584

Fur Seal Investigations, 1966

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UNITED STATES DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES

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Marine Mammal Biological Laboratory

United States Fish and Wildlife Service

Special Scientific Report--Fisheries No. 584

Washington, D.C.
June 1969

Frontispiece.--The M/V Pribilof, Bureau of Commercial Fisheries Pribilof Island supply vessel, on fur seal research cruise off California in 1966.

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FUR SEAL INVESTIGATIONS, 1966

by

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ABSTRACT

In 1966, 52,497 male and 391 female fur seals (Callorhinus ursinus) were killed on the Pribilof Islands.

Counts of dead fur seals included 27,392 pups, 222 adult males, and 227 adult females.

Malnutrition, hookworm disease, infections, and bite wounds were the major causes of death of 164 pups examined in 1966.

On the Pribilof Islands 9,948 harem and 6,856 idle males were counted in 1966.

Of the 51 4-year-old females examined, one was primiparous and post partum; none of the 65 3-year-old females had been gravid.

Handling apparently causes pups to lose weight or slows their rate of weight gain.

A total of 12,499 pups were tagged and checkmarked and 12,077 were marked. Two tags were attached to 2,978 males older than pups on St. Paul Island. Recoveries of seals marked in previous years included 4,418 marked as pups and 159 marked at age 1 or older on the Pribilof Islands, and 30 seals marked as pups on the Soviet Islands.

Pups tagged in late September apparently survive the effects of tagging better than pups tagged in mid-August. On the basis of tag recoveries, the estimated number of pups born decreased steadily from 643,000 in 1960 to 440,000 in 1964. The estimate of pups born in 1966 from marked-to-unmarked ratios was 380,000. Estimates from marked-to-unmarked ratios were similar to total counts of pups on three rookeries.

An estimated 78,000 males from each of two year classes (1961 and 1962) survived to age 1.

The forecasted kill of 3- and 4-year old male seals on St. Paul Island in 1966 was 40,000; the actual kill was 37,669. The forcasted kill of males on the Pribilof Islands in 1967 includes 4,000 of ages 2 and 5, 34,300 of age 3, and 17,900 of age 4.

The 249 adult males killed for study and the 157 adult males found dead had similar age distributions. The annual replacement rate for males age 10 and older is estimated as 0.38.

Sixty-six genital tracts from adult females were collected from 13 September to 28 November. The first of 17 tracts with implantation chambers was collected 4 November; all 5 tracts taken on 28 November had implantation chambers.

In a test to determine accuracy in assigning the correct ages to fur seals from canine teeth, the lowest errors were 2.5 to 3.9 percent for males in ages 2 to 5 and 3.8 to 21.3 percent for females in ages 3 to 7. Japanese and U.S. readers disagreed on 18.2 percent of males in ages 1 to 4 and 36.5 percent of females in ages 1 to 7 in two other groups of teeth.

Succinylcholine apparently is unsafe for use in immobilizing adult male fur seals.

Seal pups gained more weight when fed calcium caseinate and fish flour than when fed fish flour alone. Colostrum milk obtained immediately post partum has much higher levels of albumin and globulin than does milk of later lactation.

Pelagic research was conducted off central and southern California from 21 January to 25 March 1966. Seal distribution was studied along transects extending 19 to 222 km. offshore between lat. 32° N. and 38° N. at 37-km. intervals. Seals were usually found 37 to 130 km. offshore. The largest concentrations of seals were usually near areas where abrupt changes in depths occur along the Continental Shelf and over seavalleys and seamounts.

Of 2,704 seals sighted, 444 were collected, 78 were wounded and lost, and 67 sank after they were killed. Males formed only a small part of the population. Of 428 females taken, 52 percent were gravid; the youngest gravid female was a primiparous 4-year-old.

A lanternfish (*Myctophum californiense*), a sciaenid (species unknown), and a squid (*Chiroteuthis veranyi*) were found in fur seal stomachs for the first time. Northern anchovy (*Engraulis mordax*), Pacific saury (*Cololabis saira*), Pacific hake (*Merluccius productus*), and squids were the principal food species of fur seals off California.

INTRODUCTION

Annually the Bureau of Commercial Fisheries reports on its fur seal investigations on the Pribilof Islands and at sea. Investigations on the islands are directed mainly toward the development of a rational system for holding the seal population at the level of maximum productivity. At sea, the primary motivations for research are the problems of fur seal predation on commercially important fishes and the intermingling of seals from the eastern and western Pacific Ocean. It is unlikely that unequivocal conclusions can be reached soon on either problem. General understanding of the pelagic life of fur seals, however, has been greatly improved during the past 9 years of research.

The object of this report is to provide results of research by the United States in 1966. The North Pacific Fur Seal Commission has recommended that each member Government make such a report.

A summary of the research data collected on the Pribilof Islands in 1966 is given in Part I of the following report. Contributors were Raymond E. Anas, Douglas G. Chapman (Laboratory of Statistical Research, University of Washington), Ancel M. Johnson, Mark C. Keyes, Alton Y. Roppel, Victor B. Scheffer, and Ford Wilke (appendix B). A description of investigations of fur seals at sea off California is given in Part II. Contributors were Clifford H. Fiscus and Hiroshi Kajimura.

Part I. FUR SEAL INVESTIGATIONS, PRIBILOF ISLANDS, ALASKA

The two interdependent major efforts of fur seal research have been to improve population estimates and find the level of maximum yield. No recorded experience allowed a timetable to be prepared for this study of the population of an animal that lives as long as 30 years.

Since 1954 we have been refining estimates of the number of fur seals in the Pribilof Islands population, and since 1956 we have reduced the population in an attempt to bring it near the level of maximum sustainable yield. By 1965, progress in achieving the two main objectives had reached the point where we could manage the seal resource and continue population research with greater confidence.

From 1955 to 1962, 50,000 to 60,000 pups were tagged yearly to provide a basis for population estimates and to make possible a study of the intermingling of seals from the eastern and western Pacific Ocean. We found, however, that population estimates based on the recovery of seals tagged as pups in those years were inflated. Since 1963, the number of pups tagged was reduced first to 25,000 and then to 12,500. Now we are also tagging about 3,000 yearling and older seals to obtain information on mortality between age groups within each year class.

At the present population level, seal pup mortality on land has declined to between one-third and one-half of the high losses of the

1950's. The reason for the decrease is not clear because of uncertainties about the causes of mortality at different sizes of the pup population. To understand how mortality will change as the size of the total pupulation changes, we need to determine the causes of death among pups as the number of seals is allowed to increase in successive steps.

We have found that handling and marking seal pups retards growth and probably reduces survival. We, therefore, face the problem of how to get needed information without causing unreasonable disturbance.

This part of the report discusses research data collected on the Pribilof Islands in 1966, methods of forecasting the kill of male seals in 1967, and results of special studies. Terms having special meanings in fur seal research are described in the glossary at the end of part I. The locations of rookeries and hauling grounds on St. Paul and St. George Islands are shown in figures 1 and 2.

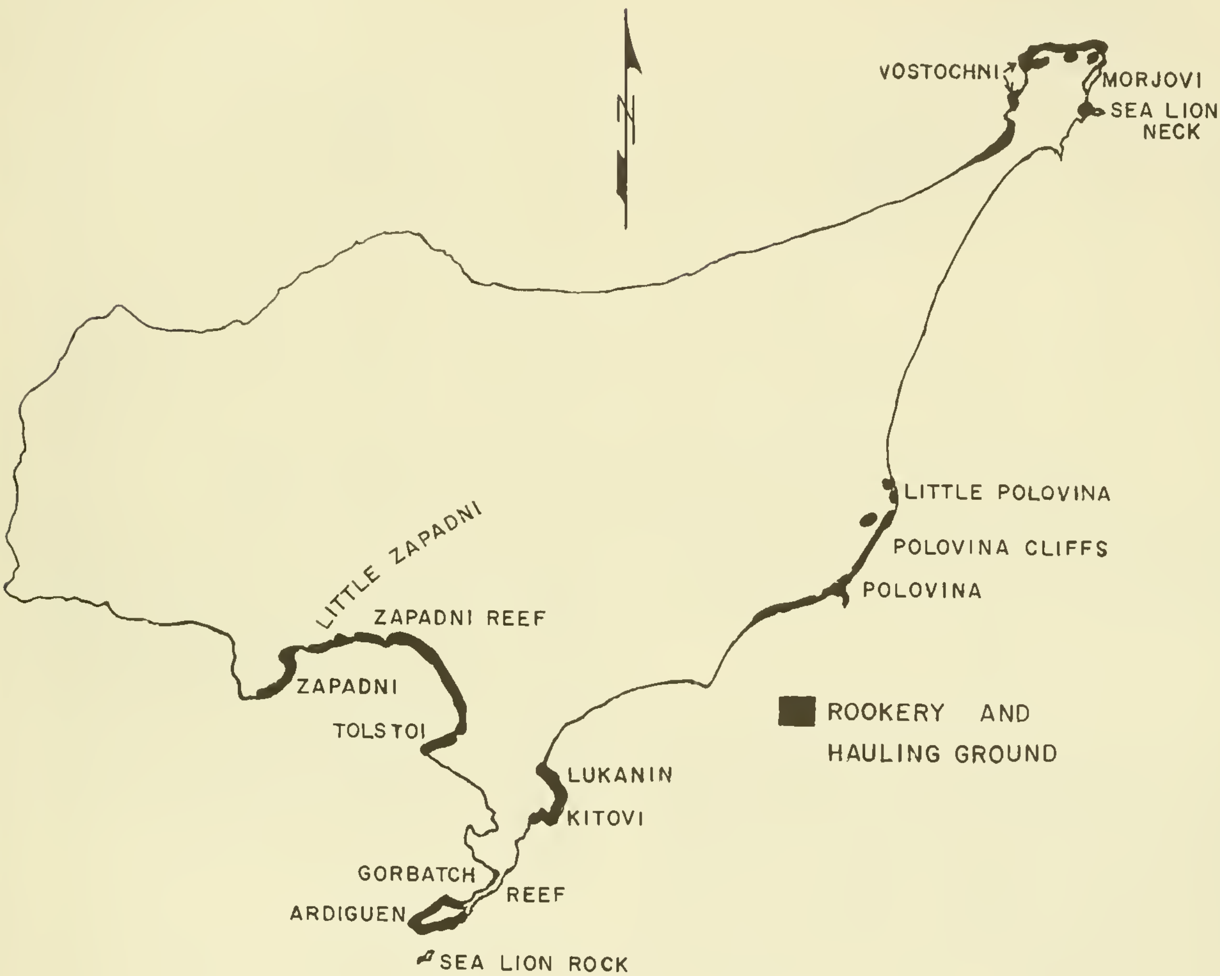

Figure 1.--Locations of rookeries and hauling grounds, St. Paul Island.

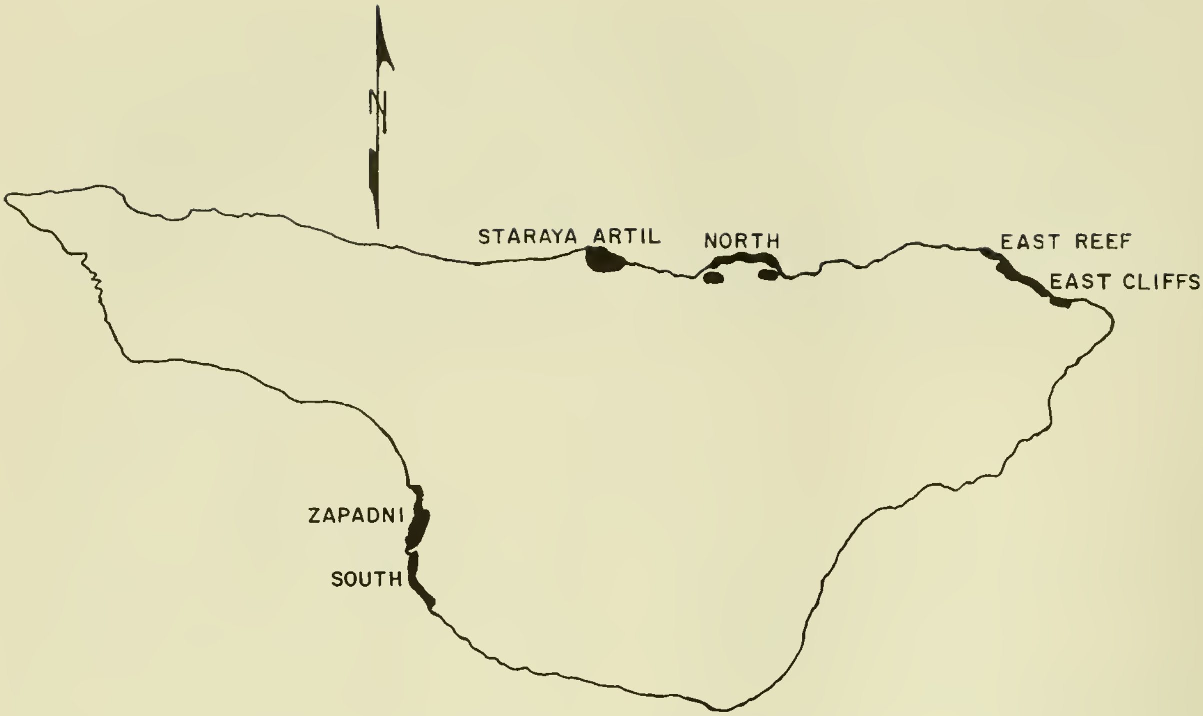

Figure 2.--Locations of rookeries and hauling grounds, St. George Island.

AGE CLASSIFICATION AND NUMBER OF SEALS KILLED, BY SEX

Only male seals were purposely killed for their skins in 1966. A few hundred females were killed accidentally, or for research purposes.

MALES

In 1966, male seals were killed daily from 7 July to 5 August on St. Paul Island and on Mondays, Wednesdays, and Fridays on St. George Island from 6 July to 5 August. Killing began about 5 a.m. on St. Paul Island and about 9 a.m. on St. George Island.

All available subadult males 42 inches (106.7 cm.) long or longer from tip of nose to tip of tail, but without manes, were taken. From 22 through 26 July the lower length limit was removed to allow a complete kill of all available 2-year-old males for a continuing study of the relation of abundance of a year class on land at age 2 to the number of the same year class available for killing at age 3. Additional data are needed to complete the study.

To determine the age composition of the kill, right upper canine teeth were collected from 20 percent of the male seals killed each day on St. Paul Island and 20 percent of the kills in excess of 300 animals on St. George Island. Kills of 300 or fewer on St. George Island were sampled at the rate of 40 percent. (The kills on St. Paul Island were rarely fewer than 300.)

A total of 52,497 male seals killed on the Pribilof Islands in 1966 included 42,104 in ages 2 to 5 on St. Paul Island and 10,393 in ages 2 to 6 on St. George Island (tables A-1 to A-4). Three-year-olds dominated the kill throughout the season on St. Paul Island (fig. 3), but only after 16 July on St. George Island (fig. 4).

The kills of male seals in year classes 1947-64 are given in table 1 for the Pribilof Islands.

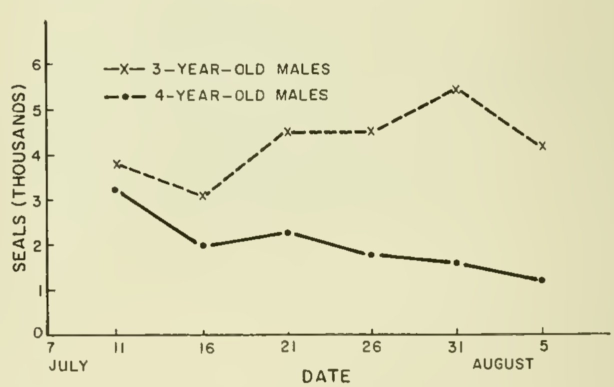

Figure 3.--Kill of 3- and 4-year-old male seals, by 5-day periods, St. Paul Island, 7 July to 5 August 1966.

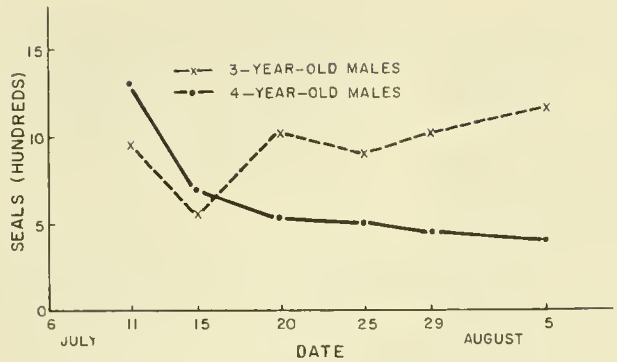

Figure 4.--Kill of 3- and 4-year-old male seals, by varying periods, St. George Island, 6 July to 5 August 1966.

Table 1.--Kill of male seals,[1] by year class, Pribilof Islands, Alaska, 1947-64

Year class	St. Paul Island, Age when killed: 2	3	4	5	Total	St. George Island, Age when killed: 2	3	4	5	Total	Grand total
	Number					Number					
1947	-	30,110	23,697	854	54,661	-	7,043	3,731	123	10,897	65,558
1948	486	25,714	19,995	103	46,298	114	5,546	3,926	22	9,608	55,906
1949	-	29,697	12,326	249	42,272	303	7,116	2,570	280	10,269	52,541
1950	855	40,656	15,365	332	57,208	1,104	8,475	4,793	147	14,519	71,727
1951	1,384	32,350	18,083	3,057	54,874	288	7,907	5,310	681	14,186	69,060
1952	1,735	30,733	31,410	675	64,553	545	8,998	8,459	506	18,508	83,061
1953	839	38,312	8,855	54	48,060	295	10,611	3,330	100	14,336	62,396
1954	2,918	23,473	5,599	554	32,544	535	6,651	2,779	162	10,127	42,671
1955	1,015	27,863	10,555	115	39,548	555	7,246	2,825	260	10,886	50,434
1956	885	10,671	2,762	532	14,850	171	2,251	1,387	218	4,027	18,877
1957	2,590	24,283	15,344	773	42,990	242	5,098	4,492	244	10,076	53,066
1958	1,977	48,458	14,149	1,587	66,171	431	9,413	3,707	540	14,091	80,262
1959	2,820	26,456	14,184	1,764	45,224	891	5,890	4,690	492	11,963	57,187
1960	1,619	14,310	10,533	1,240	27,702	636	4,332	2,579	178	7,725	35,427
1961	1,098	22,468	12,046	1,270	36,882	921	6,948	2,592	502	10,963	47,845
1962[2]	2,539	19,009	12,156	-	33,704	1,139	3,736	3,881	-	8,756	42,460
1963[2]	1,264	25,535	-	-	26,799	167	5,586	-	-	5,753	32,552
1964[2]	3,143	-	-	-	3,143	391	-	-	-	391	3,534
Mean	1,698	27,652	14,191	877	[3] 44,377	513	6,638	3,816	297	[4] 11,520	[3] 55,994

1/ Includes only 2- to 5-year-old seals taken during the kill of males on the Pribilof Islands. From the 1956 through the 1964 year classes, 137 1-year-olds and 397 6-year-olds were taken on St. Paul Island and 20 1-year-olds and 124 6-year-olds were taken on St. George Island. In addition, age was not determined for 3,494 males taken on St. Paul Island and 785 taken on St. George Island.

2/ Incomplete returns.

3/ 1947, 1949, 1962, 1963, and 1964 year classes not included.

4/ 1947, 1962, 1963, and 1964 year classes not included.

FEMALES

The kill of female seals on the Pribilof Islands in 1966 was 391; 61 were taken for research and 330 were killed accidentally during the kill of males. Canine teeth for determining age were not collected from females.

SURVEY DATA

Data collected in 1966 to follow the response of population to changes in its size included: (1) Counts of dead adults and pups; (2) counts of living adult males; (3) major causes of mortality of pups; (4) reproductive condition of females; and (5) weights of live pups.

MORTALITY

This section includes data on pups that died on the Pribilof Islands during most years since 1941, and adults that died on St. Paul Island in 1965-66 and on St. George Island in 1966.

Pups

Biologists have counted dead pups on the Pribilof Islands about mid-August nearly every year since 1941 (table A-5). Until 1966, only the total numbers of dead pups were recorded for each rookery. In 1966, we subdivided the rookeries on St. Paul Island into sections that contained about 100 harem males each in mid-July, and counted the dead pups in each section (table A-6). In future years, the mortality of pups within each section will be compared with the density of harem males and other characteristics to determine if they are related to mortality.

The causes of mortality of pups each day on a selected sampling area of Reef Rookery were also recorded.

Counts of dead pups.--The count of dead pups in 1966 was 22,485 on St. Paul Island and 4,907 on St. George Island--or a total of 27,392 (the figures include a 5 percent addition for overlooked pups). The count for St. Paul Island was the lowest since 1941, but only slightly lower than the count of 22,651 in 1964. The count in 1966 on St. George Island was more than double the number observed in 1964.

Estimates of mortality.--Counts of dead pups are useful for showing changes in mortality on land over short periods of time when it can be assumed that the same number of pups are born each year. Comparisons of mortality over several years or between pup populations on different rookeries, however, cannot be made unless the fractions of the population represented by the counts are known.

Estimates of the number of pups born based on tag recoveries from 1956 to 1960 cannot be used with counts of dead pups to calculate mortality by rookery, because the estimates were inaccurate and highly variable from year to year.

Estimates based on sampling for marked-to-unmarked ratios in the year of birth became available beginning in 1960. By 1963, this method was sufficiently improved to make the estimates, in conjunction with complete counts of live pups, reasonably accurate. To overcome year-to-year variability due to sampling, the means of the estimates from 4 years (1963-66) of marking and sampling were used to develop estimates of mortality for St. Paul Island (table 2). Live pups were first sheared and sampled on St. George Island in 1966, and we used the estimate of the number of pups born to calculate mortality by rookery in 1966, and also in 1963, 1964, and 1965 (table 2). We assumed that the population was constant during the 4-year period. Though the populations of both islands may have changed somewhat, sampling for marked-to-unmarked ratios probably provides the best estimate of the pup population on which to calculate annual mortality by rookery.

Total mortality of pups varies considerably from year to year, and the loss, in proportion to the number born, tends to be higher on certain rookeries than on others. In addition, the mortality of pups in 1963-65 was much lower on St. George Island than on St. Paul Island. A correlation coefficient of 0.90 between islands shows that even though mortality on each followed the same trend (whether up or down), the magnitude of the changes has varied widely (fig. 5). This variation also held for individual rookeries on each island.

Causes of pup mortality.--To determine the relative importance of the major causes of pup mortality and relate these causes to variations in the size of the total population, an annual survey of pup mortality was begun in 1966. This program was based on a study of pup mortality made in 1964 when all dead pups that could be reached from a catwalk were removed daily with a 5-m. gaff and autopsied (Keyes, 1965). The catwalk used in 1964 and 1966 is on the east shore of Reef Rookery between tripods 5 and 6-7 (fig. 6) and provides access to about 1,672 $m.^2$ of breeding space. The survey in 1966 was begun on 28 June when the first dead pups were found, and ended on 22 August, after which very few pups die.

Table 2.--Estimated mortality of pups from birth to about 25 August, by rookery, year classes 1963-66, Pribilof Islands, Alaska

Island and rookery	Mean estimated pup population 1/	Count of dead pups 1963	Count of dead pups 1964	Count of dead pups 1965	Count of dead pups 1966	Estimated mortality 2/ 1963	Estimated mortality 2/ 1964	Estimated mortality 2/ 1965	Estimated mortality 2/ 1966
St. Paul Island	- - - - - - - -	- - - - -	- - - - -	-Number-	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
Gorbatch	20, 569	2, 431	1, 549	3, 123	1, 593	0. 11	0. 07	0. 13	0. 07
Reef	34, 602	5, 688	3, 000	7, 664	3, 562	0. 14	0. 08	0. 18	0. 09
Ardiguen	2, 595	141	102	459	160	0. 05	0. 04	0. 15	0. 06
Polovina	5, 024	1, 237	783	1, 176	312	0. 20	0. 13	0. 19	0. 06
Polovina Cliffs	20, 828	2, 160	1, 097	2, 856	809	0. 09	0. 05	0. 12	0. 04
Little Polovina	3/7, 170	923	631	1, 132	449	0. 11	0. 08	0. 14	0. 06
Vostochni	40, 303	5, 057	3, 404	4, 214	2, 785	0. 11	0. 08	0. 09	0. 06
Morjovi	17, 618	2, 348	1, 830	2, 649	1, 686	0. 12	0. 09	0. 13	0. 09
Tolstoi	25, 724	3, 274	2, 614	3, 955	3, 425	0. 11	0. 09	0. 13	0. 12
Lukanin	5, 682	546	402	1, 126	432	0. 09	0. 07	0. 17	0. 07
Kitovi	12, 708	881	462	2, 202	406	0. 06	0. 04	0. 15	0. 03
Zapadni	30, 009	4, 614	4, 172	5, 384	3, 710	0. 13	0. 12	0. 15	0. 11
Little Zapadni	17, 302	2, 580	1, 101	2, 461	1, 634	0. 13	0. 06	0. 12	0. 09
Zapadni Reef	3/5, 604	718	425	723	451	0. 11	0. 07	0. 11	0. 07
Sea Lion Rock	17, 992				2, 122				0. 11
Island total	264, 372 5/(246, 380)	32, 598	21, 572	39, 124	23, 536	4/0. 12	4/0. 08	4/0. 14	0. 08
St. George Island									
East Reef	2, 645	105	272	676	198	0. 04	0. 02	0. 05	0. 07
East Cliff	10, 208	397			566	0. 04			0. 04
North	26, 507	2, 525	792	1, 854	1, 561	0. 09	0. 03	0. 07	0. 06
South	7, 574	162	-	-	445	0. 02			0. 06
Staraya Artil	8, 854	1, 041	767	1, 186	1, 127	0. 10	0. 08	0. 12	0. 13
Zapadni	8, 970	542			751	0. 06			0. 08
Island total	64, 758	4, 772	1, 831	3, 716	4, 648	0. 07	0. 03	0. 07	0. 07
Total both islands	329, 130	37, 370	23, 403	42, 840	28, 184	0. 11	0. 07	0. 13	0. 08

1/ Mean of estimates at time of shearing obtained for year classes 1963-66 from samplong for marked-to-unmarked ratios.
2/ Obtained by adding the number of dead pups counted to the mean estimated pup population and dividing by the latter.
3/ Mean of complete counts.
4/ Calculated from estimate for St. Paul Island excluding Sea Lion Rock.
5/ Total for St. Paul Island excluding Sea Lion Rock.

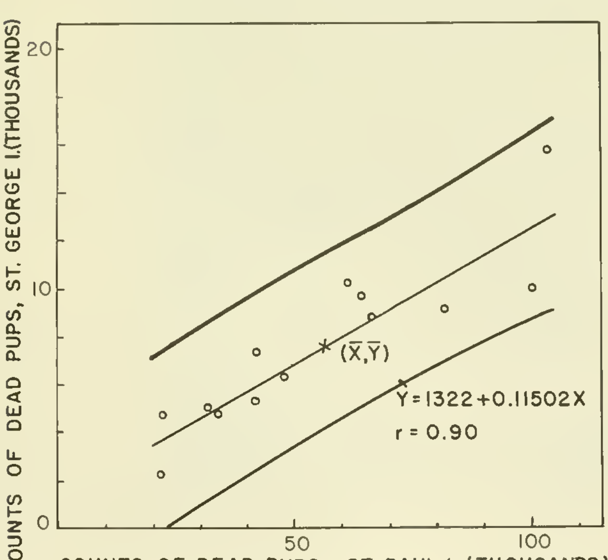

Figure 5.--Least squares line and 95 percent confidence limits for a comparison of counts of dead pups, Pribilof Islands, Alaska, 1953-54 and 1956-66.

Figure 6.-- Pup mortality study area, Reef Rookery, St. Paul Island, 11 July 1966.

Table 3.--Primary causes of death among pups, Reef Rookery study area, St. Paul Island, 28 June to 22 August 1966

Cause of death	Dead pups	
	Number	Percent
Malnutrition	69	42.1
Hookworm disease	29	17.7
Trauma	22	13.4
Bite wounds	(15)	(9.1)
Skull fractures	(2)	(1.2)
Liver rupture and hemorrhage	(4)	(2.4)
Contusions	(1)	(0.6)
Infection	16	9.8
Navel	(9)	(5.5)
Peritonitis	(3)	(1.8)
Pleuritis	(2)	(1.2)
Enteritis	(1)	(0.6)
Abscess	(1)	(0.6)
Miscellaneous	5	3.0
Undetermined	13	7.9
Unsuitable for examination	10	6.1
Total	164	100.0

The distribution of primary causes of death is given in table 3; a summary of other findings follows:

1. Seasonal variation in primary causes of death: Trauma (mostly bite wounds from females) was the leading cause of death during the first 2 weeks of the survey; malnutrition during the next 5 weeks, and hookworm disease during the 8th week. Infections (bacterial and viral) were never a leading cause of death (fig. 7 and table A-7).

2. Distribution of primary causes of death by age: Table 4 shows the ages at which the primary causes of death were most prevalent. Of the pups that died of malnutrition, most females did so from 1 to 3 weeks of age and males from 1 to 4 weeks of age. Most of the pups that died from hookworm infection were over 3 weeks old. Only one female over 3 weeks and one male over 4 weeks of age died of trauma (physical injuries). Age was estimated by the eruption of the permanent canine teeth and the presence or absence of an umbilical cord. The permanent canines usually erupt by age 3 weeks in females and by age 4 weeks in males. The umbilical cord drops off about 1 week after birth.

3. Body condition and causes of death: There was some correlation between condition index (ratio of weight to length X 100) and cause of death (table A-8). Pups that died of malnutrition had obviously lost weight, but pups that died of hookworm disease, infections, or undetermined causes had lost little or no weight. Pups that died of bite wounds from strange females were intermediate.

4. Secondary causes of death: Enteritis was a secondary cause of death in 40 of 69 pups that died of malnutrition and in 3 of 29 pups that died of hookworm disease (table A-9). Abscesses and phlegmons were secondary causes of death in 9 of 22 pups that died of bite wounds. Trauma (10 bite wounds, 1 skull fracture, and 1 liver rupture) was a secondary cause in five cases of malnutrition, three cases of infection, and in four cases where the primary cause of death was undetermined.

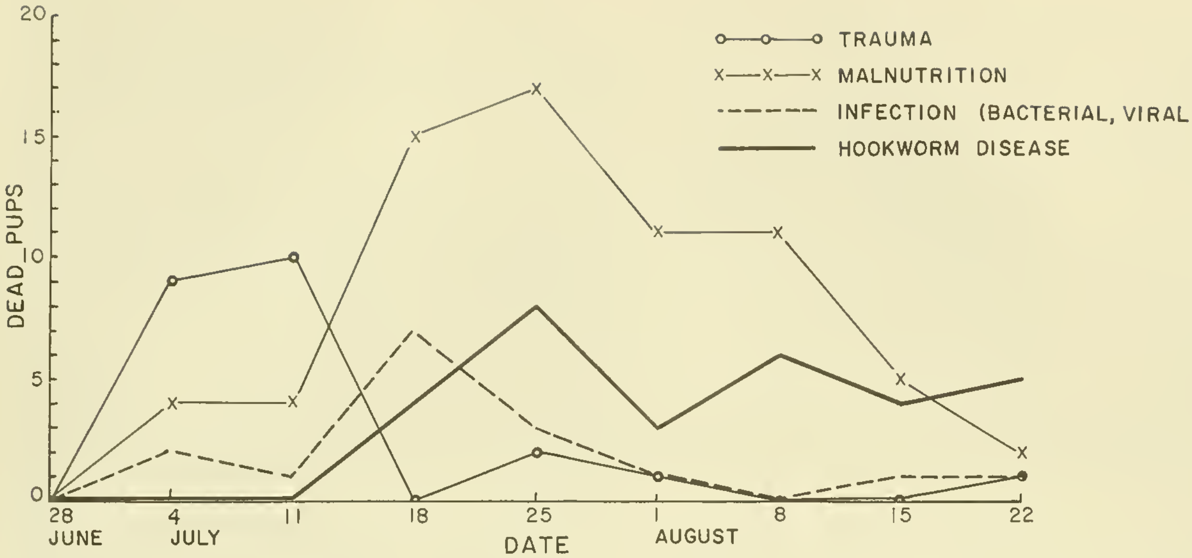

Figure 7.--Frequency of the most prevalent primary causes of death among pups, Reef Rookery study area, St. Paul Island, 28 June to 22 August 1966.

Table 4.--Distribution of primary causes of death among pups, by age, Reef Rookery study area, St. Paul Island, 28 June to 22 August 1966

Cause of death	Under 1 week (♂ and ♀)	Females		Males	
		1-3 weeks	Over 3 weeks	1-4 weeks	Over 4 weeks
	Number	Number	Number	Number	Number
Malnutrition	0	24	17	20	8
Hookworm disease	0	4	10	7	8
Trauma	3	12	1	5	1
Infection	0	4	3	6	3
Miscellaneous	4	0	0	0	1
Undetermined	4	2	2	2	3

5. Miscellaneous causes of death: Five pups died of miscellaneous causes. Two were stillborn, one had a ruptured umbilical hernia with eventration of viscera, one had a cardiovascular anomaly (ventricular septal defect and persistent right aortic arch), and one died of impaction of retained meconium (fig. 8). The last condition is not uncommon as a cause of death in foals during the first 72 hours of life but apparently has not been reported in marine mammals.

6. Comparison of pup mortality in 1964 and 1966: Table 5 compares causes of death from 9 July to 22 August in 1964 and 1966. No direct

Figure 8.--Impaction of the colon with retained meconium in a fur seal pup, St. Paul Island, 1 July 1966.

Table 5.--Primary causes of death among pups, Reef Rookery study area, St. Paul Island, 9 July to 22 August 1964 and 1966

Cause of death	Pups 1/ 1964	1966	1964	1966
	Number		Percent	
Malnutrition	41	62	37.6	50.4
Hookworm disease	13	29	11.9	23.6
Trauma	19	8	17.4	6.5
Bite wounds	(7)	(7)	(6.4)	(5.7)
Infection	17	13	15.6	10.6
Navel	(8)	(7)	(7.3)	(5.7)
Miscellaneous	4	4	3.7	3.3
Undetermined	15	7	13.8	5.7
Total	109	123		

1/ Does not include 52 pups in 1964 and 7 in 1966 that were unsuitable for examination.

comparison could be made for the period 28 June to 8 July because we did not examine the pups that died during this interval in 1964.

There is a lag between birth of the first pups and maturation of hookworms, and no pups were found dead from hookworm disease in either year before 17 July. We can assume, therefore, that hookworm disease caused no deaths before examination began on 9 July and that the incidence of death from this cause from 28 June to 22 August was 8.1 percent in 1964 and 17.7 percent in 1966.

Mortality from malnutrition and hookworm disease was about 10 percent higher and mortality from trauma about 10 percent lower in 1966 than in 1964. The peaks of death from malnutrition, hookworm disease, and infection occurred at the same time in both years, but the peaks from trauma did not (fig. 9).

The number of dead pups collected, death rates for Reef Rookery, and time of peak mortality were similar for the 2 years (tables 2 and 6 and figs. 10 and 11). In 1965, the total

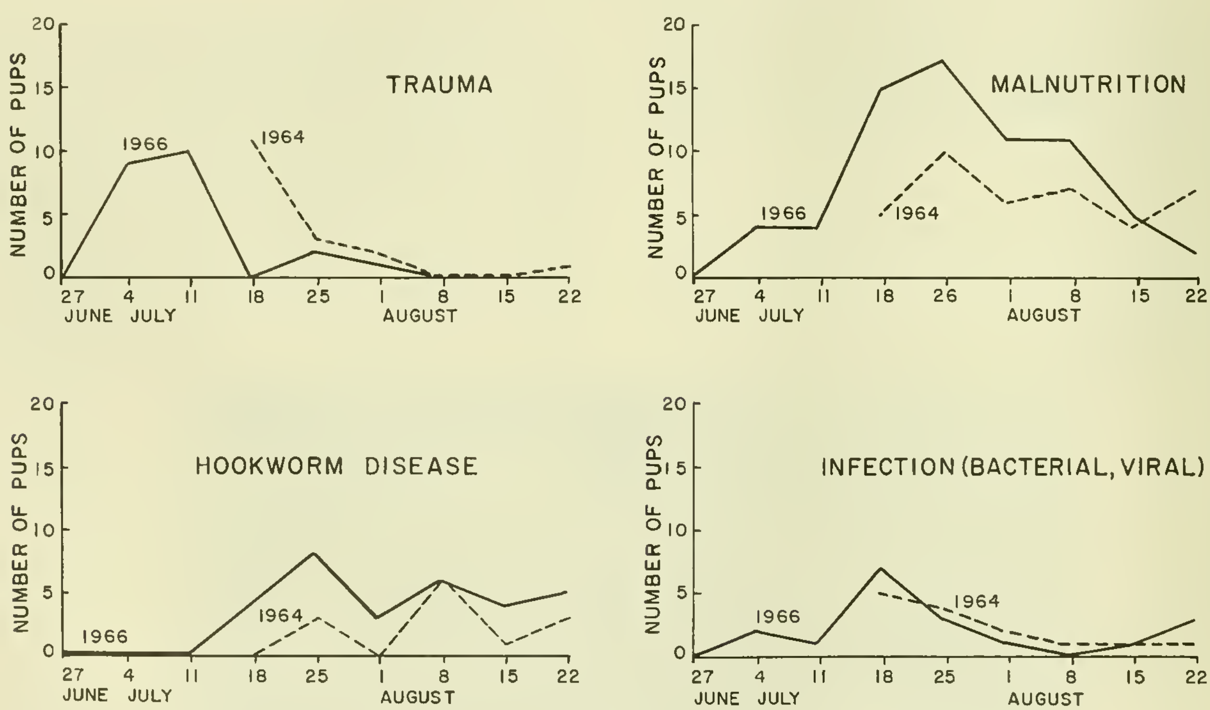

Figure 9.--Comparisons of the prlmary causes of death among pups, Reef Rookery study area, St. Paul Islands 1964 and 1966.

Table 6.--Comparison of number of dead pups on Reef Rookery study area and St. Paul Island, 1964-66

Mortality	1964 Pups	1965 Pups	1965 Change from 1964	1966 Pups	1966 Change from 1964
	Number	Number	Percent	Number	Percent
Dead pups cleared from Reef Rookery study area	161	337	+109.0	164	+2.0
Dead pups counted on Reef Rookery	3,000	7,664	+155.0	3,562	+19.0
Dead pups counted on St. Paul Island	21,572	39,124	+81.0 [redacted]	21,414	-1.0

mortality for Reef Rookery was 155 percent greater than in 1964. Causes of death were not determined in 1965, so we do not know if the increase was due to a proportional increase in all causes or in one or a few causes. Apparently the changes in mortality for the study area were similar to those on the entire rookery in 1964-66 (table 6).

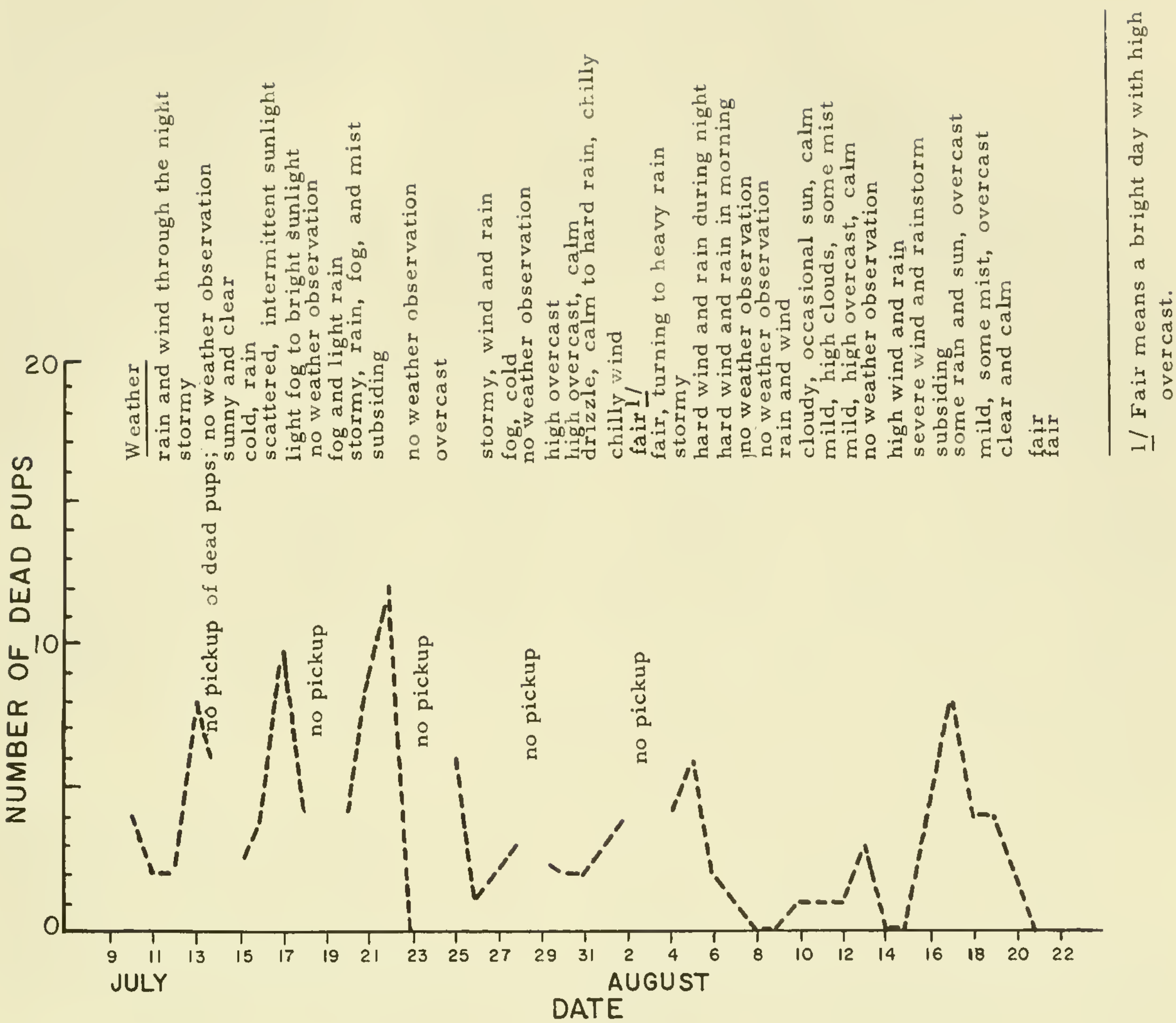

Figure 10.--Pup mortality on Reef Rookery study area, and weather on St. Paul Island, 9 July to 22 August 1964.

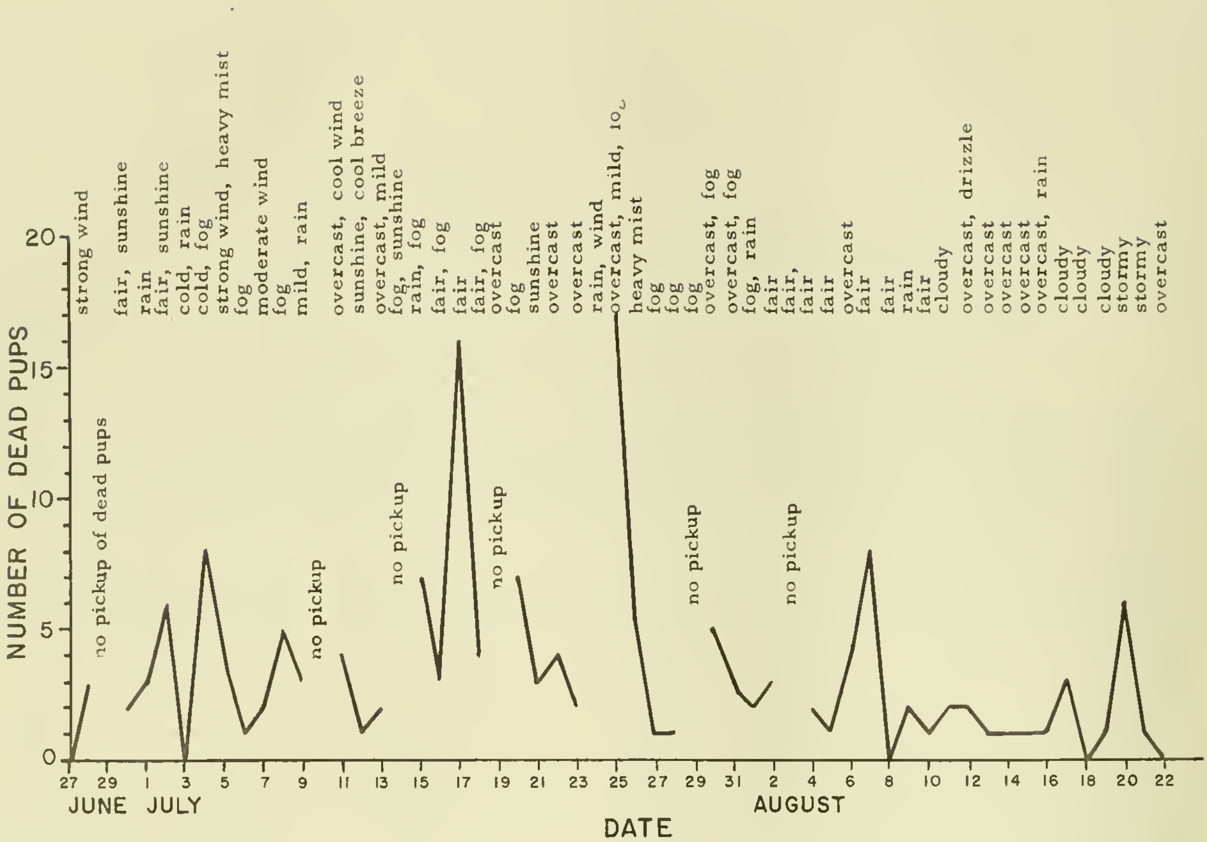

Figure 11.--Pup mortality on Reef Rookery study area, and weather on St. Paul Island, 27 June to 22 August 1966.

An increase in mortality of pups after stormy weather on the Pribilof Islands has been reported.[1] Data associating weather and mortality of pups in 1964 and 1966 (figs. 10 and 11) also show an increase in the number of deaths following rains. It is not known whether storms appreciably increase mortality or create focal points for deaths that would occur anyway.

Adults

In 1965, dead adult males found on the rookeries and all other beaches on St. Paul Island were counted, and upper canine teeth still in the skulls were collected for determining age. This program was expanded in 1966 to include dead adult females on St. Paul Island and dead adults of both sexes on St. George Island. The ages of males found dead on St. Paul Island in 1965 have been used in a study of adult males (see special studies section of this report).

We counted 158 dead adult males in 1965 and 181 in 1966 on St. Paul Island, and 41 on St. George Island in 1966.

In 1966 we counted 55 dead adult females on St. George Island and 172 on St. Paul Island.

COUNTS OF LIVING ADULT MALES

Harem and idle males have been counted about mid-July nearly every year on the Pribilof Islands since 1911; natural and artificial markers on the rookeries have been used as section boundaries for aids in counting. Boundaries were changed from time to time; in recent years, the number of harem males in the various sections has ranged from 2 to over 200. Before counting the adult males on St. Paul Island in 1966, we placed markers (marine plywood 1.9 by 40.6 by 40.6 cm. (3/4 by 16 by 16 inches) with orange numerals on a white background) on each rookery, spaced so that the area between successive markers contained about 100 harem males. (Counts obtained in 1965 were used as a basis for placing the markers.) Numbered sections facilitate counting and will be useful for making detailed comparisons of the populations of harem and idle males from year to year.

The total number of adult males counted on the Pribilof Islands in mid-July decreased for

[1] Carl E. Abegglen, Alton Y. Roppel, and Ford Wilke. 1957. Alaska fur seal investigations, Pribilof Islands, Alaska, report of field activities, June-October 1957. Bureau of Commercial Fisheries Marine Mammal Biological Laboratory, Seattle, Wash. [Manuscript report.]

the fifth successive year--from 28,286 in 1961 to 16,804 in 1966. Harem males on the rookeries in 1966 approximated 71 percent of the number counted in 1961, and idle males were 47 percent. Counts of adult males are given in tables A-10 to A-12.

