PELAGIC FUR SEAL INVESTIGATIONS ALASKA

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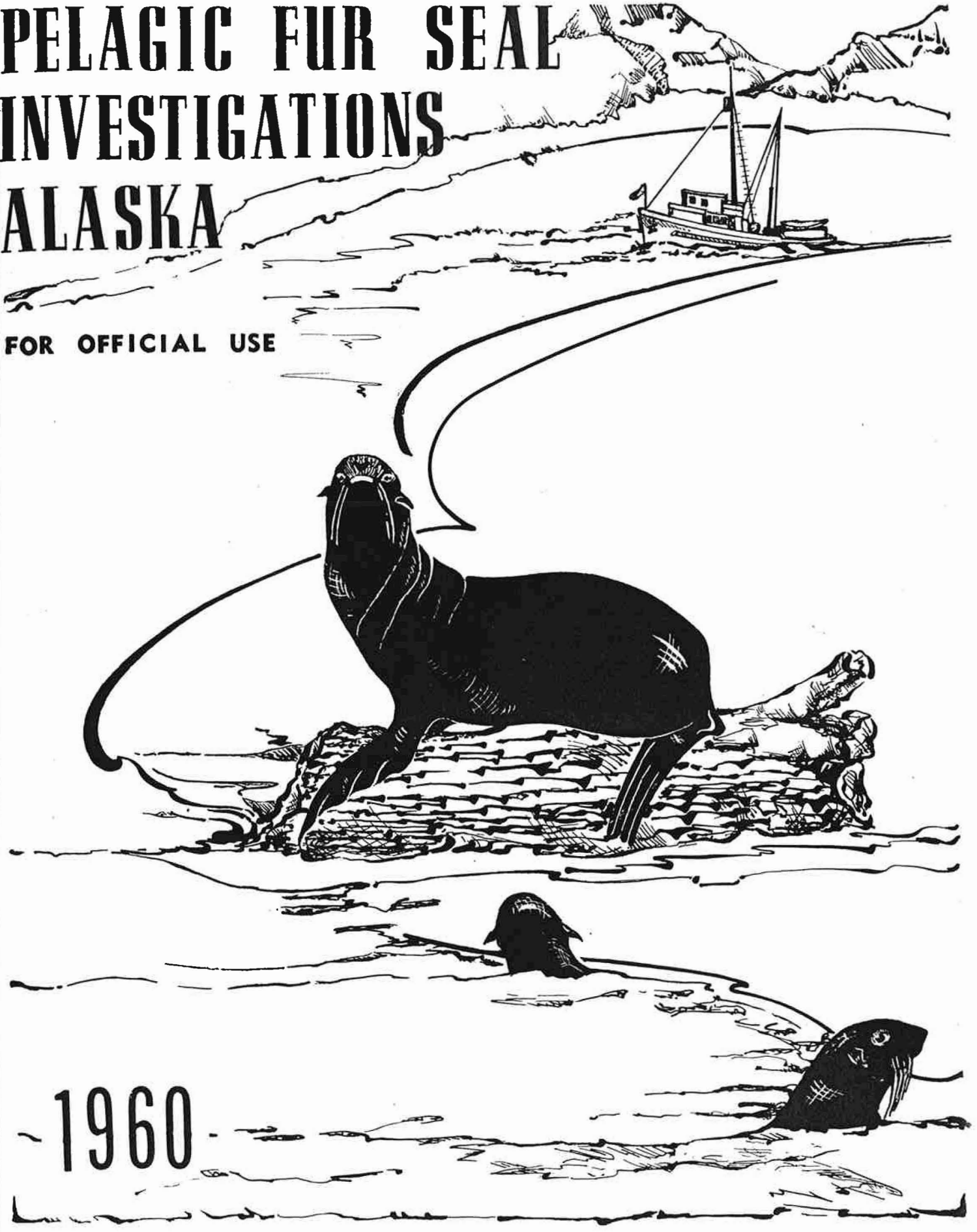

1960

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ALASKA

1960

U. S. Fish and Wildlife Service
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SUMMARY

The third year of pelagic fur seal research, under the terms of Interim Convention on Conservation of North Pacific Fur Seals, was carried out in 1960 off Alaska.

Two vessels, chartered by the United States for the research, worked from March to May from near Sitka into the Gulf of Alaska, in June between Kodiak and Unalaska, and in July and August from Unimak Pass to Pribilof and St. Matthews Islands, and adjacent sea area. Only one vessel operated during March and the first half of April and during July and August.

Of a total of 1,495 seals collected, 1,324 were females, and 171 were males.

The ages of seals were determined by the count of annual growth lines in the dentine layer of upper canine teeth. Females were most heavily represented between ages 8 and 14, and males from ages 1 to 4. Young seals, although inadequately represented in all areas, were most abundant in Southeastern Alaska (yearlings, both sexes) and from western Alaska to the Bering Sea (females). The composition by age has been fairly uniform in the last 3 years' collections (1958-60), despite widely separated sampling locations.

Twenty-five tagged seals, ranging from 1 to 19 years, were collected. The ratio of tagged seals is within the range of expectancy based on the tag ratio in the Pribilof Islands commercial kill but has been consistently in the low portion of the range. No seals tagged on the Commander Islands or Robben Island were recovered.

The pregnancy rate for 1,271 females, 4 years and older, was 81 percent; for 1,289 females, 3 years and older, the rate was 80 percent. An additional 2.5 percent of multiparous, and 7.4 percent of primiparous animals had aborted. Generally speaking, the pregnancy rate for 1960 is higher than in 1958 or 1959.

One seal carrying twin fetuses was collected in 1960. The

left uterine horn developed pregnancies more frequently by a slight degree than the right horn. The sex ratio of fetuses was about equally divided in each of the past three years.

Sandlance, capelin, herring, walleye pollack, and squid, which were the 5 most important food items in the total of 23 species identified, constituted 95 percent by volume of total food found in 1,489 stomaches examined (59 percent were empty). However, the relative importance of these five food items varied according to location. Sandlance was a much more important food species than in the seal stomach collection made in Alaska in 1958. Salmon was recorded from 22 stomachs; it composed about 1.5 percent of the total food by volume. Ronquil, halibut, lumpsucker, Atka mackerel, and daggertooth were all identified in fur-seal stomachs for the first time, so far as is known.

No evidence of predation on fur seals was observed. The one killer whale examined had fed on halibut.

INTRODUCTION

This is a report on the third year of pelagic fur seal research carried on by the United States as agreed in the Interim Convention on Conservation of North Pacific Fur Seals (item 4 of the Schedule).

The 1960 fur seal collections were made entirely in Alaskan waters from Dixon Entrance to Bering Sea[1/]. Early season collecting was confined principally to Sitka Sound. In April and May hunting was carried on in the Gulf of Alaska, and on Portlock and Albatross banks. During the month of June the research vessels operated in the area between Kodiak and Unalaska. In July and August the area between Unimak Pass and Pribilof Islands in Bering Sea was covered.

Collections from the locality of Sitka and in the Gulf of Alaska verify results of previous seasons. Collecting in the western area has contributed some new information in regard to migration, food habits, and distribution. The collections from Bering Sea and Unimak Pass complement previous work and add considerable knowledge on the same subjects.

METHODS, EQUIPMENT, AND PERSONNEL

Vessels

Two vessels were chartered for the 1960 pelagic sealing operations: M/V Tacoma -- a purse seiner, registered length 71.5 feet, cruising speed 9 knots; M/V Windward -- a purse seiner, registered length 72.8 feet, cruising speed 9 knots. Both vessels were required to have Loran navigating equipment, radio direction finders, ship-to-shore and ship-to-ship radio, radar, and fathometers.

Each vessel carried a crew consisting of captain, engineer, cook, and deckhand and four Fish and Wildlife Service biologists

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1/ For exceptions, refer to figure 4.

or biological aids. Two small boats were carried by each vessel for hunting during periods of good weather. Small boats are more efficient than the vessel for collecting when seals have been located.

In March, the vessel working from Sitka could return to port nightly but later in the season, when Kodiak was used as a base of operations, vessels remained out for periods of one to two weeks. In June, one call was made at Sand Point. During the months of July and August, Unalaska was used as a base for fuel and water because these items could not be obtained on the Pribilof Islands. Shelter from storms was found in various bays and anchorages throughout the working area. Working days at sea usually began at 0600 and ended at 1800, with the vessel drifting at sea during the night, or anchored if land was close by.

Hunting Methods

Hunting methods have been described in previous reports and there has been little change in these methods. Twelve-gauge shotguns and magnum loads of 00-buckshot were used to collect the seals. In a few cases large males were taken with shotgun slugs or .243-caliber rifles.

Records were kept by the vessels of total seals sighted, seals collected, seals wounded and lost, and seals killed and lost. The totals are:

Seals sighted	6,287
Seals collected	1,495 (23.8 percent of seals sighted)
Seals wounded and lost	271 (4.3 percent of seals sighted)
Seals killed and lost	241 (3.8 percent of seals sighted)

The method of processing seals aboard vessels has been described in other reports. Routine processing methods remain essentially the same from year to year. New techniques have been used for collecting and processing special material such as skin samples, genital tracts, and pituitary glands.

Laboratory Methods

Age Determination

The techniques used in preparing and aging teeth have been described in previous reports. The only change in procedure this year was the adoption of a method developed by Mr. Carl E. Abegglen and Mr. Alton Y. Roppel for longitudinal sectioning of seal teeth with a band saw preliminary to grinding and polishing.

Stomach Examination

The methods used in collecting, preparing and examining stomachs have remained essentially the same as methods used in previous years.

Identification of food items appearing in the stomach was made by comparing stomach contents with whole specimens, skeletons, otoliths, scales, and squid remains, including whole squid, pens and beaks.

In addition, the following keys and other literature were used in identification: (Berry, 1912; Clemens and Wilby, 1949; Clothier, 1950; O'Brien, 1959; Sasaki, 1920 and 1929; Schultz, 1936; and Wilimovsky, 1958).

Personnel

The following personnel took part in the 1960 pelagic fur seal investigation:

Permanent employees: Ford Wilke, Laboratory Director; Karl Niggol, Biologist; Clifford H. Fiscus, Biologist; and Thomas P. O'Brien, Biologist.

Temporary employees: Harold L. Hansen, Biologist; Terry S. Luoma, Fishery Aid; Jack E. Melland, Fishery Aid; Donald Siedelman, Fishery Aid; Rex Thomas, Fishery Aid; Gene A. Whitaker, Biologist.

RESEARCH IN 1960

For the purposes of this report the Alaska region of investigation has been divided into four areas which are defined below:

1. Southeastern Alaska
   Alaskan waters south of Cape Spencer (58°10'N.)
2. Gulf of Alaska
   Waters from Cape Spencer (58°10'N.) north and west to Cape Sitkinak, Trinity Islands (153°52'W.)
3. Western Alaska
   Waters from Cape Sitkinak (153°52'W.) west to Unalaska Island (166°00'W.)
4. Bering Sea and Unimak Pass
   Waters of Unimak Pass and all waters north of the Aleutian Islands in Bering Sea.

Distribution of Seals by Time, Place, and Numbers

The distribution of seals observed and collected is shown in figures 1, 2, and 3. Areas through which the vessels worked has been divided into a series of squares, each representing 10 square miles (nautical). The number in the upper half of the square represents the total number of seals sighted and the number in the lower half of the square represents the total number of seals collected in that area throughout the season. Table 1 and 2 show the numbers and relative abundance of seals seen and collected in the four major areas and by 10-day periods. Grouping of seals (table 3) follows the general pattern observed in previous years.

Southeastern Alaska

The 1960 pelagic sealing season began with the arrival of a vessel in Sitka in early March (fig. 4). Hunting was carried out in Sitka Sound and the surrounding area from 6 March through 3 April, when the vessel moved on into the Gulf of Alaska. During this period no large concentration of seals was observed in Sitka Sound. The largest number of seals was seen on 24 March (72)

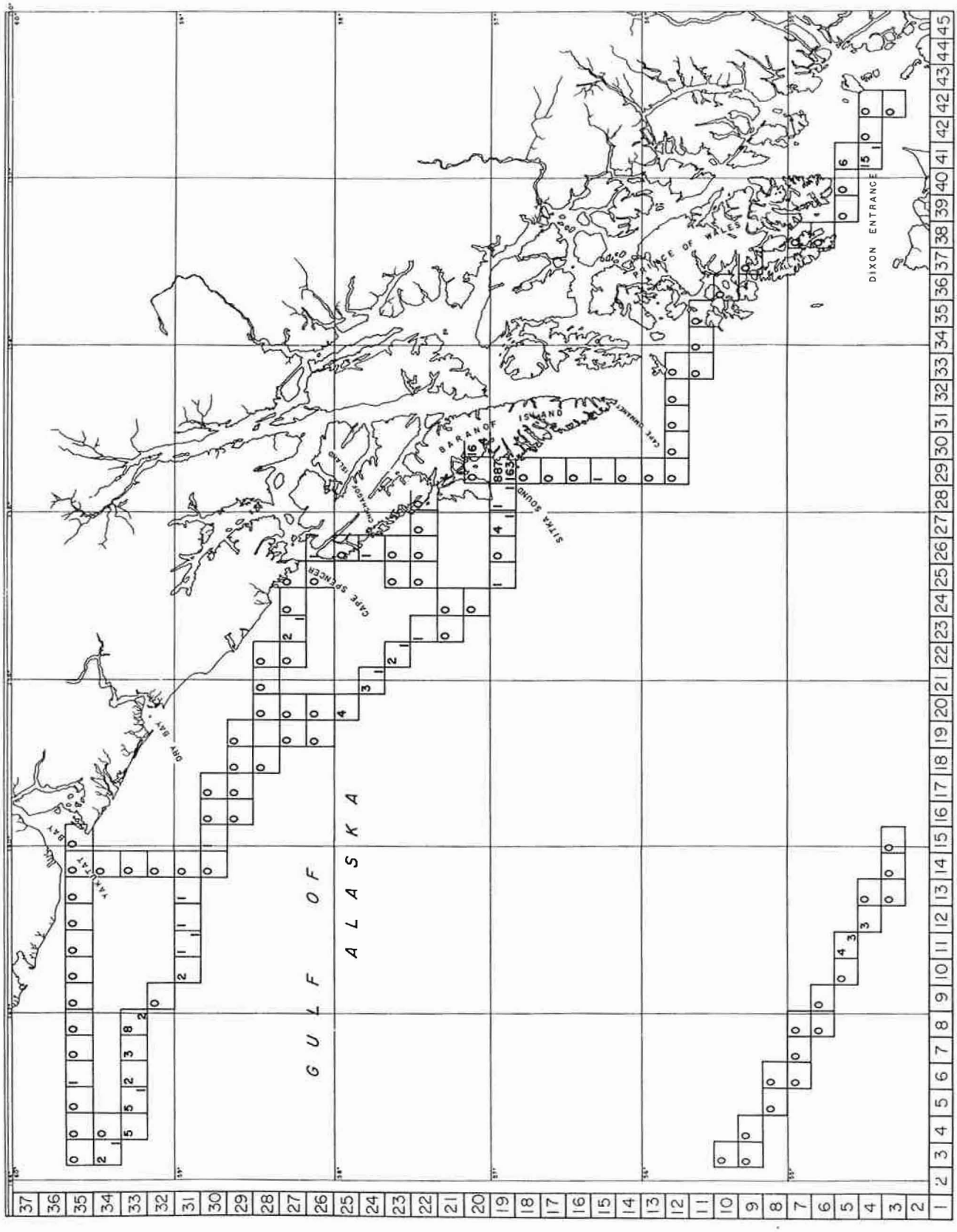

Figure 1. -- Distribution of seals observed (upper number) and collected (lower number) from 54°N. to 144°W. in 1960.

