on Polovina. Tag sighted and read on left only, no note of right flipper's condition.
23	Polovina	0764	Allflex	orange	c	Tagged 24 Aug. 1986 on Polovina. Tag number 0765 on right.
23	Polovina	A04855	monel			Tagged in 1987 as a pup.
23	Zapadni	A01429	monel			Tagged in 1987 as a pup.
23	Zapadni Sands	A06155	monel			Tagged in 1987 as a pup.
23	Zapadni Sands	MA1462	monel			
24	Tolstoi	0034	Allflex	orange	c	Tagged 12 July 1985 on Morjovi. No note of tag on left side.
24	Tolstoi	5187	Allflex	white	e[r]	Tagged 4 Aug. 1986 on Lukanin. Tag scar on left.
24	Tolstoi	0371	Allflex	orange	c	Tagged 23 July 1986 on Tolstoi.
24	Tolstoi	1245	Allflex	orange	c	
24	Tolstoi	bA3416	monel			No tag on right.
24	Zapadni	70	Allflex	blue	c	Tagged 22 July 1988 on Polovina; also tagged with radio tag.
24	Zapadni	1172	Allflex	orange	c	
24	Zapadni	1186	Allflex	orange	e[r]	
24	Zapadni	1252	Allflex	orange	c	
24	Zapadni	5137	Allflex	white	e	Disentangled but too big to take controls. Tagged on Zapadni 1 Aug. 1986.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
24	Zapadni	ME263	monel			
25	Morjovi	350	Allflex	orange	e	Retagged 1270 with broad orange Allflex tags. Tagged 22 July 1986 on Kitovi as a control. The first control to become entangled. No tag on left.
25	Morjovi	XM6365	monel			No note of tag on left.
25	Morjovi	0742	Allflex	white	c	Tagged 24 Aug. 1986 on Vostochni. Tag number on right sighted but not read.
25	Morjovi	5155	Allflex	white	e[r]	Tagged 3 Aug. 1986 on Polovina. No tag sighting on right.
25	Morjovi	5833	Riese	orange?		No note of tag on right.
25	Morjovi	A01354	monel			Tagged in 1987 as a pup.
25	Morjovi	A07195	monel			Tagged in 1987 as a pup.
25	Vostochni	1211	Allflex	orange	e[r]	
25	Vostochni	1220	Allflex	orange	c	
25	Vostochni	5195	Allflex	white	c	Tagged on Vostochni, 5 Aug. 1986.
25	Vostochni	bA657	monel			
26	Kitovi	A00051	monel			No tag on left. Tagged in 1987 as a pup.
26	Kitovi	159	Allflex	blue	c	Tagged on 31 July 1988 at Kitovi.
26	Kitovi	0518	Allflex	orange	c	Tagged on 31 July 1986 at Kitovi.
26	Kitovi	0956	Allflex	orange	c	Tagged on 8 Oct. 1986 at Morjovi. Tag number 0957 on right.

Table C-3.--Continued.

Date (July)	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
26	Kitovi	1257	Allflex	orange	c	
26	Kitovi	A00599	monel			Tagged in 1987 as a pup.
26	Reef	A01461	monel			No note of tag on left. Tagged in 1987 as a pup.
26	Reef	81	Allflex	blue	c	Tagged 25 July 1988 at Tolstoi.
26	Reef	93	Allflex	blue	c	Tagged 26 July 1988 at Kitovi.
26	Reef	132	Allflex	orange	c	Tagged 30 July 1985 at Tolstoi.
26	Reef	154	Allflex	blue	c	Tagged 31 July 1988 at Tolstoi.
26	Reef	0382	Allflex	orange	c	Tagged 23 July 1985 at Gorbatch.
26	Reef	0582	Allflex	orange	c	Tagged 5 Aug. 1986, at Reef. Tag number 0583 on right.
26	Reef	1233	Allflex	orange	e^r	
26	Reef	1250	Allflex	orange	c	
26	Reef	MK1477	monel			No note of tag on right.
26	Zoltoi Sands	0354	Allflex	orange	c	Tagged on 22 July 1986 at Zoltoi Sands.
26	Zoltoi Sands	1164	Allflex	orange	c	
26	Zoltoi Sands	1239	Allflex	orange	c	

*c = seals that were controls when tagged, e = seals that were entangled at time of being sighted, e^r = seals from which debris had been removed earlier.

