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Fur Seal Investigations, 1991

by
Elizabeth H. Sinclair

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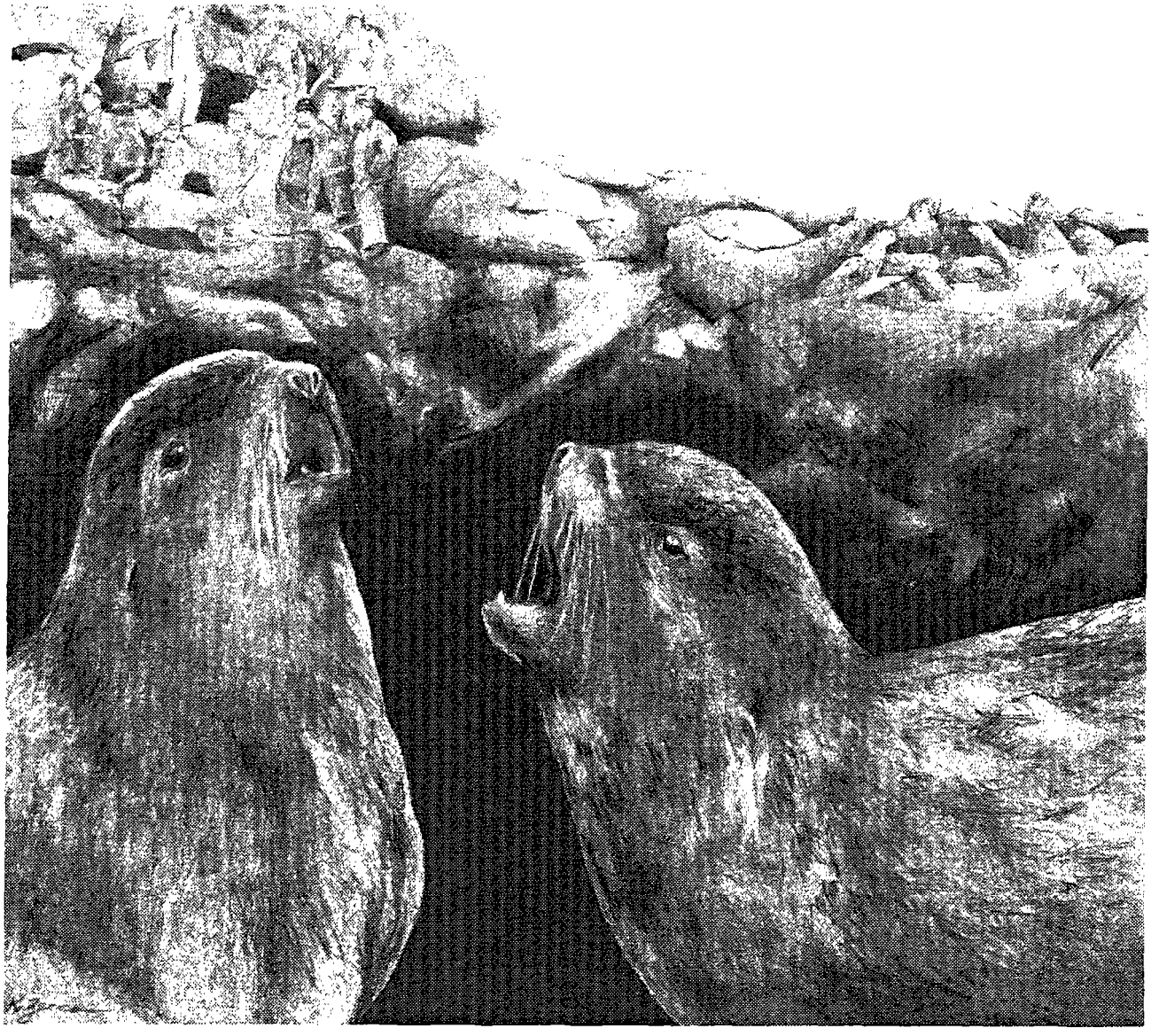

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ABSTRACT

This report is a collection of papers resulting from northern fur seal (Callorhinus ursinus) research on the Pribilof Islands (St. Paul and St. George) in the eastern Bering Sea (30 June - 2 August), and San Miguel Island off southern. California (30 April - 22 August) in 1991. Research conducted on St. Paul Island in 1991 included assessment of the numbers of adult males (bulls), resights and weights of juvenile males tagged as pups, and disease and entanglement studies. A pilot study on age determination of females based on physical characteristics and comparison of age structure between St. Paul and St. George Islands was conducted in 1991. Bull counts and disease studies were also conducted on St. George Island, and pup counts and tag resights were recorded on San Miguel Island. Results of a pilot study on the weights and sex ratio of pups born in 1990 are also presented in this report. Pribilof Island research conducted by National Marine Mammal Laboratory (NMML) personnel in 1991 included cooperative studies with three guest researchers from the All-Russia Research Institute for Fisheries and Oceanography (VNIRO) and the Pacific Research Institute of Fisheries and Oceanography, (TINRO) marine mammal research.

agencies of Moscow and Kamchatka, Russia.

A total of 4,729 harem and 9,543 idle bulls were counted on St. Paul Island. Counts on St. George Island totaled 736 harem and 1,271 idle bulls. Tag resights were obtained for males 2 (n = 52), 3 (n = 270), and 4 (n = 281) years of age on St. Paul

Island. Weight data from tagged 3- and 4-year-old males indicated that neither size nor age influenced the proportion of time spent ashore for those age classes. Weights of 3-year-old individuals were significantly correlated-with their weights as pups, but weights at ages 2 and 4 were not significantly correlated with pup weight. Weight of individuals at age 3 were significantly correlated with weight at age 2. Likewise, weight at age 4 was significantly. correlated with weight at age 3.

The weights of pups from all but two rookeries on St. Paul Island 25 August to 30 August, and from all rookeries on St. George Island 19-20 August 1990 indicated there are significant differences in average weights by rookery for male and female pups, males outweigh females, and the average weight of sheared pups is less than that of nonsheared pups but not consistently and not always significantly.

Preliminary results of cooperative research between Russian and U.S. scientists indicate that older females (age 12+ years) arrive earliest in the season and younger females (age 3-6 years) arrive late in the season on both St. Paul and St. George Islands, but that proportionally more young females are present on St. Paul Island. These. results indicate the importance of simultaneous surveys in inter-island, comparisons. Two hundred and fifty-three-tags were deployed in 1991 to assess neonatal survival.

Emaciation was the most common cause of mortality accounting for 43% of deaths among 332 pups -(full-term fetuses to 8 weeks of age) on St. Paul and St. George Islands from 6 July to

7 August 1991.

The observed proportion of juvenile male seals entangled in 1991 (0.21%) was less than that observed during the last several years and lower than that recorded during the commercial harvest and roundups from 1967 to 1986. This reflects a continued, reduction in the incidence of entanglement in trawl webbing fragments. The frequency of occurrence of trawl webbing among the entangling debris in 1991 was about one-half that observed for 1990, which itself was about one-half the frequency observed in earlier years. In contrast, the rate of entanglement did not change. These studies confirm earlier estimates indicating that after 1 year, seals entangled in small debris (light enough to permit the animals to return to land) are reduced to about one-half the number expected had they not been entangled. Studies in 1991 also confirm survival rates of tagged seals from which debris is removed is significantly higher than for tagged seals which were left entangled.

On San Miguel Island, a maximum of 64 adult males maintained territories during the breeding season. A minimum of 1,011 pups were born in Adams Cove and 520 on Castle Rock based on direct counts of pups conducted 7 August and 14 August, respectively. Three hundred pups were tagged in September and October of 1991. Tag resights totaled 210 throughout 1991. representing 80 individuals. No pups tagged in 1990 were resighted.

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INTRODUCTION

by

Elizabeth H. Sinclair

This report summarizes northern fur seal (Callorhinus ursinus) research conducted by scientists from the National Marine Mammal Laboratory in 1991. Research was conducted on St. George Island and St. Paul Island of the Pribilof Island group in the eastern Bering Sea, and on San Miguel Island and Castle Rock- in Southern California (Fig. 1).

The nearly 1 million northern fur seals on the breeding rookeries of St. Paul and St. George Islands (Pribilof Islands) (Figs. 2 and 31 in the eastern Bering Sea comprise 75% of the total population. Commercial harvesting of fur seals ceased on St. Paul Island in 1985 and on St. George Island in 1973. Juvenile male fur seals, mostly 2 and 3 years of age are harvested for native subsistence on both islands. No fur seals are harvested on the remaining U.S. breeding rookeries (Figs. 4 and 5) of Bogoslof Island (total population 1,400) in the southeastern Bering Sea or on San Miguel Island, California, and nearby Castle Rock (breeding population 4,000).

Annual studies of northern fur seals on the Pribilof Islands have been conducted since 1958. From 1962 to 1990, annual estimates of population abundance were based on pup counts generated from shear sampling techniques, a mark-recapture, method (York and Kozloff 1987). Since 1990, pup counts have been conducted semi-annually during even years on all Pribilof Island

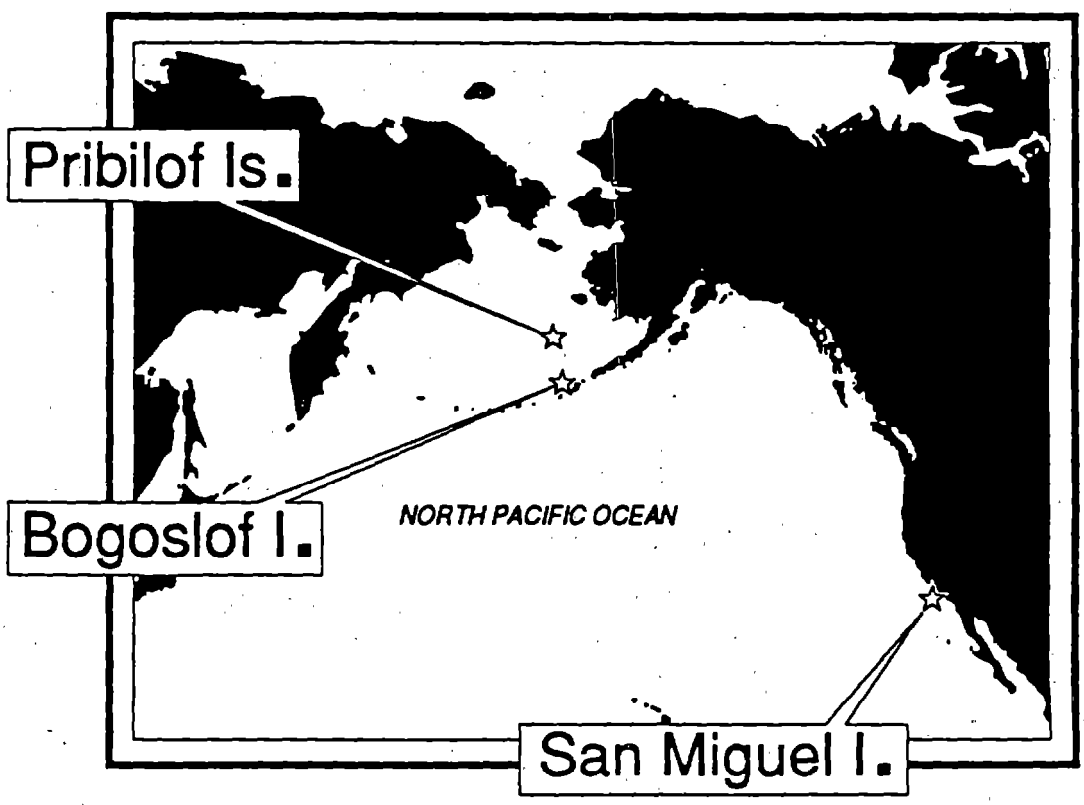


Figure I.--Location of the four northern fur seal breeding rookeries within U.S. waters.

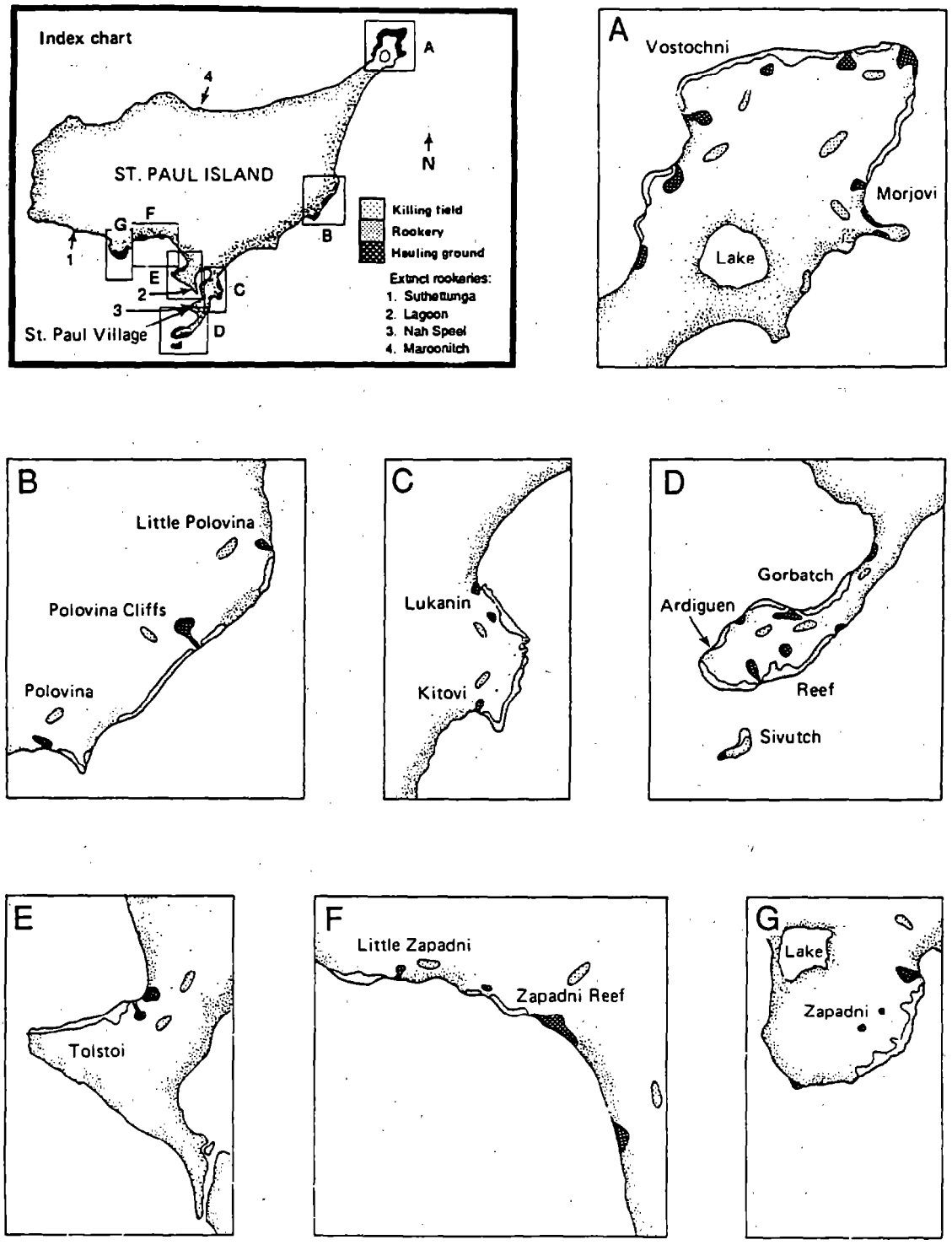


Figure 2.7--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. Paul Island, Alaska.

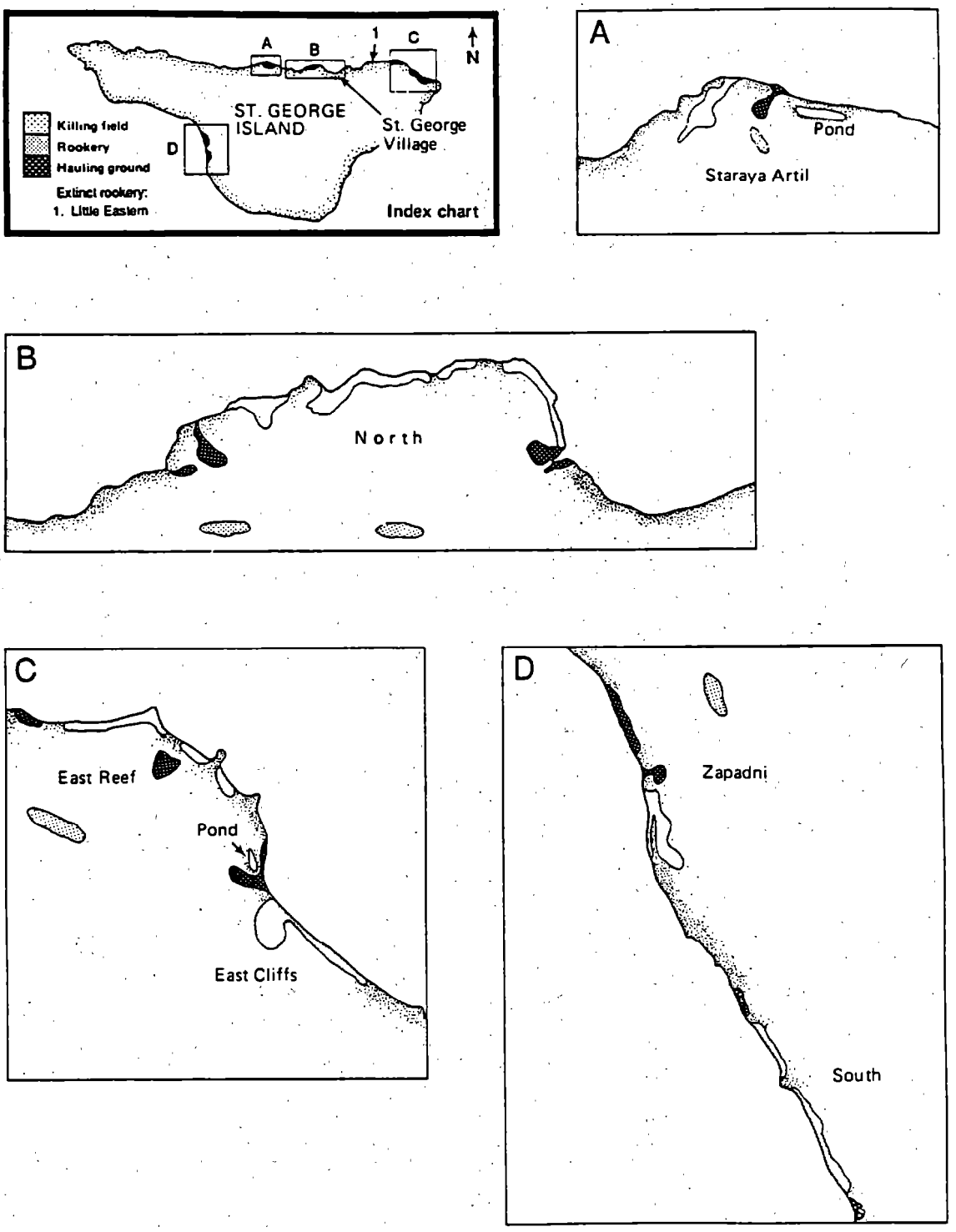


Figure 3.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. George Island, Alaska.

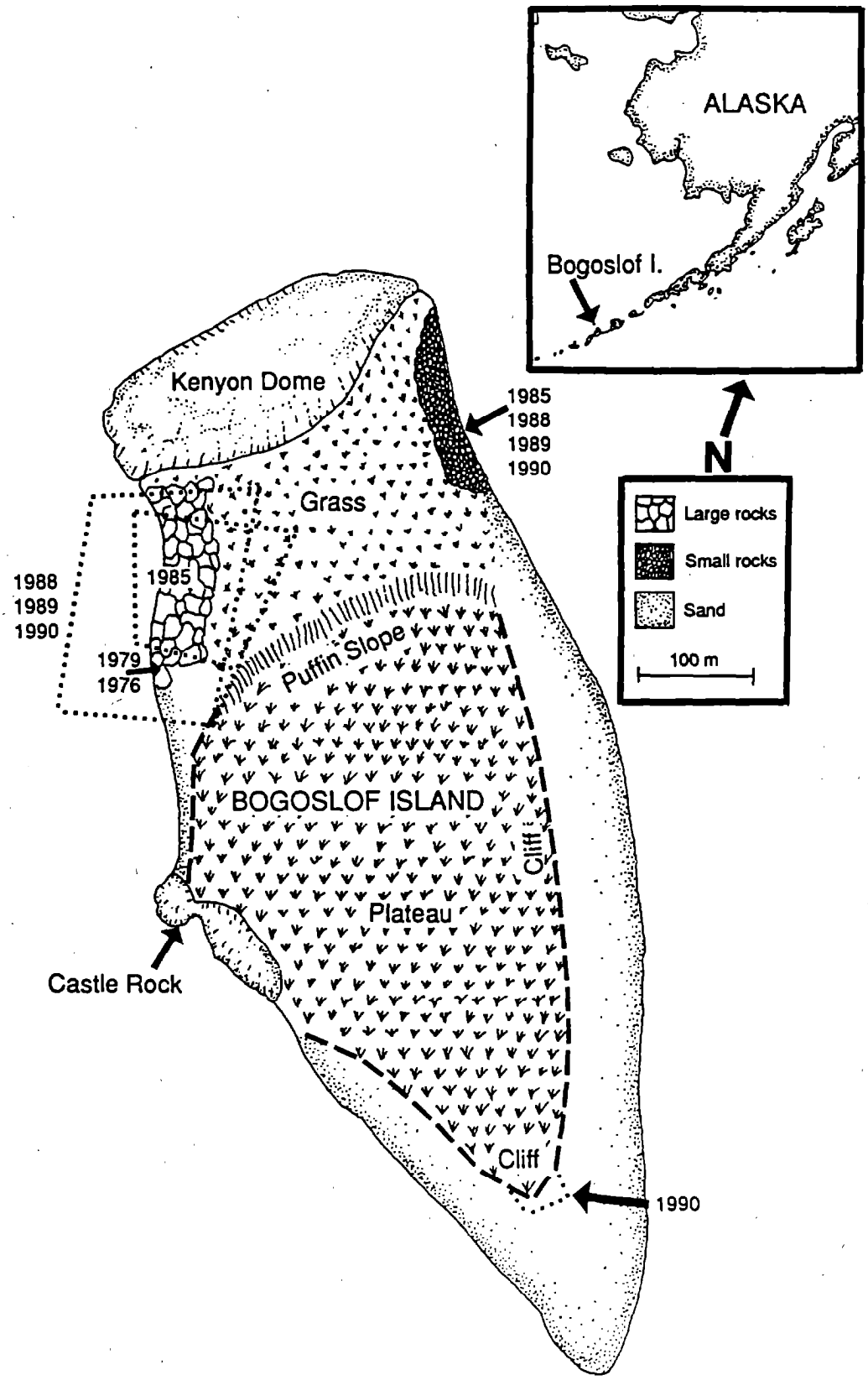


Figure 4. --Location of fur seals on Bogoslof Island, Alaska, indicated by year of observations.

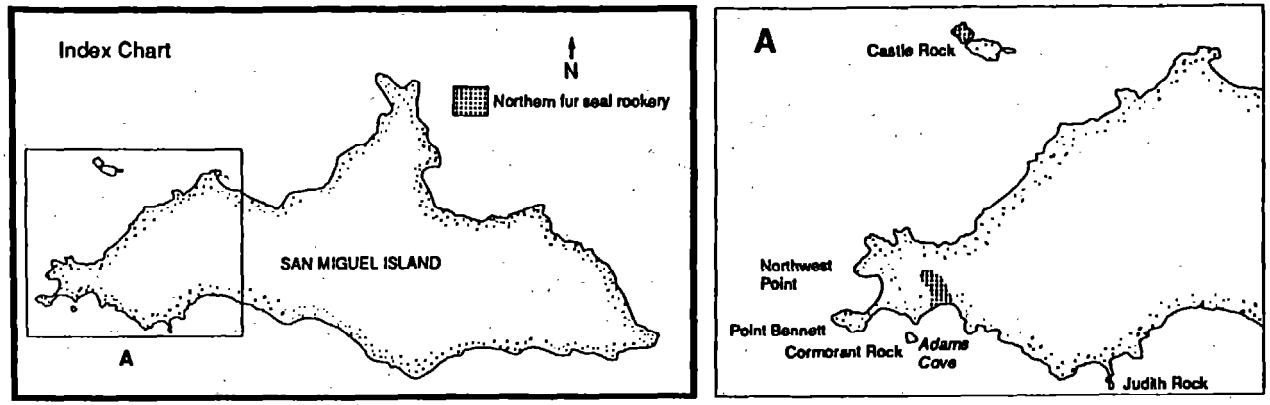


Figure 5.--Location of northern fur seal breeding colonies, San Miguel Island, California.

rookeries; Annual bull counts continue on a yearly basis. Pup tagging studies for the purpose of population monitoring were discontinued on the Pribilof Islands in 1991, but annual tagging of pups on San Miguel Island continues.

Russian placename translations are listed in Table 1 and a glossary of terms is provided in Appendix A. Appendix B-l lists the identification numbers of tagged males resighted on St. Paul Island. Appendix B-2 lists the identification numbers and biological data collected from pups tagged on San Miguel Island.

This research was conducted under Marine Mammal Permit Number 598.

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

Island and, Russian name	English translation	Comments and derivation of name
St. Paul Island		
Vostochni	---	From "Novoctoshni" meaning "place of recent growth"; applied to the west side of 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	Whale	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 slope above the rookery.
Tolstoi	Thick	In this case, thick, headland on which the rookery is located.
Zapadni	West	Western part of the island.
Lukanin		Named after a Russian pioneer sailor who was said to have harvested over 5,000 sea otters from St. Paul Island in 1787.
Zoltoi (hauling ground)	Golden.	Named to express the metallic' shimmering of the sands.
St. George Island		
Staraya Artil	Old work brigade or small collective enterprise	There was once a settlement or village adjacent to the 'rookery.
Sea Lion Rock		
Sivutch	Sea lion	Sea lions haul out but do not breed here.

POPULATION ASSESSMENT, PRIBILOF ISLANDS, ALASKA

by

Charles W. Fowler and Elizabeth H. Sinclair

In accordance, with the original provisions established by the Interim Convention of Conservation of North Pacific Fur Seals, the National Marine Mammal Laboratory (NMML) continues to monitor the population status of northern fur seals on the Pribilof Islands. Data on the number of adult males on St. Paul Island and the number of seals taken in the subsistence harvest on both St. Paul and St. George Islands are collected annually. In 1991, the number of adult males was also determined for St. George Island. The number and sex compostion of pups born on St. Paul and St. George Islands, and the number of dead animals of all ages and sexes are determined during even-numbered years only.

Population Parameters

Seals Harvested

Subsistence harvesting of northern fur seals was conducted on St. Paul Island for 20 days between 1 July and 7 August and on St. George Island on 7 days between 30 June and 5 August. A total of 1,645 and 281 seals were killed on St. Paul Island and St. George Island, respectively (Tables -2). All were male seals with the exception of one female killed the week of 5 August on St. Paul Island.

Table 2.--Date, location, and number of seals killed in subsistence harvest drives on St. Paul and St. George Islands, Alaska,-in 1991.