REPRODUCTIVE CONDITION OF FEMALES

The genital tracts of 65 3-year-old and 51 4-year-old females killed 23-27 August 1965 on St. Paul Island were examined for evidence of parturition in 1965, and the ovaries were sectioned to reveal developing corpora lutea and other indicators of sexual maturity described by Roppel, Johnson, and Chapman (1965). Of the 116 females examined, one 4-year-old was primiparous and recently post partum; the remaining 4-year-olds and all of the 3-year-olds were nulliparous (table 7). If we assume that a developing corpus luteum or a Graafian follicle at least 5 mm. in diameter indicates sexual maturity (Craig, 1964), then 46 percent of the 3-year-olds and 59 percent of the 4-year-olds in the sample of 116 females were mature.

WEIGHTS OF PUPS

Seal pups have been weighed on St. Paul Island annually about 1 September since 1957 to determine if body weight in autumn is related to survival. A consistent relation would be useful for predicting the kill from a year class. These data are discussed in the section on forecasts.

Tagged and marked pups have weighed less than untagged and unmarked pups 1 or 2 weeks after tagging each year in 1957-65. In 1965, pups that were marked by removing the tip of the first digit on the right hind flipper also weighed less than untagged and unmarked pups.

Information on the effect of handling was obtained in 1966. We marked 800 pups on each of two rookeries on St. Paul Island 17 August by shearing a patch of fur from the rump. One or two men prevented the pups from escaping while three teams of two men each (one holder and one shearer) worked on small groups of pups driven into three-sided barricades from the main group as needed. Samples of marked and unmarked male and female pups were weighed 13 days after marking. The mean weights for each sex in each sample were less for marked (handled) pups than for unmarked (unhandled) pups (fig. 12 and table A-13). A combined probability test of sexes and rookeries showed that handled pups weighed significantly less than unhandled pups ($P<.05$).

Tagging, marking, and handling, individually or combined, causes a loss of weight or slows the normal rate of weight gain. Loss of weight may cause tagged or marked pups to die at a greater rate than untagged and unmarked pups during their first winter at sea, thus inflating later estimates of the population based on recoveries of tagged and marked seals.

Table 7.--Ovarian activity of 3- and 4-year-old female seals, St. Paul Island, 1965

Age	Postovulation 1/		Preovulation 2/		Active 3/		Inactive 4/		Total
Years	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number
3	4	6	26	40	32	49	3	5	65
4	6	12	24	47	19	37	2	4	51
Total (3 and 4)	10	9	50	43	51	44	5	4	116

1/ Evidence of ovulation based on a developing corpus luteum in one ovary.

2/ One or more Graafian follicles each 5 mm. or larger in diameter. Measurements were taken after the ovaries were sectioned.

3/ Both ovaries with Graafian follicles, all less than 5 mm. in diameter.

4/ One or both ovaries without Graafian follicles.

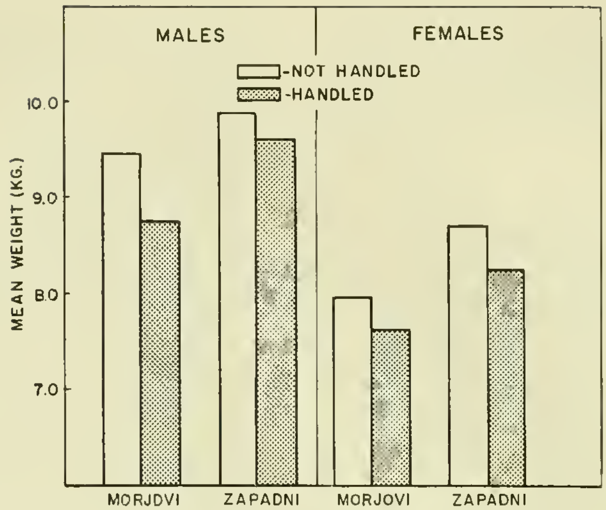

Figure 12.--Mean weights of handled and unhandled pups, by sex and rookery, St. Paul Island, 30 August 1966.

MARKING

Use of permanent marks on fur seals provides data for estimating the size of the population and for studying age and growth, mortality, distribution at sea, homing, and commercial value of the pelts. Application and recovery of marks are discussed in this section.

APPLICATION

Monel cattle-ear tags have been used to mark fur seal pups on the Pribilof Islands since 1941 (table A-14) and, more recently, to mark older seals. Because of evidence that cattle-ear tags cause mortality when attached to pups and because the pups tend to lose this type of tag, other marks are being tested.

Marking in 1966

Pups of both sexes, yearling males, and 2- to 4-year-old males were marked on the Pribilof Islands in 1966.

Pups.--We attached single S-series tags to 10,000 pups on St. Paul Island and 2,499 pups on St. George Island (tables A-15 and A-16). On St. Paul Island, tags were attached to the rear edge of the right front flipper at the hairline, and the tip of the second digit of the right hind flipper was removed as a checkmark (fig. 13). On St. George Island, tags were attached to the left front flipper at the hairline, and the tip of the same flipper was cut off (fig. 13). Seals that lose their tags can be identified as to the year of birth by these checkmarks.

Male yearlings.--We attached double 1S-series tags to 1,495 males selected as yearlings on St. Paul Island in 1966 (table A-17). Of these, 132 had been tagged or marked as pups on the Pribilof Islands and 4 had been tagged on Medny Island, U.S.S.R. The tags used on male yearlings were attached to the rear edge of the front flippers at the hairline (fig. 13).

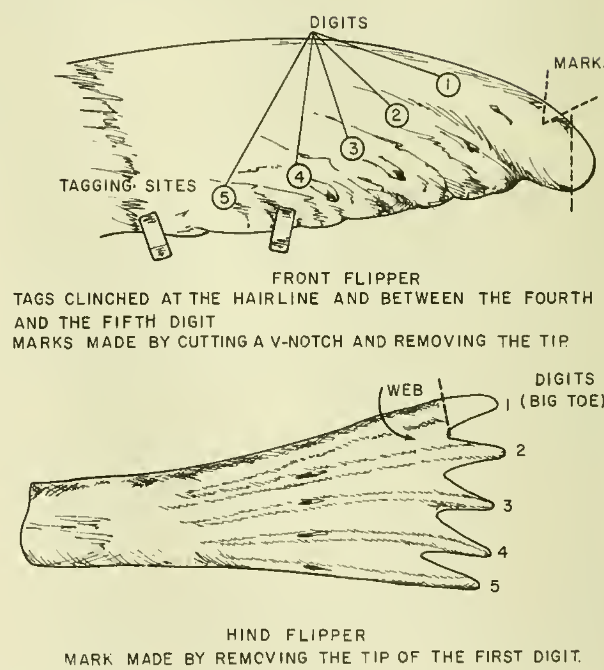

Figure 13.--Examples of mark locations that have been used on fur seals, Pribilof Islands, Alaska.

Nylon hoop nets 35.5-45.7 cm. (14-18 inches) in diameter mounted on 2.4 m. (8 foot) wooden handles were used to capture the seals. In other details, the methods used to select and tag yearlings in 1966 were similar to those described by Roppel, Johnson, and Chapman (1965). The mean body length of males selected as yearlings for tagging was 93.1 cm. (Males less than 100.0 cm. long, tip of nose to tip of tail, are considered yearlings.) Known-age yearlings (tagged as pups) averaged 92.7 cm. These mean body lengths are probably low because many of the struggling seals could not be stretched to full length. The distribution of lengths was similar for known-age seals and for seals selected as yearlings (fig. 14).

Figure 15 illustrates the method of measuring a "yearling" seal before a tag is attached to each front flipper.

Males ages 2 to 4.--Double 2S-series tags were attached to 1,483 male seals selected by approximate body length as 2-, 3-, and 4-year-olds on St. Paul Island in 1966 (table A-18). Of

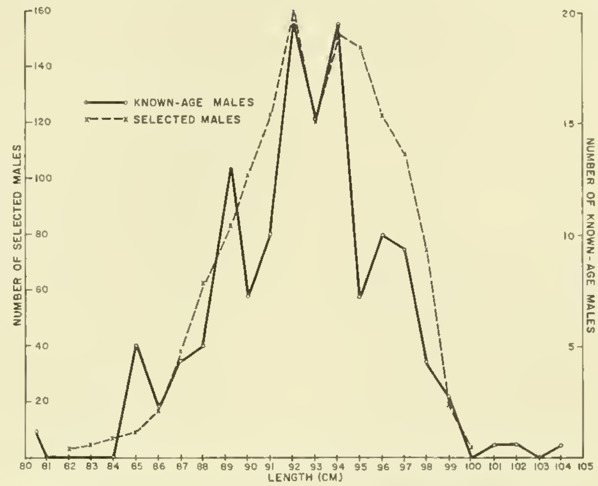

Figure 14.--Body lengths of known-age and selected yearling male seals, St. Paul Island, 1966.

Figure 15.--Measuring a male seal selected as a yearling for tagging, St. Paul Island, 1966.

these, 67 had been previously tagged as pups, 3 had been tagged as yearlings, and 1 had been tagged as a pup and again as a yearling. A tag was attached to the rear edge of each front flipper at the hairline (fig. 13). Ideally, 2-year-old males only would have been tagged. This was not possible, however, because 2- to 4-year-old animals overlap in body length. Age at the time of tagging, therefore, will be determined from subsequent recoveries of tags and canine teeth.

Body lengths of selected males were not actually measured because of the extra time required, a factor that contributed to distress and some deaths from overheating, especially on warm days.

Experimental Marks

Several tags and other kinds of marks have been tried as substitutes for the cattle-ear tag. Tags tested included coded wire, plastic roto, button ear, Monel ear (size 4), and Monel butt-end bird leg band (fig. 16). Cryogenic or freeze branding was also tested. Other marks tried included V-notches cut into the leading edges of front flippers and excisions such as removal of the tips of front flippers and of the tips of various digits on hind flippers. Not all of the tests were extensive, and quantitative data are yet to be collected from those that

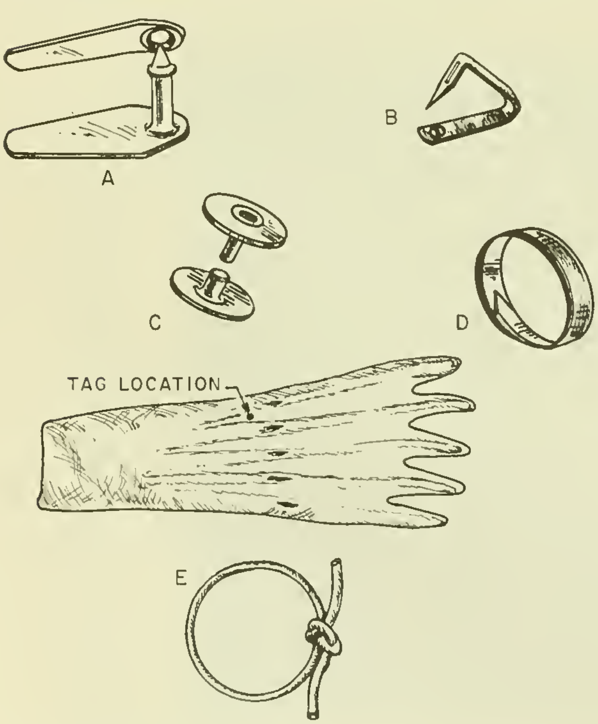

Figure 16.--Experimental tags used on pups, St. Paul Island, 1964-65: plastic roto (A), small cattle ear (B), button ear (C), bird leg band (D), and spaghetti (E).

were. The general effectiveness of each type of mark, however, was examined.

Coded wire.--This tag, which has been used for marking salmon (Jefferts, Bergman, and Fiscus, 1963), was cut from type 302 stainless steel wire of two sizes, 0.058 and 0.10 cm. (0.023 and 0.04 inch). In 1963, five pups were marked by using a hypodermic syringe to implant tags 0.16 by 0.058 cm. (1/16 by 0.023 inch) next to the cartilage in the leading edge of each front flipper, so that the tags were perpendicular to the long axis of the flipper. The syringe had been modified by attaching to the plunger a wire of sufficient length to bring it to the tip of the needle when the plunger was fully depressed. In use, a wire tag was placed in the tip of the needle, the needle was inserted into the flipper, and the tag was implanted into the cartilage by depressing the plunger. Six days after tagging, only 6 of the 10 tags implanted could be found. The tissue did not react to the tag.

Since the syringe as used in 1963 was unsatisfactory, it was further modified in 1964 by attaching a larger diameter wire to the plunger. Correspondingly larger wire tags, 0.32 by 0.10 cm. (1/8 by 0.04 inch), were inserted into the flippers of 100 pups at the same site used in 1963. Guard hair was sheared from the head of each pup to permit later identification. Twenty-three days after tagging, 48 of the 100 pups were found; tags were recovered from 18 by making a small incision at the tagging site (an unsatisfactory method of recovery). The tags did not irritate the tissue. Of the 30 pups from which tags were not recovered, some had obviously lost their tags and others had either lost their tags or the technique of application or recovery was at fault. Though the wire was compatible with seal tissues, development of a tag applicator and detector would require considerable effort and expense. A disadvantage of this type of tag is that it cannot be seen externally.

Plastic roto rag.--This tag is used primarily on domestic animals and is available in at least two sizes. In 1965, 99 large and 100 small roto tags were fastened between the second and third digits of the right hind flipper just above the nails. These tags were easily applied and seen, and caused no tissue reaction. Many tags were lost within a month after tagging but no quantitative data are available.

Button-ear tag.--This is an aluminum tag used primarily on small domestic animals. In 1965, 158 pups were tagged between the second and third digit of the right hind flipper. These tags were easily seen after attachment to the animal but difficult to apply. Some were lost within a month after application, but one found on a male recovered during tagging of yearlings in 1966 was in good condition. This tag will not be practical for use on large numbers of seals until an easier method of application is developed.

Monel ear tag (size 4).--This tag is a smaller version of the Monel tag now used to mark large numbers of pups. In 1965, 195 pups were tagged between the second and third digits of the right hind flipper by making a slit in the web perpendicular to the long axis of the flipper and clinching the tag over the forward edge of the slit. This tag was difficult to apply; the metal was so flexible that many tags did not clinch properly and were later lost.

Monel butt-end leg band.--This tag is normally used for banding birds. In 1965, two territorial males were immobilized and marked with this type of tag. In 1966, 99 size-28 bands, modified by grinding one of the butt ends to a beveled point, were applied around the first digit of the right hind flipper of 2-year-old males that had been previously tagged as pups. Use of an applicator designed for attaching size-24 bands, however, permitted the ends to slip past one another. (Normally, the two ends of this tag butt against each other.) This tag may be suitable for marking older animals but seems too large (and subject to tearing out) to consider for use on pups.

Other marks.--Since 1947, pups have been marked by removing various parts of flippers as well as by tagging, so that those that lose their tags can be identified as to the year of birth. These marks have been designated as "checkmarks" when used with tags. Marking without tagging was first tried in 1965 when a V-notch was cut into the leading edge of the right front flipper of each of 10,007 pups on St. Paul Island (fig. 13). An additional 10,080 pups were marked in that year by removing the tip of the first digit of the right hind flipper at the web (fig. 13). In 1966, the tip of the third digit of the right hind flipper was removed from 9,578 pups on St. Paul Island, and the tip of the second digit of the left hind flipper from 2,503 pups on St. George Island (fig. 13).

The advantages of marking without tagging are several: It is done quickly, and effort can be easily distributed throughout the rookeries. In addition, we believe that mortality from marking is much less than mortality from tagging because the wound made by marking is open and can drain while healing. We know that fastening tags to seals causes some deaths through infection that cannot drain. Marking without tagging, however, does not permit identification of individuals.

RECOVERIES

This section deals with the recovery of tags and other marks from seals taken commercially in 1966 and includes data on the homing of male seals killed in 1954-66.

Recoveries in 1966

Tagged and marked animals taken in 1966 were within the length limits for killing untagged seals, except for a few females taken for research or killed accidentally during the kill of males.

In the commercial kill, 4,620 tagged or marked seals were taken. This number included 4,418 that had been tagged and marked as pups on the Pribilof Islands (table 8). Other marked seals taken (all males) were 172 that had been selected as yearlings and double-tagged on St. Paul Island in previous years (table 9) and 28 tagged on the Commander Islands and 2 tagged on Robben Island by Soviet biologists (table A-19).

Summary of Homing Data

Data on the tendency of fur seals of both sexes and all ages to return (home) to the rookery or vicinity of birth or to stray to other areas have been included in annual reports on fur seals by the Marine Mammal Biological Laboratory since 1955. The data given in this section form a summary of that collected on the Pribilof Islands in past years for males seals in ages 2 to 5 only. Homing and straying were determined from the recapture of seals that were tagged as pups and taken during a season that varied in length within the period 27 June to 20 August.

Most male seals 2 to 5 years old return to hauling grounds on the Pribilof Islands during the summer (mid-June to mid-August and later). The size and accessibility of a hauling

Table 8.--Summary of tagged and lost-tag[1/] seals recovered, by age and sex, Pribilof Islands, Alaska, 6 July to 5 August 1966

Seal sex and tag series	Age	Tagged seals: St. Paul Island	Tagged seals: St. George Island	Tagged seals: Total	Lost-tag seals: St. Paul Island	Lost-tag seals: St. George Island	Lost-tag seals: Total	Grand total
	Years	Number						
Males								
O	2	121	10	131	60	21	81	212
P	3	1,038	244	1,282	491	72	563	1,845
O	4	835	302	1,137	675	141	816	1,953
N	5	94	16	110	202	67	269	379
M	6	-	2	2	-	-	-	2
Total		2,088	574	2,662	1,428	301	1,729	4,391
Females								
Q	2	-	1	1	-	-	-	1
P	3	1	1	2	1	-	1	3
O	4	5	1	6	2	-	2	8
N	5	4	1	5	-	1	1	6
M	6	3	-	3	-	-	-	3
L	7	1	-	1	-	-	-	1
K	8	1	-	1	-	-	-	1
J	9	2	1	3	-	-	-	3
H	11	1	-	1	-	-	-	1
Total		18	5	23	3	1	4	27

1/ Seals that had lost their tags were identified from checkmarks applied at the time of tagging.

Table 9.--Tag recoveries from male seals[1/] that had been selected and tagged as yearlings in previous years, Pribilof Islands, Alaska, 6 July to 5 August 1966

Year tagged and tag series	Age when: Tagged	Age when: Recovered	St. Paul Island	St. George Island	Total
	Years	Years	Number	Number	Number
1962					
N	1	5	11	2	13
N	Unknown[2/]		1	-	1
	Total		12	2	14
1963					
O	1	4	75	17	92
O	2	5	4	1	5
O	Unknown[2/]		5	-	5
	Total		84	18	102
1965					
IR	1	2	33	3	36
IR	2	3	10	2	12
IR	3	4	-	1	1
IR	Unknown[2/]		7	-	7
	Total		50	6	56

1/ No tagged females were killed.
2/ Tags were recovered, but the canine teeth for determining ages were not collected.

ground may be important for determining whether a young male seal homes or strays. Small hauling grounds, for example, may become overcrowded, or access from the sea may become blocked by harem males. In the latter situation, harem males tend to discourage young males from using traditional access ways to inland areas.

Rookery names have been used in the text and tables because the hauling grounds are adjacent to the rookeries. Zapadni Reef and Tolstoi Rookeries on St. Paul Island have some hauling-ground areas in common. A few tags recovered from seals taken from these hauling grounds may, therefore, be incorrectly classified.

We have summarized the data on homing by pooling the tag recoveries from male seals killed from 1958 to 1966 and by considering individual year classes for those killed from 1954 to 1966. The assumptions are that the probability of recovering a tag on either island is constant once a seal has hauled out, and that the pups were on their rookery of birth when tagged.

Homing and straying, 1958-66.--Zapadni, Northeast Point, and Polovina Rookeries on St. Paul Island have the highest rates of homing (table 10). These rookeries also have the largest and most accessible hauling grounds. Homing to Reef, Tolstoi, and Lukanin-Kitovi Rookeries is much lower, even at age 5 (the tendency to return to the rookery or vicinity of birth increases with age). More seals that have strayed from their rookery of birth haul out near Zapadni and Northeast Point Rookeries than near other rookeries. The proximity of the rookery of birth and the rookery of recapture is apparently related, even for those seals that have strayed. For example, seals from Reef and Tolstoi strayed to Zapadni, and those born on Polovina and Lukanin-Kitovi strayed to Northeast Point (see figs. 1 and 2 for location of rookeries and hauling grounds). The degree of straying was highest for the rookeries with the least accessible hauling grounds.

On St. George Island, North and East Rookeries have the highest rate of homing, and the rate for Staraya Artil is particularly low (table 10). Homing of seals to Zapadni on St. George Island was low for ages 2 and 3, but increased to 59 percent at age 4. Some of the samples of 5-year-old males were too small to permit conclusions.

Homing by year class, 1954-66.--For each year class, homing increased with age on both islands. For example, the percentage of seals that homed to Northeast Point Rookery increased from 61 to 91 from age 2 to age 5 years. For seals of a given age, homing to St. Paul Island was more pronounced than to St. George Island (table 11). The data on the return of seals of different year classes to their island of birth were generally consistent. The major exception was the year class of 1961 on St. George Island: the percentage of seals that homed was considerably higher at age 2 than at ages 3, 4, or 5. In general, variability among year classes decreased with increased age.

The results of homing of each year class to the rookery of birth were extremely variable (table A-20). The homing of 3-year-old males to Reef Rookery appears to have been stronger for year classes 1960-64 than for the earlier year classes.

Effects of the Time of Tagging

To determine if time of tagging (and thus the age and size of pups) has an effect on rate of recovery, half of the tags used on St. Paul Island in 1963 (P-series) and 1964 (Q-series) were attached to pups 12-21 August and half were attached 16-25 September. The data from this study will not be complete until 1968, when seals from both year classes have contributed fully to the commercial kill. Some comparisons, however, can now be made.

For the tags attached to pups in 1963, the rate of recovery was significantly higher from the group tagged in late September than from the group tagged in August (table 12). The data from recoveries of tags attached to pups in 1964, however, indicated no such difference in rate of recovery (table 12). The inconsistency may have been caused by the use of different sites for application of the tags (and possibly

Table 10.--Tag recoveries from male seals, by island and rookery of birth, and age, Pribilof Islands, Alaska, 1958-66

Tagged on:	Sample size	Percent recovered, by rookery, on:											
		St. Paul Island							St. George Island				
		ZAP	POL	NEP	REEF	TOL	LK	Total	NOR	EAST	STAR	ZAP	Total
						Age 2							
St. Paul Island													
ZAP	183	51.37	5.46	13.66	2.73	5.46	5.46	84.14	4.37	4.37	1.64	5.46	15.84
POL	145	8.28	48.97	17.93	2.07	4.83	3.45	85.53	3.45	6.21	3.45	1.38	14.49
NEP	274	12.04	5.84	60.95	1.46	2.55	2.19	85.03	6.93	4.01	2.55	1.46	14.95
REEF	237	15.19	7.17	16.03	35.02	5.91	1.69	81.01	6.33	5.06	2.53	5.06	18.98
TOL	113	25.66	4.42	19.47	8.85	27.43	0	85.83	4.42	4.42	1.77	3.54	14.15
LK	69	14.49	4.35	24.64	5.80	5.80	34.78	89.86	1.45	7.25	0	1.45	10.15
Subtotal	1,021												
St. George Island													
NOR	129	8.53	4.65	16.28	2.33	2.33	3.88	38.00	41.86	7.75	6.98	5.43	62.02
EAST	46	10.87	0	15.22	0	8.70	4.35	39.14	13.04	41.30	4.35	2.17	60.86
STAR	32	3.12	3.12	9.38	6.25	3.12	9.38	34.37	12.50	6.25	34.38	12.50	65.63
ZAP	71	9.86	2.82	21.13	4.23	5.63	2.82	46.49	4.23	11.27	12.68	25.35	53.63
Subtotal	278												
Total	1,299												
						Age 3							
St. Paul Island													
ZAP	2,307	59.90	3.60	12.96	2.82	11.49	2.69	93.46	2.12	1.91	0.48	2.04	6.55
POL	1,373	7.72	42.24	31.39	2.69	3.79	2.69	90.52	3.71	3.57	0.66	1.53	9.47
NEP	2,526	8.87	6.29	71.30	2.22	2.61	2.30	93.59	2.73	2.14	0.48	1.07	6.42
REEF	2,239	26.57	4.24	14.52	31.80	10.63	4.02	91.78	3.08	2.68	0.58	1.88	8.22
TOL	1,173	35.04	5.63	15.77	3.67	30.69	2.64	93.44	2.47	1.71	0.77	1.62	6.57
LK	751	13.72	9.32	24.37	4.79	8.79	28.76	89.75	3.73	4.39	0.80	1.33	10.25
Subtotal	10,369												
St. George Island													
NOR	876	9.82	3.42	10.96	2.74	2.85	2.28	32.07	50.34	11.19	1.26	5.14	67.93
EAST	516	7.36	5.62	11.63	3.49	2.52	2.13	32.75	9.30	52.52	2.13	3.29	67.24
STAR	326	7.67	6.13	8.90	4.29	4.29	1.23	32.51	26.99	14.72	22.09	3.68	67.48
ZAP	468	13.89	3.42	11.54	4.70	3.85	2.78	40.18	14.96	10.47	2.14	32.26	59.83
Subtotal	2,186												
Total	12,555												
						Age 4							
St. Paul Island													
ZAP	1,075	59.91	2.88	11.91	1.95	13.95	1.30	91.90	2.33	2.60	0.28	2.88	8.09
POL	625	3.68	49.60	32.48	2.56	2.88	4.00	95.20	1.44	2.56	0	0.80	4.80
NEP	1,080	5.65	4.72	80.09	2.22	2.41	1.02	96.11	1.57	1.67	0	0.65	3.89
REEF	1,046	23.90	3.63	10.33	41.87	11.66	2.87	94.26	2.39	1.91	0.19	1.24	5.73
TOL	520	27.31	4.04	11.35	3.46	46.92	0.96	94.04	2.31	2.12	0	1.54	5.97
LK	340	12.06	15.00	23.53	5.29	7.65	28.24	91.77	2.94	3.82	0.59	0.88	8.23
Subtotal	4,686												
St. George Island													
NOR	436	4.36	2.06	11.70	1.61	1.38	2.06	23.17	59.17	11.24	2.29	4.13	76.83
EAST	254	3.94	2.36	7.48	1.57	2.36	0.39	18.10	9.06	67.32	1.57	3.94	81.89
STAR	160	6.25	3.75	7.50	2.50	1.25	1.88	23.13	28.75	18.75	26.88	2.50	76.88
ZAP	259	8.11	3.09	3.86	1.93	1.54	1.16	19.69	10.42	8.49	2.32	59.07	80.30
Subtotal	1,109												
Total	5,795												
						Age 5							
St. Paul Island													
ZAP	90	70.00	3.33	2.22	1.11	18.89	2.22	97.77	0	2.22	0	0	2.22
POL	54	3.70	72.22	24.07	0	0	0	99.99	0	0	0	0	0
NEP	90	3.33	2.22	91.11	0	1.11	0	97.77	1.11	1.11	0	0	2.22
REEF	93	18.28	5.38	7.53	51.61	8.60	4.30	95.70	2.15	1.08	0	1.08	4.31
TOL	38	10.53	5.26	13.16	0	63.16	2.63	94.74	2.63	2.63	0	0	5.26
LK	33	6.06	15.15	12.12	9.09	3.03	54.55	100.00	0	0	0	0	0
Subtotal	398												
St. George Island													
NOR	27	3.70	3.70	0	0	0	0	7.40	77.78	7.41	0	7.41	92.60
EAST	16	12.50	0	0	0	6.25	0	18.75	12.50	68.75	0	0	81.25
STAR	13	0	0	15.38	0	23.08	0	38.46	15.38	0	38.46	7.69	61.53
ZAP	25	0	0	4.00	4.00	0	0	8.00	4.00	4.00	0	84.00	92.00
Subtotal	81												
Total	479												

Table 11.--Tag recoveries from male seals, by island of birth, age, and year class, Pribilof Islands, Alaska, 1958-66

[Numbers in parentheses are sample sizes]

Year class and island of birth	Recovered by age 2	3	4	5
	- - - - - - Percent	- - - - - -		
1956				
St. Paul	85 (100)	95 (444)	93 (148)	100 (22)
St. George	67 (36)	59 (90)	82 (44)	- (7)
1957				
St. Paul	92 (124)	92 (1, 222)	94 (905)	95 (41)
St. George	40 (20)	62 (256)	74 (203)	93 (15)
1958				
St. Paul	91 (116)	93 (2, 525)	96 (801)	99 (101)
St. George	53 (19)	63 (454)	74 (141)	83 (18)
1959				
St. Paul	81 (106)	92 (1, 162)	93 (643)	97 (65)
St. George	58 (26)	66 (169)	80 (154)	- (14)
1960				
St. Paul	82 (164)	90 (1, 207)	94 (616)	96 (75)
St. George	56 (41)	76 (210)	79 (122)	- (11)
1961				
St. Paul	61 (92)	91 (1, 421)	96 (730)	98 (94)
St. George	93 (42)	70 (431)	80 (151)	88 (16)
1962				
St. Paul	82 (160)	94 (1, 380)	93 (843)	
St. George	72 (53)	68 (302)	82 (294)	
1963				
St. Paul	94 (52)	92 (1, 008)		
St. George	44 (16)	60 (274)		
1964				
St. Paul	94 (107)			
St. George	17 (24)			

Table 12.--Number of tags recovered from two periods of tagging, St. Paul Island

Tag series 1/	Age at recovery	Tags recovered from seals tagged: 12-21 Aug.	16-26 Sept.	Total tags recovered	Chi-square	P
	Years	Number	Number	Number		
P	2	13	34	47	9.38	<0.01
	3	354	568	922	49.68	<0.001
Total		367	602	969	57.00	<0.001
Q	2/ 1	25	15	40	2.50	0.12
	2	49	56	105	0.47	0.5
Total		74	71	145	0.03	0.88

1/ Half of the tags in a series were applied during each of the two periods of tagging.
2/ Tag numbers recorded during tagging of yearlings in 1965.

related differences in loss of tags or mortality) in the early and late groups in 1964. Tags used in August were attached at the hairline, whereas those used in September were attached between the fourth and fifth digits (fig. 13). Both groups of tags used in 1963 were attached to the rear edge of a front flipper at the hairline.

POPULATION ESTIMATES

This section presents estimates of the size of various segments of the population based on the most recent data. Methods used and sources of data have been described by Roppel, Johnson, Bauer, Chapman, and Wilke (1963); Roppel, Johnson, and Chapman (1965); and Roppel, Johnson, Anas, and Chapman (1965 and 1966).

NUMBER OF PUPS BORN

The size of each year class at birth is estimated from recoveries of tagged and marked seals and from marked-to-unmarked ratios obtained in the year of birth by shearing and sampling live pups.

Estimates Based on Tag Recoveries

Estimates of the pup population based on tag recoveries (including seals that lost their tags) from male seals are presented in tables 13, 14, and 15. The estimates based on tag recoveries from 3- and 4-year-old males by 5-day periods were reasonably consistent (table 13). The estimated number of pups born has steadily decreased from 643,000 in 1960 to 440,000 in 1964 (table 15).

The ratio of tagged to lost-tag seals recovered in 1966 was higher on St. Paul Island than on St. George Island. An adjustment in the number of lost-tags recovered on St. George Island, however, was not made because of uncertainty as to whether the difference was real or was caused by incomplete recovery of seals that had lost their tags.

Estimates Based on Shearing and Sampling Live Pups

Fur seal pups have been marked on St. Paul Island each year since 1963 by shearing a patch of fur from the top of the head, and groups of 25 pups have been later sampled to obtain marked-to-unmarked ratios for estimating the number of pups born. The program was extended to St. George Island and Sea Lion Rock in 1966. Tagged-to-untagged ratios for estimating the number of pups born were obtained on St. Paul Island in 1961 and 1962. The sampling stations have been permanently marked on St. Paul Island rookeries by 91.4-cm. (3-foot) steel stakes set 23.1 m. (25 yards) apart in concrete or rock. On St. George Island and Sea Lion Rock we selected stations by pacing or by visually estimating distances during sampling.

A total of 30,942 pups were marked by shearing in 1966. The pup population on St. Paul Island was sampled twice to obtain a

Table 13.--Estimates of the pup population based on tag recoveries from 3- and 4-year-old male seals, by 5-day periods, year classes 1962-63, Pribilof Islands, Alaska

Date	Age 3 (year class 1963) Killed	Tagged	Tag recoveries	Population estimate at time of tagging	Age 4 (year class 1962) Killed	Tagged	Tag recoveries	Population estimate at time of tagging
	Number	Number	Number	Number	Number	Number	Number	Number
July 6-11	4,790	24,971	317	376,229	4,578	49,908	605	377,118
12-16	3,636	-	203	445,212	2,695	-	322	416,578
17-21	5,515	-	305	450,149	2,803	-	347	402,140
22-26	5,437	-	313	432,477	2,343	-	260	448,225
27-31	6,399	-	386	412,974	2,011	-	240	416,668
Aug. 1-5	5,329	-	321	413,356	1,600	-	179	443,913
Total	31,106	-	1,845	420,804	16,030	-	1,953	409,463

Table 14. --Estimates of the pup population based on tag recoveries from male seals killed in 1966 from year classes 1961-64, Pribilof Islands, Alaska

Year class	Age	Killed	Tagged	Tag recoveries	Population estimate at time of tagging
	Years	Number	Number	Number	Number
1961	5	1,770	49,921	379	232,663
1962	4	16,030	49,908	1,953	409,463
1963	3	31,106	24,971	1,845	420,804
1964	2	3,533	24,991	212	414,656

marked-to-unmarked ratio, and the population on St. George Island was sampled once. The first and second estimates for St. Paul Island (excluding Sea Lion Rock) differed by about 30,000 (table 16). An estimated 18 percent of the total pup population on the Pribilof Islands was born on St. George Island.

To determine the accuracy of the estimates, we counted all the pups on three St. Paul Island rookeries. The mean of the two estimates was 5 percent higher than the total counts (table 17). The estimate for the Pribilof Islands (360,000) does not include pups that died before the shearing--probably 15,000 to 20,000. Therefore, the total number of pups born on the Pribilof Islands in 1966, estimated by this method, is about 380,000.

Uncorrected estimates of the number of pups at the time of marking for year classes 1961-66 on St. Paul Island (table 18) were expanded by adding counts of dead pups, then multiplying the number of pups born on St. Paul Island by 1.25 to represent estimates of the total number of pups born on the Pribilof Islands (table 19).

Table 15. --Estimates of the pup population based on tag recoveries from male seals and the count of dead pups, year classes 1960-64, Pribilof Islands, Alaska

Year class	Pups alive at time of tagging	Count of dead pups	Total pups born
	Number	Number	Number
1960	568,000	75,000	643,000
1961	489,000	71,000	560,000
1962	430,000	54,000	484,000
1963	421,000	39,000	460,000
1964	415,000	25,000	440,000

1/ Estimates are based on tag recoveries from males of the year class killed at ages 3 and 4 for year classes 1960, 1961, and 1962; at age 3 for year class 1963; and at age 2 for year class 1964.

Table 16. --Estimates of the pup population based on shearing and sampling, year class of 1966, Pribilof Islands, Alaska

Island and rookery	Pups sheared	First sampling period, 14-16 August: Samples	Pups counted: Sheared	Pups counted: Total	Estimated pup population at time of shearing	Second sampling period, 22-23 August: Samples	Pups counted: Sheared	Pups counted: Total	Estimated pup population at time of shearing	Mean estimate from two periods
	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
St. Paul Island										
Gorbatch	1,830	76	167	1,900	20,820	60	132	1,500	20,795	20,808
Reef	3,163	129	305	3,225	33,445	81	176	2,025	36,392	34,918
Ardiguen	276	11	31	275	2,448	9	20	225	3,105	2,776
Polovina	595	21	57	525	5,480	13	33	325	5,860	5,670
Polovina Cliffs	1,878	55	112	1,375	23,056	52	104	1,300	23,475	23,266
Little Polovina	656	23	47	575	8,026	12	21	300	9,371	8,698
Vostochni	4,376	127	305	3,175	45,553	121	254	3,025	52,116	48,834
Morjovi	1,939	67	177	1,675	18,349	54	131	1,350	19,982	19,166
Tolstoi	2,467	118	314	2,950	23,177	75	150	1,875	30,838	27,008
Lukanin	414	23	36	575	6,612	21	28	525	7,762	7,187
Kitovi	1,245	64	135	1,600	14,756	41	96	1,025	13,293	14,024
Zapadni	2,877	164	377	4,100	31,288	90	150	2,250	43,155	37,222
Little Zapadni	1,627	67	110	1,675	24,775	48	92	1,200	21,222	22,998
Zapadni Reef	610	25	77	625	4,951	11	34	275	4,934	4,942
Sea Lion Rock	1,363	66	125	1,650	17,992	-	-	-	-	17,992
Island total	25,316	1,036	2,375	25,900	280,728	688	1,421	17,200	292,300	295,509
St. George Island										
East Reef	402	10	38	250	2,645					
East Cliff	735	30	54	750	10,208					
North	2,166	70	143	1,750	26,507					
South	843	23	64	575	7,574					
Staraya Artil	721	28	57	700	8,854					
Zapadni	759	26	55	650	8,970					
Island total	5,626	187	411	4,675	64,758					64,758
Total both islands	30,942	1,223	2,786	30,575	345,486					360,267

Table 17.--Counts of pups on three rookeries compared to estimates based on shearing and sampling, year class 1966, St. Paul Island

Rookery	Total count	First sampling		Second sampling		Mean of two estimates	
		Estimated number	Percent of count	Estimated number	Percent of count	Estimated number	Percent of count
Little Polovina	7,071	8,026	114	9,371	133	8,698	123
Morjovi[1/]	17,388	16,980	98	18,915	109	17,948	103
Zapadni Reef	5,729	4,951	86	4,934	86	4,942	86
Total	30,188	29,957	99	33,220	110	31,588	105

1/ Excluding point south of Sea Lion Neck.

Table 18.--Estimates of the pup population at the time of marking based on shearing and sampling, year classes 1961-66, St. Paul Island[1/]

Rookery	1961	1962	1963	1964	1965	1966
	- - - - -	- - - - -	- - -Number	- - -	- - - - -	- - - - -
Reef, Gorbatch, Ardiguen	85,700	73,800	55,600	65,100	51,800	58,500
Polovina, Polovina Cliffs	21,600	23,000	23,800	27,400	23,300	28,900
Little Polovina	7,500	5,900	6,500	8,400	7,000	8,700
Vostochni, Morjovi	47,400	38,800	52,000	59,800	51,900	68,000
Tolstoi	34,800	21,600	23,600	25,400	26,800	27,000
Little Zapadni	18,900	13,200	20,000	17,100	15,300	23,000
Zapadni, Zapadni Reef	38,000	31,600	32,400	39,900	32,500	42,200
Lukanin, Kitovi	22,100	23,900	16,000	19,200	17,100	21,200
Sea Lion Rock	---	---	---	---	---	18,000
Total	276,000	231,800	229,900	262,300	225,700	295,500

1/ Estimates for some rookeries have been combined to permit comparison by years. The estimates do not include pups that died before marking. Pups were marked by tagging in 1961 and 1962 and by shearing in 1963-66.

Table 19.--Estimates of the total pup population based on shearing and sampling and the count of dead pups, year classes 1961-66, Pribilof Islands,[1/] Alaska

	1961	1962	1963	1964	1965	1966
	- - - - -	- - - - -	- - -Number	- - -	- - - - -	- - - - -
Estimate at time of marking for St. Paul Island	276,000	231,800	229,900	262,300	225,700	277,500
Dead pups counted on St. Paul Island	60,800	47,600	34,200	22,700	41,100	22,500
Number of pups born on St. Paul Island	336,800	278,400	264,100	285,000	266,800	300,000
Estimate for Pribilof Islands[2/]	421,000	348,000	330,000	356,000	334,000	377,000

1/ Does not include estimate for Sea Lion Rock (Sivutch Rookery).

2/ The estimate for 1966 includes that taken from table 18 plus a count of 27,400 dead pups. The estimates for 1961-65 were derived by expanding the number of pups born on St. Paul Island by a factor of 1.25.

Pups per Harem Male

On the basis of annual counts of harem males in mid-July and estimates of the pup populations from shearing and sampling, the average number of pups per harem male has been calculated for year classes 1963-66 on St. Paul Island and for year class 1966 on St. George Island. (This ratio was called "average harem" until 1947.) As shown in table 20, the number of pups per harem male on St. Paul Island increased in 1966.

Table 20.--Estimate of the number of pups per harem male,[1/] year classes 1963-66, Pribilof Islands, Alaska

Rookery	Year 1963	1964	1965	1966
	- - - - - - -	-Number-	- - - - - -	
St. Paul Island				
Gorbatch	25.2	30.9	26.3	34.3
Reef	25.2	29.7	27.0	32.3
Ardiguen[2/]	----	28.2	21.8	30.4
Polovina	17.6	21.1	23.1	30.9
Polovina Cliffs	27.5	30.6	28.0	35.2
Little Polovina	23.1	30.5	29.7	39.9
Vostochni	21.8	27.6	24.9	33.7
Morjovi	23.9	25.1	22.0	29.8
Tolstoi	26.4	27.7	30.6	33.0
Lukanin	23.5	23.1	25.6	47.4
Kitovi	19.7	28.7	24.5	33.9
Zapadni	32.9	32.1	27.7	38.9
Little Zapadni	24.4	30.6	27.7	42.4
Zapadni Reef	25.0	30.7	24.5	24.1
Grand average	25.0	28.9	26.4	36.4
St. George Island				
East Reef	----	----	----	18.7
East Cliff	----	----	----	40.5
North	----	----	----	34.8
South	----	----	----	25.9
Staraya Artil	----	----	----	36.3
Zapadni	----	----	----	31.9
Grand average	----	----	----	32.8

1/ Based on annual counts of harem males in mid-July and annual estimates of the pup populations from shearing and sampling.

2/ The estimate of the number of pups born on Ardiguen in 1963 was included with the estimate for Gorbatch in that year.

Although the number of pups per harem male was similar for most rookeries in 1966, the ratios for a few rookeries deviated considerably from the average. These large deviations probably reflect errors in estimates of the number of pups born.

NUMBER OF MALE YEARLINGS

Male seals older than pups but less than 100 cm. long were tagged as probable yearlings on St. Paul Island in 1962, 1963, 1965, and 1966. Because of overlap in body size between seals of adjacent year classes, use of body length as an indicator of age has resulted in the tagging of a few 2- and 3-year-old males. On the basis of recoveries of tags and determination of ages from canine teeth, we estimated this error to be 2.9 percent in 1962 and 5.4 percent in 1963.

On the basis of tag recoveries, the number of male yearlings has been calculated for year classes 1961 and 1962 (table 21). It is encouraging that the estimates (78,000) for the two year classes were similar.

Table 21.--Estimates of the population of yearling male seals based on tag recoveries from male seals selected and tagged as yearlings, year classes 1961-62, Pribilof Islands, Alaska

Year class	Year when killed	Age when killed	Killed	Tags applied[1/]	Tags recovered	Estimates of yearling males
		Years	Number	Number	Number	Number
1961				[2/]603		
	1963	2	2,019		44	27,113
	1964	3	28,827		227	76,369
	1965	4	14,638		81	107,829
	1966	5	1,770		13	82,101
Pooled			47,254		365	78,066
1962				[2/]521		
	1964	2	2,726		42	33,815
	1965	3	22,745		138	85,871
	1966	4	16,030		97	86,099
Pooled			41,501		277	78,056

1/ N-series tags were applied in 1962 to yearling male seals born in 1961, and O-series tags were applied in 1963 to yearling male seals born in 1962.

2/ The total number of tags applied to males selected as yearlings on the basis of body length in 1962 and 1963 were corrected according to ages determined from the canine teeth of tagged animals taken in the kill.

FORECAST OF THE KILL OF MALES IN 1967

In the past 6 years we have used several methods to predict the kill of male seals on the Pribilof Islands. The predictions have been derived from:

Method 1. Forecast of the total return of a year class based on the pup population-return equation developed from the population dynamics model. An estimate of the size of a given pup population was derived first from tag recoveries at age 2, then modified when tag recoveries from seals of the same year class became available from animals killed at age 3.

Method 2. Forecast of the kill from a year class at age 4 based on:

a. an estimate of the number of 3-year-old males that escaped the kill;
b. a regression using the number of males killed at age 3 and the mean date of killing;

c. a regression of the percentage kill of males at age 3 against median and terminal dates of the kill of 3-year-old males.

Method 3. Forecast of the kill from a year class at ages 3 and 4 based on:

a. a dead-pup count regression;
b. an annual mean air temperature;
c. the estimated number of yearlings, based on tag recoveries at age 2.

Method 4. Forecast of the kill from a year class at age 3 based on:

a. the kill of males at age 2 or some index thereof;
b. a regression against the mean weight of untagged pups.

When the total return of a year class is forecast (method 1), it is necessary to determine the proportion of the year class that will escape the kill and be recruited into the stock of breeding males. We have discarded this method because we cannot estimate the escapement of males accurately, and because:

1. We question estimates of the size of the pup population based on tag recoveries, particularly those made for year classes 1953 through 1959.
2. Estimates based on tag recoveries at age 2, which provided the only basis for using this method to forecast the kill of 3-year-old males, are extremely variable.
3. The validity of the population-return equation for recent years is questionable because of probable bias in the population estimates derived from tag recoveries from the 1953 to 1959 year classes.

No problem exists when the forecast yields the total kill at ages 3 and 4, and the kill at age 4 is to be forecasted after the kill at age 3 has been achieved. The kill at age 3 can be estimated as 67 percent of the total kill from the year class at ages 3 and 4 (an average of 67 percent of the males killed on St. Paul Island from year classes 1947-62 were 3-year-olds). Although actual percentages have varied from a low of 49 (1952 year class) to a high of 81 (1953 and 1954 year classes), much of the variation has been caused by changes in the terminal date of the kill, and, to a lesser extent, changes in the maximum body length limit of seals taken. In recent years, both of these factors have been stabilized and the percentage taken at age 3 has been correspondingly more stable.

Method 2a was discarded when we found that estimates of total escapement were too low and when postponement of the start of the season had decreased the reliability of the estimates of the postseason escapement. Estimates of through-the-season escapement of undersized animals has been unsatisfactory for some time.

Method 3a has also been eliminated from current use. A study of methods of forecasting in 1963 (Roppel, Johnson, and Chapman, 1965) showed that data on annual mean temperatures provide forecasts that are as precise as those based on data from the counts of dead pups. Moreover, the counts of dead pups are definitely weak as a forecasting tool because, as the total population declines, the count of dead pups also declines regardless of the condition of the year class.

Method 4a was never satisfactory because there has been almost no relation between the kill at age 2 and the kill from the year class in subsequent years, nor has it been possible to improve on this approach by using some index to measure the lateness of the returns, such as the number taken during the last 5 days of the kill.

To achieve the best forecast of the kill of males, a reasonably accurate estimate of the number of pups alive in autumn of the year of birth is necessary, together with an estimate of mortality at sea from 3 months to 3 years of age. A recently developed method of estimating the pup population from shearing and sampling for marked-to-unmarked ratios provides reasonably accurate estimates of the pup population. Since the causes of loss at sea remain unknown, estimates of ocean mortality are difficult to obtain.

Assuming that the variables of annual mean air temperatures and mean weight of pups in autumn are related to causes of ocean mortality or to viability of young seals, we believe regressions based on data from these variables are indirect measures of ocean mortality.

If, however, most of the variation in mortality of pups at sea occurs during the first year of life, and if the total number of yearlings can be satisfactorily estimated from the tagging of yearlings and subsequent tag recoveries at age 2, then a satisfactory forecast can be obtained sufficiently in advance of the kill at age 3 to be useful. We have not yet accumulated sufficient experience with these estimates to rely on them alone. Thus, several methods are now producing several estimates. The final estimate is a weighted average of different estimates with the weights being those suggested by statistical theory, i.e., inversely proportional to the variances of the estimates.

FORECAST OF THE KILL OF 4-YEAR-OLD MALES ON ST. PAUL ISLAND

Three methods currently used to forecast the kill of 4-year-old males are: (1) Regression of the kill of 4-year-old male seals on the kill of 3-year-old male seals and the mean round of the kill of 3-year-old males seals; (2) regression of returns at ages 3 and 4 on mean air temperature; and (3) regression of returns at ages 3 and 4 on estimated number of yearlings.

