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Fur Seal Investigations, 1992

by
Elizabeth H. Sinclair (editor)

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

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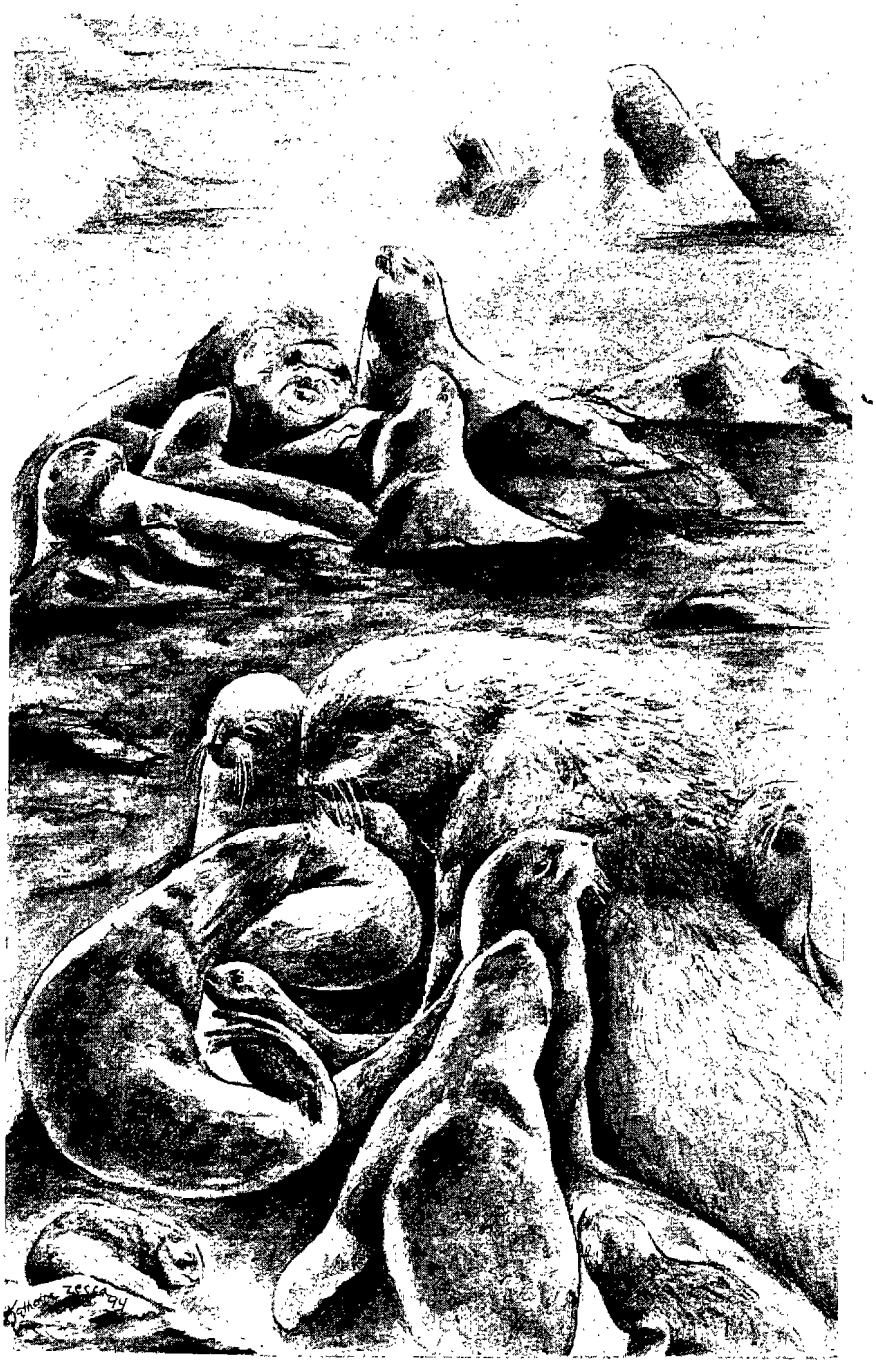

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ABSTRACT

This report is a collection of papers resulting from northern fur seal (Callorhinus ursinus) research conducted by the National Marine Mammal Laboratory in 1992 on the Pribilof Islands (10 July - 1 September) in the Bering Sea, and San Miguel Island (20 May - 1 November) off southern California.

Since 1991, harem bull counts increased 15.5% and 39.8% on St. Paul and St. George Islands, respectively?, The total number of pups born on St. Paul Island (182,468 + 19,263) was estimated from shear sampling surveys conducted during 17 August - 1 September and was not significantly different from the 1989 and 1990 estimates; The total number of pups born on St. George Island (25,160 + 1,730) was estimated from surveys conducted during 14-17 August and was not significantly different from the 1990 estimates.

A tagging project was initiated in 1987 to examine variability in population dynamics. The 1992 studies based on this tagged population support past findings that there is a tendency for males to be resighted near their natal rookery; that the date of first sighting is significantly related to age ($P < 0.001$) (older males arrive earlier in the season than younger ones); and a significant relationship exists between male pup weight and weight at age 2 ($P = 0.001$, $n = 20$) and age 3 ($P = 0.006$, $n = 8l$), but not at age 4 ($P = 0.07$, $n = 78$) or age 5 ($P = 0.18$, $n = 15$).

The estimated incidence of entanglement in net debris among

female fur seals on St. Paul Island was 0.062% for 1991 and 0.036% for 1992 with a 2-year mean of 0.046%. This is a reduced level of entanglement compared with a similar study in 1985 which showed entanglement rates of 0.06%-0.23% and a mean of 0.14%. The ‘proportion of juvenile males observed entangled in 1992 was 0.29%. The frequency of occurrence of trawl webbing among entangling debris in 1992 was about one-half that observed prior to 1988. The proportion of seals entangled in other types of debris did not change. The 1992 studies on male entanglement confirm earlier estimates that the annual survival of seals entangled in small debris is about one-half that of nonentangled seals. Seals from which debris was removed had significantly ($P < .05$) higher survival rates than those which remained entangled.

The maximum number of territorial bulls on San Miguel Island was 72 on 8 July. Live pup counts on 29 July and 5 August totaled 1,124 and 965, respectively. On 11 August, 274 dead pups were counted. One hundred and fifty pups were tagged on 27 September and another 150 were tagged on 1 November. Mean pup weights for 1992 were significantly lower ($P < .OOl$) than mean pup weights for all non-El Niño years between 1977 and 1991, but significantly greater ($P < .001$)Pthan those of the El Niño years of 1976 and 1983. This indicates that while the health of pre-weaned pups was compromised during the 1991-1992 El Niño, it was not as detrimental as previous warm water events.

CONTENTS

INTRODUCTION

Scientists from the National Marine Mammal Laboratory (NMML) have published reports of annual studies of northern fur seals (Callorhinus ursinus) from the Pribilof Islands (St. Paul and St. George) since 1958, and from San Miguel Island off Southern California since 1968. This document presents the results of research conducted in 1992.

From 1962 to 1990, annual estimates of population abundance were based on pup counts generated from shear sampling, a mark-recapture technique. Since 1990, pup counts have been conducted semi-annually during even years on all Pribilof Island rookeries. Bull counts on St. Paul Island have been conducted since 1958 and continue on a yearly basis. Pup tagging studies' began in 1987 and were discontinued on the Pribilof Islands for the purpose of population monitoring after 1990. Pup tagging began on San Miguel Island in 1975 and continues on a yearly basis. The location of U.S. fur seal rookeries and detailed maps of each island are illustrated in Figures l-5. Russian placename translations are listed in Table 1 and a glossary of terms is provided in Appendix A.

Northern fur seal research was conducted by the NMML under Marine Mammal Permit Number 598.

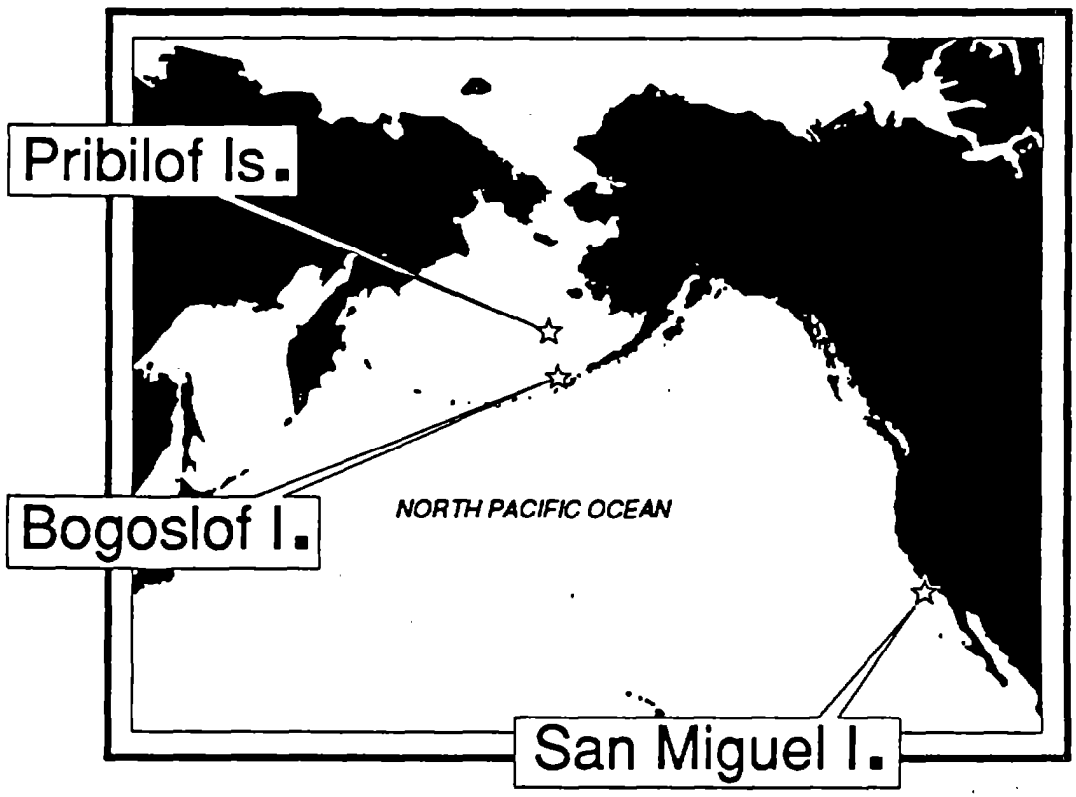


Figure 1. --Location of the four northern fur seal breeding rookeries within U.S. waters.

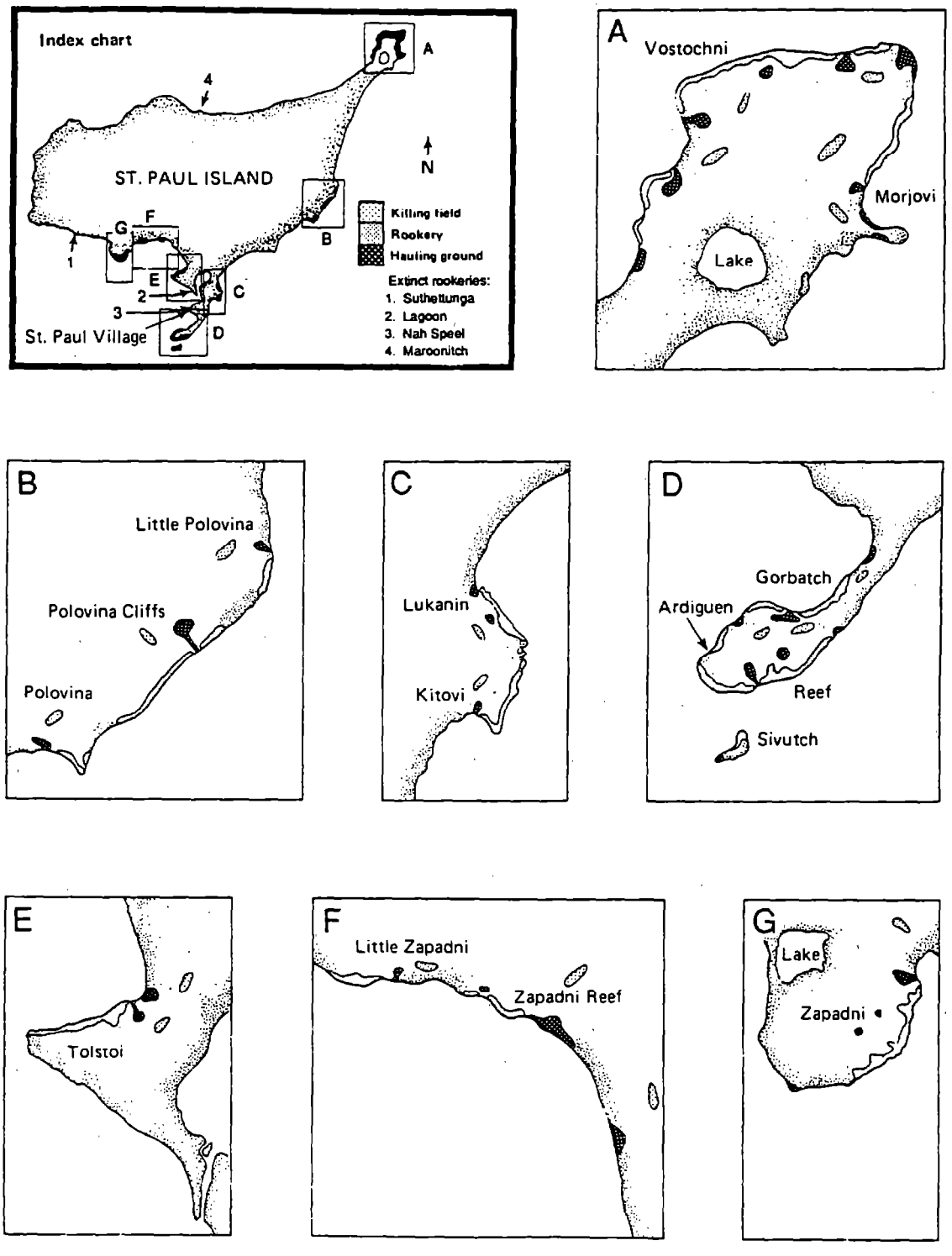


Figure 2. --Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. Paul Island, Alaska.

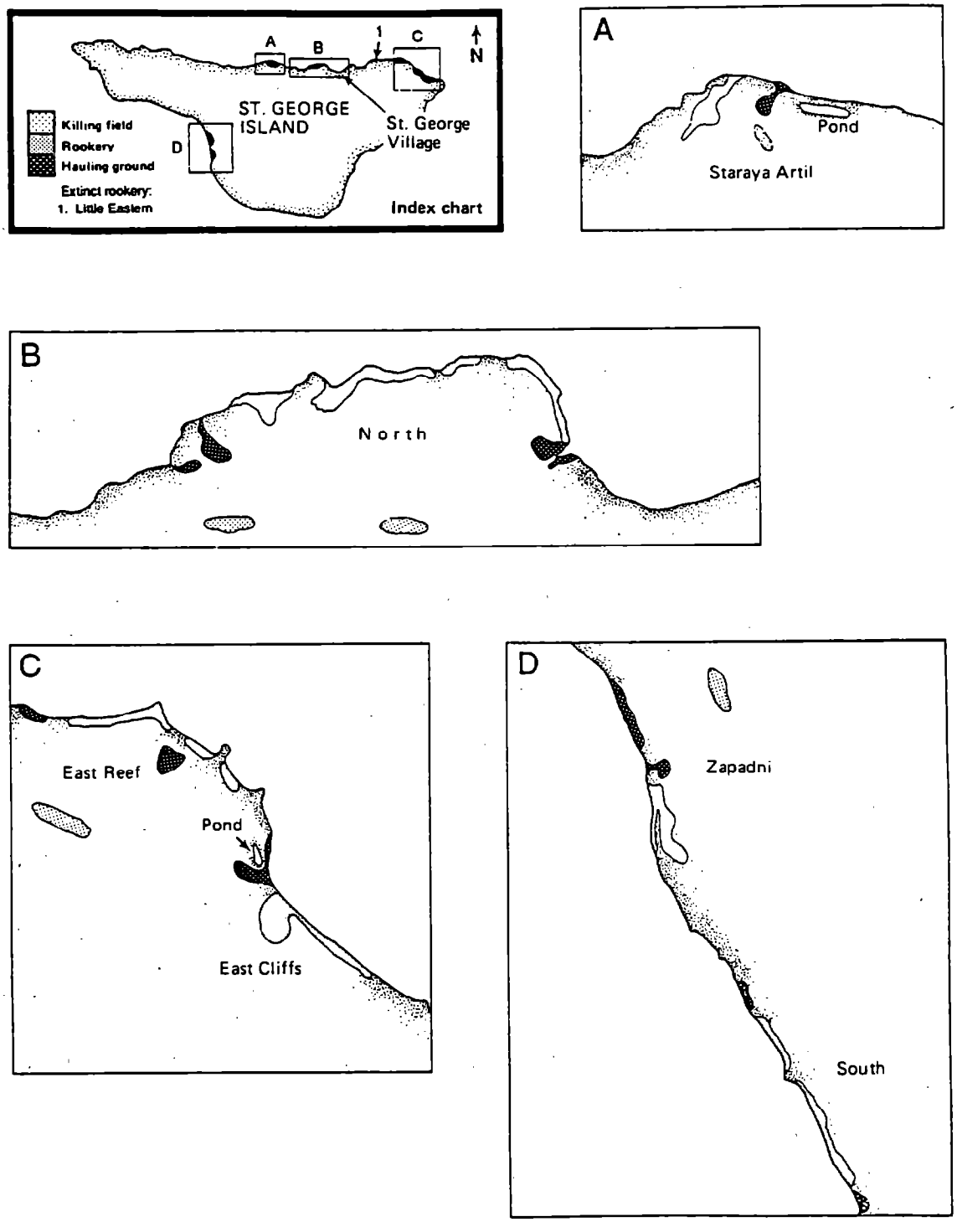


Figure 3.--Location of northern fur seal rookeries (present and extinct), hauling grounds, and harvesting areas, St. George Island, Alaska.

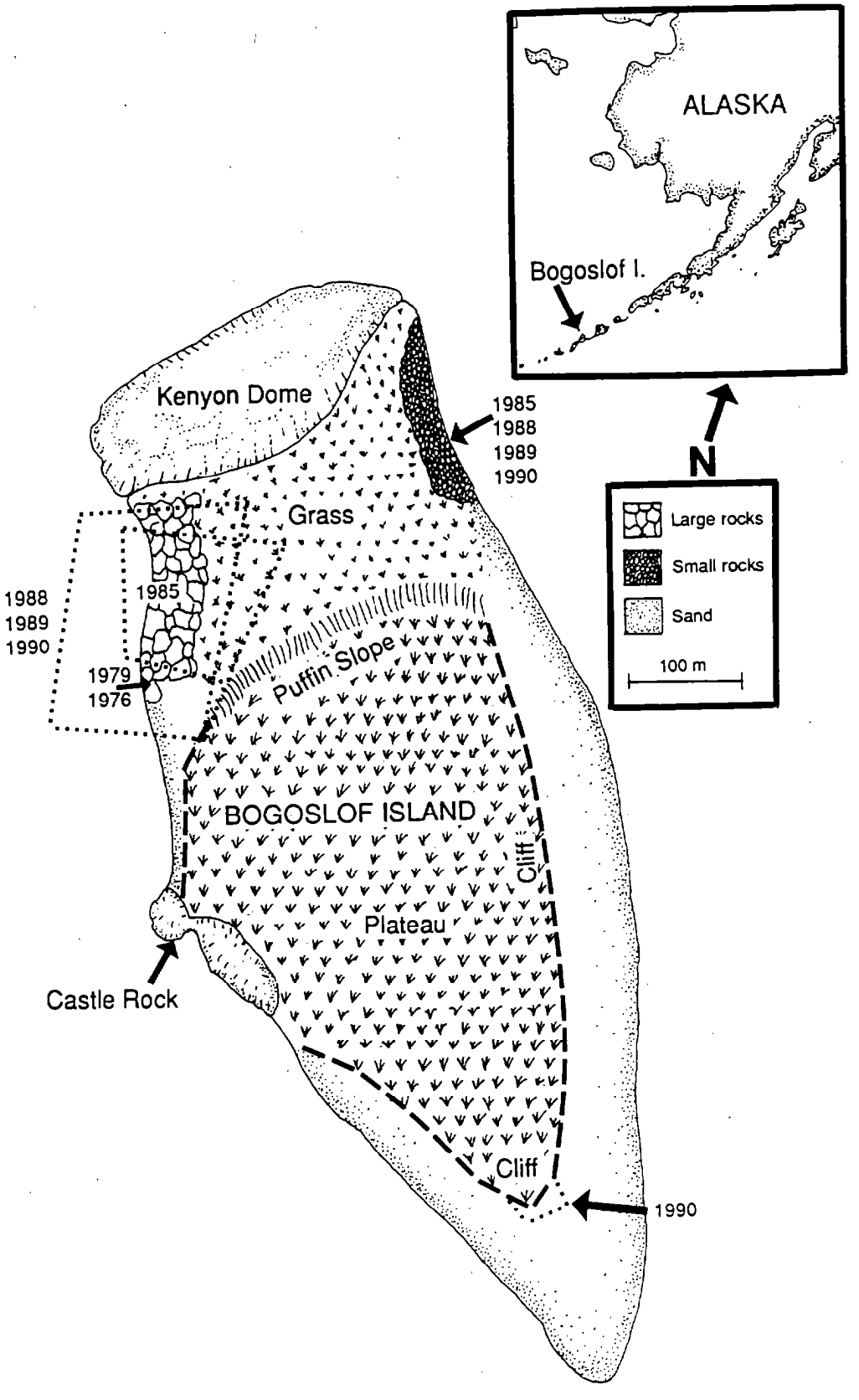


Figure 4.--Location of fur seals on Bogoslof Island, Alaska, indicated by year of observations.

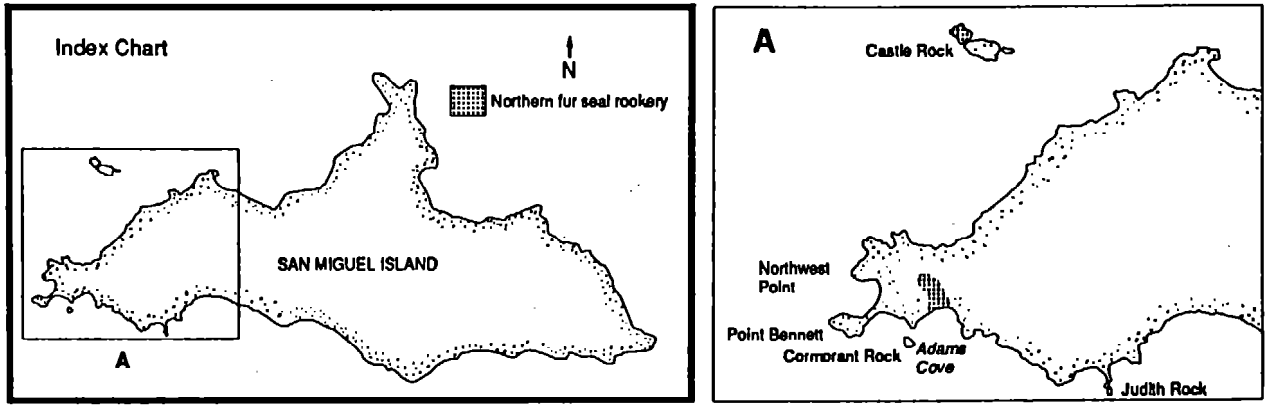


Figure 5. --Location of northern fur seal breeding colonies, San Miguel Island, California.

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

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

STATUS OF THE NORTHERN FUR SEAL POPULATION IN THE UNITED STATES DURING 1992

by

Thomas R. Loughlin, George A. Antonelis, Jason D. Baker, Anne E. York, Charles W. Fowler, Robert L. DeLong, and Howard W. Braham

This paper provides a brief overview of the distribution and status of northern fur seals, Callorhinus ursinus, in the United States. Northern fur seals range from the Pribilof Islands in the Bering Sea (where they were discovered in 1786) to San Miguel Island in the California Channel Islands. The San Miguel Island colony was discovered in the late 196Os, but the island was probably colonized in the late 1950s or early 1960s (Peterson et al. 1968). More recently, a rookery was discovered in 1976 on Bogoslof Island (53°56'N lat., 168°O2'W long.) in the southern Bering Sea. Two pups were first observed there in 1980 (Lloyd et al. 1981) and by 1992 the rookery had grown to at least 183 pups and 295 adult females (1,473 total animals) (Baker and Kiyota 1992, Loughlin and Miller 1989). Northern fur seals temporarily haul out on land at other sites in Alaska and British Columbia, and on islets along the coast of the continental United States, but generally not during the breeding season (Fiscus 1983).

There is significant interchange among the various breeding groups so they are considered components of a single species. Based on geographic separation, we recommend that the San Miguel and Pribilof Island's stocks be considered separate.

World-wide, northern fur seals occur from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan (Fig. 6). During the breeding season approximately 72% of all fur seals world-wide can be found on the Pribilof Islands, 19% can be found on the Commander Islands in the western Bering Sea' (Russia), 4% are on Robben Island in the Okhotsk Sea (Russia), <2% are on the Kuri1 Islands in the western North Pacific Ocean, and <l% are on San Miguel Island and Bogoslof Island (Lander and Kajimura 1982) . The estimated sizes of these populations in 1979 and 1992 are given in Table,2.

Estimation Methods

It is difficult to obtain an accurate estimate of the fur seal population because the estimation procedures are conducted while the seals are on land and at any given time some portion of the population is at sea. It is widely accepted that the best index of population trends is the number of pups born. Pups are counted in the middle of the breeding season after most pups are born and still on land. Pups comprise roughly 20%-30% of the total population (Fowler l985a) depending on the population's age structure (as determined by reproductive rates and mortality).

Various techniques were used to derive estimates of pup births including tagging, aerial photography, and counts of sample rookeries (Kenyon et al. 1954). Since 1962, pup production has been estimated using a mark-recapture technique called shearing-sampling (Chapman 1964, Chapman and Johnson 1968). From 1980 to 1989, the method was modified to subsample

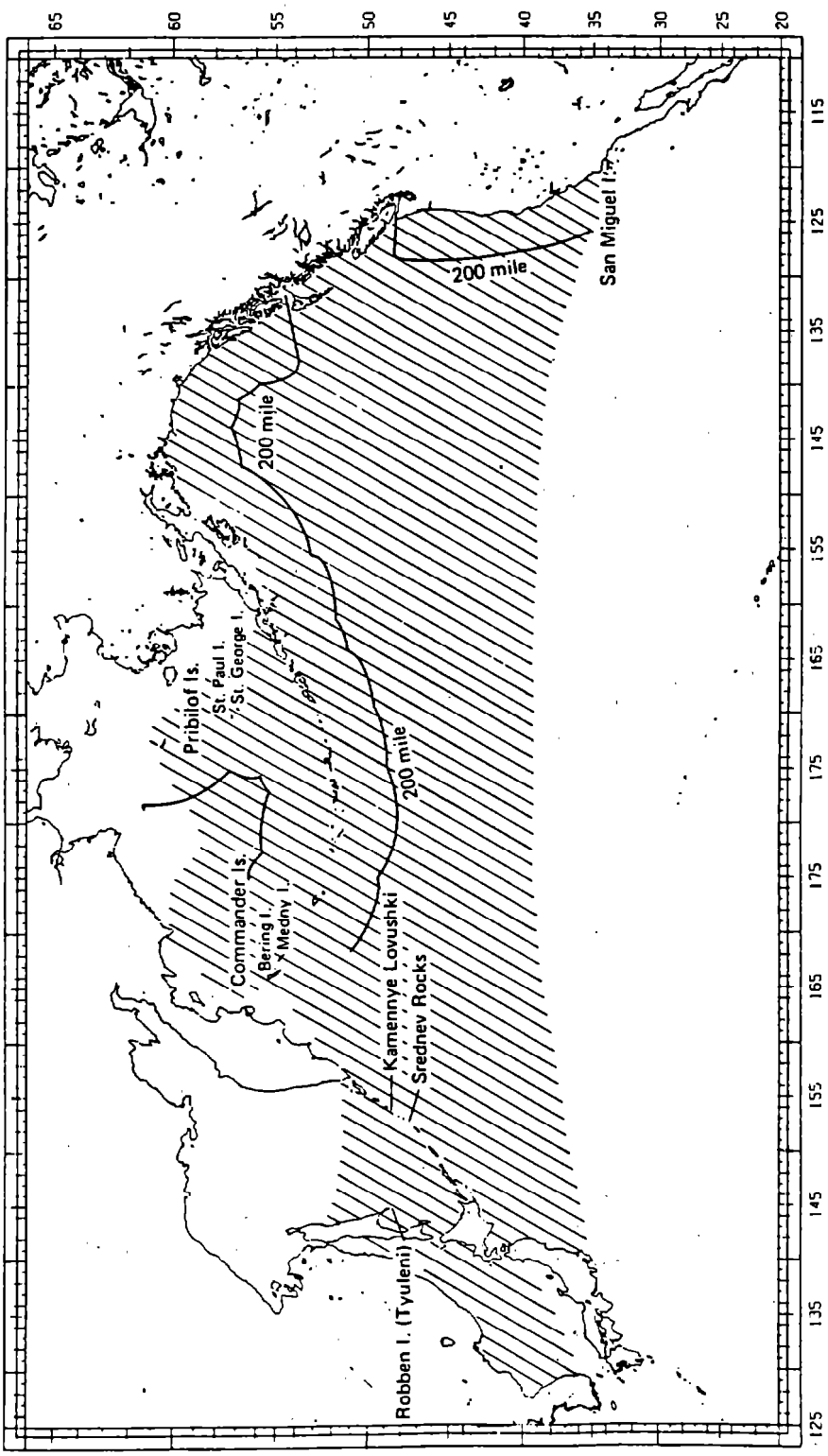


Figure 6.--Range of the northern fur seal with breeding islands indicated.

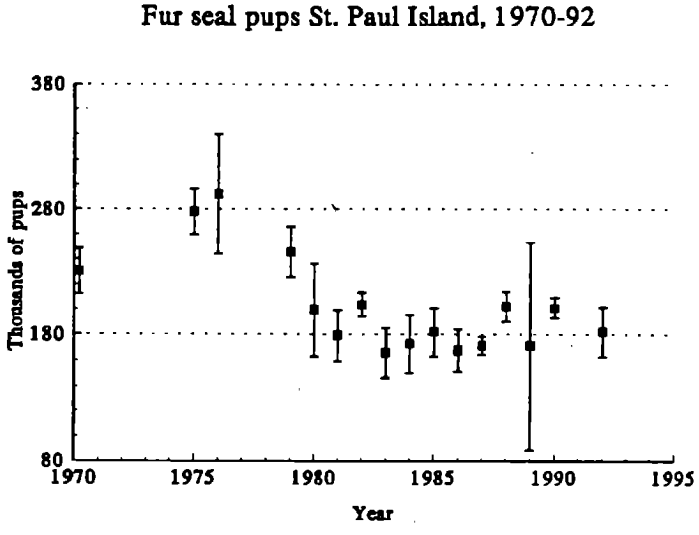
Table 2.--Estimated sizes of the northern fur seal stocks in 1979 and 1492. Number of pups born are shown in (). Russian estimates are from Vladimirov (1992).

Breeding island	Estimated size, 1979	Estimated size, 1992
Pribilof Islands	1,300,000 (294,000)[a]	982,000[b] (218,000)
Commander Islands	250,000 (65-75,000)	225-230,000 (65-75,000)
Robben Island	190,000 (56,500)[c]	50,000 (15,000)
Kuril Islands	33,000 (18,400)[d]	50,000 (13,800)[e]
San Miguel Island	6,543 (1,487)	8,211 (1,837)
Bogoslof Island	0	2,235[f] (500 minimum)

[a] 1978 estimate.
[b] See Table 4 for calculation of population estimate.
[c] Maximum count in 1967.
[d] Russian estimates for 1990 (V. Vladimirov, VNIRO, Moscow, pers. commun., 1991).
[e] 1988 count.
[f] 1990 estimate.

several of the 14 rookeries on St. Paul Island and to derive a total population (all age groups) estimate based on the ratio of pups to adult males (York and Kozloff 1987). However, due to the increase in the number 'of adult males following cessation of the commercial harvest of males in 1984, the ratio of adult males to pups became quite variable. This variability led to an imprecision in the shearing-sampling technique with subsampled rookeries (note the large confidence intervals for the 1989 estimate in Fig. 7). As a result, a new procedure was initiated in 1990 whereby all rookeries on both islands are censused every other year.

Adult males have been counted annually since 1911 to measure the recruitment of breeding males and general population trends (Figs. 8-11). Two categories of males, harem and idle, have been recorded for each year. For purposes of consistency in data, a harem male is defined in this text as one that is defending a territory containing one or more females. Idle males are usually about 7 years of age or older and may have territories but never with females. Between 1980 and 1992, the male counts were used to calculate estimates of pup production based on the' relationship between the number of territorial males and parturient females with pups (York and Kozloff 1987). The male counts are usually made in mid-July (l0-25 July) when most of the females have arrived and have given birth.