Date	Rookery	Number killed
	St. Paul Island	
July 1	Reef	49
July 2	Zapadni	38
July 8	Polovina/Reef	77
July 9	Zapadni	81
July 10	Lukanin	32
July 15	Reef	94
July 16	Zapadni	91
July 17	Polovina	79
July 18	Lukanin	46
July 20	Reef	124
July 23	Zapadni	86
July 24	Polovina	59
July 25	Lukanin	59
July 26	Reef	97
July 27	Northeast Point	134
July 31	Reef	94
August 3	Zapadni	148
August 5	Polovina	79
August 6	Lukanin	69
August 7	Reef	109
	Island total	1,645
	St. George Island	
June 30	-	41
July 8	-	13
July 14	-	45
July 20	-	31
July 27	-	51
July 31	-	65
Aug. 5	-	35
	Island total	281

Living Adult Male Seals Counted

A total of 4,729 harem (see Glossary for definition) and 9,543 idle (classes 1,2,4, and 5 as defined in Glossary) adult male seals (bulls) were counted on St. Paul Island from 10 to 14 July (Table 3). On St. George Island, 736 harem and 1,271 idle bulls were counted from 8 to 15 July. The total numbers of harem and idle bulls counted annually since 1982 are given in Table 4. The relative locations of the different classes of adult males are indicated for the fur seal rookery-hauling ground complexes on St Paul Island in Table 5.

The effects of the cessation of commercial harvesting on St. Paul Island in 1984 continue to be apparent in the increase in male counts. Harem and idle bull counts on St. Paul Island were higher in 1991 than in 1990. On St. George Island, however, where the commercial harvest ceased in 1972, the 1990 and 1991 counts of both idle and harem males decreased. The decreases in abundance of idle and harem males on St. George Island are too small to account for the increase in male abundance observed on St. Paul Island.

Table 3. --Number of adult male northern fur seals counted, by rookery, Pribilof Islands, Alaska., July 1991.

Rookery	Date (July)	Class of adult male* 2	3	5	Total
St. Paul Island					
Lukanin	13	47	103	181	331
Kitovi	13	113	225	379	717
Reef	10	345	485	762	1592
Gorbatch	10	216	388	703	1307
Ardiguin	10	24	86	30	140
Morjovi	14	120	391	687	1198
Vostochni	14	244	869	810	1923
Little Polovina	13	8	13	509	530
Polovina	13	37	57	432	526
Polovina Cliffs	13	164	433	320	917
Tolstoi	11	331	567	868	1766
Zapadni Reef	12	74	170	447	691
Little Zapadni	12	141	391	334	866
Zapadni	12	271	551	946	1768
Island total		2,135	4,729	7,408	14,272
St. George Island					
Zapadni	12	38	84	161	283
South	12	62	145	34	241
North	13	162	229	234	625
East Reef	15	24	52	40	116
East Cliffs	15	86	192	259	537
Staraya Artil	8	78	34	93	205
Island total		450	736	821	2,007

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

Table 4. --Number of harem and idle male northern fur seals counted in mid-July, Pribilof Islands, Alaska, 1982-91. A dash indicates no data;

Year	St. Paul Island		St. George Island		Total	
	Harem	Idle	Harem	Idle	Harem	Idle
1982	5,767	4,009	1,410	1,319	7,177	5,328
1983	4,827	4,242	-	-	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
1990	4,430	7,632	909	1,666	5,339	9,298
1991	4,729	9,543	736	1,271	5,465	10,814

* The total for 1983 does not include males from St. George Island.

Table 5.--Number of adult male northern fur seals counted, by class and rookery section, St. Paul Island, Alaska, 10-14 July 1991. A dash indicates nosection.

Rookery and class of male	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Lukanin															
2	24	23	-	-	-	-	-	-	-	-	-	-	-	-	47
3	55	48	-	-	-	-	-	-	-	-	-	-	-	-	103
5	154	27	-	-	-	-	-	-	-	-	-	-	-	-	181
Kitovi[b]															
2	26(10)	4	21	25	27	-	-	-	-	-	-	-	-	-	113
3	40(16)	12	54	58	45	-	-	-	-	-	-	-	-	-	225
5	26(90)	7	8	37	211	-	-	-	-	-	-	-	-	-	379
Reef															
2	27	40	49	19	26	40	19	49	42	27	7	-	-	-	345
3	43	89	60	29	46	72	3	43	61	33	6	-	-	-	485
5	27	33	113	30	162	26	76	119	15	53	108	-	-	-	762
Gorbatch															
2	50	42	40	0	11	73	-	-	-	-	-	-	-	-	216
3	106	68	86	0	18	110	-	-	-	-	-	-	-	-	388
5	318	55	12	270	5	43	-	-	-	-	-	-	-	-	703
Ardiguen															
2	24	-	-	-	-	-	-	-	-	-	-	-	-	-	24
3	86	-	-	-	-	-	-	-	-	-	-	-	-	-	86
5	30	-	-	-	-	-	-	-	-	-	-	-	-	-	30
Morjovi[c]															
2	15(9)	17	22	15	31	11	-	-	-	-	-	-	-	-	120
3	48(21)	62	50	50	109	51	-	-	-	-	-	-	-	-	391
5	235(51)	51	96	39	36	179	-	-	-	-	-	-	-	-	687
Vostochni															
2	17	2	13	9	16	39	16	21	21	4	7	17	43	19	244
3	44	9	54	51	32	90	73	74	53	29	30	78	163	89	869
5	22	29	0	139	116	74	47	19	0	0	6	101	85	172	810
Little Polovina															
2	8	-	-	-	-	-	-	-	-	-	-	-	-	-	8
3	13	-	-	-	-	-	-	-	-	-	-	-	-	-	13
5	509	-	-	-	-	-	-	-	-	-	-	-	-	-	509
Polovina															
2	25	12	-	-	-	-	-	-	-	-	-	-	-	-	37
3	35	22	-	-	-	-	-	-	-	-	-	-	-	-	57
5	247	185	-	-	-	-	-	-	-	-	-	-	-	-	432
Polovina Cliffs															
2	12	13	7	24	42	17	49	-	-	-	-	-	-	-	164
3	38	39	34	51	98	40	133	-	-	-	-	-	-	-	433
5	87	26	9	8	54	54	82	-	-	-	-	-	-	-	320
Tolstoi															
2	30	30	32	46	47	39	55	52	-	-	-	-	-	-	331
3	62	68	51	61	97	93	89	46	-	-	-	-	-	-	567
5	6	7	9	25	42	56	78	645	-	-	-	-	-	-	868
Zapadni Reef															
2	62	12	-	-	-	-	-	-	-	-	-	-	-	-	74
3	129	41	-	-	-	-	-	-	-	-	-	-	-	-	170
5	169	278	-	-	-	-	-	-	-	-	-	-	-	-	447
Little Zapadni															
2	5	22	43	21	27	23	-	-	-	-	-	-	-	-	141
3	13	45	96	88	75	74	-	-	-	-	-	-	-	-	391
5	27	47	53	32	40	135	-	-	-	-	-	-	-	-	334
Zapadni[d]															
2	28(0)	40	33	33	47	32	47	11	-	-	-	-	-	-	271
3	61(0)	79	97	78	74	86	64	1							

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

STUDIES OF JUVENILE MALES TAGGED AS PUPS AND RESIGHTED DURING ROUNDUPS IN 1991

by

Jason D. Baker George A. Antonelis, and Charles W. Fowler

The influence of variability in population dynamics on the survival and growth of northern fur seals on St. Paul Island was examined using tagging experiments during the 1987-90 summer field seasons. This project was initiated upon recommendation by scientists concerned with the decline of the Pribilof Island fur seal population. The program began as a feasibility study to test tagging methodology. The first objective was to evaluate the use of a newly developed monel cattle ear tag with a round post in estimating male survival from birth to-age 2-5 years. Survival estimates were based on resights of previously tagged individuals in subsequent years.

In addition to tag resight data, information on other aspects of the fur seal population have been collected during this study. Antonelis et al. (1992) presented preliminary results on tag resights, frequency of tag loss, homing tendencies of tagged males, the effects of body size and age on juvenile male haul-out patterns, and the influence of the weight of pups on their size later in life up to 1990. This chapter provides an update of the data collected during 1991.

METHODS

In 1987, the total number of pups tagged on each rookery (none were applied on Little. Polovina or Sea Lion Rock in any year) on St. Paul -Island was approximately 4% of the estimated pup production from the previous year. The application of tags was distributed among rookeries according to the proportion each rookery contributes to the total estimate of- pups born. After 1988, application of tags to males continued at a rate of approximately 4%, but only small numbers (400-500) of females were tagged on St. Paul Island at selected study sites. Tagging procedures are described in Antonelis (1992).

Weights were recorded for at least 10% of the pups handled (both males and females) from each rookery. Pups were randomly. selected for weighing. The minimum number of pups to be weighed at any rookery was 100. Pups were weighed by placing the animal head first into a weighing bucket or net which was suspended by hand from a spring scale. All weights were measured to the nearest 0.25 kg.

Most resights of juvenile male seals occur during roundups on hauling grounds conducted during the breeding season, (Antonelis 1992). A few tagged seals are either resighted or killed in the subsistence harvest on St. Paul and St. George Islands. For comparison with rookeries where tags were applied, hauling grounds were assigned to specific rookeries. For example, a hauling ground between the Little Zapadni and Zapadni rookeries could be assigned to, either rookery'. The hauling

ground was assigned to the Zapadni rookery, in view of location and movement of seals onto areas more clearly associated with this rookery. Similarly, the very tip of Northeast Point is between the Vostochni and Morjovi rookeries but was designated as part of Morjovi.

The methods for conducting roundups and tag resighting (originally undertaken for studies of entanglement) are described in Fowler and Ragen (1990) and Fowler et al. (1990a). Some individuals are seen on more than one occasion during the roundups; Data recorded at the time of recapture include the tag number, condition of the tag, presence or absence of a tag on both flippers, and condition of the flippers at the site of tag attachment. Seals were physically restrained using a restraint board and procedures described in Gentry and Holt (1982). A nylon harness was used to suspend the restraint board and seal from a spring scale, which was attached to a metal pipe held by two workers while the weight was read. Seals killed during the subsistence harvest were weighed directly on a platform scale. Weight values were recorded to the nearest 1.0 kg.

RESULTS AND DISCUSSION

Tag Resights

The tag numbers of northern fur seal pups from St. Paul Island in 1989 are listed in Table 6, which also shows the numbers tagged for each sex and rookery. The same information for 1987 and 1988 are presented in Antonelis et al'. (1992). In

Table 6.--Ranges of tag numbers and numbers of monel tags applied to northern fur seal pups on the rookeries of St. Paul Island in 1989.

Rookery	Tag number		Males	Females	Tags applied
	Beginning	Ending			
Vostochni	A15164	A16116	630	0	630
Morjovi	A16117	A16353	254	0	254
Little Polovina	-	-	0	0	0
Polovina Cliffs	A16403	A17110	434	267	702*
Polovina	A16354	A16402	49	0	49
Lukanin	A17739	A18034	152	142	294
Kitovi	A17495	A17738	241	0	241
Reef	A14387	A15243	448	4	452
Ardiguen	A17419	A17494	75	0	75
Gorbatch	A17111	A17418	305	0	305
Tolstoi	A18359	A18931	570	0	570
Zapadni Reef	A15301	A15463	162	0	162
Little Zapadni	A18037	A18358	321	0	321
Zapadni	A14838	A15237	383	5	388
Total	A14387	A18931	4024	418	4443

*Includes one pup whose sex was not determined.

addition to the exceptions described above no pups were tagged on the Ardiguen rookery in 1987.

Roundups of male northern fur seals were conducted on St. Paul Island during July and early August of 1991. During these roundups, 22,524 male seals judged to be of the size historically taken in the commercial harvest were counted. A total of 603 seals with monel tags were resighted, 23.9% (n = 144) of which were resighted at least twice. This is similar to the multiple resight rate of 23.6% observed in 1990 (Antonelis et al. 1992). Of the total number of tagged seals resighted, 76.1% were seen only once, 21.2% were seen twice, 2.0% three-times, 0.5% four times, and 0.2% five times. Excluding those seals taken in the subsistence harvest, at least 279 4-year-olds, 261 3-year-olds and 49 2-year-olds remained in the tagged population of seals during summer 1991. Fourteen monel-tagged seals were killed in the subsistence harvest, including three 2-year-olds, nine 3-year-olds, and two 4-year-olds.

Of the monel-tagged seals resighted in 1991, 281 (46.6%) were 4-year-olds (tagged in 1987), 270 (44.8%) were 3-year-olds (tagged in 1988) and 52 (8.6%) were 2-year-olds (tagged in 1989). Most of the 2-year-old seals were resighted late in the series of roundups (Figs. 6 and 7) as was the case in 1990. A list of monel-tagged fur seals resighted during roundups and the subsistence harvest in 1991 is presented in Appendix Table B-l.

Roundups were not conducted on Polovina Cliffs or Ardiguen rookeries. Unlike previous years, several roundups were conducted at Little Polovina in 1991. The distribution of

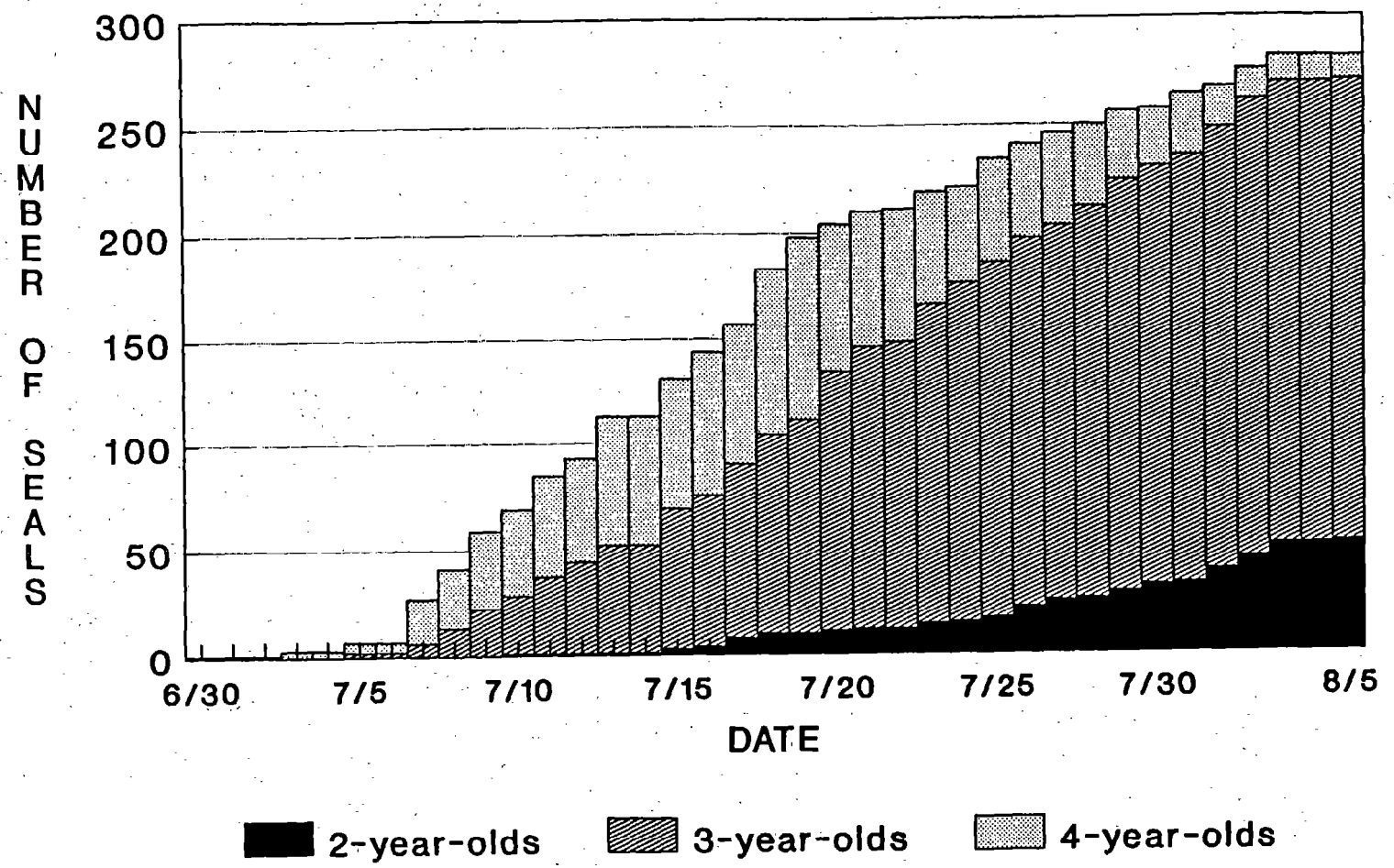


Figure 6. --Daily accumulation of tagged 2- to 4-year-old male northern fur seals resighted during roundups and the subsistence harvest using only the first of multiple resightings on St. Paul Island,-Alaska, in 1991.

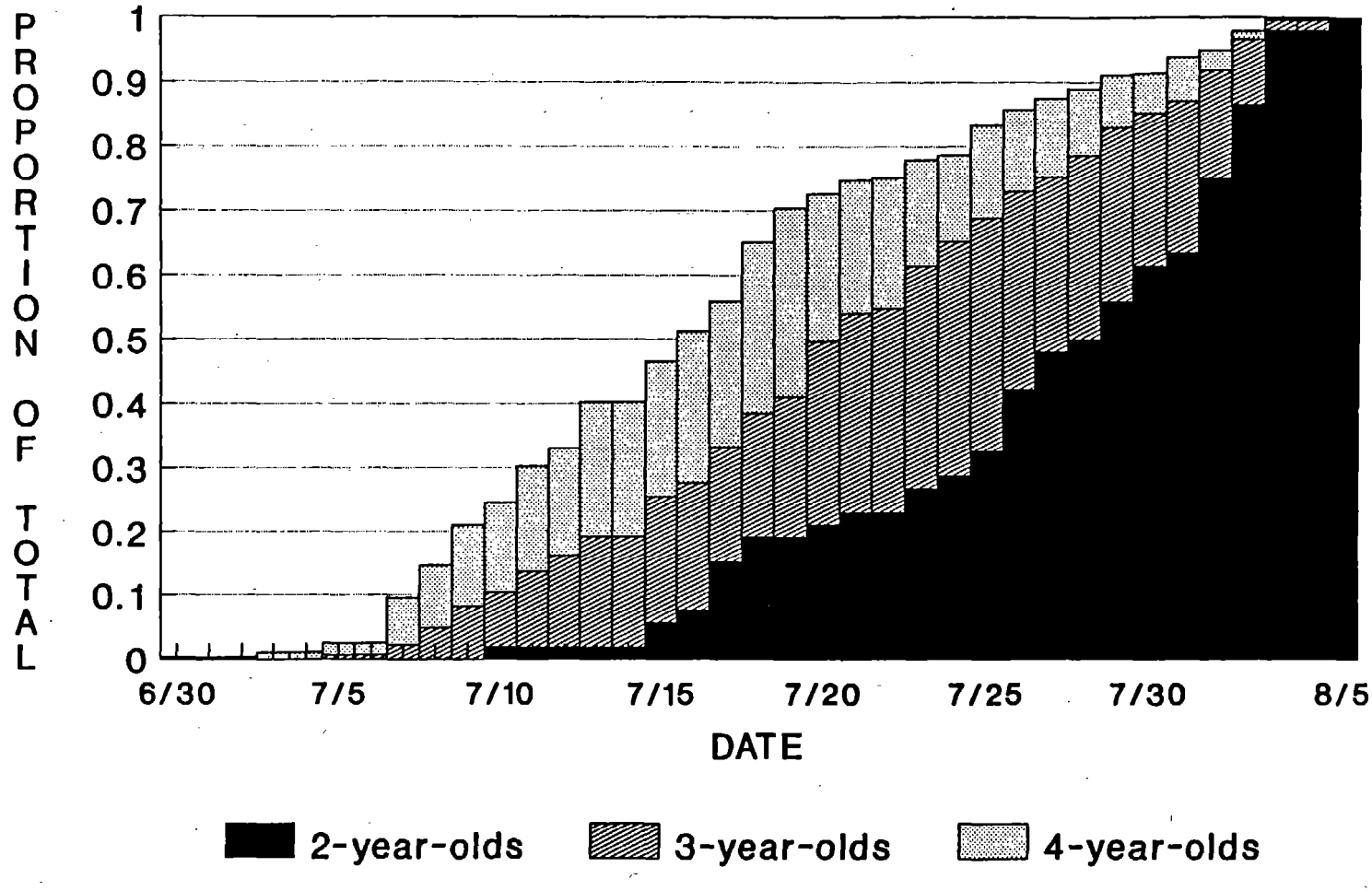


Figure 7.--Proportional daily accumulation of tagged 2- to 4-year-old male northern fur seals resighted during roundups and the subsistence harvest using only the first of multiple resightings on St. Paul Island,, Alaska, in 1991.

rookery of resighting, compared to the rookery of tagging is presented for 2- 3- and 4-year-olds in Tables 7, 8 and 9, respectively. These tables include all-multiple sightings for seals in 1991 and rookeries are listed in clockwise arrangement for St. Paul Island, starting with Vostochni rookery. Thus, the nearest rookeries are adjacent to each other in the table. The tendency for individuals to be resighted at their natal rookery is apparent from the larger numbers along the diagonal axis of the tables. This is especially apparent for the large samples of 3- and 4-year-olds.

Of the 60 2-year old males resighted in 1990 (Antonelis et al. 1992), 18 (30.0%) were seen again in 1991. A similar proportion of 3-year-olds, 92 of 326 (28.2%), resighted in 1990 were seen again in 1991.

The numbers of seals with missing tags are summarized in Table 10. As in 1990 (Antonelis et al. 1992), tag loss becomes more frequent with age. In addition, it seems that there was a proportionately higher rate of tag loss among seals tagged in 1987 compared with those tagged in 1988 and 1989. Estimated double tag loss at age 3 was 1.85% for the 1987 cohort (Antonelis et al. 1992), compared to only 0.23% for the 1988 cohort. Two seals lost tags during the season of 1991.

Weights of Tagged Fur Seals

A total of 590 juvenile males were weighed &ring 1991. A summary of weight data for juvenile males captured in 1990 (Antonelis et al. 1992) and 1991 are presented in Table 11. Since there -is a preference for smaller seals in the Aleut native

Table 7.--Numbers of 2-year-old juvenile male northern fur seals resighted at the haul out(s) of a particular rookery (identified on top row) as compared to the -rookery where tagged (left column), St. Paul Island, Alaska, 1991.

Site of tagging	Site of tag resighting											
	A	B	C	E	F	G	H	J	K	L	M	N
A	2	3	0	1	1	0	0	1	0	0	1	0
B	0	2	0	2	0	0	0	0	1	1	0	0
C	0	0	0	0	0	0	0	0	0	0	0	0
D	1	0	0	5	0	0	0	0	0	0	0	0
E	0	0	0	1	0	0	0	0	0	0	0	0
F	1	0	0	0	1	0	0	0	0	0	0	0
G	0	1	0	1	1	0	0	2	0	0	0	0
H	0	1	0	1	0	0	1	4	0	0	0	2
I	0	0	0	0	0	0	0	0	0	0	0	0
J	0	1	0	0	0	0	0	3	0	0	0	2
K	0	1	0	0	0	0	0	1	2	0	0	0
L	0	0	0	0	0	0	0	1	0	1	0	0
M	0	1	0	0	0	0	0	0	0	0	0	2
N	0	0	0	0	0	0	0	0	0	0	0	0

'Rookery identity for St. Paul-Island is as follows: A = Vostochni; B = Morjovi; C = Little Polovina; D = Polovina Cliffs; E = Polovina; F = Lukanin; G = Kitovi; H = Reef; I = Ardiguen; J = Gorbatch; K = Tolstoi; .L = Zapadni Reef; M = Little Zapadni; N = Z Zapadni; N = Zapadni

Table 8.--Numbers of 3-year-old juvenile male northern fur seals resighted at the haul out(s) of a particular rookery (identified on top row) as compared to the rookery where tagged (left column), St. Paul Island, Alaska, 1991.[1]

Site of tagging	Site of tag resighting											
	A	B	C	E	F	G	H	J	K	L	M	N
A	17	11	0	4	2	0	0	5	0	2	0	7
B	3	11	0	2	6	1	0	2	1	1	0	2
C	0	0	0	0	0	0	0	0	0	0	0	0
D	2	4	2	15	2	0	0	3	0	0	0	1
E	1	0	0	0	0	0	0	1	0	1	0	0
F	1	4	0	2	8	0	1	2	1	0	0	1
G	1	2	1	1	6	6	0	3	1	2	0	0
H	3	4	1	3	2	0	3	14	0	0	0	5
I	1	0	0	0	0	0	0	4	2	0	0	0
J	0	1	0	2	3	1	3	23	1	0	0	4
K	5	5	2	4	3	1	2	10	13	3	0	5
L	0	1	0	3	0	0	0	4	0	1	0	2
M	0	3	1	0	4	0	1	7	0	2	0	6
N	1	5	0	5	3	0	0	7	0	2	0	10

[1]Rookery identity for St. Paul Island is as follows: A = Vostochni; B = Morjovi; C = Little Polovina; D = Polovina Cliffs; E = Polovina; F = Lukanin; G = Kitovi; H = Reef; I = Ardiguen; J = Gorbatch; K = Tolstoi; L = Zapadni Reef; M = Little Zapadni; N = Zapadni

Table 9.--Numbers of 4-year-old juvenile male northern fur seals resighted at the haul out(s) of a particular rookery (identified on top row) as compared to the rookery where tagged (left column), St. Paul Island, Alaska, 1991.

Site of tagging	Site of tag resighting											
	A	B	C	E	F	G	H	J	K	L	M	N
A	17	3	1	3	0	0	0	2	0	1	0	1
B	1	10	0	1	0	0	0	2	0	1	0	0
C	0	0	0	0	0	0	0	0	0	0	0	0
D	3	4	21	19	0	0	1	2	0	0	0	2
E	0	1	1	0	0	0	0	0	0	0	0	1
F	1	1	1	2	18	3	0	4	1	3	0	3
G	1	6	0	3	8	22	1	3	0	1	0	2
H	0	1	0	3	1	0	5	9	1	0	0	5
I	0	0	0	0	0	0	0	0	0	0	0	0
J	4	0	0	3	2	1	0	18	1	2	0	5
K	1	0	0	4	1	1	0	9	10	2	1	13
L	1	1	0	0	0	0	0	2	0	13	1	0
M	1	1	0	1	0	0	0	7	2	3	3	7
N	2	2	0	1	0	0	1	8	1	2	0	16

*Rookery identity for St. Paul Island' is as follows: A = Vostochni; B 7 Morjovi; C = Little Polovina; D = Polovina Cliffs; E = Polovina; F = Lukanin; G = Kitovi; H = Reef; I = Ardiguen; J = Gorbatch; K = Tolstoi; L = Zapadni Reef; M. = Little Zapadni; N = Zapadni

Table. 10. Listing of the numbers of tags lost by flipper (with percent of total in parentheses) and age for individual juvenile male northern fur seals seen in roundups during 1991, St. Paul Island, with the estimated double tag loss rate (percent) for each age.

Age	No. of fur seals	Tag loss			Double tag loss* (%)
		Left	Right	Neither	
2	52	2 (3.9)	1 (1.9)	49 (94.2)	0.08
3	270	11 (4.1)	14 (5.2)	245 (90.7)	0.23
4	281	53 (18.9)	50 (17.8)	178 (63.3)	5.03

*Calculated with the expression $p = (n_1 n_2)/((n_1+n_3)\ (n_2+n_3))$ where (assuming the probability of tag loss on one flipper is independent of loss on the other):

p = the fraction of both tags lost.

n_1 = the number of seals of a specific age with tags lost on the left side.

n_2 = the number of seals of a specific age with tags lost on the right side.

n_3 = the number of seals of a specific age with both tags present.

Table 11-Summary of juvenile male weight data from 1990 to 1991. Weights recorded during the subsistence harvest were excluded from these calculations. The mean of all weighings for each individual were used.