Table C-4.--List of juvenile male fur seals tagged as entangled animals during surveys conducted during July 1989, St. Paul Island, Alaska, showing the nature of the debris on each animal.

Tag Number	Date (July)	Rookery	Description of debris							Footnote
			Type	Wt. (g)	Color	Tightness[a]	Wound (deg.)	Mesh size (cm)	Twine size (mm)	
1151	14	Tolstoi	trawl	12.4	grey	t	0	22.5	6.0	
1154	14	Zapadni Reef	trawl	15.1	grey	vt	360	22.5	2.6	
1155	14	Zapadni Reef	trawl	34.8	green	vt	360		3.5	
1156	15	Zoltoi Sands	trawl	47	grey	vt	360		4.1	
1157	15	Zoltoi Sands	trawl	184.5	grey	t	0	20.5	5.8	
1158	15	Zoltoi Sands	trawl	34.9	grey	vt	180	20.3	3.2	
1173	15	Gorbatch	packing band	2.3	blue	l	0	23		
1176	15	Reef	trawl	1125	two	t	0	25.7	4.5	b
1181	15	Reef	trawl	5.1	white	vt	360	37.7	3.1	
1186	16	Polovina	trawl	40.8	green	l	0	21.0	3.9	
1187	16	Polovina	packing band	1.5	blue	l	0	27.5		
1188	16	Little Zapadni	packing band	2.8	yellow	t	0	21.3		
1189	16	Little Zapadni	trawl	270	grey	t	360	21.3	3.7	
1190	16	Zapadni Sands	packing band	1.1	black	t	0	25.6		
1197	18	Morjovi	monofilament	0.1	clear	vt	180	8.7	0.4	c
1198	18	Morjovi	string	0.3	black	vt	360	20.5	0.9	
1202	18	Morjovi	packing band	2.9	green	vt	360	26.5		
1204	18	Morjovi	packing band	1.4	yellow	vt	360	20		
1210	18	Vostochni	twine	1.7	green	vt	300	39		d
1211	18	Vostochni	trawl	67.0	green	m	0	21.5	3.4	
1214	18	Vostochni	two kinds	s	two	vt	360			e
1217	19	Vostochni	twine	9.2	green	vt	90	27	5.1	
1222	19	Vostochni	packing band	1.8	yellow	vt	360	43.3		
1223	19	Tolstoi	twine	91	grey		36	10.0	4	
1224	19	Tolstoi	trawl	1325	grey	vt	360	22.0	3.8	f,g
1227	19	Zapadni Reef	gill net	168	green	vt	360	12.4	1.6	h
1230	21	Zoltoi Sands	packing band	4.2	blue	l	0	47.8		d

Table C-4.--Continued

Tag Number	Date (July)	Rookery	Description of debris							
			Type	Wt. (g)	Color	Tightness[a]	Wound (deg.)	Mesh size (cm)	Twine size (mm)	Footnote
1233	21	Reef	trawl	280	white	vt	90	19.2	5.0	
1234	22	Reef	antenna wire	4.3	black	t	90	28		
1235	22	Reef	packing band	2.4	white	l	0	32.0		d
1238	22	Kitovi	gill net	0.5	clear	vt	90	6.43	0.5	g,h
1241	23	Lukanin	packing band	2.5	yellow	t	0	24.5		
1246	23	Polovina	trawl	167	grey	t	0	21.5	3.6	
1255	23	Zapadni	twine	4.0	white	t	0	28	3.6	
1258	24	Tolstoi	twine	3.6	green	t	0	25.4	4.4	i
1261	24	Zapadni	string	1.0	white	t	360	23.8	1.7	
1264	24	Zapadni	packing band	1.5	yellow	t	0	21.7		
1268	24	Zapadni	packing band	2.2	white	m	0	31		
1274	25	Morjovi	trawl	420	orange	t	0	17.8	4.4	
1278	25	Vostochni	rubber ring	7.3	black	t	60	23	5.0	
1281	25	Vostochni	trawl	114.5	grey	t	0	22.2	3.3	
1286	25	Vostochni	packing band	1.8	white	t	0	23.5		
1287	26	Reef	string	3.0	green	vt	360	29	1.9	

[a]l = loose, m = moderately tight, t = tight, vt = very tight.