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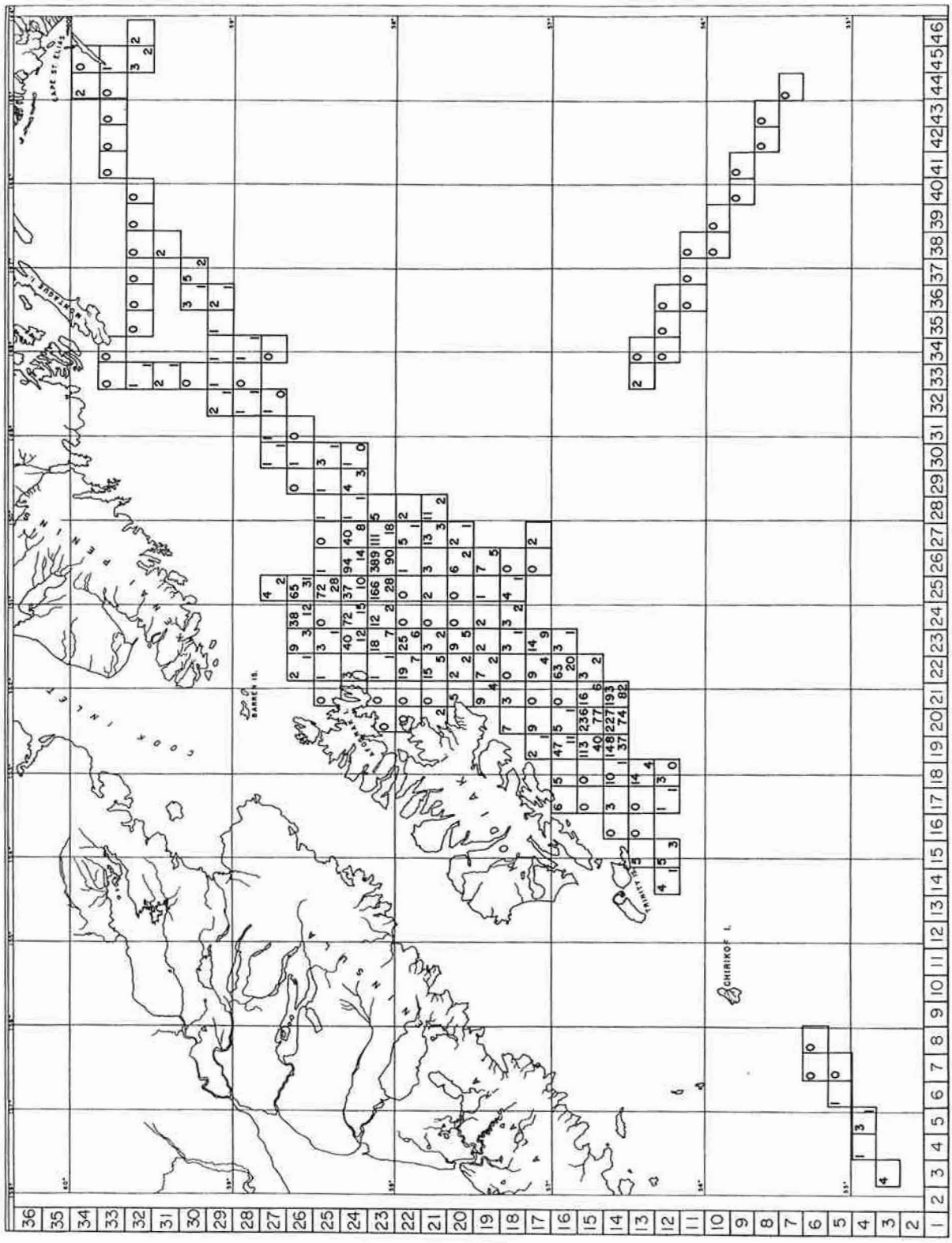

Figure 2. -- Distribution of seals observed (upper number) and collected (lower number) from 144°W. to 158°W. in 1960.

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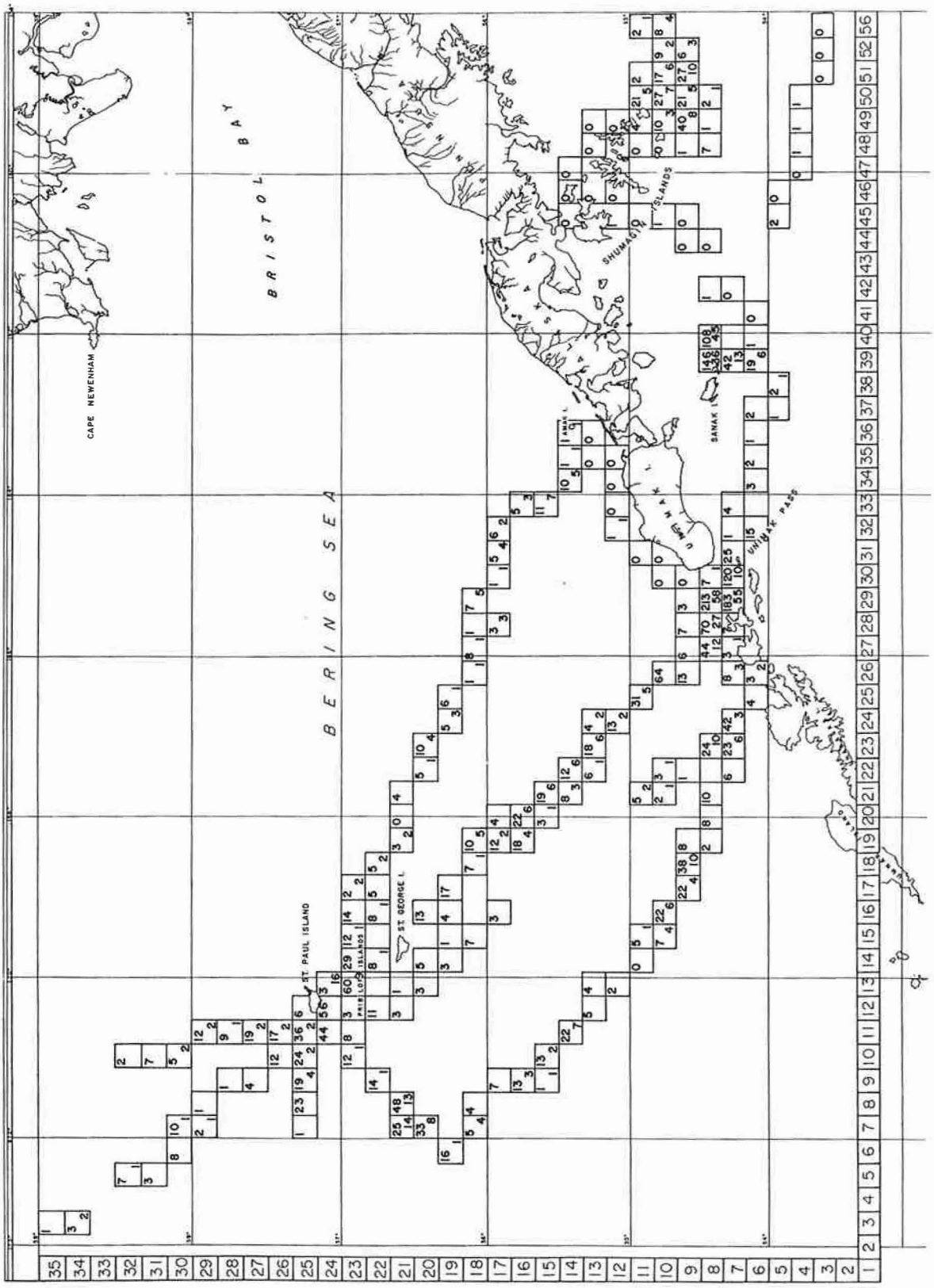

Figure 3.--Distribution of seals observed (upper number) and collected (lower number) from 158°W. to 173°20'W. in 1960.

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Table 1. -- Number and relative abundance of seals seen in Alaskan waters, by 10-day periods, 6 March to 28 August 1960

Period	Number of boat-hunting days	Total seals seen	Seals seen per boat-hunting day	Percent seen per boat-hunting day
Southeastern Alaska				
6-12 March	4.75	271	57.1	28.2
13-22 March	5.75	374	65.0	38.9
23 March - 1 April	4.50	258	57.3	26.8
2-11 April	2.00	5	2.5	0.5
12-21 April	0.75	21	28.0	2.2
22 April - 1 May	5.00	18	3.6	1.9
1-10 June	2.00	13	6.5	1.4
20-28 August	4.00	1	0.3	0.1
Total	28.75	961	33.4 [1/]	100.0
Gulf of Alaska				
2-11 April	5.00	43	8.6	1.6
12-21 April	6.50	172	26.5	6.6
22 April - 1 May	8.50	699	82.2	26.8
2-11 May	14.25	576	40.4	22.1
12-21 May	10.75	599	55.7	22.9
22-31 May	14.50	487	33.6	18.7
1-10 June	4.00	32	8.0	1.2
20-28 August	1.00	1	1.0	0.1
Total	64.50	2,609	40.4 [1/]	100.0
Western Alaska				
1-10 June	7.25	127	17.5	21.3
11-20 June	6.00	162	27.0	27.1
21-30 June	4.75	290	61.1	48.6
20-28 August	2.50	18	7.2	3.0
Total	20.50	597	29.1 [1/]	100.0

[1/] Average number of seals seen per boat day.

Table 1 (con.)--Number and relative abundance of seals seen in Alaskan waters, by 10-day periods, 6 March to 28 August 1960

Period	Number of boat-hunting days	Total seals seen	Seals seen per boat-hunting day	Percent seen per boat-hunting day
Bering Sea and Unimak Pass				
21-30 June	5.50	220	40.0	10.4
1-10 July	6.25	277	44.3	13.0
11-20 July	6.25	415	66.4	19.6
21-30 July	6.50	552	84.9	26.0
31 July - 9 August	4.00	171	42.8	8.1
10-19 August	4.00	396	99.0	18.7
20-28 August	0.50	89	178.0	4.2
Total	33.00	2,120	64.2 [1/]	100.0
Grand total	146.75	6,287	42.8 [1/]	

[1/] Average number of seals seen per boat day.

Table 2. --Number and relative abundance of seals collected in Alaskan waters, by 10-day periods, 6 March to 28 August 1960

Period	Number of boat-hunting days	Males	Females	Total	Number collected per boat-hunting day	Percent collected per boat-hunting day
Southeastern Alaska						
6-12 March	4.75	8	51	59	12.4	33.5
13-22 March	5.75	8	55	63	11.0	35.8
23 March-1 April	4.50	6	39	45	10.0	25.5
2-11 April	2.00	1	1	2	1.0	1.1
12-21 April	0.75	-	1	1	1.3	0.6
22 April-1May	5.00	3	1	4	0.8	2.3
1-10 June	2.00	-	1	1	0.5	0.6
20-28 August	4.00	1	-	1	0.3	0.6
Total	28.75	27	149	176	6.1 [1/]	100.0
Gulf of Alaska						
2-11 April	5.00	3	9	12	2.4	1.7
12-21 April	6.50	2	44	46	7.1	6.3
22 April-1 May	8.50	12	199	211	24.8	28.9
2-11 May	14.25	14	179	193	13.5	26.5
12-21 May	10.75	8	95	103	9.6	14.1
22-31 May	14.50	10	148	158	10.9	21.7
1-10 June	4.00	2	4	6	1.5	0.8
20-28 August	1.00	-	-	-	-	-
Total	64.50	51	678	729	11.3 [1/]	100.0
Western Alaska						
1-10 June	7.25	6	27	33	4.6	20.3
11-20 June	6.00	11	36	47	7.8	28.8
21-30 June	4.75	12	71	83	17.5	50.9
20-28 August	2.50	-	-	-	-	-
Total	20.50	29	134	163	8.0 [1/]	100.0

[1/] Average number of seals seen per boat day.