	1991				1990			
Age	Mean weight (kg)	Standard deviation (kg)	Coefficient of variation	Sample size	Mean weight (kg)	Standard deviation	Coefficient of variation	Sample size
2	21.6	2.5	0.11	48	21.7	2.9	0.13	58
3	28.9	3.9	0.13	263	28.1	4.1	0.15	318
4	38.9	5.8	0.15	279	-	-	-	-

subsistence harvest, weight measurements taken during this harvest were not used in calculations present in Table 11. Only weights taken during the roundups. were used. Also, if a-seal was weighed more than once in a season, the mean of all weights was used. In 1991, the mean weight of 3-year-olds was significantly greater than in 1990 (Students t; $P = 0.017$). Mean weights of 2-year-olds were not significantly different ($P = 0.83$) for 1990 and 1991. The weight distributions of 2- 3- and 4-year-olds in 1991 are illustrated in Figure 8.

Consistent with results from 1990. (Antonelis et al. 1992); variation in the date of juvenile male-arrival on St. Paul Island is more associated with age than with weight. Regression analysis indicated that the date of first sighting of monel-tagged seals is significantly related to the seal's age ($P < 0.001$). The earlier arrival of older animals is apparent in Figure 7. Based on multiple-regression analysis including age. and body weight, weight is not a significant factor influencing date of first sighting ($P = 0.16$).

A related question pertains to the proportion of time, seals spend ashore once they have returned to the island. If different size or age groups of males spend different proportions of time ashore, they should also have different, capture probabilities. during roundups. Regression analysis showed no significant relationship between either weight or age and the number of times a seal was seen among 3- and,4-year-old tagged males indicating that there was no significant difference during 1991 in the proportion of time 3- or 4-year-old juvenile males spend ashore..

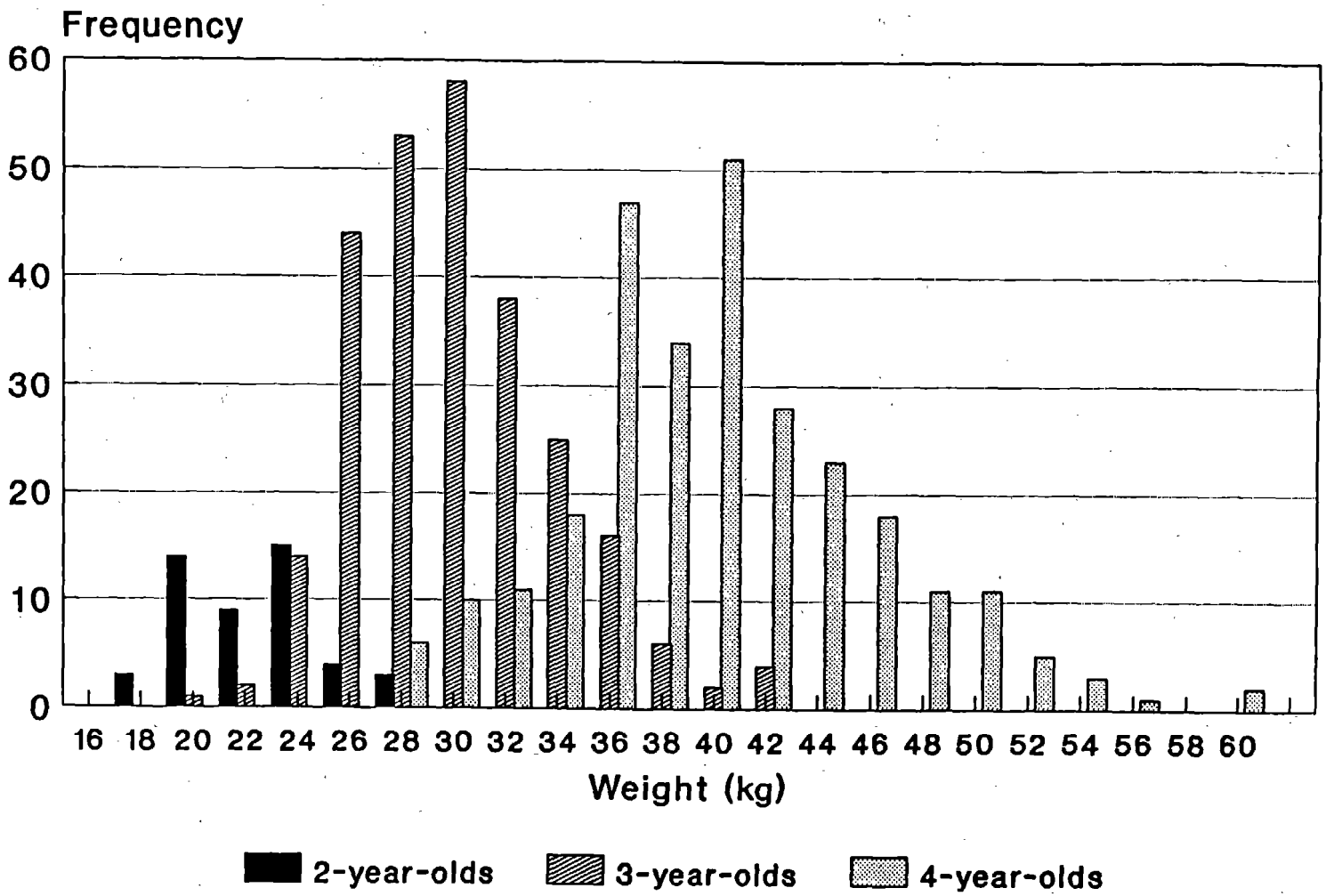


Figure 8.--Weight distributions (kg) of 2- to 4-year-old tagged northern fur seals captured during roundups on St. Paul Island, Alaska, in 1991.

Two-year-olds begin arriving too late in the field season to permit testing for age- or weight-specific differences. These results confirm findings in 1990 which showed no significant relationship between weights and the number of times 3-year-olds were resighted during 1990 roundups (Antonelis et al. 1992).

Weights of seals which were captured more than once during the season were highly variable,. but did demonstrate a trend. Antonelis et al. (1992) found that male weight decreased during the 12 days following first capture with some individuals losing as much as 30% of their body weight. After 12 days there was a discontinuity in the data where proportions of weight at first capture are more variable but have, on the average, increased. Similar results were found in 1991 for 3- and 4-year-olds (Figs. 9 and 10). The mean proportion (recapture weights as a proportion of first capture weights) for seals weighed 14 or more days after their first capture was 1.20 (SD = 0.17, n = 7) for 3-year-olds and 1.06 (SD = 0.19, n = 19) for 4-year-olds, indicating that while they lose weight during initial onshore periods, males probably gain weight during the course of the summer.

Some of the tagged juvenile males weighed in 1991 had previously been weighed as pups. Regression analysis indicated a significant relationship between pup weight and weight at age 3 ($P = 0.002$,. $n = 112$); but not at age 2 ($P = 0.88$, $n = 11$) or age 4 ($P = 0.11$, $n = 40$). Weight at age 3 and 4 are plotted against pup weight in Figures 11 and 12, respectively. Among these seals, the mean pup weight for resighted 4-year-old males was

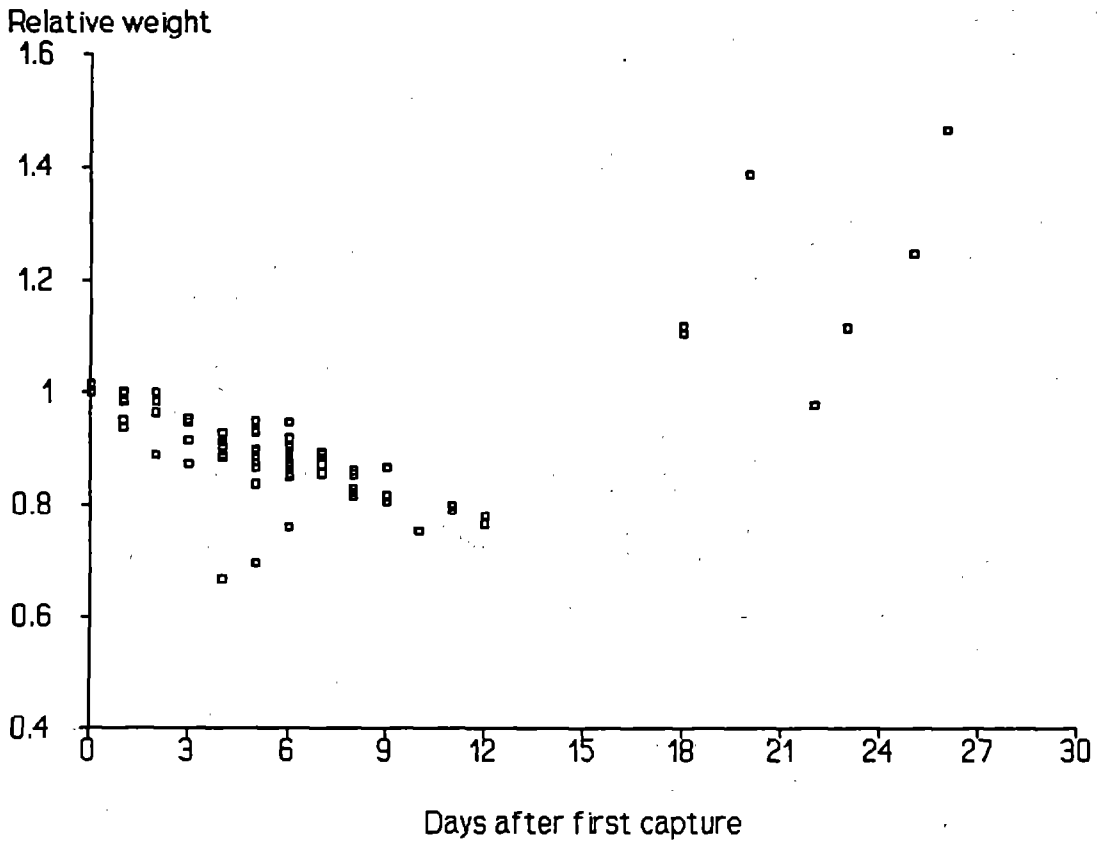


Figure 9. --Subsequent weights of 3-year-old male northern fur seals expressed as proportion& of their weight at first capture and plotted against the number of days since the first capture on St. Paul Island, Alaska, in 1991.

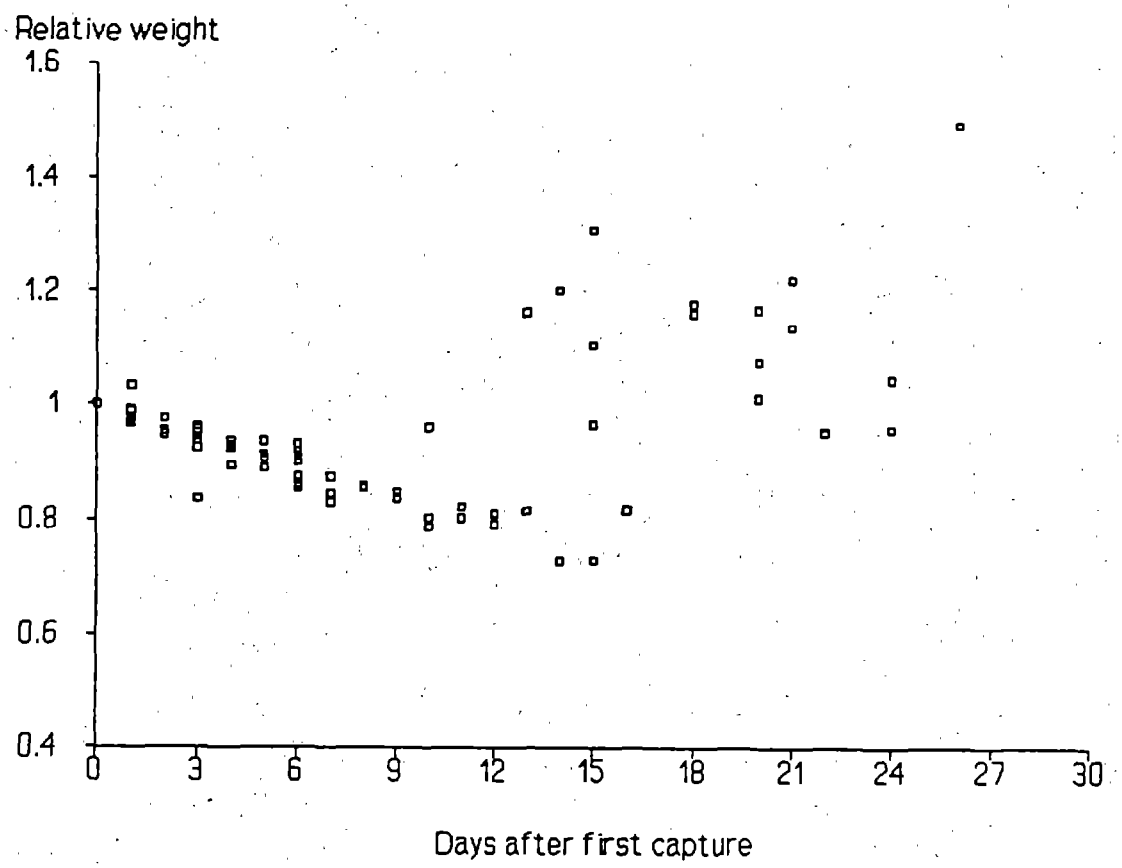


Figure 10.-- Subsequent weights of 4-yedr-old male. northern fur seals expressed as proportions of their weight at first capture and plotted against the number of days since the first capture on St. Paul Island, Alaska, in 1991.

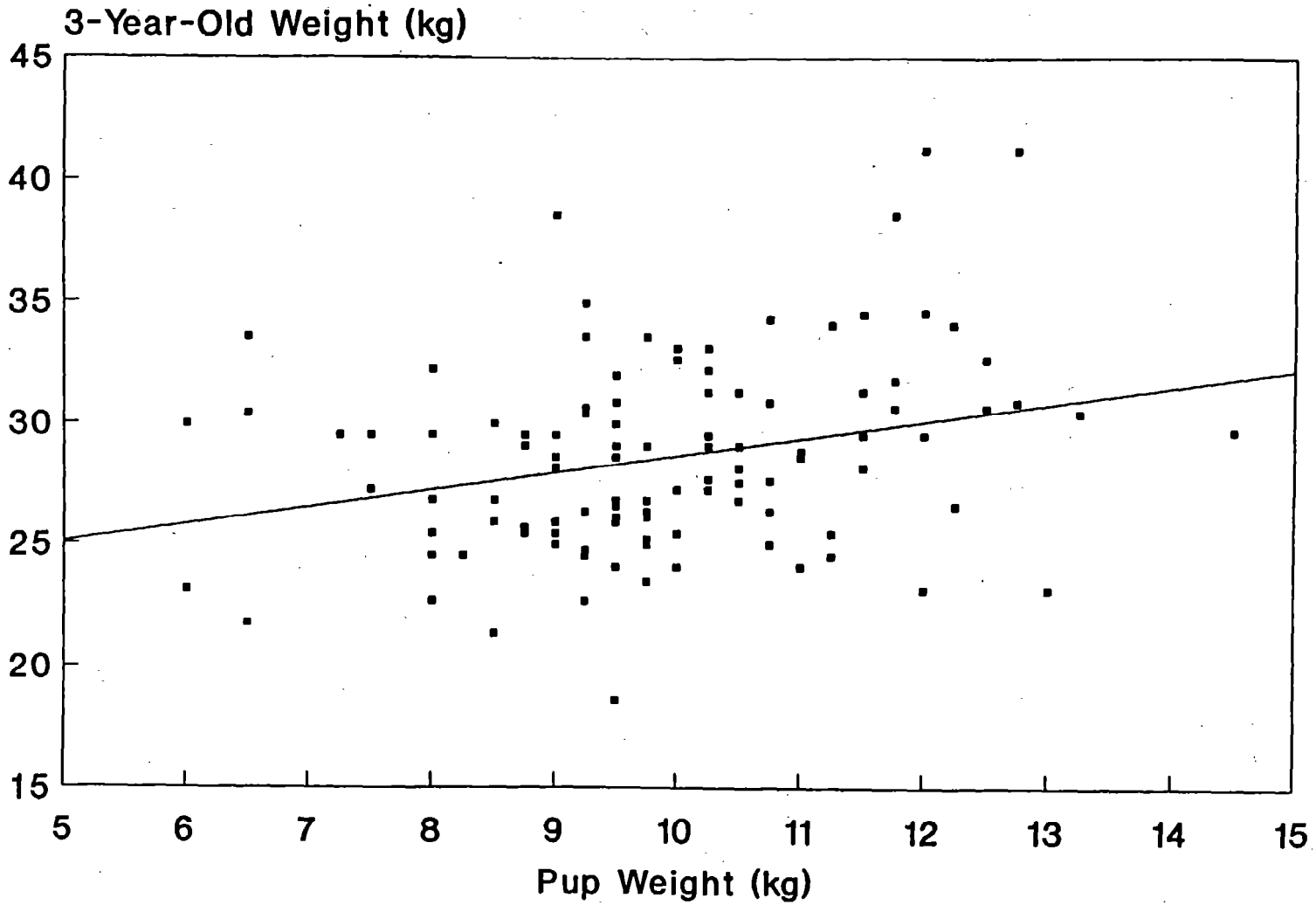


Figure ll.--Weight at age 3 plotted against pup weight for 112 male northern fur seals weighed in both 1988 and 1991. A least squares line has been fitted through the data.

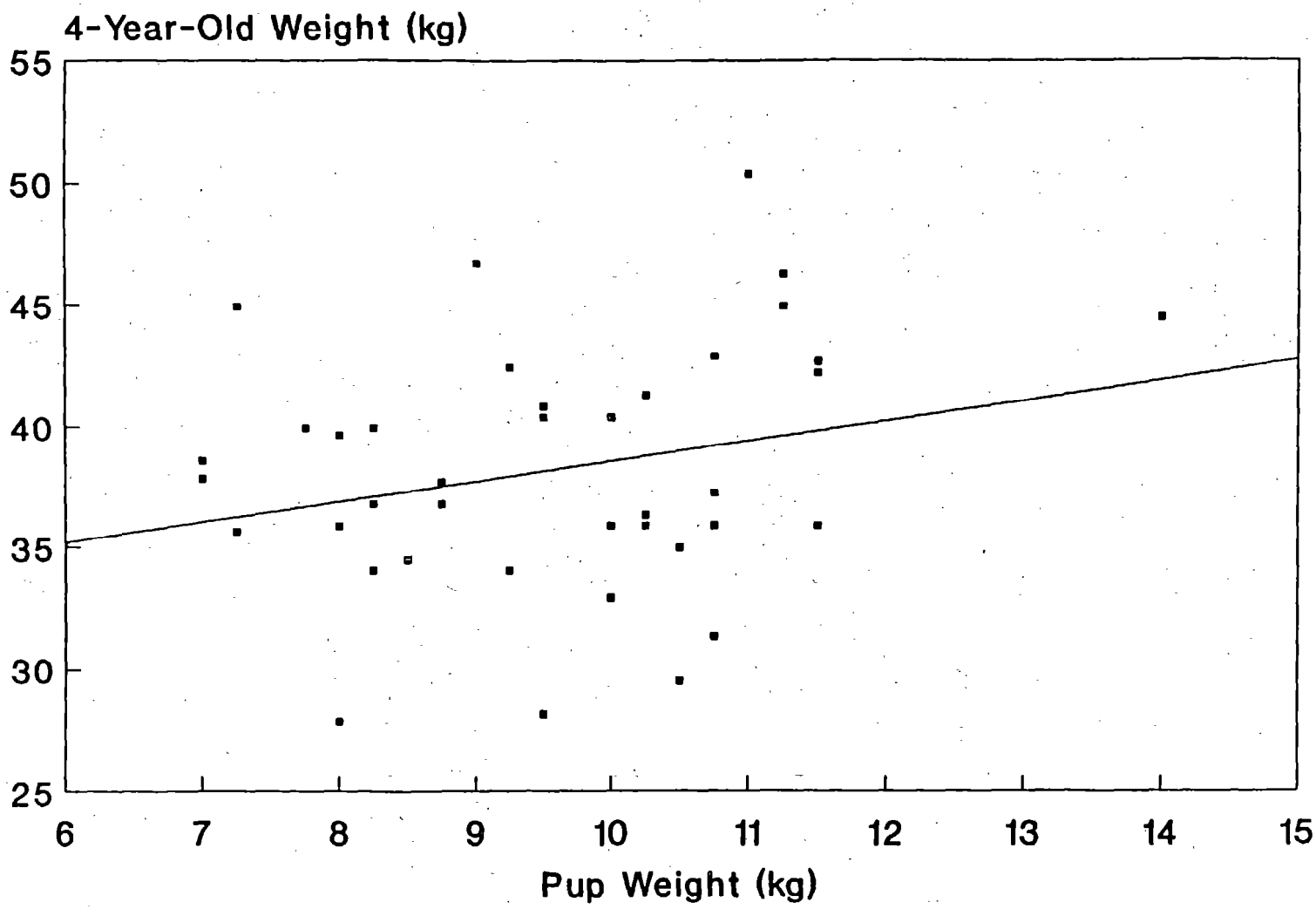


Figure 12.--Weigh at age 4 plotted against pup weight for 40 male northern fur seals weighed in both 1987 and 1991. A least squares line has been fitted through the data.

9.55 kg (SD = 1.54, n = 40) compared to 9.64 kg (SD = 1.93, n = 658) for all male pups weighed from the 1987 cohort (no significant difference, P = 0.77). Resighted 3-year-olds weighed an average of 9.87 kg (SD = 1.61, n = 118) as pups compared to 9.52 kg (SD = 1.76, n = 1,224) for all male pups weighed as pups in 1988 (significant difference, P = 0.006). Finally, resighted 2-year-olds weighed 9.98 kg as pups on average (SD = 1.56, n = 13) compared to 9.48 kg (SD = 1.81, n = 1,385) for all male pups weighed in 1989 (no significant difference, P.= 0.18).

Several seals weighed in 1991 had also been weighed in 1990. Eighteen 3-year-olds weighing 29.8 kg on average in 1991 weighed an average 22.0 kg in 1990. The average weight increase from age 2 to 3 was 36.4% (s = 14.9%, range 16.8% - 57.6%). Ninety-two 4-year-olds weighing an average 38.6 kg in 1991 had weighed 28.6 kg on average the previous year. The average weight increase from age 3 to age 4 was 38.8% (SD = 16.2%, range -0.1% - 82.8%). Figures 13 and 14 plot changes in individuals' weights at age. Regression analysis showed a significant relationship between weight at age 3 and age 2 ($P < 0.003$, n = 18) as well as between weight at age 4 and age 3 ($P < 0.001$, n = 92).

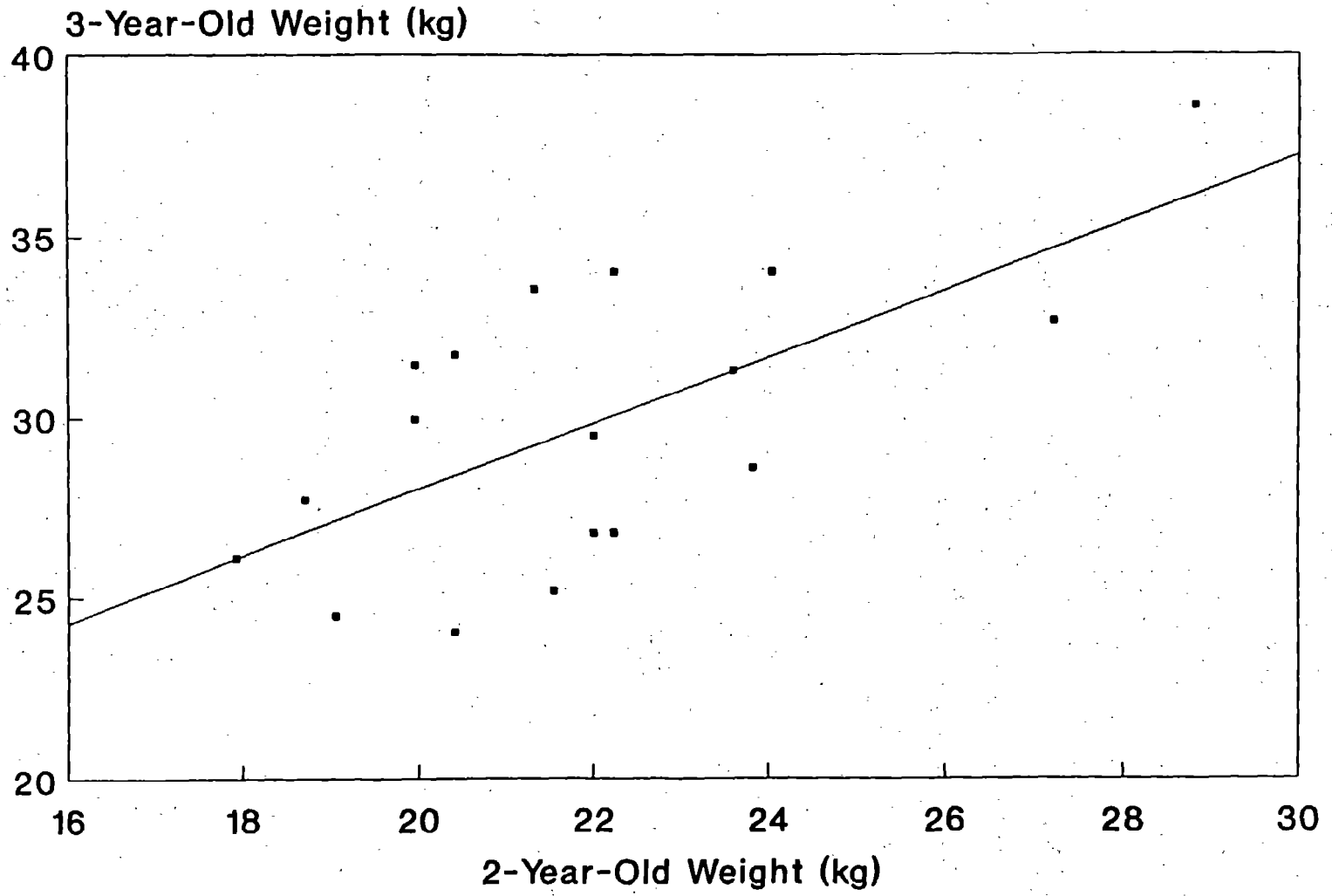


Figure 13.--Weight at age 3 plotted-against weight at age. 2 for 18 male northern fur seals weighed in both 1990 and 1991. A least squares line has been fitted through the data.