Regression of the Kill of 4-year-old Male Seals on the Kill of 3-year-old Male Seals and the Mean Round of the Kill of 3-year-old Male Seals

A regression was originally substituted for the estimate of the kill of 4-year-old males based on the estimated escapement of 3-year-olds. One problem with this regression has been variations in the terminal date of the kill of 3-year-old males; many of the data had to be "adjusted" accordingly. In the past, this regression has been based on the kill to 31 July, the approximate terminal date in the early 1950's. In 1965, however, the mean round[2] of the kill of 3-year-old male seals fell outside the range observed in past years. Associated with this deviation was a forecast that seemed unreasonable (the actual kill has since proved that the forecasted kill of 25,000 4-year-old males was much too high). For use in forecasting the kill of 4-year-old males in 1967, we have modified the method by using only the data for the 1953 and later year classes and for the kill through 5 August each year. This change has minimized the need for adjusting the data; in only 2 years since 1956 has the kill of males ended before 5 August. Additionally, to make the mean round calculations consistent throughout the series, all kills before the round of 7-11 July have been pooled with the kill for this round. Thus, the data for all years have been made closely comparable. The data for this regression are shown in table 22.

The resulting regression is:

$$\hat{Y} = -49{,}420 + 0.38X_1 + 14{,}540X_2 \qquad (1)$$

For the 1963 year class: $X_1 = 25{,}500$ $X_2 = 3.7$ and hence $\hat{Y} = 14{,}100$.

The standard error of the forecast, $\hat{Y}$, is 1,800.

The coefficient of multiple correlation of Y with X_1, X_2 is 0.96 ($R^2 = 0.92$), indicative of a very strong relation.

Because of this very high correlation, there can be no practical gain in making additional regressions based on similar data; however, we explored the possibility of replacing the mean round with the median date of the kill of 3-year-old males. The median date is also unaffected by variations in the beginning date of the kill, if we can safely assume that seals arriving before this date are taken early in the season. If the median date rather than the mean round for X_2 is used, then $R = 0.93$ ($R^2 = 0.86$).

[2] Mean round = mean of rounds weighted by number taken by round. See glossary.

Table 22.--Data for regression of the kill of 4-year-old male seals on the kill of 3-year-old male seals and mean round of the kill of 3-year-old male seals, year classes 1953-62, St. Paul Island

Year class	Kill of 3-year-old males before 5 August (X_1)	Mean round of the kill of 3-year-old males 1/ (X_2)	Adjusted kill of 4-year-old males before 5 August 2/ (Y)
	Number		Number
1953	31,700	3.5	13,500
1954	3/ 19,800	3.4	8,700
1955	31,200	3.2	8,100
1956	4/ 11,700	3.3	1,900
1957	21,600	4.0	16,200
1958	38,900	3.8	21,000
1959	25,100	3.6	14,900
1960	14,000	3.7	10,800
1961	22,200	3.8	11,300
1962	15,200	4.0	15,100

1/ The mean round of the kill of 3-year-old males through 5 August; kills before 7 July were pooled into the round of 7-11 July and this period was considered as round 1.

2/ The kill of 4-year-old males before 5 August adjusted according to termination of the kill of 3-year-old males the previous year. If killing ended after 5 August, this figure was increased by 80 percent of the number of 3-year-old males taken after 5 August. If killing ended 5 August, this figure was decreased by 80 percent of the estimated number of 3-year-old males that could have been taken from the actual termination date through 5 August.

3/ The killing of males in 1958 ended 31 July; an estimated 4,000 3-year-old males could have been taken 1-5 August.

4/ The killing of males in 1959 ended 31 July; an estimated 1,500 3-year-old males could have been taken 1-5 August.

We also tried to forecast the kill of 4-year-old males in 1966 by using the regression of percentage of kill taken at age 3 on date of termination and the mean date of the kill of 3-year-olds. For the 1966 data, the value of R (the multiple coefficient of correlation) was 0.64. An additional year of data did not change this value. The regression follows:

$$p_3 = 60.3 - 2.37m + 2.01t$$

where p_3 = percentage of the kill of 3- and 4-year-old males from a year class taken at age 3
m = median date in days after 20 July
t = termination date (in days after 31 July)

The regression used to forecast the kill of 4-year-old males in 1966 was similar:

$$p_3 = 62.4 - 2.21m + 1.95t \qquad (2)$$

The current regression yields a value of 66.1 for p_3 for the 1963 year class, and a forecast of a kill of 9,700 4-year-old males in 1967. Though difficult to determine exactly, the standard error of this forecast is about 5,000. Since the forecast based on regression (1) has a much smaller standard error, and since the underlying data used are essentially similar, it seems inappropriate to use relation (2) and the prediction derived from it.

Regression of Returns at Ages 3 and 4 on Mean Air Temperature

The data for a regression of returns at ages 3 and 4 on mean temperature (table 23) include as a predictive variable the annual mean air temperature at St. Paul Island for the 12-month period ending 30 June of the year of birth of the year class in question.

The resulting regression equation is:

$$K = 15{,}800 + 10{,}500T \quad (r = 0.80)$$

For the 1963 year class T = 2.8 and hence $\hat{K}$ = 45,500.

The kill of 3-year-olds in 1966 was 25,500, so this estimate implies a balance of 20,000 4-year-olds. The standard error of the predicted K is 9,700, which was also the standard error of the forecast of the kill of 4-year-old males in 1966 by this method.

Regression of Returns at Ages 3 and 4 on Estimated Number of Yearlings

Since seals of the 1963 year class were not tagged as yearlings in 1964, a forecast based on tag recoveries from yearlings cannot be made.

Table 23.--The kill of 3- and 4-year-old male seals and mean air temperature, year classes 1950-62, St. Paul Island

Year class	Temperature (in degrees above 32°) (T)	Kill at ages 3 and 4 (K)
	°F	Number
1950	3.5	56,000
1951	3.6	50,000
1952	3.7	62,000
1953	1.6	47,000
1954	1.0	29,000
1955	1.7	38,000
1956	0.1	13,000
1957	2.3	40,000
1958	3.4	63,000
1959	3.3	41,000
1960	2.6	25,000
1961	1.8	35,000
1962	2.1	31,000

Combined Estimates

The two most satisfactory estimates and their S.E. (standard errors) are:

1. From regression on kill of 3-year-olds and the mean round:

   Estimate 14,000 S.E. 1,800

Since the terminal date of killing in 1966 was 5 August, no adjustment is required in the $\hat{K}$ obtained from the regression equation.

2. From regression on mean air temperature:

   Estimate 20,000 S.E. 9,700

The combined estimate is 14,300; since the weighting was inversely proportional to the square of the standard error, almost all the weight was attached to the apparently very reliable first estimate.

FORECAST OF KILL OF 3-YEAR-OLD MALES ON ST. PAUL ISLAND

This section describes three methods currently used to forecast the kill of 3-year-old males. They are: (1) Regression of mean air temperature on return; (2) regression of the kill of 3-year-old male seals on weight of pups; and (3) regression of the percentage of year class taken in the harvest on the dead-pup count percentage. Estimates of the number of yearling males and their potential use in predicting the size of the kill at age 3 are also discussed.

Regression of Mean Air Temperature on Return

As shown in an earlier section, the regression of the kill (K) at ages 3 and 4 on the annual mean temperature (T) of the year class for the 12-month period prior to 30 June is:

$$\hat{K} = 15{,}800 + 10{,}600T$$

This equation is based on data for 13 year classes. For the 1964 year class that will contribute 3-year-olds in 1967, T was 1.5 (the mean temperature was 33.45°) which implies that $\hat{K}$ = 31,700. The standard error is 9,700. If 67 percent of this estimated total is taken at age 3, then the forecasted kill at age 3 in 1967 is 21,200.

Regression of the Kill of 3-year-old Male Seals on Weight of Pups

The data for the regression of the kill at age 3 on St. Paul Island on the weight of untagged pups in autumn are shown in table 24.

Table 24.--Data on the mean weight of untagged pups and the kill of male seals at ages 3 and 4 from the same year class, year classes 1957-63, St. Paul Island

Year class	Mean weight (W)	Kill of male seals at ages 3 and 4 (K)
	Kg.	Number
1957	8.7	40,000
1958	11.4	63,000
1959	9.4	41,000
1960	9.8	25,000
1961	8.5	35,000
1962	9.2	31,000
1963	8.9	[1]40,000

1/ Estimated by using the kill of 25,535 3-year-olds in 1966 plus the forecast given earlier in this section of 14,300 4-year-olds that will be taken in 1967.

The regression equation is:

$$K = 8{,}070W - 36{,}650 \quad (r^2 = 0.44 \quad r = 0.66)$$

where W = mean weight of untagged pups in kg.

K = kill on St. Paul Island at ages 3 and 4 from the same year class (in thousands).

As pointed out previously, the regression is greatly affected by a single point--that of the 1958 year class. Adjustment must also be made for the shortness of this series as compared to most regressions used in these predictions.

For the 1964 year class W = 9.1, and hence $\hat{K}$ = 36,800. This regression implies a kill of 3-year-old males in 1967 of 24,700, as derived from (36,800)(0.67). The standard error of K is 10,600.

Regression of the Percentage of Year Class Taken in the Harvest on the Dead-Pup Count Percentage

This is a new method of prediction--one that uses the counts of dead pups and estimates of the size of the pup population in autumn.

The number of pups that die during their first summer is related to the eventual harvest of the year class because the greater the proportions dying immediately, the fewer can survive to ages 3 and 4. Furthermore, if the percentage of dead pups is a reflection of the condition of the year class, this percentage may indirectly measure the ocean mortality that occurs during the first winter at sea and perhaps also in later years. More specifically, it is reasonable to assume as a first approximation that:

$$\frac{K}{N_o - D} = a + b\frac{D}{N_o} \qquad (3)$$

where K = the kill from a year class

D = the count of dead pups, i.e., the number of pups that die during their first summer, and

N_o = the estimate of the number of pups born.

To obtain a usable series of data, some assumptions must be made concerning the number of seals born from 1950 through 1960. The accumulative estimates developed by Chapman (1964) seem to agree closely with the fall sampling estimates shown in recent reports provided λ is between 1.0 and 1.25 (λ represents the differential ratio of survival of females to males from birth to 3 years of age).

Estimates of the number of pups born have been derived from Chapman (1964, table 8) by interpolating for $\lambda = 1.1$, with some modifications. This computation yields the number of mature (age 3 and older) females which, when multiplied by 0.6 (pregnancy rate of mature females), provides an estimate of the number of pups born. Since the first seven estimates, 1950 through 1956, differed only slightly--much less than expected from the unaccounted for fluctuations in pregnancy rate and natural mortality--it seemed preferable to replace these estimates by a 7-year average of 450,000 (table 25).

Table 25.--Estimated number of pups born, count of dead pups, and number of male seals killed at ages 2 to 5, year classes 1950-62, St. Paul Island

Year class	Estimated pups born	Count of dead pups	X[1]	Kill from year class at ages 2 to 5	Y[2]
	Number	Number		Number	
1950...	450,000	56,000	12.4	57,000	14.5
1951...	450,000	74,000	16.4	55,000	14.6
1952...	450,000	[3]45,000	10.0	65,000	15.7
1953...	450,000	82,000	18.2	48,000	13.0
1954...	450,000	101,000	22.4	32,000	9.2
1955...	450,000	79,000	17.6	40,000	10.8
1956...	450,000	104,000	23.1	15,000	4.3
1957...	420,000	65,000	15.5	43,000	12.1
1958...	387,000	33,000	8.5	66,000	19.2
1959...	341,000	42,000	12.3	45,000	15.1
1960...	320,000	66,000	20.6	28,000	11.0
1961...	329,000	61,000	18.5	37,000	13.8
1962...	317,000	48,000	15.1	34,000	12.6

[1] $\hat{X} = \frac{\text{Count of dead pups} \times 100}{\text{Number of pups born}}$

[2] $\hat{Y} = \frac{100\ (\text{kill at ages 2 to 5})}{\text{Number of pups born} - \text{count of dead pups}}$

[3] Estimated as in Chapman (1964).

The kill figures given in table 25 are those for males from each year class at ages 2 to 5. The number of seals taken varies with the survival success of the year class, with the availability of seals on the hauling grounds, and with whether the harvest is concentrated on the larger (older) or smaller (younger) animals.

The regression equation derived from these data is:

$$Y = 24{,}000 - 690X \quad (r^2 = 0.765 \quad r = 0.875)$$

where Y = percentage in harvest of the number of pups alive in autumn, i.e., $100K/N_0 - D$ referring to equation (3)

X = percentage that the dead pups represent of the original number of pups, i.e., $100 \frac{D}{N_0}$ referring to equation (3).

Before this equation is applied to the forecasting problem, it is useful to review the estimates of the number of pups born (table 26).

The estimate for 1961 agrees closely with the accumulative estimate given in table 25, but the estimate for 1962 does not. Both estimates, however, were based on shearing and sampling, a method still in a developmental stage at that time.

Application of the regression procedure to estimates of the 1963 year class (N_0 = 264,000, D = 34,000) yields an estimated kill of 34,700 from the year class. This estimate seems especially low because the kill from this year class has already totaled 26,784. Sampling errors may be associated with the regression, or the estimate of the pup population in 1963 may have been lower than the number actually born.

Application of the procedure to estimates of the size of the 1964 year class (N_0 = 285,000, D = 23,000 so X = 11.3) yields a forecast of the total kill of 48,200 from this year class. If 3,000 of this number are 2- and 5-year-olds and 67 percent of the rest are 3-year-olds, we suggest a kill of 30,300 3-year-old males in 1967. The standard error of the estimated total kill is 5,500.

Table 26.--Estimates of the total number of pups born, based on shearing and sampling and on the counts of dead pups, year classes 1961-65, St. Paul Island

Year class	Estimate of pups born	Count of dead pups	Total pups born
	Number	Number	Number
1961...	276,000	61,000	337,000
1962...	232,000	48,000	280,000
1963...	230,000	34,000	264,000
1964...	262,000	23,000	285,000
1965...	226,000	41,000	267,000

Combined Estimates

The estimates together with their standard errors are:

1. From mean temperature regression
   21,200 S.E. 9,700

2. From pup weight regression
   24,700 S.E. 10,600

3. From dead-pup count regression
   30,300 S.E. 5,500

The weighted mean estimate is 27,500.

The standard errors used here are those of the total kill of 3- and 4-year-olds, but since all forecasts are derived from the total kill at these ages by multiplying by the factor 0.67, the reciprocals of the standard errors sequence are the correct weights. The mean estimate has a larger standard error, however, because of the variability associated with the proportions taken at age 3 and at age 4 (i.e., the unreliability of the factor 0.67 used to convert an estimated total to a forecast of the kill of 3-year-old males).

FORECAST OF THE TOTAL KILL ON THE PRIBILOF ISLANDS

In 1966, the kill on St. Paul Island was 80.2 percent of the total, in almost perfect agreement with long-term trends. This percentage has fluctuated in 1961-65 from a low of 75.2 to a high of 82.7 percent. The 6-year average is 79.6 percent. Hence, the extrapolation to the total for both islands by multiplying the kill on St. Paul Island by about 1.25 is justified, and is now the most reasonable basis for extrapolation available.

The forecast of the kill of male seals on the Pribilof Islands for 1967 is given in table 27. The total forecast for 1967 is very close to that for 1966, the most accurate yet obtained (table 28).

Table 27.--Forecast of the kill of male seals in 1967, by age, Pribilof Islands, Alaska

Island	Age 2+5	Age 3	Age 4	Total
	Number	Number	Number	Number
St. Paul	3,000	27,500	14,300	44,800
St. George	1,000	6,800	3,600	11,400
Total	4,000	34,300	17,900	56,200

Table 28.--Forecasted and actual kill of male seals, Pribilof Islands, Alaska, 1966

Island	Ages	Forecasted kill	Actual kill
	Years	Number	Number
St. Paul	2+5	3,000	4,410
	3	26,000	25,520
	4	14,000	12,149
Total		43,000	42,079
St. George	2+5	1,000	893
	3	7,000	5,586
	4	3,000	3,881
Total		11,000	10,360
Total both islands		54,000	52,439

Table 29.--Estimated numbers of yearling male seals, year classes 1961, 1962, and 1964, Pribilof Islands, Alaska

Year class	Estimate based on recoveries at age 2	Estimate based on recoveries through age 4
	Number	Number
1961	27,200	78,000
1962	34,500	78,000
1964	70,800	---

Yearling Estimate

Except in 1964, we have selected and tagged yearling seals on St. Paul Island each year since 1961 (see section on marking) to provide a basis for estimating the size of the year class in the autumn of birth and again at age 1. The estimated numbers of yearling males for year classes 1961, 1962, and 1964 are listed in table 29. Though information from this source on the size of the pup population in autumn is not now used to predict the size of the kill at age 3, we discuss it here because of its potential use for this purpose.

Estimates of the number of yearlings are based on tag recoveries from both islands. The 1961 and 1963 year classes, apparently almost identical in size at age 1, produced through age 4 harvest of 45,484 and 41,501 animals, respectively. Because the relative standard deviation of the difference between these two estimates was about 8 percent, the difference between the kills from the two year classes to date can be reasonably attributed to sampling errors. The difference may also reflect variability in survival after age 1, however, as well as differences in ultimate escapement.

The meaning of the difference between harvests from the 1961 and 1962 year classes is much less important than the interpretation of the currently available estimate of the number of yearlings alive in 1965 (from the 1964 year class). A simple comparison of this estimate with completed estimates of the number of yearlings alive in 1962 and 1963 (year classes 1961 and 1962) suggests that the kill on St. Paul Island at ages 3 and 4 from the 1964 year class should be $\frac{70.8}{78} \times 33{,}000$ or 30,000. Here, 33,000 is the average of the kill on St. Paul Island at ages 3 and 4 from the 1961 and 1962 year classes. If, however, we assume a constant bias in the estimates of yearlings based on tag recoveries at age 2, then the yield from the 1964 year class could be estimated as:

(Yield of the 1962 year class at ages 3 and 4 times the estimate of the number of yearlings from the 1964 year class from tag recoveries at age 2) $\div$ (Estimate of the number of yearlings from the 1962 year class from tag recoveries at age 2)

$$= (31{,}158)\,\frac{70.8}{34.5} = 63{,}941 \text{ or } 64{,}000$$

Estimates of the number of yearlings based on recoveries at age 2 may be biased if some of the yearlings did not return to the islands at age 1 and if some of the same group hauled out on the islands as 2-year-olds after the killing season. Whether the proportion of the group that remains at sea or arrives late is constant from year to year is a matter of conjecture at this time.

Because of the great discrepancy between the two estimates--one extremely high and the other low--we prefer not to use this approach to predict the size of the kill at age 3 until some of the questions can be answered.

This section includes short-term and other studies of various aspects of fur seal biology that are carried on in addition to the continuing studies described in the main body of this report.

AGE COMPOSITION, MEASUREMENTS, AND MORTALITY OF TERRITORIAL MALE FUR SEALS

Biologists and managers working with fur seals have frequently discussed the number of male seals that must be spared in the kill to maintain the breeding population. The following report on a study of 250 territorial males killed in 1965 gives evidence of the current age composition, annual mortality, and rate of replacement of these territorial males (Johnson, 1968).

Territorial males used for this study were collected from two areas on each of two rookeries on St. Paul Island; the testes of all (250) were collected for studies of reproduction, and the bacula from 250 and canine teeth from 249 of the males were saved for studies of age and growth.

Age Composition of Territorial Males

The age composition of territorial males collected from the four areas and that of 157 males found dead on St. Paul Island were similar (table 30). The high value ($0.3<P<0.5$) of P in a Chi square test indicated that the samples could have come from the same population. The territorial males were 7 to 17 years old and 71 percent were 10 to 13 years old; the dominant age was 10 years.

Estimate of Annual Mortality of Territorial Males

The rate of replacement (a) was estimated by using the equation of Chapman-Robson (1960):

$$\hat{a} = 1-x/(1+\bar{x}-1/n)$$

where n = number of animals in the sample
$\bar{x}$ = mean age; ages coded beginning with age of full recruitment as zero

If age 10, the most frequently assigned age among the samples, is considered as the age of full recruitment, the estimated annual replacement based on all males 10 years old and older is 0.38.

An additional estimate was calculated by regressing the natural logarithm of the number in each age on age. This method, which required neither constant recruitment nor constant survival, produced an estimate of replacement of 0.37.

The annual estimated replacement of territorial males (0.38) agrees with an estimate

Table 30.--Age composition of territorial male seals killed for study and mature male seals found dead, St. Paul Island, 1965

Age	NEP[1/] Rookery			SLR[2/] Rookery			Total both rookeries	Replacement males on area 3[3/]	Males found dead	Grand total
	Area 1	Area 2	Total	Area 3	Area 4	Total				
	Number									
5	-	-	-	-	-	-	-	-	1	1
7	1	-	1	-	-	-	1	1	5	7
8	2	1	3	2	2	4	7	7	17	31
9	2	7	9	4	6	10	19	5	24	48
10	11	17	28	8	13	21	49	15	37	101
11	13	6	19	14	14	28	47	11	29	87
12	6	3	9	5	7	12	21	0	15	36
13	5	11	16	9	6	15	31	2	20	53
14	4	3	7	5	1	6	13	5	5	23
15	3	1	4	2	0	2	6	2	4	12
16	-	3	3	1	1	2	5	1	0	6
17	-	-	-	-	-	-	-	1	-	1
Total	47	52	99	50	50	100	199	50	157	406

1/ Northeast Point.
2/ Sea Lion Rock.
3/ Males that occupied areas where the original territorial males were killed.

Table 31.--Rate at which territories were re-established in areas where territorial male seals were killed, St. Paul, 1965

Days after killing original territorial males	Original territories 1/	Territories re-established	
Number	Number	Number	Percent
0	100	33	33
1	127	74	58
2	100	72	72
3	75	55	73
4	150	129	86
5	112	89	80
6	100	95	95
8	36	32	89
10	102	103	100
12	36	35	97
19	52	56	100

1/ All areas were not observed every day.

of annual mortality of 0.36 calculated by Chapman (1964) from the age composition of males 7 years old and older in pelagic research collections. Peterson[3] concluded from observations of 18 tagged and marked territorial males that annual mortality was 0.33. Because the estimates are similar and because there is not a good basis for making a correction, we conclude that the estimate of 0.38 calculated from the data presented here represents annual mortality.

Replacement of Territorial Males

One hundred territorial males were killed 18-25 June on two areas of Northeast Point Rookery and removed. The territories of these males were quickly reoccupied (table 31); within 24 hours more than 50 percent of the original number of territorial males had been replaced. Occasionally, a male tried to occupy a territory within 2 or 3 minutes after the original holder had been killed and before the data had been collected from the dead animal. Thirty-five of fifty-two males killed on Northeast Point Rookery were removed between 9 a.m. and noon. By noon, 13 males had moved into this area. This number had increased to 17 by 4 p.m. and to 26 by 8 p.m.

[3] Richard S. Peterson. 1965. Behavior of the northern fur seal. The Johns Hopkins Univ., Baltimore, Md., D.Sc. thesis, 12 + 214 pp.

The areas appeared completely reoccupied by about the 6th day after the original territorial males were killed. Beginning at the edge of the water, replacement males established territories progressively farther inland. Although most of the replacement males apparently came from the water, their real origin could not be determined.

The age compositions were similar for 50 territorial males killed 5-8 July on Sea Lion Rock, and their 50 replacements taken 15 July (table 30).

The high mortality of adult males and the short time that elapsed before territories were reoccupied indicate that the rate of utilization of males can be increased without adversely affecting reproduction.

Measurements of Territorial Males

Body length and the weights of the baculum, body, and paired testes were taken from the territorial males killed in 1965, though all four measurements were not recorded for each. Weights of the testes and bacula were taken for nearly all of the males, whereas body length and weight were recorded only for those killed in June (table 32). The means for body length and weight are probably slightly less than they would have been if the animals had not lost blood before they were weighed and if it had been possible to place the animals on a flat surface before length was measured.

The testes of territorial males taken 5-10 July were significantly heavier ($P<0.001$) than those from males collected 18-23 June--126.4 g. compared to 113.2 g. Fifty males occupying the territories of males killed 5-8 July were taken on 15 July. Their testes, which averaged 122.6 g., were significantly heavier ($P<0.05$) than the testes of males taken in late June, though they were not significantly different from those of territorial males killed in July. The greater weight of the testes in early July probably reflects an increase in breeding activity.

Body length and weights of the baculum, testes, and body showed no relation to age (figs. 17, 18, 19, and 20), nor was there a relation between weights of the baculum and testes (fig. 21). There was, however, a slight indication of a positive correlation between body length and baculum weight (fig. 22).

Table 32.--Means and ranges of measurements of territorial male seals, St. Paul Island, 1965

Measurement	Mean	Range	Number
Body length...........	197.1 cm.	168-214	86
Body weight............	190.8 kg.	138.9-237.4	99
Testes weight (pair)...	[1] 120.3 g.	64-199	248
Baculum weight.........	9.4 g.	5.7-16.1	250

[1] The weights of testes taken in July were significantly heavier than those in June, 125.1 compared to 113.2 (see text).

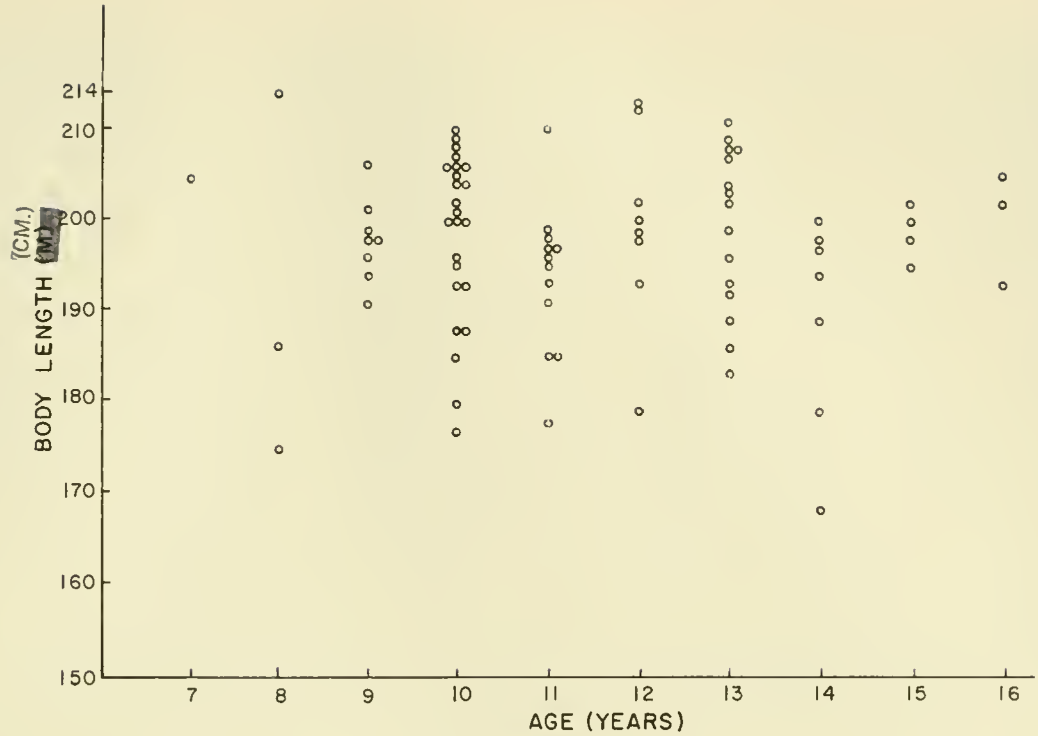

Figure 17.--Age and body length of 85 territorial male seals, St. Paul Island, 18-23 June 1965.

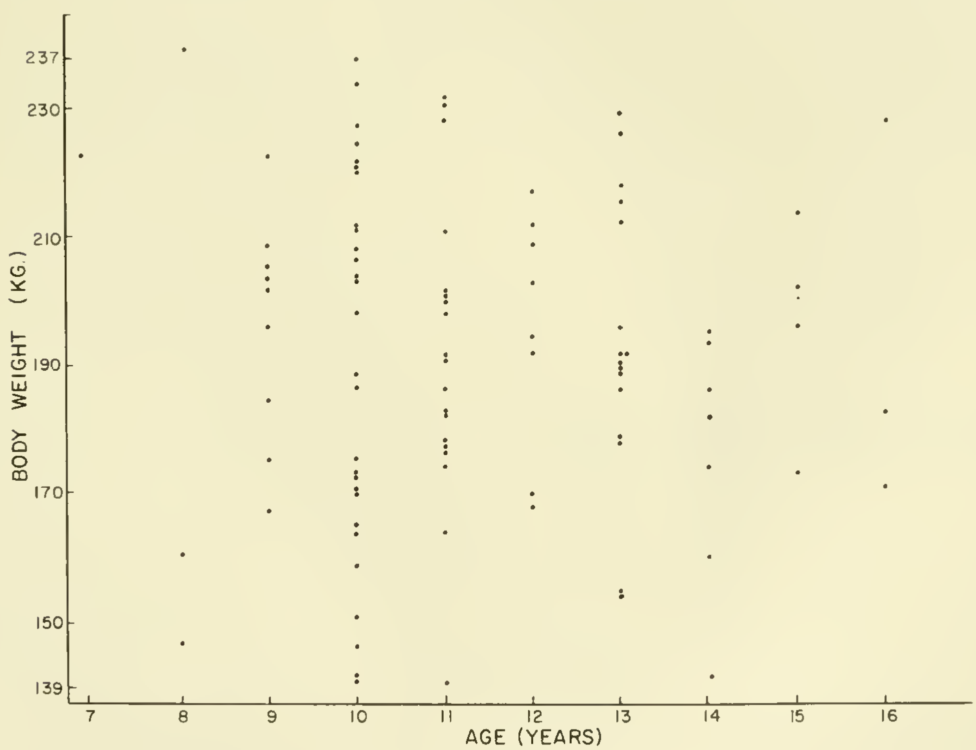

Figure 18.--Age and body weight of 98 territorial male seals, St. Paul Island, 18-23 June 1965.

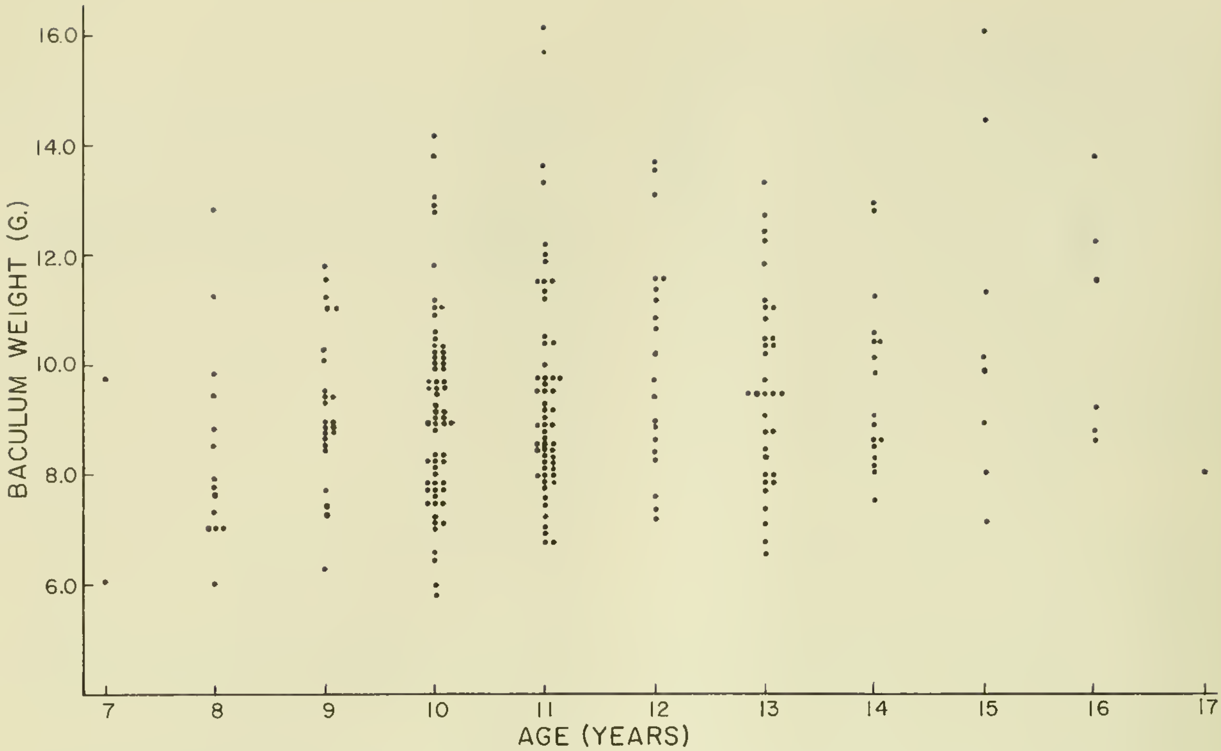

Figure 19.--Age and baculum weight of 248 male seals, St. Paul Island, 18 June to 15 July 1965.

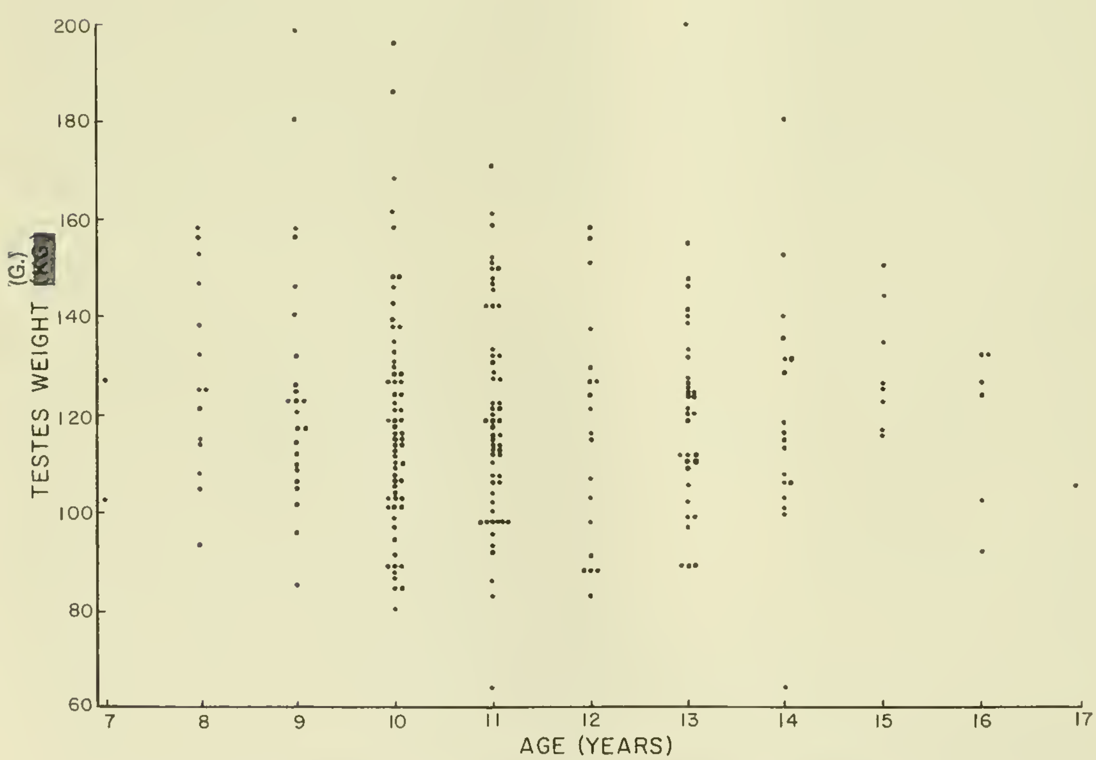

Figure 20.--Age, and weight of paired testes of 248 male seals, St. Paul Island, 18 June to 15 July 1965.

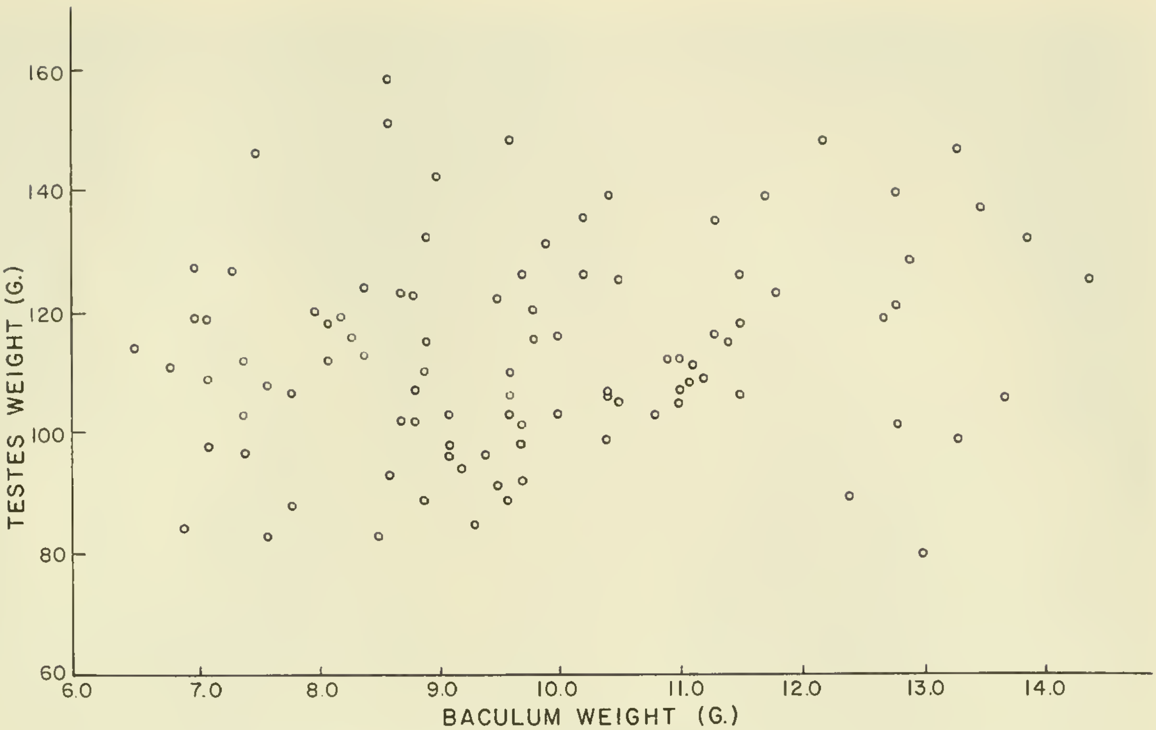

Figure 21.--Weights of baculum and testes of 97 male seals, St. Paul Island, 18-23 June 1965.

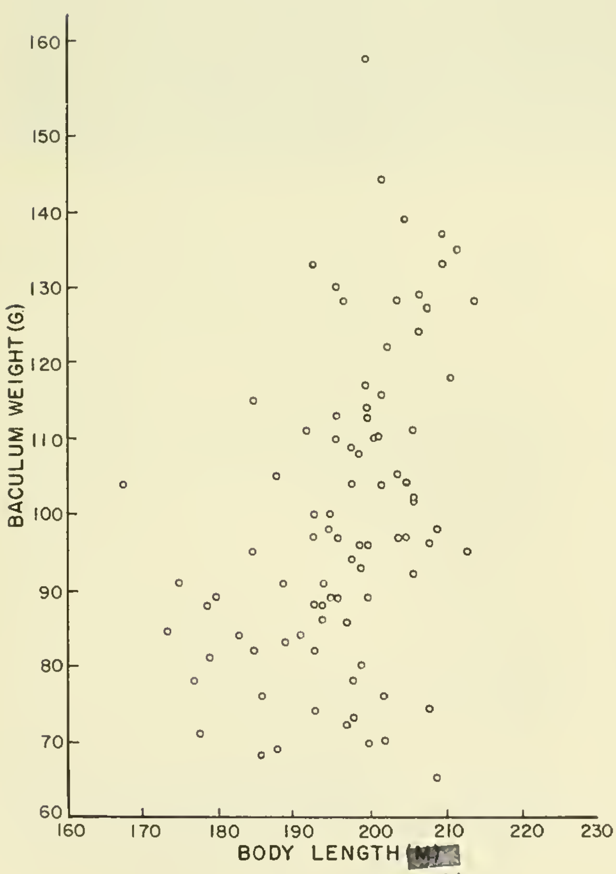

Figure 22.--Body length and baculum weight of 85 territorial male seals, St. Paul Island, 18-23 June 1965.

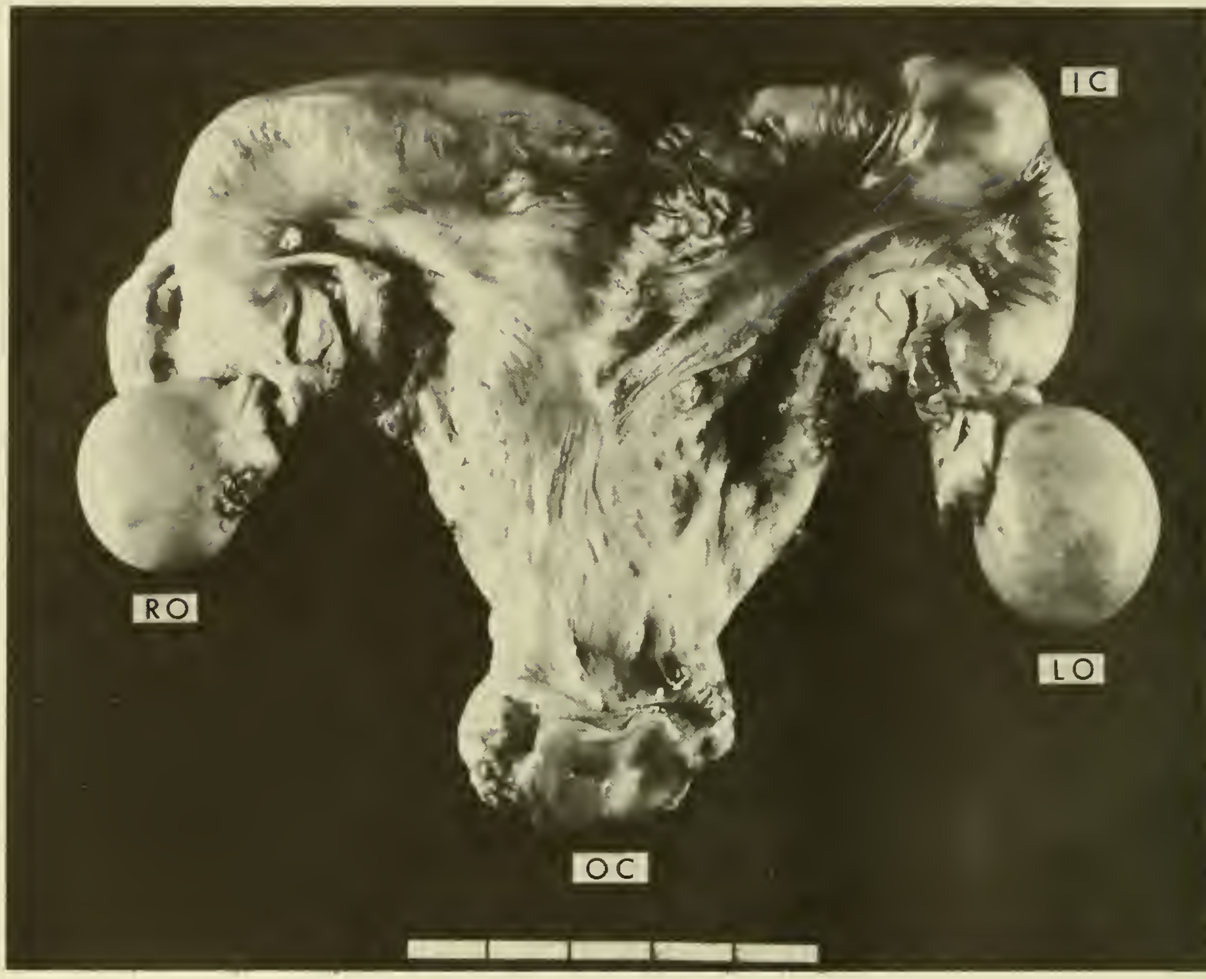

Figure 23.--Genital tract of female fur seal showing implantation chamber (IC), right ovary (RO), left ovary (LO), and os cervix (OC). Specimen no. 66, 28 November 1965, age 17; ventral aspect of freshly thawed tract; scale = 5 cm. (Photo VBS 6177.)

IMPLANTATION OF THE BLASTOCYST IN FUR SEALS

In 1960, Douglas G. Chapman estimated the mean date of implantation of the blastocyst in fur seals as early November. He based his conclusion on extrapolation of the weights of 398 fetuses collected at sea from January to June (In Scheffer, 1962).

In 1965, the genital tracts of 70 adult, white-whiskered females on St. Paul Island were collected for a study of implantation. The tracts were collected at about 6-day intervals from 13 September to 28 November, and placed in a freezer within 1 hour after death. In March 1966 they were thawed and examined. The external diameter of each uterine horn at its midpoint was measured, and each horn was examined for the presence of a placental scar (fig. 23). Each ovary was sliced by scalpel, and the presence of a corpus luteum or a corpus albicans was noted.

General Conditions of Genital Tracts

The right ovary of one tract was lost on the killing field. Of the remaining 69 tracts, 66 (96 percent) had a normal corpus luteum and were assumed to be pregnant (table 33). Data for the three tracts showing no evidence of parturition follow:

	Diameter of uterine horns		
Age	Right	Left	Remarks
Years	Mm.	Mm.	
4	10	10	Immature?
17	11	14	Corpus luteum small, regressing (?)
13	21	25	Corpus albicans in each ovary; cyst on right ovary

Time of Implantation

Seventeen tracts contained an implantation chamber (table 33). The earliest was collected on 4 November; in the last collection on 28 November all of the five tracts had implantation chambers. In this small sample, no relation between time of implantation and age of seal was evident (table 34).

Embryos

Five embryos were identified in tracts collected during the 19-day period 9-28 November. They ranged from 8 to 19 mm. in crown-rump length, as follows:

Date	Crown-rump length of embryo
9 Nov.	8
23 Nov.	8? (broken)
23 Nov.	10
28 Nov.	14
28 Nov.	19

Persistence of Corpus Albicans

Of 65 tracts having a new corpus luteum and a corpus albicans of the 1964-65 pregnancy, 24 also had a corpus albicans of the 1963-64 pregnancy. The 24 tracts with both old and new corpora albicantia were distributed as follows:

8 of 12 in September (67%)
9 of 25 in October (36%)
7 of 28 in November (25%)

The percentages suggest that the proportion of corpora albicantia identifiable in gross examinations decrease progressively 4 or more months after parturition.

Placental Scars

A placental scar (or its absence) was correctly identified in 41 of 70 tracts (table 35). Identification was incorrect in 29 tracts mainly through failure of the examiner to record a doubtful scar. A placental scar cannot always be recognized after early October.

Diameter of Uterine Horns

The diameter of the uterine horns is shown in table 36 for 49 tracts in which one ovary had a corpus albicans and the other had a corpus luteum (excluding 17 tracts that had an implantation chamber, 3 tracts that showed no evidence of pregnancy, and 1 tract that lacked an ovary). Presumably, for most of the tracts, the horn on the side with a corpus albicans delivered a fetus in 1965.

Table 33.--Percentage of genital tracts with a corpus luteum and with an implantation chamber, by date of collection

Collection date	Tracts with corpus luteum		Tracts with implantation chamber	
	Number	Percent	Number	Percent
13 Sept.	4	80	0	0
22 "	5	100	0	0
28 "	4	80	0	0
6 Oct.	5	100	0	0
13 "	5	100	0	0
20 "	4	80	0	0
24 "	5	100	0	0
29 "	5	100	0	0
4 Nov.	5	100	1	20
9 "	5	100	[1] 2	40
14 "	[2] 4	100	2	40
19 "	5	100	3	60
23 "	5	100	4	80
28 "	5	100	5	100
Total........	66	96	17	24

[1] One of the tracts probably, but not certainly, had an implantation chamber.
[2] One of five tracts lacked the right ovary.