Table 2. (con.)--Number and relative abundance of seals collected in Alaskan waters, by 10-day periods, 6 March to 28 August 1960

Period	Number of boat-hunting days	Males	Females	Total	Number collected per boat-hunting day	Percent collected per boat-hunting day
Bering Sea and Unimak Pass						
21-30 June	5.50	15	42	57	10.4	13.3
1-10 July	6.25	14	74	88	14.1	20.6
11-20 July	6.25	14	62	76	12.2	17.8
21-30 July	6.50	11	96	107	16.5	25.1
31 July-9 August	4.00	-	17	17	4.3	4.0
10-19 August	4.00	10	70	80	20.0	18.7
20-28 August	0.50	-	2	2	4.0	0.5
Total	33.00	64	363	427	12.9[1/]	100.0
Grand total	146.75	171	1,324	1,495	10.2[1/]	

[1/] Average number of seals seen per boat day.

Table 3.--Grouping of 6,287 seals sighted in Alaska waters, 6 March to 28 August 1960

Area	Number of seals per group											
	1	2	3	4	5	6	7	8	9	10	10+ 1/	total
Southeastern Alaska												
No. of groups	206	114	52	24	15	12	3	3	-	4	3	436
No. of seals	206	228	156	96	75	72	21	24	-	40	43	961
Percent seals	21.4	23.7	16.2	10.0	7.8	7.5	2.2	2.5	-	4.2	4.5	100.0
Gulf of Alaska												
No. of groups	765	244	112	57	27	24	2	11	1	3	11	1257
No. of seals	765	488	336	228	135	144	14	88	9	30	372	2609
Percent seals	29.3	18.7	12.9	8.7	5.2	5.5	0.5	3.4	0.3	1.2	14.3	100.0
Western Alaska												
No. of groups	300	64	34	9	1	2	2	-	-	-	-	412
No. of seals	300	128	102	36	5	12	14	-	-	-	-	597
Percent seals	50.3	21.4	17.1	6.0	0.8	2.0	2.4	-	-	-	-	100.0
Bering Sea and Unimak Pass												
No. of groups	941	324	84	31	10	9	2	2	-	1	1	1405
No. of seals	941	648	252	124	50	54	14	16	-	10	11	2120
Percent seals	44.4	30.6	11.8	5.8	2.4	2.5	0.7	0.8	-	0.5	0.5	100.0
Grand total												
No. of groups	2212	746	282	121	53	47	9	16	1	8	15	3510
No. of seals	2212	1492	846	484	265	282	63	128	9	80	426	6287
Percent seals	35.2	23.7	13.5	7.7	4.2	4.5	1.0	2.0	0.1	1.3	6.8	100.0

1/ Estimated group sizes for the 10+ group = 11, 12, 12, 13, 13, 15, 15, 23, 28, 29, 45, 46, 48, 52, 64

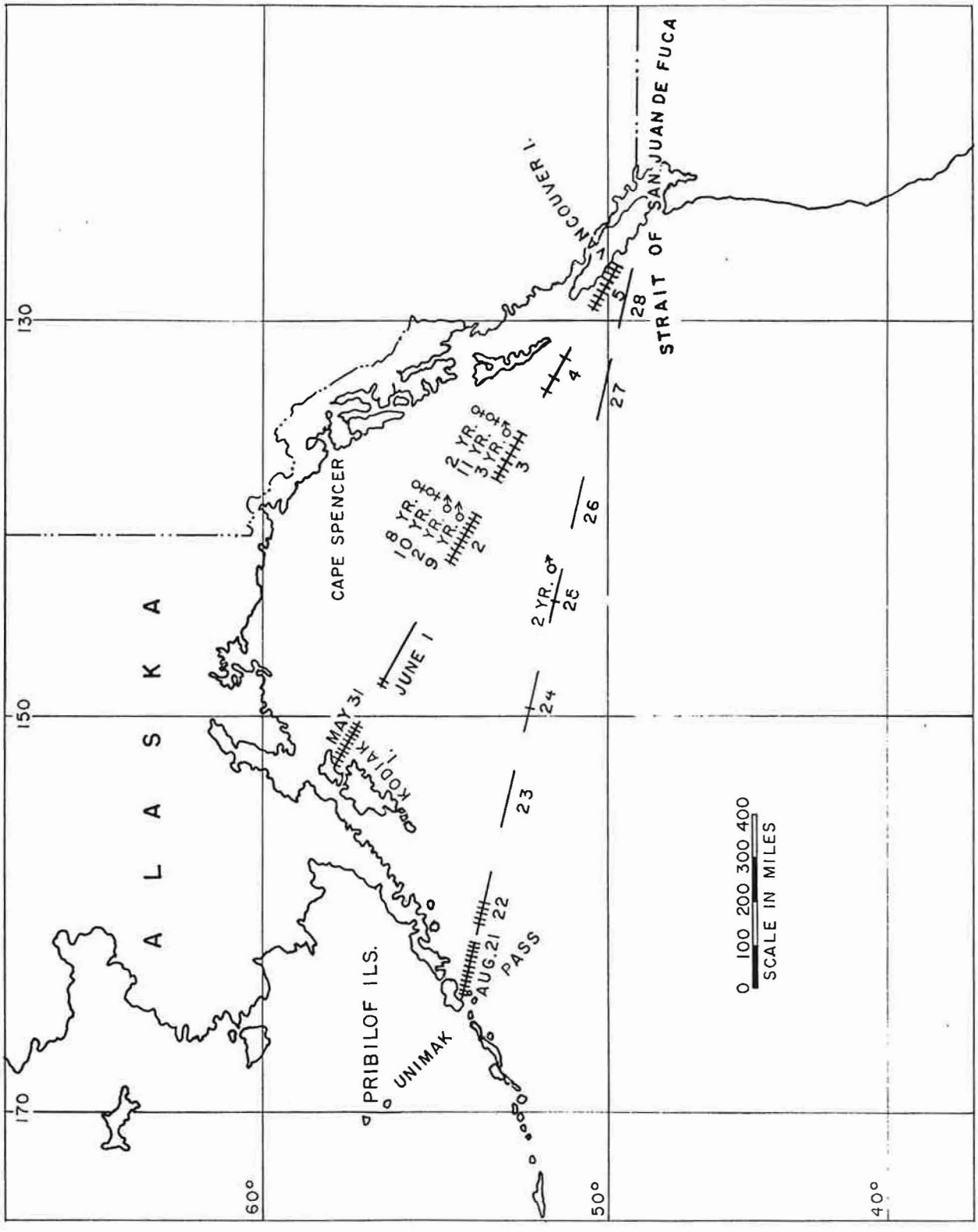

Figure 4. -- Track chart of courses run by the chartered vessels M/V Tacoma, 31 May to 5 June, and the M/V Windward, 21 to 28 August 1960.

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and on 26 March (83). Another vessel worked through the area from 21-27 April and, with the exception of Dixon Entrance, few seals were seen during this period.

Gulf of Alaska

One vessel worked in the Gulf from 3 April through 3 June and the other vessel from 28 April through 2 June. Most hunting was carried on in two localities, Albatross Bank and Portlock Bank. During this period seals were plentiful on these banks. Large concentrations of seals were observed on Albatross Bank on 26 April, 27 April, and 10 May when 61, 101, and 82 seals were collected. Concentrations of seals were observed on Portlock Bank on 9, 12, 13, 19, and 27 May.

An area in which seals were abundant one day often would be devoid of seals on the following day, then another build-up and decline would occur as the next wave moved through. A build-up and decline of seal numbers which usually takes several days to complete, was also noticed in the western Alaska area, and has been found characteristic of the fur seal in migration.

One vessel departed Kodiak on 31 May bound for Seattle. Daily runs, seals sighted, and seals collected (includes sex and age) are illustrated in figure 4.

Three adult females were collected, two on 2 June, one of which was pregnant, and one on 3 June, which was pregnant. The vessel entered the Strait of Juan de Fuca the evening of 5 June.

Western Alaska

This area was worked from 2 June through 25 June by one vessel. The Shumagin grounds were hunted during the period 3-15 June. No large concentrations of seals were found at this time and the seals appeared to be moving through fairly rapidly. From 20-24 June hunting was carried on near Sanak Island, where seals were found in abundance, 20-22 June, feeding fairly close in to the island. On 21 June 158 seals were seen.

Bering Sea and Unimak Pass

The northern end of Unimak Pass and its approaches were hunted from 26-30 June, 3-7 July, 23-24 July and 21 August. Early in the season the seals appeared to be moving through the pass fairly rapidly but, as the season progressed, the movement through the pass slowed and more and more post-partum females from the Pribilof Islands appeared in the area to feed.

In July and August the vessel ran courses in the Bering Sea between the Pribilof Islands and (1) Amak Island, (2) Unimak Pass, (3) Unalaska, (4) to a point 40 miles north of Bogoslof Island, (5) St. Matthew Island, and (6) to a point 50 miles west of St. Matthew Island. In addition, local trips were made between St. Paul and St. George Islands, trips around each island, and several short trips out from St. Paul Island. Seals were seen in practically all areas covered in the Bering Sea. On 21 August the vessel passed through Unimak Pass bound for Seattle. Daily runs, seals sighted, and seals collected (includes sex and age) are illustrated in figure 4. The vessel entered the Strait of Juan de Fuca the morning of 29 August.

Distribution by Age and Sex

Age and Sex

A total of 1,495 seals was collected in Alaskan waters in 1960, 1,324 (88.6 percent) females, and 171 (11.4 percent) males. For comparison, in the 1958 collection 82.7 percent were females and 17.2 percent males. Proportions by age are fairly uniform in the past three years' samples (1958-60) despite the fact that collecting localities varied each year. The ages for 19 seals (17 females, 2 males) could not be determined, and these seals have been omitted from tables where age is required. The age and sex of 1,476 seals is shown in table 4. Of these, 1,307 were females and 169 males. The most numerous age groups were between ages 3 and 14, the median being 9 years. The majority of the yearling seals collected (86 percent females, and 75 percent males) were taken in Southeastern Alaska. No male fur seals, 6-year-olds and older, were found (with one exception) south of Cape Spencer. The number of males represented in samples is higher in Alaska, as the older males

Table 4.--Age and sex of 1,476[1/] fur seals collected off Alaska, by areas, in 1960

Age (years)	Southeastern Alaska 6 March-27 April				Gulf of Alaska 3 April-2 June			
	males		females		males		females	
	no.	%	no.	%	no.	%	no.	%
1	21	77.8	12	8.2	5	10.0	1	0.1
2	2	7.4	1	0.7	10	20.0	2	0.3
3	2	7.4	1	0.7	16	32.0	6	0.9
4	-	-	1	0.7	5	10.0	17	2.5
5	1	3.7	-	-	2	4.0	14	2.1
6	-	-	1	0.7	1	2.0	12	1.8
7	-	-	5	3.4	1	2.0	31	4.6
8	-	-	3	2.1	5	10.0	55	8.2
9	-	-	5	3.4	3	6.0	67	10.0
10	1	3.7	9	6.2	1	2.0	77	11.6
11	-	-	7	4.8	1	2.0	80	12.0
12	-	-	7	4.8	-	-	71	10.6
13	-	-	20	13.7	-	-	67	10.0
14	-	-	20	13.7	-	-	55	8.2
15	-	-	11	7.5	-	-	47	7.0
16	-	-	15	10.3	-	-	21	3.1
17	-	-	14	9.6	-	-	24	3.6
18	-	-	5	3.4	-	-	9	1.3
19	-	-	5	3.4	-	-	9	1.3
20	-	-	1	0.7	-	-	3	0.4
21	-	-	3	2.0	-	-	2	0.3
22	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	1	0.1
Total	27	100.0	146	100.0	50	100.0	671	100.0

1/ A total of 1,495 seals was collected, but because of lost or damaged teeth, the ages of 19 seals could not be determined.

Table 4 (con.).--Age and sex of 1,476[1/] fur seals collected off Alaska, by areas, in 1960

Age (years)	Western Alaska 3 June-25 June				Bering Sea, Unimak Pass 26 June-28 August			
	males		females		males		females	
	no.	%	no.	%	no.	%	no.	%
1	1	3.4	-	-	1	1.6	1	0.3
2	4	13.8	-	-	14	22.2	1	0.3
3	8	27.6	1	0.8	26	41.3	10	2.8
4	2	6.9	1	0.8	5	7.9	17	4.7
5	4	13.8	3	2.3	3	4.8	38	10.6
6	1	3.4	3	2.3	6	9.5	29	8.1
7	2	6.9	4	3.0	4	6.3	26	7.2
8	-	-	17	13.0	-	-	30	8.3
9	3	10.3	20	15.2	2	3.2	52	14.4
10	2	6.9	13	9.9	1	1.6	30	8.3
11	1	3.5	19	14.5	1	1.6	31	8.6
12	-	-	13	9.9	-	-	15	4.2
13	1	3.5	9	6.9	-	-	24	6.9
14	-	-	8	6.1	-	-	24	6.7
15	-	-	3	2.3	-	-	6	1.7
16	-	-	8	6.1	-	-	7	1.9
17	-	-	5	3.8	-	-	3	0.8
18	-	-	3	2.3	-	-	6	1.7
19	-	-	1	0.8	-	-	4	1.1
20	-	-	-	-	-	-	3	0.8
21	-	-	-	-	-	-	1	0.3
22	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	1	0.3
24	-	-	-	-	-	-	-	-
Total	29	100.0	131	100.0	63	100.0	359	100.0

1/ See first page of this table.