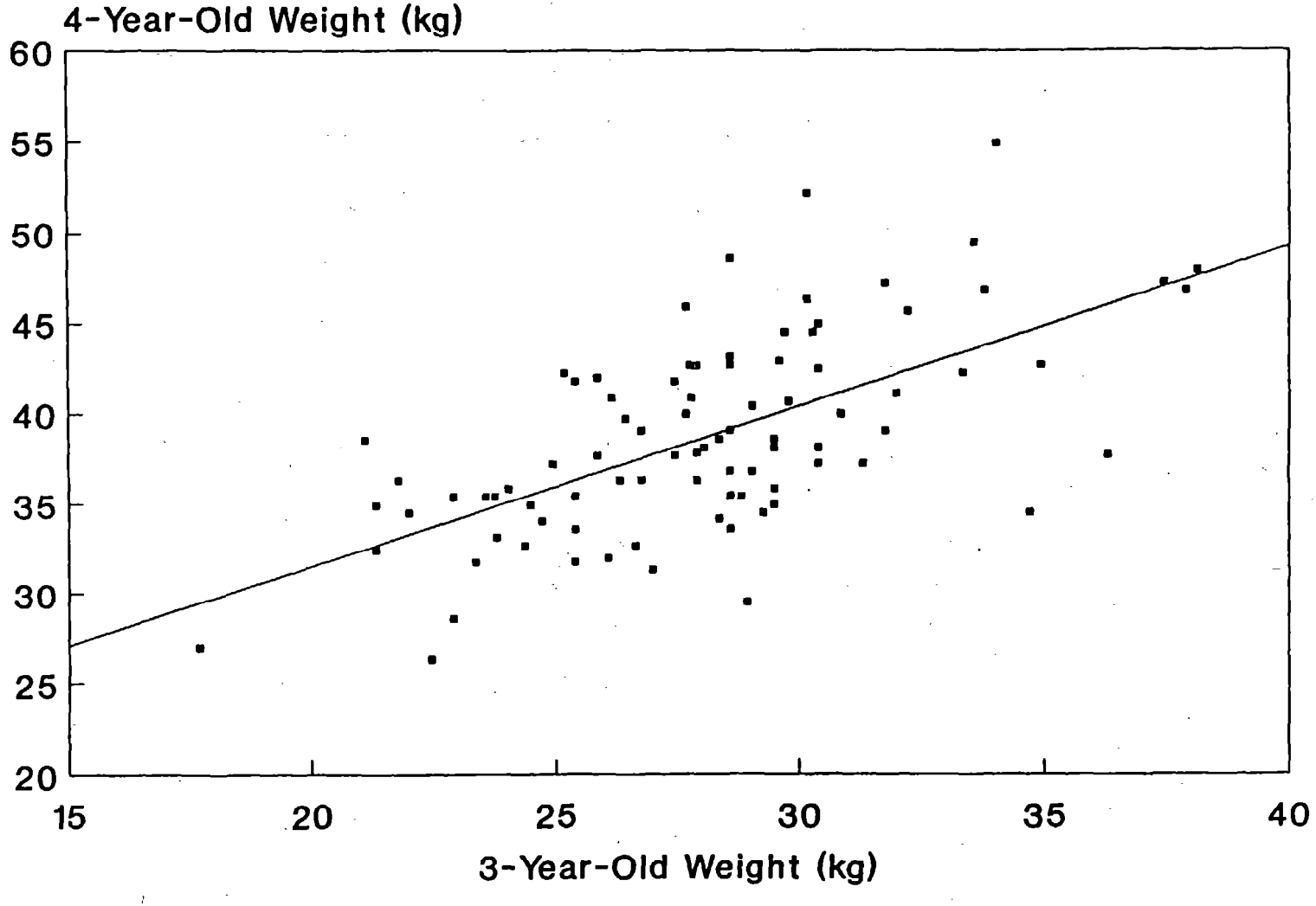


Figure 14.--Weight at age 4 plotted against weight at age 3 for 92 male northern fur seals weighed in both 1990 and 1991. A least squares line has been fitted through the date.

WEIGHTS AND SEX RATIOS OF NORTHERN FUR SEAL PUPS, 1990

by

Anne E. York and Rodney G. Towell

Relative trends in fur seal body weight serve as one measure of population health between the Pribilof Islands and associated rookeries. In -this section we report sex ratio and average weights for male and female pups for each rookery studied on St. Paul Island and St. George Island. For St. Paul Island, we also analyze weight and sex-ratio differences for sheared and nonsheared animals. Pups were weighed from-all rookeries except Little Polovina and Ardiguen during tagging operations on St. Paul Island from 25 to 30 August 1990, approximately 1 week after shearing-sampling studies were completed. Pups were weighed -from all rookeries on St. George Island during shearing-sampling activities on 19-20 August 1990. Only male pups were tagged, except on special study sites where female pups were tagged for future reproductive studies.

Pup tagging and weighing methods are described in Antonelis (1992). In 1990, random samples of approximately 10% of the tagged males and 10% of the tagged females were weighed. Weights were taken to the nearest l/4 kg. Variations of weights of pups on St. Paul Island were analyzed using analysis of variance on sex, rookery, and shearing status (sheared or nonsheared), and by sex and rookery for St. George Island (weights were sampled before shearing on St. George Island).

RESULTS AND DISCUSSION

Sample sizes, mean weights, and standard deviations for each rookery by sex and shearing status and by sex only are shown in Table 12 (St. Paul Island) and Table 13 (St. George Island), respectively. Mean weights and 95% confidence intervals by rookery for male and female pups are illustrated in Figure 15 (St. Paul Island) and in Figure 16 (St. George Island). Mean weight for northern fur seal pups on St. Paul Island (1987-90) and St. George Island (1990) are illustrated for males and females in Figure 17.

Pup, Weights

A preliminary analysis showed a significant interaction between sex and rookery ($P = 0.030$) and sex and shear status ($P= 0.089$) for St. Paul Island, so separate analyses were done for males and females. The analysis of variance of the weights over sex and rookery is presented in Table 14. For St. George Island the analysis of variance of the weights over sex and rookery is presented in Table 15. All pups on each rookery were weighed the same day, confounding the weight factor with rookery. We therefore examined the effect of weighing date on weight. The effect due to the day was not consistent with growth over time so we concluded that using the model with the rookery effect was more sensible. In Tables 14 and 15 each factor was 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

Table 12. --Sample size (n), mean weights (w), and standard deviation (SD) for a sample of sheared and nonsheared pups on St,. Paul Island, Alaska, during 25-30 August 1990.

Rookery		Females		Males	
		Nonsheared	Sheared	Nonsheared	Sheared
Lukanin	n	28	11	39	4
27 Aug.	w	7.830	7.527	9.641	8.875
	SD	1.564	1.447	1.854	2.437
Kitovi	n	43	5	39	4
29 Aug.	w	8.198	8.050	9.949	8.313
	SD	1.448	0.622	1.805	0.543
Reef	n	62	8	76	13
29 Aug.	w	8.319	7.219	10.207	9.538
	SD	1.438	1.290	1.761	1.859
Gorbatch	n	44	10	57	15
30 Aug.	w	8.136	7.100	10.022	9.440
	SD	1.470	1.029	1.816	1.865
Morjovi	n	65	14	69	10
26 Aug.	w	7.916	7.607	9.388	10.050
	SD	1.223	1.566	1.532	1.471
Vostochni	n	134	38	149	24
25 Aug.	w	8.392	8.053	9.393	9.333
	SD	1.362	1.458	1.715	1.715
Polovina	n	25	16	32	11
28 Aug.	w	7.661	6.906	8.734	9.886
	SD	1.431	1.376	1.703	2.139
Pol. Cliffs	n	116	18	60	14
28 Aug.	w	7.940	7.333	9.162	8.482
	SD	1.251	1.455	2.073	1.839
Tolstoi	n	81	15	88	15
29 Aug.	w	8.623	8.200	9.702	9.350
	SD	1.605	1.545	1.590	2.087
Zap. Reef	n	39	3	32	2
27 Aug.	w	8.167	8.083	9.719	8.250
	SD	1.279	1.286	1.287	1.768

Table 12.- -Continued.

Rookery		Females		Males	
		Nonsheared	Sheared	Nonsheared	Sheared
L. Zapadni	n	58	5	64	9
26 Aug.	w	8.332	7.550	9.176	9.028
	SD	1.451	0.891	1.641	1.098
Zapadni	n	59	14	67	10
27 Aug.	w	8.453	7.429	9.552	9.500
	SD	1.448	1.512	1.925	1.067
Combined	n	754	157	772	131
	w	8.218	7.617	9.559	9.308
	SD	1.413	1.424	1.763	1.748

Table 13. --Sample sizes (n), mean mass (kg), and standard deviation (SD) of male and female northern fur seal pups weighed on St. George Island, Alaska, 19 and 20 August 1990

Rookery		Females	Males	Combined
East	n	50	50	100
20 Aug.	kg.	8.42	10.04	9.23
	SD	1.159	1.491	1.558
East Cliffs	n	31	69	100
20 Aug.	kg.	8.089	9.065	8.762
	SD	1.072	1.71	1.601
Starya Artil	n	39	61	100
19 Aug.	kg.	8.256	9.246	8.86
	SD	1.482	1.659	1.657
North	n	47	53	100
19 Aug.	kg.	8.043	9.33	8.725
	SD	1.115	1.529	1.491
Zapadni	n	45	55	100
19 Aug.	kg.	7.822	9.132	8.542
	SD	1.085	1.803	1.651
South	n	38	62	100
19 Aug.	kg.	8.362	9.484	9.057
	SD	1.474	1.687	1.693
Combined	n	250	350	600
	kg.	8.166	9.361	8.863
	SD	1.242	1.673	1.619

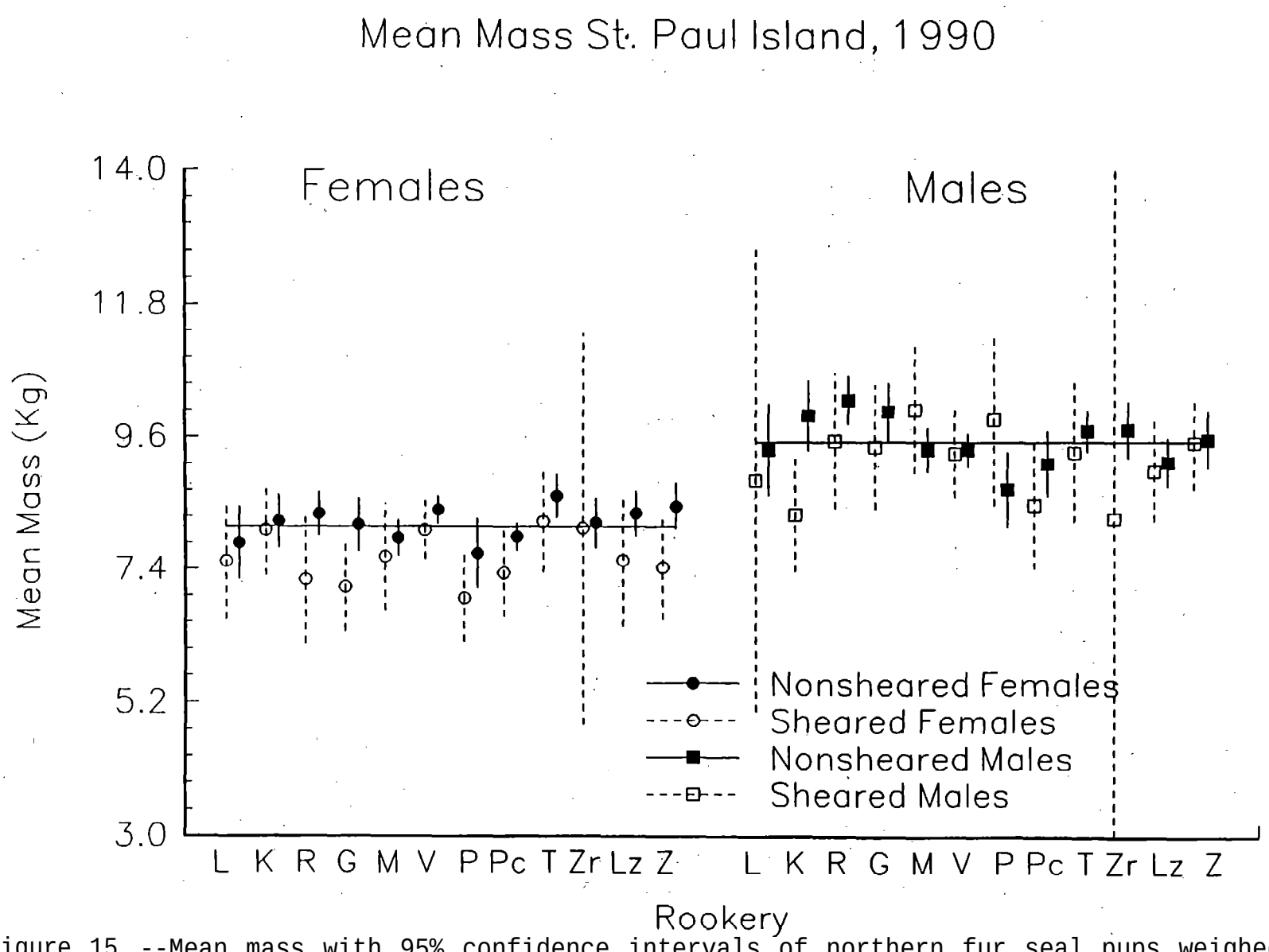


Figure 15. --Mean mass with 95% confidence intervals of northern fur seal pups weighed during tagging operations, August 1990, St. Paul Island, Alaska: Lukanin (L), Kitovi (K), Reef (R), Gorbatch (G), Morjovi (M), Vostochni.(V), Polovina (P), Polovina Cliffs (Pc), Tolstoi (T), Zapadni Reef (Zr), Little Zapadni (Lz), and Zapadni (Z).

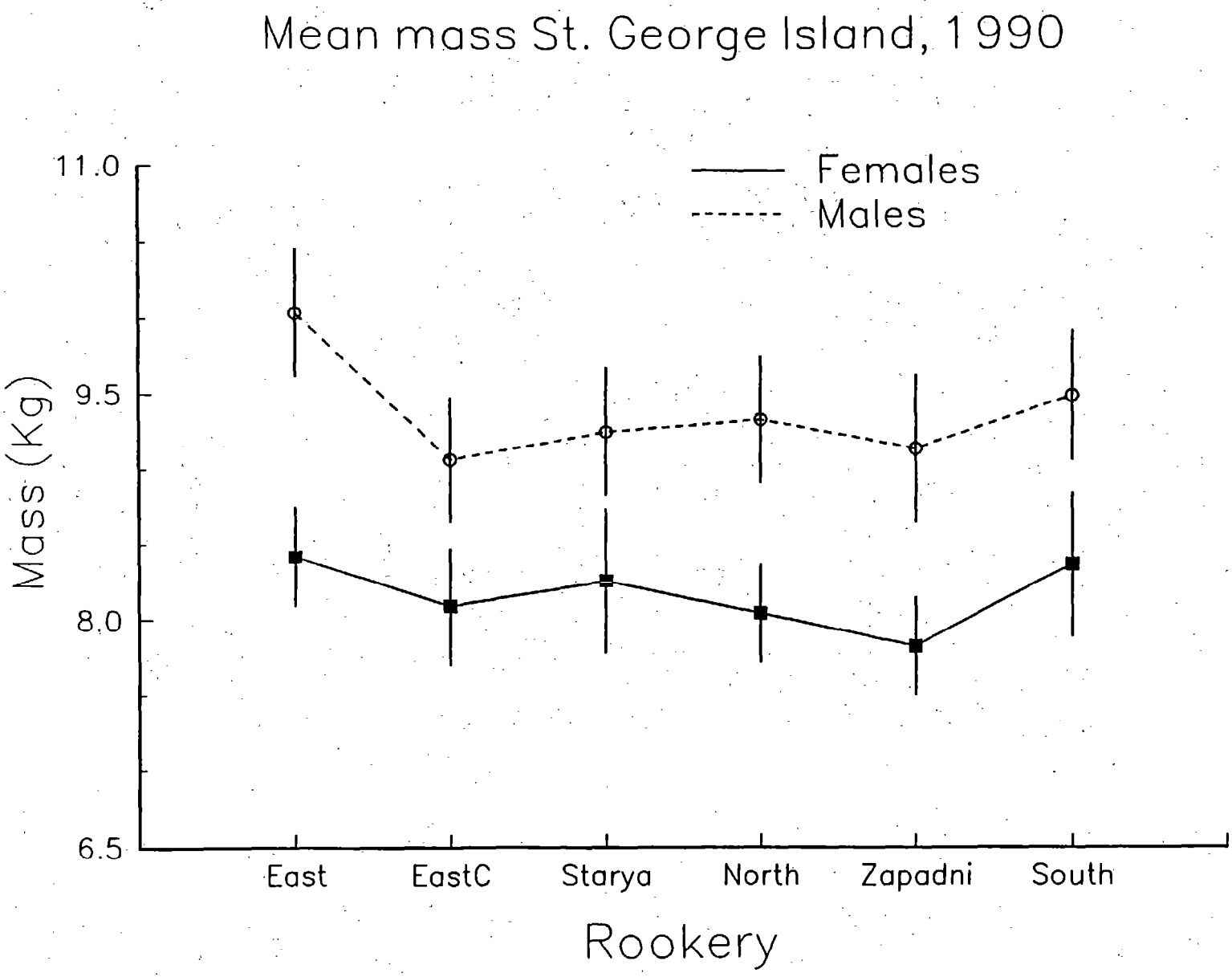


Figure 16. --Mean mass with 95% confidence intervals of northern fur seal pups weighed during tagging operations, August 1990, St. George Island, Alaska.

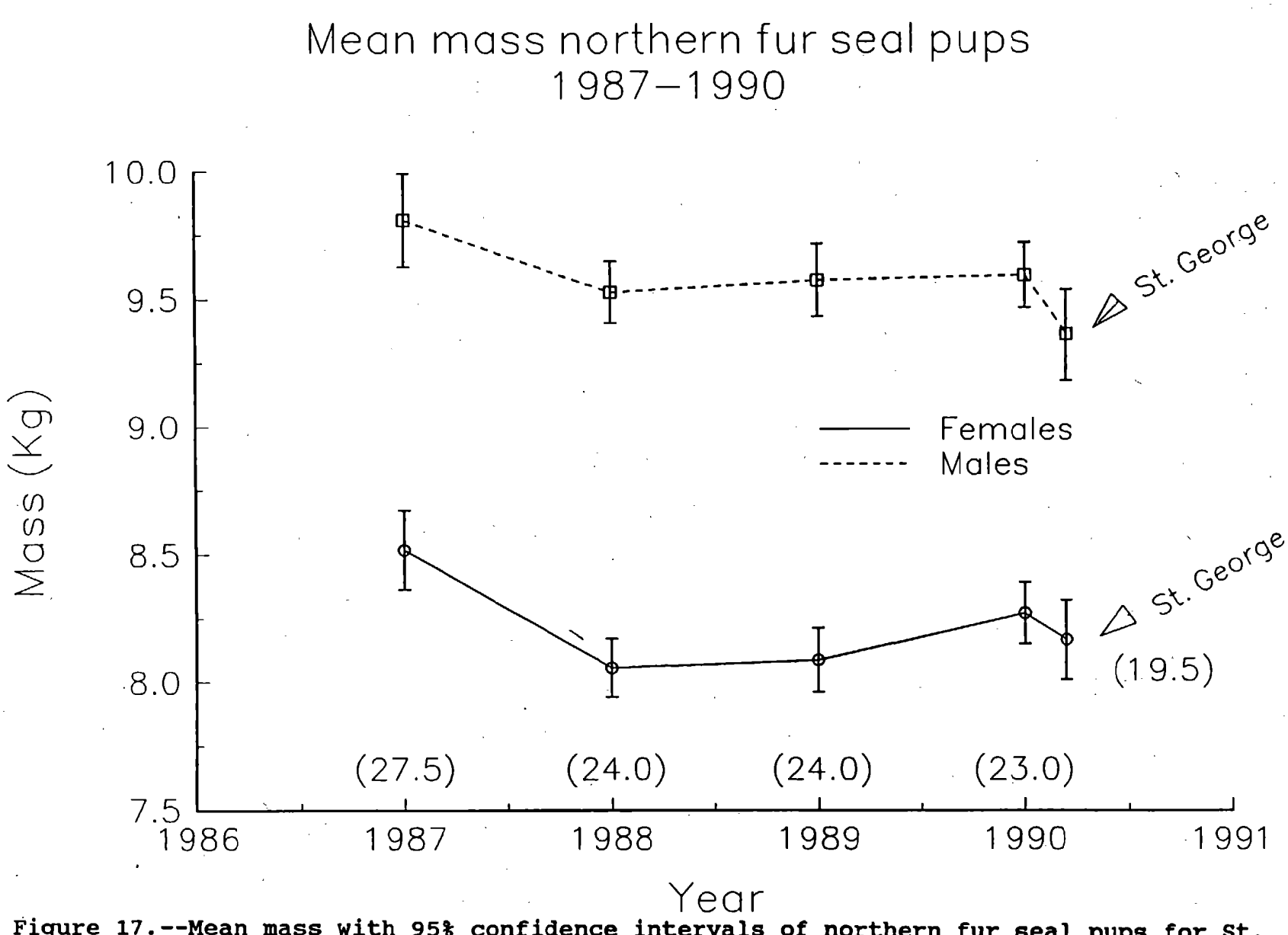


Figure 17.--Mean mass with 95% confidence intervals of northern fur seal pups for St. Paul Island, 1987-90, and St. George Island, 1990. Mean weighing date in August is enclosed in parenthesis.

Table 14. --Analysis of variance of mass for male and female northern fur seal pups on St. Paul Island, Alaska, 1990. The most-parsimonious (see text for details) model based on shearing status and rookeries is shown.

Source	Sum square	df	MSS	F	P
Females 1990 (Mean weight 8.110 kg, SE = 0.047 kg)					
Total	1,867.40	910			
Shearing	46.95	1	46.95	23.44	0.001
Rookery	65.98	11	6.00	3.07	0.001
Shear x Rookery	11.31	11	1.03	0.52	0.889
Residual	1,743.10	887	1.96		
Males 1990 (Mean weight 9.520 kg, SE = 0.059 kg)					
Total	2,801.80	902			
Rookery	87.85	11	7.99	2.62	0.003
Shearing	7.05	1	7.05	2.27	0.132
Residual	2,706.90	890	3.04		

MSS = Mean square error.

SE = Standard error.

Table 15. --Analysis of variance of the effects of sex and rookery on the mass of northern fur seal pups weighed on St. George Island, Alaska, 15 and 19 August 1990.

Source	df	Seq SS	MS	F	P
Sex	1	208.154	208.154	92.960	0.001
Rookery	5	37.928	7.586	3.388	0.005
Sex X Rookery	5	7.065	1.413	0.630	0.676
Error	588	1,316.640	2.239		
Total	599	1,569.787			

Seq SS - Sequential sum of squares.

MS - Mean square equals sequential sum of squares (Seq SS) divided by degrees of freedom (df).

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 14 and 15) indicate the following: 1) male and female weights are significantly different (P = 0.001, St. Paul; P = 0.001, St. George); 2) there are significant differences in average weights by rookery (P = 0.001, St. Paul; P = 0.007, St. George); 3) there are significant differences in average weights by shearirig status infemales (P = 0.001) but not in males (P =0.132) on St. Paul Island.-. The previously reported sex X rookery interaction is due to the larger difference between the mean weight of males and the mean weight of females on Lukanin, Kitovi, Reef, Gorbatch, and Morjovi rookeries as compared to other rookeries.

In order to compare the weights for 1990 with the 1987, 1988 and 1989 values, a separate analysis was carried out. The pup weight sampling procedure during the 4 years was not consistent. The number of animals weighed in each year are not necessarily proportional to the population size on the rookery; there are significant differences among rookeries, and neither tagging nor shearing-sampling, studies were conducted on the same rookeries each year. Therefore, mean weights for St. Paul Island were calculated for males and females for 1990 using the same method as in 1987 and 1988 (York and Antonelis 1990) and were compared to the previously calculated means for 1987-89. 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 4 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 (Table 16). These fractions are considered representative of the size of the pup population on each rookery and are independent of the weight data. The means for St. George Island were weighted using the fraction of pups, contributed by that rookery to the total number of pups on the island (Table 16). All rookeries on St. George Island but not all rookeries on St. Paul Island were shear sampled, thus the difference in weighting factors. 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 rookery.

The calculations were carried out in the following way: Let B_1, B_2,...B_{12} be the 1990 bull counts on the 12 rookeries where weighing studies were conducted all 4 years (1987-90). Let W_{ij} 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 12. Let V_{ij} be the variance for W_{ij}; V_{ij} is calculated as the square of the standard deviation (in Table- 12) divided by the sample size (from Table 12). For example, $V(1,1) = 1.56.4^2/28$. For each rookery, i, the fraction of bulls (f_i) 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:

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

Similar calculations were made for St. George, Island where B_i is replaced by P_i = number of pups (on a given rookery i). 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. Degrees of freedom are determined to be the total number of sample points (pups) in year 1, plus the total number of sample-points in year 2, less-the number of rookeries in year 1, less the number of rookeries in year 2.

The weighting factors (f_i in the above equations) are shown for 1990 in Table 16 (St. Paul Island and St. George Island). The estimated mean weights of pups and standard error for each sex for 1987-90 from St. Paul Island and for St. George Island 1990 are presented in Table 17. The calculated t-statistics for each year comparison are summarized in Table 18 with the highlighted values indicating a significant difference in mean weight between years or location in those comparisons including

Table 16. --Fraction of northern fur seal males contributed by each rookery to total breeding number of males on St. Paul Island, Alaska, (excluding Little Polovina and Ardiguen rookeries) and St. George Island, Alaska, for 1990.

Rookery	Fraction
St. Paul Island	
Lukanin	0.030
Kitovi	0.053
Reef	0.112
Gorbatch	0.083
Morjovi	0.079
Vostochni	0.181
Polovina	0.014
Polovina Cliffs	0.094
Tolstoi	0.127
Zapadni Reef	0.033
Little Zapadni	0.074
Zapadni	0.120
St. George Island	
East Reef	0.034
East Cliff	0.168
North	0.382
Starya Artil	0.085
Zapadni	0.156
South	0.175

Table 17. --Estimated mean mass (kg) (with its standard error) for northern fur seal female and male pups, St. Paul Island, Alaska, 1987-90 and St. George Island, Alaska, 1990.

	St. Paul				St. George
	1987	1988	1989	1990	1990
Females	8.518	8.057	8.087	8.270	8.103
SE	0.077	0.057	0.063	0.056	0.087
Males	9.811	9.531	9.577	9.594	9.299
SE	0.091	0.061	0.072	0.066	0.104

Table 18. --Calculated t-statistics for comparison-between years of mean mass of northern fur seals on St. Paul Island and St. George Island, Alaska. Significantly different years are in highlighted text.

	St. Paul			St. George
	1988	1989	1990	1990
Females				
1987	**-4.810**	**-4.330**	**-2.605**	**-3.572**
1988		0.353	**2.660**	0.442
1989			**2.171**	0.149
1990				-1.614
Males				
1987	**-2.556**	**-2.017**	-1.930	**-3.705**
1988		0.487	0.701	-1.924
1989			0.174	**-2.198**
1990				**-2.895**

mean mass comparisons for St. George Island, 1990. Male pups on St. Paul Island are significantly (P = 0.001) heavier than male pups on St. George Island for 1990. Female pups on St. Paul Island are marginally heavier (P = 0.053) than female pup weights on St. George Island. However, St. George Island pups were weighed up to 10 days earlier than the pups on St. Paul Island. The standard deviation of the mean weight of females was smaller than for that of males for all samples, Animals of both sexes were heaviest in 1987. Weights of females collected on St. Paul Island in 1990 were significantly lower in 1990 than 1987, and significantly' higher than 1988 and 1989. Although the ordering of weights across years was the same for males, the differences were not significantly different (P=0.05).

Sex Ratios

The fraction of female pups in samples collected on St. Paul Island are summarized by rookery and shearing status (Table 19). An analysis of the sex ratios was conducted by analyzing the fraction of female fur seals by rookery and shearing status (Table 20). The analysis was carried out using the General Linear Interactive Modelling (GLIM,) program assuming that the fraction of females in each section was a-binomial random variable. The logit of the fraction of females. [log,(p/(1-p)] was modelled as a linear function of rookery and shearing status. The results from that analysis. (Table 20) can be interpreted like an analysis of variance except that the significance of a factor is. judged by comparing the total sum of squares explained by that

Table 19.--Numbers of female pups, total number of pups, and fraction (that are female) of northern fur seal pups sampled during tagging operations on St. Paul Island, Alaska, 20-30 August 1990. The fraction of females is significantly less than 50% (P = 0.95) for highlighted items.

	Nonsheared animals			Sheared animals		
Rookery	Females	Total	Fraction	Females	Total	Fraction
Lukanin	94	216	0.435	23	44	0.523
Kitovi	95	197	0.482	8	15	0.533
Reef	**260**	**602**	**0.432**	**12**	**39**	**0.308**
Gorbatch	**180**	**405**	**0.444**	**20**	**48**	**0.417**
Ardiguen						
Morjovi	325	701	0.464	63	105	0.600
Vostochni	674	1355	0.497	115	234	0.491
Polovina	35	81	0.432	19	31	0.613
Polovina Cliffs	270	545	0.495	57	115	0.496
Tolstoi	**313**	**681**	**0.460**	**41**	**84**	**0.488**
Zapadni Reef	172	321	0.536	15	26	0.577
Little Zapadni	**229**	**540**	**0.424**	**25**	**68**	**0.368**
Zapadni	**292**	**640**	**0.456**	**47**	**104**	**0.452**
Total	2939	6284	0.468	445	913	0.487

Table 20. --Analysis of deviance for dependence of sex ratio on rookery and shearing status of northern fur seal pups on St. Paul Island, Alaska, 1990. Fraction of females was modelled as a general linear-model with binomial errors and logit link functions. The "reduction in deviance"' is the amount the residuals are reduced when the given factor is entered into the model in order of significance; the deviance is the weighted residual sum of squares for the model.