Table 34.--Number of female seals showing evidence of implantation (I) and no evidence (NI), by collecting date and age[1]

Date	Age in years[2]										Total	
	6		7		8		9		>9			
	NI	I	NI	I	NI	I	NI	I	NI	I	NI	I
	Number											
13 Sept....	--	--	--	--	--	--	--	--	4	0	4	0
22 "	1	--	1	0	--	--	--	--	2	0	4	0
28 "	1	0	--	--	--	--	2	0	2	0	5	0
6 Oct.....	--	--	2	0	1	0	--	--	2	0	5	0
13 "	--	--	1	0	--	--	--	--	4	0	5	0
20 "	--	--	--	--	--	--	1	0	4	0	5	0
24 "	--	--	1	0	--	--	1	0	3	0	5	0
29 "	--	--	--	--	--	--	--	--	5	0	5	0
4 Nov.....	--	--	--	--	--	--	--	--	4	1	4	1
9 "	0	[3] 1	--	--	--	--	1	0	2	1	3	2
14 "	--	--	1	1	0	1	--	--	2	0	3	2
19 "	--	--	1	1	--	--	--	--	1	2	2	3
23 "	--	--	1	0	--	--	--	--	0	4	1	4
28 "	0	1	--	--	0	1	--	--	0	3	0	5
Total	4		10		3		5		46		68	

[1] Excluding one 4-year nullipara and one adult for which age was not estimated.
[2] Age estimated from examination of canine teeth. For females 8 years old and older, estimates may be in error by ± 2 years.
[3] Probably, but not certainly, implanted.

Table 35.--Accuracy of identification of placental scar[1]

Month	Total tracts	Placental scar recorded as present and		Placental scar recorded as absent and	
		Corpus albicans present	Corpus albicans absent	Corpus albicans present	Corpus albicans absent
		Number			
Sept...	15	10	0	2	3
Oct....	25	17	1	7	0
Nov....	30	11	1	18	0
Total..	70	38	2	27	3
Original identification of placental scar		right	wrong	wrong	right

[1] During examination of each pair of uterine horns, judgment was made as to the presence or absence of a placental scar. Later, during examination of the ovaries, the presence or absence of a corpus albicans did or did not substantiate the judgment.

Table 36.--Frequency of diameters of uterine horns in fur seals, by month

Diameter of uterine horn[1]	Uterine horn with:[2]							
	Corpus albicans				Corpus luteum			
	Sept.	Oct.	Nov.	Total	Sept.	Oct.	Nov.	Total
Mm.	Number							
9	1			1	1			1
10							2	2
11								
12						2		2
13						1	1	2
14					2	2		4
15					1			1
16		1		1	1	3		4
17	1	4	2	7	2	4	2	8
18	1		1	2	1	2	1	4
19	1	2		3	1	3		4
20	1	3	1	5	2	6	1	9
21	3	2	1	6	1		3	4
22	3	4	3	10			1	1
23	1	2		3		1		1
24		2	1	3			1	1
25		2	2	4	1			1
26			1	1				
27		2		2				
28								
29								
30								
31	1			1				
Total	13	24	12	49	13	24	12	49
Mean, mm.	20.5	21.3	21.6	21.2	17.3	17.4	17.8	17.5

[1] External diameter of freshly thawed horn measured at its midpoint.
[2] The fur seal has a bicornuate uterus.

In 41 tracts, the horn of the albicans side was larger (up to 12 mm. larger) than the horn of the luteum side. In six tracts the horns were equal. In two tracts the horn of the albicans side was 3 mm. smaller than the horn of the luteum side.

ERRORS IN DETERMINING AGES OF FUR SEALS FROM CANINE TEETH

Methods used at the Marine Mammal Biological Laboratory to collect and prepare teeth and determine ages were described by Scheffer (1950b) and Fiscus, Baines, and Wilke (1964). To test the accuracy of the method, right upper canine teeth collected from male and female seals of known age that had been tagged as pups on the Pribilof Islands and killed later there or at sea were given to four readers.[4] The readers had no knowledge of the correct ages.

The tests were based on whole and on sectioned teeth because the ages of most seals killed on the Pribilof Islands have been determined from whole teeth, whereas the ages of those taken at sea have been based on sectioned teeth. Each reader read each tooth twice. Conference readings were not made for whole teeth of males or females, or for sectioned teeth of males. Because the teeth of males are much larger than those of females, the tests for each sex are discussed separately.

Males

A sample of 380 whole teeth from males 2 to 5 years old was used in the tests. Ages 2 to 5 were selected because nearly all males killed on the Pribilof Islands are within this range. Reader error increased from a range of 2.0 to 6.1 percent for 2-year-olds to a range of 2.5 to 28.1 percent for 5-year-olds for two readings (table A-21). Ninety-nine percent of the assigned ages were within plus or minus 1 year of the correct age. Reader A had the lowest error (table 37).

For 120 sectioned teeth from male seals in ages 2 to 5, errors ranged from 0 to 33.3 percent (table A-22). Ninety-nine percent of the assigned ages were within plus or minus 1 year of the correct age. Reader A again had the lowest error (table 38).

A binomial test was used to determine if the assigned ages were distributed equally above and below the correct age. Reader A had no significant bias for whole or sectioned

[4] Reader A--A. Y. Roppel
Reader B--C. H. Fiscus
Reader C--H. Kajimura
Reader D--R. E. Anas

Table 37.--Errors in assigning ages of male fur seals from from whole canine teeth

Reader	Error for age 1/ 2	3	4	5
	- - - - - - -Percent- - - - - - -			
A	2.5	3.5	3.9	3.2
B	5.0	6.1	11.3	25.6
C	4.1	10.1	13.8	4.4
D	1.5	9.1	10.8	9.4
Sample size	99	99	102	80

1/ Average of two readings.

Table 38.--Errors in assigning ages of male fur seals from sectioned canine teeth

Reader	Error for age 1/ 2	3	4	5
	- - - - - - - Percent - - - - - - - -			
A	6.7	5.0	0	0
B	7.8	18.4	13.3	10.0
C	10.0	28.3	30.0	23.4
D	8.4	20.0	8.4	1.7
Sample size	30	30	30	30

1/ Average of two readings.

teeth for any age and Reader D had no significant bias for sectioned teeth (P>.05). Among observed errors, there was a tendency for readers to call 3-year-old seals 1 year older and 4-year-old seals 1 year younger than they actually were. Ages 2 and 5 were the limits and therefore cannot be used to show bias.

An analysis of variance test of the percent errors transformed by square root showed that the readers, ages of seals, whether the tooth was whole or sectioned, and all of the interactions of these factors were highly significant (P<.01). Duplicate readings were not significant (P>.05). Interpretation of the results for readers, ages, and methods (whether the tooth was whole or sectioned) is questionable because of the highly significant interaction terms. The reader and method with the lowest error, however, should give the best results.

We conclude that Reader A should determine the ages of male seals 2 to 5 years old from a single reading of whole teeth. Reader A had lower errors for sectioned teeth from males 4 and 5 years old, but the improvement in accuracy is not great enough to justify the extra effort required to section the canine teeth of all 4- and 5-year-old males. These results can be applied to the kill of seals on the Pribilof Islands by calculating the possible error in age classification of males taken. Solving for "n" in the equation $nP = A$, will give the corrected kill, where:

n = the 1 by 4 matrix of the unknown corrected number for each age

P = the 4 by 4 matrix of the percentage error by age for Reader A from whole teeth

A = the 4 by 1 matrix of the number assigned to each age in the kill on the Pribilof Islands by Reader A.

The assigned and corrected number of male seals of each age taken on the Pribilof Islands in 1966 is given in table 39, together with the percentage errors in assigned ages.

Females

A sample of 527 whole teeth collected from seals in ages 3 to 7 were used in the tests. Whole teeth have been used for assigning ages to females ≤ 7 years on the Pribilof Islands since 1963; ages of females older than 7 years were not determined. Ages were determined from whole teeth for females ≤ 10 years old from 1956 to 1962. Few females ≤ 2 years old are taken on the Pribilof Islands. A range of 4.2 percent to 11.7 percent for 3-year-olds to a range of 11.9 to 31.7 percent for 7-year-olds was observed for two readings (table A-23). Ninety-six percent of the assigned ages were within plus or minus 1 year of the correct age. Reader A had the lowest error (table 40).

A sample of 283 sectioned teeth collected from female seals in ages 3 to 11 was tested. A conference reading of readers A, B, and C has been used since 1966 for data collected since 1964. The procedure followed is: (1) Each reader assigns an age for each seal

Table 39.--Assigned and corrected number of male seals of each age killed and the percentage errors in assigned ages, Pribilof Islands, Alaska, 1966

Assigned age	Seals in: Assigned age	Seals in: Corrected age	Error
Years	Number	Number	Percent
2	3,534	3,138	+12.62
3	31,121	31,606	- 1.53
4	16,037	15,974	+ 0.39
5	1,772	1,746	+ 1.49
Total	1/ 52,464	1/ 52,464	

1/ Does not include thirty-three 6-year-olds killed on St. George Island.

Table 40.--Errors in assigning ages of female fur seals from whole canine teeth

Reader	Error for age 1/ 3	4	5	6	7
	Percent				
A	5.5	3.8	5.1	12.0	21.3
B	11.3	8.9	6.1	21.5	27.8
C	9.2	15.9	11.1	15.0	24.3
D	6.7	7.5	7.1	19.5	29.7
Sample size	120	107	99	100	101

1/ Average of two readings.

without consulting the other readers; (2) any disagreements between readers are then reconciled in a joint meeting of the readers. Errors ranged from 6.7 to 50.0 percent for 150 females in ages 3 to 7, and from 30.0 to 100.0 percent for females in ages 8 to 11 for two readings (table A-24). For seals $\leq$ 7 years old and $\geq$ 8 years old 91 percent and 82 percent of the assigned ages, respectively, were within plus or minus 1 year of the correct age. For seals $\geq$ 8 years old, 96 percent of the assigned ages were within plus or minus 2 years of the correct age. In general, a conference reading between readers A, B, and C (the most experienced readers) gave lower errors than the individual readings (table 41).

A binomial test for bias in the number of errors above and below the correct age showed that Reader A had no significant bias for whole teeth and Reader D had no significant bias for sectioned teeth in ages 1 to 6 years ($P > .05$). For whole teeth from 7-year-olds, all readers tended to assign ages too low ($P < .01$). Only Reader B had no significant bias for females 8 to 11 years old. Among observed errors, there was a tendency for readers to call 4- and 5-year-old seals 1 year younger, and 6-year-old and older seals 1 or more years younger than they actually were.

An analysis of variance test of the percent errors transformed by square root showed that the readers, ages of seals, whether the tooth was whole or sectioned, and the age-type of tooth interaction were highly significant ($P < .01$). The reader-age and reader-type of tooth interactions, and the mean square for duplicate readings were not significant ($P > .05$). The reader and method with the lowest error should give the best results.

We conclude that Reader A should determine ages of female seals $\leq$ 6 years old from a single reading of whole teeth. The error for Reader A is higher than the conference reading from sectioned teeth for 3-year-olds, but the difference is too small to warrant sectioning the teeth of 3-year-olds and making additional readings. Corrected numbers of females killed on the Pribilof Islands were not computed because no females were killed there in 1966. A method similar to that used for males, and using the errors for Reader A from whole

Table 41.--Errors in assigning ages of female fur seals from sectioned canine teeth

Reader	Error for age 1/ 3	4	5	6	7	8	9	10	11
	Percent								
A	6.7	11.7	30.0	28.3	21.7	44.3	55.0	51.7	75.0
B	16.7	15.0	31.7	38.4	33.4	48.4	46.7	55.0	58.8
C	19.8	18.4	31.7	30.0	31.7	51.7	63.3	81.7	80.0
D	11.7	11.7	21.7	31.7	36.7	53.4	46.7	63.4	58.4
Conference reading	3.3	6.7	20.0	16.7	23.3	26.7	50.0	36.7	66.7
Sample size	30	30	30	30	30	30	30	30	2/ 30

1/ Average of two readings.
2/ Sample size=24 for reader B and conference reading.

teeth for females ≤ 6 years old and the errors for the conference reading from sectioned teeth for females ≥ 7 years old could be used. Intuitively, the errors for other readers could be substituted if Reader A should stop determining ages of fur seals.

COMPARISON OF AGES ASSIGNED TO FUR SEALS BY JAPANESE AND U.S. BIOLOGISTS

Dissimilar criteria and methods used by biologists from Japan and the United States to determine the ages of fur seals from laminations on canine teeth could lead to errors in interpreting biological data. Age compositions and pregnancy rates of groups of seals are examples of data that could be affected.

To test the possibility that the methods of determining age have differed, biologists of each country determined ages from the canine teeth of seals collected at sea in 1964. Collections of teeth were exchanged, and ages determined by each country were compared. The true ages of most of the seals in each sample were unknown because only a few of the animals had been tagged as pups.

Sample of Teeth Collected and Prepared by Japan

Teeth collected from seals taken in the western Pacific Ocean by Japan were prepared by cutting a thin longitudinal section from the center of each tooth. The surfaces of each section were not polished. Thin sections allow laminations used to determine age to appear as dark lines on a white field when the tooth is viewed by transmitted light.

Japanese biologists assigned a single age to each tooth, and U.S. biologists assigned ages on two occasions separated by several months. The results from each reading by the United States are compared with the single reading provided by the Japanese, and the two readings by the United States are compared. The data for each sex are discussed separately.

Males.--Japanese and U.S. readers disagreed on an average of 3.8 percent of the teeth from males in ages 1 to 4 (range--0-8.3 percent) for the first reading. The percentage disagreement increased markedly for the small sample of 5-year-old males (25 percent error for 12 seals tested).

For the second reading, the two countries disagreed on an average of 3.3 percent (range--0-6.8 percent) of the males in ages 1 to 4, and percentage differences again increased at age 5.

Differences in determining ages were less between the first and second readings of U.S. biologists than between readings made by U.S. and Japanese biologists. Also, the difference between the first and second readings of U.S. biologists was slight for 5-year-olds.

Females.--An increase in differences was apparent between ages 5 and 6 for the Japanese and first U.S. readings (from 5.0 to 28.6 percent). For the Japanese and second U.S. readings, and the two U.S. readings, the increase occurred between ages 6 and 7.

For ages 8 and older, the disagreement was 40.0 percent for the Japanese and first U.S. readings, 42.2 percent for the Japanese and second U.S. readings, and 41.1 percent for both U.S. readings.

Sample of Teeth Collected and Prepared by the United States

Teeth collected from seals taken in the eastern Pacific Ocean were prepared by cutting each longitudinally but slightly off center from the apex of the root to the tip of the crown, ground to expose the root canal, and polished on the cut surface. The exposed laminations used to determine age appear as white intervals with a dark space between each.

U.S. readers determined ages for all the teeth in the sample. Japanese biologists were unable to read all the teeth from female seals. Ages were determined for only 2.2 percent of females age 9 years old and older by Japan. Each sex is discussed separately.

Males.--Differences between the two countries of over 20 percent are indicated in determining the ages of male seals, though sample sizes were too small to prove conclusively that the differences are meaningful.

Females.--Japanese and U.S. biologists differed on 36.5 percent of the teeth from females. Where differences occurred, ages assigned by the United States were always older than those assigned by the Japanese. These differences affect calculated pregnancy rates. For example, if ages determined by Japanese biologists are used, the pregnancy rate for the small sample of 5-year-olds included in the collection was 76.0 percent. On the basis of ages obtained for the sample by U.S. biologists, the pregnancy rate was 45.5 percent (table 42). The reason for the large disagreement between Japanese and U.S. biologists for determining ages for 5-year-olds (68.0 percent) is not known. To test possible differences in pregnancy rates due to reader error, larger sample sizes of canine teeth should be read twice by U.S. biologists, first whole, then sectioned. The same sample of teeth should then be sent to Japan to be prepared and read by Japanese biologists, because they section canine teeth much thinner than do U.S. biologists.

Table 42.--Pregnancy rates determined from Japanese and United States age determinations of fur seal teeth, by age, United States pelagic collection, 1964

Age by Japan	Japan			United States		
	Sample size	Pregnant		Sample size	Pregnant	
Years	Number	Number	Percent	Number	Number	Percent
1	1	0	0	1	0	0
2	9	0	0	9	0	0
3	16	1	6.3	11	0	0
4	15	1	6.7	17	2	11.8
5	25	19	76.0	11	5	45.5
6	17	16	94.1	27	24	88.9
7	8	8	100.0	12	11	91.7
8	3	3	100.0	5	5	100.0
9 and older	2	2	100.0	3	3	100.0
Total	96	50	52.1	96	60	62.5

DRUG IMMOBILIZATION OF FUR SEALS

A drug that would effectively immobilize adult male fur seals would be useful in furthering certain kinds of research on these animals. Immobilization with drugs administered by projectile syringe eliminates the need for physical restraint that might injure the animals or be hazardous for the investigator to apply. Numerous drugs, giving a wide variety of responses, have been used successfully on several species of animals. Harthoorn (1965) reviews much of the research on this subject. The choice of drugs depends mainly on the specific effect desired, but also on species-related drug idiosyncracy (a given drug may produce the desired effect in one species but not in another).

Territorial males that are to be marked for studies of behavior should be immobilized with a drug which will wear off quickly so that the animals can effectively resume defense of themselves and their territories. Peterson (1965) found a succinylcholine superior to several other drugs and combinations of drugs in this respect but could not determine a safe and effective dosage. Establishment of the proper dosage of any drug, however, depends on a fairly uniform rate of absorption of a drug of uniform strength. Peterson contended with considerable variation in both. The strength of solutions of succinylcholine varies because the drug decomposes very rapidly after it is in solution, and rate of absorption varies because assimilation of the drug is slower in fatty tissue than in muscle. Peterson's target for injecting succinylcholine was the lattisimus dorsi, a muscle which lies between two layers of blubber. There was no way to prevent deposition of the drug short of or beyond this muscle into fat.

Keyes (1966) minimized variations in strength and absorption by injecting solutions of freshly reconstituted crystalline succinylcholine[5] into the relatively fat-free muscular hump of the neck. In general, the rate of absorption is proportional to the concentration of a drug, and rapid effect is followed by rapid recovery; hence, recovery time can be reduced by increasing the concentration of a drug in solution. Keyes induced rapid recovery by injecting concentrated succinylcholine with 1- and 2-cc. syringes rather than those of 10-cc. capacity used by Peterson.

Keyes used these techniques on nine adult male seals (table 43). In the first three animals, the latent period (time from injection to first signs of effect) was 5 to 8 minutes; complete immobilization lasted 11 to 20 minutes, and the time from injection to full recovery was 24 to 34 minutes. Thus, the critical time lapses were considerably less than the average latent period of 12 minutes and recovery period of 48 to 95 minutes observed by Peterson, and the period of immobilization was longer (11 to 20 minutes compared to 3 to 10 minutes). Male number 9 was somewhat larger than the first three but died after being given the same dosage; however, he was handled and marked whereas the others were not. Since wild animals paralyzed by succinylcholine are fully conscious, they experience great anxiety when approached and particularly when handled. This emotional stimulation intensifies and prolongs the action of succinylcholine by increasing the animal's production of acetylcholine, a molecule with an effect similar to that of succinylcholine. Death from suffocation results from prolonged and more complete paralysis of the thoracic muscles. Death might also be caused by heart failure because of a sharp rise in blood pressure caused by stimulation of the sympathetic nervous system (Harthoorn, 1965). Perhaps if the animals were first given a sedative, paralysis would be less intensive and of shorter duration.

Because 50 mg. of succinylcholine had little or no effect and 60 mg. was at times lethal, we conclude that when used alone succinylcholine has a margin of safety too narrow for routine use on territorial male fur seals.

[5] Anectine, Burroughs Wellcome. Trade names referred to in this publication do not imply endorsement of commercial products.

Table 43.--Immobilizing trials with succinylcholine, St. Paul Island, 1966

Adult male seals	Estimated weight		Actual weight		Dosage	Effect	Latent period	Period of immobilization	Total time from injection to full recovery or death
Number	Lb.	Kg.	Lb.	Kg.	Mg.		Minutes	Minutes	Minutes
1	400	182	-	-	60	Immobilized	5	19	24
2	400	182	-	-	60	----do. ----	8	20	34
3	400	182	-	-	60	----do. ----	7	11	25
4	450-500	205-227	400	182	80	Lethal	6	-	29
5	500-600	227-273	460	209	80	--do. -	6	-	23
6	400	182	-	-	50	Incomplete	7	-	-
7	400	182	-	-	50	---do. ---	7	-	-
8	400	182	-	-	50	No effect	-	-	-
9	400	182	-	-	60	Lethal	7	-	20

Figure 24.--Pup enclosure showing position of sea-water tank, slatboard racks, heat lamps (L), and thermometer (T), St. Paul Island, 1965.

NUTRITION OF PUPS

Two variations of a formula were fed for 5 weeks to two groups of four newborn pups.

Housing and Preparation

The pup enclosure (fig. 24) used in 1966 was identical to that used by the end of the first month of trials in 1965 (Wilson, 1966[6]). Eight newborn (1-3 days old) pups presumed to have nursed[7] were weighed, bathed, had

[6] T. M. Wilson. 1966. Behavior and husbandry methods for captive northern fur seal pups. Master's thesis, Dept. Conserv., Cornell Univ., Ithaca, N.Y. vii + 38 pp.

[7] Pup number 4 was taken from his mother before he had nursed.

Table 44.--General formula and ingredients for artificial seal milk, St. Paul Island, 1 July to 4 August 1966

Component	Percent
Protein	8.4-12.4
Calcium caseinate (85 percent protein)[1]	
Fish flour (fine grind for animal use[2], 73 percent protein)	
Fat	30.0-40.0
Whale oil, (baleen, bleached triglyceride)[3]	
Water	45.0-57.0
Supplements	0.81
BO-SE (R) (selenium[4]	.00001
and vitamin E)	.0075
DL methionine[1]	.4
Glycerin[5]	.4
Additives	.11
Antioxidant-Ethoxyquin (Santoquin [R])[6]	.01
Emulsifier-lecithin (soybean, oil not removed)[1]	.1

[1] Nutritional Biochemicals Corp., Cleveland, Ohio.
[2] VioBin Corp., Monticello, Ill.
[3] Del Monte Fishing Co., San Francisco, Calif. and Bureau of Commerical Fisheries Technological Laboratory, Seattle, Wash.
[4] Haver Lockhart, Kansas City, Mo.
[5] Colgate-Palmolive Co., New York, N.Y.
[6] Monsanto Chemical Co., St. Louis, Mo.

their umbilical cords disinfected, and were marked by clipping numerals from 1 to 7 in the guard hairs of the head; the 8th pup was not marked. On the 8th day they were treated for lice and on the 17th day for possible hookworm infestation.

Composition of Formula

The general formula and ingredients, based on analysis of five samples of fur seal milk (Ashworth, Ramaiah, and Keyes, 1966), are given in table 44.

Rationale for ingredients.--Most ingredients were selected because they gave the best results of those tested in 1965 (Keyes, 1966).

Protein.--Calcium caseinate was used in place of casein because it is more soluble and forms a more stable suspension.

Fats.--Whale oil, found superior to menhaden oil, was bleached[8] to remove impurities but not distilled as in the past because distillation removes oil-soluble vitamins.

[8] The oil was mixed with clay and charcoal, and agitated under vacuum at 60° to 70° C., at the Bureau of Commercial Fisheries Technological Laboratory, Seattle, Wash.

Supplements.--Diets high in polyunsaturated fats require relatively high levels of vitamin E. Selenium and methionine reduce the requirement for vitamin E (Witting and Horwitt, 1964). Glycerin enables some animals to utilize free fatty acids in a carbohydrate-free diet (Renner, 1964).

Additives.--Ethoxyquin prevents oxidation of fat and potentiates vitamin E. The emulsifier lecithin was used to keep the oil in suspension. (Separation of the oil after ingestion may lead to oil inhalation and foreign body pneumonia.)

Because of the high vitamin and mineral content of fish flour and whale oil, no supplement was added. Antibiotics may have been beneficial in 1963 and 1964, when the experimental diet and methods of care were inadequate, but they showed no observable benefit in 1965; therefore, they were not given to pups in 1966.

Experimental Design

Changes in number of feedings and amounts fed of two variations of a formula (C and F) were tried (table A-25). Formula C contained equal parts of fish flour and calcium caseinate; formula F was identical except that it contained no calcium caseinate. Four pups (numbers 1 to 4) were fed formula C and four (numbers 5 to 8) were fed formula F. Each lot contained two females (numbers 1, 3, 5, and 7) and two males (numbers 2, 4, 6, and 8).

Preparation of Formula

The formula, which was prepared just before each feeding, and the ingredients were kept at room temperature. Dry ingredients and water, and fat and emulsifier had to be blended separately before they could be mixed together. Because calcium caseinate required excess water to make a fluid suspension with the other ingredients, numerous modifications of the original formula and amounts fed were made to make formula C and F alike in total solids (table A-25).

Feeding

The method of feeding was that described by Wilson (1966).[9] One new feeding instrument was used--a toy plastic syringe which would deliver up to 230 cc. Amounts of formula fed to each pup daily are given in table A-26.

[9] See footnote 6.

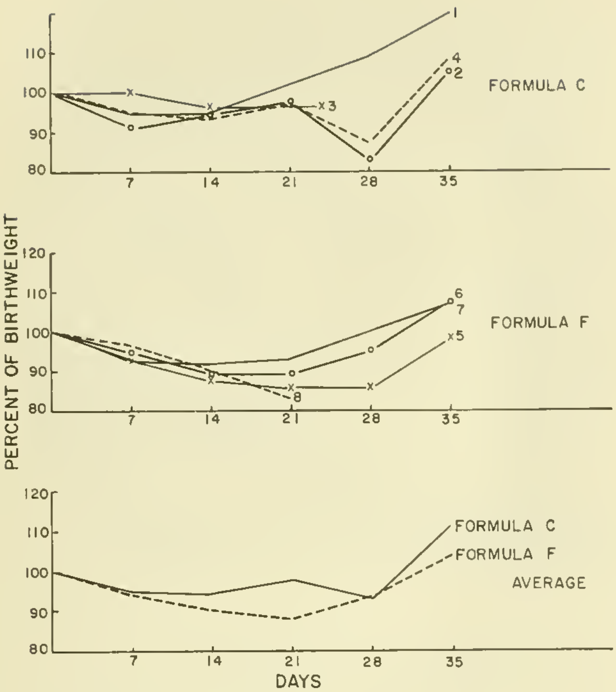

Figure 25.--Relation between birthweights and subsequent weights of eight captive pups, by formula, St. Paul Island, 1 July to 4 August 1966. Pup no. 3 died on 25 July and no. 8 on 22 July.

Evaluation of Formula

The rate of gain in weight was the primary criterion for evaluating and comparing formulas C and F. The relation between individual and group average birthweights and subsequent weights of the eight pups, by formula, is shown in figure 25. Weekly weights, in kilograms, are shown in table A-27.

The combination of calcium caseinate and fish flour in formula C appeared to produce greater and more rapid weight gains than formula F with fish flour alone as the protein. Pups 2 and 4 were temporarily dehydrated from vomiting (possibly because of overfeeding) when weighed on 28 July. Before the trials ended, one pup in each group died from undetermined causes.

Figure 26 shows the progress of pup care and feeding trials represented by the best individual records of captive pups from 1963 to 1966. Weight gains by rookery pups for a similar period are included for comparison.

In 1964, rookery pups gained at the rate of about 0.5 kg. per week (females 0.42; males 0.52) for the first 5 weeks. Four of six captive pups in 1966 equalled or surpassed this rate during the 4th and 5th week, although they lost weight during the first 2 weeks. Several factors probably contributed to failure of the pups to make adequate gains the first 3 weeks: Excess water used to make the formula fluid prevented pups from getting sufficient solids until they were able to digest greater volumes. Time was required for the digestive system of pups to adjust to the differences between formula and seal milk; normal digestion was hampered by overfeeding, leading to weight loss from diarrhea which may have been aggravated by treatment for parasites; pups did not receive a natural measure of passive immunity to infectious microbes before they were captured; and pups were under the stress of being held in captivity (separation from their mothers, and handling and force feeding by humans).

Disposition of Captive Pups

At the end of the feeding trials (35 days) the six surviving pups were shipped by air to the Stanford Research Institute where artificial rearing was continued. Pup number 5 died on route, and pup number 1 died when a feeding tube was mistakenly passed down the trachea. From 5 August to 11 November the weight of pup number 2 increased from 6.5 to 9.9 kg.; pup number 6, 5.7 to 9.9 kg.; and pup number 7, 5.9 to 8.4 kg. Each was fed a formula similar to formula C.

Pup number 4 was transferred to the San Jose Zoo where its diet was changed to blended fresh mackerel fingerlings, whale oil, and water on 17 August. Its daily intake was 0.57 kg. (20 oz.) of mackerel, 0.20 kg. (7 oz.) of whale oil, 0.34 kg. (12 oz.) of water, and a multivitamin capsule.[10] By 12 October, the pup was spending half its time in water, where it learned to swallow whole mackerel (about 10.2 cm. (4 inches) long). Just before its death from a strangulated umbilical hernia on 1 December, this pup was eating about 1.6 kg. (3.5 lb.) of fresh mackerel per day.

[10] Theragran, Squibb.

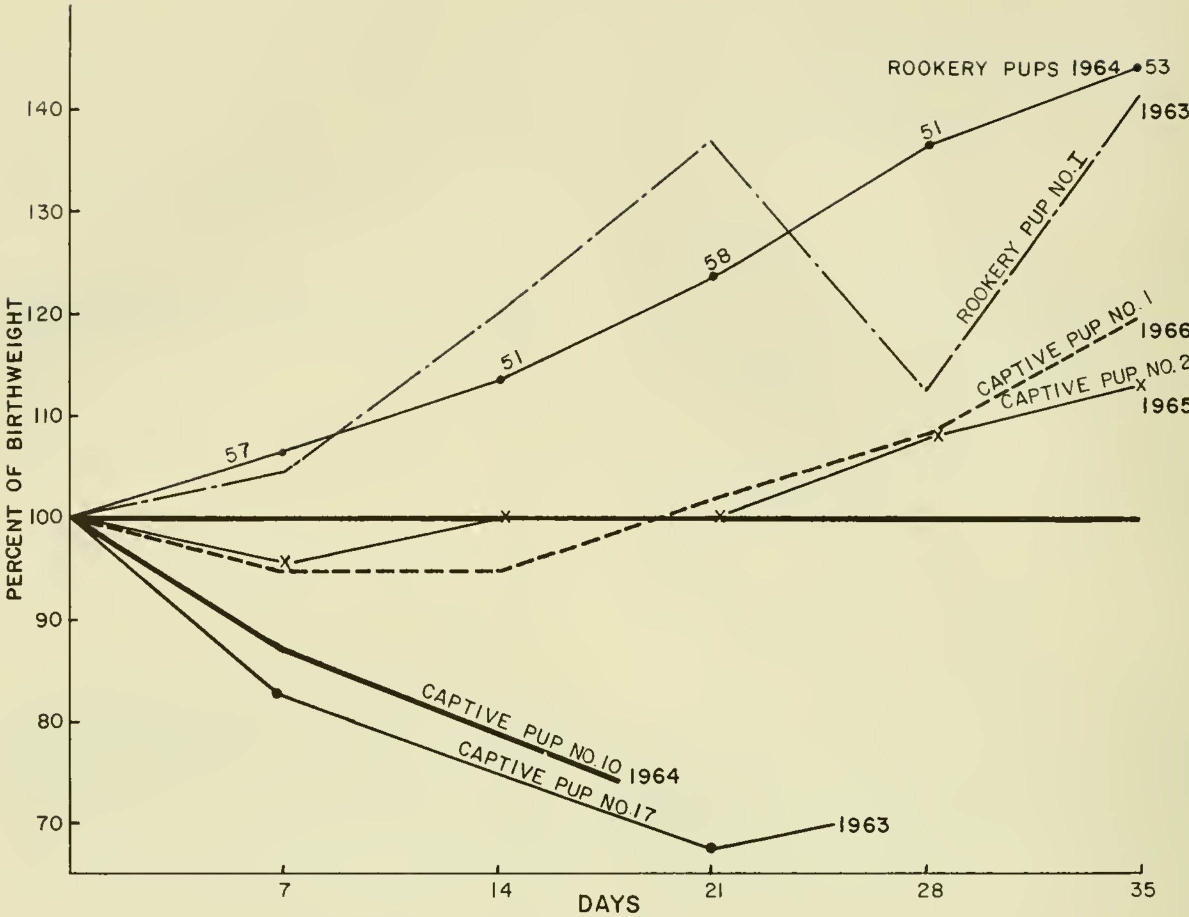

Figure 26.--Best individual growth records of captive pups fed artificial diets during each of 4 years, St. Paul Island, 1963-66. Average weights of samples of naturally fed rookery pups in 1964 (numerals indicate number of pups weighed) and of one rookery pup in 1963 are shown for comparison. The solid horizontal line indicates 100 percent of birthweight.

ANALYSIS OF FUR SEAL MILK

Since 1963, six samples of fur seal milk taken at different stages of lactation have been analyzed for gross composition, fatty and amino acids, and nitrogen distribution by the Department of Dairy Sciences, Washington State University.

In July 1965 a sample was collected immediately post partum to test for colostrum milk, which contains high levels of albumin and globulin. The level of these components was 50 percent higher than in milk from later lactation (Ashworth, Keyes, and Ramiah, 1966). In another sample of colostrum milk obtained in July 1966, the values for albumin and globulin were 150 percent higher than in samples collected later in lactation (table 45). High levels are presumed to indicate antibody transfer through the milk.

Table 45.--Distribution of nitrogenous compounds in fur seal milk by percentage of total nitrogen[1]

	Date of collection				
Compound	August 1964	July 1965	August 1965	October 1965	July 1966
Casein	55.3	44.0	50.7	52.0	31.6
Albumin-globulin	22.0	33.0	21.5	21.0	[2]57.1
Proteose-peptone	19.3	20.9	-	-	0.5
Nonprotein nitrogen	-	-	7.0	-	8.5

1/ A sample taken in 1963 is not included because nitrogen distribution was not determined.
2/ U.S. Ashworth, 1966, unpublished data.

The average gross composition of six samples of fur seal milk is given in table 46.

Table 46.--Gross composition of fur seal milk, average of six samples collected in 1963-66, St. Paul Island

Component	Percentage of total
Total solids	63.5
Fat	51.6
Protein	9.6
Reducing sugars	0.11
Ash	.51
Calcium and magnesium	.054
Phosphorus	.50
Chlorine	.124

pH - 6.1

CRYOGENIC MARKING

Cryogenic or "freeze" branding is a relatively new[11] method of marking animals. When extreme cold is applied to skin from which the hair has been shaved to reduce insulation, melanocytes (pigment cells) of the hair follicles and dermis are selectively destroyed without damage to the skin. Hair follicles so treated produce only white hairs. In the summer of 1966, cryogenically induced white hair had persisted for 10 months through two shedding and regrowth periods in dairy cows (Farrell et al., 1966).[12] Reversion to pigmented hair is not expected because hair that turns white, for whatever reason--old age, saddle sores in horses, and X-irradiation in other animals--persists for life.

Freeze branding has several advantages over hot branding. Hot branding is painful and causes inflammation, swelling, and scarring which distorts the marks and restricts their size. Freeze branding is relatively painless and causes very little inflammation, swelling, or scarring so that legible figures as small as 1 cm. high and 2 mm. wide can be produced. Wounds caused by hot brands have a greater tendency to become infected than wounds caused by freeze brands. White hair marks produced by freeze branding are legible at greater distances than hot brands, depending on the size and the degree of contrast achieved.

Disadvantages of freeze branding are: The refrigerants are dangerous to personnel if carelessly handled; "runs"[13] may result if too much refrigerant remains on the branding instrument as it is applied; smears or blurs may result from an animal's movement; and contact may be incomplete when the surfaces to be marked are uneven (Farrell et al., 1966).

After preliminary tests by R. Keith Farrell on black swine and a captive elephant seal, cryogenic marking of fur seal pups was tested on St. Paul Island in 1966. A round-faced copper instrument in the form of an "S" was chilled to -70° C. in a mixture of absolute isopropyl alcohol and dry ice and applied to both the naturally bare skin of the front flipper, and the furred skin of the forearm. The naturally bare or shaved surfaces were first wet with alcohol. The struggling movements of the pups during the process seemed to be random attempts to get free and did not necessarily coincide with application of the instrument. From this we concluded that the process was not painful. Exposure times tested were 15, 20, 25, and 30 seconds. By positioning the brands differently in relation to the axis of either the right or left flipper, we were able to distinguish the marks made at each exposure time, during observations of the pups from 13 July to 14 November.

We applied brands to the dorsal surface of either the left or right front flipper (manus) of each of 40 pups on Zapadni Reef Rookery 13 July. The results are illustrated in figure 27. The frozen impression left on the skin was visible for only a few minutes. An "S"-shaped blister formed in 8 days, then peeled, exposing a light pink "S" on the 13th day. Healing was complete by the 22d day, but partial or complete repigmentation was evident on the 41st day. We concluded that cryogenic marking of the naturally bare skin of the flipper is unsatisfactory because depigmentation is not permanent.

On 14 July, brands were applied to the furred forearms (antebrachiums) of an additional 40 pups on Zapadni Reef Rookery. A small patch of fur was first removed from each marking site with electric clippers. The results are illustrated in figure 28. One day after branding there was some barely recognizable "S"-shaped erythema and edema, but initial scab formation produced legible marks by the 7th day. The legibility of the marks changed little between the 12th and 41st days. During this time the scab and hairs exfoliated and epithelium healed. White hair began to show on the 41st day. Twenty seconds of exposure produced the most distinct marks.

[11]The first legible mark made on any animal by this process was a 1.9-cm. high letter H formed from white hairs produced by a superchilled, copper, horn branding instrument applied to the hind limb of a dog by R. Keith Farrell on 5 May 1965 (Farrell, Koger, and Winward, 1966).

[12]By 1968, when this manuscript was edited, the white hair had persisted for 3-1/2 years and through seven shedding and regrowth periods.

[13]Refrigerant runs off the instrument and freezes skin next to the brand.

8 days after 30-second exposure

13 days after 30-second exposure

22 days after 20-second exposure

41 days after 20-second exposure

Figure 27.--Changes in cryogenic brands of the naturally bare flipper skin of fur seal pups, Zapadni Reef Rookery, St. Paul Island, 13 July to 23 August 1966.

Some 15-second brands were satisfactory, but white hair growth was not dense. Many of the 25- and 30-second brands were contracted, and some 30-second brands destroyed the hair follicles.

Standardization of the technique to that which produced satisfactory marks in these trials should result in an excellent method for permanently marking fur seals. Branded seals must be observed for several years, however, to be certain that depigmentation of the treated follicles is permanent. Errors in chilling the marking instrument, timing the exposure, and achieving uniform contact

12 days after 15-second exposure

35 days after 20-second exposure

72 days after 25-second exposure

4 months after 15-second exposure

Figure 28.--Changes in cryogenic brands of the forearm pelage of fur seal pups, Zapadni Reef Rookery, St. Paul Island, 14 July to 14 November 1966.

with the skin affect the uniformity of results. We estimate that one thousand pups could be marked per 8-hour day by using two men for catching, two for restraining, one for clipping, and one for branding. The use of six marking instruments would make a pre-chilled instrument always available, and battery powered animal clippers could be used in place of a gasoline generator.

SUMMARY

AGE CLASSIFICATION AND NUMBER OF SEALS KILLED, BY SEX

Males

Of 52,497 male seals killed on the Pribilof Islands in 1966, 42,104 were taken on St. Paul Island and 10,393 on St. George Island. Male seals from 42 inches (106.7 cm.), tip of nose to tip of tail, up to but not including those having a mane were killed.

Females

The kill of female seals on the Pribilof Islands in 1966 was 391, including 61 taken for research and 330 killed accidentally during the kill of males.

SURVEY DATA

Mortality

Pups.--The count of dead pups on the Pribilof Islands was 27,392.

The major causes of death among 164 pups collected through the season in 1966 were apparent malnutrition (42 percent), hookworm disease (18 percent), infections (10 percent), and bite wounds (9 percent). Miscellaneous and undetermined causes of death accounted for 15 percent; 6 percent of the pups collected were not examined because of decomposition.

Adults.--On St. Paul Island the number of dead adult seals counted was 158 males in 1965 (females were not counted) and 181 males and 172 females in 1966. On St. George Island, 41 males and 55 females were counted in 1966.

Counts of Living Adult Males

Harem males counted on the Pribilof Islands in mid-July of 1966 decreased for the fifth consecutive year, to 71 percent of the number counted in 1961; idle males equaled 47 percent of the count in 1961.

Reproductive Condition of Females

Of the 65 3-year-old females examined, none had ever been gravid. One of the 51 4-year-olds was primiparous and recently postpartum.

Weights of Pups

An experiment in 1966 indicated that handling causes pups to lose weight or retards their growth.

MARKING

Pups

Single S-series tags were attached to the right front flippers of 10,000 pups on St. Paul Island, and the tip of the second digit of the right hind flipper was removed as a checkmark. On St. George Island, single S-series tags were attached to the left front flipper of 2,499 pups and the tip of the same flipper was removed as a checkmark.

Small numbers of pups have been marked experimentally since 1963 with coded wire, plastic roto tags, button ear tags, "spaghetti" tags, small cattle-ear tags, and butt-end leg bands. Additional pups have been marked by cryogenic ("freeze") branding. In 1966, 9,578 pups on St. Paul Island were marked by removing the tip of the third digit of the right hind flipper and 2,503 on St. George Island were marked by removing the tip of the second digit of the left hind flipper.

Male Yearlings

Double 1S-series tags were attached to the front flippers of 1,495 males selected as yearlings.

Males Ages 2 to 4

Double 2S-series tags were attached to the front flippers of 1,483 males selected as 2-, 3-, and 4-year-olds.

TAG RECOVERIES

Recoveries of seals on the Pribilof Islands included 4,418 marked as pups--2,685 with tags and 1,733 with checkmarks--and 159 males tagged as yearlings on St. Paul Island in previous years. A total of 30 Soviet-tagged seals were killed--28 of Commander Islands origin and 2 from Robben Island.

Recoveries of tags since 1954 have shown that the tendency of fur seals to return to their rookery of birth increases as the animals become older, that homing tendency is more pronounced for seals born on St. Paul Island than for those born on St. George Island, and that seals from some rookeries have higher rates of homing than do seals from other rookeries.

To test the possibility that older pups may survive the effects of tagging better than pups tagged earlier in summer, one group of pups was tagged in mid-August and another in late September in each of 2 years (1963 and 1964). Data collected in 1966 indicated a higher rate of recovery from the late than from the early group.

POPULATION ESTIMATES

The number of pups born on the Pribilof Islands, estimated from tag recoveries, has steadily decreased from 643,000 in 1960 to 440,000 in 1964.

Shearing of live pups and later sampling for marked-to-unmarked ratios yielded an estimate of 380,000 pups born on the Pribilof Islands in 1966. The estimates and total counts of pups on three rookeries were similar.

On the basis of tagged seals taken in 1963-66, an estimated 78,000 males from each of two year classes (1961 and 1962) survived to age 1.

FORECAST OF THE KILL CF MALES

The predicted kill of males on St. Paul Island by 5 August 1966 included 26,000 of age 3 and 14,000 of age 4; actual kills were 25,520 and 12,149.

The forecasted kill of male seals on the Pribilof Islands in 1967 includes 4,000 of ages 2 and 5, 34,300 of age 3, and 17,900 of age 4.

SPECIAL STUDIES

Age Composition, Measurements, and Mortality of Territorial Male Fur Seals

The age compositions of 249 territorial males killed for study and 157 adult males found dead were similar. The territorial males were 7 to 17 years old; 71 percent were in ages 10 through 13; the predominant age was 10.

The annual replacement rate for territorial males age 10 and older is estimated as 0.38. Body length and weight of the baculum, testes, and body showed no relation to age, nor was there a relation between weights of the baculum and testes. Body length and baculum weight may be related.

Implantation of the Blastocyst in Fur Seals

Of 70 genital tracts of adult females collected at about 6-day intervals from 13 September to 28 November 1965, 17 contained an implantation chamber. The earliest was observed 4 November; all five tracts collected on 28 November had implantation chambers.

Errors in Determining Ages of Fur Seals from Canine Teeth

Canine teeth collected from seals of known age were examined by four readers. For whole teeth from males in ages 2 to 5, the lowest reader error ranged from 2.5 to 3.9 percent; for sectioned male teeth, the lowest error was 0.0 to 6.7 percent. The lowest error in determining the ages of females from whole teeth in ages 3 to 7 was 3.8 to 21.3 percent. A conference reading by four readers of sectioned teeth from females in ages 2 to 11 produced errors ranging from 3.3 to 66.7 percent.

Comparison of Ages Assigned to Fur Seals by Japanese and U.S. Biologists

Possible differences between Japan and the United States in determining the ages of seals were tested by exchanging samples of canine teeth each had collected from seals taken at sea in 1964. For teeth prepared by the Japanese, readers from the two countries disagreed on about 3.5 percent of 128 males in ages 1 to 4 and on 4.4 percent of 204 females in ages 1 to 7. For teeth prepared by U.S. biologists, the readers disagreed on 2 of 11 males in ages 2 to 3 and on 36.5 percent of 91 females in ages 1 to 7.

Drug Immobilization of Fur Seals

Succinylcholine was found to be too unpredictable in its effect on adult male fur seals for safe use.

Nutrition of Fur Seal Pups

Two variations of an articial formula were fed for 5 weeks to two groups of four newborn pups. The use of a combination of calcium caseinate and fish flour as the source of protein produced greater and more rapid weight gains than did fish flour alone.

Analysis of Fur Seal Milk

Six samples of fur seal milk from different stages of lactation were analyzed for gross composition, fatty and amino acids, and nitrogen distribution. Colostrum milk obtained immediately post partum contained much higher levels of albumin and globulin than did milk collected later in lactation. High levels of albumin and globulin are presumed to indicate antibody transfer through the milk.

ACKNOWLEDGMENTS

The research staff had the cooperation of C. Howard Baltzo, Program Director; Howard Euneau, St. Paul Island Manager; Roy D. Hurd, St. George Island Manager; Bertel W. Johnson, Management Staff Officer; Roy L. Ellerman, Program Engineer; and Richard A. Hajny, Wildlife Management Biologist, Pribilof Islands. Others who cooperated were Lee Paola, Superintendent, Oregon-Alaska Marine Products; Iliodor Merculief, President, St. Paul Island Community Council; Victor Misiken, Sealer III Foreman; and Alex Melovidov, Sealer I Foreman.

GLOSSARY

The following terms used in fur seal research and management on the Pribilof Islands have special meanings or are not readily found in standard dictionaries.

Checkmark A notch, slit, hole, or other mark made on a seal flipper when a tag is applied, to ensure later recognition of an animal that has lost its tag. See marked and lost tag.

Drive The act of surrounding and moving groups of seals on land from one location to another.

Escapement Seals that were not killed because they were too old, too large, or not available.

Female kill That part of the annual harvest devoted principally to the kill of female seals, usually in August. See male kill.

Handling The act of driving, holding, and restraining seals for marking.

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 to a rookery or hauling ground on shore.

Homing tendency The inclination of seals to return to the rookery where they were born.

Known age Applied to seals for which age is definitely known because they bear an inscribed tag or have a certain combination of tag-scar and checkmark.

Lost-tag Applied to a seal known to have been tagged because of a checkmark.

Lost-tag-to-tag ratio The number of seals that have lost tags as compared with the number retaining tags.

Male kill That part of the annual harvest devoted principally to the kill of male seals, usually in late June, in July, and in early August. See female kill.

Mane Long, silver-colored guard hairs on the shoulders and on back of the neck--a secondary sex characteristic of males. The mane appears on some males at age 5, on most at age 6, and on all at age 7 and older.

Marked Seals that have been tagged or sheared so that they can be identified. Removing a digit from a flipper, cutting a V-notch in the leading edge of a front flipper near the tip, or slicing off the tip of a front flipper are also examples of marking. These marks, when applied to seals in conjunction with tags, are considered checkmarks. See checkmark and lost-tag.

Marked-to-unmarked ratio The number of marked seals compared with the number of unmarked seals.

Pregnancy rate Percentage of females that were carrying or had borne pups in the year of examination.

Rookery An area on which breeding seals congregate.

Round The sequence in which hauling grounds on St. Paul Island are visited to collect seals for harvest. When used, a circuit or round of the hauling grounds is completed in 5 days and the procedure is repeated throughout the kill of males. Calculate the mean round of the kill by multiplying the round number by the number killed in that round and dividing the cumulative product by the cumulative kill.