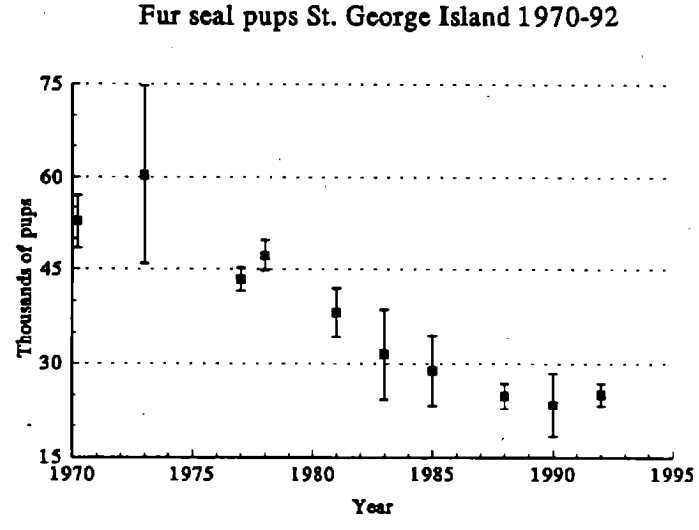


Figure 7 .--Estimated number of northern fur seal pups born on St. Paul Island and St. George Island Alaska, from 1970 to 1992 with 95% confidence intervals (York and Fowler 1992).

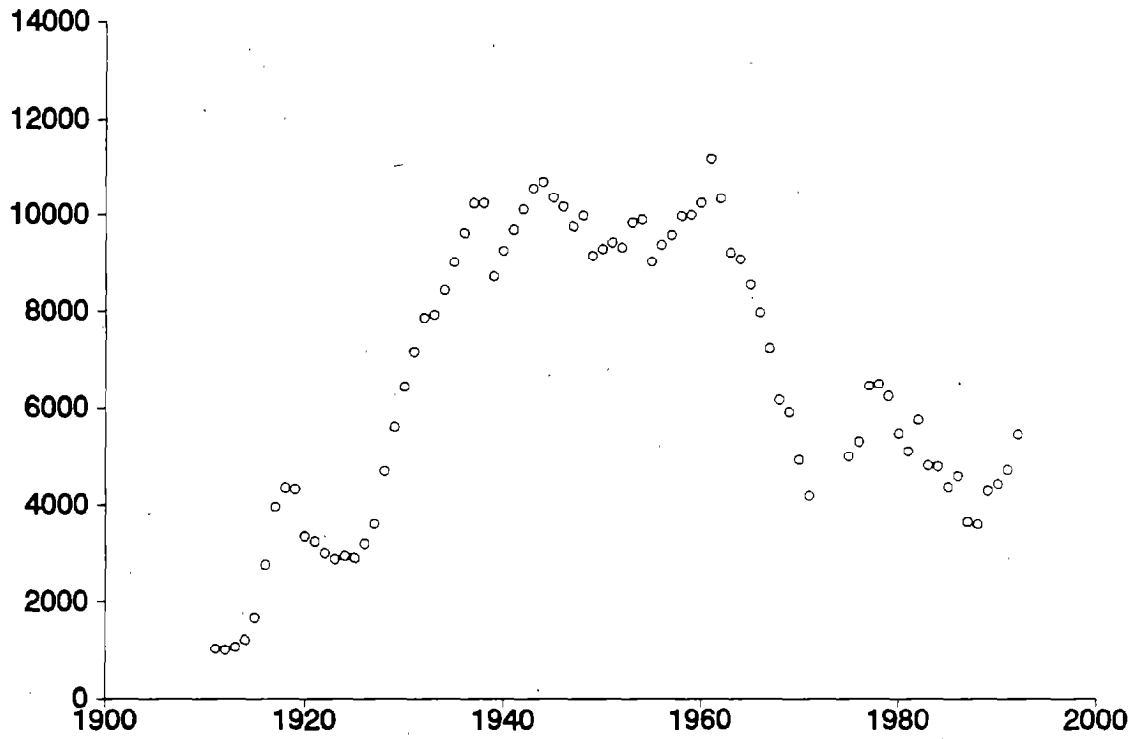


Figure 8. --Number of harem males counted, at St. Paul Island, Alaska, 1911-1992. The 1992 count was 5,460 seals.

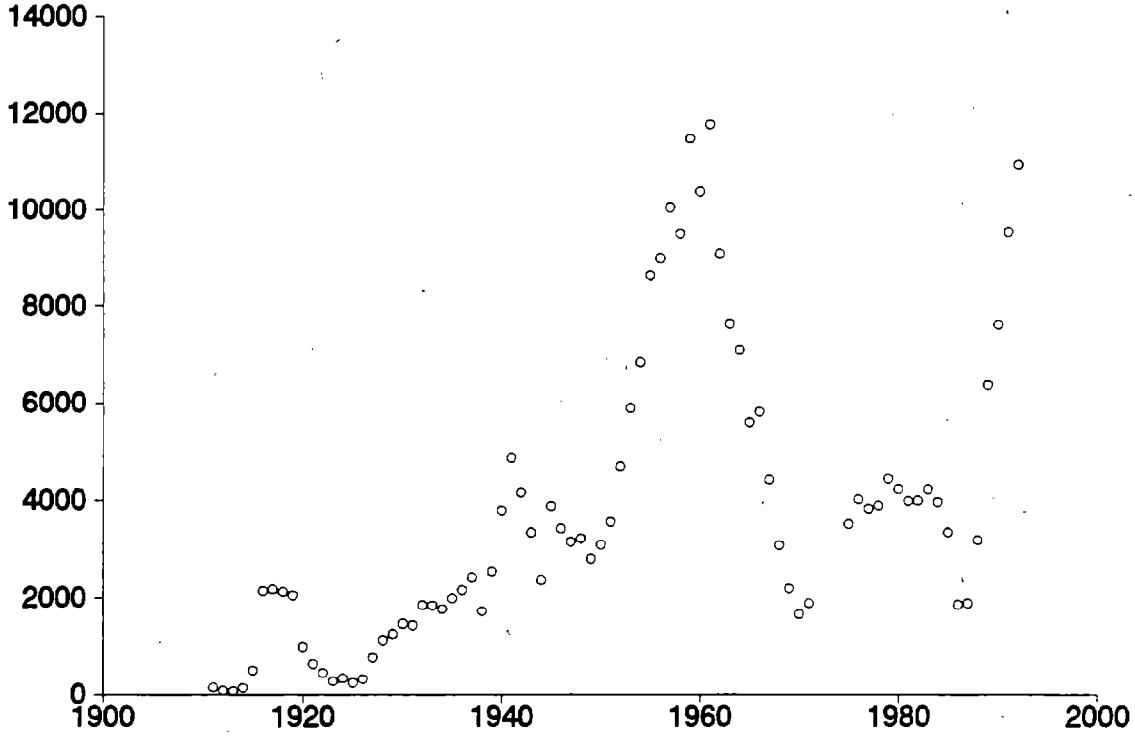


Figure 9. --Number of idle males counted at St. Paul Island, Alaska, 1911-1992. The 1992 count was 10,940 seals.

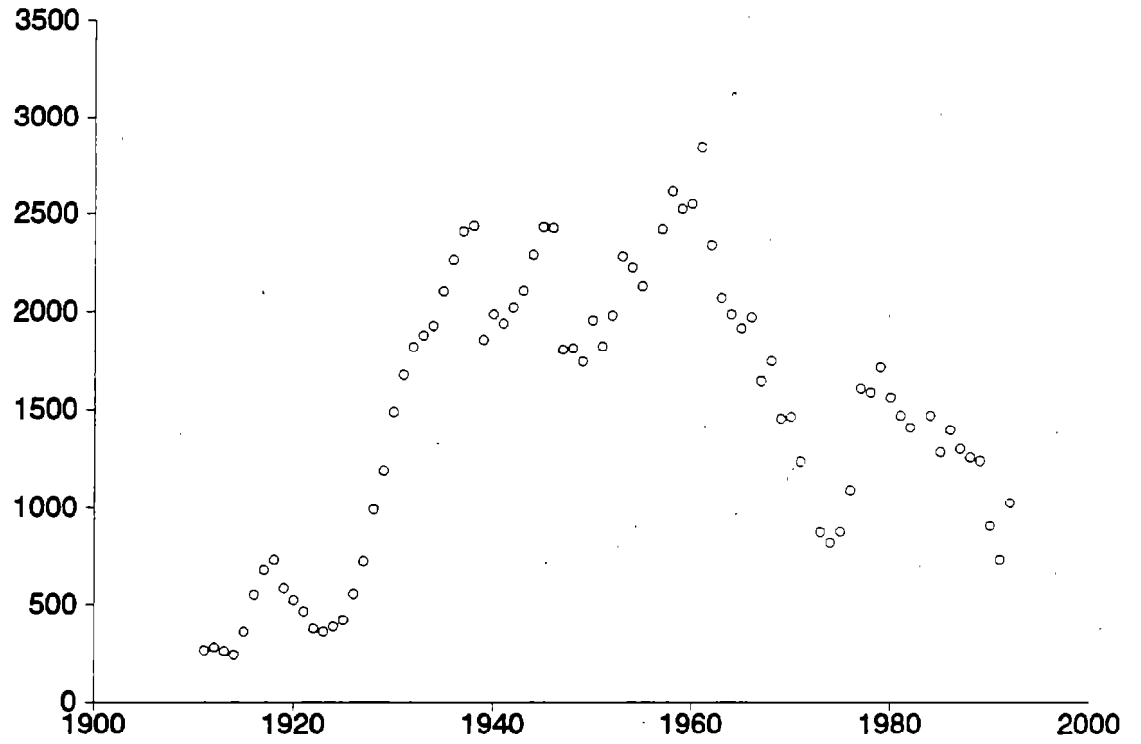


Figure 10. --Number of harem males counted at St. George Island, Alaska, 1911-1992. The 1992 count was 1,028 seals.

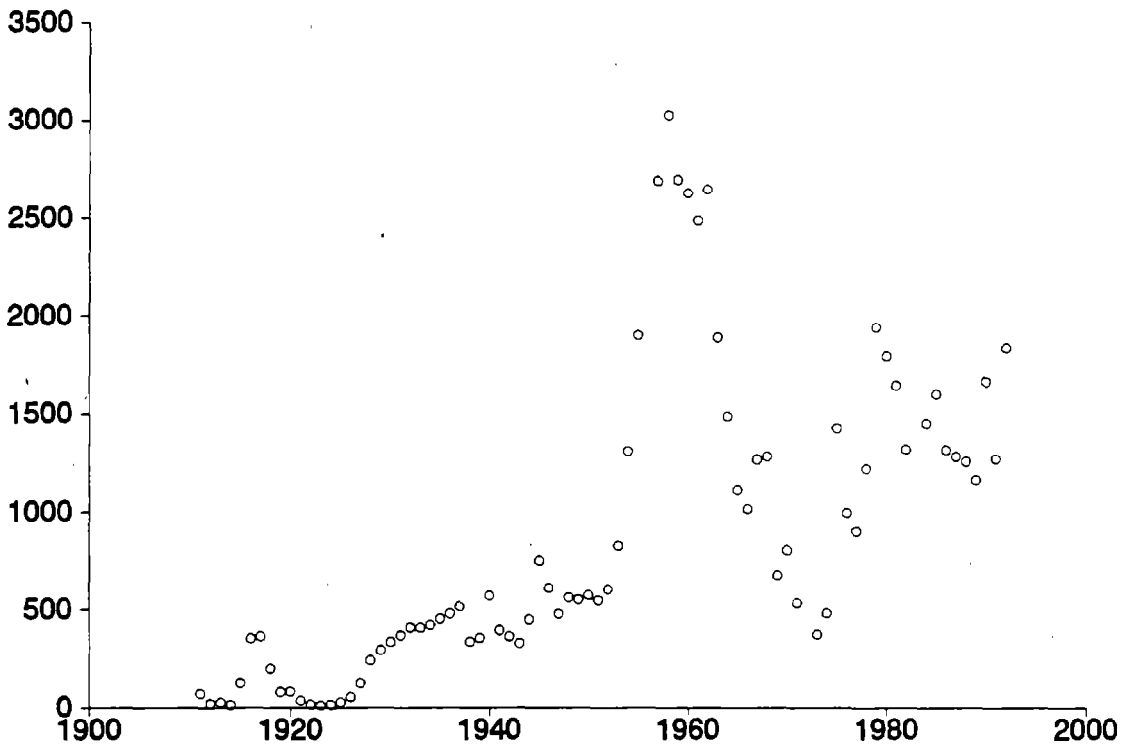


Figure ll.- -Number of idle males counted at St. George Island, Alaska, 1911-1992. The 1992 count was 1,834 seals.

Population Estimates

Estimates of the number of pups born on the Pribilof Islands are listed in Table 3. The number of pups born on St. Paul Island, which comprises the majority of the Pribilof Islands population, increased from about 67,000 pups in 1912 to about 162,000 pups in 1924. Records do not exist for the period 1925-1939, but in 1940 there were an estimated 469,000 pups born on St. Paul Island (York 1985a). The number of pups remained high until the mid- to late 1950s when it began to steadily decline (Briggs and Fowler 1984). Pup births declined following a commercial harvest of females during 1956-1968 (York and Hartley 1981). After the cessation of the female harvest, pup births appeared to increase (in the early 197Os), but then decreased at 4%-S% per year from 1976 to 1981 or 1982 (York and Kozloff 1987). No significant increase or decrease has occurred since then, based on combined Pribilof Islands counts, although pup births on St. George Island continued to decrease through the 1980s (York 1987b, Ream et al., Chapter 5, this volume).

The number of males counted at St. -Paul and St. George Islands is depicted in Figures 8-11 for the period 1911-1992. For 1992, the total number of males counted was 19,262. This total is based on harem and idle male counts at St. Paul Island of 5,460 and 10,940, respectively, and harem and idle male counts at St. George Island of 1,028 and 1,834, respectively.

From 1956 to 1968 the total Pribilof Island stock declined as a result of the female harvest. Following the termination of

Table 3.--Estimated numbers of pups born on the Pribilof Islands, 1912-1992.

Year	Pups born		Year	Pups born	
	St. Paul	St. George		St. Paul	St. George
1912	67,000	12,000	1963	262,000	
1913	75,000	13,000	1964	284,000	
1914	75,000	14,000	1965	254,000	
1915	83,000	15,000	1966	299,000	69,000
1916	93,000	18,000	1967	291,000	
1917	103,000	19,000	1968	235,000	
1918	116,000	20,000	1969	233,000	
1919	126,000	23,000	1970	230,000	54,000
1920	135,000	24,000	1972	269,000	
1921	141,000	27,000	1973	237,000	60,000
1922	150,000	27,000	1974	266,000	
1924	162,000	36,000	1975	278,000	
1940	469,000		1976	298,000	
1949	414,000	55,000	1977	235,000	43,000
1950	451,000		1978	247,000	47,000
1951	447,000		1979	246,000	
1952	438,000		1980	200,000	
1953	445,000		1981	179,000	38,000
1954	450,000		1982	204,000	
1955	461,000		1983	166,000	31,000
1956	453,000		1984	174,000	
1957	420,000		1985	183,000	29,000
1958	387,000		1986	168,000	
1959	335,000		1987	171,000	
1960	320,000		1988	202,000	25,000
1961	342,000		1989	172,000	24,000
1962	277,000		1990	212,000*	23,000
			1992	193,000*	25,000

*Includes 10,000 pups born on Sea Lion Rock from a 1990 estimate.

the female harvest in 1968, the stock increased between 1970 and 1976. In 1974, the stock was estimated to be 1.25 million fur seals with about 326,000 pups born on both Pribilof Islands (Lander 1981). After 1976, the stock abundance began to decline again along with a decline in pup production (York 1987b) resulting in a total stock estimate in 1983 of 877,000 fur seals (Briggs and Fowler 1984). As mentioned above, the, number of pups born on the Pribilof Islands did not change significantly from 1981 to 1988, suggesting that the total stock size had not changed (York 1987b; York and Fowler 1992).

We used recent estimates of pup births on the Pribilof Islands and annual male counts to obtain an estimate of the stock size for 1992. Applying these counts to the algorithm presented in Kozloff et al. (1985), and adjusted to remove harvest mortality of males (Table 4), we estimated the Pribilof Islands' northern fur seal population stock size to be 982,000 in 1992.

The fur seal population on San Miguel Island has slowly increased since its discovery in 1968 (Fig. 12). Counts of fur seals at Adams Cove on San Miguel Island in 1992 included a maximum of 72 territorial males, of which 59 had females. The minimum number of pups born at Adams Cove was estimated at 1,239 and 598 were estimated for Castle Rock. These estimates are based on live pup counts in early August at both rookeries and a dead pup count at Adams Cove (n = 274). Dead pup counts were estimated at Castle Rock assuming the same mortality rate as Adams Cove (22%).

Table 4.--Information used to calculate the 1992 Pribilof Island stock size using the life table reported by Lander (1981), and adjusted for lack of harvest mortality. Estimates of the standard deviations are based only on the estimated standard deviations for numbers of pups, and not on any standard deviations for the life table, nor do they account for year-to-year variations in survival rates.

Year	Pup production: St. Paul	St. George[a]	Sea Lion Rock	Total[b]	Average 1989, 1990, and 1992
1992	182,468	25,160	-	217,845	219,548
1990	201,305	23,397	10,217	234,919	
1989	171,534	24,130	-	205,881	
1988	202,229	24,862	-	237,308	

Formula for estimate	Pribilof Island total stock estimate: Estimate	SD	Age group
Average[c]	219,548	27,760	pups
(219,548) X (0.5)	109,774	13,880	yearlings
(109,774) X (0.8)	87,819	11,104	2 year olds
(87,819) X (0.86)/2	37,762	4,775	3 year-old females
(87,819) X (0.8)/2	35,128	4,442	3 year-old males
(219,548) ÷ (0.6)	121,729	46,267	adult females
(35,128) X (3.6)	126,460	15,991	adult males
	Total Pribilof Islands stock (4.4747 X pups)	124,219	
Rounded to 1,000s	982,000	124,000	Total population estimate

[a] 1989 represents the mean of the 1990 and l988 estimates.

[b] All totals include the 1990 estimate of 10,217 pups produced on Sea Lion Rock (south end of St. Paul Island).

[c] Average for 1992, 1990, 1989.

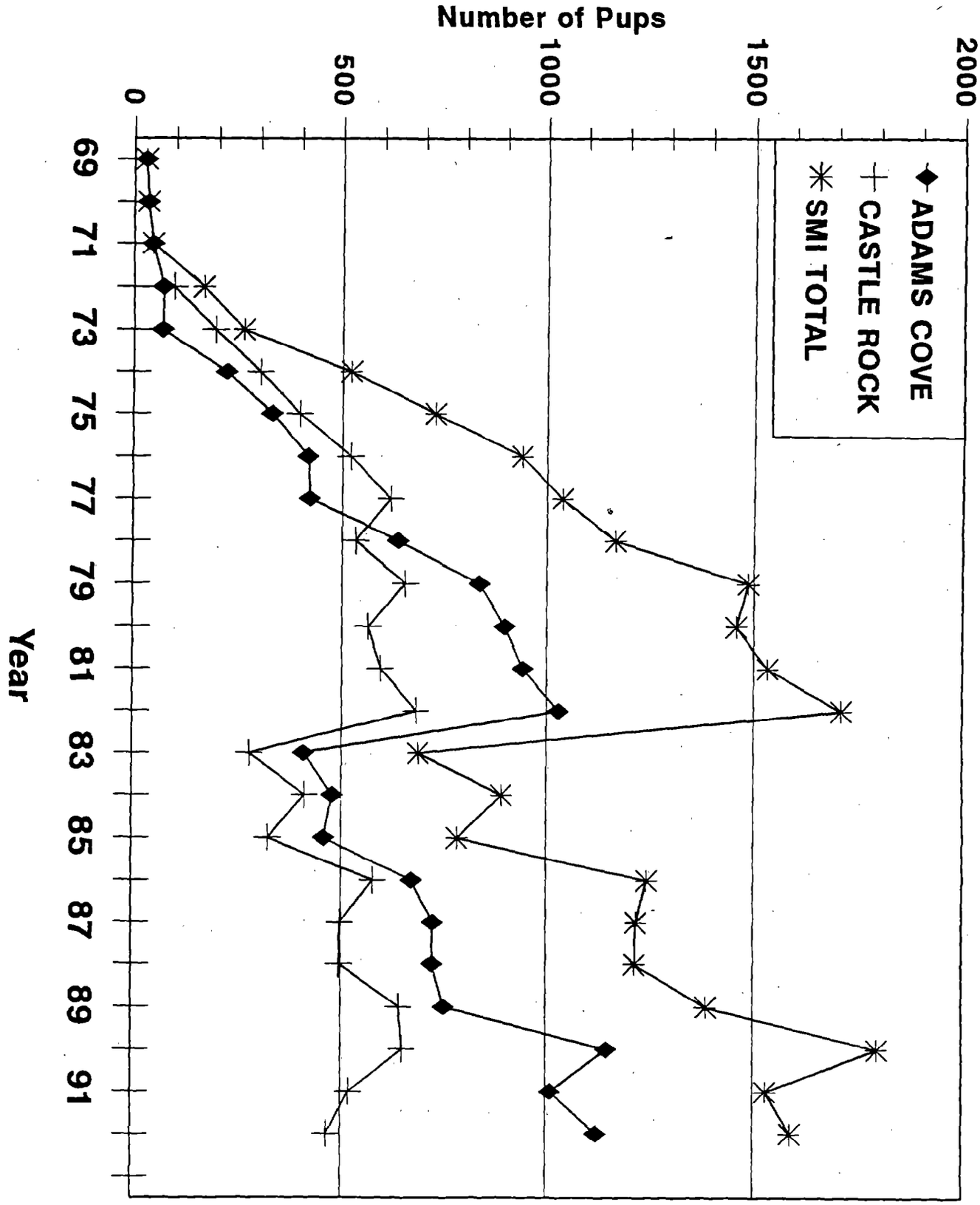


Figure 12.--Number of northern fur seal pups counted at San Miguel Island and Castle Rock, California, 1969 to 1992.

Population Growth Rates and Trends

The rate of juvenile fur seal mortality on land is density dependent and higher at high population levels than at low population levels. The juvenile mortality rate on St. George Island is lower than on St. Paul Island (York 1985c). Since the late 197Os, mortality rates of pups up to 4 months of age have been less than 10% on the Pribilof Islands, although historically they have been as high as 20%. During the first 2 years of life, mortality may be 60%-80% (Keyes 1965, Lander 1981, Fowler 1985a, York 1987c). Males have a higher mortality rate than females after 2 years of age, particularly after 7 years of age when males begin defending territories (Lander and Kajimura 1982). Survival of adult females remains high (>80%) until age 14, after which it decreases to about 30% by age 19 (Smith and Polacheck 1981).

All indications suggest that the Pribilof Island population is below its carrying capacity (K), therefore a positive growth rate is expected. Yet, from 1976 to 1981, the St. Paul Island population declined approximately 7.8% per year and St. George Island fur seal numbers declined at 5%-6% per year (York 198733). Many possible causes (entanglement, diet, disease) for the decline have been considered (Sinclair et al. 1994, Fowler 1985a, National Marine Fisheries Service 1993), yet no clear explanation exists. Likewise, why the decline ended on St. Paul Island and persisted on St. George Island is not understood.

The birth rate of fur seals on Point Bennett, San Miguel Island, and on Castle Rock increased about 24% annually from 1972 through 1982, then decreased by 63% in 1983 due to a significant El Niño event (DeLong and Antonelis 1991). Birth rates remained low through 1986 resulting in about 50% fewer births in 1984 and 1985 than in 1982; the number of births increased in 1986, but there were still 30% fewer pups born than in 1982 (DeLong and Antonelis 1991). No detailed information is available from Bogoslof Island, but counts of the entire population indicate that the colony is continuing to grow.

Stock Status Relative to Optimum Sustainable Population and Carrying Capacity

Growth Rate at Maximum Net Productivity Level

Based on empirical information for northern fur seals (Smith 1973) and interspecific comparisons (Fowler 1984a), maximum net productivity level is estimated. to occur at approximately 60% of carrying capacity (K). Ragen (1992) presented frequency distributions for the number of pups born at MNPL. Based on these distributions, Ragen concluded that the current population level (producing approximately 200,000 pups) is very likely below MNPL.

Methods of Optimum Sustainable Population Determination

OSP is defined as the range of population levels between MNPL and K. Ragen (1992) conducted a simulation analysis using numerous combinations of estimated values for fur seal population

parameters which yielded frequency distributions for MNPL with modal values at approximately 65% of K. His analyses yielded frequency distributions rather than point estimates which reflected the uncertainty in life table values and density-dependent mechanisms influencing the growth of the fur seal population on the Pribilof Islands.

It is assumed that northern fur seals were at their carrying capacity when the population was relatively stable and at historically high levels (1940s and 1950s). It is also assumed that the mean populationlevel for this period represented the carrying capacity of the Pribilof Island stock.

The MMPA defines a species, population, or stock as depleted if it falls below optimum sustainable population (OSP). As discussed above, the lower bound of OSP for northern fur seals is thought to be at least 60% of K. The Pribilof Islands population was designated as depleted under the MMPA in 1988 because it declined to less than 50% of levels observed in the late 1950s and there was no compelling evidence that carrying capacity had changed substantially since the late 1950s (Department of Commerce 1988).

The percentage declines of several population parameters were presented by the National Marine Fisheries Service (1993) and are updated in Table 5. There has been a recent increase in the number of adult males on St. Paul Island, which reflects the cessation of the harvest of juvenile males in 1984 (York and Fowler 1992). Adult males which would have otherwise been killed

Table 5.--Parameter estimates used to illustrate the reduction of northern fur seals on St. Paul Island (rounded to the nearest hundred) since the 1940s and 1950s when the population was thought to be at or near maximum levels (presumed carrying capacity). Updated from National Marine Fisheries Service (1991). Data for 1989-1992 from Antonelis et al. (1990), York and Fowler (1992), and Antonelis et al. (this volume).

Parameter measured	Abundance estimates		Percent decline	Abundance estimates 1989-1992 means	Percent decline
	Previous peak	Recently			
Pup production	461,000 (1955)	175,000 (1981-88)[1]	62%	192,000	58%
Commercial harvest[2]	52,600 (1947-53)	24,700 (1976-84)	53%	none	--
Rookery space[3]	109,100 (1967)	41,400 (1985)	62%	no data	--
Harem males[4]	10,300 (1958-62)	4,200 (1984-88)	59%	4,700	54%
Total adult males[5]	20,800 (1958-62)	7,100 (1984-88)	66%	13,400	35%

[1] Mean of means; the range of the 95% confidence intervals is 148,000 (low; 1983) to 210,000 (high; 1988).

[2] Highest annual harvest of juvenile (l-6 year old) males during peak abundance in 1940-58 (mean 52,643, sd 7,517, range 42,272 to 64,481), compared with the period beginning with the recent decline in 1976 through the last year of a commercial harvest in 1984 (mean 24,741, sd 1,813, range 22,034 to 28,396).

[3] Measured in square meters (m^2). Four major rookeries were compared (Tolstoi, Kitovi, Morjovi, and Zapadni), which make up about 65% of space used by fur seals on St. Paul Island. A comparison of five rookeries (Kitovi, Polovina, Little Zapadni, Lukanin, and Zapadni), where data are available for 1948 and 1985, suggests a decline greater than 70%.

[4] Five-year mean harem bull count for peak abundance (1958-62) (95% CI 9,910 to 10,776) and lowest mean count (95% CI 3,701 to 4,699) for the period of no statistical trend in pup production (1981-84). The greatest decline in harem bull counts occurred between 1962 and 68, from 10,000 to 6,000. Since 1968, the number of harem males has ranged from 6,496 in 1978 to 3,585 in 1988.

[5] Includes harem and idle adult males only: 1958-62 mean 20,803 (95% CI 19,482 to 22,124) and 1984-88 mean 7,058 (95% CI 5,944 to 8,172). There was no change at St. George Island.

in the harvest are now mature and are 35% fewer in number since their historical high in 1958-62. The decrease in birth rates relative to peak production in 1955 (Table 4) has not changed significantly. It has remained from 60% to 62% of historical levels during the 1980s and early 1990s. The most recent census in 1992 estimated 193,000 pups were born on St. Paul and 25,000 on St. George Islands (Table 3). This level of pup production, relative to that observed in the 1940s and 195Os, indicates that the fur seal population remains depleted (33%-67% of K).

POPULATION ASSESSMENT, PRIBILOF ISLANDS, ALASKA

b y

George A. Antonelis, Anne E. York, and Charles W. Fowler

In accordance with provisions originally established by the Interim Convention on Conservation of North Pacific Fur Seals, the National Marine Mammal Laboratory (NMML) continues to monitor the status of fur seal populations on the Pribilof Islands. To meet this objective, data on population size, age and sex -composition., and natural mortality are collected annually following the methods described by Antonelis (1992).

Population Parameters

Population characteristics monitored in 1992 include the number of adult males, pups born, and mortalities of fur seals on St. Paul Island and St. George Island.

Sex Composition of Seals Harvested

A total of 1,482 sub-adult male seals were killed in the subsistence harvest by St. Paul Island residents in 1992 (Table 6). Two female fur seals were taken accidentally on St. Paul Island. On St. George Island, 194 sub-adult male seals were taken in the subsistence harvest in 1992 (Table 7).

Living Adult Male Seals Counted

Adult male seals were counted by section for each rookery (see Appendix A glossary for definition of terms) on St. Paul Island from 10 to 16 July (Appendix Table B-l). A total of 5,460 harem (class 3) and 10,940 idle (classes 2 and 5) adult male

Table 6. -- Date, location, and number of subadult male seals killed in subsistence harvest drives on St. Paul Island, Alaska, in 1992.

Date	Rookery	Number killed
June 30	Reef	60
July 2	Zapadni	55
July 3	Polovina	40
July 6	Reef	56
July 8	Lukanin	40
July 9	Polovina	60
July 10	Zapadni	57
July 13	Reef	70
July 14	Polovina	73
July 15	Lukanin	28
July 16	Little Zapadni	20
July 17	Zapadni	75
July 21	Reef	44
July 22	Lukanin	39
July 23	Polovina	46
July 24	Northeast Point*	53
July 25	Zapadni	55
July 28	Reef	79
July 29	Kitovi	67
July 30	Polovina	48
July 31	Zapadni Reef	70
August 1	Zapadni	36
August 3	Lukanin	22
August 4	Polovina	44
August 5	Zapadni Reef	48
August 6	Zapadni	52
August 7	Reef	145
Total		1,482

* Includes Vostochni and Morjovi rookeries

Table 7.--Date, location, and number of subadult male seals killed in subsistence harvest drives on St. George' Island, Alaska, in 1992.

Date	Rookery	Number killed
July 3	Zapadni	15
July 5	Zapadni	21
July 9	Zapadni	29
July 12	Zapadni	17
July 14	Zapadni	14
July 20	Zapadni	12
July 25	Zapadni	23
July 28	Zapadni	6
August 1	Zapadni	11
August 5	Zapadni	14
August 6	Zapadni	13
August 8	North	19
Total		194

seals, also referred to as bulls, were counted by section. The relative location of the different classes of adult males is illustrated for a typical fur seal rookery-hauling ground complex on the Pribilof Islands in Figure 13. Total numbers of harem and idle bulls counted since 1975 are given in Appendix Table B-2 and the classification and number of male seals counted by-rookery for St. Paul and St. George Islands are presented in Table 8.

Harem bull counts on St. Paul Island were 15.5% higher in 1992 than in 1991. On St. George Island, harem bull counts increased 39.8% between 1991 and 1992. After the last commercial harvest of sub-adult males on St. Paul Island in 1984, counts of harem and idle bulls increased by 24.9% and 225.3%, respectively, in 1992. In 1992, counts of harem and idle bulls on St. George Island increased 17.6%, and 389.1%, respectively, since the last commercial harvest of sub-adult males in 1972.

Number of Pups Born on St. Paul Island in 1992

The number of pups born on St. Paul Island was estimated in August and early September by adding the estimated number of live pups from a shearing/sampling (mark/recapture) study and the total count of dead pups on all rookeries (except Little Polovina rookery on St. Paul Island[1]). The previous estimate of pup production on all rookeries was obtained in 1990. Detailed information on the techniques used to estimate pup production are found in York and Kozloff (1987) and Antonelis (1992).

[1]A census was not conducted on Little Polovina because the number of pups born there has declined precipitously since 1980, and any disturbance to the rookery was considered inadvisable.