Table 4 (con.).--Age and sex of 1,476[1/] fur seals collected off Alaska, by areas, in 1960

Age (years)	Combined areas males no.	Combined areas males %	Combined areas females no.	Combined areas females %	Combined areas males and females no.	Combined areas males and females %
1	28	16.6	14	1.1	42	2.8
2	30	17.7	4	0.3	34	2.3
3	52	30.8	18	1.4	70	4.7
4	12	7.1	36	2.8	48	3.2
5	10	5.9	55	4.2	65	4.4
6	8	4.7	45	3.4	53	3.6
7	7	4.1	66	5.0	73	4.9
8	5	3.0	105	8.0	110	7.5
9	8	4.7	144	11.0	152	10.3
10	5	3.0	129	9.9	134	9.1
11	3	1.8	137	10.5	140	9.5
12	-	-	106	8.1	106	7.2
13	1	0.6	120	9.2	121	8.2
14	-	-	107	8.2	107	7.2
15	-	-	67	5.1	67	4.5
16	-	-	51	3.9	51	3.4
17	-	-	46	3.5	46	3.3
18	-	-	23	1.8	23	1.5
19	-	-	19	1.5	19	1.3
20	-	-	7	0.5	7	0.5
21	-	-	6	0.4	6	0.4
22	-	-	-	-	-	-
23	-	-	1	0.1	1	0.1
24	-	-	1	0.1	1	0.1
Total	169	11.4	1307	88.6	1476	100.0

1/ See first page of this table.

migrate the shortest distance from the Pribilof Islands, and males of all ages become relatively concentrated as they move in spring and summer toward the islands.

Old females, between 13 and 17 years of age, were heavily represented in Southeastern Alaska (Sitka) and the Gulf of Alaska, whereas, younger females were relatively more numerous in western Alaska, Unimak Pass and Bering Sea (table 4).

The postulated and observed distribution of females 11 years and older (Wilke et al, 1958) was compared in 1960 (table 5), by combining all females, 11 years and older, taken in the past 3 years, with the postulated figures (Kenyon et al, 1954) (figure 15, 1959). It is obvious from this table that seals 17 years and older disappear more rapidly than postulated.

Males ranging in age from 1 to 14 years were scattered throughout the area investigated. One-year-old males (yearlings) were most numerous in Southeastern Alaska. Yearlings become widely dispersed and return to the Pribilof Islands late in the fall, if at all.

Two-year-old males were widely scattered in the Gulf of Alaska and composed only a small proportion of the sample. In Unimak Pass and Bering Sea, as they progress toward the islands, the proportion increases.

Three-year-old males were the most numerous male group in all areas except Southeastern Alaska. The extent of their wintering range is not well known but their arrival at the Pribilof Islands can be accurately timed by means of the commercial kill.

The younger animals, although composed of the most numerous year classes, have not been properly represented in pelagic samples taken by the United States. Concentrations of young seals of either sex were not encountered as has been true of older females. Evidence from waters off Asia and Robben Island and the Commander Islands suggests extensive wandering by young males.

Tag Recoveries

Twenty-five tagged seals were recovered in the 1960 collection (table 6). One seal, a 19-year-old female, tagged in 1941, is the

Table 5.--Postulated and observed distribution of females in age group of 11 to 26 years in 1958, 1959, and 1960 combined

Age	Postulated (percent)	Observed in 1958, 1959, and 1960	
		number	percent
11	16.8	348	18.3
12	15.2	316	16.6
13	13.5	286	15.1
14	11.9	269	14.2
15	10.3	225	11.8
16	8.7	176	9.3
17	7.2	118	6.2
18	5.7	72	3.8
19	4.3	49	2.6
20	3.0	15	0.8
21	1.9	14	0.7
22	1.0	6	0.3
23	0.4	2	0.1
24	0.1	2	0.1
25	trace	-	-
26	-	1	0.1
Total	100.0	1,899	100.0

Table 6. -- Tag recoveries in pelagic sample taken off Alaska in 1960

Tag series	Year attached	Age of seal	Southeastern Alaska		Gulf of Alaska		Western Alaska		Bering Sea and Unimak Pass		Combined areas	
			male	female	male	female	male	female	male	female	male	female
USA	1941	19	-	-	-	1	-	-	-	-	-	1
A	1947	13	-	1	-	-	-	-	-	1	-	2
CS	1949	11	-	-	-	1	-	1	-	1	-	3
D	1951	9	-	-	-	1	-	-	-	-	-	1
E	1952	8	-	-	-	2	-	1	-	-	-	3
H[1/]	1955	5	-	-	-	-	-	1	-	1	-	2
I	1956	4	-	-	-	1	-	-	-	2	-	3
J	1957	3	-	-	2	-	-	-	1	1	3	1
K	1958	2	-	1	-	-	-	-	1	-	1	1
L	1959	1	3	1	-	-	-	-	-	-	3	1
Total			3	3	2	6	-	3	2	6	7	18
	Total tagged seals taken										25	

[1/] Includes H - Nos. 1-10,000, No letter - Nos. 10,001-50,000.

oldest known recovery to date. Tag recoveries have increased during the past three years, with the addition of more tagged year classes, as shown below:

Year	1958	1959	1960
Number of seals taken	1,503	1,548	1,495
Number of tags recovered	14	19	25
Percent of tagged seals recovered	0.9	1.2	1.7

In table 7, the estimated percentage of tagged seals in each tag series was derived by dividing the estimated total kill from a year class by the total known tagged animals recovered. Because of cumulative tag loss, all of which may not be recognized, this direct method may give a higher-than-actual tag ratio. Where data are very few, the estimate obtained has little value. Question marks (?) indicate estimates with questionable reliability.

The recovery of tagged seals is not greatly different than would be expected from a collection of similar seals on the Pribilof Islands. Although confidence limits were not calculated, the number of tags found probably falls within the expected range for samples of the size collected.

Size and Reproductive Condition

Size

The average length of collected seals, by year classes, follows the pattern of previous collections (tables 8 and 9). The weight tends to be higher for all age classes taken in 1960. The weights of adult female fur seals have considerably wider range than in previous collections because of the inclusion of post-partum animals whose weight has dropped suddenly and pregnant ones shortly before giving birth, when the weight is maximum. To illustrate the weight differences mentioned above, the weights of 17 pregnant and 17 post-partum seals were taken at almost identical times in Unimak Pass. Pregnant seals averaged 44.6 kilograms and post-partum seals 33.5 kilograms, a difference of 11 kilograms. Increase in weight and length for fetuses is shown, by 10-day periods, in table 10. The greater length of pregnant over nonpregnant seals in same age class, referred to in previous reports, is present but no valid explanation can be given.

Table 7. -- Comparison of expected and actual numbers of Pribilof-tagged seals recovered off Alaska in 1960

Year tagged	Tag series	Age of tagged seals	Number tagged	Estimated percent age of tagged seals in year class		Number of seals of each age recovered		Number of tagged seals expected		Number of seals actually recovered	
				male	female	male	female	male	female	male	female
1941	USA	19	10,000	(?)	(?)	-	19	-	-	-	1
1947	A	13	19,183	(?)2.58	(?) 2.93	-	107	-	(?) 3	-	2
1948	B	12	19.532	3.69	(?)11.11	1	120	-	(?)13	-	-
1949	CS	11	19,960	3.44	4.22	3	137	-	6	-	3
1951	D	9	1,000	0.19	0.42	8	144	-	1	-	1
1952	E	8	19,979	3.84	4.89	5	105	-	5	-	3
1953	F	7	10,388	1.39	1.86	7	66	-	1	-	-
1954	G	6	10,000	1.27	1.82	8	45	-	1	-	-
1955	H [1/]	5	49,870	6.85	6.76	10	55	1	4	-	2
1956	I	4	49,900	5.58	4.19	12	36	1	2	-	3
1957	J	3	49,842	6.56	(?) 4.81	52	18	3	(?) 1	3	1
1958	K	2	49,917	(?)6.19	-	30	4	(?)2	-	1	1
1959	L	1	49,881	-	-	28	14	-	-	3	1
Total										7	18
	Total tagged seals taken									25	

[1/] Includes H - Nos. 1-10,000, No letter - Nos. 10,001-50,000.

Table 8. -- Length and weight of 169 male and 241 nonpregnant female seals collected off Alaska, 6 March to 28 August 1960

Age (years)	Number measured and weighed	Length (centimeters) mean	range	standard deviation	Weight (kilgrams) mean	range	standard deviation
Males							
1	28	77.4	69.0-86.0	3.81	11.4	8.5-15.0	4.75
2	30	98.1	87.0-111.0	5.60	17.8	11.0-26.0	10.55
3	52	109.6	97.0-126.0	5.81	24.6	14.5-34.0	13.74
4	12	120.8	110.0-128.0	5.46	32.8	24.0-39.0	4.39
5	10	130.0	120.0-141.0	6.75	40.0	35.0-47.0	4.22
6	8	145.1	134.0-159.0	7.59	56.4	26.5-90.0	19.99
7	7	151.9	139.0-161.0	7.20	71.3	51.0-80.0	9.42
8	5	163.2	160.0-170.0	4.09	78.4	70.0-97.0	11.19
9	8	173.4	159.0-188.0	9.62	115.1	55.0-158.0	33.93
10	5	175.4	165.0-192.0	10.26	115.2	97.0-137.0	17.72
11	3	174.3	161.0-189.0	-	92.2	65.0-110.5	-
12	-	-	-	-	-	-	-
13	1	208.0	-	-	188.0	-	-
Females							
1	14	73.9	69.0-77.0	3.11	9.8	7.0-12.0	1.67
2	4	95.3	89.0-105.0	6.94	16.5	13.0-21.0	3.42
3	18	101.0	94.0-111.0	5.10	19.2	13.0-24.0	3.76
4	35	108.8	101.0-124.0	4.65	23.2	15.5-29.0	1.15
5	26	113.9	107.0-123.0	4.32	26.9	23.0-33.0	2.81
6	8	118.8	110.0-133.0	6.67	30.3	25.0-42.0	5.34
7	10	120.3	112.0-130.0	5.56	30.7	22.0-50.0	7.32
8	15	124.3	118.0-136.0	5.34	34.9	29.0-45.0	4.15
9	8	124.3	117.0-134.0	6.32	36.1	29.0-42.0	4.45
10	8	124.4	117.0-135.0	6.52	35.9	22.0-43.0	7.01
11	7	129.6	127.0-137.0	4.65	43.6	38.0-52.0	5.56
12	7	126.1	115.0-141.0	8.69	38.7	30.0-49.0	6.32
13	13	126.3	115.0-137.0	6.20	36.5	29.0-46.0	5.85
14	16	128.4	122.0-138.0	5.73	39.9	27.0-50.0	5.91
15	11	131.1	120.0-140.0	5.66	40.3	35.0-51.0	4.22
16	12	130.8	120.0-142.0	7.42	43.6	35.0-56.0	6.25
17	11	126.5	121.0-131.0	2.98	40.0	31.0-47.0	4.67
18	3	127.0	126.0-128.0	-	42.0	36.0-45.0	-
19	6	129.2	117.0-132.0	6.37	40.3	28.0-47.0	6.95
20	6	130.0	127.0-136.0	3.35	41.7	33.0-47.0	5.92
21	2	128.5	123.0-134.0	-	40.3	39.0-41.0	-
22	-	-	-	-	-	-	-
23	1	133.0	-	-	38.5	-	-

Table 9.--Length and weight, by age, of 1,066 pregnant seals collected off Alaska, 6 March to 28 August 1960

Age (years)	Number measured and weighed	Length (centimeters)			Weight (kilograms)		
		mean	range	standard deviation	mean	range	standard deviation
4	1	118.0	-	-	31.0	-	-
5	29	117.6	109.0-125.0	4.42	33.4	23.0-46.0	6.04
6	37	120.6	109.0-129.0	4.74	33.4	22.0-45.0	6.60
7	56	122.3	111.0-138.0	8.04	37.8	24.0-54.0	6.44
8	90	124.0	110.0-141.0	5.14	39.0	26.0-53.0	6.83
9	136	125.8	110.0-141.0	5.35	40.7	25.0-55.0	6.53
10	121	125.9	111.0-142.0	5.35	40.7	26.0-51.0	5.77
11	130	127.0	112.0-141.0	5.69	43.4	27.0-57.5	6.06
12	99	127.5	117.0-142.0	8.43	43.5	30.0-57.0	6.15
13	107	128.4	116.0-146.0	5.19	44.8	28.0-60.0	6.73
14	91	129.4	112.0-142.0	6.01	45.1	30.0-63.0	7.37
15	56	129.3	117.0-144.0	6.41	47.4	29.0-63.0	7.49
16	39	130.5	121.0-143.0	5.62	48.5	35.0-57.0	5.92
17	35	129.4	116.0-144.0	6.57	46.4	29.0-62.0	6.37
18	20	129.9	118.0-143.0	7.30	45.6	29.0-66.0	8.53
19	13	129.8	118.0-138.0	5.23	46.0	36.5-60.0	7.30
20	1	127.0	-	-	35.0	-	-
21	4	131.0	128.0-138.0	4.69	44.3	38.0-51.0	6.70
22	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-
24	1	133.0	-	-	45.0	-	-
Total	1,066						

Table 10.--Mean length and weight increase of fetuses, by 10-day periods, 6 March to 30 July 1960

Period	Number	Mean length (cm.)	Cumulative percent increase	Mean weight (kg.)	Cumulative percent increase
6-12 March	36	35.0	-	1.18	-
13-22 March	38	38.3	9.4	1.49	26.9
23 March-1 April	35 1/	41.7	19.1	1.71	45.4
2-11 April	8	41.5	18.6 2/	2.08	76.6
12-21 April	33	47.6	36.0	2.62	123.5
22 April-1 May	168	48.7	39.1	2.88	145.2
2-11 May	145	50.8	45.1	3.48	196.3
12-21 May	73	53.0	51.4	3.74	218.8
22-31 May	103	55.0	57.1	4.18	255.8
1-10 June	25	66.5	90.0	5.14	337.8
11-20 June	33	59.8	70.9	4.91	317.5 2/
21-30 June	90	58.5	67.1	5.45	363.8
1-10 July	24	60.8	73.7	5.41	360.8
11-20 July	11	64.5	84.3	6.12	420.7
21-30 July	3	61.7	76.3	5.73	387.9

1/ Includes one set of twins.