[b]The debris taken from this seal consisted of both gray and orange trawl material.

[c]This seal was entangled about the face.

[d]Seals tagged with numbers 1210, 1214, 1223, 1230 and 1235 were larger than harvestable size and not counted in the calculation of the entanglement rate.

[e]This seal was entangled in a yellow packing band and a green twine. Each had resulted in 360 degree wounds. Seal showed evidence of severely stunted growth.

Table C-4.--Continued

[f]The entangling material on this seal included twine in addition to the trawl webbing.

[g]The debris was embedded in a wound that was healing so as to embed the debris in the flesh.

[h]The gill net on 1227 was made of twisted twine; on 1238 it was monofilament webbing.

[i]This seal was entangled in a twine wrapped twice around the neck. The mesh size is the length of the doubled loop.

Table C-5.--Debris found on juvenile male fur seals in 1989 compared to seven earlier years, expressed as the observed percent of juvenile male seals entangled by debris category.

Type of debris	Entanglement (%) 1981	1982	1983	1984	1985	1986	1988	1989
Trawl net fragments	0.29	0.24	0.30	0.22	0.36	0.27	0.15	0.12
Monofilament net fragments	0.00	0.01	0.01	0.02	0.01	0.01	0.00	0.02
Plastic packing bands	0.08	0.10	0.07	0.09	0.05	0.06	0.07	0.10
Chord, rope, string	0.04	0.04	0.02	0.05	0.08	0.07	0.05	0.06
Miscellaneous items	0.03	0.01	0.03	0.01	0.01	0.01	0.01	0.01
Total	0.43	0.41	0.43	0.39	0.51	0.42	0.28	0.30
Sample size	102	102	112	87	76	70	53	47

Table C-6.--Comparison of numbers of tags applied (in parentheses) and resighted (percent resighted shown in brackets below the numbers resighted) by year for entangled and nonentangled seals, each row corresponding to the tags released in the first year for that row.[1]

Controls	Year				
	1985	1986	1987	1988	1989
Nonentangled	(172)	37	-	13	8
		[21.5]	-	[7.6]	[4.7]
		(279)	-	40	32
			-	[14.3]	[11.5]
			-	-	-
			-	-	-
				(104)	20
					[19.2]
					(86)
Entangled	(85)	12	-	1	0
		[14.1]	-	[1.2]	[0]
		(128)	-	6	4
			-	[4.7]	[3.1]
			-	-	-
			-	-	-
			(52)		5
					[9.6]
					(43)

[1]Updated from Fowler et al. (1990)

Table C-7.--Annual percentage frequency distribution of the size of debris on entangled seals that were tagged and released.

Year	n	<150 g (%)	150-500 g (%)	>500 g (%)
1983	84	53(63)	19(23)	12(14)
1984	57	46(81)	7(12)	4(7)
1985	78	56(72)	16(20)	6(8)
1986	128	92(72)	27(21)	9(7)
1988	53	38(72)	8(15)	7(13)
1989	43	34(79)	7(16)	2(5)
Total	443	319(72)	84(19)	40(9)

Table C-8.--The numbers and percentages of tagged animals listed in Table 7 that were resighted by year in relation to size of entangling debris and year.