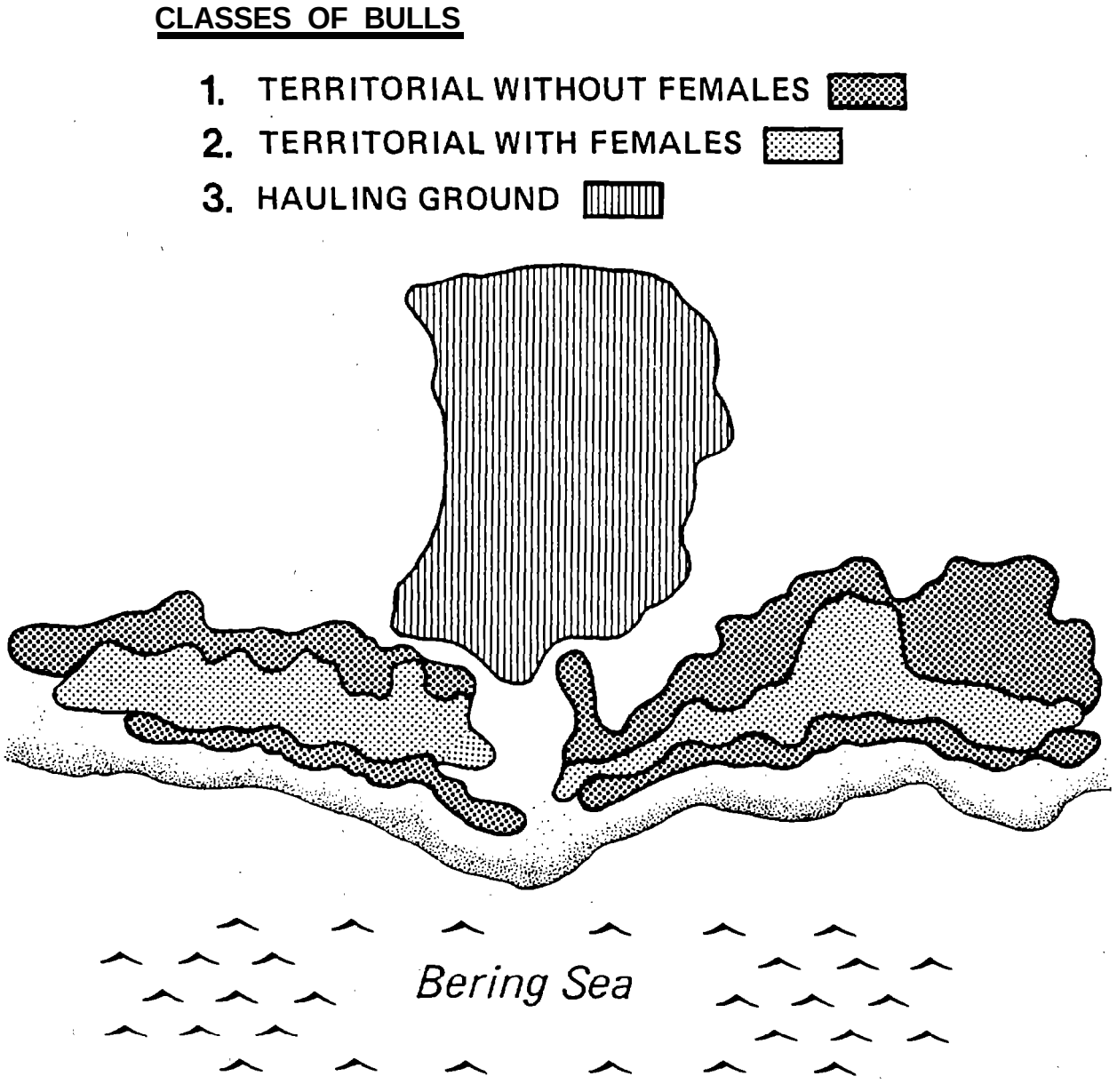


Figure 13.--General composition of a typical fur seal rookery. Class 2 as depicted here corresponds to classes 1 and 2 of Appendix A and class 5 corresponds to classes 4 and 5 of Appendix A.

Table 8. --Number of adult male northern fur seals counted, by rookery, Pribilof Islands, Alaska, July 1992.

Rookery	Date (July)	Class of adult male* 2	3	5	Total
St. Paul Island					
Lukanin	10	71	119	224	414
Kitovi	10	126	313	430	869
Reef	11	227	536	841	1604
Gorbatch	11	123	468	937	1528
Ardiguen	11	16	77	17	110
Morjovi	15	138	465	706	1309
Vostochni	15	389	936	1,301	2,626
Little Polovina	12	7	18	407	432
Polovina	12	22	66	341	429
Polovina Cliffs	12	128	502	304	934
Tolstoi	16	243	790	842	1875
Zapadni Reef	10	116	159	605	880
Little Zapadni	10	164	342	566	1,072
Zapadni	12	191	669	1,458	2,318
Island total		1,961	5,460	8,979	16,400
St. George Island					
Zapadni	11	72	128	344	544
South	11	98	200	125	423
North	11	187	360	341	888
East Reef	12	40	56	63	159
East Cliffs	12	125	209	286	620
Staraya Artil	10	60	76	93	228
Island total		582	1,028	1,252	2,862

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

From 6 to 16 August, 21,164 pups were shear-marked. The number of pups sheared on each rookery was approximately 10% of the 1990 pup production estimate. Shear marks were allocated proportionally on each rookery by section (Appendix Table B-3) according to the fraction of the rookery total harem males counted on each section. Counts of harem bulls in 1991 at St. Paul Island were used to determine the allocation of shear marks on pups for each rookery. The ratio of marked to unmarked pups was determined by at least two researchers on two occasions for each rookery; first from 17 to 25 August, and again from 26 August to 1 September. Each researcher obtained counts of marked and unmarked pups independently and in different areas to ensure that the entire rookery was well sampled. Each sampling day was considered an independent replicate from which the variance was computed for each rookery.

Dead pups were counted on all rookeries except Little Polovina from 17 to 24 August. Numbers of dead pups counted by section are given in Appendix Table B-4. A summary by rookery of the number of pups sheared, sampling data, and the estimated mean number of pups alive at the time of marking is, given in Table 9. For each sampled rookery, the standard deviation of the pup estimate is computed from the standard error of the two estimates. The estimated number of pups born, dead pups, counts of harem bulls,. and ratios of pups to adult males for all rookeries on St. Paul Island is summarized in Table 10. The estimate for the total number of pups alive on St. Paul Island at the time of marking was 173,912 (SD = 8,918). The number of dead

Table 9.-- Total number of northern fur seal pups sheared, number of sheared pups resighted on two sampling occasions (R1 and R2), total number sampled on two sampling occasions (T1 and T2), number of pups estimated to be alive at the time of marking (E1 and E2), end the mean number alive (Mean) and standard deviation (SD), St. Paul Island, Alaska, 1992. Separate information is given for Kitovi Arphitheater and 2nd Point South of Sea lion Neck; these are considered as part of Section 1 of Kitovi and Morjovi rookeries, respectively.

Rookery	Sheared	R1	R2	T1	T2	E1	E2	Mean	SD
Lukanin	501	140	141	1,050	975	3,758	3,464	3,611	146.6
Kitovi	984	220	225	1,450	1,575	6,485	6,888	6,687	201.3
Kitovi Amph.	72	12	18	75	75	450	300	375	75.0
Reef	2,573	397	402	2,925	3,350	18,957	21,442	20,199	1,242.2
Gorbatch	1,702	237	270	2,175	2,500	15,620	15,759	15,689	69.8
Ardiguen	289	93	73	625	500	1,942	1,979	1,961	18.6
Morjovi	1,246	176	204	1,775	1,950	12,566	11,910	12,238	327.9
2nd Point South	70	16	13	125	150	547	808	677	130.4
Vostochni	3,329	659	395	3,975	4,400	20,080	37,083	28,581	8,501.2
Polovina	258	29	46	225	300	2,002	1,683	1,842	159.6
Polovina Cliffs	1,934	404	514	3,275	4,075	15,678	15,333	15,505	172.5
Tolstoi	2,901	388	426	2,800	3,300	20,935	22,473	21,704	768.7
Zapadni Reef	663	102	115	1,050	1,050	6,825	6,053	6,439	385.8
Little Zapadni	1,820	383	310	2,575	2,825	12,236	16,585	14,411	2,174.6
Zapadni	2,751	377	568	3,200	4,850	23,351	23,490	23,420	69.7

Table 10.-- Number of pups alive at the time of marking, its standard deviation /SD), numbers of dead pups, total pups born, mortality rate, idle males, harem males, and ratio of pups alive at marking to harem bulls, St. Paul Island, Alaska, 1992.

Rookery	Pups alive at marking	SD	Dead pups[a]	Total pups born	Mortality rate (%)	Idle bulls	Harem bulls	Ratio pups/bulls
Lukanin	3,611	146.6	204	3,815	5.35	295	119	30.34
Kitovi	7,062	214.8	221	7,283	3.03	556	313	22.56
Reef	20,199	1,242.2	1,247	21,446	5.81	1,068	536	37.68
Gorbatch	15,689	69.8	767	16,456	4.66	1,060	468	33.52
Ardiguen	1,961	18.6	85	2,046	4.22	33	77	25.47
Morjovi	12,915	352.9	514	13,429	3.83	844	465	27.77
Vostochni	28,581	8,501.2	949	29,530	3.21	1,690	936	30.54
Polovina	1,842	159.6	49	1,891	2.59	363	66	27.91
Polovina Cliffs	15,505	172.5	554	16,059	3.45	432	502	30.89
Tolstoi	21,704	768.7	1,409	23,113	6.10	1,085	790	27.47
Zapadni Reef	6,439	385.8	402	6,841	5.88	721	159	40.50
Little Zapadni	14,411	2,174.6	632	15,043	4.20	730	342	42.14
Zapadni	23,420	69.7	1,495	24,915	6.00	1,649	669	35.01
Little Polovina[b]	573	26.1	28	601	4.66	414	18	31.83
Island total[a]	173,912	8,918.6	8,556	(192,468)[c]	4.69	10,940	5,460	31.85

[a] Includes dead pups taken for necropsies: 166 at Reef and 61 at Vostochni.

[b] Pups alive et marking and its standard deviation are calculated from the jackknife ratio estimates of pups to breeding males. Numbers of dead pups are estimated from an average mortality based on all rookeries excluding Little Polovina. Total is estimated from the sum of estimates of live pups and dead pups.

[c] Estimate includes approximately 10,000 animals counted at Sea Lion Rock in 1990 (Kajimura and Sinclair 1992; NMFS 1993).

pups was estimated to be 8,556 (8,528 counted on all rookeries and 28 estimated for Little Polovina rookery); the estimated mortality rate for late August was 4.69%. The total number of pups born on St. Paul Island and the approximate 95% confidence interval was 192,468 + (2.16 X 8,918) or 192,468 + 19,263 (the total includes an estimate of 10,000 pups for Sea Lion Rock in 1990). The confidence interval was computed by multiplying the standard deviation (calculated as the square root of the sum of the variances for each rookery and assuming counts from the 13 rookeries were independent) by 2.16, the 97.5 percentile of Student's t-distribution with 13 degrees of freedom. Estimates of the number of live pups for Little Polovina rookery were. computed from a jackknife estimate of the ratio of pups alive at marking to breeding males on the sampled rookeries. The standard deviation of the number of liye pups for Little Polovina was then computed from the standard error of the jackknife ratio., An estimate of the number of dead pups at Little Polovina was computed assuming that the mortality rate there was the same as the average mortality of the other rookeries (Table 10). The estimated number of pups born and their 95% confidence intervals for St. Paul Island, 1970-92, are shown in Figure 14. The total estimated number of pups born in 1992 was not significantly different (P>2 0.05) from the 1989 and 1990 estimates. Appendix Table B-2 summarizes pup production and mortality since 1975.

The number of pups born and the number of harem bulls at different rookeries on St. Paul Island are highly correlated (Fig. 15). When numbers of pups born are regressed on numbers of

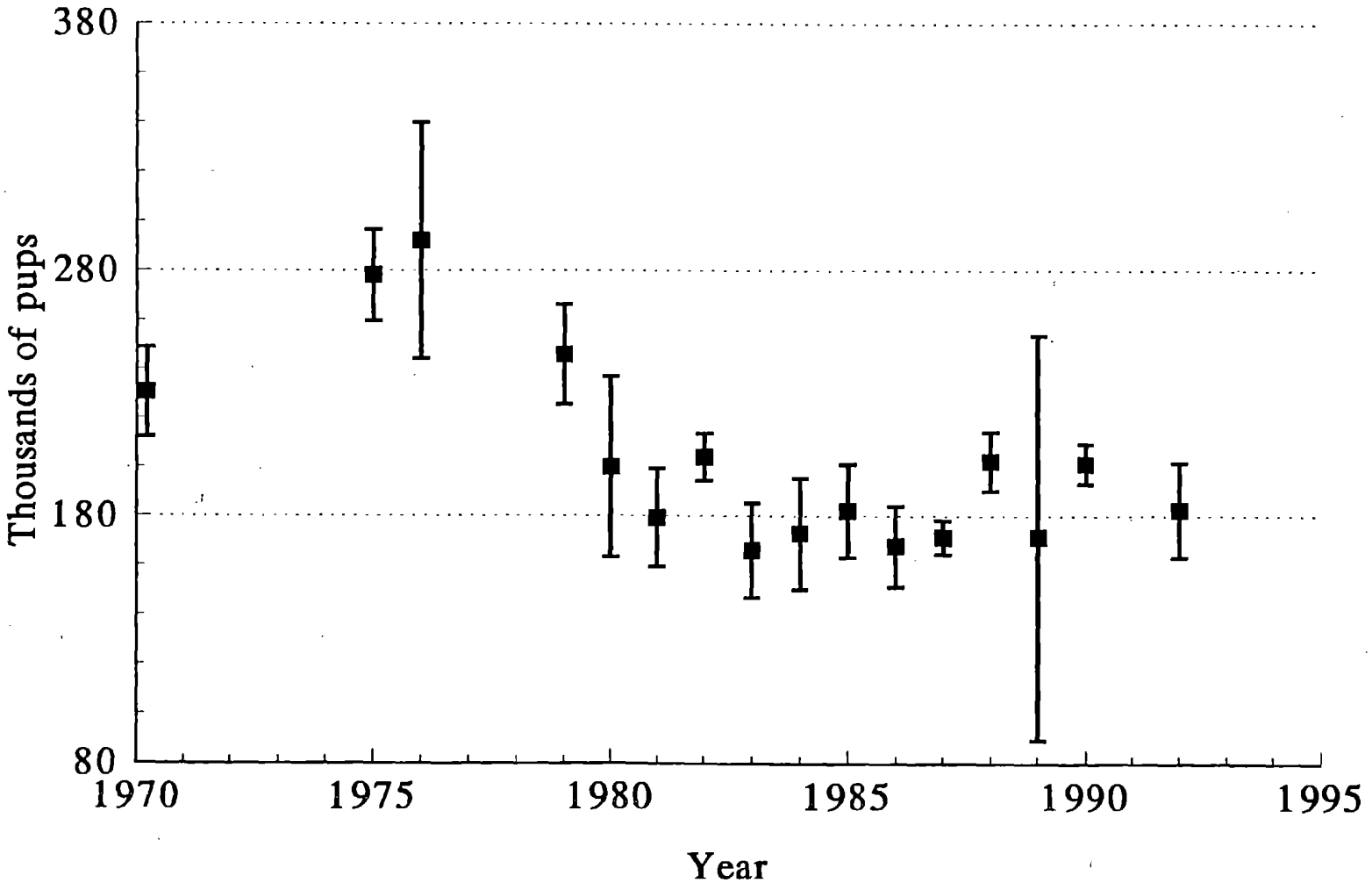


Figure 14.--Number of northern fur seal pups born on St. Paul Island, Alaska, 1970-92. Approximate 95% confidence intervals are shown.

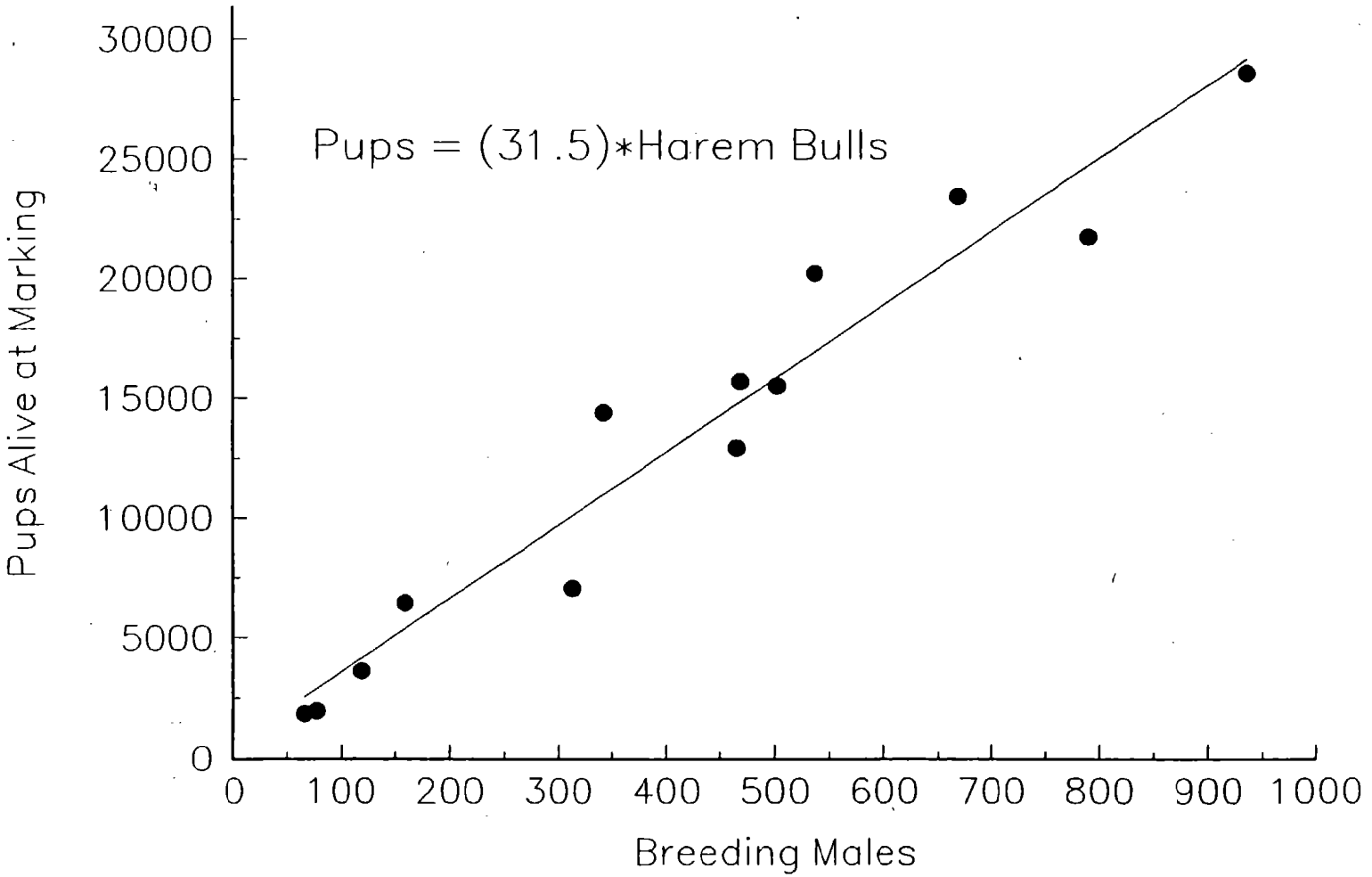


Figure 15.--Number of northern fur seal pups alive at the time of sampling versus number of harem bulls at the rookeries on St. Paul Island, Alaska, 1992.

harem bulls, the value of R^2 is about 0.94. The intercept of the regression line is not significantly different from zero ($P > 0.05$) and was not included in the regression equation; the slope of the regression line is 31.5.

Number of Pups Born on St. George Island in 1992

The number of pups born on St. George Island was also estimated from a shearing-sampling study conducted on all rookeries. The most recent estimate of pup production prior to this study was obtained in 1990. From 12 to 13 August, a total of 2,332 pups were shear-marked on St. George Island. These marks were allocated proportionally on all rookeries according to the fraction of harem bulls counted in 1992. The ratio of marked to unmarked pups on each rookery was determined by two researchers on two occasions: once from 14 to 15 August, and again from 16 to 17 August. A summary by rookery of the number of pups sheared, sampling data, and the estimated mean number of pups alive at the time of marking is given in Table 11. Counts of dead pups were made from 14 to 15 August 1992. The ratio of marked to unmarked pups and the estimate of the number alive was calculated in the same manner as described for St. Paul Island. The estimated number of pups born, dead pups, counts of breeding bulls, and ratios of pups to harem bulls for all rookeries on St. George Island are summarized in Table 12.

The estimated total number of pups alive on St. George Island at the time of marking was 24,354 (SD = 707). The total number of dead pups was 806 and the mortality rate for late August was 3.20%. The total number of pups born on St. George Island and

Table 11 .--Number of pups sheared, number of sheared pups resighted on two sampling occasions (Rl and R2), total number sampled on two sampling occasions (Tl and T2). number of pups estimated to be alive at the time of marking (El and E2), mean number alive (Mean) and standard deviation (SD), for all rookeries, St. George Island, Alaska, 1992.

Rookery	Sheared	R1	R2	T1	T2	E1	E2	Mean	SD
East Reef	83	41	32	375	300	759	778	769	9.5
East Cliff	409	99	104	1,250	1,175	5,164	4,621	4,893	271.6
North	903	218	217	2,350	2,050	9,734	8,531	9,132	601.8
Staraya Artil	200	52	67	550	575	2,115	1,716	1,916	199.5
Zapadni	370	105	79	1,075	750	3,788	3,513	3,650	137.7
South	367	117	97	1,250	1,075	3,921	4,067	3,994	73.2

Table 12.--Number of pups alive at the time of marking, its standard deviation (SD), numbers of dead pups, total pups born, mortality rate, idle males, harem males, end ratio of pups alive at marking to harem males, St. George Island, Alaska, 1992.

Rookery	Pups alive at marking	SD	Dead pups*	Total pups born	Mortality rate (%)	Idle bulls	Harem bulls	Ratio pups/bulls
East Reef	769	9.5	8	777	1.03	103	56	13.73
East Cliff	4,893	271.6	99	4,992	1.98	411	209	23.41
North	9,132	601.8	202	9,334	2.16	528	360	25.37
Staraya Artil	1,916	199.5	103	2,019	5.10	153	75	25.21
Zapadni	3,650	137.7	166	3,816	4.35	416	128	28.52
South	3,994	73.2	228	4,222	5.40	223	200	19.97
Island Total	24,354	707.2	806	25,160	3.20	1,834	1,028	23.67

* Includes dead pups taken for necropsies: 60 at Staraya Artil, 32 at Zapadni and 1 at North.

the approximate 95% confidence interval was 25,160 + (2.447 X 707), or 25,160 + 1,730. This count is not significantly different ($P > 0.05$) from the 23,397 pups observed on St. George Island in 1990, nor is it significantly different ($P > 0.05$) from the predicted number of pups born based on a regression fitted to the 1973-90 data, which showed a 5.7% decline (19,942 + 2,549; cf York 1990). Estimates and 95% confidence intervals of numbers of pups born on St. George Island for 1970-90 are shown in Figure 16.

The number of pups born and the number of harem males on St. George Island rookeries are highly correlated (Fig. 17). When the number of pups born are regressed on the number of, males, the value of R^2 is about 0.97. The intercept of the regression line is not significantly different from zero ($P > 0.05$) and was not included in the regression equation; the slope of the regression line is 24.16.

Counts of Dead Fur Seals Older Than Puns and Collection of Teeth

The rookeries and adjacent beaches of St. Paul and St. George Islands (except Little Polovina) were surveyed for dead fur seals older than pups during July and August 1992. In 1992, tooth samples were collected from a total of 362 (97 males and 265 females) and 26 (7 males and 19 females) animals found dead on St. Paul and St. George Islands, respectively (Table 13). Tooth samples (usually canines) were collected from all dead fur seals other than pups whenever possible. Appendix Table B-5 summarizes the total number of dead male and female fur seals from which teeth were collected from 1965 to 1992.

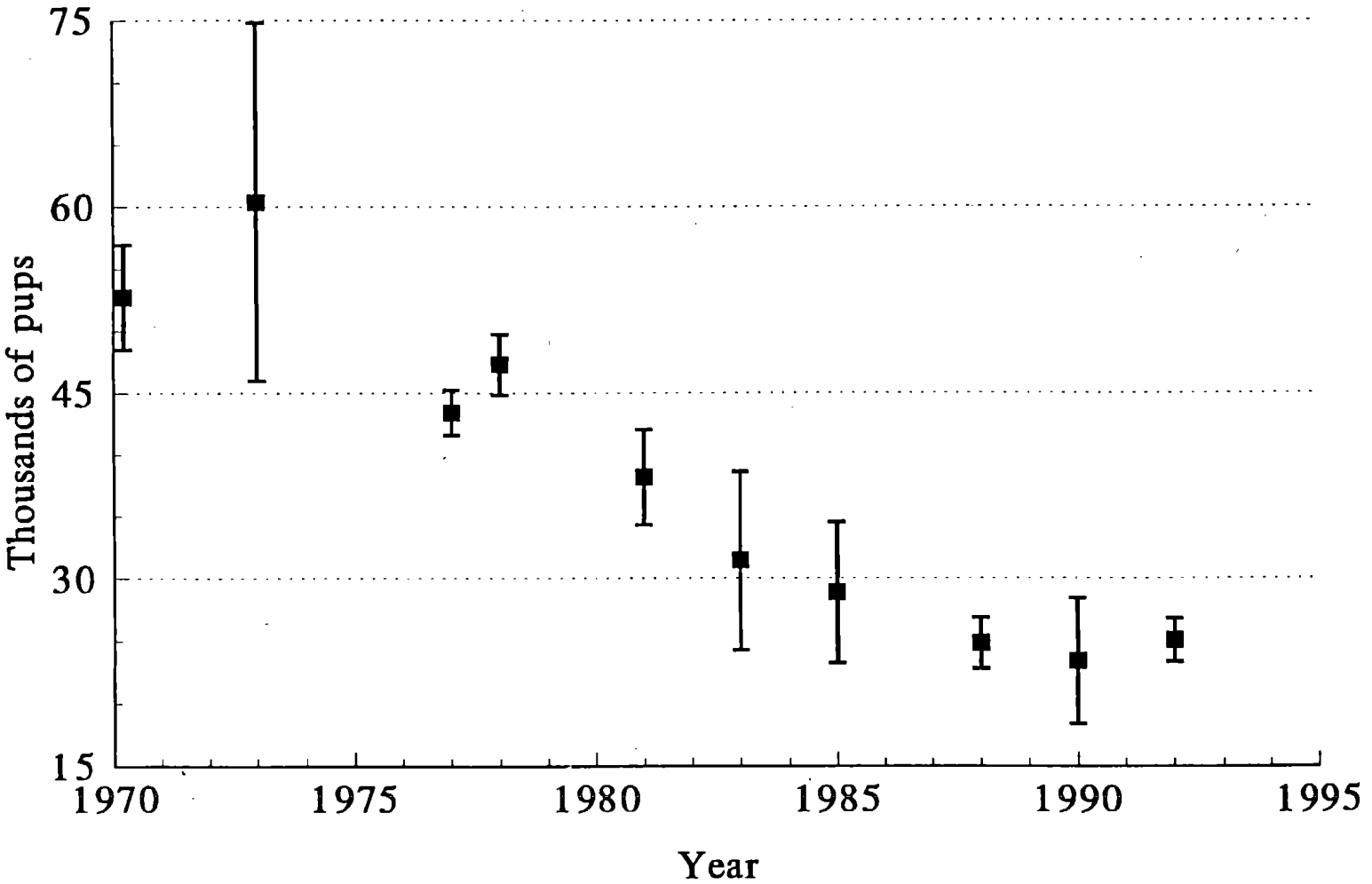


Figure 16.--Number of northern fur seal pups born on St. George Island, Alaska, 1970-92. Approximate 95% confidence intervals are shown.

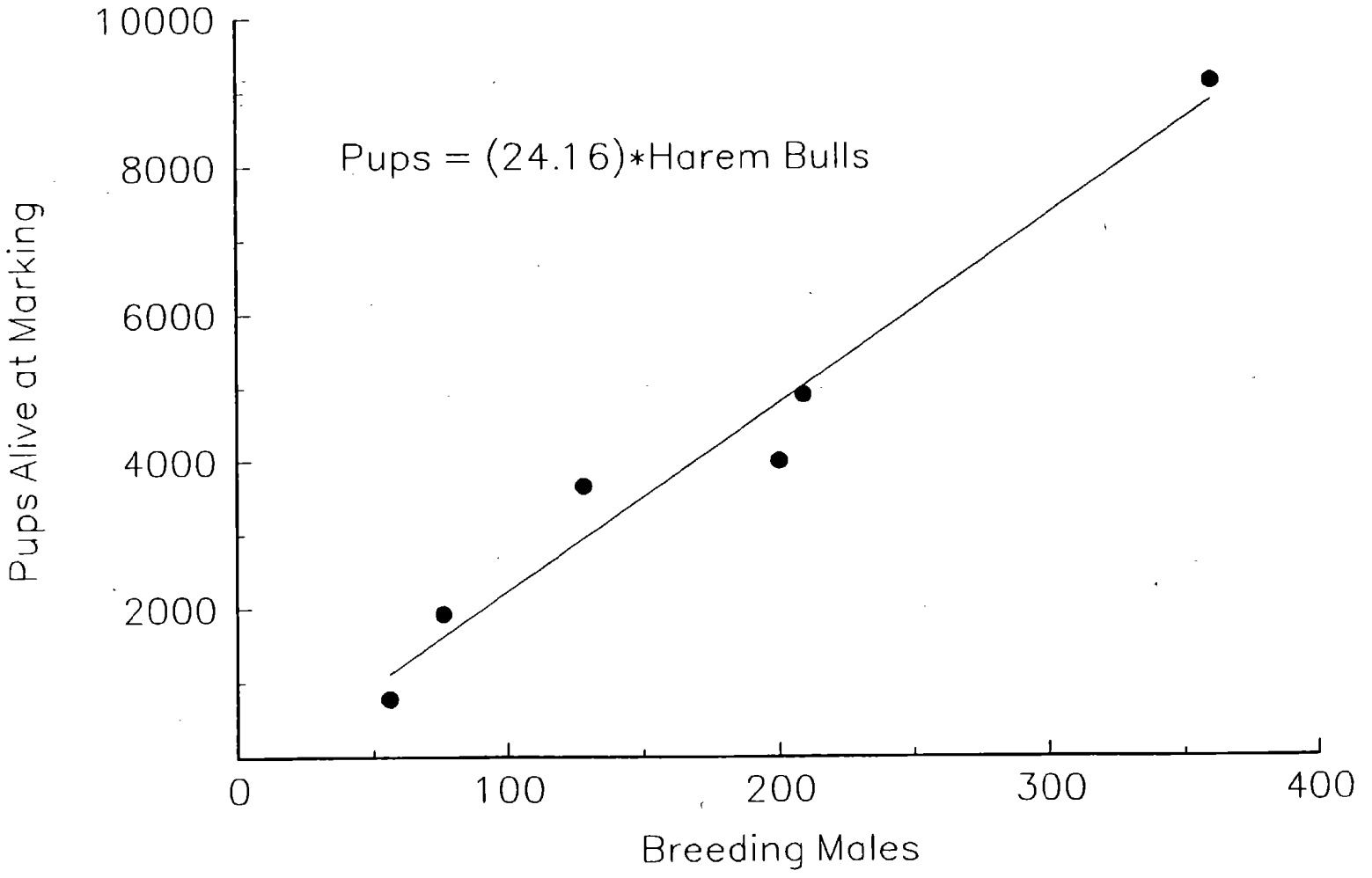


Figure 17.--Number of northern fur seal pups alive at the time of sampling versus number of harem bull fur seals for the rookeries on St. George Island, Alaska, 1992.

Table 13.-- Number of animals older than pups found dead on the Pribilof Islands from which teeth were collected during July and August 1992.

Rookery	Males	Females	Total
St. Paul			
Ardiguen	1	2	3
Gorbatch	4	24	28
Kitovi	0	5	5
Little Zapadni	15	18	33
Lukanin	2	10	12
Morjovi	7	12	19
Polovina	1	1	2
Polovina Cliffs	4	12	16
Reef	17	42	59
Tolstoi	10	48	58
Vostochni	11	33	44
Zapadni	19	41	60
Zapadni Reef	3	12	15
Unidentified	3	5	8
Total St. Paul	97	265	362
St. George			
East Cliffs	1	1	2
East Reef	0	0	0
North	2	9	11
South	2	3	5
Staraya Artil	1	3	4
Zapadni	1	3	4
Total St. George	7	19	26
Total both islands	104	284	388

STUDIES OF JUVENILE MALES TAGGED AS PUPS AND RESIGHTED DURING ROUNDUPS IN 1992

by

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

During the summers of 1987-1990, northern fur seal pups were tagged on St. Paul Island. During roundups in 1989-1992, juvenile males which had been tagged as pups were recaptured, weighed, and released on St. Paul Island haul outs. Tag resight data, frequency of tag loss, homing tendencies of tagged males, and body weight and growth data are reported for 1991 and 1992 in Antonelis et al. (1992) and Baker et al. (1993). Here we report on similar data collected during 1992.

METHODS

In 1987, the total number of pups tagged on each rookery on St. Paul Island was approximately 4% of the estimated pup production from the previous year (none were applied on Little Polovina or Sea Lion Rock in any year). The application of tags was distributed among rookeries according to the proportion that each rookery contributes to the total estimate of pups born. For example, if 200,000 pups are born on St. Paul Island, approximately 8,000 pups would be tagged (about 4,000 of each sex, assuming a 50:50 sex ratio). If 10% of the total number of pups born were on a specific rookery, then 800 pups would be tagged on that rookery. After 1988, only small numbers (400-500) of females were tagged on St. Paul Island at selected

study sites. Application of tags to males continued at a rate of approximately 4% each year during pup tagging procedures (Antonelis et al. 1992).