2/ Decrease in fetus weight caused by small sample size.

Reproductive Condition

The pregnancy rate in 1960 (excluding aborted seals) was high, 79.8 percent as compared with 76.1 in 1958 and 73.8 in 1959 (tables 11 and 12). By the addition of aborted seals, which were obviously pregnant at one time, and seals for which age was not determined, the pregnancy rate rises to 81.6 percent.

In 1960, 79.6 percent of 54 primiparous females were pregnant or aborted; in 1959 the proportion of 143 seals pregnant was 76.9.

Among multiparous females, the pregnancy rate, including abortions in 1960, was 88.3 percent. A comparable figure for 1959 was 97.1. In 1960, 327 multiparous females 14 years old or older were taken; in 1959 the number was 322. Thus, the pregnancy rate decline was not caused by a preponderance of old, sterile animals. Instead, it is traceable to the larger number of abortions identified in 1959. By including abortions, the pregnancy rates for all seals for 1959 and 1960 are 83.3 and 83.7 percent, respectively. United States biologists are unable to say at this time how much of the difference in the number of abortions in the two years is a variation of the sample and how much is caused by a different interpretation of the evidence. As phases of current laboratory studies of reproductive tracts near completion, identification of abortions and resorptions should become less difficult.

Seals between 11 and 16 years of age are an important segment of the breeding population. In the past three years combined, there were as many pregnant seals in the eight year classes from 11 to 18 as in the lower eight year classes from 3 to 10. Some females 17 years or older produce pups but almost none less than 4 years old can be expected to give birth.

Anomalies

One seal carrying twins was collected off Sitka, Alaska. Prior to 1960, twin fetuses were recorded in collections by the United States twice in 1959, twice in 1958, and once in 1923.

Table 11.--Reproductive condition of 1,307 female seals collected off Alaska, 6 March to 28 August 1960

Age	Nullipara		Primipara							Multipara							Grand	
			preg.		nonpreg.		aborted			preg.		nonpreg.		aborted				
	no.	%	no.	%	no.	%	no.	%	total	no.	%	no.	%	no.	%	total	total	%
1	14	14.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	1.1
2	4	4.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.3
3	18	19.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	1.4
4	33	35.1	-	-	2	18.2	-	-	2	1	0.1	-	-	-	-	1	36	2.8
5	19	20.2	17	43.5	3	27.3	1	25.0	21	10	1.0	4	2.9	1	2.9	15	55	4.2
6	1	1.1	9	23.1	3	27.3	2	50.0	13	27	2.7	4	2.9	-	-	31	45	3.4
7	1	1.1	4	10.3	1	9.0	1	25.0	7	48	4.9	8	5.8	2	5.9	58	66	5.0
8	3	3.2	2	5.1	2	18.2	-	-	4	88	8.9	10	7.3	-	-	98	105	8.0
9	-	-	3	7.7	-	-	-	-	3	130	13.2	8	5.8	3	8.8	141	144	11.0
10	-	-	2	5.1	-	-	-	-	2	116	11.7	8	5.8	3	8.8	127	129	9.9
11	-	-	1	2.6	-	-	-	-	1	123	12.5	7	5.1	5	14.7	135	136	10.4
12	1	1.1	-	-	-	-	-	-	-	96	9.7	7	5.1	2	5.9	105	106	8.1
13	-	-	-	-	-	-	-	-	-	105	10.6	13	9.6	2	5.9	120	120	9.2
14	-	-	1	2.6	-	-	-	-	1	85	8.6	16	11.7	5	14.8	106	107	8.2
15	-	-	-	-	-	-	-	-	-	56	5.7	11	8.0	-	-	67	67	5.1
16	-	-	-	-	-	-	-	-	-	38	3.9	13	9.6	2	5.9	53	53	4.0
17	-	-	-	-	-	-	-	-	-	31	3.1	11	8.0	4	11.8	46	46	3.5
18	-	-	-	-	-	-	-	-	-	19	1.9	3	2.2	1	2.9	23	23	1.8
19	-	-	-	-	-	-	-	-	-	11	1.1	6	4.4	2	5.9	19	19	1.5
20	-	-	-	-	-	-	-	-	-	1	0.1	5	3.6	-	-	6	6	0.5
21	-	-	-	-	-	-	-	-	-	3	0.3	2	1.5	1	2.9	6	6	0.4
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	1	0.7	-	-	1	1	0.1
24	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2.9	1	1	0.1
Group totals	94	100.0	39	72.2	11	20.4	4	7.4	54	988	85.3	137	11.8	34	2.9	1159		
Grand total	94	7.2	39	3.0	11	0.8	4	0.3	54	988	76.1	137	10.3	34	2.3	1159	1307	100.0

Table 12.--Pregnancy rate of seals taken off Alaska in 1960 compared with that of seals taken off California, Oregon, Washington, and Alaska in 1958 and 1959

Age (yrs.)	Number females taken			Number pregnant			Percent pregnant		
	1958	1959	1960	1958	1959	1960	1958	1959	1960
3	39	43	18	1	-	-	2.6	-	-
4	42	93	36	1	6	1	2.4	6.4	2.8
5	70	114	55	32	64	27	45.7	56.1	50.9
6	99	118	45	80	91	36	80.8	77.1	80.0
7	103	143	66	92	109	52	89.3	76.2	78.8
8	102	164	105	91	142	90	89.2	86.6	85.7
9	81	108	144	78	96	133	96.3	88.9	93.1
10	97	96	129	85	82	118	87.6	85.4	91.5
11	113	98	136	104	88	124	92.0	89.8	91.2
12	134	76	106	110	67	96	82.1	88.2	91.5
13	110	56	120	91	50	105	82.7	89.3	87.5
14	92	70	107	75	59	86	81.5	84.3	80.4
15	71	87	67	56	77	56	78.9	88.5	83.6
16	56	69	53	44	52	38	78.6	75.4	72.5
17	36	36	46	20	29	31	55.6	80.6	67.4
18	22	27	23	13	23	19	59.1	85.2	82.6
19	14	16	19	4	13	11	28.6	81.3	68.4
20	3	5	6	1	2	1	66.7	40.0	14.3
21	1	7	6	1	6	3	100.0	85.7	66.7
22	1	5	-	-	2	-	-	40.0	-
23	-	1	1	-	-	-	-	-	-
24	-	1	1	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-
26	-	1	-	-	-	-	-	-	-
Total	1,286[1/] & [2/]	1,434[2/]	1,289[2/]	979	1,058	1,027[3/]	76.1	73.8	79.7

1/ Two 10+ year-old seals omitted.

2/ One- and two-year-old seals (34 in 1958, 49 in 1959, and 18 in 1960) omitted as being immature.

3/ Aborted seals excluded in 1960 count to conform with 1958 and 1959 counts.

Fetal sex ratio and uterine horn of pregnancy

In the samples, pregnancies take place most often in the left horn, as shown below:

Date	Percent of occurrences		Percent of fetus sex	
	left horn	right horn	male	female
1958	53.5	46.5	52.4	47.6
1959	51.2	48.8	48.9	51.1
1960	52.3	47.7	46.9	53.1

The sex ratio for the past three years is about equal, as expected.

Food Habits

As in previous years, a few species of fish made up most of the stomach contents. Five species of fish and squid made up 95 percent of the total volume. Despite the importance of a few species, 23 different species of fish were identified, several recognized for the first time in fur-seal stomachs.

Preceding examinations have shown that the amount of food in seal stomachs decreases throughout the day, indicating night or early morning feeding. This was found to be generally true in 1960.

Figure 5 illustrates the amount of food in stomachs from six major collecting areas in Alaskan waters. A "trace" of food is considered to be less than 10 grams. The percent of empty stomachs in the areas ranged from 28.7 (Sitka Sound) to 52.3 (Portlock Bank).

Figure 6 illustrates the quantity of food found in the stomachs of fur seals collected in Bering Sea after 7 July 1960. Seals collected in Unimak Pass, up to and including this date, were considered to be in migration and, as such, would be passing through the area rather than following a normal feeding pattern. The basis for establishing break-off date at 7 July is that up to then only 27.5 percent of females taken in the Pass had recently given birth while during the next collection period in late July 96 percent had given birth. Courses run by the vessel on collecting trips are shown on the figure. The region was divided into eight concentric areas at intervals of 30 miles from a point midway between St. Paul and St. George Islands.

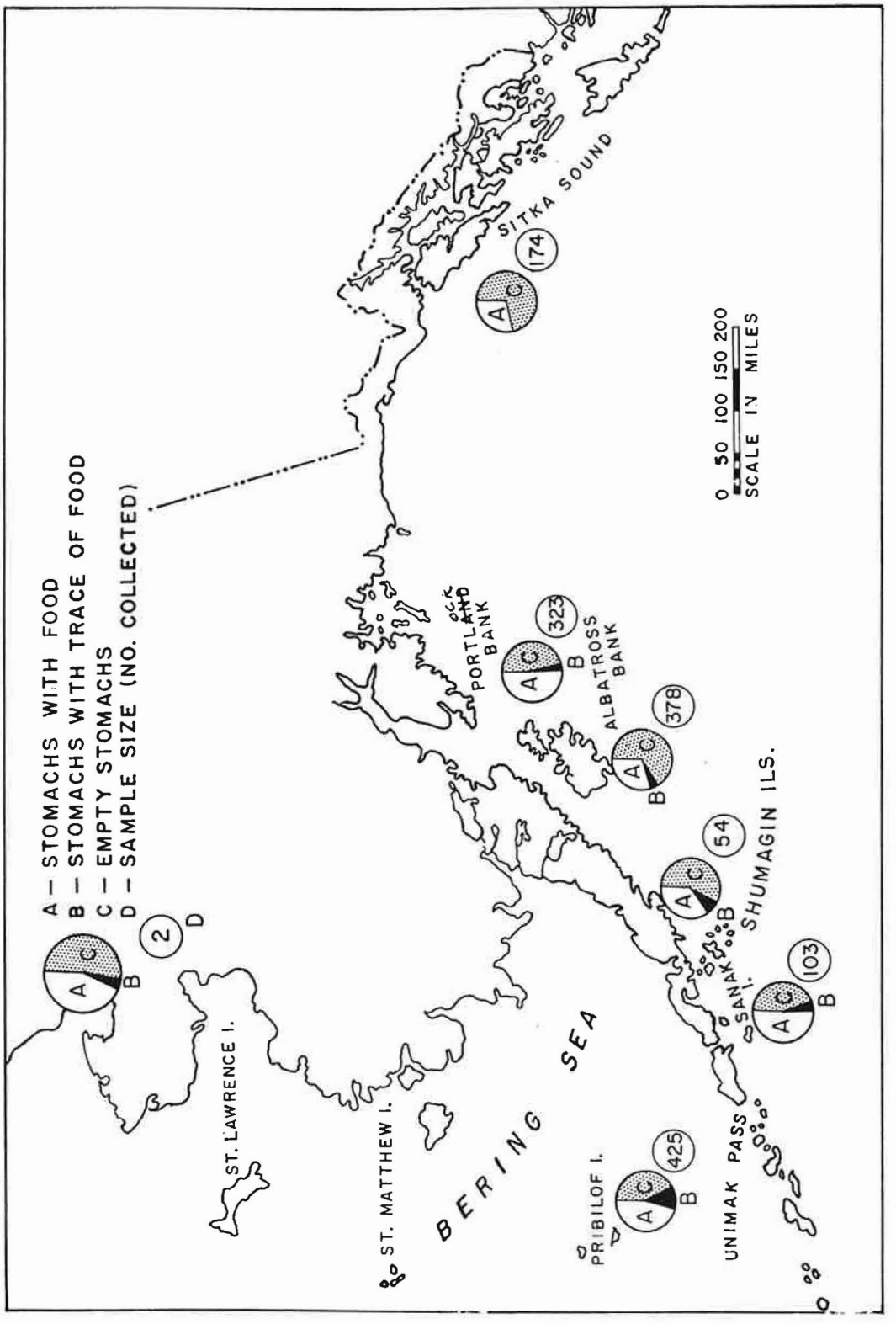

Figure 5. --Percent of fur-seal stomachs from major collection areas in Alaska, in 1960, containing food, trace of food, or no food.