Factor	df	Deviance	df	Deviance reduction	P
Grand mean	23	43.08			
Rookeries	12	14.81	11	28.27	0.003
Shearing | Rookeries	11	13.97	1	00.84	0.359

factor with a chi-square random variable with degrees of freedom equal to the degrees of freedom of that factor.

When all categories are considered simultaneously, the addition of the rookery term reduces the deviance significantly (P = 0.003, Table 20). That is, one rejects the null hypothesis of no significant difference in the fraction of females among the rookeries on St. Paul Island. There is no significant difference in sex ratio between the sheared and nonsheared animals on St. Paul Island. Among the nonsheared animals, the-fraction of females was significantly less (P = 0.05) than 50% on Reef, Gorbatch, Tolstoi, Little Zapadni, and Zapadni rookeries; these items are highlighted in Table 19. The fraction of female& was not significantly different from 50% on the other rookeries.

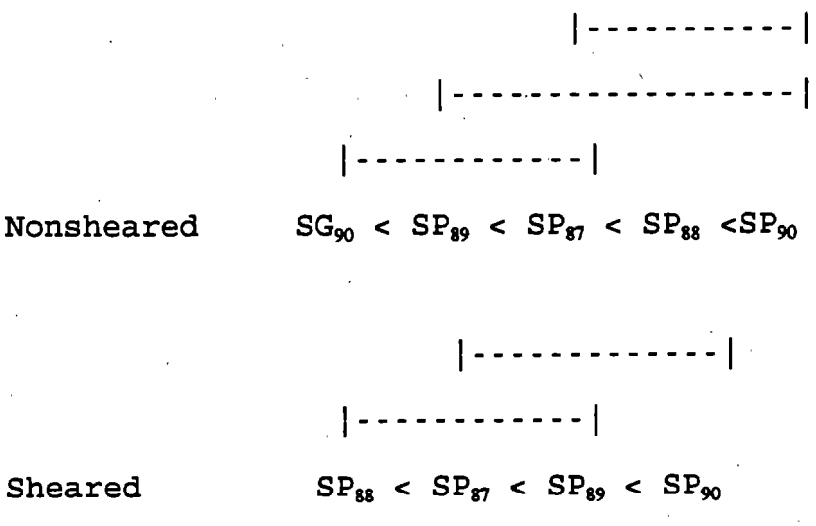
On St. George Island, there is no significant difference among rookeries (P = 0.072), but females comprise 41.7% (Table 13) of all animals which is significantly different than 50,% (exact binomial test, P = 0.001). Females comprised 47% (Table 19) of all animals on St. Paul Island; this fraction is significantly different from 50% (exact binomial test, P = 0.001).

The fraction of females captured during tagging operations in 1987-90 (St. Paul) and 1990 (St. George) are presented in Table 21. Fractions of sheared animals are presented for the St. Paul Island samples. The ordering of-frequency of females is shown below. A line joins groups whose sex ratios were not, significantly different from each other. For example, among the nonsheared animals the fraction of females in the St.-Paul Island

Table 21.--Numbers of female pups, total number of pups, and fraction (that are female) of northern fur seals captured during tagging operations on St. Paul Island and St. George Island, Alaska, for the years 1987-1990.

Location	Date	Nonsheared			Sheared		
		Females	Total	Fraction	Females	Total	Fraction
St. Paul	1987	484	1,063	0.455	51	130	0.392
	1988	1,051	2,228	0.472	22	69	0.319
	1989	1,102	2,422	0.455	54	119	0.454
	1990	754	1,526	0.494	157	288	0.545
St. George	1990	250	600	0.417	---	---	---

1990 sample (SP_{90}) was significantly greater than in the St. George Island 1990 sample (SG_{90}) but not significantly different from that of the St. Paul Island, 1987 (SP_{87}) sample.



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

SUMMARY

Consistent with data from 1987, 1988, and 1989, 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 1990 with that of 1987, 1988, and 1989, the pattern of differences among rookeries is not consistent across years. The average

weight of pups on St. Paul Island in 1990 was not significantly different from 1988 or 1989, but was significantly less than the 1987 samples. The St. Paul Island pups were heavier than the St. George Island pups but note that St. 'Paul Island pups were weighed up to 10 days later than St. George Island pups. The mean weight for St. Paul Island males was significantly heavier than St. George Island males. The mean weight for St. Paul Island females was heavier than St. George Island females but the difference was not significant.

PRELIMINARY INVESTIGATION OF AGE-SEX STRUCTURE OF NORTHERN FUR SEALS ON THE PRIBILOF ISLANDS, 1991

by

Valery A. Vladimirov and Victor S. Nikulin

We present preliminary results on the age structure of female northern fur seals on the Pribilof Islands based on our evaluation of their physical characteristics. We also report on the relationship between the estimated age of mothers and sex of their offspring and identify possible phenetic characteristics which might reflect intermixture between populations.

Assessment of external physical characteristics of northern fur seals is a promising tool in determining population parameters such as age, sex, and ultimately the dynamics of pup production and reproductive health of the population. During the 1991 summer breeding,season on the Pribilof Islands, we estimated the age of female fur seals by evaluating the length and color pattern of vibrissae, body size, size and color of the pelage on the chest and muzzle, amount of wear of lower canine teeth, and ear color (Nikulin unpubl. data). For pups the amount of pelage in the genital region, coloration of throat and chest and stomach pelage were used. to determine sex of individuals on different rookeries and the possible relationship between seals from different islands (Nikulin unpubl. data).

Age Structure of Female Fur Seals

The survey was conducted on St. Paul Island from l to 28 July on Reef, Vostochni, Polovina Cliffs, and Zapadni rookeries (Table 22). All rookeries were surveyed on St. George Island on 27 July (Table 23).

We categorized the age of females into groups of 3-4, 5-6, 7-8, 9-11, 12-15, and 15+ years of age based on pelage characteristics (Table 24) and found that the age composition of females on St. Paul. Island showed similarities to the Commander Islands (unpubl. data). Older females tend to arrive on rookeries earlier than younger females during the breeding season.

Differences in the age composition of female fur seals on St. George and St. Paul Islands were detected during the latter part of July. On July-27 on St. George Island, the proportion of females older than 12 years of age was 40% and females younger than 7 years of age comprised 27% of the sample. On St. Paul Island on July 28 the proportion -of females older than 12 years of age was 29%, and 40% of the females were youngerthan 7 years of age. The relatively higher percentage of younger females in the St. Paul Island population indicates that it may have a higher reproductive potential than the population on St. George Island. The degree to which these lower percentages of young females influence population growth on St. George Island is impossible to determine. Additional studies are recommended to determine the relationship between the age composition of females and pup production on the Pribilof Islands.

Table 22.--Age structure of female northern fur seals on St. Paul Island, 1991. Ages were determined by visual assessment of physical characteristics.

Rookery	Date	Female age groups (% composition)						Sample size (n)
		3-4	5-6	7-8	9-11	12-15	15+	
Reef	7/1	-	3.9	10.0	22.9	36.8	26.4	231
	7/3	1.4	6.5	9.6	19.5	27.0	36.0	292
	7/6	3.0	8.5	10.1	17.5	27.3	33.6	366
	7/8	3.3	15.4	14.8	22.5	25.1	18.9	454
	7/10	4.0	15.6	17.6	21.0	30.0	11.8	537
	7/12	3.2	14.9	15.1	23.8	28.1	14.9	496
	7/14	5.1	22.5	17.5	19.9	22.5	12.5	583
	7/16	8.9	22.3	17.5	24.4	17.9	9.0	667
	7/18	11.0	26.6	18.0	17.7	19.1	7.6	527
	7/20	7.6	24.1	22.0	15.9	21.0	9.4	477
	7/24	9.9	24.1	18.9	20.1	18.0	9.0	433
	7/28	15.1	24.2	15.6	15.5	21.8	7.8	794
Vostochni	7/2	2.6	13.0	8.4	23.4	31.8	20.8	154
	7/4	1.9	6.2	9.9	29.7	29.6	32.7	162
	7/7	2.3	7.9	20.7	20.3	28.9	19.9	266
	7/9	4.2	12.7	14.5	25.8	26.8	16.0	213
	7/11	4.8	14.7	14.1	26.7	27.3	12.3	333
	7/13	5.9	16.9	16.1	24.1	26.3	10.7	354
	7/15	7.9	13.5	17.2	24.9	22.8	13.7	378
	7/17	6.2	19.9	17.2	21.7	23.6	11.4	402

Table 22.--Continued.

Rookery	Date	Female age groups (% composition)						Sample size (n)
		3-4	5-6	7-8	9-11	12-15	15+	
	7/19	9.3	24.5	21.9	20.5	17.0	5.8	429
	7/21	8.1	23.4	23.7	17.7	18.7	8.4	418
	7/24	11.3	25.1	18.5	17.2	21.1	6.9	319
	7/28	19.8	23.8	16.4	12.6	20.7	6.7	542
Polovina Cliffs	7/6	1.1	11.5	21.9	11.5	25.3	28.7	87
	7/7	1.8	13.6	14.6	19.1	29.1	21.8	110
	7/9	3.5	10.5	15.8	20.2	29.8	20.2	114
	7/11	2.7	9.8	17.0	27.7	23.2	19.6	112
	7/13	3.2	13.8	18.1	18.6	26.6	19.7	181
	7/15	4.7	19.3	13.3	19.3	29.4	14.0	150
	7/17	9.0	17.0	18.5	18.0	26.0	11.5	200
	7/19	10.8	23.9	20.7	15.3	20.7	8.6	221
	7/21	9.3	19.5	27.6	14.8	20.3	8.5	236
	7/24	5.1	27.0	23.0	16.8	19.8	8.2	196
	7/28	9.6	22.3	19.7	15.4	22.9	10.1	188
Zapadni	7/9	2.1	14.9	14.9	29.8	19.1	19.1	47
	7/15	4.3	21.3	4.3	17.0	34.0	19.1	47
	7/20	7.7	27.7	18.5	13.8	20.0	12.3	65
	7/28	12.6	24.9	16.1	14.9	18.4	13.8	87
Total	7/28	15.9	23.8	16.4	14.5	21.4	8.0	1,610

Table 23.--Age structure of female northern fur seals on St. George Island, 1991. Ages were determined by visual assessment of pelagic characteristics 27 July 1991.

Rookery	Female age groups (% composition)						Sample size (n)
	3-4	5-6	7-8	9-11	12-15	15+	
South	14.9	19.9	6.6	17.4	19.2	21.7	161
Zapadni	11.5	19.2	12.8	15.4	24.3	16.7	78
Staraya Artil	11.9	13.0	8.7	14.1	28.3	23.9	92
North	11.4	16.9	15.9	16.9	24.7	14.3	313
East Reef	13.5	11.3	17.7	19.1	21.4	17.0	141
East Cliffs	7.7	14.8	14.8	16.2	34.5	12.0	142
Total	11.3	15.4	12.9	20.3	24.0	16.1	968

Table 24. --Age categories of female northern fur seals based on physical characteristics.

Age in years	Characteristics
3-4	Vibrissae dark, short length; body size small; light (straw brown) coloration of chest and muzzle; coloration of chest extends beyond the edge of the neck; coloration of muzzle extends beyond the posterior edge of the eye, width of coloration greater than-one-half the distance between the lower margin of the eye and the upper lip; canines small, sharp; ears dark brown.
5	Vibrissae mixed black and white coloration, medium length; body size medium/small; chest and muzzle coloration light (straw brown); coloration of chest extends beyond edge of neck; coloration of muzzle extends beyond the posterior edge of the eye, width of coloration is approximately one-half the distance between the lower margin of the eye and the upper lip; canines small, sharp; ears brown.
6	First order (longest) vibrissae white, but-with dark tips; shorter vibrissae (second order) are dark, medium length; body size medium/small; light (straw brown) chest and muzzle coloration; coloration of chest extends beyond edge of neck; coloration of muzzle extends beyond the posterior edge of the eye width of coloration is approximately one-half the distance between the lower margin of the eye and the upper lip; canines small,, sharp; ears brown.
7	First order (longest) vibrissae white, but the tips are tan (not dark) and second order vibrissae are tan, medium length; medium body size, light (straw brown) chest and vibrissae coloration; coloration of chest reaches the edge of the neck; coloration of muzzle reaches eye level, width of coloration is approximately one-half the distance between the lower margin of the eye and the upper lip; canines small, sharp; ears brown.

Table 24. --Continued.

8	First order (longest) vibrissae white, but tips and second order vibrissae are tan, medium length; medium body size; light (straw brown) chest and muzzle coloration; coloration of chest reaches the edge of the neck; coloration of muzzle within posterior and anterior margin of the eye, width of coloration is approximately one-half the distance between width of the lower margin of the eye and the upper lip; canines medium size, sharp; ears brown.
9-11	First order whiskers white, medium length, tips and second order vibrissae are tan, medium body ‘size; light (straw brown) chest and muzzle coloration; coloration of chest reaches the edge of the neck; coloration of muzzle within posterior and anterior margin of the eye, width of coloration is approximately one-half or less than one-half the distance between the lower margin of the eye and the upper lip; canines medium size, sharp; ears brown.
12-13	Vibrissae of all orders are white, long first order vibrissae; body sizes medium/large; chest and muzzle coloration light (straw brown) or tan; coloration of chest reaches the edge of the neck; coloration of muzzle within posterior and anterior margin of the eye, width of coloration is less- than one-half the distance between the lower margin of the eye and the upper lip; canines large,. sharp; ears brown.
14-15	Whiskers of all orders, are white, long first order vibrissae; body sizes medium/large; tan chest and muzzle coloration; chest coloration reaches the edge of the neck; coloration of muzzle reaches eye level, width of coloration is less than one-half the distance between the lower margin of the eye and the upper lip; canines large, moderately worn; ears brown or light-brown.
16-20 and older	All vibrissae are white and of various lengths; body size large; tan chest and muzzle coloration, chest coloration does not extend past the edge of the neck; coloration of muzzle extends within the anterior and posterior on margin of the eye, width of coloration is less than one-half the distance between the lower margin of the eye and the upper lip; coloration of muzzle may be brown or grey; canines severely worn or blunted; ears light-brown; large front flippers.

Color Patterns of Fur Seal Pups

The majority of newborn fur seal pups are overall black in color. However, variable shades from black to light brown are often evident on the ventral side of their body. This color variation can be used to determine sex and may be associated with stock origin.

Preliminary analyses of color patterns of fur seal pups on Vostochni and Reef rookeries indicate that color patterns of pups on the two rookeries-are similar (Table 25). Additionally, the color patterns of these pups were also similar to those of rookeries on Medny Island and dissimilar to those on Bering Island (Table 26). In addition, pups from the Tchazhnyy section on the Southeastern rookery (Medny Island), which are markedly different in color from all other Russian rookeries and sections, exhibit the, same color type as pups from St. George Island. The degree to which these phenotypic similarities reflects general mixing between different populations or rookeries remains-to be examined by using more sophisticatedtechniques. for evaluating population genetics (e.g., mDNA analysis).

Age of Females and Sex of Pups

One hundred and eight mother/pup pairs at Vostochni and Reef rookeries were examined visually with binoculars and a spotting, scope to estimate female age and to determine the sex of their offspring (Table 27). Although preliminary, these data indicate that females 4-6 years of age tend to give birth to female pups (86.1%), and females 12 years of age and older tend to give birth

Table 25. --Ventral color patterns of fur seal pups at Vostochni and Reef rookeries, St. Paul Island, 1991.

Color pattern	Males		Females		Total	
	n	%	n	%	n	%
Vostochni rookery						
DDD	87	74.4	54	51.9	141	63.8
DDB	23	19.7	39	37.5	62	28.1
BDB	6	5.1	10	9.6	16	7.2
BDL	-	-	1	1.0	1	0.45
LBL	1	0.8	-	-	1	0.45
Total	117	100	104	100	221	100
Reef rookery						
DDD	108	73.5	55	49.1	163	62.9
DDB	34	23.1	45	40.2	79	30.5
BDB	5	3.4	11	9.8	16	6.2
DDL	-	-	1	0.9	1	0.4
Total	147	100	112	100	259	100
Grand total	264		216		480	

Note: 1st letter - shade of throat area; 2nd letter - shade of chest; 3rd letter - shade of belly
D - dark brown
B - brown
L - light brown

Table 26.--Ventral color patterns of fur seal pups on Commander Island rookeries, 1986-1990.

Color pattern	Males		Females		Total	
	n	%	n	%	n	%
BERING ISLAND						
Northern rookery						
DDD	428	68.7	266	47.8	694	58.8
DDB	185	29.7	253	45.4	438	37.1
BDB	9	1.4	32	5.7	41	3.5
DBB	1	0.2	-	-	1	0.1
DDL	-	-	1	0.2	1	0.1
BDL	-	-	4	0.7	4	0.3
LDL	-	-	1	0.2	1	0.1
Total	623	100	557	100	1,180	100
North-Western rookery						
DDD	541	64.9	363	47.9	904	56.2
DDB	269	32.2	353	45.7	622	38.7
BDB	14	1.7	45	5.8	59	3.7
BBB	1	0.1	1	0.1	2	0.1
DBB	1	0.1	-	-	1	0.1
BDL	4	0.5	8	1.0	12	0.7
LDL	-	-	1	0.1	1	0.1
DDL	4	0.5	2	0.3	6	0.4
Total	834	100	773	100	1,607	100
MEDNY ISLAND						
South-Eastern rookery						
DDD	597	75.2	403	57.0	1,000	66.7
DDB	185	23.3	254	36.0	439	29.2
BDB	12	1.5	46	6.5	58	3.9
BDL	-	-	2	0.3	2	0.1
LBL	-	-	1	0.2	1	0.1
Total	794	100	706	100	1,500	100
South-Eastern rookery (main breeding area)						
DDD	317	70.8	209	51.4	526	61.5
DDB	121	27.0	163	40.0	284	33.2

Table 26. --Continued.

Color pattern	Males		Females		Total	
	n	%	n	%	n	%
BDB	10	2.2	33	8.1	43	5.1
BDL	-	-	2	0.5	2	0.2
Total	448	100	216	100	457	100
South-Eastern rookery (Tchazhnyy area)						
DDD	212	88.0	149	69.0	361	79.0
DDB	28	11.6	62	28.7	90	19.7
BDB	1	0.4	4	1.8	5	1.1
BDL	-	-	1	0.5	1	0.2
Total	241	100	216	100	457	100
Uril'ye rookery						
DDD	341	71.5	221	51.4	562	62.0
DDB	128	26.8	185	43.0	313	34.5
BDB	8	1.7	23	5.4	31	3.4
BDL	-	-	1	0.2	1	0.1
Total	477	100	430	100	907	100

Note: 1st letter - shade of throat area, 2nd letter - shade of chest;
3rd letter - shade of belly
D = dark brown
B = brown
L - light brown

Table 27. --Relationship between fur seal female ages and sex of their pups at Vostochni and Reef rookeries, St. Paul Island, 1991.

Age of females (n)	Sex of pups			
	Males		Females	
	n	%	n	%
4 (15)	2		13	
5-6 (21)	3	13.9	18	86.1
7-8 (24)	12		12	
9-11 (22)	12	52.2	10	47.8
12-15 (18)	10		8	
15+ (8)	5	57.7	3	42.3
Total (108)	44	40.7	64	59.3

to males (47.7%). Intermediate aged (9-11) females seem to give birth to pups in similar proportions of males (52.2%) and females (47.8%) (Table 27). This relationship between female age and sex of offspring has also been reported for fur seals on the Commander Islands and for other mammalian species (Vladimirov 1990). These and other preliminary impressions of seal age and sex and phenotypic relationships based on visual assessment require further investigation.

DISEASE STUDIES

by

Terry R. Spraker

As part of an ongoing disease monitoring study, 332 northern fur seal (Callorhinus ursinus) pups ranging-from term fetuses to 8 weeks were necropsied on St., Paul and St. George Islands, Alaska, during July and August 1991. Dead pups were collected daily and necropsied. The methods of study were gross pathology, serology, and bacteriology. No physiological data was taken and no drugs or medicalprocedures were conducted. on any of the animals.

Pathology

From 6 July through 7 August 248 pups were collected from Reef and Northeast Point rookeries. Eighty-four pups from Staraya Artil and Zapadni rookeries. on St. George Island were. collected and necropsied.

Emaciation was the most common cause of mortality accounting for 43% of the deaths. Trauma, both blunt and sharp, was the next most common at 12%, and infections accounted for about 10%. Stillborn, neonatal mortality, fetal anomalies, White Muscle Syndrome, and miscellaneous causes accounted for the. remaining 35%.

Emaciation

The causes of emaciation/malnutrition are numerous and include failure of the female to, find her pup after returning

from sea, death of the female at sea, sickness in female that results in little or no milk production, and sickness or trauma to the pups. It has also been shown that exposure to harsh weather exacerbates and hastens death with emaciation and malnutrition (Keyes 1965; Spraker et al. 1991).

Neonatal mortality

The rate of neonatal and stillborn mortality is high. Neonatal mortality is defined as pups that die within 12 hours of birth as determined by the amount of meconium in the colon. Causes of neonatal mortality included *Erysipelothrix* infection, trauma, and amniotic membrane retention.

Congenital anomalies

Six congenital anomalies were found this year: two from St. George Island and four from St. Paul Island. Two cases of scoliosis were found on St. Paul Island (sample numbers 91Cu33-P and 91Cu218-P), as well as an umbilical hernia which allowed total eviceration (91Cu9-P). A pup with agenesis of both humeri and partial agenesis and hypoplasia of the radii/ulni was found on St. Paul Island (91Cu84-P). One pup on St. George Island (91Cul0-G) had a persistent trunchus arteriosus (a common vessel for the pulmonary artery and aorta), a cardiovascular defect incompatible with extrauterine life. The second anomaly on St. George Island was difficult to understand but appeared to be some type of defect in the structure of the gall bladder. There was a bile duct atresia leading to a grossly enlarged gall bladder and bilistasis.

Serology

Three pups were tested for anitibodies to Brucella and Leptospira (serotypes: Canicola, Grippo, Hardjo, Ictero, and Pomona) and three sera were negative. All subadult (harvested) males (n = 70) were also tested for Leptospira and Brucella. With the exception of two low titer positives (1:50 and 1:200), all samples were negative.

Bacteriology

The results from the bacteriology revealed three major findings. The first was Erysipelothrix sp. isolated from samples taken on St. George Island from a stillborn (91Cu5-G) and a dead neonate (91Cu24-G), and from a stillborn (91Cu74-P) on St. Paul Island. Another important finding was beta-hemolytic Escherichia coli, which was isolated from 10 pups with pneumonia on St Paul Island. This suggests that aspiration of rookery mud may cause the E. coli infection. Finally, no significant bacteria were isolated from White Muscle Syndrome cases.

ENTANGLEMENT STUDIES, ST. PAUL ISLAND, 1991
JUVENILE MALE NORTHERN FUR SEALS

by
Charles W. Fowler, Rolf Ream,
Bruce Robson, and Masashi Kiyota

Entanglement in marine debris, specifically in plastics associated with the commercial fishing industry, has been implicated as a significant factor in population trends observed for northern fur seals (Callorhinus ursinus) on the Pribilof Islands, Alaska (Fowler 1982, 1987, 1988; Fowler et al. 1990b). The effects of entanglement in such debris on northern fur seals have been examined at the population level (Fowler 1982, 1985, 1987) and at the level of the individual (Fowler 1988). Studies of entanglement and mortality among fur seals have been conducted by the National Marine Mammal Laboratory (NMML), in cooperation with the National Research Institute of Far Seas Fisheries of Japan (Fowler and Baba 1991).

The objectives of this work are 1) continued monitoring of the proportion of the seal population entangled, 2) determination of the nature of entangling debris, 3) determination of the mortality caused by trawl webbing, especially as related to effects at the population level, and 4) comparison of the frequency of repeated sightings for entangled and nonentangled seals.

This report presents the results of field research conducted during 1991 in the study of entanglement and its impact on

juvenile male northern fur seals. Results of this, and previous work with which it is compared, focus on juvenile males (aged 2 to 5 years) from St. Paul Island, as the component of the population most readily studied.

METHODS

Entanglement among juvenile male northern fur seals is studied during roundups, as described in Antonelis (1992). During roundups,, seals are herded into a group and allowed to pass between observers who watch for animals with tags or entangling debris. When such seals are seen, the flow of seals is stopped while each tagged or entangled seal is captured and the relevant information (e.g., tag number, tag type, degree of wound, and type of debris) is recorded. Entangled seals and control animals are tagged. All work is conducted during the breeding season while animals congregate at, or near, breeding rookeries along the shoreline of the island.

As in previous years, the seals on which entanglement research is focused are those judged to be of the size historically taken in the commercial harvest (approximately 105-125 cm in total length). Unless indicated otherwise, data in this, report apply to juvenile (subadult) male seals of this size. The overall incidence of entanglement is estimated by the ratio of all (both initial and subsequent) entanglement sightings to the total number -of seals examined (Bengtson et al. 1988, Fowler et al. 1990b). In l991, the total count of juvenile males for one roundup on one area (Zoltoi Sands on 31 July) -was not

recorded. In calculating the incidence of entanglement, we substituted the mean number counted for the other roundups in that area for the missing count.

In 1991, as in 1989 and 1990, entangled seals were caught and tagged, the nature of each entanglement was recorded, tags were applied to previously untagged seals, and debris was removed from each entangled seal. This is in contrast to roundup. procedures in years prior to 1989 during which entangling debris was left on the animals. In addition to entanglement and tag data, characteristics of the entangling debris were also recorded, including the color, weight, and type of debris. The mesh and twine size were determined for net fragments and the length of materials such as packing bands and ropes was recorded. Samples were retained for future analysis. As in previous years of this study, two control seals about the same size as the entangled animal were also tagged to compare rates of return in succeeding years.

In comparing results from studies conducted before and after 1989, the removal of debris was taken into account. This was particularly important in calculating the proportion of seals entangled. Under circumstances prior to 1989, some of the resighted seals, having originally been entangled, would have died and not been observed. For entangled seals seen in 1989 and after, the debris was removed and the increased survival resulted in more being, resighted. To account for this, and to make the data comparable, we used the estimated survival of seals entangled in small debris (50% from past studies: Fowler 1984,

1985, 1987; Fowler et al. 1989, 1990a,b; Fowler and Ragen 1990). The number. of seals resighted after having had their debris removed in 1989 and 1990 was multiplied by this value. Half of the resighted seals from which debris had beenremoved in 1990, for example were assumed to have been seals that would have been resighted as entangled seals in 1991 and would thus contribute to the observed proportion entangled. This number, corrected for growth (below), was added to the number of seals observed entangled.

The growth of seals was also taken into account, as some of the surviving tagged seals were too large to meet the size criteria above. Estimates of the incidence of entanglement from 1990 presented in Fowler and Baba (1991) were biased slightly upwards from the-lack of data to adjust for-this factor including the tagged seals that had been entangled at the time of tagging., In 1991, the size of a sample of the resighted seals tagged in 1990 and 1989 was recorded and used to estimate the portion of tagged seals that meet the size criteria 1 and 2 years after being tagged. Only that portion of tagged seals within the designated size criteria were included. in the count of entangled, seals in this report.

Because some animals are rounded up more than once, the sampling scheme for both control and entangled seals is one of sampling with replacement (i.e., counting the repeated resights). This is to be compared to the methods used in estimating the incidence of entanglement from the commercial harvest (prior to

1985). in which both entangled and nonentangled seals were killed and, therefore, not counted again.