A monel cattle ear tag with a rounded post was attached to each foreflipper, approximately 1.0 cm to the distal side of the hairline, and 1.7 cm from the posterior edge of the flipper. Weights were collected from at least 10% of the pups handled 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 occurred during roundups (Fowler and Ragen 1990, Antonelis 1992). During this procedure, seals judged to be of the size historically taken in the commercial harvest (approximately 105 cm to 125 cm total length) are counted on haul outs where juvenile males congregate during the breeding season. Some individuals are seen on more than one occasion during the roundups. A few tagged seals are either resighted or killed in the subsistence harvest on St. Paul and St. George Islands. For comparison of resight data with rookeries where tags were applied, the various haul outs were assigned to the nearest rookery. In a few cases, the assignment of haul outs to associated rookeries was somewhat arbitrary. For example, a hauling. ground between Little Zapadni and Zapadni rookeries (referred to as Zapadni Sands) could be assigned to either rookery. Here it is assigned to Zapadni rookery, in view

of location and movement of, seals onto areas more clearly associated with this rookery. The very tip of Northeast Point is between the Vostochni and Morjovi rookeries, but it was designated as part of Morjovi.

Data recorded during recaptures included the tag number, tag condition, presence or absence of a tag on both flippers, and condition of the flippers at the site of tag attachment., Seals were caught with a noose pole and 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 digital suspension scale, which was attached to a metal pipe held by two workers while the weight was read. Weight values were recorded to the nearest 1 lb, and then converted to kilograms. The weight of the restraint board was subtracted from the total to determine the weight of each seal.

In 1992, several captures were made using a hoop net mounted on a handle. This method was often used to capture and hold a second tagged seal while the first was being held on the restraint board., thus speeding up the roundup and reducing stress on the animals. The net was also often selectively used for larger seals which were more difficult to handle with a noose pole and restraint board. Seals were weighed in the net by suspending it from the same scale used with the restraint board. The weight of the net was subtracted from the total to determine the weight of each seal: Tagged seals killed during the subsistence harvest were weighed on a platform scale.

RESULTS AND DISCUSSION

Tag Resights

The number of northern fur seal pups tagged on St. Paul Island from 1987 to 1990 are listed in Table 14 by sex and rookery. Pups were never tagged on Little Polovina rookery during this study, and none were tagged on Ardiguen rookery in 1987.

Roundups of male northern fur seals were completed on St. Paul Island during July and early August of 1992 (see Table 27, Fowler et al., Chapter 8, this volume). During roundups, 17,630 male seals judged to be of the size historically taken in the commercial harvest were observed. A total of 622 seals with monel tags were resighted, 17.5% (n = 109) of which were resighted at least twice. This is lower than the multiple resight rates observed in 1991 (23.9%, Baker et al. 1993) and 1990 (23.6%, Antonelis et al. 1992). Of the total, 82.5% (n = 513) were seen only once, 15.1% (n = 94) were seen twice, 2.1% (n = 13) three times, and 0.3% (n = 2) four times. Seventeen monel-tagged seals were killed in the subsistence harvest: five 2-year-olds, eleven 3-year-olds, and one 4-year-old.

Of the monel-tagged seals resighted in 1992, including those killed in the subsistence harvest, 81 (13%) were 5-year-olds, 200 (32.2%) were 4-year-olds, 273 (43.9%) were 3-year-olds, and 68 (10.9%) were 2-year-olds. The accumulation of these totals (using only the first resighting) over the season are illustrated in Figure 18, which shows that most of the 2-year-old seals were

Table 14. --Range and number of monel tags applied to northern fur seal pups on St. Paul Island rookeries, 1987-1990. Total number tagged for a given rookery includes males, females, and any pups whose sex was not recorded.

Rookery	1987				1988			
	Tag Range	Males	Females	Total	Tag Range	Males	Females	Total
Vostochni	A06859-A07706	430	413	847	A09494-A10419	498	428	926
Morjovi	A06449-A06858	239	168	408	A11106-A11528	229	189	418
Little Polovina	-	0	0	0	-	0	0	0
Polovina Cliffs	A01814-A02769 A07707-A08055	720	584	1,304	A09294-A09493 A11529-A12147	263	522	788
Polovina	A01659-A01813	84	70	155	A09194-A09293	43	57	100
Lukanin	A01009-A01658	344	305	650	A10654-A11105	83	358	444
Kitovi	A00001-A00607	322	282	605	A14115-A14386	155	114	271
Reef	A03945-A04651	375	331	706	A08056-A08667	307	300	609
Ardiguen	-	0	0	0	A09089-A09193	56	48	104
Gorbatch	A04652-A05195	281	263	544	A08668-A09088	219	199	419
Tolstoi	A02770-A03944	626	524	1,151	A13301-A14114	437	362	800
Zapadni Reef	A00608-A01008	234	166	400	A10420-A10653	120	112	233
Little Zapadni	A05959-A06448	264	224	488	A12148-A12598	246	189	438
Zapadni	A05196-A05958	400	361	762	A12599-A13300	385	286	672
Total	A00001-A08055	4,319	3,691	8,020	A08056-A14386	3,041	3,164	6,222

Table 14.--Continued.

Rookery	1989				1990			
	Tag Range	Males	Females	Total	Tag Range	Males	Females	Total
Vostochni	A15464-A16116	630	0	630	A18932-A19750	796	15	811
Morjovi	A16117-A16353	254	0	254	A19751-A20125	358	16	374
Little Polovina	-	0	0	0	-	0	0	0
Polovina Cliffs	A16403-A17110	434	267	702	A21401-A22100	302	374	676
Polovina	A16354-A16402	49	0	49	A22476-A22551	58	15	73
Lukanin	A17739-A18034	152	142	294	A21101-A21400	104	192	296
Kitovi	A17495-A17738	241	0	241	A22101-A22225	109	16	125
Reef	A14387-A15243	448	4	452	A22976-A23350	359	15	374
Ardiguen	A17419-A17494	75	0	75	-	0	0	0
Gorbatch	A17111-A17418	305	0	305	A22226-A22475 A23351-A23375	248	13	261
Tolstoi	A18359-A18931	570	0	570	A22552-A22975	405	16	421
Zapadni Reef	A15301-A15463	162	0	162	A20926-A21100	160	15	175
Little Zapadni	A18037-A18358	321	0	321	A20126-A20500	354	17	371
Zapadni	A14838-A15237	383	5	388	A20501-A20925	405	16	421
Total	A14387-A18931	4,024	418	4,443	A18932-A23375	3,658	720	4,378

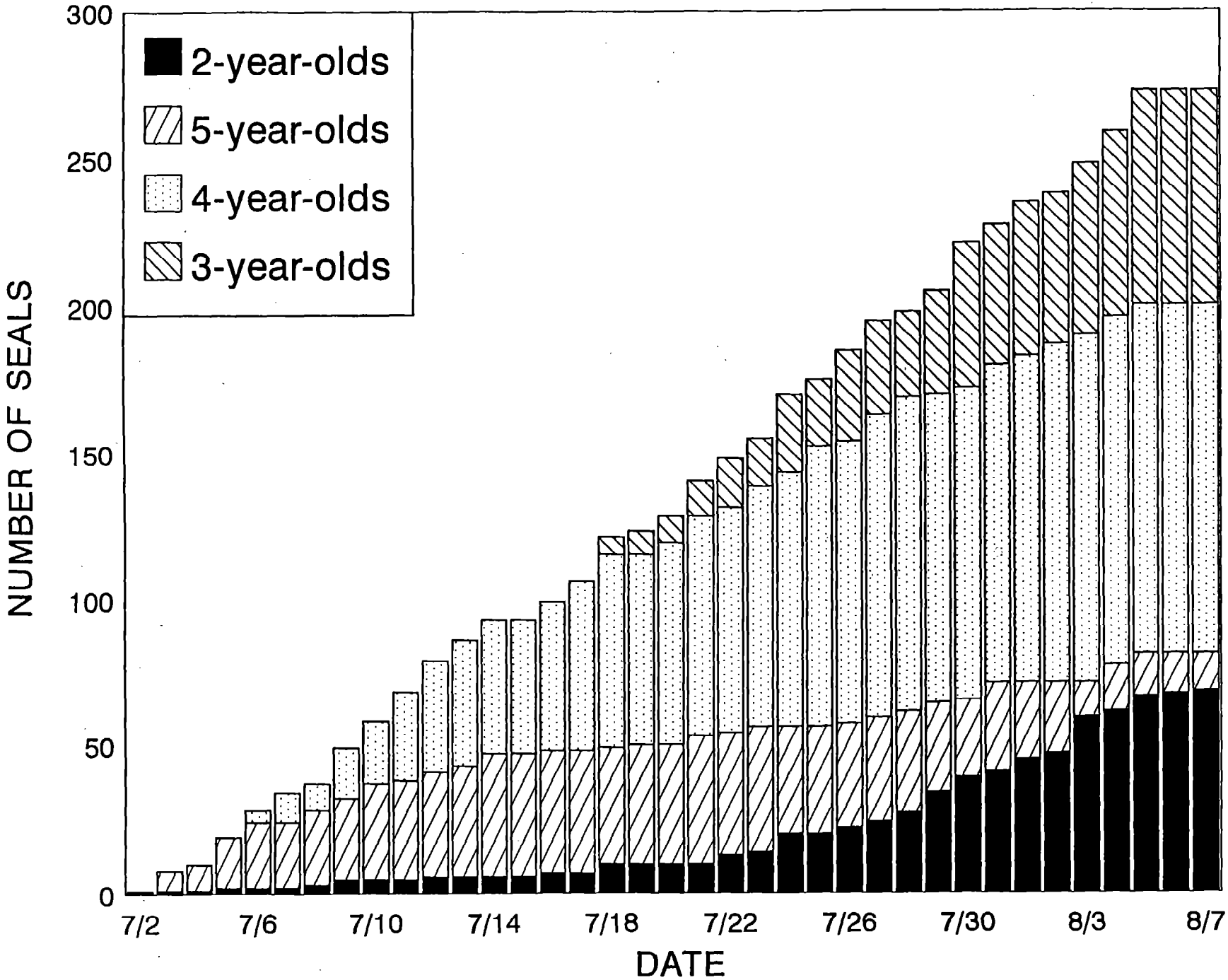


Figure 18. --Daily accumulation of tagged 2-to 5-year-old male northern fur seals resighted during roundups and the subsistence harvest on St. Paul Island, Alaska, 1992. Only first sightings are included here.

resighted late in the series of roundups, while most 5-year-olds were seen early. A list of monel-tagged fur seals resighted during roundups and the subsistence harvest in 1992 is presented in Appendix Table B-6.

The distribution of rookery of resighting compared with the rookery of tagging is presented for 2- through 5-year-olds in Tables 15-18, respectively. These tables include all multiple sightings. for seals seen in 1992 and are arranged with the rookeries listed in clockwise order 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.

Table 19 summarizes the numbers of seals with missing tags. The higher rate of tag loss noted previously (Baker et al. 1993) for seals tagged in 1987 compared with those tagged in later years was still evident in 1992. Estimated double tag loss at age 4 was 5.03% for the 1987 cohort (Baker et al. 1993) compared with only 1.30% for the 1988 cohort.

Weights of Tagged Fur Seals

A total-of 587 juvenile males were weighed during 1992. A summary of weight data for juvenile males captured during 1990-1992 is presented in Table 20. Since there is a preference for smaller seals in the Aleut native subsistence harvest, weight measurements taken during this harvest were not used in calculations presented in Table 20. Only weights taken during

Table 15.--Number of 2-year-old juvenile male northern fur seals seen at the haul out(s) of a particular rookery (identified on top row) as compared with the rookery where tagged (left column), St. Paul Island, Alaska, 1992.*

	Rookery seen										
Rookery tagged	A	B	E	F	G	H	J	K	L	M	N
A	19	0	1	1	2	0	0	2	1	0	2
B	1	2	0	0	0	0	0	1	0	0	1
D	3	0	2	0	1	0	2	0	1	0	1
E	0	0	0	0	0	1	0	0	0	0	0
F	0	0	0	0	0	0	0	0	0	0	0
G	0	0	0	0	2	0	0	1	0	0	0
H	2	1	0	0	0	0	2	0	2	0	3
I	0	0	0	0	0	0	0	0	0	0	0
J	0	1	0	0	0	0	2	1	2	1	0
K	0	0	1	0	0	0	0	0	2	0	1
L	0	0	0	0	0	0	1	0	0	0	0
M	0	0	0	0	0	0	0	1	0	0	1
N	0	0	0	0	0	0	2	0	1	0	1

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

Table 16.--Number of 3-year-old juvenile male northern fur seals seen at the haul out(s) of a particular rookery (identified on top row) as compared with the rookery where tagged (left column), St. Paul Island, Alaska, 1992*.

	Rookery seen										
Rookery tagged	A	B	E	F	G	H	J	K	L	M	N
A	9	0	2	1	2	0	1	0	4	0	4
B	9	12	1	0	2	0	5	3	1	0	0
D	6	2	4	2	5	0	2	2	2	1	5
E	0	0	1	0	1	0	0	1	0	0	1
F	2	1	1	2	1	0	2	0	3	0	0
G	3	0	2	1	13	0	2	3	3	0	4
H	4	0	4	0	2	16	19	1	0	0	5
I	2	0	0	0	0	1	2	0	1	0	1
J	1	1	1	0	0	3	15	4	2	0	4
K	7	2	2	3	2	0	8	6	8	0	1
L	10	3	1	0	0	0	2	1	2	0	5
M	2	0	1	0	0	0	2	1	5	1	7
N	5	1	1	2	0	0	1	1	3	0	8

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

Table 17.--Number of 4-year-old juvenile male northern fur seals seen at the haul out(s) of a particular rookery (identified on top row) as compared with the rookery where tagged (left column), St. Paul Island, Alaska, 1992.*

	Rookery seen										
Rookery tagged	A	B	E	F	G	H	J	K	L	M	N
A	15	8	2	2	0	0	2	1	0	0	2
B	4	10	0	1	1	0	2	0	0	0	0
D	1	0	9	0	0	0	0	0	1	0	1
E	0	1	1	0	0	0	0	0	0	0	0
F	1	0	0	2	0	0	1	1	1	0	0
G	0	1	0	0	9	0	2	0	1	0	0
H	2	3	1	0	0	16	11	5	1	0	5
I	0	0	0	0	0	2	5	0	0	0	0
J	0	1	0	0	1	1	16	2	1	0	2
K	2	1	3	1	0	0	6	12	4	0	4
L	1	0	0	1	0	0	0	0	4	0	1
M	1	1	0	0	0	0	1	0	6	1	11
N	2	2	0	1	1	0	0	1	1	0	20

*Rookery identity for St. Paul Island 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 1 B.--Number of 5-year-old juvenile male northern fur seals seen at the haul out(s) of a particular rookery (identified on top row) as compared with the rookery where tagged (left column), St. Paul Island, Alaska, 1992.*

	Rookery seen										
Rookery tagged	A	B	E	F	G	H	J	K	L	M	N
A	8	3	0	0	0	0	0	0	0	0	0
B	1	5	1	1	1	0	0	0	0	0	0
D	0	1	1	0	0	0	0	0	0	0	1
E	0	0	0	0	0	0	0	0	0	0	0
F	1	0	1	2	2	0	3	0	2	0	0
G	0	0	0	1	9	0	0	1	0	0	1
H	0	1	1	0	0	5	3	0	0	0	1
I	0	0	0	0	0	0	0	0	0	0	0
J	0	0	0	0	0	0	5	0	0	0	0
K	1	1	0	0	0	1	1	9	2	0	2
L	0	0	0	0	0	0	0	1	1	0	0
M	1	0	0	0	0	0	2	0	2	1	5
N	0	0	0	0	0	0	0	0	1	0	1

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

Table 19.--Listing of the number of tags lost by flipper (with percent of total in parentheses) and age for individual juvenile male northern fur seals seen in roundups during 1992, St. Paul Island, Alaska, with the estimated double tag loss rate (percent) for each age.

Age	Number of fur seals	Tag loss			Double Tag Loss* (%)
		Left	Right	Neither	
2	68	2 (2.9)	3 (4.4)	63 (92.7)	0.14
3	273	12 (4.4)	23 (8.4)	238 (87.2)	0.42
4	200	22 (11.0)	19 (9.5)	159 (79.5)	1.30
5	81	18 (22.2)	19 (23.5)	44 (54.3)	8.76

*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 with 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 20.--Summary of juvenile male weight data from 1990 to 1992. Weights recorded during the subsistence harvest were excluded from these calculations. The mean of all weighings for each individual were used (W=mean weight, S =standard deviation, CV=coefficient of variation, N=sample size).

	1992				1991				1990			
Age	W (kg)	S (kg)	CV	N	W (kg)	S (kg)	CV	N	W (kg)	S (kg)	CV	N
2	21.7	2.5	0.11	63	21.6	2.5	0.11	48	21.7	3.0	0.14	56
3	29.4	4.9	0.13	257	28.9	3.9	0.13	263	28.1	4.1	0.15	316
4	40.3	6.2	0.15	196	38.9	5.8	0.15	279				
5	52.2	8.5	0.16	71								

the roundups were used. Also, if a seal was weighed more than once in a season, the mean of all weights was used.

A one-way analysis of variance indicated no difference between mean weights of 2-year-olds weighed each summer from 1990 to 1992 (i.e., 1988-90 cohorts, $P = 0.96$). There were significant differences between mean weights at age 3 among the 1987-89 cohorts ($P = 0.001$). Multiple comparisons using the Student-Newman-Keuls test showed that 3-year-olds in 1990 (1987 cohort) weighed significantly less than those from both 1991 (1988 cohort, $P < 0.05$) and 1992 (1989 cohort, $P < 0.001$). There was no difference between the mean weights of 3-year-olds weighed in 1991 and 1992 ($P > 0.05$). Finally, a two-sample t-test showed that 4-year-olds from the 1987 cohort weighed significantly less than the 1988 cohort ($P = 0.016$).

Figure 19 shows the weight distribution of 2- through 5-year-olds. The weight distributions of the age groups overlapped a great deal; for example, some 3-year-olds weighed more than some 5-year-olds. The lightest 5-year-old (tag number A07073) was entangled in a piece of twine which was very tight and had opened a wound which extended three-quarters of the way around his neck.' He weighed less (25.8 kg) than one-half the average for his age and less than the largest a-year-old (27.2 kg). It seems certain that the severe entanglement caused the seal to become both emaciated and stunted.

During 1992, we handled 5-year-old males on a regular basis for the first time. We suspect that the 5-year-olds weighed in the roundups are not representative of the age group as a whole,

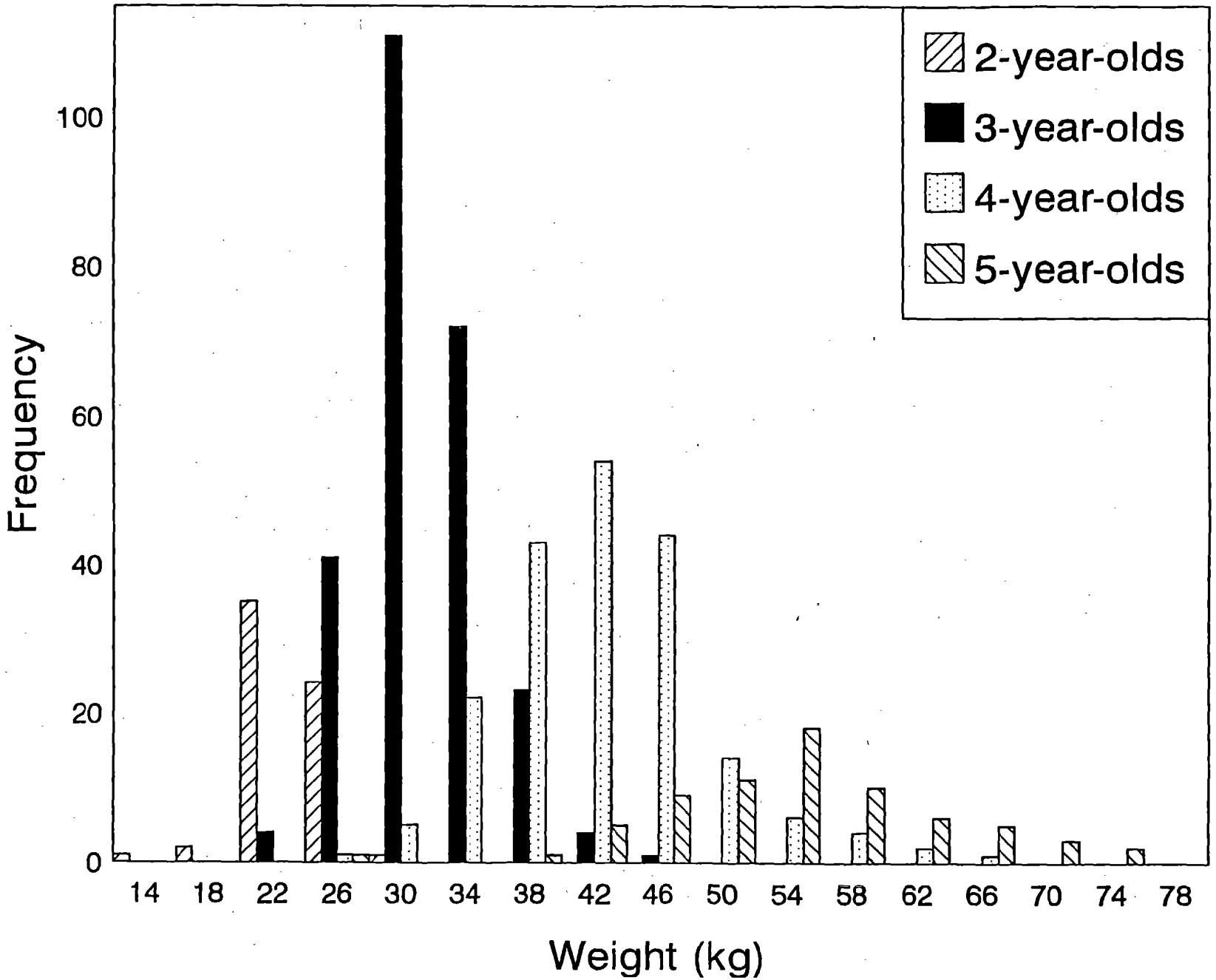


Figure 19.--Weight distributions (kg) of 2- to 5-year-old tagged male northern fur seals captured during roundups on St. Paul Island, Alaska, 1992.

and the mean weights of 5 year-olds (Table 20) are probably an underestimate. For example, because the proportion of adult and near-adult sized males has dramatically increased on the haul outs in recent years (Fowler and Sinclair 1993), we often attempt to round up groups of mostly smaller sub-adult males, -a procedure which may exclude the largest 5-year-olds. Also, these large 5-year-olds may haul out in association with adult males in areas such as rookery peripheries which we generally avoid so as not to disturb breeding seals and pups. In one case, a very large 5-year-old was captured but not weighed because he seemed too strong to be handled safely. These concerns must-be considered when interpreting any analysis of 5-year-olds' weights.

Consistent with results from previous analyses (Antonelis et al. 1992, Baker et al. 1993), variation in date of juvenile males' arrival on St. Paul Island in 1992 was associated more with age than with weight. Regression analysis showed that date of first sighting of monel-tagged seals is significantly related to age ($P < 0.001$), as older animals tend to be sighted earlier (Fig. 18). A multiple-regression analysis of date of first sighting using age and weight at first capture as independent variables indicated a significant interaction (age X weight, $P = <0.001$). Regression analyses of date of first sighting on weight were then conducted for each age group separately. Date of first sighting and weight were significantly positively correlated for 4- and 5-year-olds ($P = 0.022$ and $P.= 0.051$, respectively). The estimated slope. remained unchanged but the P-value rose to 0.079 when the emaciated 5-year-old entangled in

net debris was removed from the analysis. There was no significant relationship between date and weight for the 2- and 3-year-olds, although the estimated slopes were positive.

To summarize, older animals show a strong tendency to arrive earlier, and since weight increases with age, heavier/older animals are seen earlier. However, within age classes the opposite trend may occur, whereby those 4- and 5-year-olds first captured later in the season tend to weigh more for their age. A likely explanation is that those who arrive later spend more time feeding and consequently weigh more when they haul out.

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. To investigate the possible effect of body size and age on probability of capture, we analyzed the capture histories of tagged males during 1992. The mean weight of all captures was used for each seal caught more than once. Regression analysis showed no significant relationship between either weight or age and the number of times a seal was seen. This suggests that there was no significant difference in the proportion of time juvenile males spent ashore according to weight or age.

Weights of seals which were captured more than once during the season were strikingly variable, and distinct trends in this variability which have been identified previously (Antonelis et al. 1992, Baker et al. 1993) were observed again. Figure 20

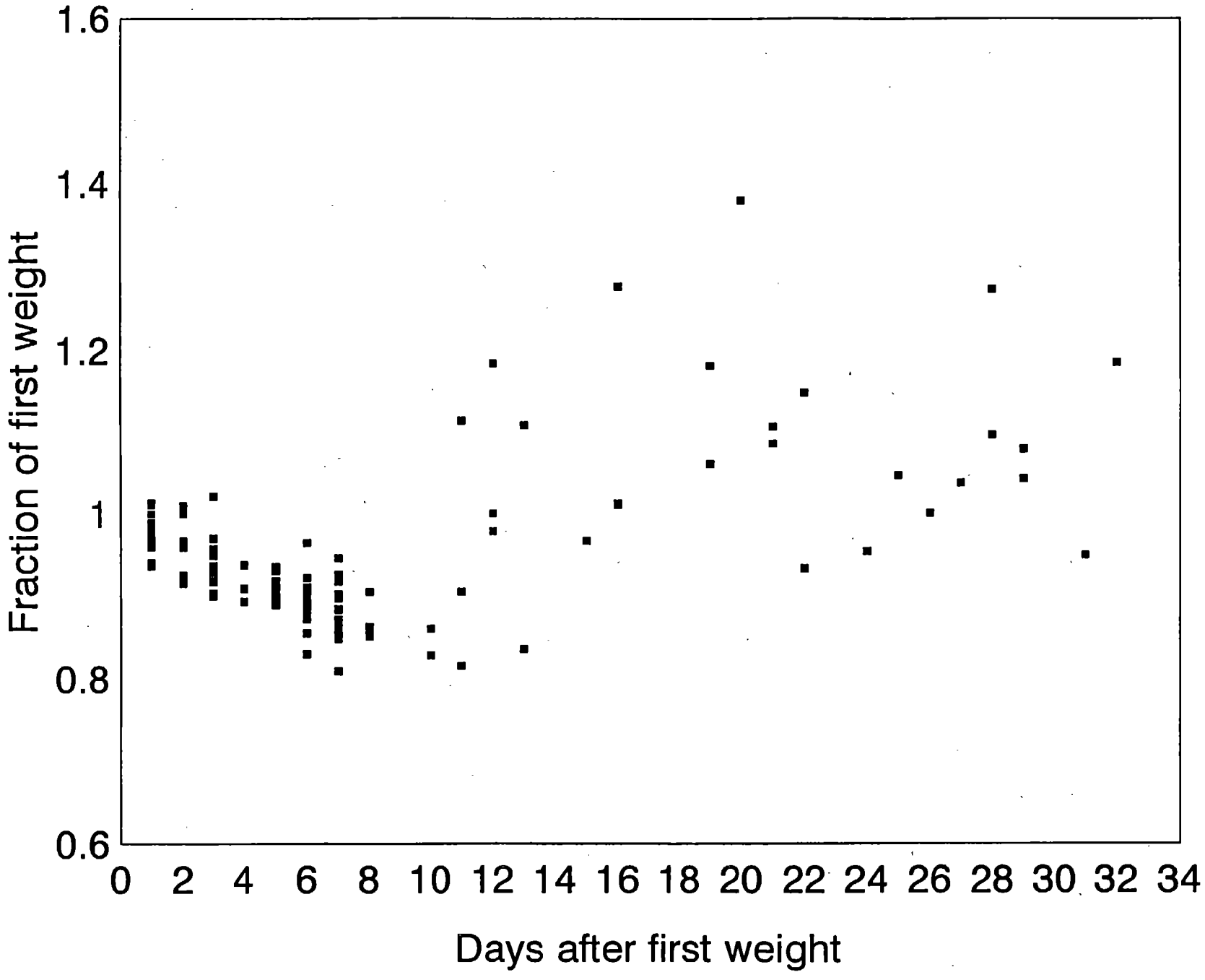


Figure 20.--Subsequent weights of 2- to 5-year-old male northern fur seals expressed as proportions of their weight at first capture and plotted against the number of days since the first capture on St. Paul Island, Alaska, 1992.

shows the weights of 2- through 5-year-old individuals as proportions of their weight at first capture against the number of days subsequent to first capture. Weight decreased following first capture with some individuals losing 20% of their body weight. After 11 days, proportions of weight at first capture are more variable but have, on the average, increased. The mean proportion for seals weighed 12 or more days after their first capture was 1.07 (s = 0.12, n = 26), which is significantly larger than 1 (one-sided t-test, P = 0.002). This indicates that while they lose weight during onshore periods, juvenile males probably grow during the course of the summer.

Some of the tagged juvenile males weighed in 1992 had previously been weighed as pups in late August. Regression analysis showed that there was a significant relationship between pup weight and weight at age 2 (P = 0.001, n = 20) and age 3 (P = 0.006, n = 8.1), but not at age 4 (P = 0.07, n = 78) or age 5 (P = 0.18, n = 15). Weight at ages 2 through 5 are plotted against pup weight in Figure 21.

Several seals weighed in 1992 had also been weighed in 1991. Twelve 3-year-olds weighing 29.0 kg on average in 1992 weighed an average of 21.5 kg in 1991. The average weight increase from age 2 to 3 was 36.2% (s = 14.3%, range 11.9% to 54.6%). Sixty-six 4-year-olds weighing an average 40.3 kg in 1992 had weighed 29.1 kg on average the previous year. The average weight increase from age 3 to age 4 was 38.8% (s = 16.0%, range -17.6% to 74.8%). Thirty-nine 5-year-olds weighing an average 51.0. kg in 1992 had weighed 36.9 kg on average in 1991. The average weight increase

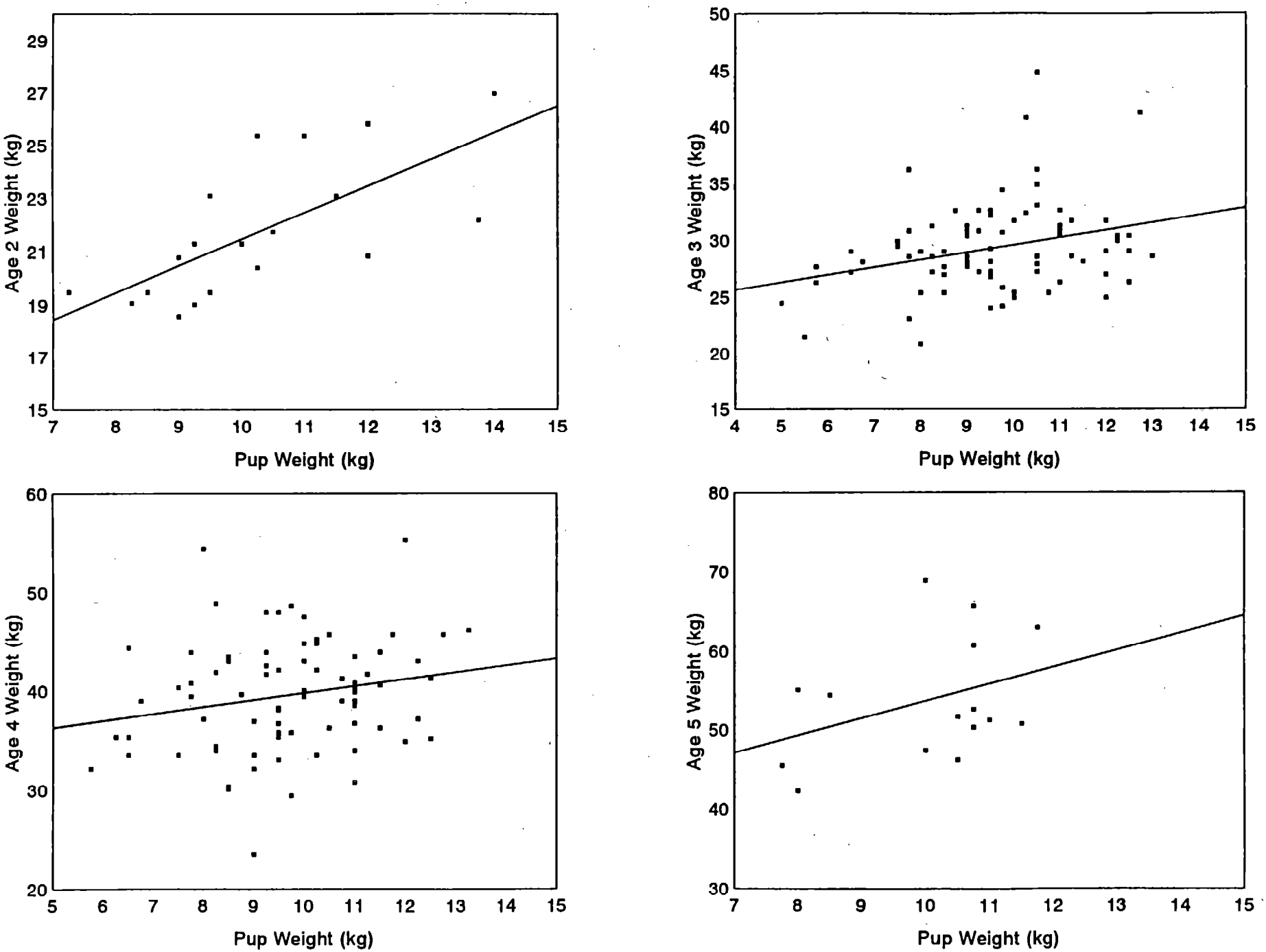
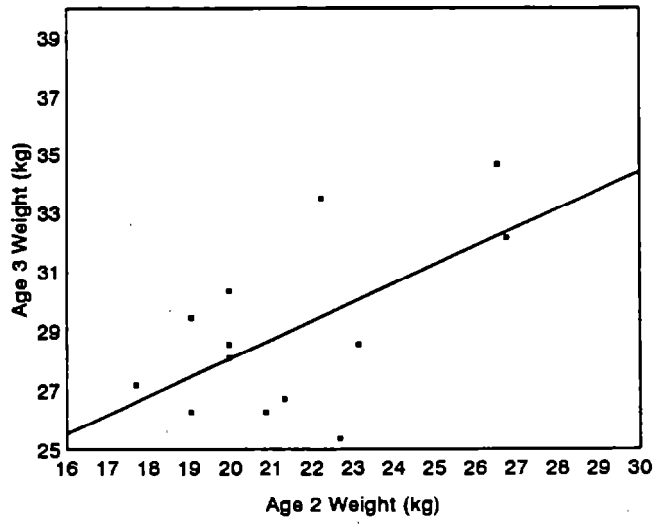
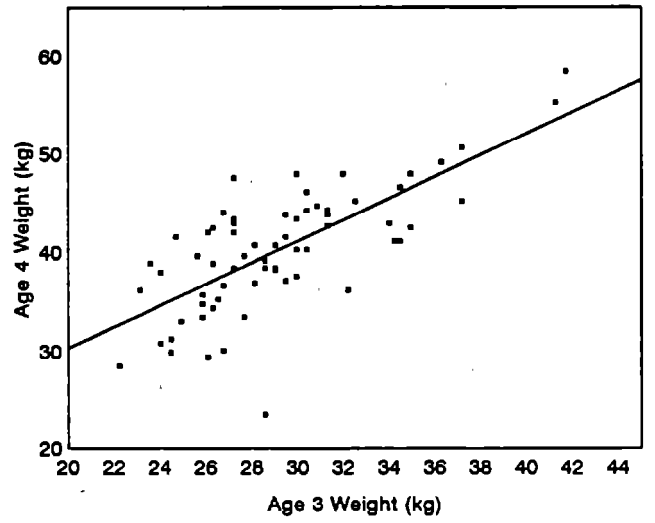


Figure 21. --Weight at age 2 to 5 plotted against pup weight for male northern fur seals weighed in as pups and in 1992. 'Least squares lines are fitted through the data.

from age 4 to 5 was 39.7% (s = 16.0%, range -11.2% to 75.1%):‘ Figure 22 plots the change in individuals' weight by age. Regression analysis showed significant relationships-between weight at age 5 and age 4 (P < 0.001, n = 39), age 4 and age three (P < 0.001, n = 66), and between weight at age 3 and age 2 (P = 0.03, n = 13).