Round-up The act of surrounding and collecting seals to be driven for harvesting, tagging, or other purposes.

Tagged Describes a seal having an inscribed metal tag or tags attached to one or more of its flippers.

Tag recoveries Includes tags recovered, marked seals recovered, and seals identified from checkmarks as having lost their tags. See checkmark, marked, and lost-tag.

Part II: PELAGIC FUR SEAL INVESTIGATIONS, 1966

Pelagic fur seal research in 1966 was carried out from 21 January to 25 March off the coast of central and southern California, one of the major fur seal wintering grounds in the eastern North Pacific. Primary objectives of the research were to study the distribution of fur seals by making a systematic survey of the area at a time of maximum abundance and to collect a representative sample of fur seals for studies of food habits, age, sex, size, and reproductive condition. The survey and collections of fur seals extended our coverage of the area south to lat. 32° N. and offshore in most places to a distance of at least 185 km. (100 miles). This was the 9th year of research under the terms of the Interim Convention on Conservation of North Pacific Fur Seals.

This part of the report summarizes research data obtained at sea in 1966 and relates it to information collected in other years. The distribution of fur seals in 1965 and 1966 are compared. Also given are the results of food habits studies for several years and observed changes in the feeding habits of fur seals.

EQUIPMENT, METHODS, AND PERSONNEL

In the past, 21- to 24-m. (70- to 80-foot) fishing vessels (purse seiner type) have been satisfactory for collecting the large numbers of seals needed to fulfill requirements of the Convention. Since 1963 the Commission has put less emphasis on collecting a large number of seals but requires that research effort be held at about the same level. This requirement has caused studies of distribution to be expanded. The distribution studies require larger vessels.

Two relatively large vessels were used for pelagic research in 1966. The M/V Pribilof[14] was used primarily for survey work and secondarily for collecting seals. The height of the bridge above the water was an advantage for observing seals during studies of distribution, and the large size of the Pribilof allowed her to work safely far offshore and to remain there during storms. A vessel's usefulness for collecting seals, however, decreases as its size increases. The Pribilof, for example, could not be used to chase seals, because most would easily escape if not collected on the first pass. A smaller but more maneuverable vessel, the M/V Lynnann,[15] a whale catcher, was chartered primarily for collecting seals in 1966.

The Pribilof and the Lynnann were satisfactory for the work in 1966. Dories launched from these vessels (when weather permitted) were useful supplements for hunting seals.

Equipment and methods, now standardized, have been described by Fiscus, Baines, and Wilke (1964), and by Fiscus and Kajimura (1967). Two observers equipped with binoculars were continuously on duty while the vessel cruised transects for studies of distribution. From their respective stations on either side of the bridge, the observers recorded all seals sighted, time observed, estimated distance from the vessel when abeam of the seal, and behavior of each (i.e., sleeping, resting, swimming, feeding, etc.). The position of the vessel was plotted hourly on a chart by the mate of the watch. The location of each seal observed was also plotted.

Seals were shot with 12-gauge shotguns loaded with 00 buckshot, weighed, measured, and examined for tags, marks, scars, general condition, barnacles, and algae. Stomachs, reproductive tracts, and upper canine teeth were collected and taken to our laboratory in Seattle at the end of the season. Here, stomach contents were identified, reproductive conditions were recorded, and teeth were sectioned for determining age. The data were recorded on punch cards and processed.

Because records for eight seals were incomplete, these animals are represented only in the sections on distribution of seals by date and locality, and relative abundance and size of groups.

Biologists aboard the vessels and in the Seattle laboratory were: Richard K. Stroud--M/V Lynnann; Clifford H. Fiscus and Hiroshi Kajimura--M/V Pribilof. Assistants aboard the vessels and in the laboratory were David Harcombe, Roger E. Paul, and Donald E. Ross. Milton E. Timmes assisted in the laboratory.

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[14] M/V Pribilof: Bureau of Commercial Fisheries Pribilof Islands supply vessel; registered length 64 m. (210 feet), 3,398 $m.^3$ (1,200 gross tons), 14,000 horsepower, cruising speed 22.2 km. per hour (12 knots).

[15] M/V Lynnann: registered length 38.3 m. (125.5 feet), 736 $m.^3$ (260 gross tons), 1,000 horsepower, cruising speed 18.5 km. (10 knots).

Pelagic investigations were made off California from 21 January to 25 March. The vessel Pribilof sailed from Seattle on 18 January and the Lynnann from San Francisco on 21 January.

Observation watches aboard the Pribilof were maintained while the vessel cruised south 167 to 185 km. (90 to 100 miles) offshore from Cape Flattery, Wash., to central California and on the return trip when it traveled 9 to 111 km. (5 to 60 miles) offshore. Dates, areas, distances traveled, and number of seals seen were as follows:

Date	Area	Distance run	Seals observed
		Km.	Number
19 Jan.	Washington, Oregon	107	7
20 Jan.	Northern California	189	3
21 Jan.	141 km. WSW. Pt. Arena to 69 km. W. Pt. Reyes	182	56
26 Feb.	Pt. Arena to Cape Mendocino	191	5
27 Feb.	Cape Blanco to Yaquina Head	204	12
28 Feb.	Willapa Bay to Cape Flattery	204	14

DISTRIBUTION OFF CALIFORNIA

A survey of seal distribution off the central and southern California coast was made along transects run at 37-km. (20-mile) intervals between latitudes 32° N. and 38° N. The Pribilof began the survey on 30 January in lat. 32° N. Observations were made from dawn to dark each day that sea conditions permitted. A distance of 185 to 222 km. (100 to 120 miles) was run on a transect during this period. The vessel moved north at night to the next transect line. The Lynnann assisted with a few transects but principally was used to collect seals.

Configuration of the ocean bottom in the region surveyed is shown in figure 29 and the distribution of fur seals expressed as seals seen per hour in different months is shown in figures 30-32. A comparison of figure 29 with figures 30 to 32 shows that seal densities are often greatest near seavalleys, seamounts, or along the Continental Shelf, where there are abrupt changes in depth and upwelling of nutrient-rich bottom water creates a very productive area.

The amount of time vessels occupied a square, and the number of seals seen, the number collected, and the number seen per hour (density value) are shown by months in tables C-1 to C-3. The highest density (41.1) in any square occupied for more than 0.5 hour was observed in March, southwest of Pt. Buchon (V18-H24), where 111 seals were seen in 2.7 hours. Values of over 10 seals per hour usually denote above-average densities.

In January, areas of seal abundance were located 37 to 46 km. (20 to 25 miles) west of San Miguel Island, near the Monterey Seavalley, and west of the Farallon Islands and Cordell Bank.

In February, seals were abundant 130 to 148 km. (70 to 80 miles) west of San Miguel Island, 56 km. (30 miles) west of Pt. Conception, off Monterey Bay and Monterey Seavalley, 111 to 130 km. (60 to 70 miles) west of the Farallon Islands, and off the western edge of Cordell Bank.

In March, seals were abundant southwest of Pt. Conception, 93 to 111 km. (50 to 60 miles) northwest of Pt. Arguello, and 74 km. (40 miles) west of Pt. Piedras Blancas. They were less numerous near the Monterey Seavalley.

Seals were scarce south of lat. 34° N. during the 6 days spent in this area, although they have been abundant there in other years. D. W. Rice (whale marking cruises, unpublished field notes for 1962, 1964, and 1965) found them in abundance 74 to 93 km. (40 to 50 miles) west of San Nicolas Island, and 19 to 56 km. (10 to 30 miles) northwest of Cortes Bank in January 1965. He observed seals in smaller numbers near San Miguel, Santa Rosa, San Nicolas, and San Clemente Islands, off Pt. Loma, and south to lat. 30° N. V. B. Scheffer saw fur seals off Pt. Loma, and near Santa Cruz and San Clemente Islands in 1952 (Taylor, Fujinaga, and Wilke, 1955).

Seals are found regularly during the winter and spring, January to June, between lat. 34° N. and 38° N. In April, May, and June 1965 seal concentrations were present west of Pt. Reyes, on Cordell Bank, west of the Farallon Islands, and near the Monterey Seavalley (Fiscus and Kajimura, 1967). Numbers are usually greatest 37 to 130 km. (20 to 70 miles) off central and southern California.

Surface water temperatures in the survey area were 12° to 15° C. in January, 10° to 15° C. in February, and 11° to 14° C. in March. Usually the highest temperatures were found offshore and the lowest temperatures nearer shore.

RELATIVE ABUNDANCE OF SEALS AND SIZE OF GROUPS

The number and relative abundance of seals seen and collected off California in 1966 are shown in tables C-4 and C-5. From 21 January to 31 March an average of 42.9 seals were seen per boat-hunting day. In 1961 during the same period off California, 37.2 seals were seen per

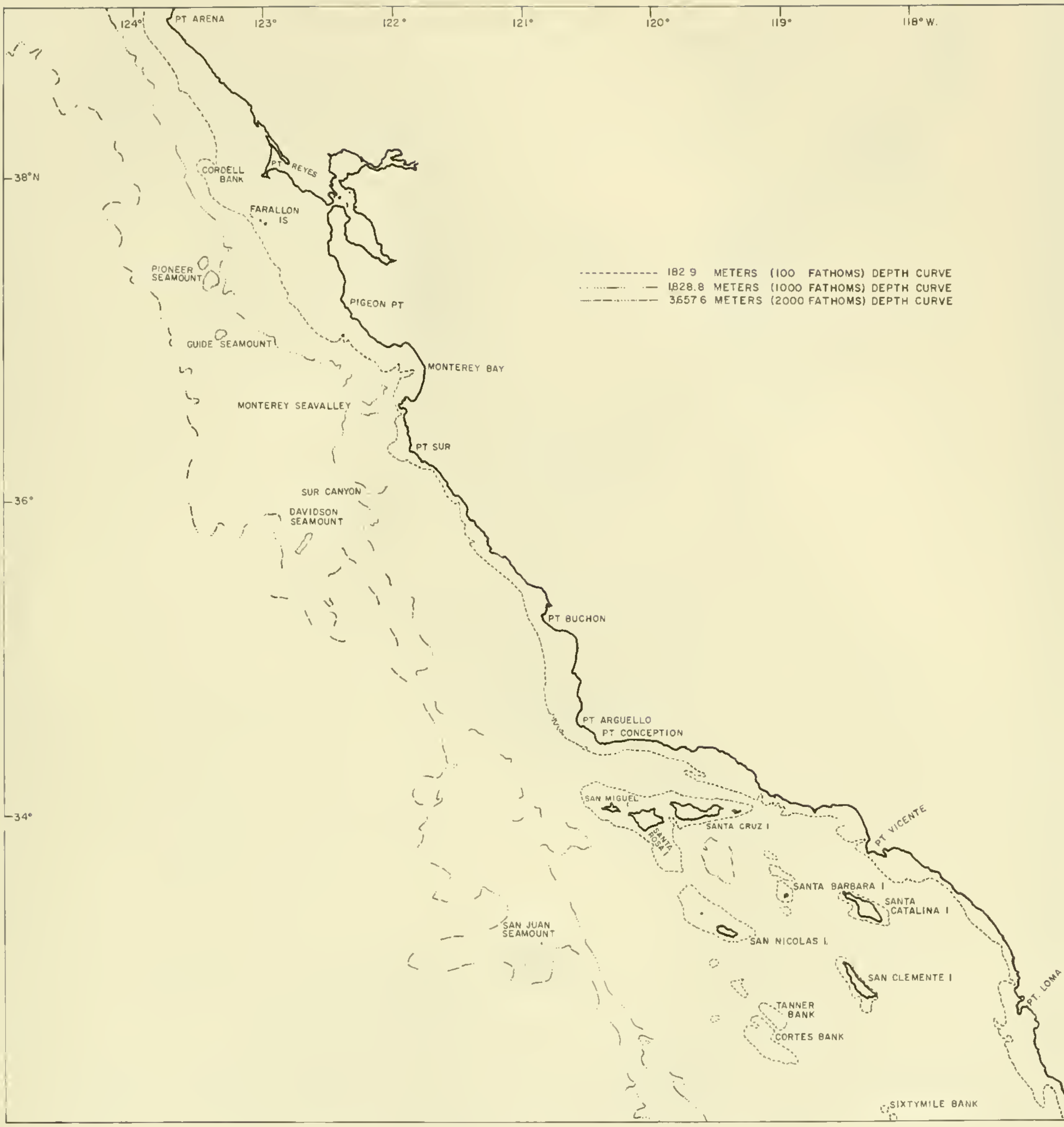

Figure 29.--The ocean off central and southern California showing bottom configuration. (From USCGS Chart No. 5002.)

boat-hunting day.[16] From April to June 1965, after the northward migration began, the number of seals seen per boat-hunting day was 25.9 (Fiscus and Kajimura, 1967).

A group of seals is defined as one or more seals that are feeding, traveling, or resting in close association with each other. Grouping of seals off California in 1966 (table C-6) was similar to that in 1961[17] during the same period. Single seals made up 31.4 percent of the total number of seals observed in 1961 and 31.0 percent in 1966. In contrast, 50.6 percent of the

[16] Clifford H. Fiscus, Karl Niggol, and Ford Wilke. 1961. Pelagic fur seal investigations, California to British Columbia, 1961. Bureau of Commercial Fisheries Marine Mammal Biological Laboratory, Seattle, Wash., 87 pp. [Processed.]

[17] See footnote 16.

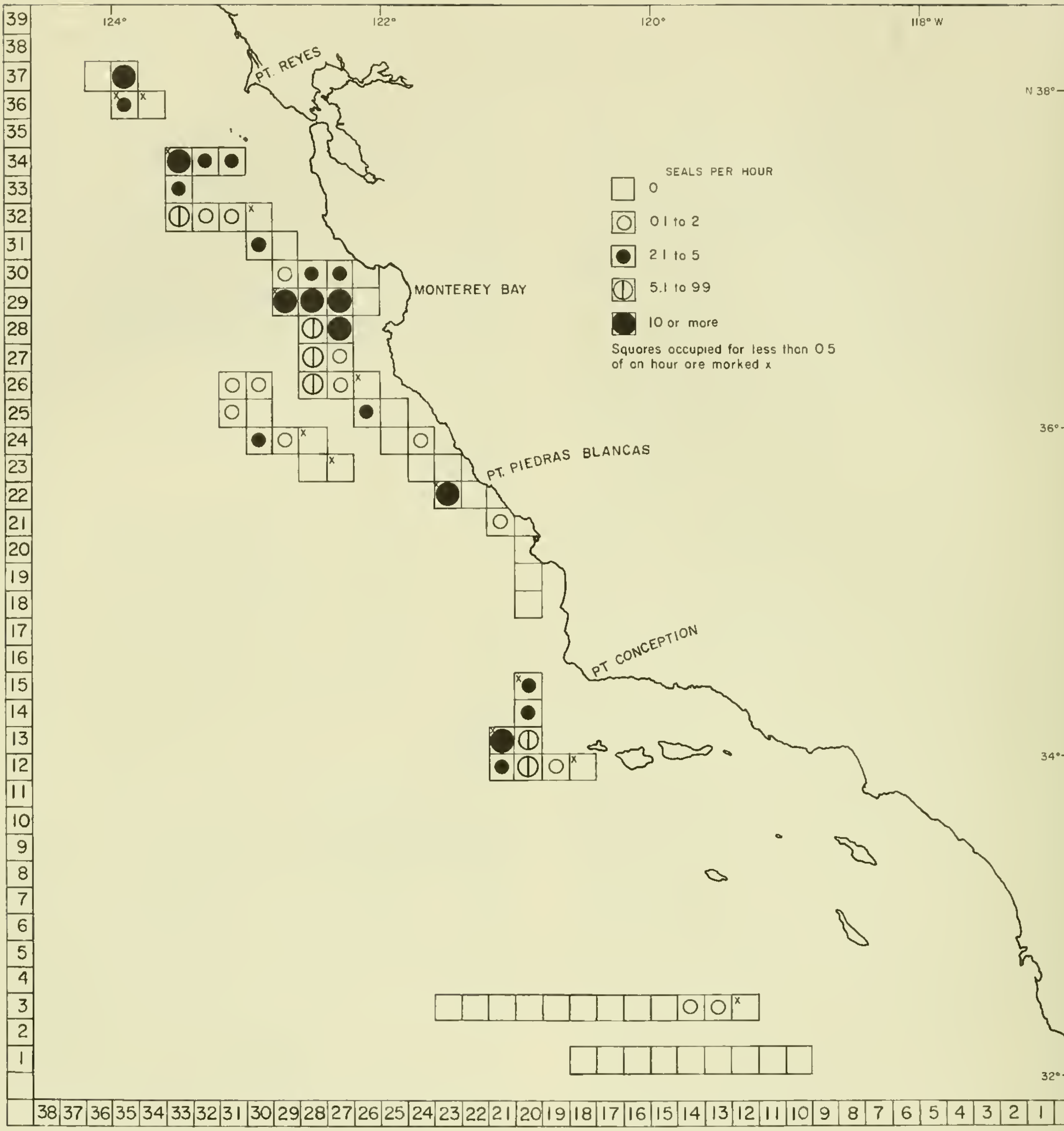

Figure 30.--Number of seals seen per hour of effort, in each square (areal unit) occupied by a research vessel in January 1966, off California. The sides of each square measure 18.52 km. (10 nautical miles). See table C-1.

seals observed April to June 1965 were single animals (Fiscus and Kajimura, 1967). The remaining percentages in all 3 years included groups of 2 to 20 seals.

Of 2,704 seals sighted in 1966, 444 were collected, 78 were wounded and lost, and 67 were killed and lost.

DISTRIBUTION BY AGE AND SEX

The age and sex of seals taken off California in 1966 are shown by month in table 47. More females age 8 and younger and fewer females age 9 and older were taken in 1966 than in 1961 (North Pacific Fur Seal Commission, 1965). This difference may reflect the kill of adult females age 10 and older on the Pribilof Islands in 1956-63 (Roppel, Johnson, Anas, and Chapman, 1965), rather than an actual change in distribution by age.

The age and sex of seals collected off California in January to June since 1958 are shown in table 48. Females 5 years old or older were dominant in the area in all months, although their numbers decreased by late March, when they began to migrate northward. Departure of the older females had the effect of increasing

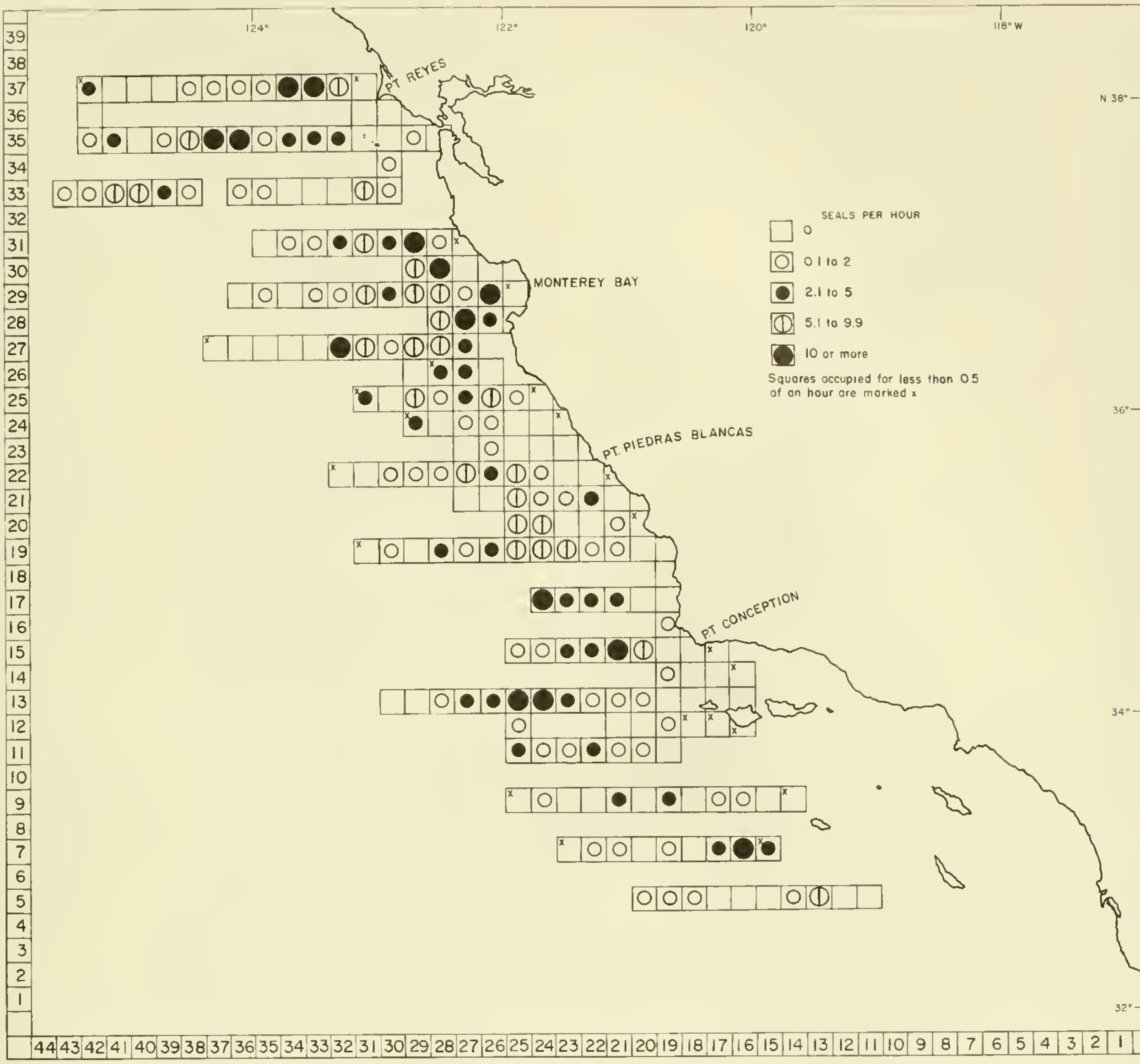

Figure 31.--Number of seals seen per hour of effort, in each square (areal unit) occupied by a research vessel in February 1966, off California. The sides of each square measure 18.52 km. (10 nautical miles). Squares V24-H25 and V23-H22 were not occupied. See table C-2.

the proportion of young animals in the population. Males formed only a small part of the population in this area and usually arrived later than the females.

TAG RECOVERIES

One tagged male and 26 tagged females were taken in 1966 (table 49). Tagged seals of both sexes made up 8.5 percent of those age 4 and younger and 5.3 percent of those age 5 and older.

No seals tagged on Robben Island or on the Commander Islands were taken at sea by U.S. research vessels; however, three seals tagged as pups on Southeastern Rookery, Medny Island (Commander Islands) in 1965[18] were found dead on U.S. west coast beaches in 1966 by beachcombers. One was found 20 March on a beach near Tillamook, Oreg. (lat. 45°33' N.), another on 17 February near Moclips, Wash. (lat. 47°14' N.), and a third on 26 February near

[18] V. A. Arseniev. Report on U.S.S.R. fur seal investigations in 1965. All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Moscow, 95 pp., 17 pls. [Processed.]

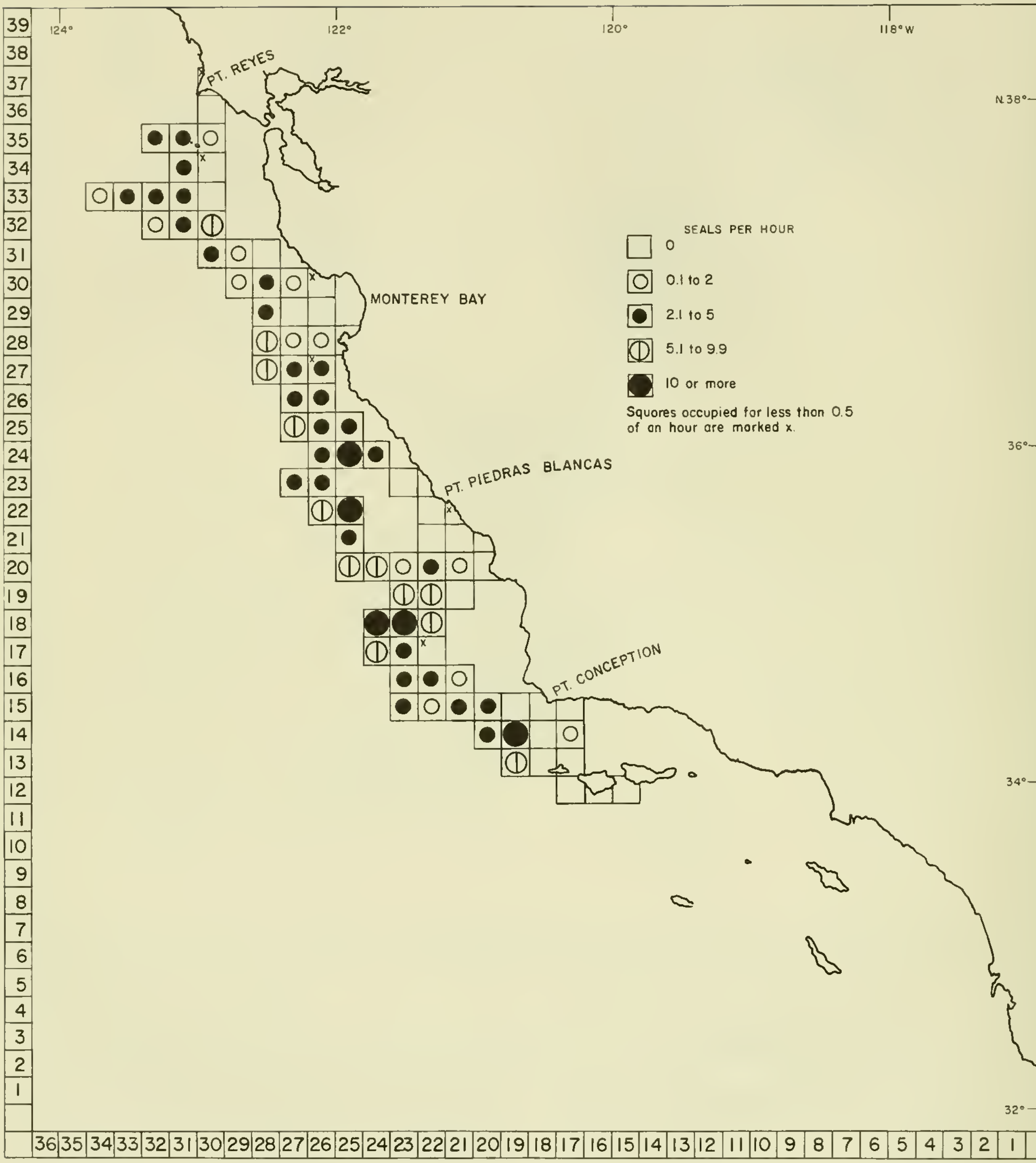

Figure 32.--Number of seals seen per hour of effort, in each square (area unit) occupied by a research vessel in March 1966, off California. The sides of each square measure 18.52 km. (10 nautical miles). Squares V14-H18 and V29-H27 were not occupied. See table C-3.

Table 47.--Age and sex, by month, of fur seals collected pelagically by the U.S.A. off California in 1966

Age	January				February				March				Total			
	Male		Female		Male		Female		Male		Female		Male		Female	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
1	-	-	-	-	-	-	4	2.1	2	40.0	3	1.6	2	25.0	7	1.6
2	1	100.0	-	-	1	50.0	1	0.5	-	-	4	2.1	2	25.0	5	1.2
3	-	-	2	4.1	1	50.0	17	8.9	3	60.0	11	5.9	4	50.0	30	7.1
4	-	-	6	12.2	-	-	27	14.2	-	-	35	18.6	-	-	68	15.9
5	-	-	4	8.2	-	-	27	14.2	-	-	35	18.6	-	-	66	15.4
6	-	-	4	8.2	-	-	14	7.3	-	-	17	9.0	-	-	35	8.2
7	-	-	7	14.3	-	-	22	11.6	-	-	17	9.0	-	-	46	10.7
8	-	-	8	16.3	-	-	16	8.4	-	-	19	10.2	-	-	43	10.0
9	-	-	1	2.0	-	-	9	4.7	-	-	10	5.3	-	-	20	4.7
10	-	-	1	2.0	-	-	7	3.7	-	-	5	2.7	-	-	13	3.0
11	-	-	4	8.2	-	-	9	4.7	-	-	10	5.3	-	-	23	5.4
12	-	-	4	8.2	-	-	10	5.2	-	-	2	1.1	-	-	16	3.7
13	-	-	4	8.2	-	-	5	2.6	-	-	3	1.6	-	-	12	2.8
14	-	-	1	2.0	-	-	10	5.2	-	-	3	1.6	-	-	14	3.3
15	-	-	3	6.1	-	-	6	3.1	-	-	6	3.2	-	-	15	3.5
16	-	-	-	-	-	-	4	2.1	-	-	1	0.5	-	-	5	1.2
17	-	-	-	-	-	-	1	0.5	-	-	4	2.1	-	-	5	1.2
19	-	-	-	-	-	-	1	0.5	-	-	2	1.1	-	-	3	0.7
20	-	-	-	-	-	-	-	-	-	-	1	0.5	-	-	1	0.2
21	-	-	-	-	-	-	1	0.5	-	-	-	-	-	-	1	0.2
Total	1		49		2		191		5		188		8		428	

Table 48.--Age and sex of fur seals collected pelagically by the U.S.A. off California by month[1]

[Combined data for 1958, 1959, 1961, 1964, 1965, and 1966]

Month	Seals collected	Males[2]		Females		Females: Ages 1-4		Females: Ages 5-20+	
	Number	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Jan....	596	5	0.8	591	99.2	61	10.3	530	89.7
Feb....	1,387	4	0.3	1,383	99.7	152	11.0	1,231	89.0
Mar....	804	10	1.2	794	98.8	143	18.0	651	82.0
Apr....	474	26	5.5	448	94.5	98	21.9	350	78.1
May....	332	18	5.4	314	94.6	97	30.9	217	69.1
June...	96	3	3.1	93	96.9	37	39.8	56	60.2

[1] Data for 1958, 1959, and 1961 from North Pacific Fur Seal Commission Report on Investigations from 1958 to 1961 (1964); data for 1964 from Fiscus and Kajimura (1965); data for 1965 from Fiscus and Kajimura (1967).
[2] All males are age 4 or younger, except one 5-year-old collected in 1964.

Table 49.--Tag recoveries from fur seals collected pelagically by the U.S.A. off California in 1966

[Figures in parentheses indicate animals that had lost tags; they are included in the totals]

Age	Year of tagging	Tag series	Seals tagged	Tag recovery ♂	Tag recovery ♀	Seals collected in each age group[1] ♂	Seals collected in each age group[1] ♀
Years			Number	Number	Number	Number	Number
3......	1963	P	24,971	1	--	4	30
4......	1962	O	49,908	--	9(1)	--	68
5......	1961	N	49,921	--	6(2)	--	66
6......	1960	M	59,981	--	3(1)	--	35
7......	1959	L	49,881	--	3	--	46
8......	1958	K	49,917	--	1	--	43
9......	1957	J	49,842	--	3(1)	--	20
12......	1954	G	10,000	--	1(1)	--	16

[1] Table does not include seals born in years when no tagging was done, or year classes from which no tagged seals were taken.

Cape Alava, Wash. (lat. 48° 10' N.). During the same period, beachcombers found 15 seals that had been tagged on the Pribilof Islands. In 1965, a seal tagged in 1959 on Medny Island was recovered in British Columbia.[19] These four are the only tagged seals from the western Pacific Ocean that have been recovered in the eastern Pacific Ocean south of Unimak Pass, Alaska.

[19] G. C. Pike, I. B. MacAskie, and A. Craig. Report on Canadian pelagic fur seal research in 1965. Fisheries Research Board of Canada, Nanaimo, B. C. [Processed.]

SIZE

Lengths and weights are given for pregnant and nonpregnant females collected in 1966 in tables C-7 to C-10, and for males in tables C-11 and C-12. Mean lengths and weights of male and female fetuses collected in 1966 by 10-day periods are shown in table C-13.

REPRODUCTION

Records of the reproductive condition of female fur seals are used in determining pregnancy rates. They are also used to determine if the distribution of female seals differs according to reproductive condition.

Reproductive Condition

The youngest pregnant female collected in 1966 was a primiparous 4-year-old (1.5 percent of the 4-year-olds collected). Four multiparous 5-year-olds (6 percent of the 5-year-olds collected) were taken. These five females conceived at age 3 and produced or would have produced pups at age 4. Of the 5-year-old females taken, 21.2 percent were primiparous.

The reproductive conditions of 428 females collected off California in 1966 are given in table C-14.

Pregnancy Rate

The number of female seals (and percentage pregnant) taken in the eastern Pacific from 1958 to 1966 is shown in table 50; those taken off California in 1966 are listed by month in table C-15. One- and two-year-old females were not included because none had been pregnant. Between ages 7 and 15, there was less than a 9-percent difference in the pregnancy rate of the total seals in an age class. The percentage of pregnant females taken during their productive years (ages 6-26) from 1958 to 1966 ranged from 73.4 in 1965 to 86.0 in 1963. In 1965 seals were collected from April to June off California and Washington; in 1963 they were collected in the Bering Sea from July to September.

Uterine Horn of Conception, Twinning, and Fetal Sex Ratio

The uterus of the fur seal is bicornuate, and the gestation period is nearly a year. Normally, conception alternates from one horn to the other; however, both ovaries may ovulate and a conceptus may develop in each uterine horn simultaneously when neither horn has supported a full-term fetus. Of 4,604 pregnant females collected at sea since 1958, 6 carried twins, 2 sets of which were in separate horns. Arseniev[20] reported twin fetuses in separate uterine horns of a seal collected in the Sea of Japan in 1964.

There is no record of both twins surviving until weaned. Peterson and Reeder (1966) observed the birth of three pairs of twins on the Pribilof Islands; in each case, at least one died.

Only 0.1 percent of the pregnant seals collected at sea since 1958 were carrying twin fetuses.

[20] V. A. Arseniev. Report on U.S.S.R. fur seal investigations in 1964. All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Moscow, 101 pp. [Processed.]

Pregnancy occurs in the left and right uterine horn with about equal frequency. Of 5,281 pregnant and postparturient females, 51 percent had conceived in the left uterine horn (1958-66).

The sex ratio among fetuses is also about equal. Of 4,592 fetuses examined since 1958, 51 percent were females and 49 percent were males.

ATTACHED ORGANISMS (COMMENSALS)

Algae and gooseneck barnacles attached to the guard hairs of seals were noted by Scheffer (1962), who reported several hundred barnacles on one seal. Since 1958, when the current pelagic research program began, algae and gooseneck barnacles have been observed on seals at various times of the year throughout their range. Algae that have been identified from samples found on fur seals are Ectocarpus sp. (Scheffer, 1962; Fiscus and Kajimura, 1965) and Erythrocladia sp. (Scheffer, 1962). Three species of gooseneck barnacles have been identified: Lepas anatifera and L. pectinata pacifica (Fiscus and Kajimura, 1965; 1967), and L. hilli (Scheffer, 1962).

No attempt was made to record all observations until 1964, when 98 of 343 fur seals collected between 19 May and 1 June off California, Oregon, and Washington were examined. Algae were attached to the guard hairs of 21 seals, and gooseneck barnacles to 6 seals (Fiscus and Kajimura, 1965). In 1965, all fur seals taken off California from April through June were examined for algae and barnacles (Fiscus and Kajimura, 1967). Examinations were resumed off California in 1966 from January through March, completing a survey during the time (January to June) when the largest numbers of seals are found on this wintering ground. Algae were found on 17.4 percent of the seals collected and barnacles on 14.0 percent (table 51). Algae grew most frequently on the throat, nape, and back. The extent of algal growth varied from a few spots to almost complete coverage of the haired part of the body. Gooseneck barnacles were most frequently attached to guard hairs on the ear pinna, nape, and back, although they have been found on most parts of the body, except for hairless skin. Gooseneck barnacles collected in 1965 and 1966 varied in capitulum size from 1 to 15 mm.; 42 were counted on one seal. In 1966, Lepas pectinata pacifica was found on eight seals, and Lepas sp. on one seal.

FOOD

Fur seals feed mainly on fish and cephalopods throughout their range in the eastern North Pacific Ocean and Bering Sea. A report on the food and feeding habits of fur seals was given

Table 50.--Number of female seals collected pelagically by the U.S.A. in the eastern Pacific and (in parentheses) percentage pregnant, 1958-66

Age	Year									1958-66
	1958	1959	1960	1961	1962	1963	1964	1965	1966	combined
Years					-Number-					
3	39	43	18	84	93	53	74	51	30	485
	(2.6)	(0.0)	(0.0)	(0.0)	(1.1)	(0.0)	(0.0)	(0.0)	(0.0)	(0.4)
4	42	93	36	96	140	113	62	73	68	723
	(2.4)	(6.4)	(2.8)	(1.0)	(2.9)	(7.1)	(1.6)	(0.0)	(1.5)	(3.2)
5	70	114	55	68	123	162	84	23	66	765
	(45.7)	(56.1)	(49.1)	(20.6)	(26.0)	(43.8)	(35.7)	(26.1)	(27.3)	(38.4)
6	99	118	45	62	72	90	81	37	35	639
	(80.8)	(77.1)	(80.0)	(75.8)	(54.2)	(74.4)	(75.3)	(56.8)	(71.4)	(73.1)
7	103	143	66	95	93	77	44	24	46	691
	(89.3)	(76.2)	(78.8)	(75.8)	(84.9)	(88.3)	(77.3)	(79.2)	(78.3)	(81.2)
8	102	164	105	107	98	87	46	33	43	785
	(89.2)	(86.6)	(85.7)	(79.4)	(89.8)	(97.7)	(84.8)	(84.8)	(79.1)	(86.9)
9	81	108	144	114	73	60	30	17	20	647
	(96.3)	(88.9)	(92.4)	(93.9)	(83.6)	(85.0)	(83.3)	(70.6)	(100.0)	(90.1)
10	97	96	129	112	100	72	49	10	13	678
	(87.6)	(85.4)	(91.5)	(93.8)	(89.0)	(93.1)	(87.8)	(90.0)	(84.6)	(89.8)
11	113	98	136	82	91	88	42	18	23	691
	(92.0)	(89.8)	(91.2)	(89.0)	(89.0)	(94.3)	(85.7)	(83.3)	(78.3)	(90.0)
12	134	76	106	71	97	92	51	15	16	658
	(82.0)	(88.2)	(90.6)	(93.0)	(89.7)	(92.4)	(84.3)	(73.3)	(100.0)	(88.3)
13	110	56	120	76	58	76	33	8	12	549
	(82.7)	(89.3)	(87.5)	(82.9)	(94.8)	(90.8)	(84.8)	(100.0)	(100.0)	(87.6)
14	92	70	107	67	65	57	38	10	14	520
	(81.5)	(84.3)	(80.4)	(92.5)	(87.7)	(80.7)	(76.3)	(80.0)	(85.7)	(83.5)
15	71	87	67	68	53	75	41	14	15	491
	(78.9)	(88.5)	(83.6)	(79.4)	(81.1)	(85.3)	(65.9)	(78.6)	(93.3)	(81.9)
16	56	69	53	55	50	45	22	12	5	367
	(78.6)	(75.4)	(71.7)	(85.5)	(82.0)	(82.2)	(72.7)	(83.3)	(80.0)	(78.7)
17	36	36	46	24	44	28	21	10	5	250
	(55.6)	(80.6)	(67.4)	(62.5)	(72.7)	(71.4)	(61.9)	(80.0)	(40.0)	(68.0)
18	22	27	23	25	25	12	20	8	-	162
	(59.1)	(85.2)	(82.6)	(64.0)	(72.0)	(58.3)	(60.0)	(37.5)	-	(68.5)
19	14	16	19	10	15	5	7	2	3	91
	(28.6)	(81.3)	(57.9)	(50.0)	(60.0)	(60.0)	(57.1)	(0.0)	(33.3)	(54.9)
20	3	5	6	7	11	11	10	2	1	56
	(33.3)	(40.0)	(16.7)	(100.0)	(72.7)	(45.5)	(20.0)	(0.0)	(0.0)	(46.4)
21	1	7	6	2	3	4	-	1	1	25
	(100.0)	(85.7)	(50.0)	(50.0)	(100.0)	(50.0)	-	(0.0)	(0.0)	(64.0)
22	1	5	-	-	3	-	-	-	-	9
	(0.0)	(40.0)	-	-	(66.7)	-	-	-	-	(44.4)
23	-	1	1	1	-	2	1	1	-	7
	-	(0.0)	(0.0)	(0.0)	-	(0.0)	(100.0)	(0.0)	-	(14.3)
24	-	1	1	1	1	-	-	-	-	4
	-	(0.0)	(0.0)	(0.0)	(0.0)	-	-	-	-	(0.0)
26	-	1	-	-	-	-	-	-	-	1
	-	(0.0)	-	-	-	-	-	-	-	(0.0)
Total	1,286	1,434	1,289	1,227	1,308	1,209	756	369	416	9,294
	(76.1)	(73.8)	(79.7)	(68.5)	(63.4)	(69.3)	(58.7)	(45.8)	(52.3)	(68.9)
6-26 years	1,135	1,184	1,180	979	952	881	536	222	252	7,321
	(83.3)	(83.4)	(84.4)	(84.3)	(83.2)	(86.0)	(77.0)	(73.4)	(81.3)	(83.2)

Table 51.--Number and percentage of fur seals collected pelagically by the U.S.A. off California in 1965 and 1966 with algae or barnacles growing on guard hairs[1]

Month	Year	Seals collected	Algae		Barnacles		Both algae and barnacles	
		Number	Number	Percent	Number	Percent	Number	Percent
Jan......	1966	50	0	0.0	0	0.0	0	0.0
Feb......	1966	193	5	2.6	3	1.6	3	1.6
Mar......	1966	193	4	2.1	6	3.1	2	1.0
Apr......	1965	46	13	28.3	7	15.2	1	2.2
May......	1965	128	63	49.2	40	31.3	27	21.1
June.....	1965	96	38	39.6	43	44.8	21	21.9
Total..		706	123	17.4	99	14.0	54	7.6

[1] The 1965 data from Fiscus and Kajimura (1967).

by Lucas (1899). Scheffer (1950a) reviewed the literature. More recent studies are: Taylor, Fujinaga, and Wilke (1955); Wilke and Kenyon (1957); North Pacific Fur Seal Commission (1965); Fiscus, Baines, and Wilke (1964); Fiscus, Baines, and Kajimura (1965); and Fiscus and Kajimura (1965; 1967).

Fish and cephalopods were identified by comparing them with a reference collection of whole and skeletal specimens, and by using identification keys prepared by Akimushkin (1963); Barnhart (1936); Berry (1912; 1914); Bolin (1939); Clarke (1962); Clemens and Wilby (1961); Clothier (1950); Fraser-Brunner (1949); Roedel (1953); Sasaki (1929); Schultz (1936); and Welander.[21]

Little or no food in the stomachs of many seals collected at sea since 1958 and observed inactivity of the animals during daylight indicate that feeding occurs primarily at night; however, seals may also feed during the day in areas where food is abundant in the upper surface layers. Fur seals appear to feed heavily on the most readily available fishes or cephalopods.

In 1966, 331 (76 percent) of 437 stomachs collected contained food; however, 110 of the 331 stomachs contained only trace amounts (i.e., less than 5 cc.). Anchovy, saury, hake, and squid constituted 98 percent of the total food volume in 1966. Anchovy contributed 74 percent. Since 1958, these four species have contributed 82 to 98 percent of the food found in stomachs of seals collected off California (fig. 33). Locations at which these and certain other important food species occurred in fur seal stomachs in 1966 are shown in figures C-1 to C-6. The results of the stomach examinations are shown in table 52.

[21] Arthur D. Welander. 1949. Outline of the classification of fishes (compiled by Arthur D. Welander). Fisheries 402 and 403, University of Washington, Seattle, Wash., 72 pp. [Processed.]

Three new species are reported for the first time in 1966 as fur seal food in the eastern Pacific; a lanternfish (*Myctophum californiense*), a sciaenid (species unknown), and a squid (*Chiroteuthis veranyi*).

The number of fur seal stomachs examined from California waters since 1958 total 3,591. The yearly totals were:

1958	1959	1961	1964	1965	1966
470	1,263	847	305	269	437

The following fishes and cephalopods were identified in 1966. Where applicable, common and scientific names of fishes are from the list published by the American Fisheries Society (1960). Names of cephalopods are those used by Berry (1912; 1914) and Sasaki (1929).

Engraulis mordax. Northern anchovies were most numerous in the stomachs of seals collected between Pigeon Pt. and Pt. Sur (fig. C-1). They ranked first both in total food volume and in frequency of occurrence in 1966. They contributed 74 percent of the total food volume and were found in 54 percent of the stomachs (fig. 33). One stomach contained the remains of 231 anchovies. Anchovies have been one of the major food species consumed by fur seals off California during each of the 6 years of collection.

Magnisudis barysoma. Barracudinas have been found in the stomachs of fur seals in 3 of 6 years that seals were collected off California. In 1959, nine occurrences were recorded off Eureka and one off Pt. Conception. One occurrence was also recorded off Eureka in 1964. In 1966, *M. barysoma* were found in the stomachs of two seals, one taken 120 km. (65 miles) west of Pt. Sur (lat. 36° 24' N., long. 123° 19' W.) and one 61 km. (33 miles) west of Pt. Piedras Blancas (lat. 35° 51' N., long. 122° 07' W.).

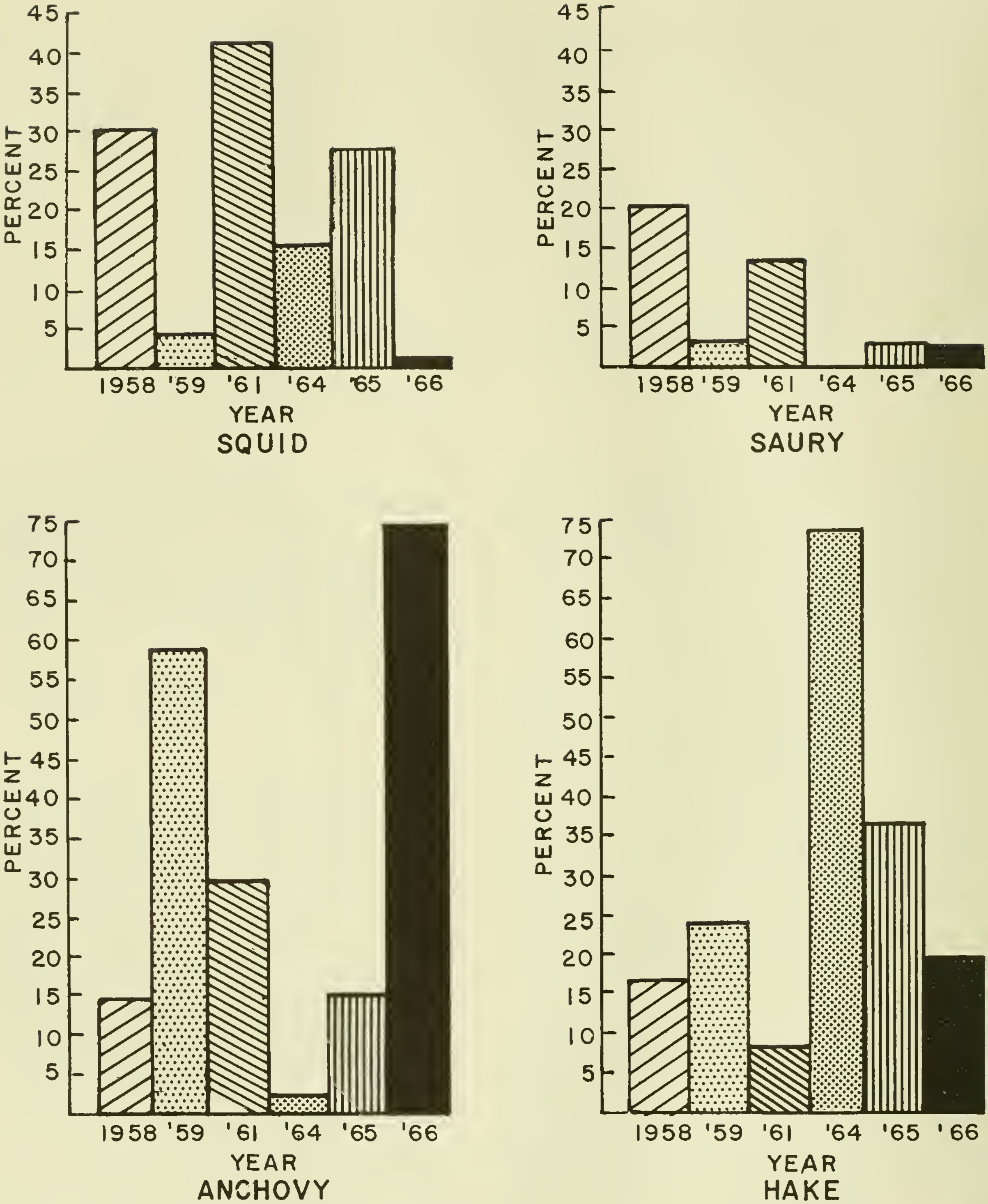

Figure 33.--Major food items found in stomachs of fur seals collected off California, by percentage of total stomach volume, 1958-66.