Analytical methods used in the analyses of resight data to estimate the survival rate of entangled seals are presented in the Appendix of Fowler and Baba (1991), as modifications of those used by Fowler and Ragen (1990) and Fowler et al. (1990b).

RESULTS

Roundups

One hundred and one roundups of subadult male northern fur seals were completed on St. Paul Island during July and early August of 1991 (Table 28). During these roundups, 22,524 male seals judged to be of the size historically taken in the commercial harvest were counted. This total includes an estimated 251 (± 109, 0.05 confidence interval) for Zoltoi Sands on, 31 July.

As in previous years, and based on counts of resighted tagged seals (Fowler and Baba 1991), about 25-30% of each of the total counts were repeat sightings. In all, 33 entangled subadult male seals judged to meet the size criteria were captured and double-tagged with numbered green Allflex tags bearing the address of the NMML (Table 29). One entangled seal, tagged with narrow white Allflex tags numbered 5524 was also captured and the debris removed. A total of 68 similarly sized-control seals with no entangling debris were tagged (Table 29).

Table 28. --Summary of roundups of juvenile (subadult) northern fur seal males conducted on St. Paul Island, Alaska, during July and August of 1991, including the number of both the control and entangled seals in the total tagged.

Date	Location	Total[a] in roundup	Tagged seals[b] resighted	Total seals tagged
7/5	Zoltoi Sands	254	7	0
7/5	Tolstoi	111	2	0
7/3	Zapadni Reef Sands	171	4	0
7/3	Zapadni Reef Sands	89	0	0
7/3	Tolstoi	45	1	0
7/7	Zapadni Sands	923	32	6
7/8	Polovina	379	9	0
7/8	Polovina	38	1	0
7/8	Polovina	31	1	0
7/8	Lukanin	155	9	0
7/8	Kitovi	150	9	0
7/9	Vostochni	263	12	0
7/9	Vostochni	25	0	0
7/9	Vostochni	245	11	0
7/9	Morjovi	230	4	0
7/9	Morjovi	119	6	0
7/9	Morjovi	158	5	0
7/10	Reef	134	4	0
7/10	Gorbatch	248	10	0
7/10	Reef	19	0	0
7/10	Zoltoi Sands	297	8	0
7/11	Zapadni Reef Sands	561	25	0
7/11	Tolstoi	209	13	3
7/12	Zapadni Sands	229	9	0
7/12	Zapadni	134	6	0
7/12	Zapadni	192	7	0
7/12	Zapadni	45	4	0
7/13	Polovina	434	13	0
7/13	Polovina	31	1	0
7/13	Lukanin	292	13	3
7/13	Kitovi	51	5	0
7/15	Vostochni	198	11	0
7/15	Vostochni	129	5	2
7/15	Vostochni	264	15	0
7/15	Vostochni	114	2	0
7/15	Morjovi	266	7	0
7/15	Morjovi	234	8	0
7/15	Morjovi	118	5	0
7/16	Reef	221	2	0
7/16	Gorbatch	683	22	1
7/16	Zapadni Reef Sands	89	6	0
7/17	Tolstoi	239	12	0

Table 28. --Continued.

Date	Location	Total[a] in roundup	Tagged seals[b] resighted	Total seals tagged
7/17	Zapadni Sands	659	22	0
7/17	Zapadni	417	18	3
7/18	Little Polovina	152	11	0
7/18	Little Polovina	135	7	0
7/18	Polovina	353	17	0
7/18	Polovina	308	18	3
7/19	Zoltoi Sands	153	9	2
7/19	Kitovi	114	13	0
7/19	Little Zapadni	45	3	0
7/19	Zapadni Reef	94	7	0
7/20	Vostochni Sands	40	2	0
7/20	Vostochni	127	2	3
7/20	Vostochni	21	0	0
7/20	Vostochni	205	9	3
7/20	Vostochni	222	5	0
7/20	Morjovi	213	10	0
7/20	Morjovi	397	21	0
7/21	Lukanin	560	23	4
7/21	Zapadni Reef Sands	139	3	7
7/22	Reef	85	5	6
7/23	Gorbatch	1,014	32	0
7/23	Tolstoi	147	9	0
9/24	Zapadni	122	7	0
9/24	Zapadni	626	15	3
7/25	Zoltoi Sands	299	16	0
7/25	Little Polovina	119	2	0
7/25	Little Zapadni	185	11	0
7/25	Zapadni Reef	301	13	0
7/26	Vostochni Sands	91	3	0
7/26	Vostochni	79	3	0
7/26	Vostochni	171	3	6
7/26	Vostochni	223	13	3
7/26	Vostochni	36	1	0
7/26	Morjovi	140	2	0
7/26	Morjovi	241	10	1
7/27	Zapadni Reef Sands	46	2	5
7/27	Polovina	190	8	3
7/27	Polovina	234	14	3
7/28	Lukanin	195	12	0
7/28	Kitovi	91	12	3
7/29	Reef	138	3	0
7/29	Gorbatch	586	25	3
7/29	Tolstoi	146	9	3
7/30	Zapadni	272	13	4
7/31	Zoltoi Sands[c]	251	8	0

Table 28.--Continued.

Date	Location	Total[a] in roundup	Tagged seals[b] resighted	Total seals tagged
7/31	Little Zapadni	97	5	0
7/31	Zapadni Reef	130	6	0
7/31	Little Polovina	282	14	3
8/1	Morjovi	420	15	4
8/1	Morjovi	216	14	1
8/1	Vostochni	187	5	0
8/2	Polovina	526	19	3
8/2	Lukanin	363	16	0
8/2	Kitovi	68	7	0
8/2	Zapadni Reef Sands	120	5	3
8/3	Reef	151	7	0
8/3	Gorbatch	248	13	0
8/3	Gorbatch	463	16	3
8/3	Tolstoi	54	1	1
	Totals	22,524	920	101

[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 (including monel tags applied to pups in 1987, 1988, or 1989) in either foreflipper and that were successfully restrained to read the tag. Includes any that were resighted more than once this year.

[c]The total count for this roundup is the mean for the counts from the other roundups conducted in the same location for 1991.

Table 29.--List of green broad-banded Allflex tags applied to northern fur seals during roundups conducted on-St. Paul Island, Alaska, 1991. The first tag number was applied to the left flipper, the second to the right. Entangling debris. was removed from entangled seals prior to their being released.

Tag number	Date	Sex	Location	Entangled (e) Control (c)
001	7/6	F	Zapadni Reef	-[a]
002	7/6	F	Zapadni Reef	-[a]
003-004	7/7	M	Zapadni Sands	e
005-006	7/7	M	Zapadni Sands	e
007-008	7/7	M	Zapadni Sands	c
009-010	7/7	M	Zapadni Sands	c
011-012	7/7	M	Zapadni Sands	c
013-014	7/7	M	Zapadni Sands	c
015-016	7/11	M	Tolstoi	e
017-018	7/11	M	Tolstoi	c
019-020	7/11	M	Tolstoi	c
021-022	7/13	M	Lukanin	e
023-024	7/13	M	Lukanin	c
025-026	7/13	M	Lukanin	c
027-028	7/15	M	Vostochni	c
029-030	7/15	M	Vostochni	c
031-032	7/16	M	Gorbatch	e
033-034	7/17	M	Zapadni	e
035-036	7/17	M	Zapadni	c
037-038	7/17	M	Zapadni	c
039-040	7/18	M	Polovina	e
041-042	7/18	M	Polovina	c
043-044	7/18	M	Polovina	c
045-046	7/18	M	Polovina	e
051-052	7/19	M	Zapadni Reef	e
053-054	7/19	M	Zapadni Reef	c
055-056	7/19	M	Zapadni Reef	c
047-048	7/19	M	Zoltoi Sands	c
049-050	7/19	M	Zoltoi Sands	c
057-058	7/20	M	Vostochni	e
059-060	7/20	M	Vostochni	c
061-062	7/20	M	Vostochni	c
063-064	7/20	M	Vostochni	e
065-066	7/20	M	Vostochni	c
067-068	7/20	M	Vostochni	e
069-070	7/20	M	Vostochni	e
071-072	7/21	M	Lukanin	c
073-074	7/21	M	Lukanin	c
075-076	7/21	M	Lukanin	c

Table.29. --Continued.

Tag number	Date	Sex	Location	Entangled (e) Control (c)
077-078	7/21	M	Lukanin	e
079-080	7/21	M	Zapadni Reef Sands	c
081-082	7/21	M	Zapadni Reef Sands	c
083-084	7/21	M	Zapadni Reef Sands	c
085-086	7/21	M	Zapadni Reef Sands	c
087-088	7/21	M	Zapadni Reef Sands	e
089-090	7/21	M	Zapadni Reef Sands	c
091-092	7/21	M	Zapadni Reef Sands	c
093-094	7/22	M	Reef	e
095-096	7/22	M	Reef	c
097-098	7/22	M	Reef	c
099-100	7/22	M	Reef	c
101-102	7/22	M	Reef	c
103-104	7/24	M	Zapadni	c
105-106	7/24	M	Zapadni	e
107-108	7/24	M	Zapadni	c
127-128	7/26	M	Morjovi	e
109-110	7/26	M	Vostochni	e
111-112	7/26	M	Vostochni	e
113-114	7/26	M	Vostochni	c
115-116	7/26	M	Vostochni	c
117-118	7/26	M	Vostochni	c
119-120	7/26	M	Vostochni	c
121-122	7/26	M	Vostochni	e
124-123	7/26	M	Vostochni	c[b]
125-126	7/26	M	Vostochni	c
139-140	7/27	M	Polovina	e
141-142	7/27	M	Polovina	c
143-144	7/27	M	Polovina	c
145-146	7/27	M	Polovina	e
147-148	7/27	M	Polovina	c
149-150	7/27	M	Polovina	c
129-130	7/27	M	Zapadni Reef Sands	e
131-132	7/27	M	Zapadni Reef Sands	c
133-134	7/27	M	Zapadni Reef Sands	c
135-136	7/27	M	Zapadni Reef Sands	c
137-138	7/27	M	Zapadni Reef Sands	c
151-152	7/28	M	Kitovi	e
153-154	7/28	M	Kitovi	c
155-156	7/28	M	Kitovi	c
157-158	7/29	M	Gorbatch	e
159-160	7/29	M	Gorbatch	c
161-162	7/29	M	Gorbatch	c
163-164	7/29	M	Tolstoi	e

Table 29.--Continued.

Tag number	Date	Sex	Location	Entangled (e) Control (c)
165-166	7/29	M	Tolstoi	c
167-168	7/29	M	Tolstoi	c
169-170	7/30	M	Zapadni Sands	e[c]
171-172	7/30	M	Zapadni Sands	e
173-174	7/30	M	Zapadni Sands	c
175-176	7/30	M	Zapadni Sands	c
177-178	7/31	M	Little Polovina	e
179-180	7/31	M	Little Polovina	c
181-182	7/31	M	Little Polovina	c
183-184	8/1	M	Morjovi	e[c]
185-186	8/1	M	Morjovi	e
187-188	8/1	M	Morjovi	c
189-190	8/1	M	Morjovi	c
191-192	8/1	M	Morjovi	e[c]
193-194	8/2	M	Polovina	e
195-196	8/2	M	Polovina	c
197-198	8/2	M	Polovina	c
199-200	8/2	M	Zapadni Reef Sands	e
201-202	8/2	M	Zapadni Reef Sands	c
203-204	8/2	M	Zapadni Reef Sands	c
205-206	8/3	M	Gorbatch	e
207-208	8/3	M	Gorbatch	c
209-210	8/3	M	Gorbatch	c
211-212	8/3	M	Tolstoi	e[d]

[a]Female seal tagged with radio transmitters for behavioral or feeding studies by Japanese biologists. Only one tag applied (to the left flipper).
[b]Tags reversed in numerical order on the flippers of this seal.
[c]This seal was judged to be too large to meet the size criteria.
[d]This seal died immediately after being freed of its debris. No control seals were tagged.

Tagged Seals from Previous Years

Ninety-nine seals which had been tagged during entanglement. research in previous years were resighted in 1991. (Table 30). Of these, 21 had Allflex tags applied in 1985, 1986, and 1988. Twenty of the 21 resighted seals were tagged in previous years as, controls. One had been entangled when tagged and had lost its entangling debris. The debris that was lost had been noted as being medium in size (150-500 g in estimated weight) at the first sighting of the seal.

Eighteen were resighted with tags applied in 1989, the first year during which debris was removed. Of these, 14 had been tagged as controls and 4 had been tagged after being disentangled. Sixty individual seals were resighted with tags applied in 1990, the second year during which debris was removed from entangled juvenile male seals. Of these, 39 had been tagged as-controls and 21 had been tagged after being disentangled.

Incidence of Entanglement.

We examined 38 entangled juvenile male seals in the 1991 roundups (the 33 seals newly tagged and 1 previously tagged, as mentioned above, and 3 that were judged to be larger than historically harvested,and 1 that died) to remove and determine the nature of their entangling debris. The sizes and kinds of entangling debris, the extent of any wounds, and the tightness of the entangling debris on the animal are presented in Table 31. A key to the tags applied during the 1990 field season is provided in Table 29. Of the 38 entangled seals examined, 12 (31.6%) were

Table 30.--List of tagged northern fur seals seen during July juvenile male roundup activities on St. Paul Island, 1991. Tags were seen on both foreflippers unless noted otherwise. Debris was removed from entangled seals.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/3	Tolstoi	6	Allflex	blue	c	Tagged July 16, 1988, on Zapadni.
7/3	Zapadni Reef Sands	132	Allflex	blue	c	Tagged July 29, 1988 on Vostochni.
7/3	Zapadni Reef Sands	1167	Allflex	orange	c	Tagged July 15, 1989, on Zapadni Reef Sands.
7/5	Tolstoi	1180	Allflex	orange	c	Tagged July 15, 1989 on Reef.
7/5	Zoltoi Sands	0703	Allflex	orange	c	Tagged Aug. 24, 1989 on Reef.
7/5	Zoltoi Sands	1182	Allflex	orange	c	Tagged July 15, 1989 on Reef.
7/7	Zapadni Sands	0734	Allflex	orange	c	Tagged August 24, 1986 on Vostochni.
7/7	Zapadni Sands	1213	Allflex	orange	c	Tagged July 18, 1990 on Vostochni.
7/7	Zapadni Sands	1250	Allflex	orange	c	Tagged July 23, 1989 on Polovina.
7/7	Zapadni Sands	1317	Allflex	white	e'	Tagged July 11, 1990 on Zapadni Sands.
7/7	Zapadni Sands	1362	Allflex	white	c	Tagged July 17, 1990 on Zapadni Reef Sands.
7/7	Zapadni Sands	1444	Allflex	white	c	Tagged July 26, 1990 on Zapadni Sands.
7/7	Zapadni Sands	1460	Allflex	white	c	Tagged July 27, 1990 on Reef.
7/8	Kitovi	0094	Allflex	orange	c	Tagged July 24, 1985 on Morjovi.
7/8	Kitovi	1182	Allflex	orange	c	Tagged July 15, 1989 on Reef.
7/8	Kitovi	1298	Allflex	orange		Adult male. From study in progress on Kitovi; only rear flippers tagged.
7/8	Kitovi	1417	Allflex	white	c	Tagged July 6, 1990 on Lukanin.
7/8	Kitovi	MK2808	Monel			Soviet tag. Missing tag on right.
7/8	Lukanin	1341	Allflex	white	c	Tagged July 16, 1990 on Gorbatch.
7/8	Polovina	1416	Allflex	white	c	Tagged July 6, 1990 on Lukanin.
7/9	Vostochni	94	Allflex	blue	c	Tagged July 26, 1988 on Morjovi. Missing left tag.
7/9	Vostochni	131	Allflex	blue	c	Tagged July 29, 1988 on Vostochni.

Table 30.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/9	Vostochni	1240	Allflex	orange	c	Tagged July 22, 1989 on Kitovi.
7/9	Vostochni	1383	Allflex	white	e'	Tagged July 22, 1990 on Vostochni.
7/9	Vostochni	1388	Allflex	white	c	Tagged July 22, 1990 on Vostochni.
7/9	Vostochni	1468	Allflex	white	c	Tagged July 28, 1990 on Vostochni.
7/9	Vostochni	1476	Allflex	white	e'	Tagged July 29, 1990 on Polovina.
7/9	Vostochni	MH391	Monel			Soviet tagged animal. Missing left tag.
7/9	Vostochni	XM7440	Monel			Soviet tagged animal.
7/10	Gorbatch	1456	Allflex	white	c	Tagged July 27, 1990 on Reef.
7/10	Reef	1340	Allflex	white	e'	Tagged July 16, 1990 on Gorbatch.
7/10	Reef	1460	Allflex	white	c	Tagged July 27, 1990 on Reef.
7/10	Zoltoi Sands	1174	Allflex	white	c	Tagged July 15, 1990 on Gorbatch.
7/11	Tolstoi	1211	Allflex	orange	e'	Tagged July 8, 1989 on Vostochni.
7/11	Tolstoi	1257	Allflex	orange	c	Tagged July 23, 1989 on Zapadni.
7/11	Tolstoi	1435	Allflex	white	c	Tagged July 26, 1991 on Lukanin.
7/11	Zapadni Reef Sands	007	Allflex	green	c	Tagged July 7, 1991 on Zapadni Sands.
7/11	Zapadni Reef Sands	009	Allflex	green	c	Tagged July 9, 1991 on Zapadni Sands.
7/11	Zapadni Reef Sands	1314	Allflex	white	c	Tagged July 9, 1990 on Zapadni Reef Sands.
7/11	Zapadni Reef Sands	1319	Allflex	white	c	Tagged July 19, 1990 on Zapadni Sands.
7/11	Zapadni Reef Sands	1352	Allflex	white	e'	Tagged July 17, 1990 on Vostochni.
7/11	Zapadni Reef Sands	1416	Allflex	white	c	Tagged July 6, 1990 on Lukanin.
7/11	Zapadni Reef Sands	1474	Allflex	white	c	Tagged July 29, 1990, on Polovina. Harvestable size.
7/12	Zapadni	007	Allflex	green	c	Tagged July 7, 1991 on Zapadni Sands.
7/12	Zapadni	019	Allflex	green	c	Tagged July 11, 1991 on Tolstoi.

Table 30.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/12	Zapadni	1317	Allflex	white	e[r]	Tagged July 11, 1990 on Zapadni Sands.
7/12	Zapadni	1319	Allflex	white	e[r]	Tagged July 11, 1990 on Zapadni Sands.
7/12	Zapadni	1440	Allflex	white	e[r]	Tagged July 26, 1990 on Zapadni Sands.
7/12	Zapadni Sands	0464	Allflex	orange	c	Tagged July 24, 1986 on Zapadni.
7/12	Zapadni Sands	1472	Allflex	white	c	Tagged July 28, 1990 on Vostochni.
7/13	Lukanin	1417	Allflex	white	c	Tagged July 6, 1990 on Lukanin.
7/13	Polovina	1257	Allflex	orange	c	Tagged July 23, 1989 on Zapadni.
7/15	Morjovi	80	Allflex	blue	c	Tagged July 25, 1988 on Tolstoi.
7/15	Morjovi	1208	Allflex	orange	c	Tagged July 18, 1989 on Polovina.
7/15	Morjovi	1331	Allflex	white	c	Tagged July 13, 1990 on Polovina.
7/15	Morjovi (NEP)	57	Allflex	blue	c	Tagged July 20, 1988 on Vostochni.
7/15	Morjovi (NEP)	0716	Allflex	orange	c	Tagged July 24, 1986 on Vostochni. Missing right tag.
7/15	Vostochni	131	Allflex	blue	c	Tagged July 29, 1988 on Vostochni.
7/15	Vostochni	133	Allflex	blue	c	Tagged July 29, 1988 on Vostochni.
7/15	Vostochni	1386	Allflex	white	c	Tagged July 22, 1990 on Vostochni. Harvestable size.
7/15	Vostochni (Sands)	1392	Allflex	white	c	Tagged July 22, 1990 on Vostochni. Too large to count.
7/15	Vostochni (Sands)	1393	Allflex	white	c	Tagged July 22, 1990 on Vostochni.
7/15	Vostochni (Sands)	1420	Allflex	white	e[r]	Tagged July 7, 1990 on Vostochni.
7/15	Vostochni (Sands)	1476	Allflex	white	e[r]	Tagged July 29, 1990 on Polovina. Showed a significant scar.
7/16	Gorbatch	009	Allflex	green	c	Tagged July 9, 1991 on Zapadni Sands.
7/16	Gorbatch	1242	Allflex	orange	c	Tagged July 23, 1989 on Lukanin. Too large to count.
7/16	Gorbatch	1435	Allflex	white	c	Tagged July 26, 1990 on Lukanin.

Table 30.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/16	Zapadni Reef Sands	1364	Allflex	white	e'	Tagged July 17, 1990 on Zapadni Reef Sands.
7/17	Tolstoi	MK2808	Monel			Soviet tagged animal. Missing tag on right.
7/17	Zapadni	023	Allflex	green	c	Tagged July 13, 1991 on Lukanin.
7/17	Zapadni	141	Allflex	blue	c	Tagged July 30, 1988 on Zapadni.
7/17	Zapadni	1192	Allflex	orange	c	Tagged July 16, 1989 on Zapadni Sands.
7/17	Zapadni Sands	011	Allflex	green	c	Tagged July 7, 1991, on Zapadni Sands.
7/17	Zapadni Sands	1211	Allflex	orange	e'	Tagged July 18, 1989, on Vostochni.
7/17	Zapadni Sands	1264	Allflex	orange	e'	Tagged July 24, 1989 on Zapadni.
7/17	Zapadni Sands	1336	Allflex	white	c	Tagged July 15, 1990, on Reef. Too large to count.
7/17	Zapadni Sands	1353	Allflex	white	e'	Tagged July 17, 1990, on Morjovi.
7/17	Zapadni Sands	1472	Allflex	white	c	Tagged July 28, 1990, on Vostochni.
7/18	Polovina	1374	Allflex	white	c	Tagged July 21, 1990, on Vostochni.
7/18	Polovina	1399	Allflex	white	e'	Tagged July 24, 1990, on Vostochni.
7/18	Polovina	1427	Allflex	white	c	Tagged July 25, 1990, on Tolstoi. Harvestable size.
7/18	Polovina	1457	Allflex	white	c	Tagged July 27, 1990, on Reef. Harvestable size.
7/19	Kitovi	1240	Allflex	orange	c	Tagged July 22, 1990, on Kitovi.
7/19	Zapadni Reef	1361	Allflex	white	c	Tagged July 17, 1990, on Zapadni Reef Sands.
7/19	Zoltoi Sands	120	Allflex	blue	c	Tagged July 29, 1988, on Vostochni.
7/20	Morjovi	027	Allflex	green	c	Tagged July 15, 1991, on Vostochni.

Table 30.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status	Notes
7/20	Morjovi	1390	Allflex	white	e'	Tagged July 22, 1990, on Vostochni.
7/20	Morjovi	1430	Allflex	white	c	Tagged July 25, 1990, on Tolstoi.
7/20	Morjovi	1466	Allflex	white	c	Tagged July 28, 1990, on Vostochni.
7/20	Morjovi	bK3304	Monel			Soviet tagged seal. Right tag missing.
7/20	Morjovi	MH265	Monel			Soviet tagged seal.
7/20	Vostochni	130	Allflex	blue	c	Tagged July 29, 1988 on Vostochni.
7/20	Vostochni	1360	Allflex	white	c	Tagged July 17, 1990, on Zapadni Reef Sands.
7/20	Vostochni	1367	Allflex	white	c	Tagged July 17, 1990, on Zapadni Reef Sands.
7/20	Vostochni	1393	Allflex	white	e'	Tagged July 22, 1990, on Vostochni.
7/20	Vostochni	1476	Allflex	white	e'	
7/20	Vostochni	1485	Allflex	white	c	Tagged Aug. 2, 1990, on Vostochni.
7/20	Vostochni Sands	1371	Allflex	white	c	Tagged July 18, 1990, on Tolstoi Sands. Harvestable size.
7/21	Lukanin	1364	Allflex	white	e'	Tagged July 17, 1990, on Zapadni Reef Sands.
7/21	Lukanin	bH3487	Monel			Left tag was missing.
7/22	Reef	5524	Allflex	white	e	This seal is not part of the entanglement research collection. Two controls were taken and the animal was disentangled but not retagged with green tags. The original tags were narrow white Allflex. The seal's weight was 67 lbs and it had black vibrissae.
7/23	Gorbatch	0003	Allflex	orange	c	Tagged July 9, 1985, on Gorbatch. Too large to count. Size of a mature bull.

Table 30.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/23	Gorbatch	1338	Allflex	white	c	Tagged July 15, 1990, on Reef. Too large to count.
7/23	Gorbatch	1457	Allflex	white	c	Tagged July 27, 1990, on Reef. Harvestable size.
7/23	Tolstoi	0224	Allflex	orange	c	Tagged Aug. 9, 1985, on Tolstoi.
7/24	Zapadni	083	Allflex	green	c	Tagged July 21, 1990, on Zapadni Reef Sands.
7/24	Zapadni	1252	Allflex	orange	c	Tagged July 23, 1989, on Little Zapadni. Too large to count.
7/24	Zapadni	1387	Allflex	white	c	Tagged July 22, 1990, on Vostochni. Harvestable size.
7/24	Zapadni	1486	Allflex	white	c	Tagged Aug. 3, 1990, on Vostochni. Harvestable size.
7/24	Zapadni	1487	Allflex	white	e[f]	Tagged Aug. 3, 1990, on Morjovi. Harvestable size.
7/25	Little Polovina	1427	Allflex	white	c	Tagged July 25, 1990, on Tolstoi. Harvestable size.
7/25	Little Zapadni	1250	Allflex	orange	c	Tagged July 23, 1989, on Polovina. Too large to count.
7/25	Little Zapadni	1412	Allflex	white	e[f]	Tagged July 5, 1990, on Zapadni. Harvestable size.
7/25	Zapadni Reef	0467	Allflex	orange	c	Tagged July 24, 1986, on Zapadni.
7/25	Zapadni Reef	1386	Allflex	white	c	Tagged July 22, 1990, on Vostochni. Harvestable size.
7/25	Zapadni Reef	1474	Allflex	white	c	Tagged July 29, 1990, on Polovina. Harvestable size.
7/25	Zoltoi Sands	1257	Allflex	orange	c	Tagged July 23, 1989, on Zapadni. Too large to count.
7/25	Zoltoi Sands	1447	Allflex	white	c	Tagged July 26, 1990, on Zapadni Sands. Too large to count.
7/26	Vostochni	059	Allflex	green	c	Tagged July 20, 1991, on Vostochni.

Table 30.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/26	Vostochni	065	Allflex	green	c	Tagged July 20, 1990, on Vostochni.
7/26	Vostochni	067	Allflex	green	e'	Tagged July 20, 1990, on Vostochni.
7/26	Vostochni	1302	Allflex	white	c	Tagged July 7, 1990, on Vostochni. Too large to count.
7/26	Vostochni	1371	Allflex	white	c	Tagged July 18, 1990, on Tolstoi Sands. Harvestable size.
7/26	Vostochni	1392	Allflex	white	c	Tagged July 22, 1990, on Vostochni. Too large to count.
7/26	Vostochni	1450	Allflex	white	c	Tagged July 26, 1990, on Zapadni. Harvestable size.
7/26	Vostochni Sands	1214	Allflex	orange	e'	Tagged July 18, 1989, on Vostochni Sands.
7/27	Polovina	005	Allflex	green	e'	Tagged July 7, 1991, on Zapadni Sands.
7/27	Polovina	005	Allflex	green	e'	Tagged July 7, 1991, on Zapadni Sands.
7/27	Polovina	1319	Allflex	white	e'	Tagged July 11, 1990 on Zapadni Sands.
7/27	Polovina	1427	Allflex	white	c	Tagged July 25, 1990, on Tolstoi. Harvestable size.
7/27	Polovina	1430	Allflex	white	c	Tagged July 25, 1990, on Tolstoi.
7/27	Zapadni Reef Sands	1359	Allflex	white	e'	Tagged July 17, 1990, on Zapadni Reef Sands. Too large to count.
7/28	Kitovi	806	Roto	blue		Number of tags and side not noted.
7/28	Lukanin	141	Allflex	green	c	Tagged July 27, 1991, on Polovina.
7/29	Gorbatch	1447	Allflex	white	c	Tagged July 26, 1990, on Zapadni Sands. Too large to count.
7/29	Tolstoi	0736	Allflex	orange	c	Tagged August 24, 1985, on Vostochni. Too large to count.
7/29	Tolstoi	bE1185	Monel			Soviet tagged animal.