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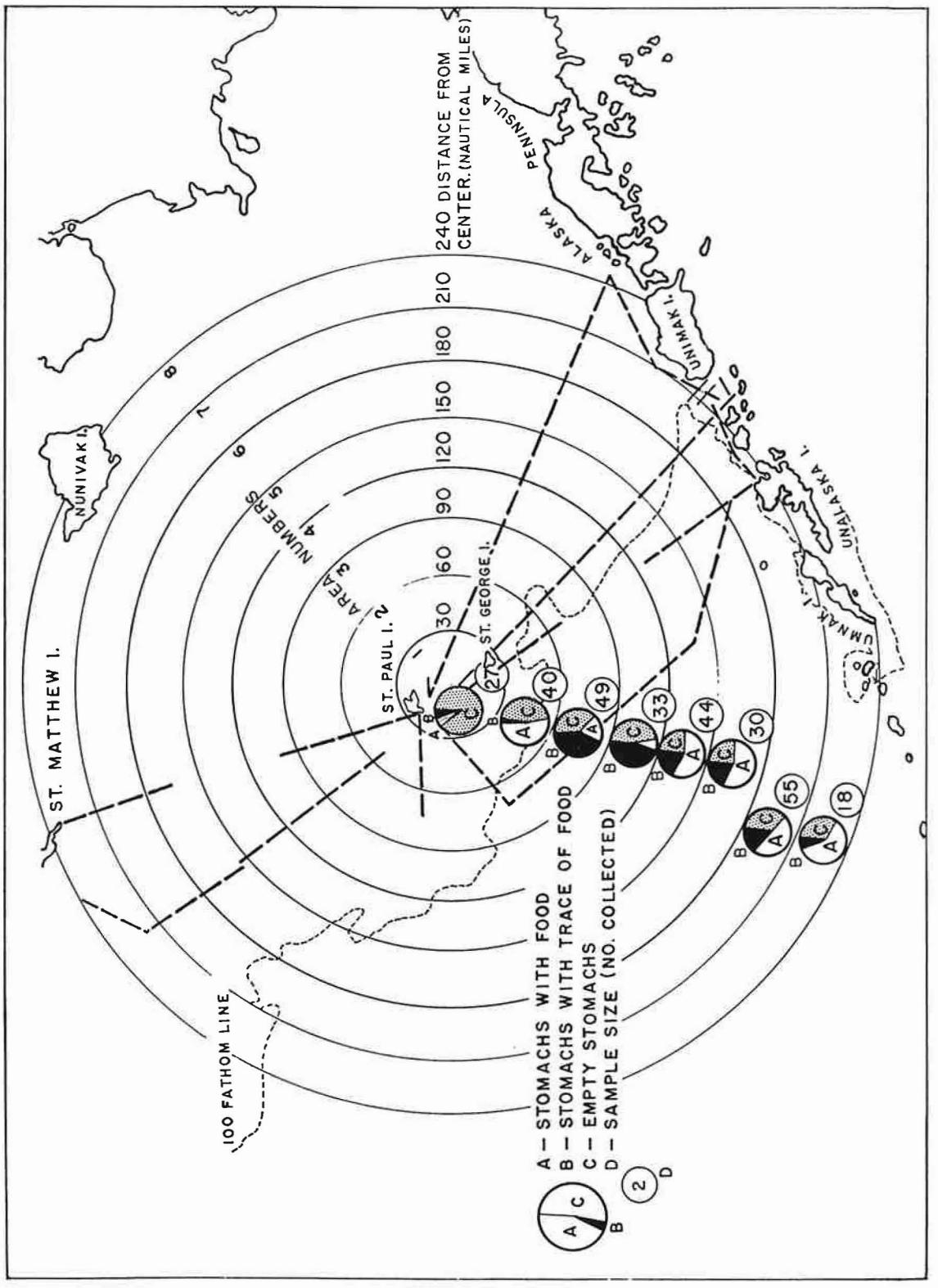

Figure 6. --Percent of fur-seal stomachs collected in Bering Sea and Unimak Pass from 9 July to 21 August 1960, containing food, trace of food, or no food, according to area. Areas are bounded by circles at 30-mile intervals from a point midway between St. Paul and St. George Islands.

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It is probable that, with hundreds of thousands of fur seals concentrated near the Pribilof Islands, little food of suitable species is available to the individual seal. Thus, 85 percent of the stomachs collected in Area 1 were empty. In Area 8, near Unimak Pass, 33 percent were empty. Since many seals travel through Unimak Pass, the relatively low percent of empty stomachs would indicate that the supply of food here is plentiful. In other Bering Sea areas the percent of empty stomachs ranged from 23 to 47, with Areas 5 and 6 showing the lowest proportion empty (both about 23 percent).

Surface-water temperatures ranged from 4°C. in Sitka Sound in March to 10°C. in Bering Sea southwest of the Pribilof Islands in August. No correlation between food species and water temperature was noticed.

In an attempt to detect a difference in feeding habits between females and young males, on the one hand, and larger males, on the other, the stomach contents of 37 males 6 years old and older were examined. Stomach contents included sandlance, capelin, pollack, squid, rockfish, salmon, ronquil, smelt, arrow-toothed halibut, and stickleback. Rockfish occurred in 10 stomachs from the Gulf of Alaska, of which 4 were from males 6, 8, 9, and 11 years old. From a total volume of 13,974 cc. of rockfish, four males accounted for 12,364 cc. These four occurrences of Sebastodes were the only ones in which specific identification was made. The specimens were identified as Sebastodes alutus. In western Alaska, the only occurrence of rockfish was in a 10-year-old male. It is of possible interest, also, that the only occurrence of the ronquil (Bathymaster signatus) was in a 9-year-old male from this same area.

From the evidence, no definite conclusions can be reached, although there is some indication that larger fishes, such as rockfish, may be taken more frequently by the larger males than by females and young males.

The kind of food occurring in seal stomachs is roughly correlated with depth of water at point of collection. In shallow water (less than 50 fathoms), sandfish (Trichodontidae), sculpins (Cottidae), and other bottom fish are relatively more important in stomach contents than are deep water species.

General Account of Stomach Contents

Stomachs from 1,489 seals were examined. Of this number, 876 (59 percent) were empty. The stomach contents of these animals are shown in table 13. This table represents four oceanic areas whose limits have been described in the section on distribution. Figure 7 represents the major food items from each area separately, and from all areas collectively.

In Southeastern Alaska, seals were taken mainly in Sitka Sound during the period 6 March to 3 April. Herring represented over 90 percent of the diet in both volume and frequency of occurrence, followed by squid 2.9 percent and capelin 2.1 percent. Salmon was found in one stomach, representing less than 0.4 percent of the total food volume. Wilke and Kenyon (1952) found that herring comprised 99.5 percent of the stomach contents from 148 seals collected in March 1950 and January 1951 in West Crawfish Inlet, near Sitka. Herring again was the predominant food species from the Sitka area in February and March 1958 (Wilke et al, 1958). The feeding habits of the fur seal here have not changed appreciably in recent years. Seals are clearly attracted to the inshore waters by the herring schools.

From the Gulf of Alaska, over 400 seal stomachs containing food were examined. The seals were taken mainly on Portlock Bank northeast of Kodiak and on Albatross Bank south of Kodiak. Sandlance (51 percent) and capelin (43 percent) formed 94 percent of the total food by volume, followed by rockfish 2.7 percent, squid 1.9 percent, and walleye pollack 0.4 percent. Collections made in previous years in the Gulf of Alaska show similar food items. Lucas (1899) lists food from 36 seals collected in April, with squid being the most important, followed in order by rockfish, salmon, and pollack. Scheffer (1950), in compiling data on the food of fur seals, found that Alexander in 1892 listed by frequency of occurrence rockfish, squid, and salmon. Taylor et al (1955) listed food from 116 stomachs collected in the Gulf of Alaska in June 1952, and at that time capelin made up 91 percent of the total food, by volume, followed by hake, squid, and a trace of sandlance. Wilke et al (1958) found that capelin, sandlance, walleye pollack, and squid were the most important seal-food items in the Gulf of Alaska. Rockfish was also found in one stomach. Except for the appearance of sandlance in the 1958 and 1960 collections, the principal foods have remained the same for many years. It is possible that sandlance

Table 13.--Analysis of the contents of seal stomachs collected in Alaskan waters in 1960 by percent of total volume and frequency of occurrence

Food item	Percent of volume	Frequency	Frequency of trace 1/
Southeastern Alaska 6 March-3 April; 21-27 April; 4 June; 25 August			
Capelin (Mallotus villosus)	2.08	2	-
Herring (Clupea harengus pallasii)	94.31	119	1
Squid (unknown gonatid)	2.90	5	1
Salmon (Oncorhynchus spp.)	0.39	1	-
Daggertooth (Anotopterus pharo)	trace	1	1
Common murre (Uria aalge)	0.31	1	-
Stones	0.01	1	-
	100.00		
Stomachs containing food		125	
Empty stomachs		51	
Missing stomachs		0	
Total stomachs collected		176	
Gulf of Alaska 3 April-3 June			
Sandlance (Ammodytes hexapterus)	50.97	231	8
Capelin	42.94	176	5
Herring	trace	1	1
Walleye pollack (Theragra chalcogrammus)	0.37	12	9
Squid (Gonatus magister)	trace	1	1
" (unknown gonatid)	1.90	16	9
Rockfishes (Sebastodes)	2.66	10	3
Pacific cod (Gadus macrocephalus)	0.35	5	-
Lumpsucker, Cyclopteridae	0.23	6	1
Arrow-toothed halibut (Atheresthes stomias)	0.23	5	1
Eulachon (Thaleichthys pacificus)	0.21	2	-
Sablefish (Anoplopoma fimbria)	0.03	1	-
Threespine stickleback (Gasterosteus aculeatus)	0.03	7	1
Sandfish (Trichodon trichodon)	trace	1	1
Fish, unidentified	0.06	5	2
Stones	0.02	4	-
	100.00		
Stomachs containing food		432	
Empty stomachs		293	
Missing stomachs		4	
Total stomachs collected		729	

1/ Times the food item occurred as only a trace -- included in frequency totals. (Trace = No volume measured, usually only a few bones, or in the case of squid, squid beaks.)

Table 13 (con.).--Analysis of the contents of seal stomachs collected in Alaskan waters in 1960 by percent of total volume and frequency of occurrence

Food item	Percent of volume	Frequency	Frequency of trace[1/]
Western Alaska 2-25 June			
Sandlance	66.32	59	-
Capelin	0.64	8	1
Herring	0.06	1	-
Walleye pollack	13.90	6	-
Squid (Gonatus fabricii)	0.01	3	2
" (unknown gonatid)	0.05	11	10
Rockfishes	0.62	1	-
Salmon	10.73	15	1
Ronquil (Bathymaster signatus)	5.64	1	-
Lumpsucker	0.11	1	-
Atka mackerel (Pleurogrammus monopterygius)	0.46	1	-
Sculpin, Cottidae	0.31	1	-
Pacific lamprey (Entosphenus tridentatus)	0.27	1	-
Sandfish	0.16	2	-
Fish, unidentified	0.01	2	1
Slender-billed shearwater (Puffinus tenuirostris)	0.60	1	-
Stones	0.11	5	-
	100.00		
Stomachs containing food		90	
Empty stomachs		73	
Missing stomachs		0	
Total stomachs collected		163	

1/ See first page of this table.

Table 13 (con.).--Analysis of the contents of seal stomachs collected in Alaskan waters in 1960 by percent of total volume and frequency of occurrence

Food item	Percent of volume	Frequency	Frequency of trace 1/
Bering Sea and Unimak Pass 25 June-21 August			
Sandlance	2.71	5	-
Capelin	14.10	57	5
Walleye pollack	65.71	109	12
Squid (Gonatopsis sp.)	1.36	13	1
" (Gonatus fabricii)	0.57	17	8
" (" magister)	6.49	15	-
" (unknown gonatid)	1.26	46	36
Salmon	3.70	6	-
Pacific halibut (Hippoglossus stenolepis)	2.32	1	-
Pacific cod	0.05	1	-
Smelt, Osmeridae	1.14	3	1
Atka mackerel	0.07	3	2
Sculpin	0.06	1	-
Sablefish	0.02	1	-
Greenling, Hexagrammidae	0.12	1	-
Lanternfish, Myctophidae	0.02	1	-
Fish, unidentified	0.26	5	4
Crustacea	trace	3	2
Mollusca	0.03	1	-
Stones	0.01	4	-
	100.00		
Stomachs containing food		229	
Empty stomachs		196	
Missing stomachs		2	
Total stomachs collected		427	

1/ See first page of this table.

Table 13 (con.).--Analysis of the contents of seal stomachs collected in Alaskan waters in 1960 by percent of total volume and frequency of occurrence

Food item	Percent of volume	Frequency	Frequency of trace 1/
Total combined areas			
Sandlance	37.21	295	8
Capelin	28.21	243	11
Herring	16.03	121	2
Walleye pollack	10.38	129	20
Squid (Gonatopsis sp.)	0.18	13	1
" (Gonatus fabricii)	0.08	20	10
" (" magister)	0.88	16	1
" (unknown gonatid)	1.81	78	56
Rockfishes	1.66	11	3
Salmon	1.56	22	1
Ronquil	0.52	1	-
Halibut	0.31	1	-
Pacific cod	0.22	6	-
Smelt	0.15	3	1
Lumpsucker	0.15	7	1
Arrow-toothed halibut	0.14	5	1
Eulachon	0.13	2	-
Atka mackerel	0.05	4	2
Sculpin	0.04	2	-
Sablefish	0.02	2	-
Threespine stickleback	0.02	7	1
Pacific lamprey	0.02	1	-
Greenling	0.02	1	-
Sandfish	0.01	3	1
Lanternfish	trace	1	-
Daggertooth	trace	1	1
Fish, unidentified	0.07	12	7
Common murre	0.05	1	-
Slender-billed shearwater	0.06	1	-
Crustacea	trace	3	2
Mollusca	trace	1	-
Stones	0.02	14	-
	100.00		
Stomachs containing food		876	
Empty stomachs		613	
Missing stomachs		6	
Total stomachs collected		1,495	

1/ See first page of this table.