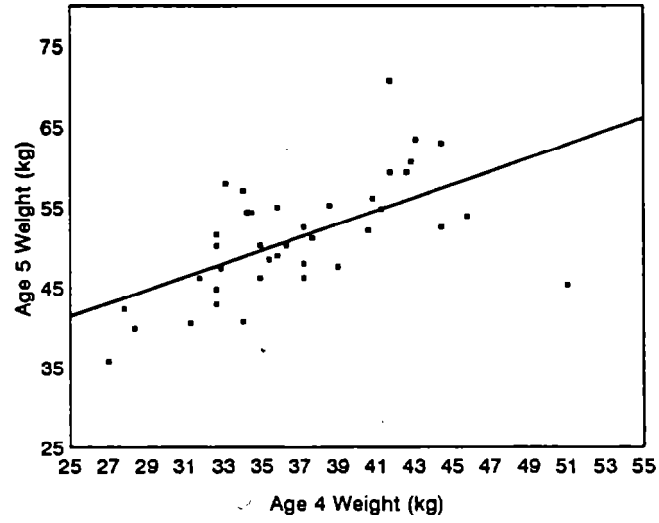


Figure 22. --Relationship between individual northern fur seals' weight at age 3 versus 2, age 4 versus 3, and age 5 versus 4, for males weighed in both 1992 and 1991. Least squares lines are fitted through the data.

WEIGHTS OF KNOWN-AGE SUBADULT MALE NORTHERN FUR SEALS TAKEN IN THE ST. PAUL ISLAND SUBSISTENCE HARVEST, 1991-1992

by

M. Bradley Hanson, Jason D. Baker, and George A. Antonelis

Considerable variation exists in the weights of each class of subadult male fur seal (Fowler et al., Ch. 3, this volume). Total body weight and age of subadult male northern fur seals killed during the subsistence harvests on St. Paul Island were compared with those of roundup animals to determine whether the weights of the harvested seals were representative of their age groups. If the weight of harvested seals are representative of their age groups, these data could be used to increase the sample size of studies of known-age animals.

Subadult males were sampled opportunistically during the 1991 and 1992 subsistence harvests. Immediately following death, each seal was weighed to the nearest 0.1 lb (converted to kilograms) and the upper snout removed for extraction of the canine teeth (Antonelis 1992). To estimate ages, the number of annual dentin layers were counted from whole teeth following the methods of Scheffer (1950).

Weights and ages were determined for 12.2% (n = 201) and 18.1% (n = 269) of the subadult males killed during subsistence harvests in 1991 and 1992, respectively (Table 21). The proportion of each age group sampled from the harvest was similar for both years.

As reported in Fowler et al. (Ch. 3, this volume) 2-, 3-,

Table 21. --Weights of subadult northern fur seals taken in the subsistence harvest on St. Paul Island, Alaska, 1991-1992.

Year		Age			
		2	3	4	Combined
1991					
	n	89	105	7	201
	% of sample	44.2	52.2	3.5	100
	mean weight(kg)	21.4	25.9	32.7	24.2
	SD	2.7	3.6	3.7	4.2
1992					
	n	109	148	12	269
	% of sample	40.5	55.0	4.5	100
	mean weight(kg)	22.3	26.4	31.1	24.9
	SD	2.8	3.1	3.5	3.8
Combined	n	198	253	19	470
	% of sample	42.1	53.8	4.1	100
	mean weight(kg)	21.9	26.2	31.7	24.6
	SD	2.8	3.4	3.8	4.0

and 4-year-olds weighed, an average of 21.6 kg, 28.9 kg, and 38.9 kg, respectively, in the 1991 roundups, and 21.7 kg, 29.4 kg, and 40.3 kg in 1992.

We conducted an analysis of variance with weight as the response variable,. and year (1991 or 1992), age (2 - 4 years old), sampling method (harvest or roundup), and all possible interactions as independent variables. There was a significant interaction between age and sampling method ($P < 0.0001$) because the difference between weights of harvested and roundup seals varied with age (Fig. 23). Consequently, the effects of year and sampling method were analyzed for each age group separately. Among 2-year-olds, there was no significant difference between the weights of males killed in the harvest or weighed during roundups ($P = 0.39$). However, harvested 3- and 4-year-old seals weighed significantly less than roundup seals for both ages ($P < 0.0001$). Small seals the size of an average 2 year-old are preferentially selected in the St. Paul Island subsistence harvest. When 3- and 4-year-olds were killed (mainly during the first half of the harvest before large numbers of 2-year-olds are available), they tended to be small for their age. Therefore, weight data collected from the subsistence 'harvest probably represents 2-year-olds as accurately as data from roundups, but weights of harvested 3- and 4-year-olds are probably biased.

We examined the weights of seals killed in the subsistence harvest to determine whether there were differences between 1991 and 1992. Two-year-olds harvested-in 1991 weighed significantly less than those harvested in 1992 ($P = 0.033$). Weights of 3- and

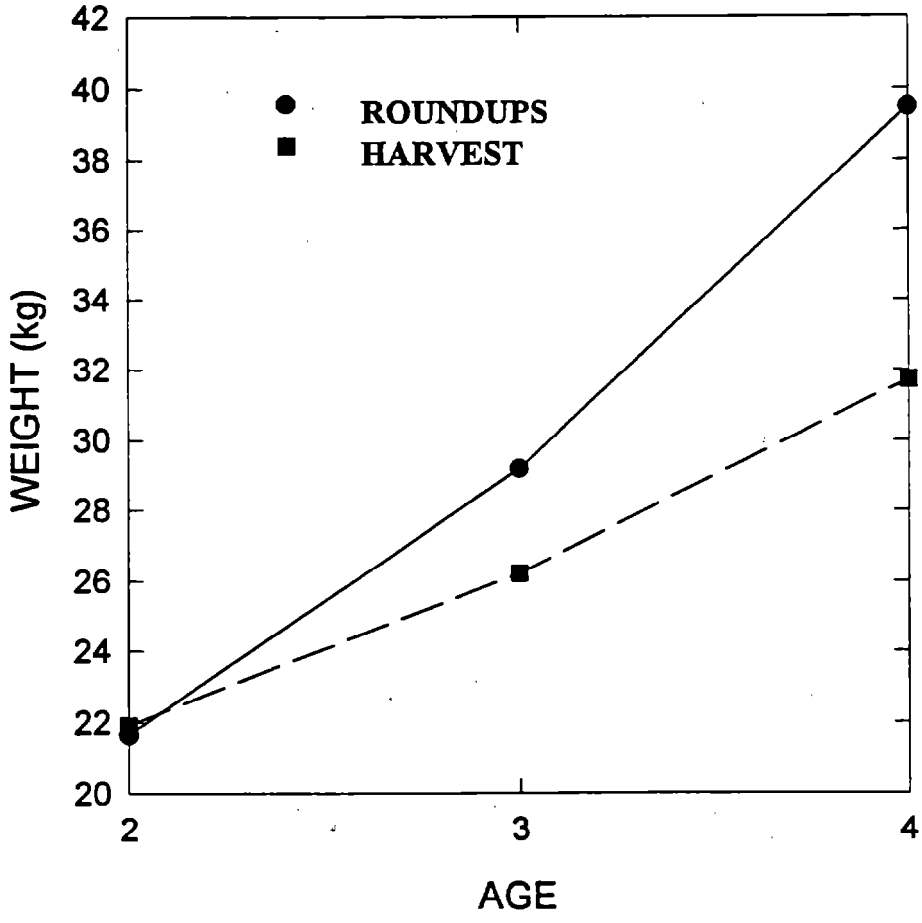


Figure 23. --Mean weight of 2-4 year-old male northern fur seals weighed during roundups and the subsistence harvest.

4-year-olds did not differ significantly between the 1991 and 1992 harvests (P=O.275 and P=O.389, respectively). It is unclear whether larger 2-year-old seals were selected for harvest in 1992 than in 1991 or whether, overall, a-year-old seals were larger in 1992.

TRENDS IN PUP PRODUCTION OF ROOKERIES ON ST. GEORGE ISLAND, ALASKA

by

Rolf R. Ream, George A. Antonelis, and Jason D. Baker

Since 1912, northern fur seal (Callorhinus ursinus), pup production has been estimated to indicate trends in population growth on St. Paul and St. George Islands, Alaska. Based on the number of pups born, the St. Paul Island population exhibited a rate of decline similar to that of St. George Island from 1966 to the early 1980s but has since shown no downward trend (York 1990). St. George Island, on the other hand, continued to decline throughout the 1980s (York 1990). In this study, we examine the decline on St. George Island by 1) describing historical trends in numbers of pups born since 1914, 2) evaluating the contribution of individual rookeries to the total island pup production over time, and 3) comparing rates of change in pup production at each rookery.

METHODS

Estimates of pups born for all rookeries on St. George Island were compiled from Lander (1980) and annual Fur Seal Investigations. From 1914 to 1916, and in 1922, these estimates were obtained by direct counts. The next reliable estimates were made in 1966, the first year the shear-sampling method (York and Kozloff 1987) was used on St. George Island. This technique was

used in all subsequent years that pup production estimates were obtained on St; George Island. We calculated the percent contribution of each rookery to the island total pup production for each year (between 1914 and 1992) that pup production estimates were obtained for all rookeries. Average annual growth rates of different rookeries were examined for the years 1966-92 using linear regression of the natural log of pup production by year. Separate slopes and intercepts were first fitted for each rookery. Slopes for rookeries which did not differ significantly were then combined. Two periods, 1966-1981 and 1981-1992, were also analyzed separately in order to investigate average annual growth rates of different rookeries when St. George and St. Paul Islands had similar rates of decline (1966-81), and when St. George Island continued to decline while St. Paul Island showed no-trend (1981-92).

RESULTS

From 1914 to 1966, pup production on St. George Island increased by 55,564 (from 13,867 to 69,431) (Fig. 24). This 400.7% increase may be misleading because of the lack of data between 1922 and 1966, when the annual numbers of pups born may have been greater than the 1966 estimate. After 1966, the number of pups born dropped dramatically. The 1992 estimate of 25,160 pups (Antonelis et al., chapter 6, this volume) was 36.2% of the 1966 estimate.

The relative contribution of individual rookeries to total pup production on St. George Island has changed over the years

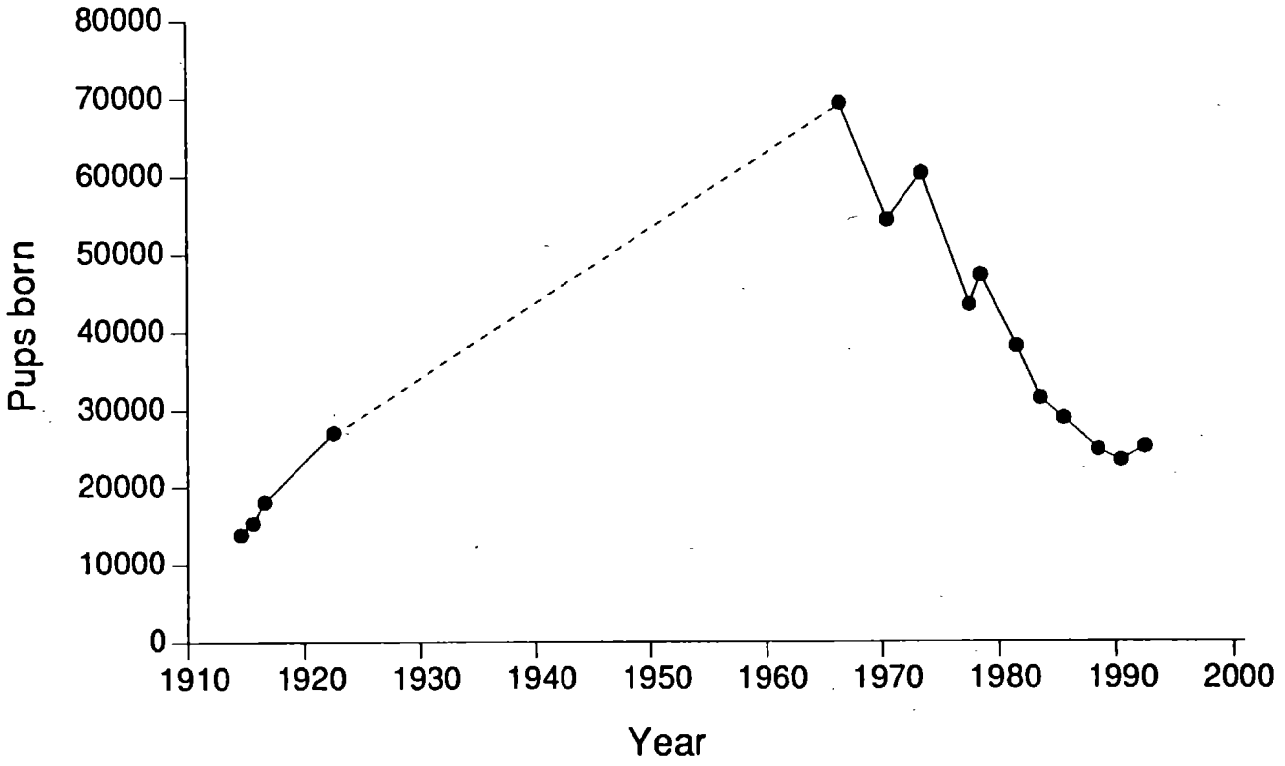


Figure 24.--The number of pups born on St. George Island, Alaska, from 1914 to 1992. Data points are included only for years that estimates were obtained on all rookeries.

(Fig. 25). The number of pups on Staraya Artil rookery declined from 30.9% of the pups born in 1914 to 18% in 1970 and 8.0% in 1992. South rookery, in contrast, has gone from 0% contribution in 1914 to 16.8% of the pups born in 1992. Zapadni rookery also increased from a low of 3.3% in 1922 to 15.2% in 1992. North, East Cliffs, and East Reef rookeries showed distinct changes during short time intervals; however, over time, their approximate levels of contribution were maintained. Since 1981, notable trends occurred on East Cliffs, East Reef, and Zapadni. East Reef, for example, fell from 8.5% of the pups born in 1981 to 2.8% in 1988.

From 1966 to 1992, Staraya Artil ($P = 0.001$) and East Reef ($P = 0.023$) rookeries showed rates of change that were significantly different from all other rookeries (Fig. 26a). Over this period, the average annual rate of growth was -6.7% for Staraya Artil and -5.8% for East Reef. The rest of the rookeries together declined at an average annual rate of 3.9% (Fig. 26a).

During 1966 to 1981, East Reef was the only rookery that exhibited a positive annual rate of growth. At l.O%, this rate was significantly different ($P < 0.001$) from all other rookeries which averaged -3.9% growth per year (Fig. 26b). From 1981 to 1992, the average annual rate of growth of Staraya Artil ($P = 0.016$) and East Reef ($P < 0.001$) were again significantly different than all other rookeries. The average annual rate of growth was -7.1% for Staraya Artil and -13.4% for East Reef. All other rookeries together grew at -2.4% per year from 1981 to 1992 (Fig. 26c).

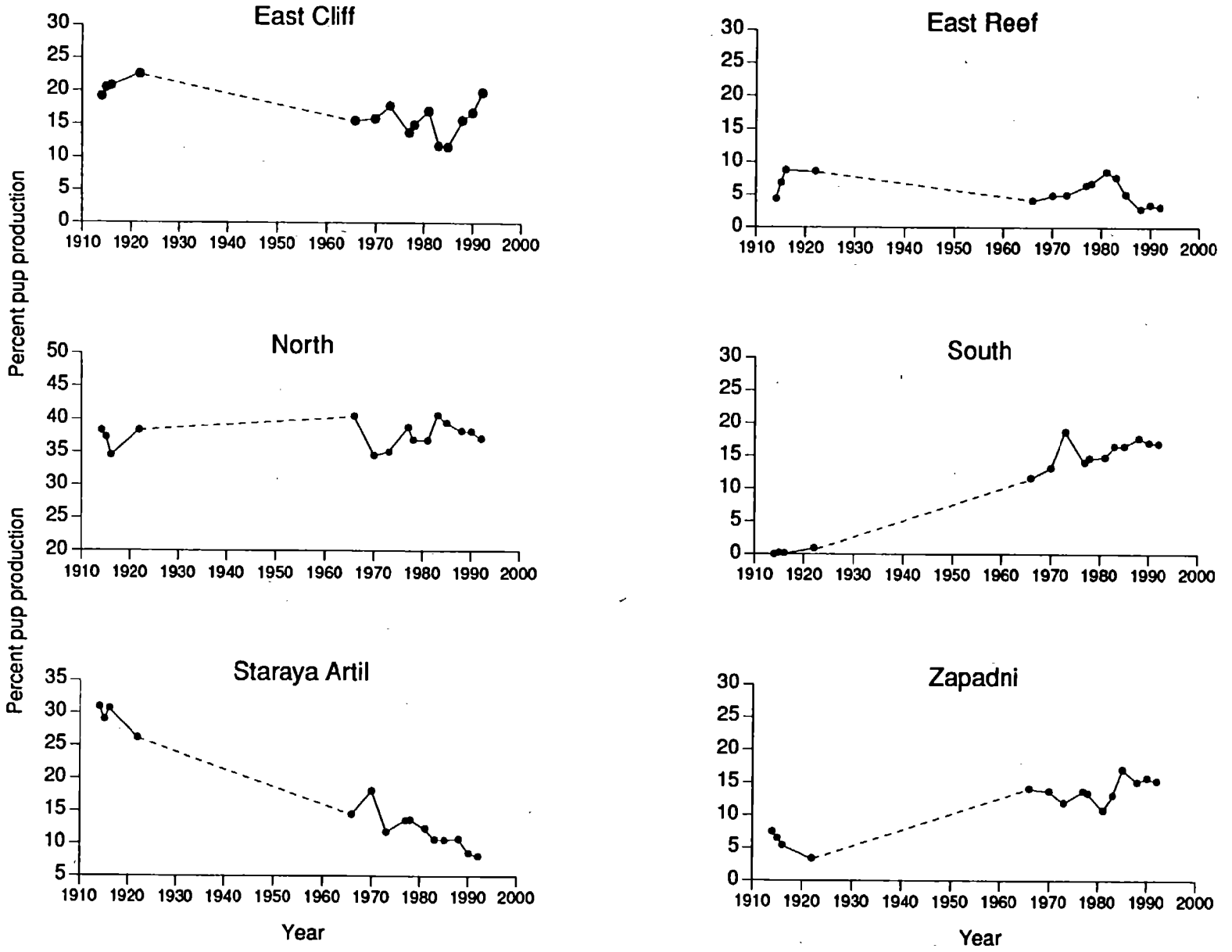


Figure 25.--The percent contribution of each rookery to the total pup production on St. George Island, Alaska, from 1914 to 1922.

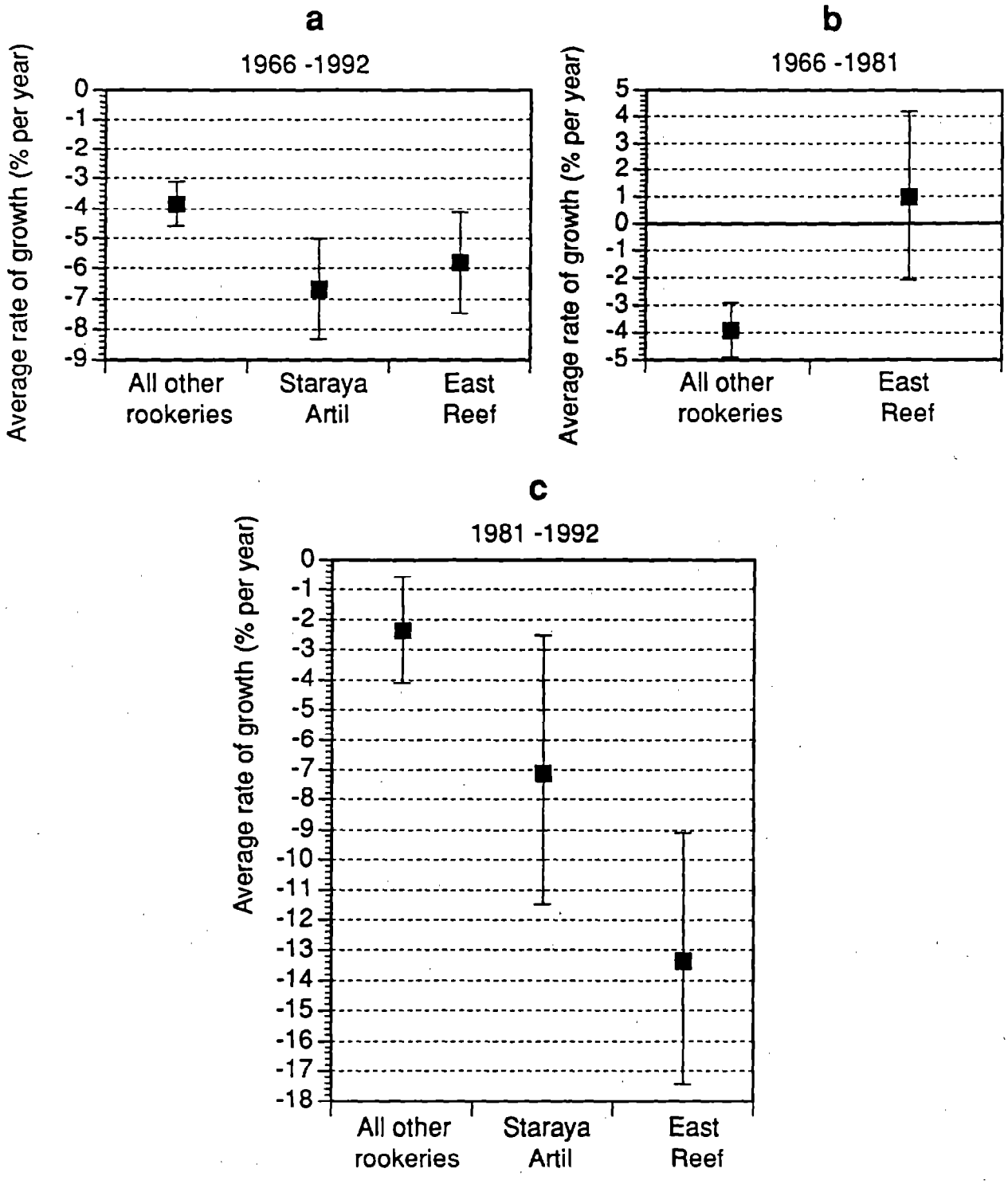


Figure 26. --Average annual rates of growth of rookeries on St. George Island, Alaska, from a) 1966 to 1992; b) 1966 to 1981 and c) 1981 to 1992. Approximate 95% confidence intervals are shown.

DISCUSSION

After considerable growth during the first half of this century, pup production on St. George Island dropped dramatically. The decline was probably precipitated by an extensive harvest of females from 1956 to 1968 on the Pribilof Islands (York and Hartley 1981). However, the female harvest can not explain the continued decline of the St. George Island population, especially throughout the 198Os, while pup production on St. Paul Island seems to have stabilized. In addition to between-island differences, individual rookeries on St. George Island have shown independent trends at various times. The relative contribution to the total Pribilof Island pup production by individual rookeries has changed. Most notably, the relative contribution of South and Zapadni rookeries increased while Staraya Artil's contribution decreased. Furthermore, rates of growth of rookeries on St. George Island differed. Staraya Artil and East Reef declined more rapidly than the other rookeries from 1966 to 1992, and in particular during the period from 1981 to 1992.

The trends observed on St. George Island suggest differential survival or reproductive success of rookery populations, redistribution of females onto different rookeries or islands, or both. The factors responsible for the trends observed are unclear at this time. Researchers are currently investigating disease and mortality, foraging behavior, and noise disturbance from vehicles, aircraft traffic, boats, and

construction projects. Other potential factors could include migration or changing prey resources, pathogens, commercial fishing, or disturbance due to human activity on or near the rookeries. Disturbance associated with human activity on or near the rookeries may be the greatest on the two most rapidly declining rookeries, East Reef and Staraya Artil, because of their accessibility and proximity to the village of St. George. This circumstantial evidence is worthy of additional research. It is important to identify factors contributing to the decline so that appropriate mitigating actions can be taken for protection of rapidly declining rookery areas.

MALE-BIASED SECONDARY SEX RATIOS OF NORTHERN FUR SEALS ON THE PRIBILOF ISLANDS, ALASKA, 1989 and 1992

by

George A. Antonelis, Timothy J. Ragen, and Nina J. Rooks

Variation in the sex ratio of neonates (secondary sex ratio) has been the topic of numerous studies on many non-human mammalian species (Clutton-Brock and Iason 1986). Some of these studies have attempted to demonstrate that within a species the sex ratio varies with the cost or benefit of producing male or female offspring and that this variability may be influenced by availability of resources or quality of habitat. If such correlations are demonstrated for northern fur seals, the sex ratio of neonates may be a useful indicator of the relationship between population trends and carrying capacity of their habitat.

For northern fur seals, the assessment of sex ratio has been based primarily on examination of fetuses from females collected at sea from 1958 to 1974. An analysis of these data (n ~ 7,000) indicated that the ratio of male to female fetuses was not significantly different from parity and did not change over time by month or year (York 1987a, and Trites 1991). However, Fowler (in press) reports a slight but significant bias toward males (50.65%, n = 27,391) after combining data collected from 1856 to 1983 from a variety of land and pelagic studies. Gentry and Francis (1981) reported that the sex ratio of pups on St. George Island in 1980 was slightly skewed toward males (51:49,

n = 1,064), and other authors have reported a possible male bias on the Pribilof Islands (Huber in press; York and Antonelis 1990a, 1990b; and York and Towel1 1993). However, none included both live and dead pups in the assessment of the secondary sex ratio.

In this study, we evaluate the sex ratio of northern fur seal pups from data collected in 1989 and 1992 on the Pribilof Islands and address the following questions: 1) Did the sex ratio of live and dead pups differ indicating differential mortality?; 2) Did the sex ratio of pups differ on St. Paul Island between 1989 and 1992?; 3) Did the ratio differ between St. George and St. Paul Island in 1992?; and 4) When data from both islands and years are combined, is the observed sex ratio consistent with a hypothetical ratio of l:l?

METHODS

The sex ratio of live and dead pups was evaluated during the last 2 weeks of August when few if any births occur. In 1989, data were collected from all St. Paul Island rookeries except Vostochni, Reef, Polovina Cliffs, and Little Polovina. In 1992, data were collected from all rookeries on St. George Island and only on Vostochni, Tolstoi, Polovina Cliffs, and Reef rookeries on St. Paul Island.

Dead pups were randomly sampled during counts of dead pups (Antonelis 1992). Gender was determined by visual inspection of the genital area or by extraction and examination of the lower canine teeth (Huber in press) from excessively decomposed carcasses. Approximately 11% and 20% of all dead pups were

sampled in 1989 and 1992, respectively.

Data for live pups were collected during pup tagging activities in 1989 and pup condition studies in 1992. Groups of 50-200 pups were herded into holding areas and each pup was examined for gender, measured, tagged (in 1989 only), and released (Antonelis 1992). Approximately 2%-4% of the total pups born were sampled on each rookery, but the sample size was never fewer than 100.

Log-likelihood G-tests and a heterogeneity analysis were used to determine if the sex ratio differed for live and dead pups (or if differences occurred between islands or years?) and to determine if the data sets (each year and island) were homogeneous (Zar 1984). A log-likelihood G-test was also used to determine if the pooled sex ratio was different than 50:50 (Zar 1984).

RESULTS

The sex ratio of live and dead pups born on St. Paul Island (Table 22) was not significantly different in 1989 ($n = 5,462$, $P > 0.90$, $G = 0.0062$), 1992 ($n = 1956$, $P > 0.50$, $G = 0.4185$), or on St. George Island in 1992 ($n = 872$, $P > 0.5.0$, $G = 0.1294$). Data sets from each island and year were homogeneous ($P > 0.50$, $G = 0.6053$), and analysis of the three data sets combined indicated no significant difference in the sex ratio of live and dead pups ($n = 8,290$, $P > 0.50$, $G = 0.2389$). The sex ratio on St. Paul Island was not significantly different in 1989 and 1992 ($_{(m}$ = 7,418, $P > 0.50$, $G = 0.6818$), and the ratio was not significantly different between St. George and St. Paul Islands

Table 22.--Secondary sex ratio comparisons of live and dead northern fur seal pups born on St. Paul Island and St. George Island in 1989 and 1992.

Island	Year	Live			Dead			G-stat	Significantly diff. (P<0.05)
		Male	Female	% Male	Male	Female	% Male		
St. Paul[1]	1989	2,663	2,256	54.1	293	250	53.9	0.0062	No
St. Paul[2]	1992	624	494	55.8	480	358	57.3	0.4185	No
St. George[3]	1992	343	291	54.1	132	106	55.5	0.1294	No
All Data		3630	3041	54.4	905	714	55.8	0.6053	No

[1] All rookeries except Reef, Zapadni Reef, and Polovina Cliffs.

[2] Four rookeries (Polovina Cliffs, Reef, Tolstoi, and Vostochni).

[3] All rookeries.

in 1992 (m = 2,828, P > 0.50, G = 0.2057).

The sex ratio of all pups sampled was skewed toward males during both years and on both islands. On St. Paul Island, males comprised 53.7% and 56.4% of the pups sampled in 1989 and 1992, respectively, and 54.4% on St. George Island in 1992. The combined data sets resulted in a male bias in sex ratio of 54.7%, which was significantly different from the predicted ratio of 50% (n = 8,290, P < 0.001, G = 73.4983).

DISCUSSION

Male-biased sex ratios of neonates on the Pribilof Islands in 1989 and 1992 were higher than previous reports dating back to 1896 (Fowler in press). These earlier reports indicate that historical sex ratios were highly variable, although some of the differences may have been due to different sampling techniques. In most cases, however, variability in sex ratio appears to be male-biased. Male fitness may be more variable and more strongly influenced by parental investment than female fitness (Bateman 1948, Trivers and Willard 1973). This could be especially true for polygynous species such as the northern fur seal, where male success and fitness are enhanced by large size (Bartholomew 1970) and early growth of males is more dependent on the amount of milk obtained from the mother because males have higher energy requirements (Costa and Gentry 1986, Glutton-Brock et al. 1981). Therefore, the degree to which sex ratios are highly biased toward males may be associated with the resources available to their mothers during pre- and postnatal care (Glutton-Brock and Iason 1986); One possible explanation for such biases is that

males tend to grow faster and require more food than females and are more likely to die during periods of depleted food resources (Meyers 1978, Case 1978). If this is true, then conditions on St. Paul and St. George Islands in 1989 and 1990 appear to favor pup growth because male and female mortality rates were similar (indicated by live and dead sex ratio) and the sex ratio was highly biased toward male offspring (54.7%).