Table 30.--Continued,

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/30	Zapadni Sands	129	Allflex	green	e'	Tagged July 27, 1991, on Zapadni Reef Sands.
7/31	Little Polovina	1336	Allflex	white	c	Tagged July 15, 1990, on Reef. Too large to count.
7/31	Little Zapadni	1419	Allflex	white	e'	Tagged July 7, 1990, on Vostochni Sands. Too large to count.
7/31	Little Zapadni	1470	Allflex	white	c	Tagged July 28, 1990, on Vostochni. Harvestable size. Missing left tag.
7/31	Zapadni Reef	085	Allflex	green	e'	Tagged July 21, 1991, on Zapadni Reef Sands.
7/31	Zoltoi	1164	Allflex	orange	c	Tagged July 15, 1989, on Zoltoi Sands. Too large to count.
7/31	Zoltoi	1279	Allflex	orange	c	Tagged July 25, 1989, on Vostochni. Too large to count.
7/31	Zoltoi	1459	Allflex	white	c	Tagged July 27, 1990, on Reef. Too large to count.
8/1	Morjovi	117	Allflex	green	c	Tagged July 26, 1991 at Vostochni.
8/1	Morjovi	143	Allflex	green	c	Tagged July 27, 1991 at Polovina.
8/1	Morjovi	1432	Allflex	white	e'	Tagged July 26, 1990, on Lukanin.
8/1	Morjovi	MH391	Monel			Soviet tagged animal. Missing tag on left.
8/1	Vostochni	1378	Allflex	white	c	Tagged July 21, 1990, on Vostochni Sands. Harvestable size.
8/2	Kitovi	31	Allflex	blue	c	Tagged July 18, 1988 on Kitovi.
8/2	Kitovi	151	Allflex	green	e'	Tagged July 28, 1991 on Kitovi.
8/2	Kitovi	1257	Allflex	orange	c	Tagged July 23, 1989, on Zapadni. Too large to count.
8/2	Lukanin	1417	Allflex	white	c	Tagged July 6, 1990 on Lukanin.
8/2	Polovina	147	Allflex	green	c	Tagged July 27, 1991 at Polovina.
8/2	Polovina	149	Allflex	green	c	Tagged July 27, 1991 on Polovina.
8/2	Zapadni Reef Sands	1166	Allflex	orange	c	Tagged July 15, 1989, on Zapadni Reef Sands. Too large to count.

Table 30.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
8/3	Gorbatch	1444	Allflex	white	c	Tagged July 26, 1990 on Zapadni Sands.
8/3	Gorbatch	1453	Allflex	white	c	Tagged July 27, 1990 on Reef. Too large to count.
8/3	Gorbatch	007	Allflex	green	c	Tagged July 7, 1991 on Zapadni Sands.
8/3	Gorbatch	141	Allflex	green	c	Tagged July 27, 1991, on Polovina.
8/3	Gorbatch	1242	Allflex	orange	c	Tagged July 23, 1989 on Lukanin. Too large to count.
8/3	Gorbatch	1441	Allflex	white	e^r	Tagged July 26, 1990, on Zapadni Sands. Harvestable size.
8/3	Reef	126	Allflex	blue	e^r	Tagged July 29, 1988 on Vostochni. Too large to count.
8/3	Reef	1369	Allflex	white	e^r	Tagged July 17, 1990, on Zapadni Reef Sands. Too large to count.
8/3	Reef	1470	Allflex	white	c	Tagged July 28, 1990, on Vostochni. Harvestable size. In previous sighting left tag was recorded as the one that was missing.

*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.

NEP = Northeast Point - A section located between Morjovi and Vostochni rookeries that is technically assigned to Morjovi.

Table 31.--List of juvenile male northern fur seals tagged as entangled animals during surveys conducted in July and August of 1991, St. Paul Island, Alaska, showing the nature of the debris on each animal. The entangling debris was removed.

Tag number[1]	Date	Location (Rookery name)	Description of debris: Type	Wt. (g)	Color	Tightness[2]	Wound (deg.)	Mesh size (cm)	Twine size (mm)	Footnote
003	7/7	Zapadni Sands	trawl	76.0	green	t	0	26.5	2	
005	7/7	Zapadni Sands	rope	35.0	yellow	t	0	23.0	13	
015	7/11	Tolstoi	packing band	2.9	blue	vt	360	20.8		
021	7/13	Lukanin	packing band	3.5	clear	m	0	23.5		
031	7/16	Gorbatch	packing band	4.0	yellow	t	0	22.3		
033	7/17	Zapadni	trawl	310.0	grey	vt	90	22.5	3	
039	7/18	Polovina	packing band	3.5	green	t	0	27.4		
045	7/18	Polovina	packing band	2.3	white	t	0	21.9		
051	7/19	Zapadni Reef	trawl	16.0	grey	t	360	31.0	2.5	
057	7/20	Vostochni	packing band	2.0	white	m	0	24.3		
063	7/20	Vostochni	trawl	38.5	grey	vt	30	51.5	2.5	
067	7/20	Vostochni	packing band	2.0	blue	m	0	24.0		
069	7/20	Vostochni	fiber	9.0	white	vt	180	39.0		
077	7/21	Lukanin	trawl	146.5	grey	vt	0	23.0	2	
087	7/21	Zapadni Reef	chord	9.0		t	15	36.5	4	[3]
093	7/22	Reef	packing band	3.3	blue	m	0	19.1		
105	7/24	Zapadni	chord	41.0	grey	t	0	25.8	8	
109	7/26	Vostochni	trawl	18.5	orange	t	0	23.0	1.5	
111	7/26	Vostochni	packing band	3.0	yellow	t	0	26.5	4.5	
121	7/26	Vostochni	chord	8.2	grey	m	0	26.2	5	
127	7/26	Morjovi	chord	3.4	Black	vt	360	33.5	3	
129	7/27	Zapadni Reef	monofilament	3.0		vt	180	21.8	<1	[4]
139	7/27	Polovina	trawl	135.0	blue	vt	160	22.5	2	
145	7/27	Polovina	packing band	1.5	green	l	0	26.4		
151	7/28	Kitovi	trawl	44.5	blue	l	0	42.5	2.5	
157	7/29	Gorbatch	trawl	130.5	grey	m	0	21.5	3	
163	7/29	Tolstoi	twine	1.3	green	m	0	24.0	5	

Table 31.--Continued.

Tag number	Date	Location (Rookery name)	Description of debris: Type	Wt. (g)	Color	Tightness[1]	Wound (deg.)	Mesh size (cm)	Twine size (mm)	Footnote
169	7/30	Zapadni Sands	trawl	203.0	white	vt	360	22.5	6	5
171	7/30	Zapadni Sands	packing band	1.6	yellow	m	0	21.7		
177	7/31	Little Polov.	trawl	23.3	blue	vm	270	15.5	2.5	
183	8/1	Morjovi	packing band	3.0	black	l	0	26.0		5
185	8/1	Morjovi	twine	3.5	brown	t	300	23.5	2	
191	8/1	Morjovi	twine	5.0	white	vt	340	31.5	1	5
193	8/2	Polovina	twine	5.8	white	vt	350	23.7	2	
199	8/2	Zapadni Reef	packing band	2.8	white	m	0	22.7		
205	8/3	Gorbatch	packing band	2.0	blue	m	180	23.0		
211	8/3	Tolstoi	monofilament	1.8	clear	vt	360	8.0	<1	6
5524	7/22	Reef	trawl		grey	vt	360			7

[1]Tag number is that placed on the left flipper (See Table 2).
[2]l = loose, m = moderately tight, t = tight, vt = very tight.
[3]Debris was a combination of black and white.
[4]Wound had healed over the debris.
[5]Seals tagged with numbers 169, 183, and 191 were larger than harvestable size and not counted in the calculation of the incidence of entanglement.
[6]Debris on this seal had cut through flesh and into trachea so that the seal breathed through the hole. Animal was released after removing the debris but died very shortly thereafter.
[7]This seal was tagged previously but apparently not during entanglement research. Two controls were taken and the animal was disentangled but not retagged with green tags. The original tags were narrow white Allflex. The seal's weight was 67 lb and it had black vibrissae. The right tag number was 5533.

entangled in trawl webbing, 14 (36.8%) in plastic packing bands, and 10 (26.3%) in string, small line, cords, or rope. The remaining 2 (5.3%) were entangled in other miscellaneous debris.

As in 1989 and 1990, the sampling design in 1991 included resightings of animals from which debris was removed during the same season; these animals were counted as entangled. Seals from which debris was removed in 1989 and 1990 were also resighted in 1991. All seals from 1989 were considered too large to be included in the calculations. Thus, one-half of the harvestable-sized seals resighted in 1991, from which debris had been removed in 1990, were counted as entangled for counting the incidence of entanglement. In all, there were 47.25 sightings that qualified for calculating the incidence of entanglement. These included 1) seals of harvestable size observed entangled (n = 35), 2) the repeated sightings of animals from which debris had been removed in 1991, (n = 6), and 3.) one-fourth of the seals resighted from 1990 after having had debris removed (n= 6.25). This latter number was obtained as follows: first we observed 25 seals tagged in 1990 as seals from which debris had been removed (the 21 mentioned earlier plus their repeated sightings). Half (n = 12.5) of these met the size criteria (based on 9 of 18 seals evaluated meeting the criteria). Of these 12.5 seals, if they had remained entangled, one-half would have, survived to be seen as entangled seals in 1991 for a total-of 6.25 seals.

The incidence of entanglement for 1991 was 0.209% (47.25/22,524), an estimate that is subject to slight upward bias as it assumes that entangled seals would-not have lost their

debris. Even so, the 1991 incidence of entanglement is less than the observed incidence of 0.32% in 1990 (Table 32; Fig. 18, noting the revision of the value for 1990 from 0.33 to account for growth and survival of seals from which debris had been removed as explained above). This reduction is continuing evidence of a decline in the observed incidence of entanglement from the 0.4% observed between 1976 and 1985 (Fig. 18; Fowler et al. 1990b, Table 32).

Compared to the rate of entanglement observed in 1976-86, the smaller proportion of entangled juvenile male seals is attributable to a reduction in the fraction entangled in trawl webbing (Table 33). For the period 1982-86, the mean percent of seals entangled in trawl webbing was 0.27% (Fowler et al. 1990b). In 1988, the percent entangled in trawl webbing dropped to 0.15%; a reduction to 56% of earlier levels (Fowler et al. 1990b). This proportion remained low in 1989 (Fowler and Ragen 1990) and 1990 (Fowler and Baba 1991), and even lower in 1991 at about 0.06% (Table 33). Thus, the 1991 rate of entanglement in trawl webbing is about 50% of the levels of incidence observed for this category of debris between 1988 and 1990 and about 20% of the levels between 1981 and 1986.

Within-Season Incidence of Entanglement

Little attention has been paid to the possibility that the incidence of entanglement among northern fur seals might change over the course of the season. Led by the subjective impression that more entangled juvenile male seals were seen in the last few roundups relative to earlier roundups of the 1991 season, this

Table 32. --The percent of juvenile male northern fur seals from St. Paul Island, Alaska, entangled in marine debris as recorded from 1967 to 1984 during the commercial harvest (data from Kozloff et al. 1986) and from 1985 to 1991 during roundups (data from Fowler and Baba 1991). The values for 1989 and 1990 have been corrected to account for survival and growth of seals. from which debris was removed the year before and, therefore, differ slightly from previously reported values.

Year	Percent entangled
1967	0.15
1968	0.16
1969	0.20
1970	0.28
1971	0.41
1972	0.43
1973	0.48
1974	0.58
1975	0.71
1976	0.42
1977	0.35
1978	0.46
1979	0.40
1980	0.49
1981	0.43
1982	0.41
1983	0.43
1984	0.39
1985	0.51
1986	0.42
1987	--
1988	0.28
1989	0.29
1990	0.32
1991	0.21

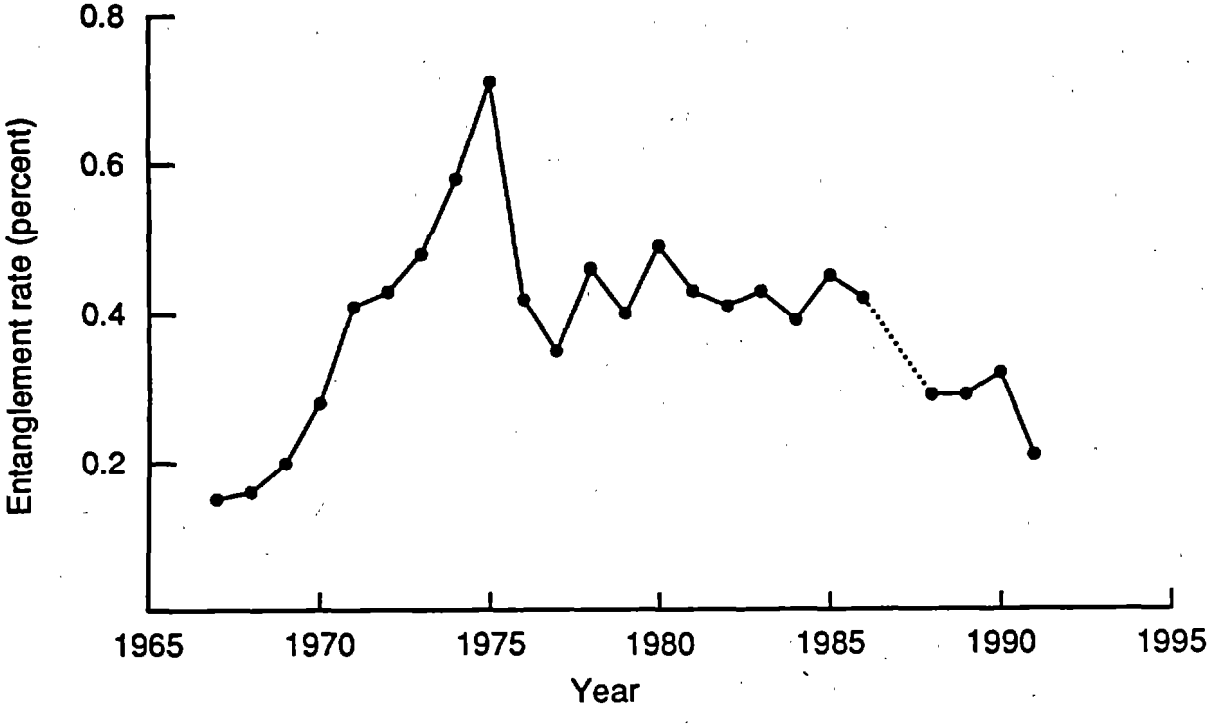


Figure 18. The percentage of juvenile male northern fur seals found entangled in the commercial harvest from 1967 to 1984 and in research roundups from 1985 to 1991 on St. Paul Island, Alaska (updated from Fowler and Baba 1991).

Table 33. --Debris found on juvenile male northern fur seals from St. Paul Island, 1981-91, expressed as the incidence of entanglement (observed percent) among juvenile males entangled by debris category (data for 1981-89 from Fowler and Ragen 1990 and for 1990 from Fowler and Baba 1991) supplemented with data from the 1991 field study.

Year	Trawl net fragments	Packing bands	Chord, rope, and string	Monofilament net fragments	Misc. items	Sample size*
1981	0.29	0.08	0.04	0.00	0.03	102
1982	0.24	0.10	0.04	0.01	0.01	102
1983	0.30	0.07	0.02	0.01	0.03	112
1984	0.22	0.09	0.05	0.02	0.01	87
1985	0.36	0.05	0.08	0.01	0.01	76
1986	0.27	0.06	0.07	0.01	0.01	70
1988	0.15	0.07	0.05	0.00	0.01	53
1989	0.12	0.10	0.06	0.02	0.01	47
1990	0.11	0.11	0.07	0.01	0.03	71
1991	0.06	0.08	0.06	0.01	0.00	38

*Sample sizes occasionally include debris from seals larger than would be counted for determining the proportion of the juvenile males that are entangled.

question was addressed with an analysis of the data for 1989 to 1991. The season was broken into five periods corresponding to the 5 weeks beginning with 1 July each year. The incidence of entanglement for each period was calculated as explained above for 1990 and 1991 (i.e., accounting for resighted seals, mortality, debris removal, and sampling with replacement). For 1989, corrections for growth and survival of seals from which debris was removed were not applied as debris was left on entangled seals in 1988. The data used in these calculations and the results are shown in Table 34. Figure 19 shows a comparison of the results over time for both season and year. As can be seen, there is a tendency for the data in 1991 to show an increase in the incidence of entanglement for the first 4 weeks. This trend, -however, is not seen in the other years, and the opposite trend is apparent in 1989. These data do not support the-conclusion of a consistent trend within season.

Resightings and Survival

An annual summary of the number of tags initially applied to juvenile males and the number resighted in each subsequent year is shown in Table 8 for each year since 1985. No roundups were conducted in 1987. A total of 171 seals judged to be of harvestable size were tagged and released in 1990. Of these, 114 were controls and 57 were entangled when captured. In 1991, 39 of these controls (34.2%) were resighted. Twenty-one (36.8% of the original group of 57) of the seals tagged, after removing their debris in 1990 were resighted in 1991. This implies that

Table 34.--Resightings of entangled seals and calculated estimates of juvenile male northern fur seal entanglement on St. Paul Island, Alaska, 1989-1991. Data has been broken into weekly periods with corresponding sample sizes. The incidence of entanglement is estimated by dividing the number of entangled seals by the sample size.

Year	Week[1]	First-year sightings	Second-year sightings	Entangled seals	Sample size	Incidence of entanglement
1989[2]						
	1	-	-	-	-	-
	2	3	2	5.00	1141	0.0044
	3	24	6	30.00	9126	0.0033
	4	18	0	18.00	8318	0.0022
	5	-	-	-	-	-
1990[2]						
	1	10	4	11.00	4787	0.0023
	2	10	4	11.00	4333	0.0025
	3	22	3	22.75	5462	0.0042
	4	26	2	26.50	7088	0.0037
	5	11	1	11.25	4159	0.0027
1991[2]						
	1	2	1	2.25	1593	0.0014
	2	2	7	3.75	4669	0.0008
	3	11	9	13.25	6909	0.0019
	4	13	5	14.25	3887	0.0037
	5	12	4	13.00	5466	0.0024

[1]Week 1 is 1-7 July, week 2 is 8-14 July, week 3 is 15-21 July, week 4 is 22-28 July, and week 5 is 29 July- 4 Aug.
[2]No correction is applied to the data for 1989 because debris was not removed in 1988. The number of entangled seals estimated to have been seen for 1990 and 1991 is based on first-year sightings plus one-fourth of the second year sightings to account for survival and growth of seals from which debris was removed in the year before.

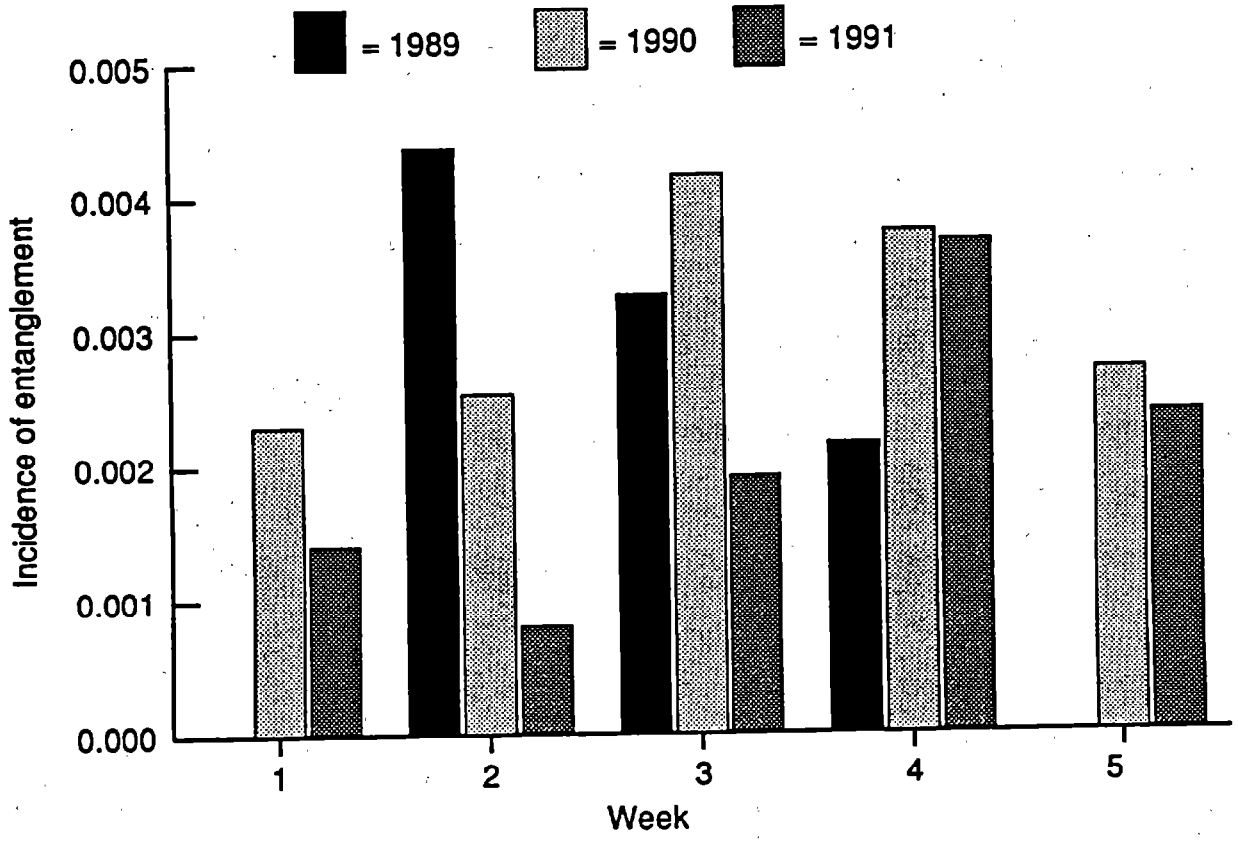


Figure 19. Weekly incidence of entanglement for juvenile male northern fur seals seen in roundups on St. Paul Island, Alaska, as based on data in Table 7 for 1989-91.

the resighting rate for disentangled seals after 1 year was 107.6% of that for the controls (36.8/34.2 = 1.076,). This is not significantly different from a ratio of 1.0 (Chi-square test, P > 0.05). The. resighting rate of disentangled seals relative to controls is significantly higher than that of entangled seals. (approximately 0:5) lumped across all years (Chi-square test, P c 0.05).

In 1991, 5 of 279 seals (or 1.8%) tagged as controls in 1986 were resighted whereas none of the group, of 128 animals tagged as entangled in 1986 were resighted. No animals tagged as entangled in 1985 were resighted in 1990; however, four controls from 1985 were resighted. These sample sizes are too small to test for a significant change from the original ratio of tagged entangled seals to controls for, that year (Table 35).

Data for relative rates of resighting entangled to control. seals tagged between 1985 and 1990 and those seen in 1991 are shown in Figure 20 along with data from previous work (updated from Fowler and Baba 1991). The data from 1991 for seals resighted from tagging from 1985 through 1988 (Fig. 20) are. consistent with the results of earlier work (Fowler et al. 1990b), showing an entanglement related survival rate of about 50%. The increase in the surival rate attributable to the removal of debris is shown in data plotted for seals tagged in 1989 and 1990 (Fig. 20). In spite of the higher survival rate indicated by the 1990-91 data, and the clearly elevated survival rate compared to seals not freed of their debris, the combined data for the three points shown by stars in Figure 20 indicate

Table 35. --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 male northern fur seals from 1985 through 1991 (none tagged in 1987). Each row corresponds to the tags released in the first year for that row.

Controls (nonentangled)	Year 1985	1986	1988	1989	1990	1991
	(172)	37 [21.5]	13 [7.6]	8 [4.7]	7 [4.1]	4 [2.3]
		(279)	40 [14.3]	32 [11.5]	25 [9.0]	5 [1.8]
			(104)	20 [19.2]	11 [10.6]	11 [10.6]
				(86)	26 [30.2]	14 [16.3]
					(114)	39 [34.2]
						(68)

Entangled	Year 1985	1986	1988	1989	1990	1991
	(85)	12 [14.1]	1 [1.2]	0 [0]	0 [0]	0 [0]
		(128)	6 [4.7]	4 [3.1]	1 [0.8]	0 [0]
			(52)	5 [9.6]	2 [3.8]	1 [1.3]
				(43)	11 [25.6]	4 [9.3]
					(57)	21 [36.8]
						(34)

*Updated from Fowler and Baba (1991).

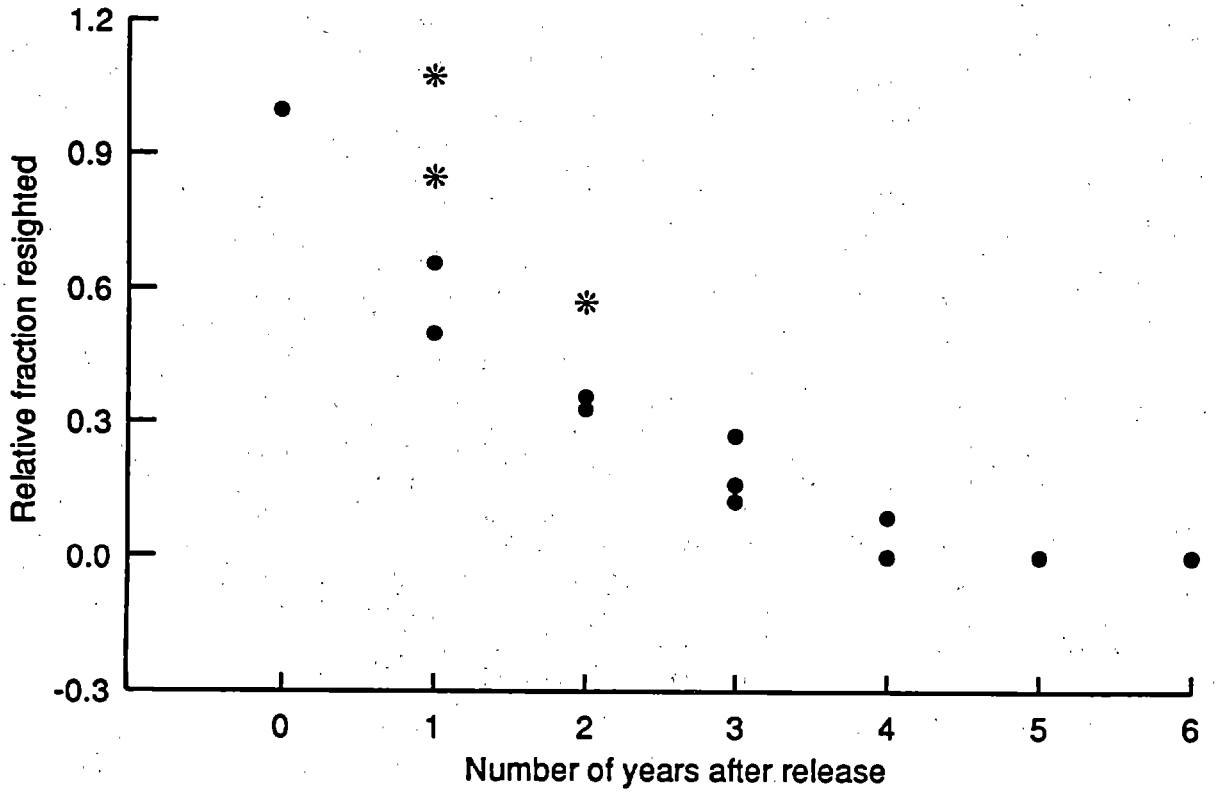


Figure 20. Relative rates of return for entangled juvenile male northern fur seals compared. to controls (nonentangled tagged seals) for varying time intervals (Updated from Fowler and Baba 1991, with the data from this report). Each data point represents the fraction of entangled seals resighted divided by the fraction of controls resighted (both from Table 7) for the corresponding t time interval (for example, there are two data points for 3 years corresponding to the 1985-88' and 1986-89 intervals). The stars correspond to the relative return rate for seals with debris-removed.

that the disentangled seals may have a lower survival rate than controls.