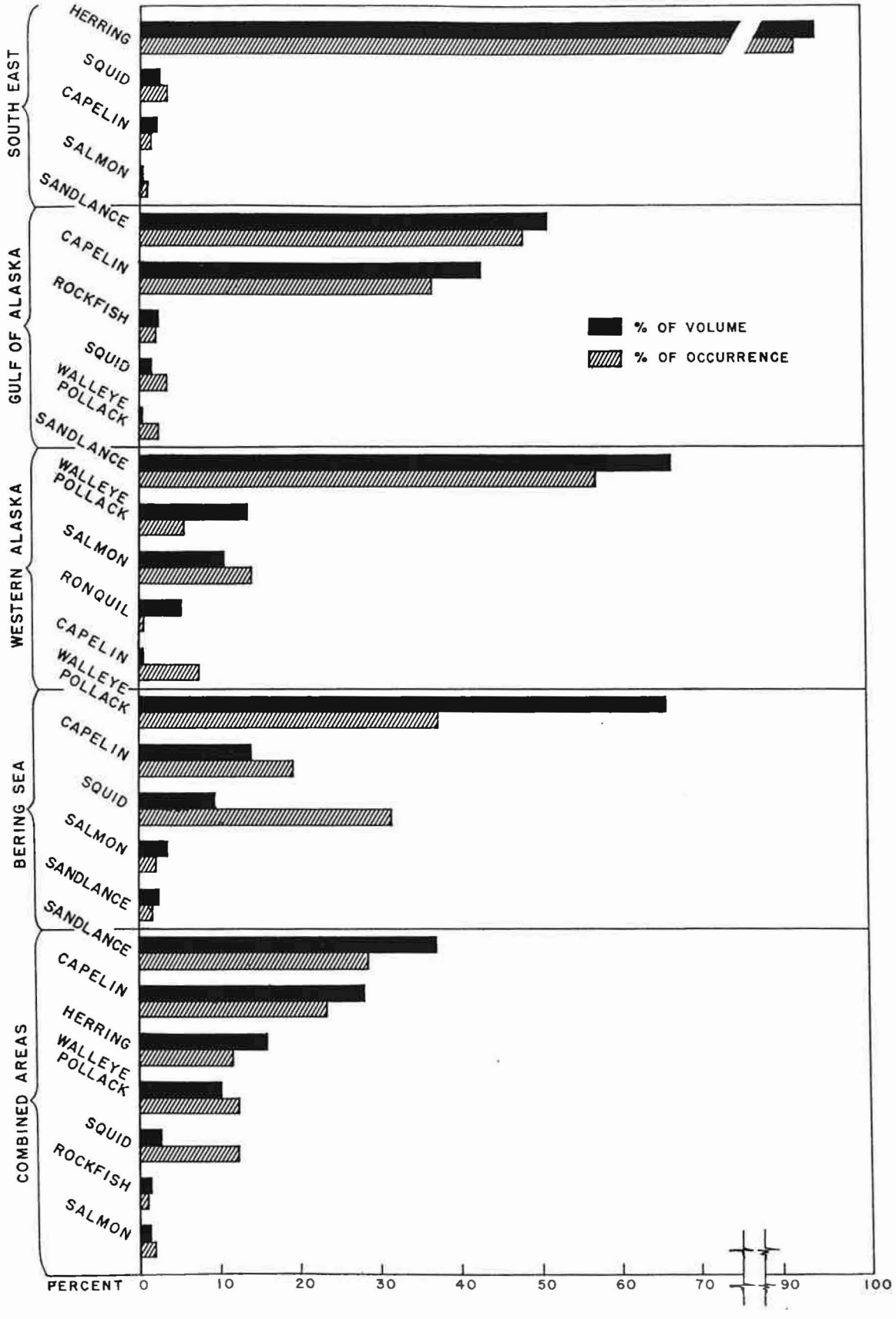

Figure 7. --Principal food of fur seals in the 1960 collection, by areas, comparing food volume and frequency-of-occurrence.

was present but that previous collectors did not happen to collect seals that were feeding on sandlance schools. It has not been determined whether or not the sandlance schools remain on the banks, available as a seal food throughout the year, or if they only appear at certain times.

In western Alaska, 90 stomachs containing food were examined. The majority came from two localities, the Shumagin grounds east and south of Simeonof Island, and from an area near the Sanak Islands. There was no appreciable difference in food between the two localities. Sandlance made up 66 percent of the food by volume, followed by walleye pollack 14 percent, salmon 11 percent, ronquil 6 percent, and capelin 1 percent. In 1958, the only other comparable year, sandlance, squid, capelin, and salmon were found in the stomachs. The 1958 collection in the Sanak area was taken farther offshore than the 1960 collection.

From Bering Sea and Unimak Pass, 427 stomachs were examined, of which 229 contained food. Walleye pollack formed the largest single food item, making up 66 percent by volume of the total food; followed by capelin 14 percent, squid 9.7 percent, salmon 4 percent and sandlance 3 percent. Lucas (1899), in showing the results of an examination of 273 seals taken in Bering Sea in August and September indicated, by frequency of occurrence, that pollack and squid were the most important food items, followed by "seal fish" [Bathylagus], salmon and lamprey. The seal fish has not been found in collections since Lucas' time, though in a large collection from deep water in Bering Sea, it might be expected (Chapman, 1943). Wilke and Kenyon (1957), collecting seals from Unimak Pass to the Pribilof Islands in June and July 1955, found in a collection of 117 stomachs containing food that capelin (52 percent) and pollack (40 percent) made up the bulk of the stomach contents, followed by squid 7 percent, salmon 0.5 percent and sandlance a trace. They stated that capelin often occurred in stomachs taken near or in Unimak Pass, while walleye pollack was taken in offshore waters. This was found to be true again in 1960.

From the evidence available, it appears that the feeding habits of the fur seal in western Alaska have not changed materially over the years.

Individual Food Items

Locations where food species occurred in seal stomachs are shown in figures 8 to 15.

Sandlance

Sandlance was the most important food item in the 1960 collection. This small schooling fish, which was distributed in the collection from the Gulf of Alaska to the Bering Sea, occurred in 243 stomachs. It represented 37.2 percent of the total volume of food.

Capelin

Capelin was found over the entire sealing area. It was the second most important food item found in 1960, representing 28.2 percent, by volume, of the total.

Herring

Herring, which made up 16 percent of the food items, occurred principally in the Sitka Sound area of Southeastern Alaska where it constituted 94.3 percent of the food volume. It occurred only twice elsewhere, once in the Gulf of Alaska and once in western Alaska.

Walleye pollack

Pollack occurred in stomachs from the Gulf of Alaska to Bering Sea. It composed 10.4 percent of the total food volume, but in Bering Sea where it was the most important seal food, it made up 65.7 percent of the total volume.

Squid

Squid ranked fifth in importance as a seal food in 1960, making up 3 percent of the food by volume, and 12.4 percent by frequency of occurrence. Squid was found over the entire range of the collection, but occurred more frequently in Bering Sea where it was 9.7 percent of the food, by volume, or 31 percent by frequency of occurrence.

Three species of squid were identified from seal stomachs this season. They are Gonatus fabricii, Gonatus magister, and Gonatopsis sp. All are members of the family Gonatidae.

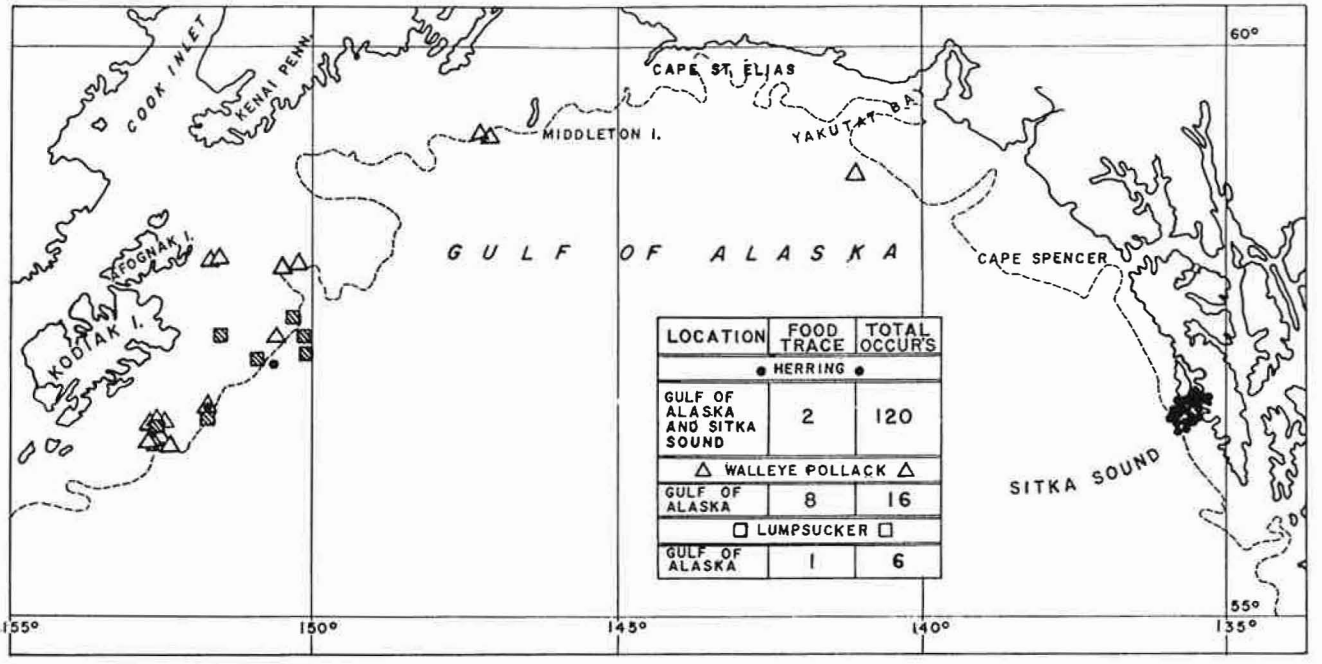

Figure 8. -- Locations from Dixon Entrance to Kodiak, Alaska, where herring, pollack, and lumpsucker occurred in seal stomachs collected 6 March to 28 August 1960.

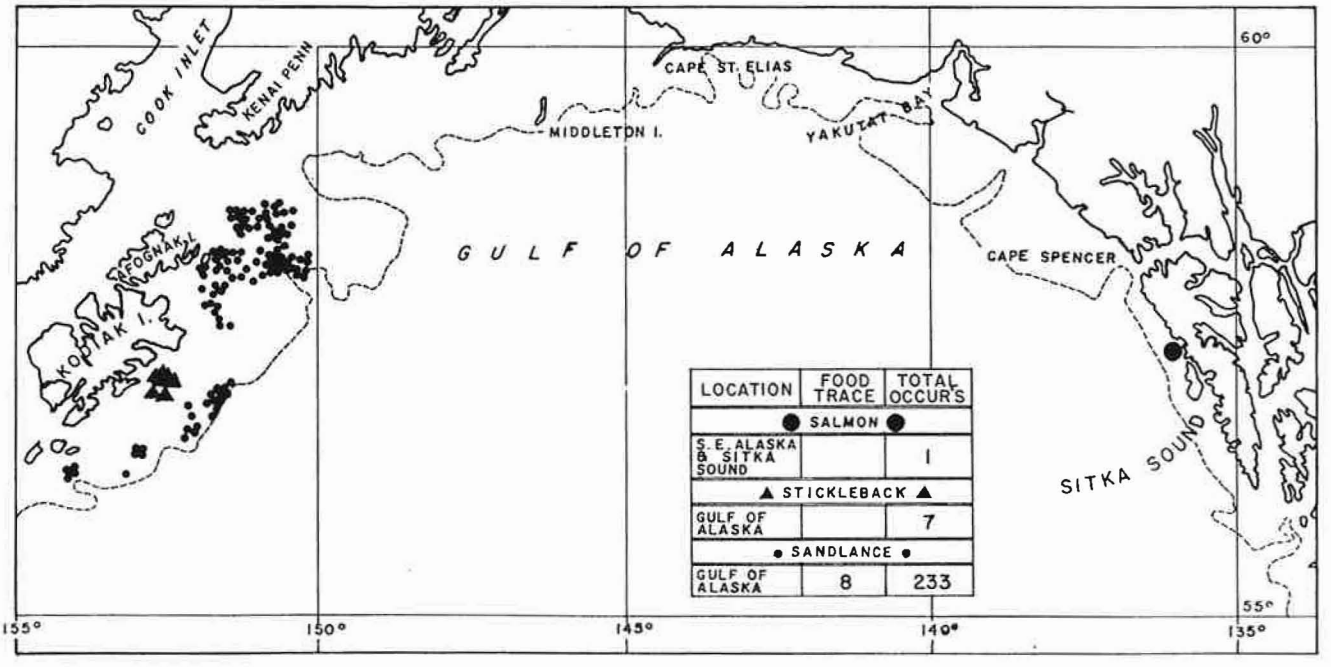

Figure 9. -- Locations from Dixon Entrance to Kodiak, Alaska, where salmon, stickleback, and sandlance occurred in seal stomachs collected 6 March to 28 August 1960.

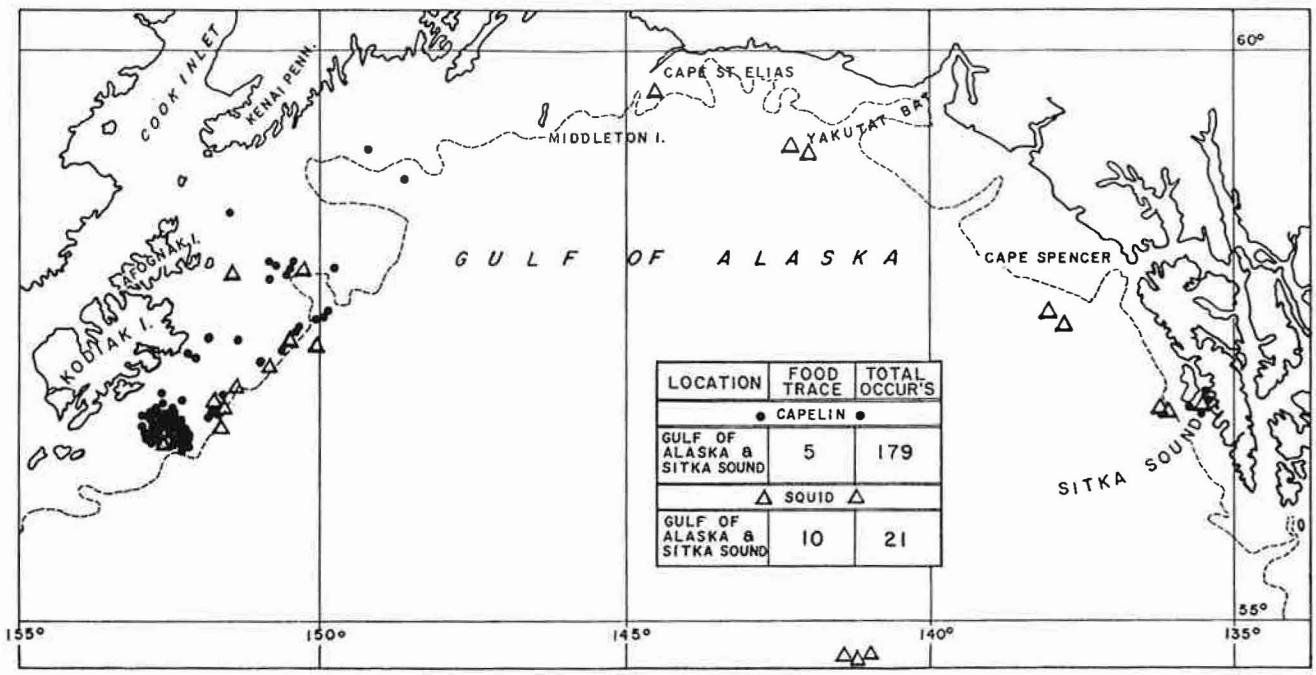

Figure 10. -- Locations from Dixon Entrance to Kodiak, Alaska, where capelin and squid occurred in seal stomachs collected 6 March to 28 August 1960.