In addition to food availability, other factors may influence the redundant sex ratio of fur seal neonates, thereby confounding the detection and interpretation of apparent trends (Clutton-Brock and Iason 1986). Such factors include quality of habitat, maternal condition, maternal age, competition for resources, timing of insemination, or parent-offspring conflict. The challenge is to evaluate these possible relationships and the mechanism(s) by which they operate. It is also important that all future studies assess the sex ratio of live and dead pups to detect possible changes in the- mortality rates of the two sexes.

SURVEYS OF ENTANGLEMENT AMONG ADULT FEMALE NORTHERN FUR SEALS, 1991-1992

by

Masashi Kiyota and Charles W. Fowler

A significant factor in mortality for northern fur seals (Callorhinus ursinus) on the Pribilof Islands, Alaska, may be entanglement in marine debris associated with the commercial fishing industry (Fowler 1982, 1987a, 1988; Fowler et al. 1990a). Studies on entanglement among females are reported by Bigg (1979), Scordino and Fisher (1983), Scordino (1985), DeLong et al. (1988), and Scordino et al. (1988). In this study, we assess the incidence of entanglement of adult females (generally older than 4 years) on- St. Paul Island in 1991 and 1992.

The objectives of this work are 1) to monitor the proportion of adult female fur seals entangled, 2) to determine the nature of entangling debris, and 3) to describe any within-season changes in the incidence of entanglement among adult female seals.

METHODS

Island-wide surveys of entanglement among adult female northern fur seals were conducted during the early breeding season (l0-14 July 1991 and l0-16 July 1992) while the fur seals congregate on rookeries along the shoreline. This work was conducted in conjunction with counts of adult males to avoid the extra disturbance of a separate survey.

Numbers of entangled and non-entangled female seals were counted using binoculars at sample areas for each rookery. Sample areas were determined as areas visible from vantage points already used to count adult males. Only seals positioned so that their necks were visible were counted. The total count and the count of entangled animals were used to 'estimate the incidence of entanglement. Characteristics of any wounds and the entangling debris were recorded, including the color and type of debris, when they could be determined. To obtain information regarding possible changes in incidence of entanglement within season, adult females were surveyed three times (11 and 22 July and 2 August) during 1992 on Reef rookery.

RESULTS

During female entanglement surveys, 16,009 seals were counted in 1991 and 25,089 were counted in 1992 (Tables 23 and 24). Seven entangled adult female seals were sighted: 4 (0.025%) in 1991 and 3 (0.012%) in 1992. Each year, 6 different seals were seen with evidence (scars or wounds without visible debris) of previous entanglement. 'Including the seals with evidence of previous entanglement, the estimated incidence of. entanglement was 0.062% for 1991 and 0.036% for 1992. Entangling debris on females, and the extent of any wounds (when visible), are described in Table 25.

During the three surveys conducted on Reef rookery in 1992, there was an increase from 0.021% to 0.155% in the incidence of scarred seals observed over the season (Table 26). There was no

Table 23. --Results of adult female northern fur seal entanglement survey, St. Paul Island, Alaska, July 1991.

Date	Rookery	No. of females counted	No. of entangled females	No. of females with scars
7/10	Gorbatch	1,627	1*	0*
	Ardiguen	322	0	0
	Reef	2,754	1	0
7/11	Tolstoi	2,844	0	1
7/12	Zapadni	759	0	1
	Little Zapadni	1,468	0	0
	Zapadni Reef	117	0	0
7/13	Polovina	127	0	0
	Polovina Cliffs	1,792	2	2
	Little Polovina	53	0	0
	Lukanin	394	0	0
	Kitovi	608	0	0
7/14	Morjovi	903	0	0
	Vostochni	2,241	0	2
Total		16,009	4	6

*Entangled debris invisible. Tightly entangled line/band or recently disentangled scar.

Table 24. --Results of adult female northern fur seal entanglement survey, St. Paul Island, Alaska, July 1992.

Date	Rookery	No. of females counted	No. of entangled females	No. of females with scars
7/10	Lukanin	609	0	0
	Kitovi	906	0	0
	Little Zapadni	741	1	1
	Zapadni Reef	276	0	0
7/11	Gorbatch	2,285	0	0
	Ardiguen	507	0	0
	Reef	5,504	0	2
7/12	Polovina	314	0	0
	Polovina Cliffs	2,288	0	0
	Little Polovina	64	0	0
7/13	Zapadni	2,957	0	0
7/15	Morjovi	1,474	0	0
	Vostochni	3,974	1	2
7/16	Tolstoi	3,190	1	1
Total		25,089	3	6*

*All the scars observed were around the neck region.

Table 25. --Characteristics of observed entanglement among adult female northern fur seal seen during surveys conducted on St. Paul Island, Alaska, July 1991 and 1992.

Date	Rookery	Position	Notes
7/10/91	Gorbatch	neck	Entangled debris invisible. Tightly entangled line/band, or recently disentangled scar.
7/10/91	Reef	neck	Blue-green trawl net, small amount.
7/13/91	Polovina Cliffs	abdomen	Entangled debris invisible. Deep scar into abdominal muscle.
7/13/91	Polovina Cliffs	neck	Green trawl net. Small amount.
7/10/92	Little Zapadni	neck	Narrow blue plastic band
7/15/92	Vostochni	neck	Bright green trawl net
7/16/92	Tolstoi	neck	Bright green trawl net

Table 26. --Summary of seasonal changes observed in the incidence of entanglement among adult female northern fur seal seen during surveys conducted on Reef rookery, St. Paul Island, Alaska, July 1992.

Date	No. females counted	No. entangled females	No. scarred females[1]	Rate of entangled females (%)	Rate of scarred females (%)
7/11	4,687	0	1	0	0.021
7/22	2,811	1[2]	1	0.036	0.036
8/02	2,561	0	4	0	0.156

[1] All the scars observed were around the neck.

[2] The female observed on 7/22 was entangled in a white packing band. She was disentangled on the following day. No wound was observed.

evidence of a seasonal trend in the incidence of entangled seals and the numbers of observed seals with scars or debris were too small for meaningful statistical analysis.

DISCUSSION

The first information regarding the incidence of entanglement among female fur seals-from the Pribilof Islands was reported by Bigg (1979) from surveys conducted during l0-19 July, 1978. Bigg's work on St. Paul Island indicated (as does this study) that a smaller fraction of adult females are entangled compared with juvenile males. 'Owing to the inability to distinguish age among females, and the low numbers of juvenile females that return to the breeding islands, little comparison can be made between young females and other groups within the population. Bigg reported that about 0.16% of the females surveyed were entangled compared with about 0.4% for juvenile males from 1976 to 1986.

Scordino and Fisher (1983) reported seeing one entangled (presumably adult) female among an estimated 5,166 (0.02%) in a survey conducted on St. Paul Island (Reef rookery) 21 July 1982. Scordino (1985) reported entanglement involving less than 0.04% of the females from surveys conducted on St. Paul Island from June through August 1982-1984. In 1984, Scordino et al. (1988) conducted surveys on two rookeries (with, four replicates on Reef rookery). In that study the incidence of entanglement (i.e., those with observed debris) ranged from 0.017% to 0.167%. The incidence of entanglement on Reef rookery appeared to increase

over the season (0.032%, 0.025%, 0.083%, and O.l67% for surveys conducted on 7, 14, 25 and 29 July 1984). The mean incidence from all samples reported for 1984 by Scordino et al. (1988) was 0.04% (in the total count of 21,600 females). Surveys of female entanglement were conducted on St. Paul Island again in 1985 (DeLong et al. 1988). Incidence of entanglement among adult females in 1985 averaged 0.140% for the three study rookeries (range = 0.06%-0.23%) in surveys conducted from July through September.

Bigg (1979) did not consider seals with scars as entangled and the dates of his surveys correspond to those of this study when restricted to females with observed debris. His method for estimating incidence of entanglement (yielding 0.16%) is therefore comparable with the methods of this study producing incidences of 0.025% (1991) and 0.012% (1992) for seals with observed debris. The incidence of entanglement in 1991-1992 appears to be lower than for 1978 as reported by Bigg (1979). The incidence of entanglement among adult female northern fur seals from the early 1980s (about 0.04%, Scordino et al. 1988) was less than observed by Bigg (1979) but was also higher than observed in 1991-1992.

Compared with the incidence of entanglement for adult females in 1985 (as estimated by DeLong et al. 1988) the data for 1991 and 1992 also show reduced levels. The calculation of incidence of entanglement among adult females in 1985 (DeLong et al. 1988) included seals with evidence of previous entanglement. These estimates ranged from 0.06% to 0.23% with a

mean of 0.14%. The mean for 1991-1992 was 0.046% (also including seals with scars). The apparent reduction in entanglement among females in recent years is consistent with the lower incidence of entanglement among juvenile male seals (Fowler et al. 1992).

Two sets of data indicate that there may be an increase in the incidence of entanglement among adult females within season (Fig. 27). The data from Scordino et al. (1988) are for entangled seals observed with debris in 1984. The data from this study involve only scarred seals seen in 1992. Both studies are for Reef rookery. These sets of data are not directly comparable since one is for entangled seals and the other is for scarred seals. Even though the magnitudes of entanglement rates can not be compared, the parallel trends in rates over time are indicative of increases. Any such increase is likely due to the late arrival of young females (Bigg 1986) and higher rates of entanglement among these age groups (Fowler 1987a). The combination of these factors would give rise to the increase in observed incidence of entanglement owing to the increasing fraction of young females to be observed in the female portion of the population on land. Because of the small sample sizes in each case, further surveys are needed to verify the existence of such trends.

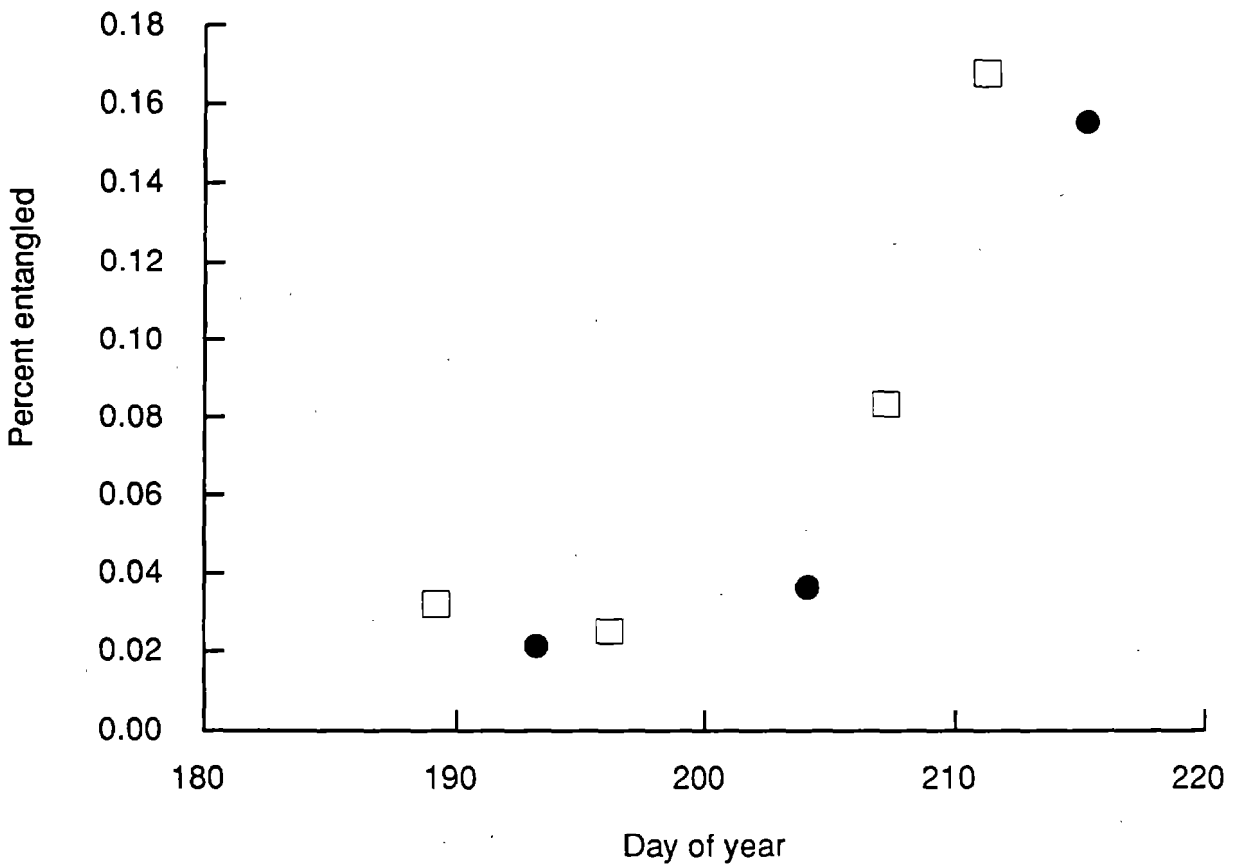


Figure 27. --Seasonal changes in incidence of entanglement and scarring observed among adult female northern fur seals on St. Paul Island, Alaska, as observed by Scordino et al. (1988, open squares) for seals in debris in comparison with data from this study (solid circles) for scarred seals.

ENTANGLEMENT STUDIES ON JUVENILE MALE NORTHERN FUR SEALS, ST. PAUL ISLAND, 1992

by

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Entanglement in marine debris, specifically in plastics associated with the commercial fishing industry, has been identified as a significant factor contributing to declining population trends observed for northern fur seals (Callorhinus ursinus) on the Pribilof Islands, Alaska (Fowler 1982, 1987a, 1988; Fowler et al. 1990b). The effects of entanglement on northern fur seals have been examined at the population level (Fowler 1982, 1985b, 1987a) and at the level of the individual (Fowler 1988). Fur seal entanglement has been studied since the early 1980s by the National Marine Mammal-Laboratory, in cooperation with the National Research Institute of Far Seas Fisheries of Japan (Fowler and Baba 1991, Fowler et al. 1992).

Research objectives are 1) to determine the proportion of the seal population entangled; 2) to classify the entangling debris; 3) to determine the effects of entanglement on mortality, especially at the population level; 4) to remove debris from entangled seals; and 5) to determine the effects of debris removal on survival.

This report presents the results of our research in 1992 on the entanglement of juvenile male (aged 2 to 5 years) northern fur seals from St. Paul Island, Alaska. Studies in 1992 examined

the incidence of entanglement and its effects on survival, characterized the entangling debris found on the seals, and compared the frequency of repeated sightings for entangled and nonentangled seals.

METHODS

Juvenile male northern fur seals were observed during roundups as described in Fowler et al. (1990a), Fowler and Ragen (1990), and Fowler and Baba (1991). Seals were herded into a group and allowed to pass between observers who watched for animals with tags or entangling debris. When an entangled or tagged seal was sighted, the flow of seals was stopped while the seal was captured and the relevant information (e.g.., tag number, tag type, degree of wound, and type of debris) was recorded. Entangled seals and control animals were tagged. All work was conducted during the breeding season when animals congregate near breeding rookeries along the shoreline of the island.

Entanglement research focuses on juvenile (subadult) male seals 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 male seals of this size. The total count and the count of entangled animals are used to estimate the incidence of entanglement.

As in all years since 1989, entangled seals were tagged and entangling debris was removed (prior to 1989; entangling debris was left on the animals). Characteristics of the entangling debris, including the type, color, and weight were recorded. 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. Two nonentangled seals about the same size as each entangled animal were also tagged to serve as controls when comparing rates of return.

The removal of debris was taken into account when comparing results from studies conducted before and after 1989. This was particularly important in calculating the proportion of seals entangled. Since we removed debris from seals beginning in 1989, the increased survival of these seals resulted in larger numbers being resighted, thus artificially inflating the proportion reported as entangled. To account for this, and to make the data comparable, we used the estimated relative survival of seals entangled in small debris (0.5 relative to controls from past studies: Fowler 1984b, 1985b, 1987a; Fowler et al. 1989; Fowler et al. 1990a; Fowler et al. 1990b; Fowler and Ragen 1990; Fowler et al. 1992). The number of seals resighted after having had debris removed in 1991 was multiplied by this value. In other words, one-half of the resighted seals from which debris had been removed in 1991 were assumed to have been seals that would have been resighted as entangled seals in 1992 and would thus contribute to the observed proportion of the population entangled.

To calculate the entanglement rate, 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. In 1992, the size of seals tagged in 1989-1991 was recorded. Thus, the

estimate for incidence of entanglement only included tagged seals within the designated size criteria in the count of entangled seals. This differs from procedures for estimation of survival where seals that were previously tagged were cpunted regardless of size (i.e., entangled seals and controls both grow and both are recounted).

Because some animals are observed more than once within a season, both control and entangled seals are sampled with replacement. This differs from the method used in estimating the incidence of entanglement from the commercial harvest (prior to 1985) in which both entangled and nonentangled seals were killed.

Analytical methods used to analyze resight data to estimate the survival rate of entangled seals are from Fowler and Baba (1991):

RESULTS AND DISCUSSION

Roundups

Ninety-four roundups of subadult male northern fur seals were completed on St. Paul Island during July and early August of 1992 (Table 27). During these roundups, 17,630 male seals which met the size historically taken in the commercial harvest were counted.

In 1992, 22.2% of all sightings of entangled or control seals were individuals that had already been seen during the same season (34 out of the total of 153). This estimate of repeat sightings is slightly less than the values (25%-30%) calcuated from previous years (Fowler et al. 1992). Thirty-nine entangled

Table 27. --Summary of roundups of juvenile (subadult) northern fur seal males conducted on St. Paul Island, Alaska, during July and August of 1992, 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
7/3	Zapadni Reef Sands	82	6	0
7/3	Polovina	83	2	0
7/3	Zoltoi Sands	165	6	0
7/4	Zapadni Sands	349	11	0
7/5	Tolstoi	126	11	0
7/5	Tolstoi	28	1	0
7/5	Lukanin	53	3	0
7/5	Kitovi	218	15	0
7/6	Morjovi	1	0	0
7/6	Morjovi	106	5	0
7/6	Morjovi	247	7	1
7/6	Morjovi	97	6	0
7/7	Vostochni	189	4	6
7/7	Vostochni	135	9	3
7/7	Vostochni	100	1	6
7/8	Vostochni	77	4	5
7/8	Vostochni	178	13	0
7/9	Gorbatch	237	10	6
7/9	Reef	127	5	0
7/9	Reef	36	1	0
7/9	Reef	65	3	0
7/9	Zapadni Reef Sands	587	27	3
7/10	Tolstoi	186	22	0
7/10	Tolstoi	26	4	3
7/11	Zapadni	138	8	3
7/11	Zapadni	212	7	0
7/11	Zapadni	221	11	3
7/12	Polovina	224	10	0
7/12	Polovina	181	9	0
7/12	Zoltoi Sands	280	14	3
7/13	Lukanin	251	11	3
7/13	Kitovi	130	9	0
7/14	Morjovi	142	5	3
7/14	Morjovi	142	7	2
7/14	Vostochni	187	8	0
7/14	Vostochni	157	3	0
7/14	Vostochni	122	6	3
7/14	Vostochni	117	6	0
7/16	Gorbatch	284	16	0
7/16	Reef	89	5	0
7/16	Reef	105	8	0

Table 27. --Continued.

Date	Location	Total[a] in roundup	Tagged seals[b] resighted	Total seals tagged
7/17	Zapadni Reef Sands	252	13	0
7/17	Tolstoi	159	9	3
7/18	Zoltoi Sands	321	17	0
7/18	Polovina	383	16	6
7/19	Lukanin	66	0	0
7/19	Kitovi	95	8	0
7/20	Zapadni Sands	243	9	0
7/20	Zapadni	158	7	6
7/20	Little Zapadni	22	1	0
7/21	Morjovi	127	7	0
7/21	Morjovi	118	6	0
7/21	Vostochni	263	12	0
7/21	Morjovi	137	7	0
7/22	Vostochni	77	5	0
7/22	Vostochni	258	12	0
7/23	Gorbatch	229	9	2
7/23	Reef	178	10	4
7/23	Reef	45	3	0
7/23	Reef	138	6	0
7/24	Zapadni Reef Sands	221	5	3
7/24	Zapadni Reef	295	13	1
7/24	Tolstoi	322	14	0
7/25	Zoltoi Sands	469	13	0
7/25	Polovina	117	6	0
7/26	Kitovi	306	16	3
7/26	Lukanin	104	5	0
7/27	Zapadni	251	14	0
7/27	Zapadni	179	10	0
7/27	Zapadni	230	9	0
7/28	Morjovi	136	9	0
7/28	Morjovi	84	4	3
7/28	Little Zapadni	128	5	3
7/29	Vostochni Sands	295	13	3
7/29	Vostochni	322	11	6
7/30	Zapadni Reef Sands	220	10	0
7/30	Tolstoi	229	14	3
7/30	Zapadni Reef	180	8	5
7/31	Gorbatch	139	7	0
7/31	Reef	278	11	0
7/31	Reef	120	5	0
7/31	Zoltoi Sands	429	17	3
8/1	Lukanin	152	7	3
8/1	Kitovi	176	13	0
8/1	Polovina	174	6	6

Table 27. --Continued.

Date	Location	Total[a] in roundup	Tagged seals[b] resighted	Total seals tagged
8/2	Morjovi	92	5	0
8/2	Northeast Point	39	6	0
8/3	Vostochni Sands	289	17	0
8/3	Vostochni	368	25	3
8/4	Zapadni Sands	297	26	0
8/4	Zapadni	382	12	0
8/5	Gorbatch	363	18	0
8/5	Reef	244	12	0
8/5	Reef	251	12	0
	Totals	17,630	854	118

[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, or in Russian research) in either foreflipper and that were successfully restrained to read the tag. Includes tags that were resighted more than once this year.

subadult male seals judged to meet the size criteria were captured and their debris was-removed. These seals were then double-tagged with numbered blue Allflex tags bearing the address of the National Marine Mammal Laboratory (Table 28). One entangled seal tagged with a monel tag (number A07073, not replaced by an Allflex tag) was also captured and released after removing the debris. Eighty similarly sized control seals with no entangling debris were also tagged (Table 28).

Tagged Seals from Previous Years

Sixty-seven seals which had been tagged during entanglement research in previous years were resighted in 1992 (Table 29). Of these, 7 had tags applied in 1985, 1986, and 1988. Six of the 7 resighted seals were tagged in previous years as controls. One had been entangled when tagged and had subsequently lost its entangling debris, which had been noted as being small (less than an estimated 150 g) at the first sighting of the seal.

Twenty-four male seals with 1991 tags were resighted. Over 70% of these seals (n = 17) had been tagged as controls and the remainder (n = 7) had been tagged after being disentangled. Twenty-six seals were resighted with tags applied in 1990. Eighteen of these (69.2%) had been tagged as controls and 8 had been tagged after being disentangled. Ten were resighted with tags applied in 1989, the first year during which debris was removed. Of these, 7 (70%) had been tagged as controls and 3 had been tagged after being disentangled.

Table 28.--List of blue broad-banded Allflex tags applied to juvenile male northern fur seals during roundups conducted on St. Paul Island, Alaska, 1992. Debris was removed from entangled seals prior to their being released.

Tag number	Date	Location	Entangled (e) Control (c)
1501	7/6	Morjovi	e
1502	7/7	Vostochni	e
1503	7/7	Vostochni	e
1504	7/7	Vostochni	c
1505	7/7	Vostochni	c
1506	7/7	Vostochni	c
1507	7/7	Vostochni	c
1508	7/7	Vostochni	c
1509	7/7	Vostochni	e
1510	7/7	Vostochni	c
1511	7/7	Vostochni	c
1512	7/7	Vostochni	c
1513	7/7	Vostochni	c
1514	7/7	Vostochni	e
1515	7/7	Vostochni	e
1516	7/7	Vostochni	c
1517	7/8	Vostochni	c
1518	7/8	Vostochni	c
1519	7/8	Vostochni	c
1520	7/8	Vostochni	c
1521	7/8	Vostochni	e
1522	7/9	Gorbatch	e
1523	7/9	Gorbatch	e
1524	7/9	Gorbatch	c
1525	7/9	Gorbatch	c
1526	7/9	Gorbatch	c
1527	7/9	Gorbatch	c
1528	7/9	Zapadni Reef Sands	e
1529	7/9	Zapadni Reef Sands	c
1530	7/9	Zapadni Reef Sands	c
1531	7/10	Tolstoi	c
1532	7/10	Tolstoi	e
1533	7/10	Tolstoi	c
1534	7/11	Zapadni	c
1535	7/11	Zapadni	c
1536	7/11	Zapadni	e
1537	7/11	Zapadni	c
1538	7/11	Zapadni	e
1539	7/11	Zapadni	c
1540	7/12	Zoltoi Sands	c

Table 28. --Continued..

Tag number	Date	Location	Entangled (e) Control (c)
1541	7/12	Zoltoi Sands	c
1542	7/12	Zoltoi Sands	e
1543	7/13	Lukanin	e
1544	7/13	Lukanin	c
1545	7/13	Lukanin	c
1546	7/14	Morjovi	e
1547	7/14	Morjovi	c
1548	7/14	Morjovi	c
1549	7/14	Morjovi	c
1550	7/14	Morjovi	c
1551	7/14	Vostochni	e
1552	7/14	Vostochni	c
1553	7/14	Vostochni	c
1554	7/17	Tolstoi	e
1555	7/17	Tolstoi	c
1556	7/17	Tolstoi	c
1557	7/18	Polovina	e
1558	7/18	Polovina	e
1559	7/18	Polovina	c
1560	7/18	Polovina	c
1561	7/18	Polovina	c
1562	7/18	Polovina	c
1563	7/20	Zapadni	e
1564	7/20	Zapadni	c
1565	7/20	Zapadni	e
1566	7/20	Zapadni	c
1567	7/20	Zapadni	c
1568	7/20	Zapadni	c
1569	7/23	Gorbatch	e
1570	7/23	Gorbatch	c
1571	7/23	Reef	c
1572	7/23	Reef	c
1573	7/23	Reef	e
1574	7/23	Reef	c
1575	7/24	Zapadni Reef Sands	e
1576	7/24	Zapadni Reef Sands	c
1577	7/24	Zapadni Reef Sands	c
1578	7/24	Zapadni Reef	e
1579	7/26	Kitovi	e
1580	7/26	Kitovi	c
1581	7/26	Kitovi	c
1582	7/28	Morjovi	e
1583	7/28	Morjovi	c
1584	7/28	Morjovi	c

Table 28. --Continued.

Tag number	Date	Location	Entangled (e) Control (c)
1585	7/28	Little Zapadni	c
1586	7/28	Little Zapadni	e
1587	7/28	Little Zapadni	c
1588	7/29	Vostochni Sands	c
1589	7/29	Vostochni Sands	e
1590	7/29	Vostochni Sands	c
1591	7/29	Vostochni	e
1592	7/29	Vostochni	e
1593	7/29	Vostochni	c
1594	7/29	Vostochni	c
1595	7/29	Vostochni	c
1596	7/29	Vostochni	c
1597	7/30	Tolstoi	c
1598	7/30	Tolstoi	c
1599	7/30	Tolstoi	e
1600	7/30	Zapadni Reef	c
1601	7/30	Zapadni Reef	c
1602	7/30	Zapadni Reef	c
1603	7/30	Zapadni Reef	e
1604	7/30	Zapadni Reef	c
1605	7/31	Zoltoi Sands	e
1606	7/31	Zoltoi Sands	c
1607	7/31	Zoltoi Sands	c
1608	8/1	Lukanin	c
1609	8/1	Lukanin	c
1610	8/1	Lukanin	e
1611	8/1	Polovina	e
1612	8/1	Polovina	c
1613	8/1	Polovina	c
1614	8/1	Polovina	c
1615	8/1	Polovina	c
1616	8/1	Polovina	e
1617	8/3	Vostochni	c
1618	8/3	Vostochni	c
1619	8/3	Vostochni	e

Table 29.--List of northern fur seals tagged with plastic tags as seen during juvenile male roundups on St. Paul Island, July-August 1992. Tags were seen on both foreflippers (where two numbers are reported the first is on the left) unless noted otherwise. Debris was removed from entangled seals. Monel tagged seals are to be reported elsewhere.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/3	Zoltoi Sands	1473	Allflex	White	c	Tagged 29 July 1990 on Polovina.
7/5	Kitovi	0744	Allflex	Orange	c	The number 0745 was originally applied to the right side but not seen at this sighting. Tagged 24 Aug. 1986 on Kitovi.
7/5	Kitovi	1396	Allflex	White	e[r]	Tagged on 22 July 1990 on Vostochni. Too large to count.
7/5	Tolstoi	017-018	Allflex	Green	c	Tagged 11 July 1991 on Tolstoi.
7/5	Tolstoi	1260	Allflex	Orange	c	Right tag was the only one sighted. Tagged 24 July 1989 on Tolstoi.
7/6	Northeast Point	1331	Allflex	White	c	Tagged on 13 July 1990 on Polovina.
7/7	Vostochni	059-060	Allflex	Green	c	Tagged 20 July 1991 on Vostochni.
7/7	Vostochni	1320	Allflex	White	e[r]	Tagged 11 July 1990 on Zapadni. Too large to count.
7/8	Vostochni	1512	Allflex	Blue	c	Tagged on Vostochni 7 July 1992.
7/8	Vostochni	1511	Allflex	Blue	c	Tagged on Vostochni 7 July 1992.
7/8	Vostochni	1388	Allflex	White	c	Tagged 22 July 1990 on Vostochni.
7/8	Vostochni	1508	Allflex	Blue	c	Tagged on Vostochni 7 July 1992.
7/9	Gorbatch	161-162	Allflex	Green	c	Only one tag noted, there may have been two present. Tagged 29 July 1991 on Gorbatch.
7/9	Reef	157-158	Allflex	Green	e[r]	Countable size. Only one tag noted, there may have been two present. Tagged 29 July 1991 on Gorbatch.

Table 29. --Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/9	Zapadni Reef Sands	54	Allflex	Blue	c	Tagged on 20 July 1988, on Vostochni (with a radio tag).
7/9	Zapadni Reef Sands	075-076	Allflex	Green	c	Only one tag noted, there were two present. Tagged 21 July 1991 on Lukanin.
7/9	Zapadni Reef Sands	131-132	Allflex	Green	c	Tagged 27 July 1991 on Zapadni Reef Sands.
7/9	Zapadni Reef Sands	077-078	Allflex	Green	e[r]	Only one tag noted, there may have been two present. Tagged 21 July 1991 on Lukanin. Countable size.
7/9	Zapadni Reef Sands	007-008	Allflex	Green	c	Tagged 7 July 1991 on Zapadni Sands.
7/9	Zapadni Reef Sands	1398	Allflex	White	c	Only one tag noted, there may have been two present. Tagged 22 July 1990 on Vostochni.
7/10	Tolstoi	1525	Allflex	Blue	c	Tagged 7 July 1992 on Gorbatch.
7/10	Tolstoi	171-172	Allflex	Green	e[r]	Tagged 30 July 1991 on Zapadni Sands. Too large to count.
7/10	Tolstoi	029-030	Allflex	Green	c	Tag number on left not read but tag was sighted. Tagged 15 July 1991 on Vostochni.
7/11	Zapadni	1198	Allflex	Orange	e[r]	Tagged 18 July 1989 on Morjovi. Too large to count.
7/12	Zoltoi Sands	039-040	Allflex	Green	e[r]	Countable size. Tagged 18 July 1991 on Polovina.
7/12	Zoltoi Sands	1528	Allflex	Blue	e[r]	Tagged on 9 July 1992 on Zapadni Reef Sands. Too large to count.
7/12	Zoltoi Sands	1453	Allflex	White	c	Tagged on 27 July 1990 on Reef. Too large to count.
7/13	Lukanin	1528	Allflex	Blue	e[r]	Tagged on 9 July 1992 on Zapadni Reef Sands.

Table 29.--Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/13	Lukanin	MH2742	Monel			Russian tagged seal, weighed 70 lb.
7/13	Lukanin	081-082	Allflex	Green	c	Tagged on 21 July 1991 on Zapadni Reef Sands.
7/13	Kitovi	MH1456	Monel			Russian tagged seal, weighed 58 lb.
7/13	Kitovi	0956-0957	Allflex	Orange	c	Tagged 8 Oct. 1986 on Morjovi.
7/14	Morjovi	1515	Allflex	Blue	e[r]	Tagged 7 July 1992 on Vostochni.
7/14	Morjovi	1354	Allflex	White	c	Tagged 17 July 1990 on Morjovi.
7/14	Vostochni	1511	Allflex	Blue	c	Tagged 7 July 1992 on Vostochni.
7/14	Vostochni	157-158	Allflex	Green	e[r]	Tagged 29 July 1991 on Gorbatch. Countable size.
7/14	Vostochni	1214	Allflex	Orange	e[r]	Tagged 18 July 1989, on Vostochni (Sands). Too large to count.
7/14	Vostochni	bH88	Monel			Russian tagged seal, weighed 72 lb.
7/14	Vostochni	1431	Allflex	White	e[r]	Tagged 25 July 1990 on Morjovi. Too large to count.
7/14	Vostochni	1521	Allflex	Blue	e[r]	Tagged 8 July 1992 on Vostochni.
7/14	Vostochni	1485	Allflex	White	c	Tagged 2 August 1990 on Vostochni.
7/14	Vostochni	1513	Allflex	Blue	c	Tagged 7 July 1992 on Vostochni.
7/14	Vostochni	1221	Allflex	Orange	c	Tagged 19 July 1989 on Vostochni.
7/16	Gorbatch	1457	Allflex	White	c	Tagged 27 July 27 1990 on Reef.
7/16	Reef	1438	Allflex	White	c	Tagged 26 July 1990 on Kitovi.
7/16	Reef	171-172	Allflex	Green	e[r]	Tagged 30 July 1991 on Zapadni Sands. Too large to count.
7/16	Reef	021-022	Allflex	Green	e[r]	Tagged 13 July 1991 on Lukanin. Too large to count.
7/16	Reef	1198	Allflex	Orange	e[r]	Tagged 18 July 1990 on Morjovi. Too large to count.