Table 52.--Stomach contents of fur seals collected pelagically by the U.S.A. off California, 1966[1/]

Food	Winter			Spring					
	January-February			March			January-March		
	Volume		Frequency	Volume		Frequency	Volume		Frequency
	Cc.	Percent	Number	Cc.	Percent	Number	Cc.	Percent	Number
Fish									
Engraulis mordax	66,809	85.2	123	24,966	55.6	57	91,775	74.4	180
Magnisudis barysoma	T	0.0	1	510	1.1	1	510	0.4	2
Tarletonbeania crenularis	-	-	-	T	0.0	1	T	0.0	1
Myctophum californiense	442	0.6	1	-	-	-	442	0.4	1
Cololabis saira	2,633	3.4	11	767	1.7	5	3,400	2.8	16
Merluccius productus	6,173	7.9	9	18,298	40.8	47	24,471	19.8	56
Trachipteridae	435	0.6	4	-	-	-	435	0.4	4
Trachurus symmetricus	5	0.0	1	-	-	-	5	0.0	1
Sciaenidae	-	-	-	10	0.0	1	10	0.0	1
Sebastodes spp.	40	0.0	1	-	-	-	40	0.0	1
Pleuronectidae	-	-	-	200	0.4	1	200	0.1	1
Unidentified	35	0.0	42	60	0.1	43	95	0.1	85
Octopus									
Tremoctopus sp.	T	0.0	1	-	-	-	T	0.0	1
Squid									
Loligo opalescens	674	0.9	60	T	0.0	10	674	0.5	70
Onychoteuthis sp.	1,064	1.3	45	134	0.3	26	1,198	1.0	71
Moroteuthis robusta	-	-	-	T	0.0	2	T	0.0	2
Abraliopsis sp.	T	0.0	1	T	0.0	3	T	0.0	4
Gonatidae	T	0.0	16	T	0.0	12	T	0.0	28
Gonatus fabricii	T	0.0	5	T	0.0	18	T	0.0	23
Unidentified	T	0.0	5	T	0.0	8	T	0.0	13
Bird									
Ptychoramphus aleutica	100	0.1	1	-	-	-	100	0.1	1
Organic material	-	-	-	T	0.0	1	T	0.0	1
Isopoda	-	-	-	T	0.0	1	T	0.0	1
Total	78,410			44,945			123,355		
Stomachs with food	187			144			331		
Stomachs empty	58			48			106		

1/ T=trace (<5 cc.). Trace counts are included in frequency counts.

Tarletonbeania crenularis. This lanternfish was found in the stomach of a seal collected in lat. 35° 47' N., long. 122° 16' W. Nine stomachs contained *T. crenularis* in 1961, and one in 1964.

Myctophum californiense. This lanternfish was recorded in 1966 as fur seal food for the first time. It was found in a stomach of a seal collected off Monterey in lat. 36°30' N., long. 122°17' W.

Cololabis saira. Pacific saury is one of the important food species of fur seals off California. This species has been found in stomachs collected every year since 1958. In 1966, Pacific saury (fig. C-2) ranked third in total food volume (2.7 percent) and seventh in frequency of occurrence.

Merluccius productus. Pacific hake (fig. C-3) occurred in 30 percent of the stomachs containing food and ranked second in total food volume (19.7 percent). As in past years, Pacific hake were eaten by seals along the entire coast of California. This species has been the second most important food fish taken by fur seals and, like Pacific saury, has occurred each year that seals were collected off California since 1958.

Trachipteridae. Fitch (1964) reported four species of ribbonfishes in the eastern Pacific Ocean. Three of these are said to be taken frequently by sport and commercial fishermen in waters off California, but members of this family are of negligible importance as fur seal food in the eastern Pacific Ocean. Vertebral remains of ribbonfishes were found in four fur seal stomachs in 1966 (fig. C-4), one in 1958, and two in 1959.

Trachurus symmetricus. Jack mackerel have occurred in stomachs of fur seals during 5 of the 6 years of collections off California, but its contribution to the fur seal diet is small. In 1966, jack mackerel occurred in the stomach of only one seal (collected in lat. 37°20' N., long 124° 42' W.).

Sciaenidae. One small juvenile fish from this family was found in a stomach collected in lat. 37° 20' N., long. 123° 39' W.[22] This specimen is the first sciaenid found in a fur seal stomach.

Sebastodes spp. Rockfishes have been of minor importance as fur seal food off California. One seal taken in lat. 37° 00' N., long. 122° 37' W. contained the remains of one rockfish.

Pleuronectidae. Flatfishes of this family were in a stomach collected in lat. 37° 45' N., long. 122° 58' W. Flatfishes have been of negligible importance as fur seal food.

Tremoctopus sp. The remains of this small pelagic octopus were found in the stomach of a seal taken in lat. 34° 04' N., long. 121° 04' W. Previously this octopus occurred in 28 seal stomachs in 1961 and 1 in 1965.

Squids. Squids are a major food item of fur seals in all areas in which seals range, including the eastern and western North Pacific Ocean, Bering Sea, Sea of Japan, and the Sea of Okhotsk. Off California squids are one of the most important foods of fur seals. Squid beaks and pens remain in the stomach long after the soft bodies are digested. These beaks and pens are listed as trace amounts when no body fragments are found.

The following squids were found in stomachs in 1966: Loligo opalescens, Onychoteuthis sp.,[23] Moroteuthis robusta, Abraliopsis sp., and Gonatus fabricii. The remains of another squid, Chiroteuthis veranyi, were found loose in a barrel of stomachs and had probably dropped out of a stomach before the collection was fixed by formaldehyde. This occurrence of C. veranyi in fur seal stomachs is the first from the eastern Pacific Ocean, although the species was found in stomachs of fur seals taken in the western Pacific Ocean in 1959 (North Pacific Fur Seal Commission, 1965).

Loligo opalescens ranked fourth in frequency of occurrence and fifth in total volume of food in 1966. Although the total food volume of L. opalescens was low in 1966, the 70 occurrences (fig. C-5) are comparable to the number of occurrences in 1964 and 1965. The dorsal mantle length of two specimens was 67 and 90 mm. One stomach had the remains (pens and beaks) of 65 L. opalescens.

Onychoteuthis sp. ranked third in frequency (71 occurrences) and fourth in total volume. Onychoteuthis sp. were found throughout the collection area in 1966 (fig. C-6). One stomach had the remains of 34 squids, mainly beaks and pens.

Moroteuthis robusta is probably not commonly eaten because of its large size. The remains of the cartilaginous end cones of M. robusta were found in two stomachs--one collected in lat. 34°40' N., long. 121°31' W. and one in lat. 35°47' N., long. 122°16' W. This record is the third and fourth occurrence of this species in seal stomachs since 1958; the other two also were off California, one in 1961 and one in 1965.

Abraliopsis sp. has been a minor food item of fur seals collected off California. In 1966 this squid was found in four seals taken between Monterey and the Farallon Islands (fig. C-4). It was found in a few seal stomachs from the same general area in 1961 and 1965.

Gonatus fabricii. This species was noted in stomachs of 23 fur seals collected in 1966 (fig. C-2). G. fabricii was also a minor food species of seals off California in 1964 and 1965.

Squids from 28 seals were identified only to the family Gonatidae and those from 13 were unidentified.

Miscellaneous. A small sea bird, Ptychoramphus aleutica (Cassin's Auklet), was found in a stomach of a fur seal taken near the Farallon Islands. Other items were a piece of wood in 1 stomach and 17 parasitic isopods, Rocinella belliceps, in another.

RELATION OF FUR SEALS TO COMMERCIAL FISHERIES

The effects of fur seal predation on commercially important food species cannot be accurately appraised with present knowledge of the ocean environment and ecology. Data collected to date indicate, however, that the food of seals is governed by abundance and availability of the prey species, and that predation on important commercial species is negligible.

An indication of the extent to which fur seals eat commercial food species can be gained by comparing the species eaten by seals with those taken commercially. The 10 leading commercial species (in order of pounds landed) taken from California waters in 1964 (California Fish and Game, 1965) were: Trachurus symmetricus (jack mackerel), Thunnus alalunga (albacore), Scomber diego (Pacific mackerel), Loligo opalescens (squid), Sardinops caerulea (sardine), Oncorhynchus tshawytscha and O. kisutch (king and silver salmon), Microstomus pacificus (Dover sole), all species of Sebastodes and Sebastolobus (rockfish), Engraulis mordax (northern anchovy), and Parophrys vetulus (English sole). Four species, jack mackerel, squid, rockfish, and anchovy, were found in both fur seal stomachs and in the list of 10 leading commercial species. Jack mackerel and rockfish, however, occurred only once in seal stomachs in 1966.

[22] Identification was made by A. D. Welander, College of Fisheries, University of Washington, Seattle, Wash.

[23] Onychoteuthis banksii and O. borealijaponicus were until recently considered synonymous. Recent evidence indicates that both may be valid species. Until this question is resolved, these specimens can only be identified to genus.

Northern anchovy, which contributed 74 percent of the total volume of food of fur seals, ranked ninth commercially in total tonnage landed in 1964 (2,257 metric tons). This catch, however, probably represents only a fraction of the total possible yield for the species. During the latest commercial anchovy season in California, which ended 30 April 1966, the total landings (15,344 metric tons) fell well below the 68,038-metric ton quota granted by the California Fish and Game Commission (Pacific Fishermen, 1966). This low catch was not due to a scarcity of anchovies, but to the reluctance of vessel owners to invest new equipment in an uncertain anchovy fishery.

The food species that ranked second in importance was Pacific hake, which contributed 19.8 percent of the total food volume. This species is of negligible commercial importance off California (50.8 metric tons landed in 1964). Pacific saury is not fished commercially off California. The present commercial harvest of Loligo opalescens (which ranked fifth in total seal food volume off California) probably represents only a small fraction of the possible yield.

Damage by fur seals to fishing gear is practically nonexistent, because seals usually remain well offshore where no commercial fishing operations are in progress.

SUMMARY

The 9th year of pelagic fur seal research under terms of the Interim Convention of North Pacific Fur Seals was conducted off California from 21 January to 25 March 1966.

The Bureau of Commercial Fisheries Pribilof Islands supply vessel, M/V Pribilof, and the chartered whale catcher, M/V Lynnann, were used in the research.

Distribution of seals was studied along transect lines extending offshore 19 to 222 km. (10 to 120 miles) at 37-km. (20-mile) intervals between latitudes 32° N. and 38° N. Seal concentrations were usually found 37 to 130 km. (20 to 70 miles) offshore over areas where abrupt changes in depths occur along the Continental Shelf and over seavalleys and seamounts.

From 21 January to 25 March, an average of 42.9 seals were seen per boat-hunting day. Single seals made up 31 percent of the total number seen. Of 2,704 seals sighted, 444 were collected. Females 5 years old or older were dominant in the area during January to March; males formed only a small part of the population. Twenty-seven seals tagged on the Pribilof Islands were recovered at sea.

The following information on reproduction was obtained. Fifty-two percent of the female seals collected were gravid; the youngest was a primiparous 4-year-old. Between ages 7 and 15 the pregnancy rate of seals varied by less than 9 percent in a sample of 202 females. Pregnancy occurred in the left and right uterine horn with about equal frequency (51 percent in left horn) in 5,281 pregnant and postparturient females (1958-66). Fifty-one percent of 4,592 fetuses examined since 1958 were females.

Fewer occurrences of algae and gooseneck barnacles were noted on seals in 1966 than in 1965.

A lanternfish (Myctophum californiense), a sciaenid, and a squid (Chiroteuthis veranyi) were recorded as seal food for the first time. The northern anchovy, Engraulis mordax, was the major food species (by volume) eaten by seals off California.

Predation by seals on commercialy important species appears negligible. Damage to fishing gear is nonexistent because seals are found well offshore where there is no commercial fishing.

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Appendix A

Table A-1. --Age classification of male seals killed on St. Paul Island, 7 July to 5 August 1966

Date	Rookery 1/	Males killed 2/	Tooth sample	Seals in each age group of sample 2	3	4	5	Estimated seals killed from each age group 2	3	4	5
		- -Number- -		- - - - Percent			- - - -	- - - - - - - -Number			- - - - - -
July											
7	NEP(east)	1,244	188	2.1	53.8	40.4	3.7	26	669	503	46
7	NEP(west)	562	113	3.5	64.6	31.0	0.9	20	363	174	5
8	TZR	2,155	480	1.5	52.7	42.5	3.3	32	1,136	916	71
9	POL	669	159	1.3	36.5	54.7	7.5	9	244	366	50
10	ZAP	1,166	211	2.4	48.8	46.4	2.4	28	569	541	28
11	REEF	1,077	191	1.6	46.1	47.6	4.7	17	496	513	51
11	L-K	653	113	6.2	54.0	38.0	1.8	40	353	248	12
12	NEP(east)	860	154	4.5	57.2	36.4	1.9	39	492	313	16
12	NEP(west)	570	99	5.0	69.7	25.3	-	29	397	144	-
13	TZR	917	168	2.4	50.0	44.6	3.0	22	458	409	28
14	ZAP	2,045	325	4.6	55.1	36.3	4.0	94	1,127	742	82
15	REEF	466	77	-	46.7	44.2	9.1	-	218	206	42
15	L-K	249	28	7.1	64.3	25.0	3.6	18	160	62	9
16	POL	384	56	1.8	60.7	33.9	3.6	7	233	130	14
17	NEP(east)	1,131	198	8.6	58.1	29.8	3.5	97	657	337	40
17	NEP(west)	573	117	2.6	60.7	35.0	1.7	15	348	200	10
18	TZR	566	125	1.6	50.4	45.6	2.4	9	285	258	14
19	ZAP	2,703	578	4.3	63.5	29.6	2.6	116	1,717	800	70
20	REEF	967	196	3.6	54.6	35.7	6.1	35	528	345	59
20	L-K	914	182	12.6	64.9	19.8	2.7	115	593	181	25
21	POL	582	105	4.8	66.7	25.7	2.8	28	388	150	16
22	NEP(east)	573	114	7.0	64.0	26.4	2.6	40	367	151	15
22	NEP(west)	799	160	9.4	66.2	23.8	0.6	75	529	190	5
23	TZR	1,507	301	6.0	57.8	32.6	3.6	90	872	491	54
24	ZAP	1,151	229	8.7	53.3	32.3	5.7	100	613	372	66
25	REEF	2,349	467	15.0	61.7	21.0	2.3	352	1,450	493	54
26	L-K	678	145	10.3	70.4	11.7	7.6	70	477	79	52
26	POL	412	82	15.8	59.8	17.1	7.3	65	246	71	30
27	NEP(east)	909	180	11.1	65.0	22.8	1.1	101	591	207	10
27	NEP(west)	1,170	231	13.9	74.0	11.2	0.9	163	866	131	10
28	TZR	1,500	300	11.0	64.0	23.0	2.0	165	960	345	30
29	ZAP	1,968	395	8.9	71.1	18.2	1.8	175	1,400	358	35
30	REEF	1,038	205	10.2	56.1	29.3	4.4	106	582	304	46
31	POL	611	122	19.7	63.1	13.9	3.3	120	386	85	20
31	L-K	931	183	20.2	62.9	14.2	2.7	188	586	132	25
Aug.											
1	NEP(east)	861	175	10.3	71.4	17.7	0.6	89	615	152	5
1	NEP(west)	541	107	23.4	62.6	14.0	-	127	339	75	-
2	TZR	1,207	244	6.1	73.8	17.6	2.5	74	890	213	30
3	ZAP	1,823	364	7.7	63.7	26.1	2.5	140	1,161	476	46
4	REEF	560	113	6.2	66.4	22.1	5.3	35	372	124	29
4	L-K	406	80	15.0	75.0	10.0	-	61	304	41	-
5	POL	657	128	1.6	75.8	19.5	3.1	11	498	128	20
Season total		42.104	8,188					3,143	25,535	12,156	1,270

1/ NEP(east)=east or Morjovi side of Northeast Point; NEP(west)=west or Vostochni side of Northeast Point; TZR=Tolstoi, Zapadni Reef, and Little Zapadni; POL=Polovina and Little Polovina; ZAP=Zapadni; REEF=Reef, Gorbatch, and Ardiguen; L-K=Lukanin and Kitovi.

2/ Includes experimental and rejected skins.

Table A-2. --Cumulative age classification of male seals killed on St. Paul Island, 7 July to 5 August 1966

Date	Rookery[1/]	Estimated seals killed from each age group[2/] 2	3	4	5	Total kill	Seals killed from each age group 2	3	4	5
		-Number-					-Percent-			
July										
7	NEP (east)	26	669	503	46	1,244	2.1	53.8	40.4	3.7
7	NEP (west)	46	1,032	677	51	1,806	2.5	57.2	37.5	2.8
8	TZR	78	2,168	1,593	122	3,961	2.0	54.7	40.2	3.1
9	POL	87	2,412	1,959	172	4,630	1.9	52.1	42.3	3.7
10	ZAP	115	2,981	2,500	200	5,796	2.0	51.4	43.1	3.5
11	REEF	132	3,477	3,013	251	6,873	1.9	50.6	43.8	3.7
11	L-K	172	3,830	3,261	263	7,526	2.3	50.9	43.3	3.5
12	NEP (east)	211	4,322	3,574	279	8,386	2.5	51.6	42.6	3.3
12	NEP (west)	240	4,719	3,718	279	8,956	2.7	52.7	41.5	3.1
13	TZR	262	5,177	4,127	307	9,873	2.7	52.4	41.8	3.1
14	ZAP	356	6,304	4,869	389	11,918	3.0	52.9	40.8	3.3
15	REEF	356	6,522	5,075	431	12,384	2.8	52.7	41.0	3.5
15	L-K	374	6,682	5,137	440	12,633	3.0	52.9	40.7	3.4
16	POL	381	6,915	5,267	454	13,017	2.9	53.1	40.5	3.5
17	NEP (east)	478	7,572	5,604	494	14,148	3.4	53.5	39.6	3.5
17	NEP (west)	493	7,920	5,804	504	14,721	3.3	53.8	39.5	3.4
18	TZR	502	8,205	6,062	518	15,287	3.3	53.7	39.6	3.4
19	ZAP	618	9,922	6,862	588	17,990	3.4	55.2	38.1	3.3
20	REEF	653	10,450	7,207	647	18,957	3.5	55.1	38.0	3.4
20	L-K	768	11,043	7,388	672	19,871	3.9	55.6	37.2	3.3
21	POL	796	11,431	7,538	688	20,453	3.9	55.9	36.9	3.3
22	NEP (east)	836	11,798	7,689	703	21,026	4.0	56.1	36.6	3.3
22	NEP (west)	911	12,327	7,879	708	21,825	4.2	56.5	36.1	3.2
23	TZR	1,001	13,199	8,370	762	23,332	4.3	56.6	35.9	3.2
24	ZAP	1,101	13,812	8,742	828	24,483	4.5	56.4	35.7	3.4
25	REEF	1,453	15,262	9,235	882	26,832	5.4	56.9	34.4	3.3
26	L-K	1,523	15,739	9,314	934	27,510	5.5	57.2	33.9	3.4
26	POL	1,588	15,985	9,385	964	27,922	5.7	57.3	33.6	3.4
27	NEP (east)	1,689	16,576	9,592	974	28,831	5.8	57.5	33.3	3.4
27	NEP (west)	1,852	17,442	9,723	984	30,001	6.2	58.1	32.4	3.3
28	TZR	2,017	18,402	10,068	1,014	31,501	6.4	58.4	32.0	3.2
29	ZAP	2,192	19,802	10,426	1,049	33,469	6.6	59.2	31.1	3.1
30	REEF	2,298	20,384	10,730	1,095	34,507	6.7	59.1	31.1	3.1
31	POL	2,418	20,770	10,815	1,115	35,118	6.9	59.1	30.8	3.2
31	L-K	2,606	21,356	10,947	1,140	36,049	7.2	59.2	30.4	3.2
Aug.										
1	NEP (east)	2,695	21,971	11,099	1,145	36,910	7.3	59.5	30.1	3.1
1	NEP (west)	2,822	22,310	11,174	1,145	37,451	7.5	59.6	29.8	3.1
2	TZR	2,896	23,200	11,387	1,175	38,658	7.5	60.0	29.5	3.0
3	ZAP	3,036	24,361	11,863	1,221	40,481	7.5	60.2	29.3	3.0
4	REEF	3,071	24,733	11,987	1,250	41,041	7.5	60.3	29.2	3.0
4	L-K	3,132	25,837	12,028	1,250	41,447	7.6	60.4	29.0	3.0
5	POL	3,143	25,535	12,156	1,270	42,104	7.5	60.6	28.9	3.0

1/ NEP (east)=east or Morjovi side of Northeast Point; NEP (west)=west or Vostochni side of Northeast Point; TZR=Tolstoi, Zapadni Reef, and Little Zapadni; POL=Polovina and Little Polovina; ZAP=Zapadni; REEF=Reef, Gorbatch, and Ardiguen; L-K=Lukanin and Kitovi.

2/ Includes experimental and rejected skins.

Table A-3. --Age classification of male seals killed on St. George Island, 6 July to 5 August 1966

Date	Rookery 1/	Males killed	Tooth sample	Seals in each age group of sample 2	3	4	5	6	Estimated seals killed from each age group 2	3	4	5	6
		---Number----		- - - - - -Percent- - - -					- - - - - - - Number- - - - - -				
July													
6	ZAP	593	123	4.0	32.5	52.9	9.0	1.6	24	193	314	53	9
8	EAST	1,104	220	2.3	40.4	50.9	6.4	-	25	446	562	71	-
11	NOR	828	165	1.2	38.8	53.3	6.1	0.6	10	321	441	51	5
13	ZAP	367	72	2.8	36.1	54.2	5.5	1.4	10	133	199	20	5
13	STAR	318	127	0.8	44.9	46.4	7.1	0.8	2	143	148	23	2
15	EAST	470	94	1.1	33.0	59.5	5.3	1.1	5	155	280	25	5
15	NOR	197	79	1.3	60.8	31.6	6.3	-	3	120	62	12	-
18	ZAP	276	112	-	42.0	43.7	14.3	-	-	116	121	39	-
18	NOR	656	130	5.4	58.5	31.5	4.6	-	35	384	207	30	-
20	EAST	779	159	3.1	66.0	27.1	3.8	-	24	514	211	30	-
22	ZAP	496	99	6.1	56.6	35.3	1.0	1.0	30	281	175	5	5
22	NOR	184	75	2.7	48.0	46.6	2.7	-	5	88	86	5	-
25	EAST	564	115	4.3	58.3	33.9	3.5	-	24	329	191	20	-
25	NOR	273	56	14.3	67.8	16.1	1.8	-	39	185	44	5	-
27	ZAP	515	100	4.0	66.0	25.0	5.0	-	21	340	129	25	-
27	STAR	237	94	1.1	53.2	36.2	9.5	-	3	126	86	22	-
29	NOR	831	170	1.8	67.6	28.2	2.4	-	15	562	234	20	-
Aug.													
1	EAST	764	162	8.0	67.3	21.6	3.1	-	61	514	165	24	-
3	STAR	87	44	6.8	59.1	31.8	2.3	-	6	51	28	2	-
3	ZAP	245	98	4.1	58.2	30.6	6.1	1.0	10	143	75	15	2
5	NOR	609	124	6.4	72.6	20.2	0.8	-	39	442	123	5	-
Season total		10,393	2,418						391	5,586	3,881	502	33

1/ ZAP=Zapadni and South; EAST=East Reef and East Cliffs; NOR=North; STAR=Staraya Artil.

Table A-4. --Cumulative age classification of male seals killed on St. George Island, 6 July to 5 August 1966

Age	Rookery 1/	Estimated seals killed from each age group 2	3	4	5	6	Total kill	Seals killed from each age group 2	3	4	5	6
		- - - - - -Number- - - - - -					Number	- - - - -Percent- - - - -				
July												
6	ZAP	24	193	314	53	9	593	4.1	32.5	53.0	8.9	1.5
8	EAST	49	639	876	124	9	1,697	2.9	37.7	51.6	7.3	0.5
11	NOR	59	960	1,317	175	14	2,525	2.3	38.0	52.2	6.9	0.6
13	ZAP	69	1,093	1,516	195	19	2,892	2.4	37.8	52.4	6.7	0.7
13	STAR	71	1,236	1,664	218	21	3,210	2.2	38.5	51.8	6.8	0.7
15	EAST	76	1,391	1,944	243	26	3,680	2.1	37.8	52.8	6.6	0.7
15	NOR	79	1,511	2,006	255	26	3,877	2.0	39.0	51.7	6.6	0.7
18	ZAP	79	1,627	2,127	294	26	4,153	1.9	39.2	51.2	7.1	0.6
18	NOR	114	2,011	2,334	324	26	4,809	2.4	41.8	48.5	6.7	0.6
20	EAST	138	2,525	2,545	354	26	5,588	2.5	45.2	45.5	6.3	0.5
22	ZAP	168	2,806	2,720	359	31	6,084	2.8	46.1	44.7	5.9	0.5
22	NOR	173	2,894	2,806	364	31	6,268	2.7	46.2	44.8	5.8	0.5
25	EAST	197	3,223	2,997	384	31	6,832	2.9	47.2	43.9	5.6	0.4
25	NOR	236	3,408	3,041	389	31	7,105	3.3	48.0	42.8	5.5	0.4
27	ZAP	257	3,748	3,170	414	31	7,620	3.4	49.2	41.6	5.4	0.4
27	STAR	260	3,874	3,256	436	31	7,857	3.3	49.3	41.4	5.6	0.4
29	NOR	275	4,436	3,490	456	31	8,688	3.2	51.0	40.2	5.2	0.4
Aug.												
1	EAST	336	4,950	3,655	480	31	9,452	3.5	52.4	38.7	5.1	0.3
3	STAR	342	5,001	3,683	482	31	9,539	3.6	52.4	38.6	5.1	0.3
3	ZAP	352	5,144	3,758	497	33	9,784	3.6	52.6	38.4	5.1	0.3
5	NOR	391	5,586	3,881	502	33	10,393	3.8	53.8	37.3	4.8	0.3

1/ ZAP=Zapadni and South; EAST=East Reef and East Cliffs; NOR=North; STAR=Staraya Artil.

Table A-5. --Dead pups counted , by rookery, Pribilof Islands, Alaska, 1941 and 1948-66

Rookery	1941	1948 1/	1949 1/	1950	1951	1952 1/	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
St. Paul Island																				
Morjovi	933	20,600	2,600	3,000	3,592	--	3,764	8,049	5,571	10,278	4,253	2,290	4,560	6,825	5,259	4,881	2,348	1,830	2,649	1,686
Vostochni	7,708		12,966	13,120	18,450	--	19,503	25,233	14,473	20,498	12,732	7,247	7,105	11,333	10,173	8,565	5,057	3,404	4,214	2,785
Little Polovina	292		1,600	1,740	2,208	--	2,211	3,852	2,782	4,443	1,695	975	1,597	2,427	2,415	2,121	923	631	1,132	449
Polovina Cliffs	2,356		--	3,800	5,580	2,954	5,451	6,413	5,964	8,637	4,425	1,826	2,586	3,462	4,576	2,957	2,160	1,097	2,856	809
Polovina			1,779	5,660	6,402	3,200	5,036	6,459	4,660	7,463	5,432	2,184	3,311	5,268	2,499	1,880	1,237	783	1,176	312
Ardiguen	42		--	170	242	--	189	282	387	364	249	102	141	331	411	225	141	102	459	160
Gorbatch	896		--	2,810	3,559	--	3,679	4,900	4,789	6,291	3,801	1,655	2,100	3,168	3,550	1,373	2,431	1,549	3,123	1,593
Reef	2,269		--	9,520	11,007	--	13,661	12,959	15,145	14,399	11,301	5,550	6,052	9,664	10,047	7,897	5,688	3,000	7,664	3,562
Kitovi	404		800	1,160	1,517	--	1,695	1,669	2,610	2,892	1,588	608	882	2,006	2,215	2,081	881	462	2,202	406
Lukanin			635	770	712	--	1,086	1,129	1,129	1,718	870	324	631	1,037	1,294	660	546	402	1,126	432
Tolstoi	1,623		--	4,230	6,033	--	6,154	7,552	6,489	6,789	5,659	2,823	3,691	5,237	4,761	3,004	3,274	2,614	3,955	3,425
Little Zapadni	372		--	2,120	2,804	--	2,446	4,979	3,555	4,611	2,325	1,312	1,691	4,148	3,047	2,399	2,580	1,101	2,461	1,634
Zapadni Reef	171		575	660	353	--	1,116	2,278	1,383	1,674	917	246	608	1,472	1,291	598	718	425	723	451
Zapadni	1,284		--	4,660	8,204	--	12,221	10,424	6,607	8,650	6,415	4,045	5,009	6,450	6,329	6,627	4,614	4,172	5,384	3,710
Counted total	18,350		--	53,420	70,663	--	78,212	96,178	75,544	98,707	61,662	31,187	39,964	62,828	57,867	45,268	32,598	21,572	39,124	21,414
Estimated oversight 5%	918		--	2,671	3,533	--	3,911	4,809	3,777	4,935	3,083	1,559	1,998	2,946	2,893	2,263	1,630	1,079	1,956	1,071
Total	19,268		--	56,091	74,196	--	82,123	100,987	79,321	103,642	64,745	32,746	41,962	65,774	60,760	47,531	34,228	22,651	41,080	22,485
St. George Island																				
North	--		--	--	--	--	3,197	3,776	--	6,357	3,942	1,626	2,653	3,489	3,883	2,242	2,525	792	1,854	1,561
Zapadni	--		--	--	--	--	1,272	1,453	--	2,742	1,569	962	1,633	1,902	2,019	1,740	704	446	1,263	1,196
East	--		--	--	--	--	846	1,524	--	2,203	1,064	616	664	1,112	1,347	504	502	272	676	764
Staraya Artil	--		--	--	--	--	3,353	2,903	--	3,806	2,729	1,552	1,987	2,000	2,514	1,435	1,041	767	1,186	1,152
Counted total	--		--	--	--	--	8,668	9,656	--	15,108	9,304	4,756	6,937	8,503	9,763	5,921	4,772	2,277	4,979	4,673
Estimated oversight 5%	--		--	--	--	--	433	483	--	755	465	238	347	425	488	296	239	114	249	234
Total	--		--	--	--	--	9,101	10,139	--	15,863	9,769	4,994	7,284	8,928	10,251	6,217	5,011	2,391	5,228	4,907
Pribilof Islands total 2/	--		--	--	--	--	91,224	111,126	--	119,505	74,514	37,740	49,246	74,702	71,011	53,748	39,239	25,042	46,308	27,392

1/ Partial counts. No counts made in 1942-47. The count in 1948 is the total for Morjovi and Vostochni Rookeries.

2/ Not included in the total are 2,228 dead pups counted on Sea Lion Rock (Sivutch) in 1966.

Table A-6. --Dead pups counted, by rookery sections, St. Paul Island, 1966

Rookery	Section number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
	Number														
Morjovi	1/ 637	186	123	303	155	282									1,686
Vostochni	107	92	91	115	206	566	131	352	363	114	128	207	200	113	2,785
Little Polovina	157	292													449
Polovina Cliffs	122	83	126	104	160	103	111								809
Polovina	198	114													312
Ardiguen 2/															160
Gorbatch	404	386	309	82	238	174									1,593
Reef	323	316	414	319	324	221	935	282	184	170	74				3,562
Kitovi	3/ 73	6	134	125	68										406
Lukanin	188	244													432
Tolstoi	188	200	326	182	459	723	472	875							3,425
Little Zapadni		4/ 452	277	453	245	207									1,634
Zapadni Reef	289	162													451
Zapadni	279	668	736	588	405	410	5/ 624								3,710
Total															21,414

1/ Includes 65 dead pups counted on point south of Sea Lion Neck.

2/ No numbered sections.

3/ Includes 43 dead pups counted in amphitheater.

4/ Dead pups counted in sections 1 and 2 combined.

5/ Dead pups counted on end of rookery combined with those in section 7.

Table A-7.--Number of fur seal pups that died of different causes, Reef Rookery study area, St. Paul Island, 28 June to 22 August 1966

Cause of death	28 June to 4 July	5-11 July	12-18 July	19-25 July	26 July to 1 August	2-8 August	9-15 August	16-22 August	Totals	Percentage
	-Number-									Percent
Malnutrition	4	4	15	17	11	11	5	2	69	42.1
Hookworm disease	-	-	4	7	3	6	4	5	29	17.7
Trauma	9	10	-	2	1	-	-	-	22	13.4
Bite wounds	(4)	(9)	-	(2)	-	-	-	-	(15)	(9.1)
Skull fracture	(1)	-	-	-	(1)	-	-	-	(2)	(1.2)
Liver rupture	(3)	(1)	-	-	-	-	-	-	(4)	(2.4)
Contusions	(1)	-	-	-	-	-	-	-	(1)	(0.6)
Infection	2	1	7	3	1	-	1	1	16	9.8
Navel	(2)	-	(5)	(2)	-	-	-	-	(9)	(5.5)
Peritonitis	-	-	(1)	-	(1)	-	-	(1)	(3)	(1.8)
Pleuritis	-	(1)	(1)	-	-	-	-	-	(2)	(1.2)
Enteritis	-	-	-	-	-	-	(1)	-	(1)	(0.6)
Abscess	-	-	-	(1)	-	-	-	-	(1)	(0.6)
Miscellaneous 1/	1	-	3	-	-	-	-	1	5	3.0
Total	16	15	29	29	16	17	10	9	141	
Undetermined	5	2	1	-	1	1	-	3	13	7.9
Unsuitable for examination	1	2	3	4	-	-	-	-	10	6.1
Total dead	22	19	33	33	17	18	10	12	164	100.0

1/ See section on Mortality.

Table A-8.--Length and weight of dead fur seal pups by cause of death, Reef Rookery study area, St. Paul Island, 1966

Cause of death	Number of pups[1]	Length Average	Length Range	Weight Average	Weight Range	Condition index[2]
		Cm.	Cm.	Kg.	Kg.	
Malnutrition	69	61.8	52.0-71.0	4.0	2.3-5.7	6.5
Hookworm disease	29	62.6	55.0-70.5	5.1	3.7-6.6	8.1
Trauma	22	61.4	55.0-71.0	4.7	3.8-6.4	7.7
Infection	16	62.7	55.0-70.5	5.6	4.3-7.2	8.9
Undetermined	13	60.4	50.0-70.5	5.0	2.8-7.6	8.3

1/ Ten pups unsuitable for examination and five pups that died of miscellaneous causes are not included.

2/ Ratio of weight to length X 100.

Table A-9.--Distribution of secondary causes among primary causes of death of pups, Reef Rookery study area, St. Paul Island, 28 June to 22 August 1966

Secondary causes of death	Primary causes of death: Malnutrition	Hookworm disease	Trauma	Infections	Miscellaneous	Undetermined
	Number of dead pups					
Malnutrition	---	---	---	1	---	1
Hookworm disease	1	---	---	1	---	---
Trauma	5	---	---	3	1	4
Bite wounds	(4)	(-)	(-)	(3)	(-)	(4)
Skull fracture	(1)	(-)	(-)	(-)	(-)	(-)
Liver rupture	(-)	(-)	(-)	(-)	(1)	(-)
Contusion	(-)	(-)	(-)	(-)	(-)	(-)
Infection	40	4	9	-	-	2
Navel	(-)	(-)	(-)	(-)	(-)	(1)
Peritonitis	(-)	(1)	(-)	(-)	(-)	(-)
Pleuritis	(-)	(-)	(-)	(-)	(-)	(-)
Enteritis	(40)	(3)	(-)	(-)	(-)	(1)
Abscess	(-)	(-)	(8)	(-)	(-)	(-)
Phlegmon	(-)	(-)	(1)	(-)	(-)	(-)
Miscellaneous	---	---	---	5	---	1

Table A-10. --Counts of harem and idle males, by rookery, Pribilof Islands, Alaska, 1966

Date	Rookery	Adult males		Total
		Harem	Idle	
		Number	Number	Number
St. Paul Island				
9 July	Polovina	188	405	593
	Polovina Cliffs	619	295	914
	Little Polovina	218	312	530
11 July	Gorbatch	607	521	1, 128
	Ardiguen	92	97	189
	Reef	1, 070	678	1, 748
12 July	Morjovi	645	534	1, 179
	Vostochni	1, 449	970	2, 419
13 July	Tolstoi	819	441	1, 260
	Lukanin	152	108	260
	Kitovi	413	194	607
14 July	Zapadni	957	847	1, 804
	Little Zapadni	542	227	769
	Zapadni Reef	203	210	413
St. Paul Island total		7, 974	5, 839	13, 813
St. George Island				
12 July	Staraya Artil	245	189	434
	North	762	278	1, 040
14 July	Zapadni	282	214	496
	South	294	115	409
16 July	East Reef	139	139	278
	East Cliffs	252	82	334
St. George Island total		1, 974	1, 017	2, 991
Pribilof Islands total		9, 948	6, 856	16, 804

Table A-11.--Counts of harem and idle males, by island, Pribilof Islands, Alaska, 1911-41 and 1943-66

Year	St. Paul Island		St. George Island		Both islands	
	Harem	Idle	Harem	Idle	Harem	Idle
	- - - - - - - - - - - -	- - - - - -	- - - - - -	-Number- - - -	- - - - - -	- - - - - -
1911	1,090	258	266	71	1,356	329
1912	1,077	93	281	20	1,358	113
1913	1,142	77	261	28	1,403	105
1914	1,316	159	243	13	1,559	172
1915	1,789	546	362	127	2,151	673
1916	2,948	2,278	552	354	3,500	2,632
1917	4,166	2,341	684	365	4,850	2,706
1918	4,610	2,245	734	199	5,344	2,444
1919	4,573	2,158	585	81	5,158	2,239
1920	3,542	1,078	524	83	4,066	1,161
1921	3,443	711	466	36	3,909	747
1922	3,184	493	378	15	3,562	508
1923	3,051	303	361	9	3,412	312
1924	3,127	375	389	15	3,516	390
1925	3,103	283	423	28	3,526	311
1926	3,478	368	556	55	4,034	423
1927	3,916	846	727	126	4,643	972
1928	5,059	1,208	991	241	6,050	1,449
1929	5,998	1,339	1,189	294	7,187	1,663
1930	6,823	1,555	1,489	344	8,312	1,899
1931	7,557	1,519	1,676	369	9,233	1,888
1932	8,268	1,940	1,820	409	10,088	2,349
1933	8,334	1,933	1,879	408	10,213	2,341
1934	8,841	1,860	1,929	422	10,770	2,282
1935	9,444	2,082	2,103	453	11,547	2,535
1936	10,055	2,253	-	-	-	-
1937	10,689	2,516	2,411	515	13,100	3,031
1938	10,720	1,787	-	-	-	-
1939	9,122	2,616	1,858	357	10,980	2,973
1940	9,662	3,968	1,988	571	11,650	4,539
1941	10,089	5,059	1,942	396	12,031	5,455
1943	10,948	3,523	2,107	330	13,055	3,853
1944	11,080	2,539	2,294	450	13,374	2,989
1945	10,750	4,055	2,434	750	13,184	4,805
1946	10,566	3,605	2,430	611	12,996	4,216
1947	10,160	3,331	1,808	479	11,968	3,810
1948	10,386	3,400	1,814	563	12,200	3,963
1949	9,554	2,976	1,746	552	11,300	3,528
1950	9,442	3,152	1,959	574	11,401	3,726
1951	9,434	3,581	1,825	549	11,259	4,130
1952	9,318	4,717	1,983	605	11,301	5,322
1953	9,848	5,912	2,285	826	12,133	6,738
1954	9,906	6,847	2,228	1,311	12,134	8,158
1955	9,034	8,650	2,130	1,902	11,164	10,552
1956	9,384	9,016	-	-	-	-
1957	9,562	10,060	2,423	2,693	11,985	12,753
1958	9,970	9,510	2,619	3,030	12,589	12,540
1959	10,003	11,485	2,527	2,699	12,530	14,184
1960	10,247	10,407	2,552	2,630	12,799	13,037
1961	11,163	11,791	2,843	2,489	14,006	14,280
1962	10,332	9,109	2,342	2,650	12,674	11,759
1963	9,212	7,650	2,071	1,890	11,283	9,540
1964	9,085	7,095	1,989	1,489	11,074	8,584
1965	8,553	5,616	1,917	1,113	10,470	6,729
1966	7,974	5,839	1,974	1,017	9,948	6,856

Table A-12. --Counts of harem and idle males, by rookery sections, St. Paul Island, 1966

Males, date, and rookery	Section number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
	Number of seals														
Harem males															
9 July															
Polovina	121	67													188
Polovina Cliffs	78	61	89	80	103	79	129								619
Little Polovina	90	128													218
11 July															
Gorbatch	113	94	99	70	93	138									607
Ardiguen 1/															92
Reef	101	124	119	58	107	97	120	124	78	81	61				1,070
12 July															
Morjovi	2/ 122	110	76	108	115	114									645
Vostochni	109	75	86	74	80	141	85	132	148	81	113	125	135	65	1,449
13 July															
Tolstoi	81	79	75	92	128	142	106	116							819
Lukanin	69	83													152
Kitovi	3/ 124	29	84	99	77										413
14 July															
Zapadni	4/ 98	144	139	138	109	148	129	52							957
Little Zapadni	60	78	112	123	79	90									542
Zapadni Reef	122	81													203
Total															7,974
Idle males															
9 July															
Polovina	348	97													405
Polovina Cliffs	16	36	31	31	38	91	52								295
Little Polovina	49	263													312
11 July															
Gorbatch	265	20	32	112	27	65									521
Ardiguen 1/															97
Reef	28	71	59	63			5/ 302	29	19	20	87				678
12 July															
Morjovi	6/ 171	38	35	41	43	206									534
Vostochni	26	35	31	93	34	68	212	49	63	47	38	163	55	56	970
13 July															
Tolstoi	12	16	9	16	28	51	29	280							441
Lukanin	90	18													108
Kitovi	7/ 22	2	15	20	135										194
14 July															
Zapadni	8/ 215	73	59	63	72	49	71	245							847
Little Zapadni	26	27	30	23	29	92									227
Zapadni Reef	42	168													210
Total															5,839

1/ No numbered sections.
2/ Includes 39 harem males counted south of the main rookery.
3/ Includes 48 harem males counted in amphitheater.
4/ Includes 9 harem males counted on Zapadni Point.
5/ Counts combined between markers 4 and 7 (Castle Rock area).
6/ Includes all idle males counted south of marker 1.
7/ Includes 9 idle males counted in amphitheater.
8/ Includes 179 idle males counted on Zapadni Point.

Table A-13.--Mean weights of handled and unhandled pups, St. Paul Island, 30 August 1966

[The number of pups in each sample is shown in parentheses]

Rookery	Males		Females	
	Handled	Unhandled	Handled	Unhandled
	Kg.	Kg.	Kg.	Kg.
NEP	8.75	9.46	7.61	7.93
	(75)	(75)	(75)	(75)
REEF	-	9.25	-	8.66
	-	(75)	-	(75)
ZAP	9.59	9.90	8.25	8.69
	(75)	(75)	(70)	(75)
POL	-	9.76	-	8.25
	-	(75)	-	(75)

Table A-14. --Pups tagged and marked, Pribilof Islands, Alaska, 1941, 1945, 1947-49, and 1951-66

Year	Series	St. Paul Island Number	St. George Island Number	Location of tag	Checkmarks or marks
1941	USA 1-10000;	10,000	---	Front flipper	Branded, nape of neck
	USA 1-1000 and USA 5001-6000	1,000 1,000	--- ---	♂♂ right front and hind flippers; ♀♀ left front and hind flippers	Double tagged, branded nape of neck
1945	10001-11000 (no letter prefix)	973	---	Left front flipper	None
1947	A 1-20000	19,183	---	Left front flipper	1/4" hole between 1st (big toe) and 2d digits left hind flipper
1948	B 1-19673	19,532	---	Left front flipper	None
1949	CS 1-20000	19,963	---	Left hind flipper	None
1951	D 1-1000	1,000	---	Right hind flipper	1/2 left ear on 100 tagged pups removed
1952	E 1-20000	19,979	---	Right front flipper	Tip of 1st digit (big toe) on right hind flipper sliced off
1953	F 1-10000	9,990	---	Left front flipper	Tip of left front flipper sliced off
	G 7001-7400	398	---	------do.------	Do.
1954	G 1-7000	7,000	---	Right front flipper	"V" notch near tip right front flipper
	G 7401-10400	3,000	---	------do.-------	Do.
1955	H 1-10000 10001-50000 (no letter prefix)	49,870	---	Left front flipper ------do.------	Tip of 1st digit (big toe) on left hind flipper sliced off
1956	I 1-10000	---	9,894	Right front flipper	Tip of right front flipper sliced off
	I 10001-50000	39,900	---	------do.-------	Do.
1957	J 1-10000	---	9,972	Left front flipper	"V" notch near tip left front flipper
	J 10001-50000	39,870	---	------do.------	Do.
1958	K 1-10000	---	9,994	Right front flipper	"V" notch near tip right front flipper
	K 10001-50000	39,923	---	------do.-------	Do.
	K 10001-15000	5,000	---	Right and left front flippers	Double tagged plus checkmark
1959	L 1-10000	---	9,980	Left front flipper	Tip of left front flipper sliced off
	L 10001-50000	39,901	---	------do.------	Do.
1960	M 1-12000	---	11,992	Right front flipper	Tip of right front flipper sliced off
	M 12001-60000	47,989	---	------do.-------	Do.
1961	N 1-10000	---	9,988	Left front flipper	"V" notch near tip left front flipper
	N 10001-50000	39,933	---	------do.------	Do.
1962	O 1-10000	---	9,980	Right front flipper	"V" notch near tip right front flipper
	O 10001-50000	39,928	---	------do.-------	Do.
1963	P 1-5000	---	4,993	Left front flipper	Tip of left front flipper sliced off
	P 5001-25000	19,978	---	------do.------	Do.
1964	Q 1-5000	---	4,993	Right front flipper	Tip of right front flipper sliced off
	Q 5001-25000	19,998	---	------do.-------	Do.
1965	R 1-10000	10,000	---	Left front flipper	"V" notch near tip left front flipper
	Marked	10,007	---	Not tagged	"V" notch near tip right front flipper
	Marked	10,080	---	---do.---	Tip of 1st digit (big toe) on right hind flipper sliced off
1966	S 1-2500	---	2,499	Left front flipper	Tip of left front flipper sliced off
	S 2501-12500	10,000	---	Right front flipper	Tip of 2d digit on right hind flipper sliced off
	Marked	9,578	---	Not tagged	Tip of 3d digit on right hind flipper sliced off
	Marked	---	2,503	--do.--	Tip of 2d digit on left hind flipper sliced off

Table A-15.--Pups tagged and marked, St. Paul Island, 15 September to 3 October 1966

Rookery	Pups marked: Clip end of 3d digit right hind flipper	Pups tagged and checkmarked: Tag numbers (S-series)	Pups tagged and checkmarked: Tag right front flipper and clip end of 2d digit right hind flipper
	Number		Number
Zapadni	1, 100	2501-3600	1, 100
Zapadni Reef	300	3601-3900	300
Little Zapadni	700	3901-4600	700
Reef	1, 206	4601-5800	1, 200
Gorbatch	902	5801-6700	900
Polovina	200	6701-6900	200
Polovina Cliffs	768	6901-7600	700
Little Polovina	300	7601-7900	300
Morjovi	1, 385	7901-8700	800
Vostochni	1, 115	8701-10400	1, 700
Tolstoi	900	10401-11300	900
Lukanin	202	11301-11500	200
Kitovi	500	11501-12000	500
Sea Lion Rock	-	12001-12500	500
Total	9, 578		10, 000

Table A-16.--Pups tagged and marked, St. George Island, 25-26 August 1966

Rookery	Pups marked: Clip end of 2d digit left hind flipper	Pups tagged and checkmarked: Tag numbers (S-series)	Pups tagged and checkmarked: Tag and slice left front flipper
	Number		Number
Zapadni	703	1-700	700
Staraya Artil	300	701-1000	300
East	500	1001-1500	500
North	1,000	1501-2500	1/ 999
Total	2,503		2,499

1/ One tag not used.