Characteristics of Entangling Debris

Specific weights and mesh sizes of debris removed from entangled seals are listed in Table 31. These distributions are very similar to those seen in previous studies (Fowler and Baba 1991). For the combined data since 1983, about 74% of the debris found on seals weighed between 0 and 150 g, about 18% of the debris weighed between 150 and 500 g, and about 8% of the debris weighed over 500 g (Table 36).

Within-Season Resighting Rate

Although the data for 1990 indicated a higher resighting rate for controls than for disentangled seals (Table 37), the data for 1991 are again consistent with historic data. The more general picture from the collective results of 6 years shows that the fraction of seals tagged as entangled seals and resighted in the same field season are about the same as the resighted fraction for controls (Fowler et al. 1990b). This resighted fraction has been close to 25% in both groups.

DISCUSSION

Entanglement-related field studies of juvenile male northern fur seals from 1989 through 1991 were different from those of earlier years in that debris was removed from entangled animals. Accounting for this difference, the incidence of entanglement continues to be lower than in years prior to 1987. The estimate

Table 36. --Annual percentage frequency distribution of the size of measured debris from entangled male northern fur seals that were tagged and released (data for 1983 to 1989 from Fowler and Ragen 1990).

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)
1990	71	59(83)	10(14)	2(3)
1991	11	9(82)	2(18)	0(0)
Total	525	387(74)	96(18)	42(8)

Table 37.--Comparison of numbers of tags applied to entangled and control juvenile male northern fur seals in 1985, 1986, 1988, 1989, and 1990 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	20(23.5)	43	8(18.6)
1990	114	56(49.1)	57	18(31.6)
1991	68	18(26.5)	34	6(17.7)
Total	707	204(28.9)	332	87(26.2)

from 1991 is the lowest of the last 4 years and provides further evidence that a change has occurred in the incidence of entanglement. The reduction for each year is attributable to less entanglement in trawl webbing, with 1991 being the lowest rate observed since 1982. An explanation for such a change can not be conclusively established at this time. However, the differences between the 1988-91 incidence of entanglement and those of previous years may be a result of changes in the rate of loss and discard of net fragments from fishing vessels. Various educational programs at national and international levels have been in place for several years, and international regulations prohibit the discard of such debris. Other studies are necessary to determine if less debris is actually entering the marine environment.

Results of the 1991 studies are consistent with those of earlier work in showing that some animals escape from their entangling debris. However, as documented in Fowler et al. (1990b), the animals that lose their debris are predominantly seals entangled in small debris (less, than 150.g). Debris loss is one factor contributing to survival from entanglement. The results of the 1991 studies are consistent with this conclusion with the demonstration of increased survival of tagged seals from which debris was removed during the 1989 and 1990 field studies.

S U M M A R Y

Entanglement research on juvenile males in 1991 demonstrated:

1) A continued reduction of the overall incidence of entanglement from about 0.4% (1975-86) to less than 0.34% in 1988 through 1990, and down to 0.21% in 1991;

2) Entanglement in trawl webbing in 1991 was less than one-half of entanglement levels observed for this kind of debris in 1990 which itself was about one-half of that in previous years (1981-86) and very similar to that observed in 1988 and 1989;

3) Data for relative return rates of entangled seals for years in which debris was not removed continued to produce an estimated rate of mortality due to the hazard of entanglement alone (i.e., independent of natural causes of mortality) of about 50% per year; and

4) There is continuing evidence from the 1991 studies that the rate of return of tagged seals from which debris is removed is significantly higher than for tagged, entangled seals but not as high as for controls.

FUR SEAL POPULATION STUDIES ON SAN MIGUEL ISLAND, CALIFORNIA

by

Robert L. DeLong and Sharon M. Melin

The 1991 field season on San Miguel Island extended from 30 April through 28 October. A maximum of 64 adult males (54 with females) maintained territories, during the breeding season. Pup counts were conducted on 7 August in Adams Cove and 14 August on Castle Rock. A minimum of 1,011 pups were born in Adams Cove and, 520 on Castle Rock. The first pup was born on 8 June in Adams Cove.

A total of three hundred fur seal pups were double-tagged with pink plastic roto tags (September 22) and October 28, (n = 150) respectively. Tag numbers and data on individual animals are listed in Appendix Table- B-2. The two groups of pups were tagged 1 month apart to continue an ongoing study to determine whether there is differential pup mortality based upon age at time of tagging.

In frequent trips made to San Miguel Island throughout 1991, 210 tags representing 80 individuals were resighted. No pups tagged in 1990 were resighted. The oldest animal resighted was a 16-year old female with a pup.

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APPENDIX A

Glossary

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

Bachelor	Young male seals of age 2-5 years.
<u>Classifications of adult male fur seals</u>	
Class 1 (shoreline)	Full-grown males apparently attached to "territories" spaced along the water's edge at intervals of 10-15 m. Most of these animals are wet or partly wet, and some acquire harems of one to four females between 10 and 20 July. They would then be called harem males (Class 3). Class 1 males should not be confused with Class 2 animals, which have definite territories, whereas the shoreline males appear to be attached to such sites but may not be in all cases.
Class 2 (territorial without females)	Full-grown males that have no females, but are actively defending territories. Most of these animals are located on the inland fringe of a rookery: some are between Class 1 (shoreline) and Class 3 (territorial with females) males, and a few are completely surrounded by Class 3 males and their harems.
Class 3 (territorial with females)	Full-grown males actively defending territories and females. Most Class 3 males and their harems combine to form a compact mass of animals. Isolated individuals, usually with small harems, may be observed at each end of a rookery, on sandy beaches, and in corridors leading to inland hauling grounds. Some territorial males have as few as one or two females. Should these females be absent during the counts, their pups are used as a basis for putting the adult male into Class 3 rather than Class 2.

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

Marked	Describes a seal that has been marked by attaching an inscribed metal or plastic tag to one or more of its flippers, by hair clipping, or by bleaching.
Mark recoveries	Recovery (sighting) of a seal that has been marked by one of several methods. See marked.
Rookery	An area on which breeding seals congregate. See Hauling ground.
Roundup	Biologists surround and herd juvenile male fur seals close to the location they haul out.
Vibrissae (facial whiskers)	To determine the relative age structure of females in a population, the color of their whiskers are used. Facial vibrissae are black at birth and remain black through age 3 years; become mixed (black and white) at ages 4 and 5 years; and by age 7, the vibrissae usually are entirely white.

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APPENDIX B

Tabulations of northern fur seal tag data collected on the Pribilof Islands, Alaska, and on San Miguel Island, California, during 1991.

Appendix table B-1. --List of monel tagged northern fur seals resighted on St. Paul Island, Alaska, 1991.

4-year-olds

A00029	A01085	A02672	A04336	A05531	A07080
A00055	A01101	A02676	A04378	A05532	A07121
A00067	A01121	A02697	A04380	A05681	A07134
A00106	A01124	A02713	A04387	A05685	A07164
A00111	A01126	A02725	A04399	A05688	A07264
A00143	A01146	A02739	A04521	A05714	A07308
A00149	A01197	A02762	A04538	A05720	A07359
A00173	A01220	A02784	A04543	A05774	A07405
A00186	A01224	A02883	A04546	A05825	A07422
A00231	A01228	A02890	A04582	A05858	A07458
A00232	A01279	A02953	A04621	A05890	A07460
A00242	A01295	A02958	A04624	A05945	A07483
A00243	A01353	A02973	A04650	A05961	A07524
A00246	A01369	A03003	A04668	A05964	A07543
A00268	A01380	A03008	A04686	A06000	A07544
A00298	A01407	A03070	A04714	A06033	A07582
A00330	A01429	A03071	A04731	A06043	A07584
A00332	A01447	A03188	A04738	A06085	A07594
A00343	A01457	A03215	A04759	A06115	A07608
A00355	A01482	A03242	A04792	A06118	A07637
A00373	A01507	A03263	A04806	A06146	A07648
A00385	A01510	A03297	A04836	A06153	A07654
A00407	A01531	A03313	A04840	A06154	A07715
A00489	A01554	A03317	A04865	A06155	A07773
A00496	A01586	A03336	A04885	A06157	A07793
A00532	A01616	A03376	A04888	A06205	A07795
A00569	A01711	A03402	A04889	A06211	A07803
A00576	A01764	A03419	A04976	A06226	A07816
A00589	A01771	A03472	A04985	A06252	A07837
A00601	A01890	A03477	A04994	A06282	A07853
A00610	A01902	A03519	A05031	A06306	A07888
A00624	A01931	A03528	A05038	A06316	A07956
A00649	A01967	A03597	A05058	A06489	A07962
A00653	A01995	A03612	A05095	A06505	A08026
A00663	A02038	A03614	A05113	A06521	A08034
A00671	A02095	A03648	A05144	A06588	A08050
A00726	A02252	A03689	A05172	A06643	
A00739	A02270	A03752	A05216	A06687	
A00749	A02305	A03778	A05221	A06710	
A00769	A02306	A03795	A05244	A06785	
A00826	A02309	A03843	A05280	A06797	
A00849	A02315	A03980	A05310	A06831	
A00923	A02446	A04078	A05327	A06834	
A00965	A02451	A04097	A05333	A06844	
A00968	A02461	A04148	A05375	A06872	
A00983	A02601	A04190	A05415	A06898	
A01015	A02618	A04228	A05474	A06974	
A01023	A02652	A04279	A05481	A07009	
A01075	A02654	A04329	A05521	A07063	

Appendix Table B-l.--Continued.

3-year-olds

A08082	A09017	A10136	A11282	A12852	A14020
A08107	A09024	A10145	A11338	A12897	A14049
A08121	A09029	A10187	A11373	A12911	A14057
A08125	A09039	A10189	A11399	A12940	A14058
A08148	A09042	A10204	A11417	A12970	A14066
A08182	A09047	A10278	A11450	A12985	A14082
A08226	A09106	A10289	A11459	A13074	A14085
A08273	A09134	A10306	A11469	A13117	A14095
A08280	A09137	A10312	A11511	A13141	A14097
A08290	A09146	A10369	A11515	A13162	A14143
A08308	A09175	A10389	A11532	A13179	A14182
A08319	A09203	A10409	A11535	A13185	A14195
A08377	A09250	A10413	A11551	A13214	A14209
A08394	A09255	A10416	A11553	A13218	A14219
A08399	A09316	A10420	A11554	A13260	A14226
A08459	A09338	A10438	A11629	A13261	A14267
A08467	A09347	A10439	A11650	A13291	A14290
A08474	A09375	A10447	A11660	A13313	A14300
A08487	A09379	A10449	A11667	A13444	A14307
A08524	A09381	A10458	A11800	A13446	A14312
A08563	A09425	A10513	A11865	A13514	A14333
A08564	A09432	A10539	A12150	A13522	A14339
A08566	A09451	A10545	A12155	A13538	A14357
A08632	A09473	A10661	A12176	A13571	A14369
A08638	A09494	A10676	A12197	A13594	A14374
A08644	A09530	A10677	A12230	A13661	
A08669	A09563	A10688	A12241	A13671	
A08676	A09569	A10695	A12351	A13681	
A08703	A09589	A10720	A12408	A13705	
A08715	A09597	A10723	A12409	A13731	
A08721	A09624	A10725	A12410	A13761	
A08722	A09671	A10728	A12419	A13764	
A08735	A09693	A10917	A12444	A13782	
A08756	A09702	A10931	A12451	A13822	
A08763	A09729	A10964	A12465	A13825	
A08781	A09741	A10966	A12475	A13842	
A08782	A09747	A11108	A12520	A13843	
A08798	A09751	A11114	A12535	A13849	
A08805	A09758	A11116	A12537	A13860	
A08852	A09771	A11133	A12616	A13863	
A08857	A09838	A11156	A12630	A13885	
A08867	A09839	A11157	A12631	A13911	
A08871	A09853	A11161	A12670	A13932	
A08875	A09941	A11171	A12693	A13945	
A08928	A09953	A11185	A12714	A13960	
A08953	A09971	A11186	A12724	A13963	
A08958	A09982	A11220	A12738	A13977	
A08982	A10063	A11258	A12787	A14003	
A09016	A10111	A11274	A12844	A14015	

Appendix Table B-l.--Continued.

2-year-olds		
A14428	A16053	A17390
A14535	A16150	A17539
A14569	A16237	A17618
A14679	A16288	A17644
A14691	A16316	A17696
A14813	A16323	A17713
A14823	A16368	A17965
A15134	A16562	A18031
A15135	A16900	A18155
A15412	A16979	A18220
A15463	A17014	A18320
A15585	A17060	A18531
A15734	A17104	A18788
A15751	A17209	A18810
A15768	A17212	A18848
A15794	A17289	A18874
A15895	A17327	
A15980	A17363	

Appendix Table B-2. --Northern fur seal pups tagged with pink plastic roto tags, San Miguel Island, California, 1991,

Month	Left tag	Right tag	Sex	Weight (kg)
September				
24	A001403	A001403	F	6.0
24	A001404	A001404	F	11.0
24	A001405	A001405	M	10.0
24	A001406	A001406	M	10.0
24	A001407	A001407	F	12.0
24	A001408	A001408	M	11.0
24	A001409	A001409	M	12.0
24	A001410	A001410	F	7.0
24	A001411	A001411	M	12.0
24	A001412	A001412	F	12.5
24	A001413	A001413	M	8.5
24	A001414	A001414	F	10.0
24	A001415	A001415	F	7.5
24	A001416	A001416	F	8.5
24	A001417	A001417	F	7.0
24	A001418	A001418	F	9.0
24	A001419	A001419	F	9.0
24	A001420	A001420	M	11.5
24	A001421	A001421	M	10.5
24	A001422	A001422	M	10.0
24	A001423	A001423	F	10.5
24	A001424	A001424	M	9.0
24	A001425	A001425	M	13.5
24	A001426	A001426	F	9.5
24	A001427	A001427	M	10.0
24	A001428	A001428	F	9.0
24	A001429	A001429	M	11.0
24	A001430	A001430	M	12.0
24	A001431	A001431	F	9.5
24	A001432	A001432	F	10.5
24	A001433	A001433	F	8.0
24	A001434	A001434	M	9.0
24	A001435	A001435	F	8.0
24	A001436	A001436	F	9.5
24	A001437	A001437	F	9.0
24	A001438	A001438	F	11.0
24	A001439	A001439	M	10.0
24	A001440	A001440	F	6.0
24	A001441	A001441	F	9.0
24	A001442	A001442	F	11.5
24	A001443	A001443	M	12.0
24	A001444	A001444	M	15.0
24	A001445	A001445	F	9.0

Appendix Table B-2.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)
September				
24	A001446	A001446	F	9.0
24	A001447	A001447	F	7.5
24	A001448	A001448	F	8.0
24	A001449	A001449	F	11.0
24	A001450	A001450	M	8.5
24	A001451	A001451	F	10.0
24	A001452	A001452	M	13.0
24	A001453	A001453	F	9.0
24	A001454	A001454	M	11.0
24	A001455	A001455	M	11.5
24	A001456	A001456	F	9.0
24	A001457	A001457	F	12.5
24	A001458	A001458	F	7.0
24	A001459	A001459	F	8.0
24	A001460	A001460	F	10.0
24	A001461	A001461	M	13.0
24	A001462	A001462	M	12.0
24	A001463	A001463	M	9.0
24	A001464	A001464	F	11.0
24	A001465	A001465	M	13.0
24	A001466	A001466	M	12.0
24	A001467	A001467	F	8.0
24	A001468	A001468	F	10.5
24	A001469	A001469	F	10.0
24	A001470	A001470	F	9.0
24	A001471	A001471	F	8.0
24	A001472	A001472	F	10.5
24	A001473	A001473	M	14.5
24	A001474	A001474	F	9.0
24	A001475	A001475	M	8.5
24	A001476	A001476	F	9.5
24	A001477	A001477	F	7.5
24	A001478	A001478	M	13.0
24	A001479	A001479	F	10.0
24	A001480	A001480	M	9.0
24	A001481	A001481	M	11.5
24	A001482	A001482	M	9.5
24	A001483	A001483	F	13.0
24	A001484	A001484	F	9.0
24	A001485	A001485	M	7.5
24	A001486	A001486	F	12.0
24	A001487	A001487	M	11.0
24	A001488	A001488	F	11.0
24	A001489	A001489	M	9.5
24	A001490	A001490	M	15.0

Appendix Table B-2.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)
September				
24	A001491	A001491	F	8.2
24	A001492	A001492	M	14.0
24	A001493	A001493	F	10.0
24	A001494	A001494	M	10.5
24	A001495	A001495	M	10.0
24	A001496	A001496	F	8.0
24	A001497	A001497	M	8.5
24	A001498	A001498	M	12.0
24	A001499	A001499	M	11.0
24	A001500	A001500	M	10.5
24	C001001	C001001	F	10.0
24	C001002	C001002	M	11.5
24	C001003	C001003	F	7.0
24	C001004	C001004	M	12.5
24	C001005	C001005	F	8.0
24	C001006	C001006	F	11.5
24	C001007	C001007	M	14.0
24	C001008	C001008	F	12.0
24	C001009	C001009	F	7.0
24	C001010	C001010	F	9.0
24	C001011	C001011	F	14.0
24	C001012	C001012	M	11.0
24	C001013	C001013	F	12.0
24	C001014	C001014	M	8.5
24	C001015	C001015	F	12.5
24	C001016	C001016	M	10.0
24	C001017	C001017	M	8.5
24	C001018	C001018	F	12.0
24	C001019	C001019	M	12.0
24	C001020	C001020	M	13.0
24	C001021	C001021	F	11.0
24	C001022	C001022	F	10.5
24	C001023	C001023	M	12.5
24	C001024	C001024	F	9.5
24	C001025	C001025	F	9.4
24	C001026	C001026	F	11.0
24	C001027	C001027	F	9.0
24	C001028	C001028	F	10.5
24	C001029	C001029	F	14.0
24	C001030	C001030	F	8.5
24	C001031	C001031	F	10.5
24	C001032	C001032	F	13.5
24	C001033	C001033	M	10.0
24	C001034	C001034	M	13.0
24	C001035	C001035	F	11.0

Appendix Table B-2.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)
September				
24	C001036	C001036	F	9.5
24	C001037	C001037	M	11.0
24	C001038	C001038	M	14.5
24	C001039	C001039	F	8.0
24	C001040	C001040	M	13.0
24	C001041	C001041	M	11.0
24	C001042	C001042	F	11.0
24	C001043	C001043	M	9.5
24	C001044	C001044	M	14.0
24	C001045	C001045	M	8.5
24	C001046	C001046	F	11.0
24	C001047	C001047	M	11.0
24	C001048	C001048	F	10.0
24	C001049	C001049	M	9.0
24	C001050	C001050	M	10.5
24	C001051	C001051	M	12.0
24	C001052	C001052	M	13.5
24	C001053	C001053	M	10.5
October				
24	C000853	C000853	F	13.0
24	C000854	C000854	F	13.5
24	C000855	C000855	F	10.5
24	C000856	C000856	M	13.5
24	C000857	C000857	F	12.0
24	C000858	C000858	F	13.0
24	C000859	C000859	F	12.0
24	C000860	C000860	M	14.5
24	C000861	C000861	M	17.5
24	C000862	C000862	M	13.5
24	C000863	C000863	F	13.0
24	C000864	C000864	M	13.0
24	C000865	C000865	F	10.5
24	C000866	C000866	F	15.0
24	C000867	C000867	M	14.0
24	C000868	C000868	F	13.0
24	C000869	C000869	F	11.0
24	C000870	C000870	F	8.0
24	C000871	C000871	M	13.5
24	C000872	C000872	M	8.5
24	C000873	C000873	M	13.0
24	C000874	C000874	F	9.0
24	C000875	C000875	M	16.0
24	C000876	C000876	F	9.5
24	C000877	C000877	F	16.5

Appendix Table B-2.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)
October				
24	C000878	C000878	M	14.0
24	C000879	C000879	F	10.0
24	C000880	C000880	F	12.5
24	C000881	C000881	M	16.0
24	C000882	C000882	F	9.5
24	C000883	C000883	F	12.0
24	C000884	C000884	F	14.0
24	C000885	C000885	M	16.5
24	C000886	C000886	F	12.0
24	C000887	C000887	F	12.0
24	C000888	C000888	F	12.5
24	C000889	C000889	M	12.0
24	C000890	C000890	M	15.0
24	C000891	C000891	F	13.0
24	C000892	C000892	M	13.0
24	C000893	C000893	M	10.0
24	C000894	C000894	M	16.5
24	C000895	C000895	M	15.5
24	C000896	C000896	F	16.0
24	C000897	C000897	M	11.0
24	C000898	C000898	F	10.0
24	C000899	C000899	F	11.0
24	C000900	C000900	F	10.0
24	C000901	C000901	M	11.5
24	C000902	C000902	M	15.5
24	C000903	C000903	F	13.0
24	C000904	C000904	F	14.0
24	C000905	C000905	F	14.0
24	C000906	C000906	F	10.0
24	C000907	C000907	M	15.0
24	C000908	C000908	M	15.0
24	C000909	C000909	F	15.5
24	C000910	C000910	F	13.5
24	C000911	C000911	F	11.5
24	C000912	C000912	F	10.5
24	C000913	C000913	F	11.5
24	C000914	C000914	M	14.0
24	C000915	C000915	F	12.5
24	C000916	C000916	M	16.0
24	C000917	C000917	F	13.0
24	C000918	C000918	F	13.0
24	C000919	C000919	M	12.5
24	C000920	C000920	F	11.5
24	C000921	C000921	F	11.5
24	C000922	C000922	M	15.0

Appendix Table B-2.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)
October				
24	C000923	C000923	M	13.5
24	C000924	C000924	M	19.0
24	C000925	C000925	F	12.5
24	C000926	C000926	F	10.0
24	C000927	C000927	F	11.0
24	C000928	C000928	M	14.5
24	C000929	C000929	F	11.5
24	C000930	C000930	M	14.0
24	C000931	C000931	M	13.5
24	C000932	C000932	F	11.0
24	C000933	C000933	M	10.5
24	C000934	C000934	F	12.5
24	C000935	C000935	M	12.0
24	C000936	C000936	M	10.5
24	C000937	C000937	M	17.5
24	C000938	C000938	M	16.0
24	C000939	C000939	M	12.5
24	C000940	C000940	M	12.0
24	C000941	C000941	F	10.0
24	C000942	C000942	M	18.0
24	C000943	C000943	M	12.0
24	C000944	C000944	M	15.0
24	C000945	C000945	M	14.5
24	C000946	C000946	M	13.5
24	C000947	C000947	F	17.5
24	C000948	C000948	M	15.0
24	C000949	C000949	M	14.0
24	C000950	C000950	F	11.0
24	C000951	C000951	F	11.5
24	C000952	C000952	F	12.5
24	C000953	C000953	M	12.0
24	C000954	C000954	F	15.0
24	C000955	C000955	F	11.5
24	C000956	C000956	M	12.0
24	C000957	C000957	F	18.5
24	C000958	C000958	M	12.5
24	C000959	C000959	M	15.5
24	C000960	C000960	F	12.0
24	C001054	C001054	F	13.0
24	C001055	C001055	F	12.5
24	C001056	C001056	F	10.5
24	C001057	C001057	M	13.0
24	C001058	C001058	F	9.5
24	C001059	C001059	M	15.0
24	C001060	C001060	M	12.5

Appendix Table B-2.--Continued.

Month	Left tag	Right tag	Sex	Weight (kg)
October				
24	C001061	C001061	F	10.0
24	C001062	C001062	F	12.0
24	C001063	C001063	M	15.5
24	C001064	C001064	M	14.0
24	C001065	C001065	M	17.0
24	C001066	C001066	F	13.0
24	C001067	C001067	F	14.0
24	C001068	C001068	M	13.0
24	C001069	C001069	M	16.0
24	C001070	C001070	M	17.0
24	C001071	C001071	M	15.5
24	C001072	C001072	M	13.5
24	C001073	C001073	M	9.0
24	C001074	C001074	F	14.0
24	C001075	C001075	F	14.0
24	C001076	C001076	M	13.0
24	C001077	C001077	F	12.0
24	C001078	C001078	F	9.0
24	C001079	C001079	F	11.5
24	C001080	C001080	M	13.5
24	C001081	C001081	M	16.0
24	C001082	C001082	M	12.0
24	C001083	C001083	F	10.5
24	C001084	C001084	F	11.0
24	C001085	C001085	M	13.5
24	C001086	C001086	F	9.0
24	C001087	C001087	M	18.5
24	C001088	C001088	M	12.0
24	C001089	C001089	F	16.0
24	C001090	C001090	F	12.0
24	C001091	C001091	M	10.5
24	C001092	C001092	F	11.0
24	C001093	C001093	M	14.0
24	C001094	C001094	M	15.0
24	C001095	C001095	F	7.5

APPENDIX C
Scientific staff engaged in northern fur seal research, 1991.

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

Name	Affiliation	Assignment
Employees		
George Antonelis	NMML	Project Leader
Jason Baker	NMML	Population Assessment
Robert DeLong.	NMML	Population Assessment
Charles Fowler	NMML	Population Assessment
Roger Gentry	NMML	Behavior Studies
Steve Insley	NMML	Behavior Studies
Thomas Loughlin	NMML	Population Assessment.
Sharon Melin	NMML	Population Assessment
Rolf Ream	NMML	Population Assessment
Bruce Robson	NMML	Population Assessment
Elizabeth Sinclair	NMML	Annual Report
Paula White	NMML	Population Assessment
Anne York	NMML	Population Dynamics
Cooperators*		
James Coe	NMFS	Entanglement Funding
Brad Hansen	NMFS	Resource Management
Steve Zimmerman	NMFS	Resource Management
Norihisa Baba	NRIFSF	Entanglement Research
Masashi Kiyota	NRIFSF	Population Assessment
Patience Brown	MLML	Population Assessment
John Mason	MLML	Population Assessment
Christy Baham	csu	Population Assessment

APPENDIX C (Continued).

Name	Affiliation	Assignment
Darlene DeGhetto	CSU	Pup Mortality Res.
Paul Silvangi	CSU	Pup Mortality Res.
Terry Spraker	CSU	Pup Mortality Res.
Victor Nikulin	VNIRO	Population Studies
Valery Vladimirov	VNIRO	Population Studies
Alexander Boltnev	TINRO	Behavior Studies
Kyle Antonelis	NA	Population Assessment
Stefanie Hawks	NA	Population Assessment
Juliana Hydanos	NA	Population Assessment
Daniel Meares	NA	Population Assessment
Sarah Peyton	NA	Russian Interpreter
Wayne Sentman	NA	Population Assessment
Marc Webber	NA	Population Assessment

Affiliation Code

MLML	Moss Landing Marine Laboratories
NMFS	National Marine Fisheries Service
NRIFSF	National Research Institute of Far Seas Fisheries
CSU	Colorado State University
VNIRO	Ministry of Fisheries - Russia
TINRO	Pacific Research Institute of Fisheries and Oceanography - Russia
NA	No affiliation

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

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