Year tagged	Year resighted	Size of debris <150 g(%)	150-500 g(%)	>500 g(%)
1983	1984	18(34)	3(16)	2(17)
1983	1985	4(8)	1(5)	0(0)
1983	1986	3(6)	0(0)	0(0)
1983	1988	1(0)	0(0)	0(0)
1984	1985	14(30)	2(29)	0(0)
1984	1986	9(16)	0(0)	0(0)
1984	1988	0(0)	0(0)	0(0)
1985	1986	9(16)	3(19)	0(0)
1985	1988	1(2)	0(0)	0(0)
1986	1988	6(7)	0(0)	0(0)
1985	1989	0(0)	0(0)	0(0)
1986	1989	3(3)	0(0)	1(11)
1988	1989	4(11)	1(13)	0(0)
Combined years		72(25)	10(13)	3(8)

Table C-9.--Comparison of numbers of tags applied to entangled and control juvenile male fur seals in 1985, 1986, 1988 and 1989 with the numbers in each category resighted the same season. The numbers in parentheses are the percent of the tags applied that were resighted.

	Number of tags			
	Controls		Entangled	
Year	Applied	Resighted	Applied	Resighted
1985	170	35(20.6)	76	21(27.6)
1986	165	54(32.7)	70	19(27.1)
1988	104	21(20.2)	52	15(28.8)
1989	86	(23.5)	43	(18.6)
Total	525	130(24.8)	241	63(26.1)

APPENDIX D

Scientific staff engaged in northern fur seal research, 1989.

National Marine Mammal Laboratory (NMML)
Howard W. Braham, Director
Robert V. Miller, Deputy Director
Thomas R. Loughlin, Leader, Bering Sea Ecosystem Program

Name	Affiliation	Assignment
Permanent employee		
Charles W. Fowler	NMML	Population Assessment
George A. Antonelis	NMML	Population Assessment
Robert L. DeLong	NMML	Population Assessment
Roger L. Gentry	NMML	Behavior Studies
Laurie Briggs	NMML	Fur Seal Data Mgmt.
Anne E. York	NMML	Population Dynamics
Temporary employee		
Camille A. Goebel-Diaz	NMML	Behavior Studies
Steven Syrjala	NMML	Population Assessment
Timothy Ragen	NMML	Population Assessment
Rolf Ream	NMML	Population Assessment
Sharon Melin	NMML	Population Assessment
Alfey Hansen	NMML	Population Assessment
Patrick Kozloff Jr.	NMML	Population Assessment
Elizabeth Sinclair	NMML	Population Assessment
Steve Osmek	NMML	Population Assessment
Melisa Bates	Volunteer	Population Assessment
William Buttermer	Volunteer	Population Assessment
Troy Antonelis	Volunteer	Population Assessment
Bruce Fowler	Volunteer	Population Assessment
Floyd Fowler	Volunteer	Population Assessment
Mike Glenn	Volunteer	Population Assessment
William Smithey	Volunteer	Population Assessment
Linda Meyers	Volunteer	Behavior Studies
Cooperators*		
Steve Zimmerman	NMFS	Resource Management
Norihisa Baba	NRIFSF	Entanglement Research
Masashi Kiyota	NRIFSF	Entanglement Research
Terry Spraker	CSU	Pup Mortality Research
Darlene Degetto	CSU	Pup Mortality Research
Brent Stewart	SWRI, HMRC	Population Assessment
Steve Jefferies	WDW	Population Assessment
Robin Brown	ODFW	Population Assessment
Douglas Skilling	OSU	Population Assessment
Mark Lowry	SWFC, NMFS	Population Assessment
Don Morris	CINP	Population Assessment

APPENDIX D (Continued)

Name	Affiliation	Assignment

Affiliation Code:

NMFS	National Marine Fisheries Service
NRIFSF	National Research Institute of Far Seas Fisheries, Japan
CSU	Colorado State University
SWRI, HMRC	Sea World Research Institute, Hubbs Marine Research Center
WDW	Washington Department of Wildlife
ODFW	Oregon Department of Fish and Wildlife
OSU	Oregon State University
SWFC, NMFS	Southwest Fisheries Center
CINP	Channel Islands National Park

*Financed wholly or in part by the National Marine Mammal Laboratory or other agency.