Table A-17.--Record of tags applied to male seals selected as yearlings, St. Paul Island, 27 September to 19 October 1966

Rookery or hauling ground	Tag numbers (1S-series)
Reef Rookery	20001-20031
Zapadni Rookery and hauling ground	20032-20050
Do.	20076-20100
Do.	20301-20329
Do.	20801-20855
Do.	21115-21196
Do.	21201-21300
Do.	21316-21325
Tolstoi Rookery	21401-21460
Do.	21476-21500
Tolstoi Sands and	20101-20300
Zapadni Reef hauling grounds	20330-20500
Do.	20856-21114
Do.	21197-21200
Do.	21301-21315
Do.	21344-21400
Do.	21461-21475
Polovina rookeries and hauling grounds	20051-20075
Do.	20701-20800
Do.	21326-21342
Northeast Point rookeries and hauling grounds	20501-20700

Table A-18.--Record of tags applied to male seals estimated to be in ages 2 to 4, St. Paul Island, 8-12 August 1966

Hauling ground	Tag number (2S-series)	Tags applied[1]	Ineffective tags[2]	Previous tag numbers recorded	Total effective tags
		Number	Number		Number
Zapadni Reef	30001-30046	46	---		
Do.------------------------	30101-30171	71	---		
Zapadni Reef total		117	6		111
Northeast Point	30047-30100	54	---		
Do.------------------------	30172-30500	329	---		
Do.------------------------	30601-30700	100	---		
Do.------------------------	30976-31000	25	---		
Do.------------------------	31246	1	---		
Do.------------------------	31270-31275	6	---		
Do.------------------------	31291	1	---		
Do.------------------------	31293-31300	8	---		
Northeast Point total		524	6	1R786-86	519
Polovina Sands	30501-30600	100	3		97
Lukanin	30701-30900	200	1	1R795-95	200
Reef	30901-30975	75	---	0-19739 P-50072	76
Zapadni	31001-31245	245	---		
Do.------------------------	31247-31269	23	---		
Do.------------------------	31276-31290	15	---		
Do.------------------------	31292	1	---		
Zapadni total		284	3		281
Tolstoi Sands	31301-31500	200	2	1R-992-92	199
Total all hauling grounds		1,500	21	4	1,483

[1] Duplicate tags; two tags bearing identical numbers were attached to each seal, one to each front flipper at the hairline.
[2] Tags receovered from seals that died shortly after being tagged, or tags that had fallen out because of poor clinching.

Table A-19.--Soviet tags receovered in the United States kill of fur seals, Pribilof Islands, Alaska, 6 July to 5 August 1966

Island and date	Tag number	Age	Sex	Island of tagging	Rookery of recovery[1]
		Years			
St. Paul Island					
28 July	P-17973	2	M	Bering	TZR
8 July	[2] H-26968	3	M	Medny	TZR
14 "	H-29964	3	M	--do.------	Zapadni
18 "	H-20722	3	M	Bering	TZR
19 "	H-2009	3	M	Robben	Zapadni
27 "	H-16267 & 16275	3	M	Bering	NEP
28 "	H-19042	3	M	--do.------	TZR
29 "	H-28439	3	M	Medny	Zapadni
29 "	H-28446	3	M	--do.------	--do.--
29 "	H-25788	3	M	--do.------	--do.--
29 "	H-20438	3	M	Bering	--do.--
3 Aug.	H-20267	3	M	--do.------	--do.--
7 July	M-16632	4	M	Medny	NEP
12 "	K-19368	4	M	Bering	--do.--
20 "	K-17851	4	M	--do.------	REEF
22 "	M-14355	4	M	Medny	NEP
22 "	M-19792	4	M	--do.------	--do.--
3 Aug.	M-13777	4	M	--do.------	Zapadni
3 "	M-18231	4	M	--do.------	--do.--
7 July	E-17551	5	M	Medny	NEP
23 July	C-37400	6	M	Medny	TZR
St. George Island					
8 July	H-27900	3	M	Medny	EAST
22 "	[2] H-22868	3	M	--do.------	Zapadni
25 "	H-25661 & 25948	3	M	--do.------	North
1 Aug.	[2] H-28213	3	M	--do.------	EAST
3 "	H-22184	3	M	--do.------	Zapadni
22 July	M-12594	4	M	Medny	Zapadni
22 "	M-17052	4	M	--do.------	North
25 "	K-18660	4	M	Bering	EAST
29 "	M-03052	4	M	Robben	North

[1] TZR = Tolstoi, Zapadni Reef, and Little Zapadni; NEP = Northeast Point (Vostochni and Morjovi Rookeries); REEF = Reef, Gorbatch, and Ardiguen; EAST = East Reef and East Cliffs; ZAPADNI of St. George Island = Zapadni and South.
[2] Double tagged--one tag lost; tag scar on untagged flipper.

Table A-20. --Tag recoveries from male seals of year classes 1952-64, by rookery and age, Pribilof Islands, Alaska, 1953-66

[Numbers in parentheses show sample size; percent recoveries were not computed for samples of less than 15 seals.]

Rookery of birth and year class	Recovery for age 2	3	4	5
	- - - - - - - Percent - - - - - - -			
1952 year class				
St. Paul Island				
ZAP	(1)	60.87 (46)	59.46 (37)	(2)
POL	41.86 (43)	54.55 (528)	60.66 (633)	(10)
NEP	50.00 (20)	40.00 (140)	68.85 (305)	(7)
REEF	5.88 (17)	11.98 (334)	17.88 (330)	(5)
1953 year class				
ZAP	(2)	57.66 (137)	83.33 (18)	(0)
POL	(5)	45.71 (105)	63.16 (19)	(0)
NEP	(3)	54.62 (130)	69.23 (26)	(1)
REEF	(3)	15.08 (179)	14.29 (35)	(0)
TOL	(1)	17.95 (78)	42.11 (19)	(0)
L-K	(1)	20.69 (29)	(8)	(0)
1954 year class				
ZAP	(11)	62.50 (80)	81.25 (16)	(3)
POL	(4)	40.00 (30)	(8)	(1)
NEP	(13)	68.42 (57)	73.91 (23)	(1)
REEF	35.00 (20)	20.35 (113)	24.00 (25)	(4)
TOL	(10)	27.91 (43)	(13)	(1)
L-K	(4)	28.57 (28)	(4)	(0)
1955 year class				
St. Paul Island				
ZAP	39.13 (23)	62.90 (434)	67.74 (155)	(2)
POL	30.30 (33)	48.75 (320)	67.19 (128)	(1)
NEP	62.07 (29)	63.29 (414)	80.92 (131)	(3)
REEF	35.59 (59)	19.86 (584)	20.31 (261)	(2)
TOL	5.56 (18)	28.63 (241)	21.74 (92)	(2)
L-K	(11)	21.82 (110)	38.30 (47)	(0)
1956 year class				
St. Paul Island				
ZAP	(12)	68.97 (87)	64.29 (28)	(2)
POL	44.44 (18)	46.67 (45)	53.33 (15)	(6)
NEP	59.26 (27)	58.33 (108)	75.00 (40)	(5)
REEF	40.00 (30)	9.48 (116)	27.27 (44)	(5)
TOL	(10)	18.18 (66)	38.89 (18)	(2)
L-K	(3)	18.18 (22)	(3)	(2)
St. George Island				
NOR	26.67 (15)	46.67 (30)	(14)	(2)
EAST	(8)	71.43 (21)	75.00 (12)	(1)
STAR	(3)	(14)	(7)	(1)
ZAP	(10)	32.00 (25)	(11)	(3)

Table A-20. --Tag recoveries from male seals of year classes 1952-64, by rookery and age, Pribilof Islands, Alaska, 1953-66--Continued

Rookery of birth and year class	Recovery for age 2	3	4	5
	Percent			
1957 year class				
St. Paul Island				
ZAP	63.16 (19)	57.32 (239)	70.06 (167)	___ (5)
POL	58.33 (36)	45.03 (171)	64.66 (133)	___ (5)
NEP	61.29 (31)	69.51 (328)	84.19 (215)	___ (14)
REEF	10.53 (19)	20.95 (253)	18.18 (198)	___ (9)
TOL	___ (12)	29.01 (131)	32.11 (109)	___ (4)
L-K	___ (7)	25.00 (100)	13.25 (83)	___ (4)
St. George Island				
NOR	___ (11)	47.13 (87)	50.00 (70)	___ (3)
EAST	___ (2)	49.35 (77)	47.62 (42)	___ (6)
STAR	___ (1)	28.57 (42)	30.00 (30)	___ (1)
ZAP	___ (6)	42.00 (50)	50.82 (61)	___ (5)
1958 year class				
St. Paul Island				
ZAP	80.77 (26)	69.08 (595)	57.92 (183)	87.50 (24)
POL	61.11 (18)	49.47 (380)	53.15 (111)	___ (12)
NEP	65.63 (32)	68.55 (566)	78.57 (196)	93.10 (29)
REEF	35.29 (17)	18.25 (537)	31.65 (158)	53.33 (15)
TOL	___ (14)	19.92 (266)	44.93 (69)	___ (10)
L-K	___ (9)	16.02 (181)	20.24 (84)	___ (11)
1958 year class (cont.)				
St. George Island				
NOR	___ (7)	48.19 (193)	68.66 (67)	___ (6)
EAST	___ (7)	50.00 (124)	72.97 (37)	___ (2)
STAR	___ (2)	22.78 (79)	23.53 (17)	___ (1)
ZAP	___ (3)	41.38 (58)	60.00 (20)	___ (9)
1959 year class				
St. Paul Island				
ZAP	51.85 (27)	57.38 (298)	72.84 (162)	___ (12)
POL	50.00 (32)	42.67 (150)	46.81 (94)	___ (11)
NEP	62.64 (22)	64.59 (209)	75.54 (139)	___ (13)
REEF	___ (15)	25.55 (274)	41.13 (141)	68.18 (22)
TOL	___ (6)	41.06 (151)	29.85 (67)	___ (2)
L-K	___ (4)	17.50 (80)	57.50 (40)	___ (5)
St. George Island				
NOR	18.75 (16)	54.41 (68)	63.64 (55)	___ (7)
EAST	___ (7)	44.44 (36)	69.70 (33)	___ (1)
STAR	___ (1)	21.43 (28)	25.00 (24)	___ (2)
ZAP	___ (2)	29.73 (37)	71.43 (42)	___ (4)

Table A-20.--Tag recoveries from male seals of year classes 1952-64, by rookery and age, Pribilof Islands, Alaska, 1953-66--Continued

Rookery of birth and year class	Recovery for age 2	3	4	5
	- - - - - - - Percent - - - - - - -			
1960 year class				
St. Paul Island				
ZAP	41.03 (39)	64.38 (292)	58.74 (143)	60.00 (25)
POL	— (10)	40.41 (146)	37.14 (70)	— (6)
NEP	68.97 (29)	73.86 (264)	79.84 (129)	— (11)
REEF	44.90 (49)	37.96 (245)	60.93 (151)	63.16 (19)
TOL	30.77 (26)	16.99 (153)	48.00 (75)	— (11)
L-K	— (11)	46.73 (107)	50.00 (48)	— (3)
St. George Island				
NOR	56.25 (16)	60.87 (92)	68.89 (45)	— (3)
EAST	— (6)	54.76 (42)	62.50 (24)	— (3)
STAR	— (5)	25.81 (31)	15.79 (19)	— (2)
ZAP	— (14)	8.89 (45)	70.59 (34)	— (3)
1961 year class				
St. Paul Island				
ZAP	— (11)	58.49 (265)	65.69 (137)	72.73 (22)
POL	— (6)	33.54 (158)	40.91 (88)	— (14)
NEP	41.67 (24)	76.79 (418)	85.42 (192)	83.33 (18)
REEF	36.67 (30)	49.52 (311)	65.19 (158)	39.13 (23)
TOL	20.00 (15)	38.65 (163)	60.19 (108)	— (9)
L-K	— (6)	46.23 (106)	6.38 (47)	— (8)
1961 year class				
St. George Island				
NOR	50.00 (20)	58.64 (191)	54.79 (73)	— (6)
EAST	— (3)	44.83 (87)	66.67 (33)	— (3)
STAR	— (9)	21.88 (64)	27.59 (29)	— (6)
ZAP	— (10)	39.33 (89)	75.00 (16)	— (1)
1962 year class				
St. Paul Island				
ZAP	53.33 (30)	52.45 (326)	43.53 (255)	
POL	53.33 (15)	36.36 (165)	44.74 (114)	
NEP	66.67 (48)	82.67 (375)	75.74 (169)	
REEF	40.00 (35)	51.94 (210)	44.39 (196)	
TOL	38.89 (18)	43.94 (132)	67.57 (74)	
L-K	— (14)	11.11 (72)	51.43 (35)	
St. George Island				
NOR	65.38 (26)	40.17 (117)	55.38 (112)	
EAST	— (6)	68.33 (60)	75.34 (73)	
STAR	— (5)	13.16 (38)	32.35 (34)	
ZAP	25.00 (16)	28.89 (87)	52.00 (75)	

Table A-20. --Tag recoveries from male seals of year classes 1952-64, by rookery and age, Pribilof Islands, Alaska, 1953-66--Continued

Rookery of birth and year class	Recovery for age 2	Recovery for age 3
	- - - -Percent- - - -	
1963 year class		
St. Paul Island		
ZAP	— (5)	43.41 (205)
POL	— (1)	36.71 (158)
NEP	81.48 (27)	62.40 (258)
REEF	— (11)	37.31 (193)
TOL	— (5)	43.24 (111)
L-K	— (3)	44.58 (83)
St. George Island		
NOR	— (9)	41.84 (98)
EAST	— (2)	53.62 (69)
STAR	— (1)	23.33 (30)
ZAP	— (4)	28.57 (77)

Rookery of birth and year class	Recovery for age 2
	Percent
1964 year class	
St. Paul Island	
ZAP	— (14)
POL	— (9)
NEP	38.24 (34)
REEF	32.26 (31)
TOL	— (7)
L-K	— (12)
St. George Island	
NOR	— (9)
EAST	— (5)
STAR	— (1)
ZAP	— (9)

Table A-21.--Errors in assigning ages of male fur seals from whole canine teeth

Correct age	Reader	Reading	Sample size	Assigned age (years) 2	3	4	5	Error Number	Percent
Years			Number	- - -Number- - -				Number	Percent
2	A	1	99	96	3	-	-	3	3.0
		2	99	97	2	-	-	2	2.0
	B	1	99	94	5	-	-	5	5.0
		2	99	94	5	-	-	5	5.0
	C	1	99	97	2	-	-	2	2.0
		2	99	93	6	-	-	6	6.1
	D	1	99	96	3	-	-	3	3.0
		2	99	99	-	-	-	0	0.0
3	A	1	99	1	96	2	-	3	3.0
		2	99	2	95	2	-	4	4.0
	B	1	99	2	93	4	-	6	6.1
		2	99	2	93	4	-	6	6.1
	C	1	99	3	90	6	-	9	9.1
		2	99	1	88	9	1	11	11.1
	D	1	99	4	89	6	-	10	10.1
		2	99	5	91	3	-	8	8.1
4	A	1	102	-	3	99	-	3	2.9
		2	102	-	4	97	1	5	4.9
	B	1	102	-	11	90	1	12	11.8
		2	102	-	11	91	-	11	10.8
	C	1	102	-	7	90	5	12	11.8
		2	102	-	3	86	13	16	15.7
	D	1	102	-	8	92	2	10	9.8
		2	102	-	11	90	1	12	11.8
5	A	1	80	-	-	2	78	2	2.5
		2	80	-	-	3	77	3	3.8
	B	1	80	-	1	22	57	23	28.8
		2	80	-	-	18	62	18	22.5
	C	1	80	-	-	5	75	5	6.3
		2	80	-	-	2	78	2	2.5
	D	1	80	-	1	6	73	7	8.8
		2	80	-	2	6	72	8	10.0

Table A-22.--Errors in assigning ages of male fur seals from sectioned canine teeth

Correct age	Reader	Reading	Sample size	Assigned age (years) 2	3	4	5	6	7	8	Errors	
Years			No.	- - - - - - -	-	Number	-	-	-	- - - -	No.	Percent
2	A	1	30	28	2	-	-	-	-	-	2	6.7
		2	30	28	2	-	-	-	-	-	2	6.7
	B	1	30	29	1	-	-	-	-	-	1	2.3
		2	30	26	4	-	-	-	-	-	4	13.3
	C	1	30	28	2	-	-	-	-	-	2	6.7
		2	30	26	4	-	-	-	-	-	4	13.3
	D	1	30	27	3	-	-	-	-	-	3	10.0
		2	30	28	2	-	-	-	-	-	2	6.7
3	A	1	30	-	29	1	-	-	-	-	1	3.3
		2	30	-	28	2	-	-	-	-	2	6.7
	B	1	30	3	24	3	-	-	-	-	6	20.0
		2	30	3	25	2	-	-	-	-	5	16.7
	C	1	30	3	23	4	-	-	-	-	7	23.3
		2	30	4	20	6	-	-	-	-	10	33.3
	D	1	30	1	25	4	-	-	-	-	5	16.7
		2	30	2	23	5	-	-	-	-	7	23.3
4	A	1	30	-	-	30	-	-	-	-	0	0.0
		2	30	-	-	30	-	-	-	-	0	0.0
	B	1	30	-	3	26	1	-	-	-	4	13.3
		2	30	-	3	26	1	-	-	-	4	13.3
	C	1	30	-	2	21	6	1	-	-	9	30.0
		2	30	-	2	21	7	-	-	-	9	30.0
	D	1	30	-	3	27	-	-	-	-	3	10.0
		2	30	-	1	28	1	-	-	-	2	6.7
5	A	1	30	-	-	-	30	-	-	-	0	0.0
		2	30	-	-	-	30	-	-	-	0	0.0
	B	1	30	-	-	2	28	-	-	-	2	6.7
		2	30	-	-	4	26	-	-	-	4	13.3
	C	1	30	-	-	-	24	6	-	-	6	20.0
		2	30	-	-	-	22	7	-	1	8	26.7
	D	1	30	-	-	1	29	-	-	-	1	3.3
		2	30	-	-	-	30	-	-	-	0	0.0

Table A-23.--Errors in assigning ages of female fur seals from whole canine teeth

Correct age	Reader	Reading	Sample size	Assigned age (years) 2	3	4	5	6	7	8	Error No.	Error Percent
Years			No.	- - - - -		-Number-		- - - -			No.	Percent
3	A	1	120	1	112	6	1	-	-	-	8	6.7
		2	120	-	115	5	-	-	-	-	5	4.2
	B	1	120	1	107	12	-	-	-	-	13	10.8
		2	120	-	106	12	2	-	-	-	14	11.7
	C	1	120	3	108	9	-	-	-	-	12	10.0
		2	120	-	110	10	-	-	-	-	10	8.3
	D	1	120	-	112	7	1	-	-	-	8	6.7
		2	120	-	112	5	3	-	-	-	8	6.7
4	A	1	107	-	1	101	5	-	-	-	6	5.6
		2	107	-	1	105	1	-	-	-	2	1.9
	B	1	107	-	1	100	6	-	-	-	7	6.5
		2	107	-	-	95	12	-	-	-	12	11.2
	C	1	107	-	8	89	7	3	-	-	18	16.8
		2	107	-	1	91	13	2	-	-	16	15.0
	D	1	107	-	1	97	7	2	-	-	10	9.3
		2	107	-	2	101	4	-	-	-	6	5.6
5	A	1	99	-	-	1	95	3	-	-	4	4.0
		2	99	-	-	4	93	2	-	-	6	6.1
	B	1	99	-	1	3	93	2	-	-	6	6.1
		2	99	-	1	1	93	4	-	-	6	6.1
	C	1	99	-	-	3	87	8	1	-	12	12.1
		2	99	-	-	3	89	7	-	-	10	10.1
	D	1	99	-	-	1	91	7	-	-	8	8.1
		2	99	-	-	-	93	6	-	-	6	6.1
6	A	1	100	-	-	1	9	86	4	-	14	14.0
		2	100	-	-	1	3	90	6	-	10	10.0
	B	1	100	-	-	2	20	74	4	-	26	26.0
		2	100	-	2	1	12	83	2	-	17	17.0
	C	1	100	-	-	2	8	83	7	-	17	17.0
		2	100	-	-	1	6	87	6	-	13	13.0
	D	1	100	-	-	2	11	80	7	-	20	20.0
		2	100	-	-	1	11	81	7	-	19	19.0
7	A	1	101	-	-	-	4	26	70	1	31	30.7
		2	101	-	-	-	1	11	89	-	12	11.9
	B	1	101	-	-	-	3	27	69	2	32	31.7
		2	101	-	-	-	1	23	77	-	24	23.8
	C	1	101	-	-	-	3	23	70	5	31	30.7
		2	101	-	-	-	1	15	83	2	18	17.8
	D	1	101	-	-	-	1	29	71	-	30	29.7
		2	101	-	-	-	1	29	71	-	30	29.7

Table A-24. --Errors in assigning ages of female fur seals from sectioned canine teeth

Correct age	Reader	Reading	Sample size	Assigned age																	Error	
				2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Years				No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	Percent
3	A	1	30	-	28	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6.7
		2	30	-	28	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6.7
	B	1	30	-	25	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	5	16.7
		2	30	2	25	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	16.7
	C	1	30	1	26	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	13.3
		2	30	-	22	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	26.3
	D	1	30	-	27	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	10.0
		2	30	-	26	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	4	13.3
4	A	1	30	-	-	28	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6.7
		2	30	-	-	25	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5	16.7
	B	1	30	-	-	23	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7	23.3
		2	30	-	1	28	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6.7
	C	1	30	-	3	25	2	-	-	-	-	-	-	-	-	-	-	-	-	-	5	16.7
		2	30	-	2	24	4	-	-	-	-	-	-	-	-	-	-	-	-	-	6	20.0
	D	1	30	-	1	26	3	-	-	-	-	-	-	-	-	-	-	-	-	-	4	13.3
		2	30	-	1	27	1	1	-	-	-	-	-	-	-	-	-	-	-	-	3	10.0
5	A	1	30	-	-	1	20	8	1	-	-	-	-	-	-	-	-	-	-	-	10	33.3
		2	30	-	-	1	22	6	1	-	-	-	-	-	-	-	-	-	-	-	8	26.7
	B	1	30	-	-	-	20	9	1	-	-	-	-	-	-	-	-	-	-	-	10	33.3
		2	30	-	-	1	21	7	1	-	-	-	-	-	-	-	-	-	-	-	9	30.0
	C	1	30	-	-	-	23	6	1	-	-	-	-	-	-	-	-	-	-	-	7	23.3
		2	30	-	-	-	18	11	1	-	-	-	-	-	-	-	-	-	-	-	12	40.0
	D	1	30	-	-	1	21	6	2	-	-	-	-	-	-	-	-	-	-	-	9	30.0
		2	30	-	-	-	26	2	2	-	-	-	-	-	-	-	-	-	-	-	4	13.3
6	A	1	30	-	-	-	1	23	5	-	1	-	-	-	-	-	-	-	-	-	7	23.3
		2	30	-	-	-	1	20	8	1	-	-	-	-	-	-	-	-	-	-	10	33.3
	B	1	30	-	-	-	2	15	13	-	-	-	-	-	-	-	-	-	-	-	15	50.0
		2	30	-	-	-	1	22	6	1	-	-	-	-	-	-	-	-	-	-	8	26.7
	C	1	30	-	-	-	2	23	5	-	-	-	-	-	-	-	-	-	-	-	7	23.3
		2	30	-	-	-	1	19	9	1	-	-	-	-	-	-	-	-	-	-	11	36.7
	D	1	30	-	-	-	3	19	7	1	-	-	-	-	-	-	-	-	-	-	11	36.7
		2	30	-	-	-	1	22	4	2	1	-	-	-	-	-	-	-	-	-	8	26.7
7	A	1	30	-	-	-	-	2	24	3	-	-	-	-	-	-	-	-	-	1	6	20.0
		2	30	-	-	-	-	1	23	5	-	1	-	-	-	-	-	-	-	-	7	23.3
	B	1	30	-	-	-	-	2	19	8	1	-	-	-	-	-	-	-	-	-	11	36.7
		2	30	-	-	-	-	2	21	7	-	-	-	-	-	-	-	-	-	-	9	30.0
	C	1	30	-	-	-	-	6	24	-	-	-	-	-	-	-	-	-	-	-	6	20.0
		2	30	-	-	-	-	7	17	6	-	-	-	-	-	-	-	-	-	-	13	43.3
	D	1	30	-	-	-	1	2	18	7	1	1	-	-	-	-	-	-	-	-	12	40.0
		2	30	-	-	1	-	2	20	7	-	-	-	-	-	-	-	-	-	-	10	33.3
8	A	1	30	-	-	-	-	-	7	21	2	-	-	-	-	-	-	-	-	-	9	30.0
		2	30	-	-	-	-	-	6	19	5	-	-	-	-	-	-	-	-	-	11	36.7
	B	1	30	-	-	-	-	-	5	13	11	1	-	-	-	-	-	-	-	-	17	56.7
		2	30	-	-	-	-	-	6	18	6	-	-	-	-	-	-	-	-	-	12	40.0
	C	1	30	-	-	-	-	2	12	13	3	-	-	-	-	-	-	-	-	-	17	56.7
		2	30	-	-	-	-	-	11	16	3	-	-	-	-	-	-	-	-	-	14	46.7
	D	1	30	-	-	-	-	-	5	18	6	-	1	-	-	-	-	-	-	-	12	40.0
		2	30	-	-	-	-	1	9	10	8	1	1	-	-	-	-	-	-	-	20	66.7
9	A	1	30	-	-	-	-	-	1	7	13	8	1	-	-	-	-	-	-	-	17	56.7
		2	30	-	-	-	-	-	1	4	14	9	2	-	-	-	-	-	-	-	16	53.3
	B	1	30	-	-	-	-	-	-	7	17	5	1	-	-	-	-	-	-	-	13	43.3
		2	30	-	-	-	-	-	-	7	15	6	2	-	-	-	-	-	-	-	15	50.0
	C	1	30	-	-	-	-	1	5	13	11	-	-	-	-	-	-	-	-	-	19	63.3
		2	30	-	-	-	-	1	2	14	11	2	-	-	-	-	-	-	-	-	19	63.3
	D	1	30	-	-	-	-	-	2	3	18	5	2	-	-	-	-	-	-	-	12	40.0
		2	30	-	-	-	-	-	2	7	14	7	-	-	-	-	-	-	-	-	16	53.3
10	A	1	30	-	-	-	-	-	1	3	5	13	7	1	-	-	-	-	-	-	17	56.7
		2	30	-	-	-	-	-	-	1	7	16	4	2	-	-	-	-	-	-	14	46.7
	B	1	30	-	-	-	-	-	-	2	7	15	4	2	-	-	-	-	-	-	15	50.0
		2	30	-	-	-	-	-	-	2	9	12	6	1	-	-	-	-	-	-	18	60.0
	C	1	30	-	-	-	-	-	1	8	15	5	1	-	-	-	-	-	-	-	25	83.3
		2	30	-	-	-	-	-	1	7	15	6	1	-	-	-	-	-	-	-	24	80.0
	D	1	30	-	-	-	-	-	1	4	4	10	11	-	-	-	-	-	-	-	20	66.7
		2	30	-	-	-	-	-	-	5	7	12	6	-	-	-	-	-	-	-	18	60.0
11	A	1	30	-	-	-	-	-	1	3	4	5	7	8	2	-	-	-	-	-	23	76.7
		2	30	-	-	-	-	1	-	2	7	10	8	1	-	-	-	-	-	1	22	73.3
	B	1	24	-	-	-	-	-	-	1	1	5	10	7	-	-	-	-	-	-	14	58.3
		2	24	-	-	-	-	-	-	1	4	7	6	6	-	-	-	-	-	-	18	59.3
	C	1	30	-	-	-	-	-	2	6	8	8	5	1	-	-	-	-	-	-	25	83.3
		2	30	-	-	-	-	-	1	5	3	14	7	-	-	-	-	-	-	-	23	76.7
	D	1	30	-	-	-	-	-	1	1	2	14	12	-	-	-	-	-	-	-	18	60.0
		2	30	-	-	-	-	-	-	2	1	12	13	2	-	-	-	-	-	-	17	56.7
12	A	1	13	-	-	-	-	-	-	-	1	1	4	3	1	2	-	1	-	-	10	76.9
		2	13	-	-	-	-	-	-	-	1	1	2	3	2	2	1	-	1	-	10	76.9
	B	1	12	-	-	-	-	-	-	-	-	-	3	4	4	1	-	-	-	-	8	66.7
		2	12	-	-	-	-	-	-	-	-	1	4	3	3	1	-	-	-	-	9	75.0
	C	1	13	-	-	-	-	-	-	-	2	4	3	3	-	-	-	1	-	-	10	76.9
		2	13	-	-	-	-	-	-	-	2	3	3	4	-	1	-	-	-	-	9	69.2
	D	1	13	-	-	-	-	-	-	-	2	2	9	-	-	-	-	-	-	-	13	100.0
		2	13	-	-	-	-	-	-	-	3	-	10	-	-	-	-	-	-	-	13	100.0

Table A-25. --Formulas for artificial fur seal milk, St. Paul Island, 1 July to 4 August 1966

Date	Formula	Fish flour	Calcium caseinate	Protein	Fat	Water	Supplement
		Percent	Percent	Percent	Percent	Percent	Percent
1 July	C	6.0	6.0	9.5	40.0	47.0	0.9
	F	12.0	-	10.2	40.0	47.0	0.9
2 July	C	5.3	5.3	8.4	35.2	53.0	0.9
	F	12.0	-	10.2	40.0	47.0	0.9
10-11 July	C	8.5	7.0	12.2	37.0	46.5	0.9
	F	17.0	-	12.4	37.0	45.0	0.9
12-17 July	C	7.0	5.7	10.0	30.0	57.0	0.9
	F	16.3	-	11.9	35.5	48.0	0.9
18-23 July	C	7.0	5.7	10.0	33.6	53.6	0.9
	F	16.3	-	11.9	35.5	48.0	0.9
24 July	C	8.5	7.0	12.2	35.5	48.0	0.9
	F	16.3	-	11.9	35.5	48.0	0.9
25 July	C	11.0	4.0	11.4	35.5	48.0	0.9
	F	16.3	-	11.9	35.5	48.0	0.9
26 July to	C	7.0	5.7	10.0	34.0	53.0	0.9
4 Aug.	F	16.3		11.9	35.5	48.0	0.9

Table A-26. --Times of feeding and grams of formula fed to captive pups at each feeding, St. Paul Island, 1 July to 4 August 1966

Formula and pup identification number	Feeding times	July 1	July 2-3	Feeding times	July 4-6	Feeding times	July 7	July 8-11	Feeding times	July 12	July 13	July 14-15	July 16-21	July 22	July 23	July 24	July 25	July 26-27	July 28-31	August 1-3	August 4
		G.	G.		G.		G.	G.		G.	G.	G.	G.	G.	G.	G.	G.	G.	G.	G.	G.
Formula C 1	8 a.m.	0	70	6:30 a.m.	70	8 a.m.	70	90	8 a.m.	120	120	120	150	150	150	150	200	140	160	160	160
	4 p.m.	60	70	11:30 a.m.	70	4 p.m.	70	90													
	12 m.	0	70	6:30 p.m.	70	11:30 p.m.	70	90	8 p.m.	120	120	120	150	150	150	0	150	140	160	160	plane 1/
				11:30 p.m.	70																
2	8 a.m.	0	70	6:30 a.m.	70	8 a.m.	70	90	8 a.m.	120	120	120	150	150	150	150	200	140	160	160	160
	4 p.m.	60	70	11:30 a.m.	70	4 p.m.	70	90													
	12 m.	0	70	6:30 p.m.	70	11:30 p.m.	70	90	8 p.m.	120	120	120	150	150	150	0	150	140	160	160	plane
				11:30 p.m.	70																
3	8 a.m.	0	70	6:30 a.m.	70	8 a.m.	70	90	8 a.m.	120	120	120	150	150	150	100	75				
	4 p.m.	60	70	11:30 a.m.	70	4 p.m.	70	90													
	12 m.	0	70	6:30 p.m.	70	11:30 p.m.	70	90	8 p.m.	120	0	120	150	150	150	0	died				
				11:30 p.m.	70																
4	8 a.m.	0	70	6:30 a.m.	70	8 a.m.	70	90	8 a.m.	120	120	120	150	150	150	150	200	140	160	160	160
	4 p.m.	60	70	11:30 a.m.	70	4 p.m.	70	90													
	12 m.	0	70	6:30 p.m.	70	11:30 p.m.	70	90	8 p.m.	120	120	120	150	150	150	0	150	140	160	160	plane
Formula F				11:30 p.m.	70																
5	8 a.m.	0	60	6:30 a.m.	60	8 a.m.	60	80	8 a.m.	120	120	120	150	150	150	150	200	140	160	160	160
	4 p.m.	60	60	11:30 a.m.	60	4 p.m.	60	80													
	12 m.	0	60	6:30 p.m.	60	11:30 p.m.	60	80	8 p.m.	120	120	120	150	150	150	0	150	140	160	160	plane
				11:30 p.m.	60																
6	8 a.m.	0	60	6:30 a.m.	60	8 a.m.	60	80	8 a.m.	0	120	120	150	150	150	150	200	140	160	160	160
	4 p.m.	60	60	11:30 a.m.	60	4 p.m.	60	80													
	12 m.	0	60	6:30 p.m.	60	11:30 p.m.	60	80	8 p.m.	120	120	120	150	150	150	0	150	140	160	160	plane
				11:30 p.m.	60																
7	8 a.m.	0	60	6:30 a.m.	60	8 a.m.	60	80	8 a.m.	120	120	120	150	150	150	150	200	140	160	160	160
	4 p.m.	60	60	11:30 a.m.	60	4 p.m.	60	80													
	12 m.	0	60	6:30 p.m.	60	11:30 p.m.	60	80	8 p.m.	120	120	120	150	150	150	0	150	140	160	160	plane
				11:30 p.m.	60																
8	8 a.m.	0	60	6:30 a.m.	60	8 a.m.	60	80	8 a.m.	120	120	120	150	died							
	4 p.m.	40	60	11:30 a.m.	60	4 p.m.	60	80													
	12 m.	0	60	6:30 p.m.	60	11:30 p.m.	60	80	8 p.m.	120	0	120	150								
				11:30 p.m.	60																
	Day	1	2-3		4-6		7	8-11		12	13	14-15	16-21	22	23	24	25	26-27	28-31	32-34	35

1/ Pup transported by plane to Stanford Research Institute was not fed at 8 p.m.

Table A-27.--Weights of captive pups fed formula, St. Paul Island, 1 July to 4 August 1966

Formula and pup identification number	July					August
	1	7	14	21	28	4
	- - - - - - - - - -		-Kg.-	- - - - - - - - - -		
Formula C						
1	5.7	5.4	5.4	5.8	6.2	6.8
2	6.8	6.2	6.4	6.6	5.6	7.1
3	5.0	5.0	4.8	4.8	died 25 July	
4	6.0	5.7	5.6	5.8	5.2	6.5
Formula F						
5	5.9	5.5	5.2	5.1	5.1	5.8
6	5.8	5.5	5.2	5.2	5.5	6.2
7	6.1	5.7	5.6	5.7	6.1	6.5
8	5.4	5.2	4.9	4.5	died 22 July	

Appendix B

PERSONS ENGAGED IN FUR SEAL RESEARCH ON THE PRIBILOF ISLANDS IN 1966

The 1966 field season on the Pribilof Islands extended from June to October. Dates of arrival and departure, and affiliations of research workers were:

Name	Arrival	Departure	Affiliation	Work
		Permanent employees		
Alton Y. Roppel	22 June	4 Aug.	Bureau of Commercial Fisheries	Seal research, general
Mark C. Keyes	27 June	3 Aug.	-------do.---------	Seal research, mortality
Ancel M. Johnson	27 July 21 Sept.	17 Aug. 13 Oct.	-------do.---------	Seal research, general
Raymond E. Anas	27 July	31 Aug.	-------do.---------	Do.
Ford Wilke	14 Sept.	13 Oct.	-------do.---------	Do.
		Temporary employees		
Daniel K. Odell	15 June	31 Aug.	Student, Cornell U.	Seal research, general
Kenneth L. Johnston	22 June	31 Aug.	Graduate, Colo. State U.	Do.
Patrick Kozloff	23 June	31 Aug.	Student, U. of Alaska	Do.
Stewart Oden'hal	27 June	31 Aug.	Student, U. of Calif.	Seal research, mortality
Jerry A. Whorton	6 July	31 Aug.	Student, U. of Colo.	Do.
Lavrenty Stepetin	23 June	13 Oct.	St. Paul Island resident	Seal research, general
Dionsey Bourdukofsky	7 July	19 Aug.	--------do.---------	Do.
Benjamin Misiken	22 July	17 Aug.	--------do.---------	Do.
Agafon Krukoff	22 July	31 Aug.	--------do.---------	Do.
Innokenty C. Lestenkof	20 June	29 Aug.	St. George Island resident	Do.

Table C-1.--List of chart squares occupied by research vessels off California in January 1966, showing: hours in square, seals seen per hour, and number of seals seen and collected 1/

Square	Hours in square	Seals seen per hour	Seals Seen	Seals Collected
	Number	Number	Number	Number
V1-H10	0.7	0.0	0	0
V1-H11	0.8	0.0	0	0
V1-H12	0.8	0.0	0	0
V1-H13	1.0	0.0	0	0
V1-H14	1.8	0.0	0	0
V1-H15	1.0	0.0	0	0
V1-H16	1.8	0.0	0	0
V1-H17	1.0	0.0	0	0
V1-H18	2.0	0.0	0	0
V3-H12	0.4	0.0	0	0
V3-H13	1.7	0.6	1	0
V3-H14	0.8	1.2	1	0
V3-H15	0.8	0.0	0	0
V3-H16	0.8	0.0	0	0
V3-H17	0.8	0.0	0	0
V3-H18	1.0	0.0	0	0
V3-H19	1.0	0.0	0	0
V3-H20	1.1	0.0	0	0
V3-H21	0.8	0.0	0	0
V3-H22	0.8	0.0	0	0
V3-H23	0.7	0.0	0	0
V12-H18	0.1	0.0	0	0
V12-H19	1.0	1.0	1	0
V12-H20	3.7	6.8	25	0
V12-H21	1.5	3.3	5	0
V13-H20	2.4	7.9	19	0
V13-H21	0.4	30.0	12	0
V14-H20	1.0	4.0	4	0
V15-H20	0.2	5.0	1	0

1/ See footnote at end of table.

Table C-1. --List of chart squares occupied by research vessels off California in January 1966, showing: hours in square, seals seen per hour, and number of seals seen and collected 1/ --Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V18-H20	0.8	0.0	0	0
V19-H20	1.2	0.0	0	0
V20-H20	1.0	0.0	0	0
V21-H20	1.4	0.0	0	0
V21-H21	0.7	1.4	1	0
V22-H21	0.5	0.0	0	0
V22-H22	1.1	0.0	0	0
V22-H23	0.1	10.0	1	0
V23-H23	1.0	0.0	0	0
V23-H24	0.5	0.0	0	0
V23-H27	0.2	0.0	0	0
V23-H28	0.9	0.0	0	0
V24-H24	0.8	1.2	1	0
V24-H25	0.7	0.0	0	0
V24-H28	0.4	0.0	0	0
V24-H29	2.9	0.3	1	0
V24-H30	1.7	2.9	5	0
V25-H25	0.5	0.0	0	0
V25-H26	1.1	3.6	4	0
V25-H30	1.2	0.0	0	0
V25-H31	0.5	2.0	1	0
V26-H26	0.4	0.0	0	0
V26-H27	0.8	1.2	1	0
V26-H28	0.7	8.6	6	0
V26-H30	0.7	1.4	1	0
V26-H31	1.7	1.2	2	0
V27-H27	1.2	1.7	2	0
V27-H28	4.7	9.6	45	8
V28-H27	2.2	19.1	42	5
V28-H28	4.9	7.6	37	10
V29-H26	0.7	0.0	0	0

1/ See footnote at end of table.

Table C-1.--List of chart squares occupied by research vessels off California in January 1966, showing: hours in square, seals seen per hour, and number of seals seen and collected 1/ --Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V29-H27	4.0	19.2	77	5
V29-H28	5.9	14.4	85	6
V29-H29	0.2	10.0	2	0
V30-H26	1.9	0.0	0	0
V30-H27	0.7	2.8	2	0
V30-H28	0.7	4.3	3	2
V30-H29	1.1	1.8	2	0
V31-H29	0.5	0.0	0	0
V31-H30	2.8	4.6	13	2
V32-H30	0.3	0.0	0	0
V32-H31	2.0	1.5	3	2
V32-H32	1.1	1.8	2	0
V32-H33	0.6	6.7	4	1
V33-H33	1.8	3.3	6	0
V34-H31	1.0	4.0	4	4
V34-H32	3.6	2.5	9	4
V34-H33	0.2	45.0	9	1
V36-H34	0.1	0.0	0	0
V36-H35	0.2	5.0	1	0
V37-H35	1.1	13.6	15	0
V37-H36	0.6	0.0	0	0

1/ The base chart is USCGS No. 5002. The side of each chart square measures 18.52 km. (10 nautical miles); a square covers an area of 343 km.^{2} (100 square nautical miles) Squares are located by a system of vertical and horizontal numbers. Horizontal numbering begins at the lower right corner of the chart (fig. 30) and vertical numbering at the lower left corner.

Table C-2.--List of chart squares occupied by research vessels off California in February 1966, showing: hours in square, seals seen per hour, and number of seals seen and collected 1/

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V5-H11	1.0	0.0	0	0
V5-H12	1.0	0.0	0	0
V5-H13	1.0	7.0	7	0
V5-H14	1.5	0.7	1	0
V5-H15	1.0	0.0	0	0
V5-H16	0.8	0.0	0	0
V5-H17	0.9	0.0	0	0
V5-H18	0.9	1.1	1	0
V5-H19	1.0	1.0	1	0
V5-H20	1.8	0.6	1	0
V7-H15	0.2	5.0	1	0
V7-H16	0.7	10.0	7	0
V7-H17	1.2	2.5	3	0
V7-H18	1.5	0.0	0	0
V7-H19	1.2	1.7	2	2
V7-H20	0.8	0.0	0	0
V7-H21	4.5	0.7	2	0
V7-H22	1.1	1.8	2	0
V7-H23	0.2	0.0	0	0
V9-H14	0.1	0.0	0	0
V9-H15	1.2	0.0	0	0
V9-H16	0.8	1.2	1	0
V9-H17	2.0	1.0	2	0
V9-H18	1.1	0.0	0	0
V9-H19	0.8	2.5	2	0
V9-H20	0.8	0.0	0	0
V9-H21	0.9	1.1	1	0
V9-H22	1.0	0.0	0	0
V9-H23	1.3	0.0	0	0
V9-H24	0.8	1.2	1	0
V9-H25	0.4	0.0	0	0

1/ See footnote at end of table.

Table C-2.--List of chart squares occupied by research vessels off California in February 1966, showing: hours in square, seals seen per hour, and number of seals seen and collected 1/--Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V11-H19	0.7	0.0	0	0
V11-H20	3.1	0.6	2	1
V11-H21	2.0	1.5	3	1
V11-H22	1.2	4.2	5	2
V11-H23	1.6	1.9	3	2
V11-H24	1.0	2.0	2	0
V11-H25	3.5	2.8	10	1
V12-H16	0.1	0.0	0	0
V12-H17	0.3	0.0	0	0
V12-H18	0.3	0.0	0	0
V12-H19	1.3	1.5	2	1
V12-H20	1.7	0.0	0	0
V12-H21	2.2	0.0	0	0
V12-H25	2.0	2.0	4	0
V13-H16	3.7	0.0	0	0
V13-H17	1.9	0.0	0	0
V13-H18	2.2	0.0	0	0
V13-H19	5.1	0.0	0	0
V13-H20	3.5	2.0	7	1
V13-H21	1.6	1.2	2	2
V13-H22	2.3	0.9	2	1
V13-H23	3.5	4.0	14	2
V13-H24	6.2	10.0	62	8
V13-H25	0.9	28.9	26	0
V13-H26	1.4	3.6	5	0
V13-H27	0.8	2.5	2	0
V13-H28	0.8	1.2	1	0
V13-H29	0.8	0.0	0	0
V13-H30	0.8	0.0	0	0
V14-H16	0.2	0.0	0	0
V14-H17	2.6	0.0	0	0
V14-H18	2.5	0.0	0	0

1/ See footnote at end of table.

Table C-2. --List of chart squares occupied by research vessels off California in February 1966, showing: hours in square, seals seen per hour, and number of seals seen and collected 1/ --Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V14-H19	3.1	1.0	3	0
V15-H17	0.1	0.0	0	0
V15-H18	1.7	0.0	0	0
V15-H19	1.1	0.0	0	0
V15-H20	1.0	8.0	8	0
V15-H21	1.2	12.5	15	0
V15-H22	1.0	5.0	5	0
V15-H23	1.2	3.3	4	0
V15-H24	1.2	1.7	2	0
V15-H25	1.4	0.7	1	0
V16-H19	1.5	0.7	1	0
V17-H19	2.0	0.0	0	0
V17-H20	0.9	0.0	0	0
V17-H21	2.1	2.4	5	0
V17-H22	2.2	2.7	6	0
V17-H23	2.4	2.9	7	0
V17-H24	1.8	12.8	23	0
V18-H19	2.1	0.0	0	0
V19-H19	1.5	0.0	0	0
V19-H20	2.1	0.0	0	0
V19-H21	2.2	0.4	1	0
V19-H22	5.0	1.0	5	0
V19-H23	8.2	7.0	57	8
V19-H24	4.1	8.0	33	0
V19-H25	1.2	6.7	8	0
V19-H26	0.9	2.2	2	0
V19-H27	0.9	1.1	1	0
V19-H28	1.2	2.5	3	0
V19-H29	1.2	0.0	0	0
V19-H30	0.8	1.2	1	0
V19-H31	0.1	0.0	0	0
V20-H20	0.4	0.0	0	0

1/ See footnote at end of table.

Table C-2. --List of chart squares— occupied by research vessels off California in February 1966, showing: hours in square, seals seen per hour, and number of seals seen and collected 1/ --Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V20-H21	1.0	1.0	1	0
V20-H22	0.6	0.0	0	0
V20-H23	0.7	0.0	0	0
V20-H24	4.3	7.0	30	7
V20-H25	3.0	5.7	17	2
V21-H20	2.2	0.0	0	0
V21-H21	3.7	0.0	0	0
V21-H22	7.8	2.2	17	3
V21-H23	3.2	0.6	2	1
V21-H24	3.7	1.6	6	3
V21-H25	6.3	6.2	39	10
V21-H26	0.9	0.0	0	0
V21-H27	1.2	0.0	0	0
V22-H21	0.1	0.0	0	0
V22-H22	2.1	0.0	0	0
V22-H23	1.5	0.0	0	0
V22-H24	1.2	1.7	2	0
V22-H25	3.7	5.4	20	5
V22-H26	3.3	3.0	10	4
V22-H27	1.9	8.9	17	0
V22-H28	1.2	0.8	1	0
V22-H29	1.2	0.8	1	0
V22-H30	0.8	1.2	1	0
V22-H31	1.9	0.0	0	0
V22-H32	0.1	0.0	0	0
V23-H23	1.3	0.0	0	0
V23-H24	0.5	0.0	0	0
V23-H25	1.3	0.0	0	0
V23-H26	3.7	0.8	3	2
V23-H27	1.4	0.0	0	0
V24-H23	0.2	0.0	0	0
V24-H24	1.2	0.0	0	0
V24-H26	1.2	0.8	1	1

1/ See footnote at end of table.