Table.29. --Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/17	Tolstoi	027-028	Allflex	Green	c	Tagged 15 July 1991 on Vostochni. Too large to count.
7/19	Kitovi	1417	Allflex	White	c	Tagged 6 July 1990 on Lukanin.
7/20	Zapadni Sands	1401	Allflex	White	e[r]	Tagged 1 July 1990, on Tolstoi.
7/20	Zapadni	181-182	Allflex	Green	c	Tagged 31 July 1991 on Little Polovina.
7/20	Zapadni	MH2451	Monel		e[r]	Russian tag, weighed 62 lbs.
7/20	Little Zapadni	1190	Allflex	Orange	e[r]	Tagged 16 July 1989 on Zapadni Sands. Very large animal.
7/21	Morjovi	1547	Allflex	Blue	c	Tagged 14 July 1992 on Morjovi.
7/21	Morjovi	PB8433	Monel		e[r]	Russian tag.
7/21	Morjovi	79	Allflex	Blue	e[r]	Tagged 25 July 1988 on Tolstoi.
7/21	Vostochni	1552	Allflex	Blue	c	Tagged 14 July 1992 on Vostochni.
7/21	Vostochni	1519	Allflex	Blue	c	Tagged 8 July 1992 on Vostochni.
7/21	Morjovi	1448	Allflex	White	e[r]	Tagged 26 July 1990 on Zapadni.
7/21	Morjovi	1215	Allflex	Orange	c	Tagged 18 July 1989 on Vostochni.
7/22	Vostochni	MH2659	Monel		e[r]	Russian tag, missing right tag; weighed 67 lb.
7/22	Vostochni	059-060	Allflex	Green	c	Tagged 20 July 1991 on Vostochni.
7/23	Gorbatch	1456	Allflex	White	c	Tagged on 27 July 1990 on Reef. Too large to count.
7/23	Reef	171-172	Allflex	Green	e[r]	Tagged 30 July 1991 on Zapadni Sands. Too large to count.
7/23	Reef	1505-1506	Allflex	Blue	c	Tagged 7 July 1992 on Vostochni.
7/23	Reef	1449	Allflex	White	c	Tagged on 26 July 1990 on Zapadni. Too large to count.
7/24	Zapadni Reef	1350	Allflex	White	c	Tagged on 16 July 1990 on Vostochni Sands. Too large to count.

Table 29. --Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/24	Zapadni Reef	0466-0467	Allflex	Orange	c	Tagged 24 Aug. 1986 on Zapadni.
7/24	Tolstoi	1486	Allflex	White	c	Tagged on 2 Aug. 1990 on Vostochni.
7/24	Tolstoi	199-200	Allflex	Green	e[r]	Tagged 1 Aug. 1991 on Zapadni Sands. Too large to count.
7/24	Tolstoi	1385	Allflex	White	e[r]	Tagged on 22 July 1990 on Vostochni.
7/25	Zoltoi Sands	209-210	Allflex	Green	c	Tagged 3 Aug. 1991, on Gorbatch. Too large to count.
7/25	Zoltoi Sands	1570	Allflex	Blue	c	Tagged 23 July 1992 on Gorbatch.
7/26	Lukanin	1476	Allflex	White	e[r]	Tagged 29 July 1990 on Polovina.
7/27	Zapadni	209-210	Allflex	Green	c	Tagged 3 Aug. 1991 on Gorbatch. Too large to count.
7/27	Zapadni	055-056	Allflex	Green	c	Tagged 19 July 1991 on Zapadni Reef. Too large to count.
7/27	Zapadni	1577	Allflex	Blue	c	Tagged 24 July 1992 on Zapadni Reef Sands.
7/28	Morjovi	1352	Allflex	White	c	Tagged on 17 July 1990 on Vostochni.
7/28	Morjovi	1546	Allflex	Blue	e[r]	Tagged 14 July 1992 on Morjovi.
7/29	Vostochni Sands	1214	Allflex	Orange	e[r]	Tagged 18 July 1989 on Vostochni Sands after removing two pieces of debris from two 360-degree wounds. It was then noted as a stunted animal and continued to appear so in 1992 and showed scars from the wounds.
7/30	Tolstoi	031-032	Allflex	Green	e[r]	Tagged 16 July 1991 on Gorbatch. Too large to count.
7/30	Tolstoi	081-082	Allflex	Green	c	Tagged 21 July 1991, on Zapadni Reef Sands. Too large to count.
7/30	Tolstoi	1570	Allflex	Blue	c	Tagged 23 July 1992 on Gorbatch.

Table 29. --Continued-.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/28	Little Zapadni	1586	Allflex	Blue	e'	Tagged 28 July 1992 on Little Zapadni.
7/30	Zapadni Reef	137-138	Allflex	Green	c	Tagged 27 July 1991 on Zapadni Reef Sands. Too large to count.
7/30	Zapadni Reef	199-200	Allflex	Green	e'	Missing the right tag. Tagged 2 Aug. 1991 on Zapadni Reef Sands. Too large to count.
7/30	Zapadni Reef	MA778	Monel		e'	Russian tag. Weighed 54 lb.
7/31	Gorbatch	1524	Allflex	Blue	c	Tagged 9 July 1992 on Gorbatch.
7/31	Gorbatch	1242	Allflex	Orange	c	Tagged 23 July 1989 at Lukanin.
7/31	Reef	99-100	Allflex	Green	c	Tagged 23 July 1991 on Reef. Too large to count.
7/31	Reef	1232	Allflex	Orange	c	Tagged 21 July 1989, at Reef.
7/31	Reef	1317	Allflex	White	e'	Tagged 11 July 1990, on Zapadni Sands. Too large to count.
7/31	Reef	095-096	Allflex	Green	c	Tagged 22 July 1991 on Reef. Too large to count.
7/30	Reef	1572	Allflex	Blue	c	Tagged 7 July 1992 on Reef.
7/31	Reef	22	Allflex	Blue	c	Tagged on 17 July 1988, on Reef.
7/31	Zoltoi Sands	1576	Allflex	Blue	c	Tagged 24 July 1992 on Zapadni Reef Sands.
7/31	Zoltoi Sands	1428	Allflex	White	c	Tagged 25 July 1990 on Tolstoi Sands.
7/31	Zoltoi Sands	1163	Allflex	Orange	c	Tagged 15 July 1989 at Zoltoi Sands.
8/1	Kitovi	0956-0957	Allflex	Orange	c	Tagged 8 Oct. 1986 at Morjovi.
8/1	Kitovi	1549	Allflex	Blue	c	Tagged 14 July 1992 at Morjovi.
8/1	Kitovi	1595	Allflex	Blue	c	Tagged 7 July 1992 one Vostochni.
8/1	Kitovi	1417	Allflex	White	c	Tagged 6 July 1990 on Lukanin.
8/1	Kitovi	1598	Allflex	Blue	c	Tagged 30 July 1992 on Tolstoi.

Table 29. --Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
8/2	Morjovi	084-083	Allflex	Green	c	Tagged 21 July 1991 on Zapadni Reef Sands. Too large to count.
8/2	Morjovi	1584	Allflex	Blue	c	Tagged 28 July 1992 on Morjovi.
8/3	Vostochni Sands	084-083	Allflex	Green	c	Tagged 21 July 1991 on Zapadni Reef Sands. Too large to count.
8/3	Vostochni Sands	1221	Allflex	Orange	c	Tagged 19 July 1989 on Vostochni.
8/3	Vostochni Sands	1486	Allflex	White	c	Tagged on 2 Aug. 1990 on Vostochni.
8/3	Vostochni	1443	Allflex	White	c	Tagged on 26 July 1990 on Zapadni Sands.
8/3	Vostochni	1593	Allflex	Blue	c	Tagged 29 July 1992 on Vostochni.
8/4	Zapadni Sands	141	Allflex	Blue	c	Tagged on 30 July 1988 on Zapadni.
8/4	Zapadni Sands	1511	Allflex	Blue	c	Tagged 7 July 1992 on Vostochni.
8/4	Zapadni	1419	Allflex	White	c	Tagged 7 July 1990 on Vostochni Sands.
8/4	Zapadni	1618	Allflex	Blue	c	Tagged 3 Aug. 1992 on Vostochni.
8/4	Zapadni	1619	Allflex	Blue	e[r]	Tagged 3 Aug. 1992 on Vostochni.
8/4	Zapadni	039-040	Allflex	Green	e[r]	Countable size. Tagged 18 July 1991 on Polovina.
8/4	Zapadni	1533	Allflex	Blue	c	Tagged 10 July 1992 on Tolstoi.
8/5	Gorbatch	091-092	Allflex	Green	c	Too large to count. Tagged 21 July 1991 on Zapadni Reef Sands.
8/5	Gorbatch	1521	Allflex	Blue	e[r]	Tagged 8 July 1992 on Vostochni.
8/5	Gorbatch	1507	Allflex	Blue	c	Tagged 7 July 1992 on Vostochni.
8/5	Reef	1182	Allflex	Orange	c	Right tag was the only one read, the left one was sighted. Tagged 15 July 1989 on Reef.
8/5	Reef	157-158	Allflex	Green	e[r]	Too large to count. Tagged 29 July 1991 on Gorbatch.
8/5	Reef	1554	Allflex	Blue	e[r]	Tagged 17 July 1992 on Tolstoi.

Table 29. --Continued.

Date	Location	Tag number	Tag type	Tag color	Entanglement status*	Notes
7/11	Zapadni	1198	Allflex	Orange	e^r	Tagged 18 July 1989 on Morjovi. Too large to count.

*c = seals that were controls when tagged, e^r = seals from which debris had been removed earlier.

Incidence of Entanglement

We examined and disentangled 40 juvenile male seals in the 1992 roundups (370 seals were newly tagged, 1 was previously tagged with a monel tag that was left intact, and two were monel-tagged seals from which the tags were removed and replaced with blue Allflex tags). 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 30.

Of the 40 entangled seals examined, 19 (47.5%) were in trawl webbing, 9 (22.5%) were in plastic packing bands, and 7 (17.5%) were in string, small line, cords, or rope. The remaining 5 (12.5%) were entangled in other debris.

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). One-half of the harvestable-sized seals resighted in 1992 after having debris removed in 1991 were counted as entangled in 1992. All seals from 1989 and 1990 were too large to be included in the calculations. In all, 51.5 sightings were used to calculate-the incidence of entanglement. These observations included 1) seals of harvestable size observed entangled (n = 40), 2) the repeated sightings of animals disentangled in 1992 (n = 9), and 3) the seals resighted from 1991 after having had debris removed (n = 2.5). This value (n = 2.5) was obtained as follows: first, we determined whether the seals tagged in 1991 were of appropriate size. There were 13 observations of 7 individual seals tagged in 1991 after their

Table 30.--List of entangled juvenile male northern fur seals tagged during surveys conducted in July and August of 1992, St. Paul Island, Alaska; showing the nature of the debris on each animal. All tags were broad green Allflex unless indicated otherwise. 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
1501	7/6	Morjovi	trawl	97.3	grey	t	0	19.5	2	
1502	7/7	Vostochni	trawl	41.7	green	vt	0	20	3	
1503	7/7	Vostochni	seine	214.5	orange	vt	360	12	1	
1509	7/7	Vostochni	rope	16	grey	vt	360	22.8	5	
1514	7/7	Vostochni	trawl	1050.2	mixed	vt	0	22	5	3
1515	7/7	Vostochni	trawl	737.8	green	vt	0	22.2	3	
A07073	7/8	Vostochni	monofilament	3.4	-	vt	270	10.5	<1	4
1521	7/8	Vostochni	trawl	218.4	green	vt	180	23	4	5
1522	7/9	Gorbatch	packing band	2	blue	vt	180	24.3	4	
1523	7/9	Gorbatch	packing band	2.7	blue	t	0	21.1	12	
1528	7/9	Zapadni Reef	rope/twine	8.4	grey	vt	90	28.3	2	6
1532	7/10	Tolstoi	trawl	376.2	green	vt	0	21.5	2	
1536	7/11	Zapadni	trawl	194.1	orange	vt	300	18.5	5	7
1538	7/11	Zapadni	seine?	15.4	blue	vt	0	22.2	1	
1542	7/12	Zoltoi Sands	waxed twine	1.6	grey	vt	360	21.3	1	
1543	7/13	Lukanin	trawl	43.9	grey	t	0	19.5	2	
1546	7/14	Morjovi	packing band	0.5	yellow	t	0	20.8	5	
1551	7/14	Vostochni	packing band	2.4	yellow	vt	0	22	15	8
1554	7/17	Tolstoi	packing band	<1	black	t	0	22.4	5	

Table 30. --Continued.

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
1557	7/18	Polovina	trawl	318	blue	t	0	23.5	3.5	
1558	7/18	Polovina	string	<1	white	t	360	24	-	
1563	7/20	Zapadni	twine	2.5	green	vt	180	21	1	9
1565	7/20	Zapadni	trawl	137.4	yellow	vt	0	21	3	
1569	7/23	Gorbatch	trawl	67.8	green	t	0	21	3	
1573	7/23	Reef	cord	3.9	green	vt	360	22.3	4	
1575	7/24	Zapadni Reef	twine	1.3	green	vt	360	23.1	2	10
1578	7/24	Zapadni Reef	packing band	0.7	blue	t	0	23.9	9	
1579	7/26	Kitovi	trawl	103.9	green	vt	150	23	2	
1582	7/28	Morjovi	trawl	77	green	t	0	21	3	
1586	7/28	Little Zapadni	trawl	13.4	mixed	vt	180	21	7	11
1589	7/29	Vostochni	trawl	18	green	t	0	22.4	3	
1591	7/29	Vostochni	trawl	1.5	grey	t	60	23.4	2	
1592	7/29	Vostochni	rubber ring	5	black	l	15	21.2	4	
1599	7/30	Tolstoi	trawl	76.5	grey	t	240	20.3	2	
1603	7/30	Zapadni Reef	packing band	1.8	yellow	t	0	21.2	14	
1605	7/31	Zoltoi Sands	packing band	1.5	black	l	0	26.1	11	
1610	8/1	Lukanin	trawl	3.5	green	l	0	22.2	1.5	
1611	8/1	Polovina	trawl	59.6	orange	l	0	20.8	4	

Table 30. --Continued.

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
1616	8/1	Polovina	plastic ring	14.8	white	t	360	37	9	
1619	8/3	Vostochni	packing band	3.5	blue	t	0	22.1	13	

[1]Tag number for tag placed on both flippers (See Table 30).
[2]1 = loose, t = tight, vt = very tight.
[3]Debris was a combination of white with some blue repair twine.
[4]This monel-tagged seal was entangled but not retagged with Allflex tags. Its weight was very light for a 5-year-old animal (57 lb = 25.9 kg).
[5]On this seal there was a 6-inch wound behind the left foreflipper where the debris had worn into the skin and the flipper had become wrapped in mesh.
[6]When captured, this seal was tagged with monel number A22457; the monel tag was replaced with an Allflex tag numbered as indicated.
[7]The twine of this webbing was flat with the maximum width about 5 mm and the minimum about 3 mm.
[8]This seal appeared to have just recently become entangled.
[9]The wound on this seal had been 360 degrees but was grown over the debris in a few spots, leaving an open wound with a total of only about 180 degrees.
[10]The wound on this seal was very deep.
[11]When captured, this seal was tagged with monel number A22303; the monel tag was replaced with an Allflex tag numbered as indicated.

debris had been removed, including the repeated sightings of these same seals in 1992. Five of these observations were of seals that met the size criteria. Of these five, we assumed a 50% survival rate if the seals had remained entangled, yielding a total of 2.5.

The incidence of entanglement for 1992 was calculated as 0.29% (51.5/17,630), an estimate that is subject to slight upward bias as it assumes that the seals from which debris was removed would not have lost their debris. Thus, the 1992 incidence of entanglement is within the range observed from 1988 to 1991, although it is higher than last year's value of 0.21% (Table 31, Fig. 28). This reduction is continuing evidence of a decline in the observed incidence of entanglement from the 0.4% observed between 1976 and 1985 (Fig. 28; Table 31). However, no trend is evident in the period since 1988.

Compared with 1976-86, the lower incidence of entanglement among juvenile male seals is attributable to a reduction in the fraction entangled in trawl webbing. During 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 of 56% (Fowler et al. 1990b). This proportion remained low in 1989 and 1990 and became even lower in 1991 (0.06%, Table 32). In 1992, however, the rate of entanglement in trawl webbing was higher than in 1991 but remains at about 50% of the levels observed for between 1982 and 1986.

Table 31. --The percentage 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 1992 during roundups (data updated from Fowler et al. 1992).

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
1992	0.29

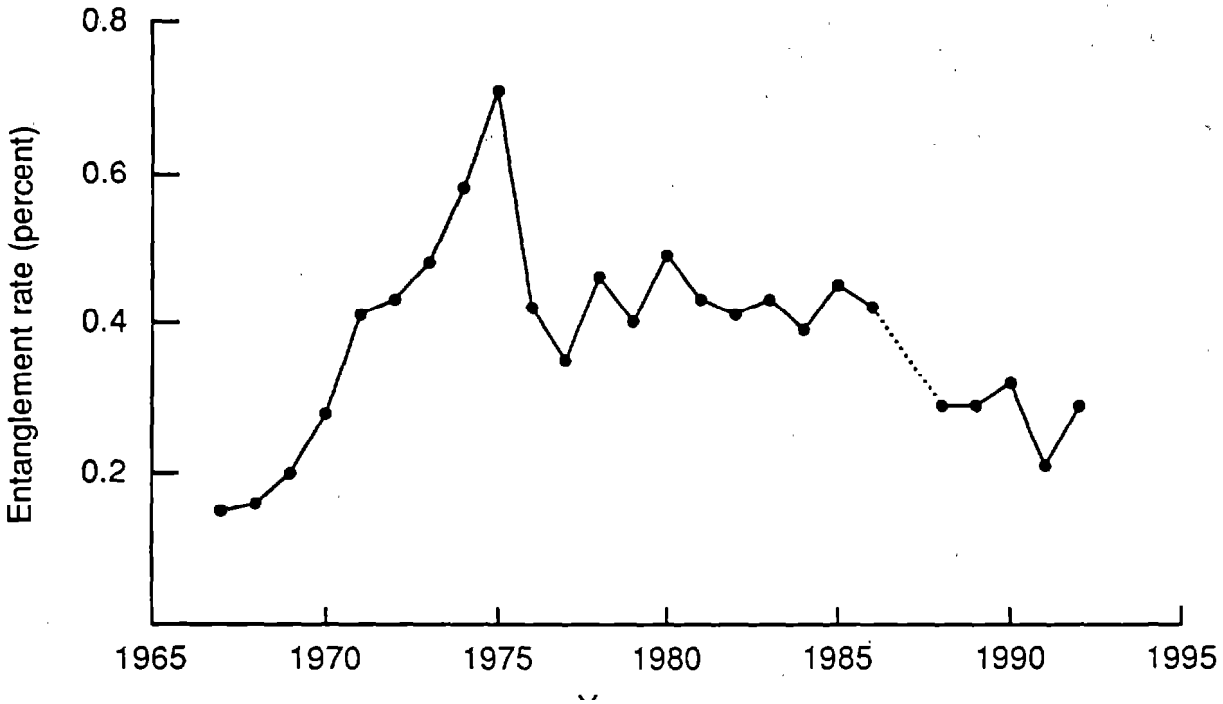

Figure 28. --The percentage of juvenile male northern fur seals found entangled in the commercial harvest from 1967 to 1984 and in research roundups from 1985 to 1992 on St. Paul Island, Alaska (updated from Fowler et al. 1992).

Table 32. --Debris found on juvenile male northern fur seals from St. Paul Island, Alaska, 1981-92, expressed as the incidence of entanglement (observed percent) among juvenile males entangled by debris category (data for 1981-91 from Fowler and Ragen 1990, Fowler and Baba 1991, and Fowler et al. 1992).

Year	Trawl net fragments	Packing bands	Cord, rope, and string	Monofilament net fragments	Misc. items	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
1992	0.14	0.07	0.05	0.01	0.03	40

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

Resightings and Survival

A summary of the number of tags applied to juvenile males and the number resighted in each subsequent year is shown in Table 33 for each year since 1985. No roundups were conducted in 1987. A total of 102 seals judged to be of harvestable size were tagged and released in 1991. Of these, 68 were controls and 34 were entangled when captured. In 1992, 17 of these controls (25.0%) were resighted. Seven (20.6%) seals tagged following removal of debris in 1991 (n = 34) were resighted in 1992. This implies that the resighting rate for disentangled seals after 1 year was 82.4% of that for the controls (20.6/25.0 = 0.824). 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 from previous years (Chi-square test, $P < 0.05$).

In 1992, 3 of the 279 "control" seals (1.1%) tagged in 1986 were resighted, whereas none of the group of 128 animals tagged as entangled in 1986 was resighted. Of the four seals resighted in 1992 and tagged in I988, one had been originally tagged as an entangled seal.

Ratios of the portion of entangled seals resighted each year to that of controls are shown in Figure 29 (updated from Fowler et al. 1992). An increase in the survival rate attributable to removing debris is shown in data plotted for seals tagged in 1989 and 1991 (stars in Fig. 29). However, the combined data for 1989-92 indicate that seals freed of their debris may have a

Table 33. --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 1992 (none tagged in 1987). Each row corresponds to the tags released in the first year for that row*.

	Year						
	1985	1986	1988	1989	1990	1991	1992
CONTROLS (nonentangled)	**(172)**	37 [21.5]	13 [7.6]	8 [4.7]	7 [4.1]	4 [2.3]	0 [0]
		(279)	40 [14.3]	32 [11.5]	25 [9.0]	5 [1.8]	3 [1.1]
			(104)	20 [19.2]	11 [10.6]	11 [10.6]	3 [2.9]
				(86)	26 [30.2]	14 [16.3]	7 [8.1]
					(114)	39 [34.2]	18 [15.8]
						(68)	17 [25.0]
							(80)
ENTANGLED (disentangled after 1988)	**(85)**	12 [14.1]	1 [1.2]	0 [0]	0 [0]	0 [0]	0 [0]
		(128)	6 [4.7]	4 [3.1]	1 [0.8]	0 [0]	0 [0]
			(52)	5 [9.6]	2 [3.8]	1 [1.9]	1 [1.9]
				(43)	11 [25.6]	4 [9.3]	3 [7.0]
					(57)	21 [36.8]	8 [14.0]
						(34)	7 [20.6]
							(40)

*Updated from Fowler et al. (1992).

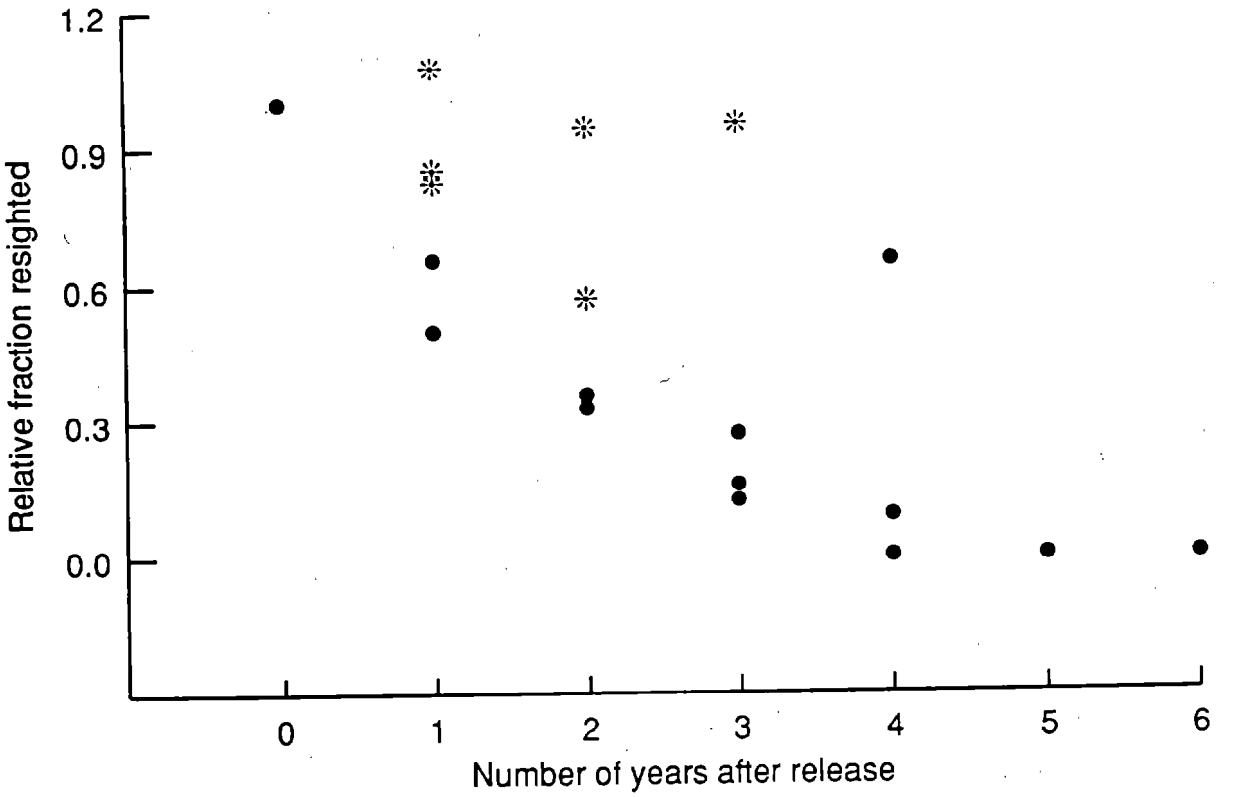

Figure 29. --Relative rates of return for entangled juvenile male northern fur seals compared with controls (nonentangled tagged seals) for varying time intervals (Updated from Fowler et al. 1992, with the data from this report). Each data point represents the fraction of entangled seals resighted divided by the fraction of controls resighted (both from Table 3-5) for the corresponding time interval (for example, there are three data points for 3 years corresponding to the 1985-88, 1986-89, and 1988-1991 intervals). The stars correspond to the relative return rate for seals with debris removed.

lower survival rate than that of controls. The weighted mean annual survival rate of disentangled seals for the data accumulated since 1989 is 0.93 of that for controls.

The approach of Fowler and Baba (1991; a weighted mean, assuming that the probability of resighting is the same for both categories of seals and that survival from entanglement in small debris is the same from year to year) may be used for estimating survival of entangled seals compared with controls. Using only, the ratios for the 1992 resight data for seals tagged during 1985-1988 (Fig. 29), the estimated survival of entangled seals is 0.53 that of controls. Using juvenile male seals tagged, without removing debris, in 1985, 1986, and 1988 as resighted in all years through 1992, the estimated annual survival is also 0.53. This is to be compared with the 0.55 from Fowler and Baba (1991).

Thus, the results from 1992, as well as the cumulative data, as presented in Table 33 and Figure 29, continue to show that the probability of survival for seals entangled in small debris is about one-half of what it would be without the debris (Fowler et al. 1990b).

Characteristics of Entangling Debris

Weights and mesh sizes of debris removed from seals in 1992 are listed in Table 30. The data for trawl net fragments are shown by size category in Table 34 and indicate that debris distributions are very similar to those seen in previous studies. For the combined data since 1983, about 74% of the trawl debris

Table 34. --Annual percentage frequency distribution of the size of measured trawl debris from entangled male northern fur seals that were tagged and released (updated from Fowler and Ragen 1990 and Fowler et al. 1992).

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)
1992	19	13(68)	4(21)	2(11)
Total	544	400(74)	100(18)	44(8)

found on seals weighed between 0 g and 150 g, about 18% of the debris weighed between 150 g and 500 g, and about 8% of the debris weighed over 500 g (Table 34).

Within-Season Resighting Rate

Although the collective data from 1985 to 1992 indicate similar intraseasonal resighting rates, there is a great deal of year-to-year variability (Table 35). Also, there is a lower intraseasonal resighting rate for entangled (or disentangled)

Table 36.--Male northern fur seals from which entangling debris was removed in 1992 during roundups. These seals were larger than could be included in calculating entanglement rates; some were full adult size.

Number	Date (July)	Location	Notes
3	**17**	**Zapadni Reef Sands**	
1	**23**	**Reef**	
2	**24**	**Zapadni Reef Sands**	
1	25	Polovina	This seal was about 7 years old with two very deep wounds which bled significantly. The debris was a large piece of green trawl webbing.
3	26	Kitovi	One of these seals was only slightly larger than would have been counted for entanglement studies. Of the other two, one may have been 6-7 years old, the other 8-9 years old.

SUMMARY AND CONCLUSIONS

Although the 1992 estimate of the incidence of entanglement was higher than that for 1991 (the lowest since the late 196Os), the incidence of entanglement estimated for 1992 is consistent with those for 1988 through 1990. The combined set of data continue to indicate that a decline occurred in the incidence of entanglement following 1986. The reduction for this period of time is attributable to less entanglement in trawl webbing, with that for 1991 being the lowest observed since 1982. An explanation for such a change can not be conclusively established at this time. However, the difference between the incidence of entanglement for 1988-92 and that of previous years may be a result of changes in the rate of loss and discard of net fragments from fishing vessels. Consistent with the data for debris on northern fur seals, the abundance of trawl webbing debris observed on sampled beaches of several Alaska islands has also declined in recent years (Johnson 1990). Various educational programs at the national and international level 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.

Entanglement research on juvenile males in 1992 demonstrated:

1) A continued reduction of the overall incidence of entanglement from about 0.4% (1975-86) to 0.32% or less from 1988 through 1992;
2) The rate of entanglement in trawl webbing in 1992 was higher than observed in 1991 but remains about one-half of entanglement levels observed for this kind of debris in previous years (1981-86), and very similar to that observed during 1988-90;
3) Relative rates of return of entangled seals from years in which debris was not removed continued, to indicate that annual survival of entangled seals that is about one-half that of nonentangled seals; and
4) There is continuing evidence from the 1992 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.

POPULATION MONITORING OF NORTHERN FUR SEALS ON SAN MIGUEL ISLAND, CALIFORNIA

by

Sharon R. Melin and Robert L. DeLong

Population monitoring studies of northern fur seals on San Miguel Island were conducted between 20 May and 4 September, 1992. Efforts to resight tagged individuals for studies on survival were conducted throughout the breeding season. Once each week, counts of adult males were conducted from a blind overlooking the Adams Cove rookery. These counts provide an index of the trend in the population growth. In late July, live and dead pup counts were conducted as an additional index of the health and growth of the population.

Adult males began to establish territories after 15 May. The maximum number of adult males holding territories was 72 on 8 July and 59 of those males held territories with females. The first female was sighted on 1 June and gave birth to the first pup later that day.

Two live pup counts were conducted in Adams Cove yielding counts of 1,124 pups and 965 on 29 July and 5 August, respectively. On Castle Rock, 466 live pups were counted on 8 August. A dead pup count conducted in Adams Cove on 11 August yielded 274 dead pups. No dead pup count was conducted at Castle Rock.

One hundred and fifty fur seal pups were tagged with pink plastic roto tags on 27 September and another 150 on 1 November

(Appendix Tables Dl and D2) to continue studies. on' survival of individuals. The two tagging periods provide two different age groups of tagged pups. The pups are part of a long-term study, initiated in 1988, on the relation between survival and age at tagging. At this time sufficient data is not available to' determine if a relationship exists.

In 1992, tag resighting efforts resulted in sightings of 62 individual animals including sightings of 17 tagged females in breeding groups. The oldest female sighted with a pup was 17 years old. In addition, a female pup tagged in 1990 at San Miguel Island was recovered in the High Seas Driftnet fishery in the North Pacific Ocean of 3 July 1991 at 42° 00 N lat. and 161° 04 W long. (Hobbs and Jones 1991), providing the first data on mid-Pacific movements of pups born on San Miguel Island.

In January of 1992, an El Niño event which began in November 1991 in the equatorial Pacific Ocean reached the Southern California Bight and El Niño conditions prevailed along the California, Oregon, and Washington coasts throughout the year. For fur seals on San Miguel Island, El Niño events can have detrimental effects on pup and adult survival (DeLong and Antonelis 1991). Pup production declined dramatically (60% in 1983) during the 1982-83 El Niño event and mean pup weights at 3 months were significantly lower from mean weights in non-EL Niño years (DeLong and Antonelis 1991). Following the 1982-83 El Niño, pup weights increased and reached normal mean pup weights in 1985. Pup production slowly but steadily increased and reached 1,011 pups in 1991, an estimate similar to pre-

1982-83 El Niño pup estimates. The slow recovery was attributed to low adult female and pup survival during the winter of 1983 and possible emigration of females to other populations (DeLong and Antonelis 1991).

The effects of the 1992 El Niño on the fur seal population at San Miguel Island were different than those observed during the 1982-83 El Niño. Fur seals on San Miguel Island did not experience a decline in pups born, however the 274 dead pups counted in August represent 24% of total number of pups born in 1992. Since there was only one dead pup survey, it is probable that the actual mortality exceeded 24%.