Table C -2. --List of chart squares occupied by research vessels off California in February 1966, showing hours in square, seals seen per hour, and number of seals seen and collected 1/ --Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V24-H27	0.7	1.4	1	0
V24-H28	0.7	0.0	0	0
V24-H29	0.2	5.0	1	0
V25-H24	0.2	0.0	0	0
V25-H25	1.3	0.8	1	0
V25-H26	1.7	6.5	11	1
V25-H27	3.1	2.2	7	2
V25-H28	1.0	2.0	2	0
V25-H29	2.2	6.8	15	0
V25-H30	0.9	0.0	0	0
V25-H31	0.4	2.5	1	0
V26-H26	0.7	0.0	0	0
V26-H27	1.8	2.2	4	1
V26-H28	0.2	5.0	1	0
V26-H29	0.8	0.0	0	0
V27-H27	3.4	3.5	12	6
V27-H28	7.7	8.6	66	7
V27-H29	2.5	5.2	13	2
V27-H30	1.4	1.4	2	0
V27-H31	1.4	8.6	12	0
V27-H32	1.0	11.0	11	2
V27-H33	1.2	0.0	0	0
V27-H34	0.9	0.0	0	0
V27-H35	0.8	0.0	0	0
V27-H36	1.1	0.0	0	0
V27-H37	0.3	0.0	0	0
V28-H25	0.8	0.0	0	0
V28-H26	3.3	3.3	11	4
V28-H27	5.0	12.0	60	2
V28-H28	3.2	5.6	18	1
V29-H25	0.4	0.0	0	0
V29-H26	4.5	10.0	45	0
V29-H27	2.4	0.8	2	0
V29-H28	1.9	5.8	11	0
V29-H29	0.9	6.7	6	0

1/ See footnote at end of table.

Table C-2.--List of chart squares[1] occupied by research vessels off California in February 1966, showing hours in square, seals seen per hour, and number of seals seen and collected 1/--Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V29-H30	0.8	3.8	3	0
V29-H31	1.0	6.0	6	0
V29-H32	1.2	1.7	2	0
V29-H33	1.0	1.0	1	0
V29-H34	1.0	0.0	0	0
V29-H35	1.1	0.9	1	0
V29-H36	1.2	0.0	0	0
V30-H25	0.8	0.0	0	0
V30-H26	1.4	0.0	0	0
V30-H27	1.6	0.0	0	0
V30-H28	2.2	16.8	37	2
V30-H29	2.9	8.6	25	6
V31-H27	0.2	0.0	0	0
V31-H28	1.7	1.2	2	0
V31-H29	7.2	21.2	153	43
V31-H30	1.0	4.0	4	0
V31-H31	0.7	5.7	4	0
V31-H32	0.9	4.4	4	0
V31-H33	0.9	1.1	1	0
V31-H34	0.9	1.1	1	0
V31-H35	0.8	0.0	0	0
V33-H30	1.1	1.8	2	0
V33-H31	1.4	6.4	9	0
V33-H32	1.0	0.0	0	0
V33-H33	1.0	0.0	0	0
V33-H34	1.0	0.0	0	0
V33-H35	1.1	0.9	1	0
V33-H36	1.3	0.8	1	0
V33-H38	1.0	1.0	1	0
V33-H39	3.7	3.2	12	8
V33-H40	1.2	5.8	7	0
V33-H41	1.7	5.3	9	3
V33-H42	1.5	1.3	2	1
V33-H43	1.8	0.6	1	0
V34-H30	2.1	0.5	1	0

1/ See footnote at end of table.

Table C-2. --List of chart squares occupied by research vessels off California in February 1966, showing hours in square, seals seen per hour, and number of seals seen and collected 1/--Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V35-H28	1.1	0.0	0	0
V35-H29	2.4	0.4	1	1
V35-H30	2.2	0.0	0	0
V35-H31	0.7	0.0	0	0
V35-H32	0.9	2.2	2	0
V35-H33	1.9	4.2	8	2
V35-H34	1.0	4.0	4	0
V35-H35	1.0	1.0	1	0
V35-H36	1.0	12.0	12	0
V35-H37	1.2	10.0	12	0
V35-H38	1.2	5.8	7	0
V35-H39	1.2	0.8	1	0
V35-H40	0.9	0.0	0	0
V35-H41	0.8	2.5	2	0
V35-H42	1.2	1.7	2	0
V36-H30	1.8	0.0	0	0
V36-H31	0.7	0.0	0	0
V36-H42	0.9	0.0	0	0
V37-H31	0.2	0.0	0	0
V37-H32	1.0	6.0	6	0
V37-H33	3.0	11.0	33	9
V37-H34	4.2	17.4	73	15
V37-H35	1.0	1.0	1	0
V37-H36	1.2	0.8	1	0
V37-H37	0.6	1.7	1	0
V37-H38	1.3	0.8	1	0
V37-H39	1.0	0.0	0	0
V37-H40	1.1	0.0	0	0
V37-H41	2.4	0.0	0	0
V37-H42	0.3	3.3	1	0

1/ The base chart is USCGS No. 5002. The side of each chart square measures 18.52 km. (10 nautical miles); a square covers an area of 343 km.^{2} (100 square nautical miles). Squares are located by a system of vertical and horizontal numbers. Horizontal numbering begins at the lower right corner of the chart (fig. 30) and vertical numbering at the lower left corner.

Table C-3.--List of chart squares occupied by research vessels off California in March 1966, showing: hours in square, seals seen per hour, and number of seals seen and collected 1/

Square	Hours in square	Seals seen per hour	Seals Seen	Seals Collected
	Number	Number	Number	Number
V12-H15	1.0	0.0	0	0
V12-H16	1.9	0.0	0	0
V12-H17	1.1	0.0	0	0
V13-H17	2.5	0.0	0	0
V13-H18	2.0	0.0	0	0
V13-H19	0.6	6.7	4	0
V14-H17	1.7	1.2	2	0
V14-H19	0.8	16.2	13	0
V14-H20	0.8	3.7	3	0
V15-H17	0.7	0.0	0	0
V15-H18	1.0	0.0	0	0
V15-H19	1.5	0.0	0	0
V15-H20	2.2	3.2	7	0
V15-H21	2.2	3.6	8	1
V15-H22	4.0	1.8	7	2
V15-H23	0.6	5.0	3	2
V16-H21	3.7	1.9	7	1
V16-H22	3.1	2.5	8	0
V16-H23	3.0	4.7	14	1
V17-H22	0.1	0.0	0	0
V17-H23	5.0	3.4	17	4
V17-H24	3.4	7.4	25	9
V18-H22	3.8	7.4	28	0
V18-H23	3.2	11.6	37	1
V18-H24	2.7	41.1	111	19
V19-H21	1.7	0.0	0	0
V19-H22	3.0	5.3	16	1
V19-H23	7.0	5.6	39	6
V20-H20	0.7	0.0	0	0
V20-H21	4.0	0.5	2	0
V20-H22	2.7	3.7	10	3
V20-H23	1.2	1.7	2	1

1/ See footnote at end of table.

Table C-3. --List of chart squares occupied by research vessels off California in March 1966, showing: hours in square, seals seen per hour, and number of seals seen and collected 1/--Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V20-H24	8.4	8.8	74	19
V20-H25	2.3	5.2	12	0
V21-H20	2.7	0.0	0	0
V21-H21	1.4	0.0	0	0
V21-H22	0.7	0.0	0	0
V21-H25	2.9	2.1	6	2
V22-H21	0.2	0.0	0	0
V22-H22	3.1	0.0	0	0
V22-H25	2.5	14.4	36	7
V22-H26	1.7	6.5	11	2
V23-H22	0.5	0.0	0	0
V23-H23	2.1	0.0	0	0
V23-H26	0.6	5.0	3	0
V23-H27	3.7	3.5	13	6
V24-H24	1.7	2.4	4	3
V24-H25	3.5	13.4	47	7
V24-H26	4.5	4.2	19	9
V25-H25	2.0	3.5	7	1
V25-H26	1.5	2.7	4	1
V25-H27	3.2	8.1	26	5
V26-H26	4.0	2.8	11	2
V26-H27	2.2	2.7	6	2
V27-H26	0.2	5.0	1	0
V27-H27	2.4	4.6	11	0
V27-H28	6.3	7.9	50	27
V28-H25	0.7	0.0	0	0
V28-H26	1.2	0.8	1	1
V28-H27	2.7	1.5	4	0
V28-H28	2.7	5.9	16	8
V29-H26	1.0	0.0	0	0
V29-H28	3.3	3.3	11	1
V30-H26	0.1	0.0	0	0

1/ See footnote at end of table.

Table C-3. --List of chart squares occupied by research vessels off California in March 1966, showing hours in square, seals seen per hour, and number of seals seen and collected 1/--Continued

Square	Hours in square	Seals seen per hour	Seals	
			Seen	Collected
	Number	Number	Number	Number
V30-H27	1.6	1.2	2	0
V30-H28	3.7	4.9	18	7
V30-H29	1.5	0.7	1	0
V31-H28	0.7	0.0	0	0
V31-H29	2.7	0.7	2	1
V31-H30	0.7	4.3	3	1
V32-H30	5.5	5.8	32	8
V32-H31	3.1	2.9	9	4
V32-H32	0.8	1.2	1	0
V33-H30	1.0	0.0	0	0
V33-H31	6.9	4.0	28	10
V33-H32	1.8	3.3	6	0
V33-H33	1.6	3.8	6	0
V33-H34	1.2	1.7	2	1
V34-H30	0.2	0.0	0	0
V34-H31	6.4	2.5	16	4
V35-H30	1.3	1.5	2	1
V35-H31	2.9	3.4	10	4
V35-H32	2.6	2.7	7	3
V36-H30	1.0	0.0	0	0
V37-H30	0.1	0.0	0	0

1/ The base chart is USCGS No. 5002. The side of each chart square measures 18.52 km. (10 nautical miles); a square covers an area of 343 km.^{2} (100 square nautical miles). Squares are located by a system of vertical and horizontal numbers. Horizontal numbering begins at the lower right corner of the chart (fig. 30) and vertical numbering at the lower left corner.

Table C-4.--Number and relative abundance of seals seen, by 10-day periods, off California, 20 January to 25 March 1966

Period	Boat-hunting days 1/	Total seals seen	Seals seen per boat-hunting day	Seals seen per 10-day interval
	Number	Number	Number	Percent
11-20 Jan.	0.50	3	6.0	0.1
21-31 "	10.50	496	47.2	18.3
1-10 Feb.	13.50	247	18.3	9.1
11-20 "	13.75	692	50.3	25.7
21-28 "	7.25	385	53.1	14.2
1-10 Mar.	8.00	561	7.0	20.7
11-20 "	4.75	132	27.8	4.9
21-31 "	4.75	188	39.6	7.0
Total	63.00	2,704	42.9	100.0

1/ A boat-hunting day is a day in which a vessel is used for 8 hours or more; units of boat-hunting days are 0.25, 0.50, 0.75, and 1.00.

Table C-5.--Number of seals collected, and number collected per boat-hunting day, by 10-day periods, off California, 20 January to 25 March 1966

Period	Boat hunting days 1/	Seals collected			Seals collected per boat-hunting day	
		Males	Females	Total		
	Number	Number	Number	Number	Number	Percent
11-20 Jan.	0.50	-	-	-	-	-
21-31 "	10.50	1	49	50	4.8	11.3
1-10 Feb.	13.50	-	27	27	2.0	6.1
11-20 "	13.75	-	82	82	6.0	18.5
21-28 "	7.25	2	85	87	12.0	19.6
1-10 Mar.	8.00	3	130	133	1.7	29.9
11-20 "	4.75	-	18	18	3.9	4.0
21-31 "	4.75	2	45	47	9.9	10.6
Total	63.00	8	436	444	7.0	100.0

1/ A boat-hunting day is a day in which a vessel is used for 8 hours or more; unit of boat-hunting days are 0.25, 0.50, 0.75, and 1.00.

Table C-6. --Number of seals per group among 2, 704 seals sighted off California, 20 January to 25 March 1966

Number of seals in group	Groups	Seals	
	Number	Number	Percent
1	838	838	31.0
2	303	606	22.4
3	152	456	16.9
4	71	284	10.5
5	32	160	5.9
6	21	126	4.7
7	6	42	1.6
8	7	56	2.1
10	5	50	1.8
11	1	11	0.4
12	1	12	0.4
13	1	13	0.5
14	1	14	0.5
16	1	16	0.6
20	1	20	0.7
Total	1, 441	2, 704	100.0

Table C-7. --Monthly mean lengths of pregnant female fur seals collected pelagically by the U. S. A off California in 1966

Age	January		February		March		January-March		
	Seals	Mean length	Seals	Mean length	Seals	Mean length	Seals	Mean length	Standard deviation
Years	Number	Cm.	Number	Cm.	Number	Cm.	Number	Cm.	Cm.
4	-	-	1	108.0	-	-	1	108.0	0.0
5	2	119.5	7	117.4	9	114.7	18	116.3	3.2
6	1	117.0	12	118.5	12	118.7	25	118.5	4.2
7	4	124.5	16	118.9	16	123.1	36	121.4	5.1
8	5	124.8	12	123.6	17	122.6	34	123.3	3.2
9	1	120.0	9	121.4	10	122.3	20	121.8	5.3
10	1	125.0	6	123.5	4	127.5	11	125.1	4.9
11	4	132.7	8	126.1	6	130.3	18	129.0	5.0
12	4	123.2	10	122.3	2	122.0	16	122.5	4.0
13	4	128.5	5	128.8	3	128.3	12	128.6	3.9
14	1	119.0	9	128.3	2	127.5	12	127.4	8.0
15	3	125.3	6	125.5	5	125.6	14	125.5	5.0
16	-	-	3	124.3	1	131.0	4	126.0	8.6
17	-	-	-	-	2	134.5	2	134.5	4.9
19	-	-	-	-	1	129.0	1	129.0	0.0
Total	30		104		90		224		

Table C-8. --Monthly mean weights of pregnant female fur seals collected pelagically by the U. S. A. off California in 1966

Age	January		February		March		January-March		
	Seals	Mean weight	Seals	Mean weight	Seals	Mean weight	Seals	Mean weight	Standard deviation
Years	Number	Kg.	Number	Kg.	Number	Kg.	Number	Kg.	Kg.
4	-	-	1	22.0	-	-	1	22.0	0.0
5	2	29.0	7	29.7	9	26.7	18	28.1	3.6
6	1	35.0	12	30.6	12	30.2	25	30.6	3.0
7	4	34.7	16	31.9	16	32.3	36	32.4	3.3
8	5	34.2	12	34.3	17	33.5	34	33.9	2.8
9	1	33.0	9	33.8	10	34.9	20	34.3	3.8
10	1	32.0	6	33.5	4	38.0	11	35.0	4.0
11	4	42.5	8	38.7	6	40.5	18	40.1	5.3
12	4	37.2	10	35.1	2	32.5	16	35.3	3.6
13	4	38.2	5	40.0	3	38.2	12	39.0	2.7
14	1	34.0	9	38.7	2	41.0	12	38.7	5.5
15	3	37.3	6	39.8	5	38.4	14	38.8	4.4
16	-	-	3	37.3	1	44.0	4	39.0	7.4
17	-	-	-	-	2	46.0	2	46.0	5.7
19	-	-	-	-	1	39.0	1	39.0	0.0
Total	30		104		90		224		

Table C-9. --Monthly mean lengths of nonpregnant female fur seals collected pelagically by the U.S.A. off California in 1966

Age	January		February		March		January-March		
	Seals	Mean length	Seals	Mean length	Seals	Mean length	Seals	Mean length	Standard deviation
Years	Number	Cm.	Number	Cm.	Number	Cm.	Number	Cm.	Cm.
1	-	-	4	73.0	3	79.0	7	75.6	3.9
2	-	-	1	97.0	4	86.7	5	88.8	7.4
3	2	97.5	17	100.5	11	98.1	30	99.4	5.4
4	6	110.8	26	105.0	35	105.6	67	105.9	6.2
5	2	113.5	20	112.9	26	112.4	48	112.7	5.2
6	3	119.0	2	115.5	5	116.0	10	116.8	4.3
7	3	123.0	6	120.7	1	122.0	10	121.5	3.7
8	3	123.0	4	117.7	2	123.5	9	120.8	5.3
10	-	-	1	117.0	1	119.0	2	118.0	1.4
11	-	-	1	132.0	4	126.0	5	127.2	3.1
14	-	-	1	128.0	1	123.0	2	125.5	3.5
15	-	-	-	-	1	124.0	1	124.0	0.0
16	-	-	1	121.0	-	-	1	121.0	0.0
17	-	-	1	130.0	2	122.0	3	124.7	5.0
19	-	-	1	127.0	1	124.0	2	125.5	2.1
20	-	-	-	-	1	124.0	1	124.0	0.0
21	-	-	1	125.0	-	-	1	125.0	0.0
Total	19		87		98		204		

Table C-10. --Monthly mean weights of nonpregnant female fur seals collected pelagically by the U.S.A. off California in 1966

Age	January		February		March		January-March		
	Seals	Mean weight	Seals	Mean weight	Seals	Mean weight	Seals	Mean weight	Standard deviation
Years	Number	Kg.	Number	Kg.	Number	Kg.	Number	Kg.	Kg.
1	-	-	4	6.7	3	8.8	7	7.6	1.5
2	-	-	1	14.0	4	12.0	5	12.4	1.5
3	2	16.5	17	17.7	11	16.1	30	17.0	2.4
4	6	23.5	26	22.2	35	20.7	67	21.5	3.0
5	2	24.0	20	24.1	26	24.1	48	24.1	2.6
6	3	28.7	2	24.7	5	25.7	10	26.4	3.5
7	3	32.0	6	30.2	1	30.0	10	30.7	2.6
8	3	35.3	4	30.7	2	31.0	9	32.3	4.0
10	-	-	1	29.0	1	27.0	2	28.0	1.4
11	-	-	1	37.0	4	37.7	5	37.6	3.9
14	-	-	1	34.0	1	36.0	2	35.0	1.4
15	-	-	-	-	1	40.5	1	40.5	0.0
16	-	-	1	37.0	-	-	1	37.0	0.0
17	-	-	1	37.0	2	34.0	3	35.0	1.7
19	-	-	1	43.0	1	36.0	2	39.5	4.9
20	-	-	-	-	1	36.0	1	36.0	0.0
21	-	-	1	36.0	-	-	1	36.0	0.0
Total	19		87		98		204		

Table C-11. --Monthly mean lengths of male fur seals collected pelagically by the U. S. A. off California in 1966

Age	January		February		March		January-March		
	Seals	Mean length	Seals	Mean length	Seals	Mean length	Seals	Mean length	Standard deviation
Years	Number	Cm.	Number	Cm.	Number	Cm.	Number	Cm.	Cm.
1	-	-	-	-	2	81.0	2	81.0	5.7
2	1	108.0	1	87.0	-	-	2	97.5	14.8
3	-	-	1	95.0	3	107.7	4	104.5	7.0
Total	1		2		5		8		

Table C-12. --Monthly mean weights of male fur seals collected pelagically by the U. S. A. off California in 1966

Age	January		February		March		January-March		
	Seals	Mean weight	Seals	Mean weight	Seals	Mean weight	Seals	Mean weight	Standard deviation
Years	Number	Kg.	Number	Kg.	Number	Kg.	Number	Kg.	Kg.
1	-	-	-	-	2	10.0	2	10.0	0.7
2	1	15.0	1	13.0	-	-	2	14.0	1.4
3	-	-	1	18.0	3	21.8	4	20.9	2.2
Total	1		2		5		8		

Table C-13. --Monthly mean lengths and weights of fur seal fetuses collected pelagically by the U. S. A. off California in 1966

Period	Male			Female		
	Fetuses	Mean length	Mean weight	Fetuses	Mean length	Mean weight
	Number	Cm.	Kg.	Number	Cm.	Kg.
21-31 Jan.	13	18.1	0.2	17	17.8	0.2
1-10 Feb.	9	23.2	0.3	11	22.3	0.3
11-20 "	15	27.4	0.6	28	25.8	0.5
21-28 "	19	29.0	0.7	22	28.7	0.6
1-10 Mar.	31	33.2	0.9	27	31.6	0.8
11-20 "	3	38.0	1.4	6	35.6	1.2
21-31 "	10	38.2	1.4	13	36.4	1.2
Total	100			124		

Table C-14.--Reproductive condition of female fur seals collected pelagically by the U.S.A. off California, in 1966

Age	Nulliparous	Primiparous			Multiparous			Total
		Nonpregnant	Pregnant		Nonpregnant	Pregnant		
Years	Number	Number	Number	Percent	Number	Number	Percent	Number
				January				
3	2	-	-	-	-	-	-	2
4	6	-	-	-	-	-	-	6
5	2	-	2	100.0	-	-	-	4
6	3	-	1	100.0	-	-	-	4
7	-	1	1	50.0	2	3	60.0	7
8	-	1	1	50.0	2	4	66.7	8
9	-	-	-	-	-	1	100.0	1
10	-	-	-	-	-	1	100.0	1
11	-	-	-	-	-	4	100.0	4
12	-	-	-	-	-	4	100.0	4
13	-	-	-	-	-	4	100.0	4
14	-	-	-	-	-	1	100.0	1
15	-	-	-	-	-	3	100.0	3
Total	13	2	5		4	25		49
Percent				71.4			86.2	
				February				
1	4	-	-	-	-	-	-	4
2	1	-	-	-	-	-	-	1
3	17	-	-	-	-	-	-	17
4	26	-	1	100.0	-	-	-	27
5	20	-	4	100.0	-	3	100.0	27
6	1	1	3	75.0	-	9	100.0	14
7	1	4	2	33.3	1	14	93.3	22
8	2	1	3	75.0	1	9	90.0	16
9	-	-	-	-	-	9	100.0	9
10	-	-	-	-	1	6	85.7	7
11	-	-	-	-	1	8	88.9	9
12	-	-	-	-	-	10	100.0	10
13	-	-	-	-	-	5	100.0	5
14	-	-	-	-	1	9	90.0	10
15	-	-	-	-	-	6	100.0	6
16	-	-	-	-	1	3	75.0	4
17	-	-	-	-	1	-	0.0	1
19	-	-	-	-	1	-	0.0	1
21	-	-	-	-	1	-	0.0	1
Total	72	6	13		9	91		191
Percent				68.4			91.0	
				March				
1	3	-	-	-	-	-	-	3
2	4	-	-	-	-	-	-	4
3	11	-	-	-	-	-	-	11
4	35	-	-	-	-	-	-	35
5	26	-	8	100.0	-	1	100.0	35
6	4	1	2	66.7	-	10	100.0	17
7	-	-	1	100.0	1	15	93.8	17
8	-	1	2	66.7	1	15	93.8	19
9	-	-	-	-	-	10	100.0	10
10	-	-	-	-	1	4	80.0	5
11	-	-	-	-	4	6	60.0	10
12	-	-	-	-	-	2	100.0	2
13	-	-	-	-	-	3	100.0	3
14	-	-	-	-	1	2	66.7	3
15	-	-	-	-	1	5	88.3	6
16	-	-	-	-	-	1	100.0	1
17	-	-	-	-	2	2	50.0	4
19	-	-	-	-	1	1	50.0	2
20	-	-	-	-	1	-	0.0	1
Total	83	2	13		13	77		188
Percent				86.7			85.6	

Table C-15. --Pregnancy rates of female seals collected pelagically by the U. S. A. off California, by month, in 1966

Age	January			February			March			Combined data	
										Calif. 1966	1958-66 pelagic collections 1/
	Seals	Pregnant		Seals	Pregnant		Seals	Pregnant		Pregnant	Pregnant
Years	Number	Number	Percent	Number	Number	Percent	Number	Number	Percent	Percent	Percent
3	2	0	0	17	0	0	11	0	0	0	0.4
4	6	0	0	27	1	3.7	35	0	0	1.5	3.2
5	4	2	50.0	27	7	25.9	35	9	25.7	27.3	38.4
6	4	1	25.0	14	12	85.7	17	12	70.6	71.4	73.1
7	7	4	57.1	22	16	72.7	17	16	94.1	78.3	81.2
8	8	5	62.5	16	12	75.0	19	17	89.5	79.1	86.9
9	1	1	100.0	9	9	100.0	10	10	100.0	100.0	90.1
10	1	1	100.0	7	6	85.7	5	4	80.0	84.6	89.8
11	4	4	100.0	9	8	88.9	10	6	60.0	78.3	90.0
12	4	4	100.0	10	10	100.0	2	2	100.0	100.0	88.3
13	4	4	100.0	5	5	100.0	3	3	100.0	100.0	87.6
14	1	1	100.0	10	9	90.0	3	2	66.7	85.7	83.5
15	3	3	100.0	6	6	100.0	6	5	83.3	93.3	81.9
16	-	-	-	4	3	75.0	1	1	100.0	80.0	78.7
17	-	-	-	1	0	0	4	2	50.0	40.0	68.0
18	-	-	-	-	-	-	-	-	-	0	68.5
19	-	-	-	1	0	0	2	1	50.0	33.3	54.9
20	-	-	-	-	-	-	1	0	0	0	46.4
21	-	-	-	1	0	0	-	-	-	0	64.0

1/ Data from Fiscus and Kajimura (1967).

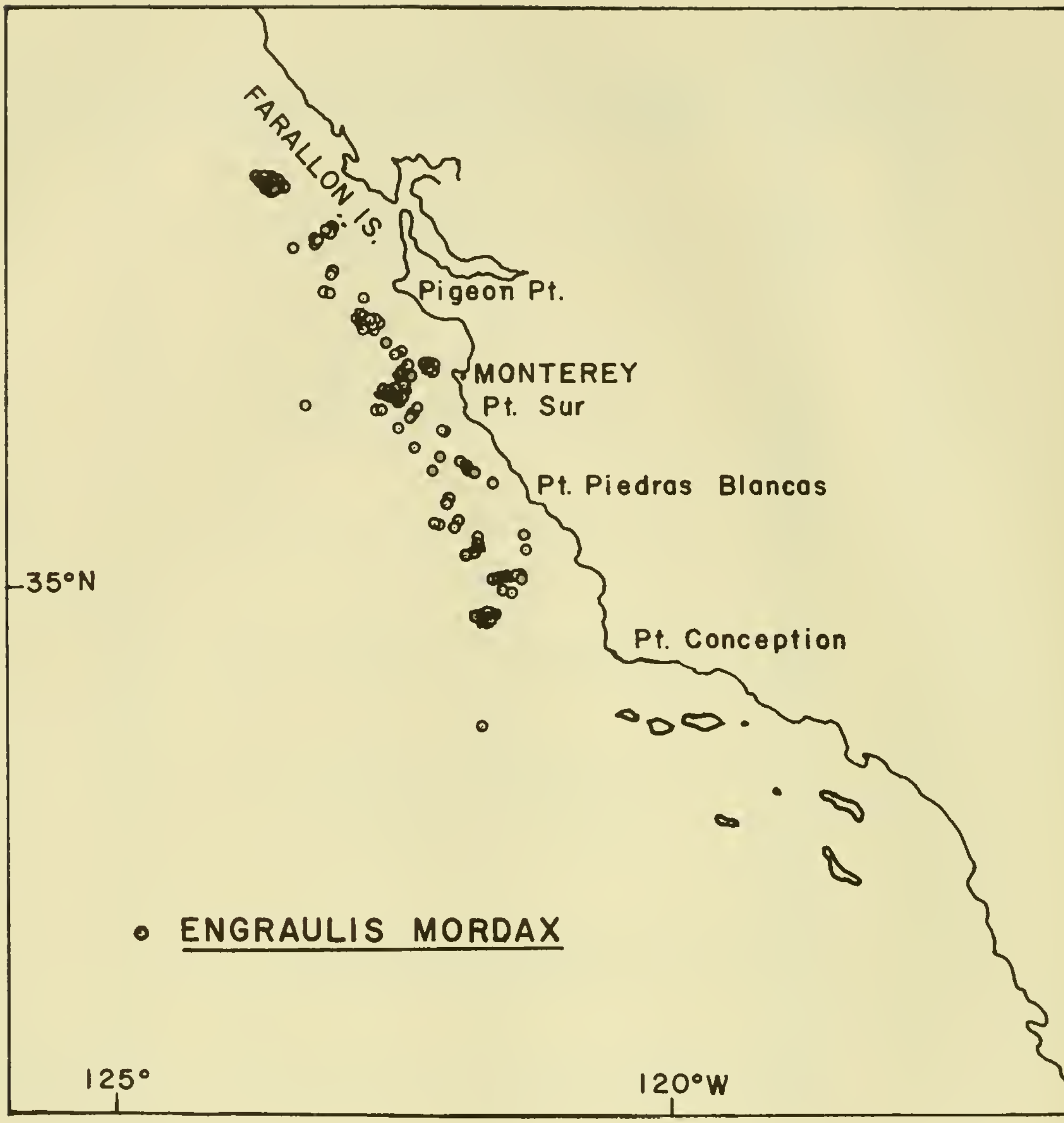

Figure C-1.--Locations where fur seal stomachs collected off California in 1966 contained Engraulis mordax (180 occurrences).

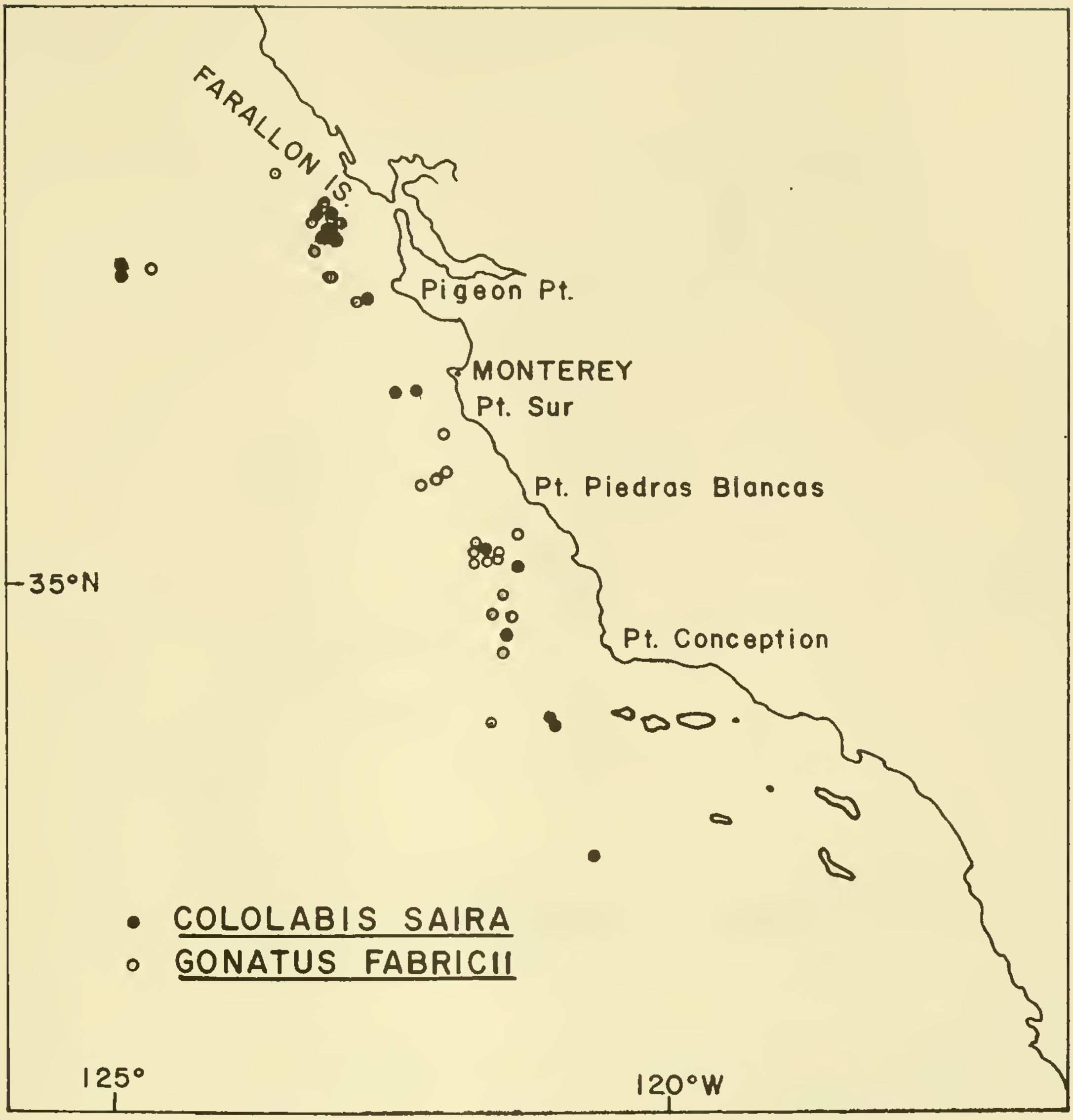

Figure C-2.--Locations where fur seal stomachs collected off California in 1966 contained Cololabis saira (16 occurrences) and Gonatus fabricii (23 occurrences).

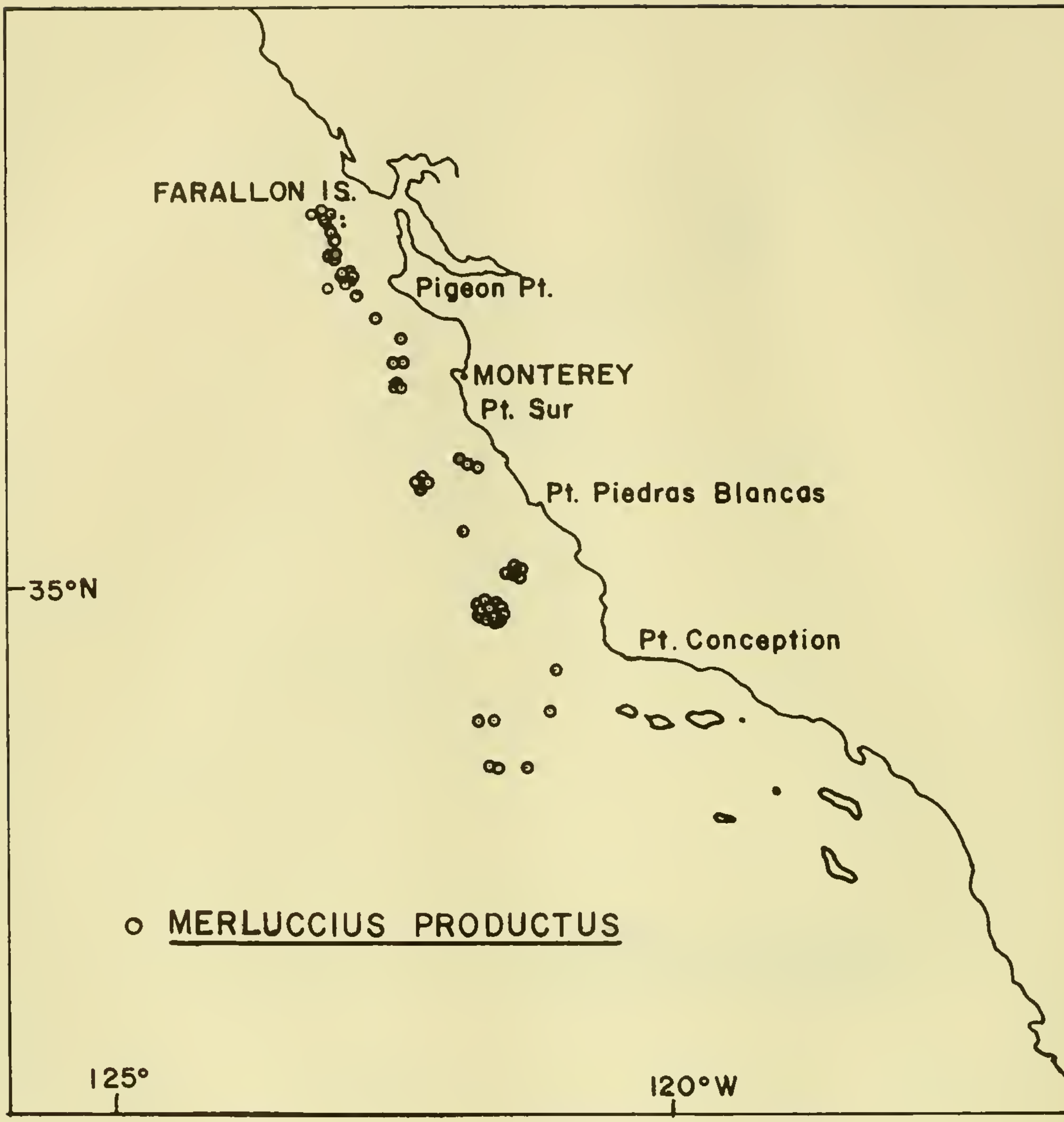

Figure C-3.--Locations where fur seal stomachs collected off California in 1966 contained Merluccius productus (56 occurrences).

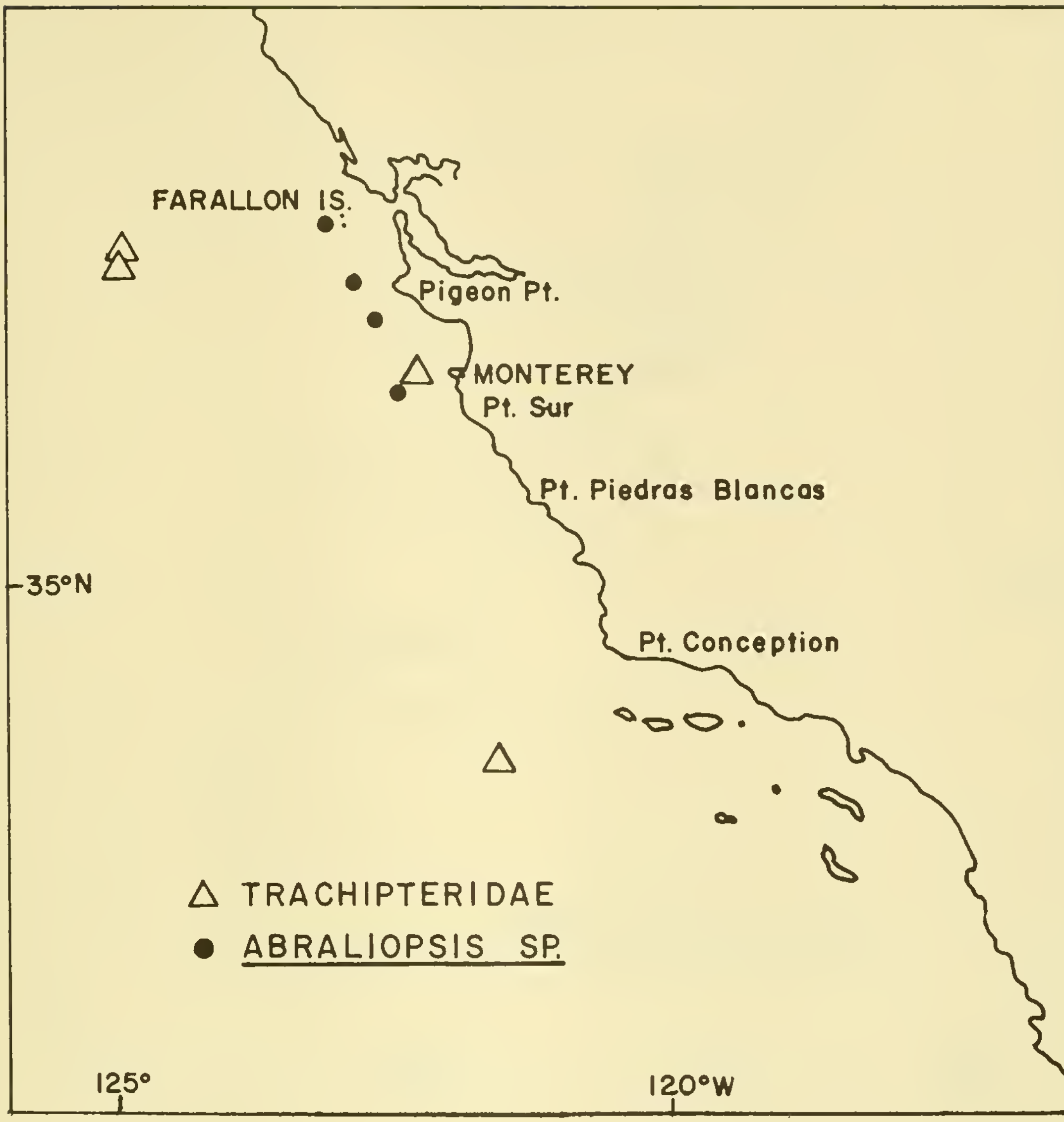

Figure C-4.--Locations where fur seal stomachs collected off California in 1966 contained Trachipteridae (4 occurrences) and Abraliopsis sp. (4 occurrences).

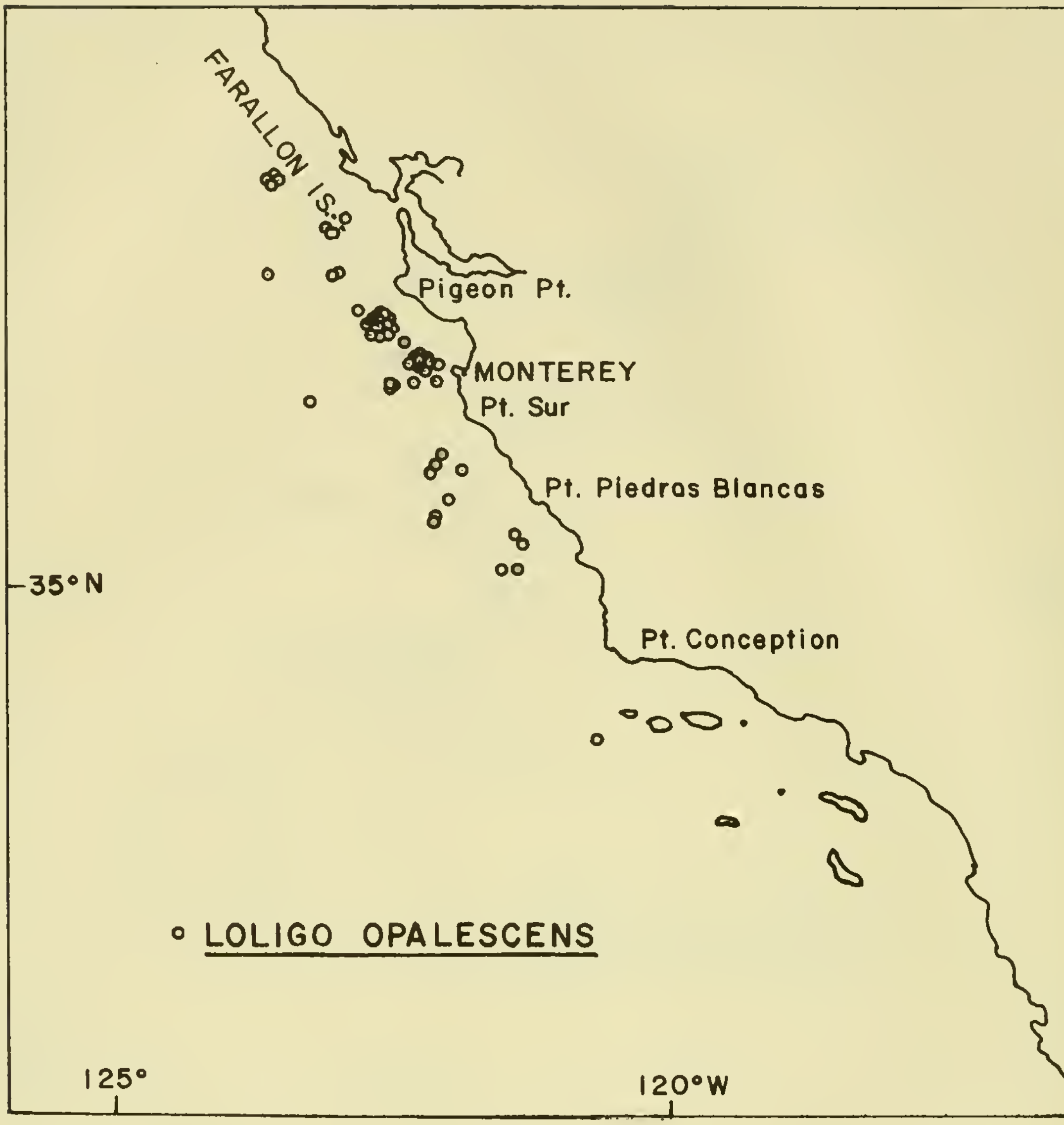

Figure C-5.--Locations where fur seal stomachs collected off California in 1966 contained Loligo opalescens (70 occurrences).

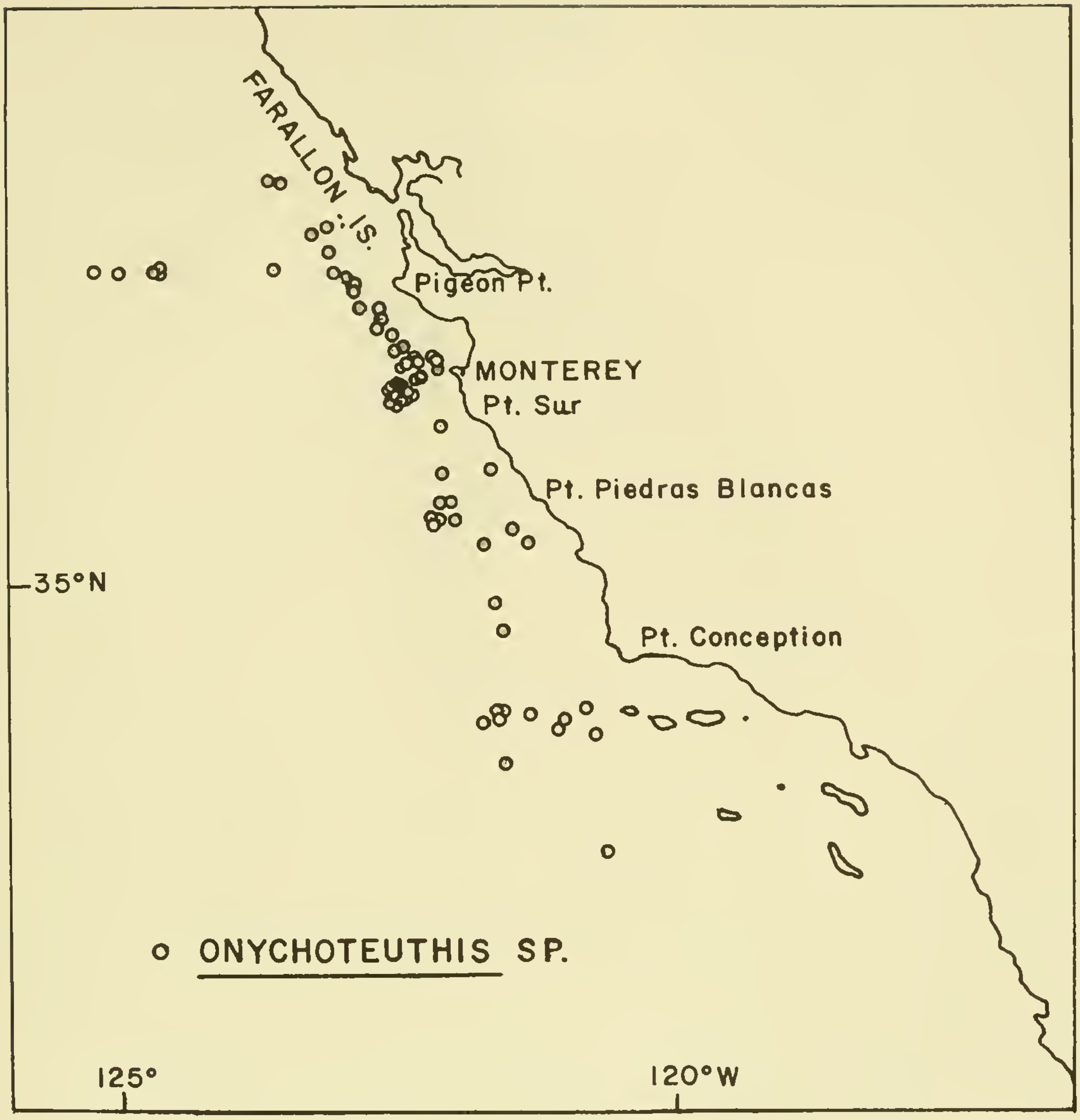

Figure C-6.--Locations where fur seal stomachs collected off California in 1966 contained Onychoteuthis sp. (71 occurrances).

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