Mean pup weights for 1992 (females, $x = 8.6$ kg, SD = 1.79; males, $x = 9.5$ kg, SD = 1.70) were significantly lower (ANOVA, $p < .001$) than mean weights of pups for all non-El Niño years from 1977 through 1991 (females, $x = 10.4$ kg, SD = 2.10; males $x = 11.8$ kg, SD = 2.42). However, the mean weights in 1992 for both sexes are significantly greater than weights in the 1982-83 El Niño year (ANOVA, $P < .001$). Although the pelagic distribution of adult females from San Miguel Island is unknown, it is probable that they spend the pelagic phase of their annual cycle in the offshore waters of central and northern California and probably Oregon and Washington where they join adult females migrating southward from the Pribilof Islands, Alaska (Dohl et al. 1983, Bonnell 1985, York 1980). Females return to San Miguel Island for parturition and are confined to the outer Southern California Bight and offshore central California waters for foraging during the breeding season due to nursing schedules.

The high pup production in 1992 indicates that adult females foraged efficiently in winter feeding areas. However, the high mortality and low weaning weights of pups suggests that females had difficulty obtaining adequate forage resources during the breeding season (DeLong and Antonelis 1991), most certainly a result of changes in prey availability in the Southern California Bight and coastal California due to the 1992 El Niño event.

The effects of the 1992 El Niño on the fur seal population on San Miguel Island show that timing of environmental changes relative to the annual cycle of fur seals is as important as the severity of the environmental change itself. The 1992 El Niño did not impact the fur seal population at San Miguel Island as severely as the 1982-83 El Niño even though many of the oceanographic changes were similar during the two events (Southwest Fisheries Science Center NOAA El Niño watch 1992, unpub.; McGowan 1985). This is probably because the onset of the 1992 El Niño in the Southern California Bight occurred later in the winter of 1992 than the 1982-83 El Niño. The onset of the 1982-83 El Niño occurred in October 1982, during or shortly after females wean their pups at San Miguel Island. When females left San Miguel Island in November 1982, they were faced with decreased prey availability and abundance along the California coast. These changes in prey availability apparently increased female mortality which resulted in the subsequent decline in pup production in 1983 (DeLong and Antonelis 1991).

Since adult females had departed San Miguel Island for the pelagic phase of their annual cycle before the onset of the 1992

El Niño event, females had a few months of foraging to replace energy stores used during lactation before changes in prey availability occurred. In addition, females were apparently able to find adequate forage resources during the winter and spring which allowed adequate accumulation of energy reserves for survival of females and successful pup production in the summer of 1992. However, the survival and health of the 1992 cohort was compromised (high mortality and low weaning weights) by the difficulty adult females encountered in obtaining adequate forage resources in the Southern California Bight and central California waters during the 4-5 month lactation period.

The 1992 El Niñio event continued into the winter of 1993 and may have affected the survival of the 1992 cohort which went to sea already compromised by low weaning weights. Survival of the 1992 cohort will not be known until the pups return as juveniles in 1994 or 1995.

El Niño events, while not predictable are a periodic. phenomenon along the California coast and clearly affect the growth of the San Miguel Island northern fur seal colony. The population dynamics of the northern fur seal population at San Miguel Island provide a unique opportunity to study both density dependent (survival, growth) and non-density dependent (El Niño events) regulatory mechanisms of a population living at the extreme of its range.

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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.

APPENDIX B

Tabulations of northern fur seal tag data collected on the Pribilof Islands, Alaska, and on San Miguel Island, California,, during 1992.

Table B-1.--Number of adult male northern fur seals counted, by class[a] and rookery section, St. Paul Island, Alaska, 10-16 July 1992. A dash indicates no numbered sections.

Rookery and class of male	Section 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Lukanin															
2	28	43	-	-	-	-	-	-	-	-	-	-	-	-	71
3	51	68	-	-	-	-	-	-	-	-	-	-	-	-	119
5	207	17	-	-	-	-	-	-	-	-	-	-	-	-	224
Kitovi[b]															
2	19(11)	5	33	36	22	-	-	-	-	-	-	-	-	-	126
3	50(18)	16	77	89	63	-	-	-	-	-	-	-	-	-	313
5	30(109)	4	8	12	267	-	-	-	-	-	-	-	-	-	430
Reef															
2	23	19	33	24	16	22	18	29	15	23	5	-	-	-	227
3	54	73	62	46	46	75	16	67	50	39	8	-	-	-	536
5	21	37	103	67	170	18	135	103	30	66	91	-	-	-	841
Gorbatch															
2	46	27	15	0	18	17	-	-	-	-	-	-	-	-	123
3	124	87	85	0	88	84	-	-	-	-	-	-	-	-	468
5	607	29	29	222	13	37	-	-	-	-	-	-	-	-	937
Ardiguen															
2	16	-	-	-	-	-	-	-	-	-	-	-	-	-	16
3	77	-	-	-	-	-	-	-	-	-	-	-	-	-	77
5	17	-	-	-	-	-	-	-	-	-	-	-	-	-	17
Morjovi[c]															
2	15(11)	13	31	13	38	17	-	-	-	-	-	-	-	-	138
3	58(36)	55	69	53	135	59	-	-	-	-	-	-	-	-	465
5	240(23)	30	103	13	25	272	-	-	-	-	-	-	-	-	706
Vostochni															
2	13	10	28	27	10	59	50	33	24	18	22	21	49	25	389
3	50	22	51	60	39	141	65	74	51	19	50	86	142	86	936
5	21	78	9	144	169	155	62	27	118	8	3	111	140	171	1301
Little Polovina															
2	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7
3	18	-	-	-	-	-	-	-	-	-	-	-	-	-	18
5	407	-	-	-	-	-	-	-	-	-	-	-	-	-	407
Polovina															
2	18	4	-	-	-	-	-	-	-	-	-	-	-	-	22
3	46	20	-	-	-	-	-	-	-	-	-	-	-	-	66
5	160	181	-	-	-	-	-	-	-	-	-	-	-	-	341
Polovina Cliffs															
2	17	10	15	26	27	19	14	-	-	-	-	-	-	-	128
3	49	48	29	66	121	78	111	-	-	-	-	-	-	-	502
5	80	42	22	30	42	41	47	-	-	-	-	-	-	-	304
Tolstoi															
2	21	16	30	10	44	36	53	33	-	-	-	-	-	-	243
3	73	80	77	93	124	124	120	99	-	-	-	-	-	-	790
5	11	20	29	16	30	85	38	613	-	-	-	-	-	-	1875
Zapadni Reef															
2	89	27	-	-	-	-	-	-	-	-	-	-	-	-	116
3	119	40	-	-	-	-	-	-	-	-	-	-	-	-	159
5	142	463	-	-	-	-	-	-	-	-	-	-	-	-	605
Little Zapadni															
2	3	22	36	39	25	39	-	-	-	-	-	-	-	-	164
3	12	45	75	70	69	71	-	-	-	-	-	-	-	-	342
5	31	47	51	45	35	357	-	-	-	-	-	-	-	-	566
Zapadni[d]															
2	15(0)	23	22	34	35	31	28	3	-	-	-	-	-	-	191
3	51(0)	93	91	110	91	115	103	15	-	-	-	-	-	-	669
5	29(251)	64	60	115	146	55	56	681	-	-	-	-	-	-	1458

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

Table B-2. --Number of harem and idle males, pups born, number of northern fur seal rookeries sampled, standard deviation (SD) of the of the number of pups born and the number of dead pups on the Pribilof Islands, Alaska, 1975-92. A dash indicates no data.

	St. Paul						St. George					
Year	Harem bulls	Idle bulls	Pups born	Rookeries sampled	SD	Dead pups	Harem bulls	Idle bulls	Pups born	Rookeries sampled	SD	Dead pups
1975	5,018	3,535	278,261	14	8,620	20,625	877	1,427	--	--	--	3,289
1976	5,324	4,041	291,000	2	11,108	23,676	1,093	996	--	--	--	2,289
1977	6,457	3,845	--	--	--	14,083	1,610	899	43,407	6	748	1,208
1978	6,496	3,908	--	--	--	8,073	1,590	1,220	47,248	6	1,009	2,518
1979	6,242	4,457	245,932	14	9,464	6,444	1,716	1,942	--	--	--	2,191
1980	5,490	4,248	203,825	4	11,672	7,859	1,563	1,795	--	--	--	2,385
1981	5,120	4,003	179,444	4	5,876	6,798	1,472	1,646	38,152	6	1,581	2,025
1982	5,767	4,009	203,581	4	3,482	7,301	1,410	1,319	--	--	--	1,600
1983	4,827	4,242	165,941	4	6,034	5,997	--	--	31,440	6	2,930	903
1984	4,803	3,977	173,274	5	8,117	6,115	1,473	1,452	--	--	--	--
1985	4,372	3,363	182,258	7	7,997	5,266	1,286	1,601	28,869	6	2,297	806
1986	4,603	1,865	167,656	4	5,086	7,771	1,394	1,342	--	--	--	--
1987	3,636	1,892	171,610	13	3,218	7,757	1,303	1,283	--	--	--	--
1988	3,585	3,201	202,229	4	3,751	7,199	1,259	1,258	24,819	6	827	1,211
1989	4,297	6,400	171,534	4	25,867	9,096	1,241	1,163	--	--	--	--
1990	4,430	7,629	201,305	13	3,724	9,136	909	1,666	23,397	6	2,054	928
1991	4,729	9,453	--	--	--	--	736	1,271	--	--	--	--
1992	5,460	10,940	192,468'	13	8,918	8,556	1,028	1,834	25,160	6	707	806

'This estimate includes approximately 10,000 pups counted on Sea Lion Rock (Kajimura and Sinclair 1992; NMFS 1993).

Table B-3:.Number of northern fur seal pups sheared on each rookery of St. Paul Island, Alaska, 1992.

Rookery	Date	Section														Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Ardiquen	16 Aug.	290														290
Gorbatch	15 Aug.	470	280	366	0	120	466									1,702
Kitovi	16 Aug.	265[a]	44	242	267	238										1,056
Little Zapadni	9 Aug.	70	211	450	404	346	339									1,820
Lukanin	16 Aug.	267	234													501
Morjovi	6 Aug.	218[b]	213	170	171	381	174									1,327
Polovina	8 Aug.	167	91													258
Polovina Cliffs	8 Aug.	186	166	164	222	429	220	559								1,946
Reef	11 Aug.	230	453	305	214	231	373	33	228	309	179	36				2,591
Tolstoi	12 Aug.	302	361	261	309	497	465	446	266							2,907
Vostochni	7,9 Aug.	164	40	202	194	119	323	314	272	206	109	120	295	642	336	3,336
Zapadni	14 Aug.	312	395	472	386	364	439	329	69							2,766
Zapadni Reef	10 Aug.	478	186													664
Total																21,164

[a] Includes 72 pups sheared at Kitovi Amphitheater.
[b] Includes 70 pups sheared at Second Point South of Sea lion Neck.

Table B-4.--Number of dead northern fur seal pups counted by section on the rookeries of St. Paul Island, Alaska, 1992

Rookery	Date	Section														Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Ardiguen	22 Aug.	85														85
Gorbatch [a]	19 Aug.	224	172			226	145									767
Kitovi [b]	24 Aug.	30	5	52	59	75										221
Little Zapadni	19 Aug.	14	60	109	133	136	180									632
Lukanin	24 Aug.	99	105													204
Morjovi [c]	17 Aug.		188	83	51	142	50									514
Polovina	22 Aug.	46	3													49
Polovina Cliffs	22 Aug.	80	39	54	174	55	60	92								554
Reef [d]	21,22 Aug.	102	139	122	122	109		440[e]	84	90	34	5				1,247
Tolstoi [f]	18 Aug.	130	159	53		209	372	244	242							1,409
Vostochni	20 Aug.	29	13	42	61	35	202	131[g]	54	12	11	27	96	146	90	949
Zapadni Reef	17 Aug.	315	87													402
Zapadni	23 Aug.	55	156	274	315	219	225	204	47							1,495
Total																8,428

[a] Dead pups for sections 3, 4, and 5 were not separated.
[b] Dead pups from Kitovi Amphitheater (7) are not included in section 1.
[c] Dead pups for sections 1 and 2 were not separated. Dead pups from Second Point South of Sea Lion Reck are also included in section 2.
[d] Dead pups for sections 6 and 7 were not separated.
[e] Includes 166 pups taken for necropsies.
[f] Dead pups for sections 4 and 5 were not sepatated.
[g] Includes 61 pups taken for necropsies.

Table B-5. --Number of dead northern fur seals counted that were older than pups, Pribilof Islands, Alaska, 1965-92. Teeth (usually canines) were collected from most of these seals. A dash indicates no data.

Year	St. Paul Island		St. George Island		Total	
	Males	Females	Males	Females	Males	Females
1965	158	-	-	-	158	-
1966	181	172	41	55	222	227
1967	108	157	41	28	149	185
1968	98	141	33	22	131	163
1969	94	141	22	29	116	170
1970	52	124	4	53	56	177
1971	39	91	5	37	44	128
1972	46	111	22	30	68	141
1973	61	65	7	30	68	95
1974	33	30	4	15	37	45
1975	92	99	-	-	92	99
1976	46	64	-	-	46	64
1977	60	69	-	-	60	69
1978	57	87	-	-	57	87
1979	56	66	-[a]	-[a]	56	66
1980	102	117	14	65	116	182
1981	44	83	12	61	56	144
1982	47	117	-	-	47	117
1983	57	66	-	-	57	66
1984	66	72	-	-	66	72
1985	5	34	17	35	22	69
1986	24	67	-	-	24	67
1987	20	90[b]	-	-	20	99[b]
1988	56	112	21	29	77	141
1989	55	162	-	-	55	162
1990	97	151	13	31	110	182
1992	97	265	7	19	104	284

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

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

APPENDIX C

Appendix Table C-l. --List of monel tagged northern fur seals resighted on St. Paul Island, Alaska, 1992.

5 year olds

A00055	A04888
A00232	A04949
A00242	A05169
A00343	A05372
A00345	A05388
A00373	A05992
A00389	A06013
A00532	A06113
A00601	A06153
A00983	A06155
A01029	A06157
A01126	A06211
A01224	A06225
A01228	A06226
A01353	A06426
A01380	A06490
A01407	A06505
A01595	A06611
A01616	A06710
A02252	A06717
A02273	A06721
A02676	A06785
A02883	A06812
A02973	A06831
A03070	A06997
A03181	A07005
A03188	A07073
A03215	A07121
A03263	A07308
A03272	A07521
A03354	A07543
A03472	A07648
A03593	A07654
A03612	A07672
A03645	
A03648	
A03752	
A04051	
A04136	
A04193	
A04297	
A04380	
A04582	
A04600	
A04604	
A04668	
A04731	

Appendix Table C-l.--Continued.

4 year olds

A08071	A09098	A10687	A12855	A14194
A08107	A09134	A10723	A12872	A14219
A08187	A09135	A10725	A12885	A14255
A08197	A09137	A10964	A12891	A14270
A08226	A09175	A11116	A12938	A14312
A08227	A09178	A11133	A12950	A14333
A08241	A09254	A11145	A12966	A14369
A08280	A09287	A11171	A12969	A14379
A08284	A09338	A11190	A12994	
A08293	A09350	A11197	A13013	
A08296	A09425	A11211	A13031	
A08299	A09445	A11224	A13077	
A08453	A09484	A11232	A13132	
A08455	A09494	A11282	A13187	
A08474	A09543	A11315	A13209	
A08492	A09547	A11361	A13214	
A08499	A09600	A11405	A13215	
A08519	A09624	A11415	A13218	
A08523	A09629	A11454	A13278	
A08535	A09643	A11511	A13301	
A08561	A09671	A11555	A13305	
A08563	A09708	A11561	A13326	
A08564	A09710	A11591	A13349	
A08566	A09729	A11629	A13356	
A08586	A09741	A11887	A13384	
A08604	A09747	A11914	A13453	
A08608	A09771	A12150	A13458	
A08624	A09838	A12160	A13477	
A08637	A09889	A12222	A13571	
A08638	A09988	A12225	A13572	
A08669	A10001	A12230	A13620	
A08676	A10201	A12327	A13665	
A08702	A10254	A12379	A13671	
A08703	A10306	A12392	A13724	
A08735	A10312	A12475	A13731	
A08757	A10318	A12477	A13760	
A08782	A10344	A12487	A13825	
A08805	A10377	A12520	A13863	
A08833	A10393	A12541	A13877	
A08862	A10413	A12554	A13885	
A08866	A10416	A12587	A13934	
A08992	A10439	A12604	A13993	
A09008	A10449	A12670	A14048	
A09016	A10460	A12713	A14049	
A09024	A10482	A12773	A14061	
A09039	A10513	A12825	A14143	
A09042	A10539	A12837	A14171	
A09061	A10544	A12852	A14193	

Appendix Table C-l.--Continued.

3 year olds

A14390	A15026	A15985	A16814	A17506	A18418
A14426	A15034	A15990	A16822	A17528	A18425
A14428	A15067	A16003	A16824	A17536	A18449
A14442	A15098	A16006	A16839	A17539	A18451
A14456	A15100	A16023	A16890	A17576	A18474
A14464	A15106	A16031	A16907	A17585	A18475
A14465	A15122	A16060	A16943	A17593	A18506
A14485	A15137	A16061	A17015	A17615	A18530
A14497	A15150	A16089	A17022	A17618	A18531
A14501	A15188	A16099	A17043	A17631	A18535
A14520	A15199	A16111	A17055	A17634	A18552
A14535	A15206	A16119	A17066	A17647	A18564
A14536	A15207	A16142	A17111	A17665	A18593
A14541	A15215	A16147	A17126	A17691	A18621
A14554	A15301	A16150	A17134	A17692	A18631
A14560	A15329	A16161	A17151	A17727	A18643
A14563	A15359	A16171	A17166	A17732	A18649
A14581	A15361	A16184	A17172	A17734	A18657
A14591	A15378	A16198	A17180	A17737	A18661
A14594	A15439	A16201	A17191	A17743	A18676
A14595	A15447	A16207	A17212	A17841	A18687
A14596	A15489	A16218	A17217	A17856	A18691
A14612	A15502	A16236	A17219	A17864	A18698
A14626	A15531	A16254	A17230	A17910	A18719
A14629	A15547	A16278	A17231	A17934	A18737
A14656	A15557	A16294	A17245	A17937	A18770
A14659	A15559	A16316	A17259	A17945	A18793
A14680	A15588	A16328	A17286	A17988	A18804
A14685	A15605	A16364	A17294	A18012	A18818
A14694	A15624	A16376	A17301	A18056	A18819
A14720	A15626	A16394	A17322	A18068	A18834
A14724	A15639	A16396	A17341	A18104	A18874
A14731	A15642	A16449	A17363	A18134	A18878
A14755	A15650	A16459	A17366	A18152	
A14764	A15700	A16472	A17369	A18153	
A14769	A15736	A16480	A17373	A18196	
A14798	A15768	A16492	A17375	A18230	
A14805	A15801	A16499	A17392	A18257	
A14823	A15809	A16525	A17395	A18300	
A14832	A15830	A16530	A17399	A18305	
A14849	A15849	A16610	A17435	A18315	
A14908	A15851	A16620	A17455	A18326	
A14909	A15856	A16668	A17474	A18330	
A14923	A15880	A16684	A17482	A18335	
A14928	A15895	A16719	A17483	A18342	
A14959	A15897	A16741	A17498	A18347	
A15000	A15928	A16756	A17499	A18360	
A15008	A15946	A16783	A17505	A18386	

Appendix Table C-l.--Continued.

2 year olds	
A18952	A22291
A18966	A22303
A18968	A22340
A18970	A22352
A19035	A22445
A19070	A22457
A19087	A22556
A19109	A22682
A19118	A22702
A19128	A22835
A19129	A22928
A19150	A22977
A19160	A23053
A19309	A23123
A19312	A23131
A19318	A23217
A19324	A23224
A19336	A23270
A19352	A23273
A19380	A23347
A19421	
A19479	
A19486	
A19515	
A19617	
A19713	
A19779	
A19810	
A19811	
A19936	
A19976	
A20428	
A20529	
A20718	
A21091	
A21402	
A21455	
A21526	
A21579	
A21680	
A21696	
A21773	
A21870	
A21928	
A22126	
A22152	
A22208	
A22245	

APPENDIX D

Northern fur seal pups tagged on San Miguel Island, California in 1992.

Appendix Table D-l.--Northern fur seal pups tagged with pink plastic rota tags at Adams Cove, San Miguel Island, California, 27 September 1992.

Left Tag	Right Tag	Sex	Weight (kg)
A1501	A1501	M	9.6
A1502	A1502	M	8.5
A1503	A1503	F	8.8
A1504	A1504	M	12.5
A1505	A1505	F	8.0
A1506	A1506	M	8.0
A1507	A1507	M	11.6
A1508	A1508	F	9.0
A1509	A1509	F	9.2
A1510	A1510	F	6.5
A1511	A1511	M	9.0
A1512	A1512	M	10.5
A1513	A1513	F	9.2
A1514	A1514	M	7.0
A1515	A1515	M	8.0
A1516	A1516	F	13.2
A1517	A1517	F	10.0
A1518	A1518	M	10.2
A1519	A1519	F	11.4
A1520	A1520	U	9.0
A1521	A1521	F	8.0
A1522	A1522	M	10.0
A1523	A1523	M	10.2
A1524	A1524	F	10.3
A1525	A1525	F	6.4
A1526	A1526	M	10.8
A1527	A1527	M	9.8
A1528	A1528	F	7.2
A1529	A1529	M	9.8
A1530	A1530	F	9.8
A1531	A1531	F	7.5
A1532	A1532	M	10.0
A1533	A1533	M	7.2
A1534	A1534	M	9.4
A1535	A1535	F	8.4
A1536	A1536	F	7.0
A1537	A1537	M	9.2
A1538	A1538	F	10.0
A1539	A1539	M	9.8
A1540	A1540	F	6.0
A1541	A1541	F	8.6
A1542	A1542	F	9.4
A1543	A1543	F	10.6
A1544	A1544	M	10.8
A1545	A1545	F	9.0

Appendix Table D-l.--Continued.

Left Tag	Right Tag	Sex	Weight (kg)
A1546	A1546	F	10.6
A1547	A1547	F	6.0
A1548	A1548	F	10.0
A1549	A1549	M	8.0
A1550	A1550	F	8.0
A1551	A1551	F	7.8
A1552	A1552	M	9.4
A1553	A1553	F	10.8
A1554	A1554	M	11.0
A1555	A1555	F	9.8
A1556	A1556	M	8.2
A1557	A1557	M	9.8
A1558	A1558	F	7.2
A1559	A1559	F	6.2
A1560	A1560	M	11.4
A1561	A1561	M	9.0
A1562	A1562	M	6.0
A1563	A1563	M	6.8
A1564	A1564	F	8.8
A1565	A1565	F	9.4
A1566	A1566	M	14.4
A1567	A1567	F	10.8
A1568	A1568	F	9.2
A1569	A1569	M	7.2
A1570	A1570	F	7.0
A1571	A1571	M	9.0
A1572	A1572	F	9.4
A1573	A1573	M	8.2
A1574	A1574	M	9.0
A1575	A1575	F	5.0
A1576	A1576	F	7.0
A1577	A1577	F	7.2
A1578	A1578	M	8.2
A1579	A1579	M	10.3
A1580	A1580	F	6.5
A1581	A1581	F	8.2
A1582	A1582	F	5.2
A1583	A1583	F	9.0
A1584	A1584	F	9.8
A1585	A1585	M	15.0
A1586	A1586	M	12.2
A1587	A1587	M	13.0
A1588	A1588	M	7.8
A1589	A1589	F	5.8
A1590	A1590	M	11.5
A1591	A1591	M	10.8
A1592	A1592	M	9.5
A1593	A1593	M	10.8

Appendix Table D-1.--Continued.

Left Tag	Right Tag	Sex	Weight (kg)
A1594	A1594	M	8.8
A1595	A1595	F	12.2
A1596	A1596	F	10.5
A1597	A1597	M	6.8
A1598	A1598	M	10.0
A1599	A1599	M	8.4
A1600	A1600	M	10.5
A1601	A1601	M	8.5
A1602	A1602	F	9.4
A1603	A1603	M	11.6
A1604	A1604	F	7.2
A1605	A1605	M	6.2
A1606	A1606	M	9.6
A1607	A1607	F	6.2
A1608	A1608	F	9.6
A1609	A1609	M	9.4
A1610	A1610	F	10.8
A1611	A1611	M	8.2
A1612	A1612	F	10.2
A1613	A1613	M	10.8
A1614	A1614	F	7.4
A1615	A1615	M	9.8
A1616	A1616	F	11.0
A1617	A1617	M	8.0
A1618	A1618	M	9.2
A1619	A1619	M	8.5
A1620	A1620	F	10.2
A1621	A1621	F	6.8
A1622	A1622	M	10.6
A1623	A1623	M	9.6
A1624	A1624	M	9.8
A1625	A1625	M	9.2
A1626	A1626	F	8.2
A1627	A1627	F	7.0
A1628	A1628	F	6.2
A1629	A1629	F	9.2
A1630	A1630	M	9.2
A1631	A1631	M	11.0
A1632	A1632	F	10.0
A1633	A1633	M	10.8
A1634	A1634	F	8.0
A1635	A1635	M	7.5
A1636	A1636	M	11.6
A1637	A1637	M	6.8
A1638	A1638	M	8.8
A1639	A1639	F	7.8
A1640	A1640	F	7.5
A1641	A1641	M	8.0

Appendix Table D-l.--Continued.

Left Tag	Right Tag	Sex	Weight (kg)
A1642	A1642	M	10.8
A1643	A1643	M	8.8
A1644	A1644	F	11.8
A1645	A1645	M	8.0
A1646	A1646	F	7.8
A1647	A1647	F	9.0
A1648	A1648	F	11.6
A1649	A1649	M	8.5
A1650	A1650	M	10.2

Appendix Table D-2. --Northern fur seal pups tagged with pink plastic roto tags at Adams Cove, San Miguel Island, California, 1 November 1992.

Left Tag	Right Tag	Sex	Weight (kg)
A1651	A1651	F	5.6
A1652	A1652	M	12.5
A1653	A1653	F	9.2
A1654	A1654	F	10.5
A1655	A1655	F	7.5
A1656	A1656	M	10.9
A1657	A1657	F	8.0
A1658	A1658	F	9.6
A1659	A1659	F	8.0
A1660	A1660	F	8.8
A1661	A1661	F	10.5
A1662	A1662	F	9.6
A1663	A1663	F	11.0
A1664	A1664	M	9.9
A1665	A1665	F	9.5
A1666	A1666	F	8.0
A1667	A1667	F	11.0
A1668	A1668	M	10.5
A1669	A1669	F	10.0
A1670	A1670	M	11.5
A1671	A1671	M	7.0
A1672	A1672	M	8.0
A1673	A1673	F	8.8
A1674	A1674	F	8.3
A1675	A1675	F	9.2
A1676	A1676	F	10.0
A1677	A1677	M	8.6
A1678	A1678	F	9.1
A1679	A1679	F	7.8
A1680	A1680	M	9.8
A1681	A1681	M	14.2
A1682	A1682	M	8.0
A1683	A1683	F	7.8
A1684	A1684	F	6.9
A1685	A1685	F	8.2
A1686	A1686	F	11.3
A1687	A1687	M	11.6
A1688	A1689	F	6.2
A1689	A1688	F	6.6
A1690	A1690	F	8.4
A1691	A1691	F	10.6
A1692	A1692	F	8.6
A1693	A1693	F	9.2
A1694	A1694	M	12.9
A1695	A1695	F	6.8

Appendix Table D-2.--Continued.

Left Tag	Right Tag	Sex	Weight (kg)
A1696	A1696	F	8.3
A1697	A1697	M	11.6
A1698	A1698	F	9.4
A1699	A1699	F	7.0
A1700	A1700	F	10.0
A1701	A1701	M	10.0
A1702	A1702	F	8.4
A1703	A1703	M	12.1
A1704	A1704	F	8.5
A1705	A1705	F	11.8
A1706	A1706	M	7.2
A1707	A1707	F	7.6
A1708	A1708	F	11.5
A1709	A1709	M	10.2
A1710	A1710	F	7.7
A1711	A1711	F	5.8
A1712	A1712	F	8.8
A1713	A1713	F	8.2
A1714	A1714	M	10.7
A1715	A1715	M	11.5
A1716	A1716	M	11.5
A1717	A1717	F	6.8
A1718	A1718	F	7.2
A1719	A1719	F	8.7
A1720	A1720	F	8.8
A1721	A1721	M	8.1
A1722	A1722	M	11.2
A1723	A1723	M	11.6
A1724	A1724	F	8.4
A1725	A1725	F	6.3
A1726	A1726	F	11.2
A1727	A1727	F	7.6
A1728	A1728	F	11.4
A1729	A1729	F	6.5
A1730	A1730	F	10.6
A1731	A1731	F	9.0
A1732	A1732	M	10.2
A1733	A1733	F	9.3
A1734	A1734	F	10.6
A1735	A1735	M	9.5
A1736	A1736	M	9.2
A1737	A1737	M	10.3
A1738	A1738	M	7.8
A1739	A1739	M	10.2
A1740	A1740	F	7.6
A1741	A1741	M	12.0
A1742	A1742	F	9.0
A1743	A1743	M	8.0

Appendix Table D-2.--Continued.

Left Tag	Right Tag	Sex	Weight (kg)
A1744	A1744	M	9.8
A1745	A1745	F	9.2
A1746	A1746	M	13.2
A1747	A1747	F	7.2
A1748	A1748	F	12.2
A1749	A1749	M	10.8
A1750	A1750	F	7.7
A1751	A1751	F	10.2
A1752	A1752	F	8.2
A1753	A1753	M	10.6
A1754	A1754	M	10.0
A1755	A1755	F	9.4
A1756	A1756	M	10.0
A1757	A1757	M	11.0
A1758	A1758	M	11.0
A1759	A1759	F	6.0
A1760	A1760	F	11.0
A1761	A1761	M	9.4
A1762	A1762	M	9.0
A1763	A1763	F	9.6
A1764	A1764	F	11.0
A1765	A1765	M	8.3
A1766	A1766	M	10.2
A1767	A1767	M	11.0
A1768	A1768	F	6.4
A1769	A1769	M	11.4
A1770	A1770	M	8.0
A1771	A1771	F	9.0
A1772	A1772	M	9.0
A1773	A1773	M	10.8
A1774	A1774	F	7.4
A1775	A1775	M	9.2
A1776	A1776	F	7.0
A1777	A1777	F	10.8
A1778	A1778	F	9.0
A1779	A1779	F	8.8
A1780	A1780	M	9.0
A1781	A1781	M	8.7
A1782	A1782	F	9.8
A1783	A1783	F	6.2
A1784	A1784	F	7.8
A1785	A1785	M	8.2
A1786	A1786	F	11.8
A1787	A1787	M	9.4
A1788	A1788	F	7.2
A1789	A1789	M	10.7
A1790	A1790	F	8.3
A1791	A1791	M	11.6

Appendix Table D-2.--Continued.

Left Tag	Right Tag	Sex	Weight (kg)
A1792	A1792	F	7.1
A1793	A1793	M	8.0
A1794	A1794	F	7.9
A1795	A1795	F	9.7
A1796	A1796	F	8.1
A1797	A1797	F	5.5
A1798	A1798	F	10.8
A1799	A1799	F	7.5
A1800	A1800	M	10.3

APPENDIX E

Scientific staff engaged in northern fur seal research, 1992.

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

Name	Affiliation	Assignment
Emoloyees		
George Antonelis	NMML	Project Leader
Jason Baker	NMML	Population Dynamics
Robert DeLong	NMML	Population Assessment
Charles Fowler	NMML	Population Dynamics
Roger Gentry	NMML	Behavioral Studies
Thomas Loughlin	NMML	Population Assessment
Sharon Melin	NMML	Population Assessment
William Meyer	NMML	Population Assessment
Rolf Ream	NMML	Population Assessment
Bruce Robson	NMML	Population Assessment
Nina Rooks	NMML	Population Assessment
Elizabeth Sinclair	NMML	Foraging Dynamics
Michael Schwartz	NMML	Population Assessment
Rod Towel1	NMML	Population Dynamics
Anne York	NMML	Population Dynamics
Cooperators		
Denise Bradley	WPI	Pup Disease and Mortality
Bryan Caswell		Population Assessment
David Cormany	NMFS	Resource Management
Darlene Deghetto		Pup Disease and Mortality
Bill Gates		Population Assessment
Carol Heart		Population Assessment
Steve Insley	UCD	Behavioral Studies
Masashi Kiyota	NRIFS	Reproduction Studies
Richard Kochutin	CSP	Population Assessment
Alexander Kushin	CSP	Population Assessment
Kaori Noda	EU	Pollution Studies
Jeffrey Philemonoff	CSP	Population Assessment
Warren Scholfield	CVI	Pup Disease and Mortality
Wayne Sentman		Pup Disease and Mortality
Terry Spraker	WPI	Pup Disease and Mortality
Michael Williams	UAF	Population Assessment
Steve Zimmerman	NMFS	Resource Management

Appendix E. --Continued.

Affiliation Code

CSP - City of St. Paul, St. Paul Island, Alaska
CVI - Cambridge Veterinary School, London, England
EH - Eihme University, Matsuyama, Japan
NMML - National Marine Mammal Laboratory, Seattle, Washington
NMFS - National Marine Fisheries Service Regional Office, Juneau, Alaska
NRIFS - National Research Institute of Far Seas Fisheries, Shimizu, Japan
UAF - University of Alaska, Fairbanks, Alaska
UCD - University of California, Davis, California
WPI - Wildlife Pathology International, Boulder, Colorado

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