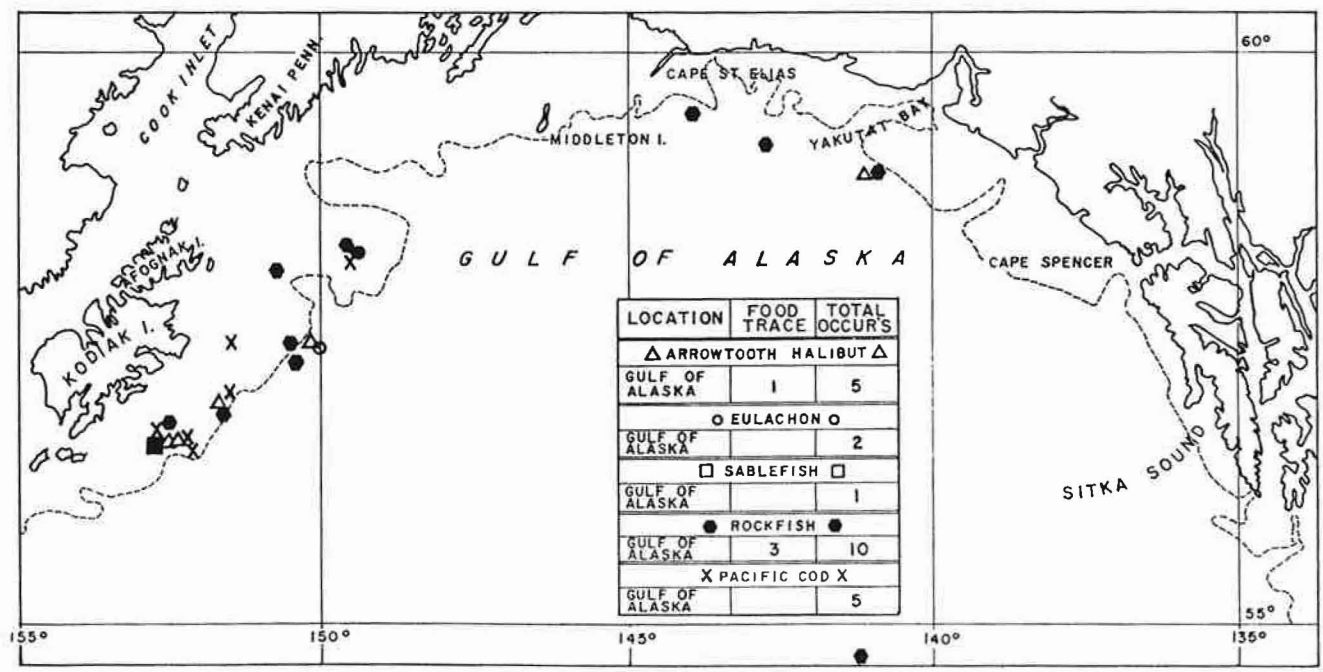

Figure 11. -- Locations from Dixon Entrance to Kodiak, Alaska, where arrow-toothed halibut, eulachon, sablefish, rockfish, and Pacific cod occurred in seal stomachs collected 6 March to 28 August 1960.

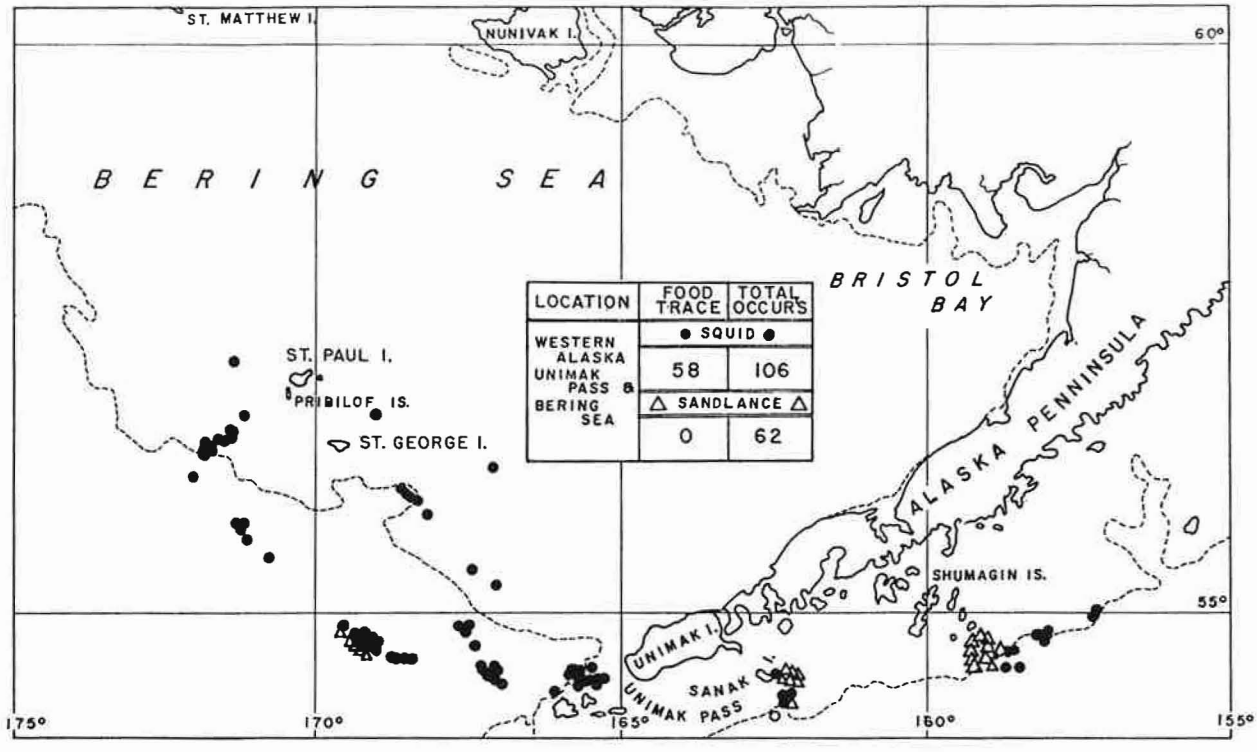

Figure 12. -- Locations from the Shumagin Islands to Bering Sea where squid and sandlance occurred in seal stomachs collected 6 March to 28 August 1960.

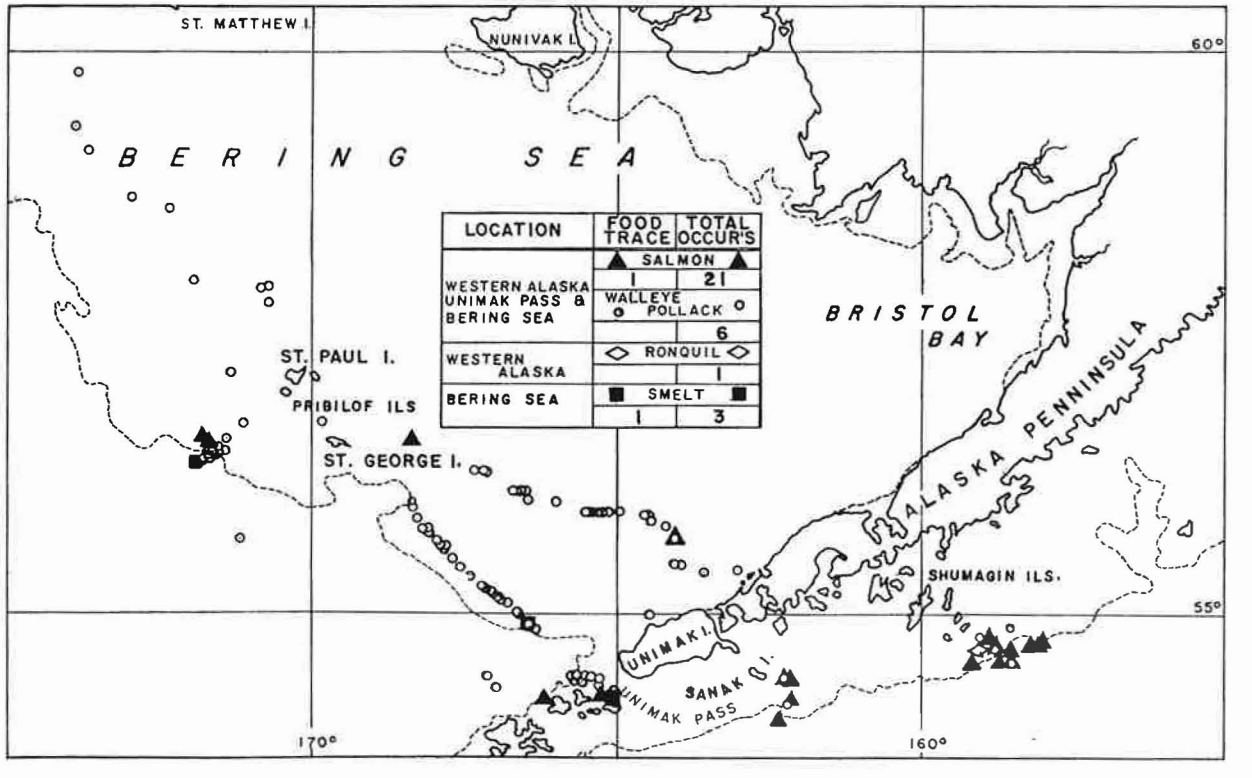

Figure 13. -- Locations from the Shumagin Islands to Bering Sea where salmon, pollack, ronquil, and smelt occurred in seal stomachs collected 6 March to 28 August 1960.

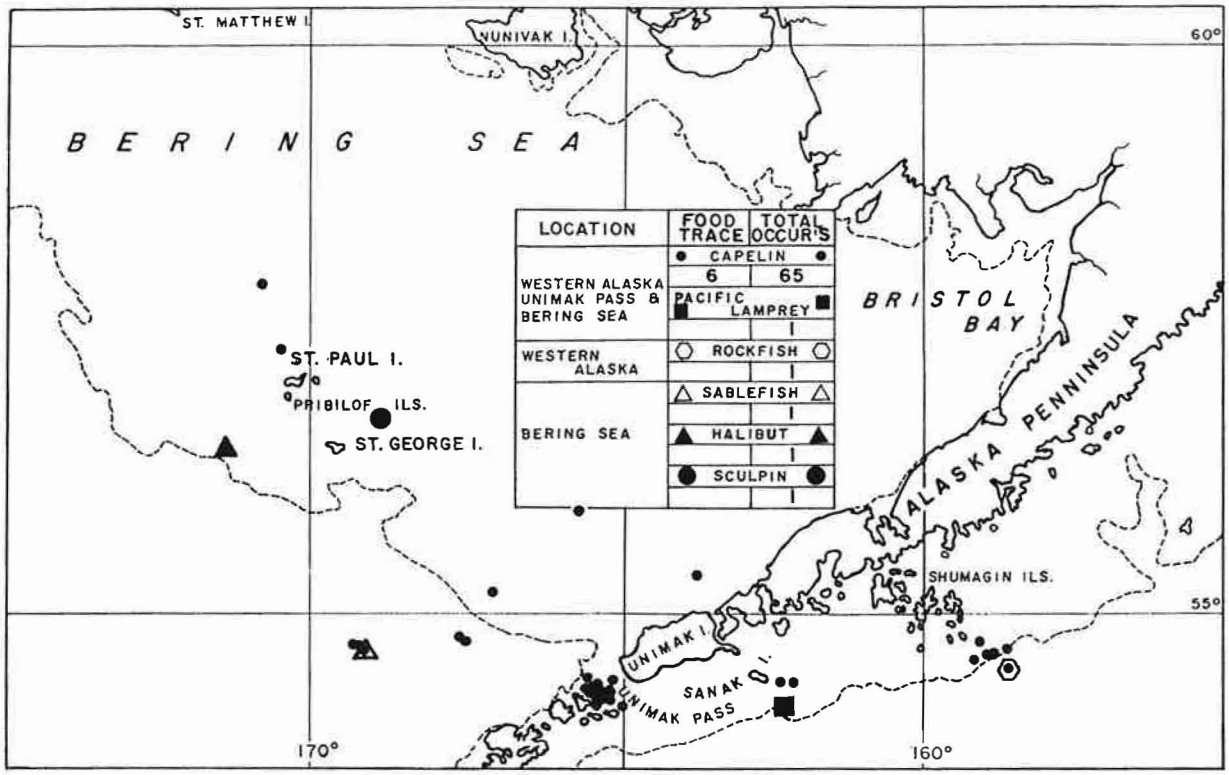

Figure 14. -- Locations from the Shumagin Islands to Bering Sea where sculpin, capelin, Pacific halibut, sablefish, Pacific lamprey, and rockfish occurred in seal stomachs collected 6 March to 28 August 1960.

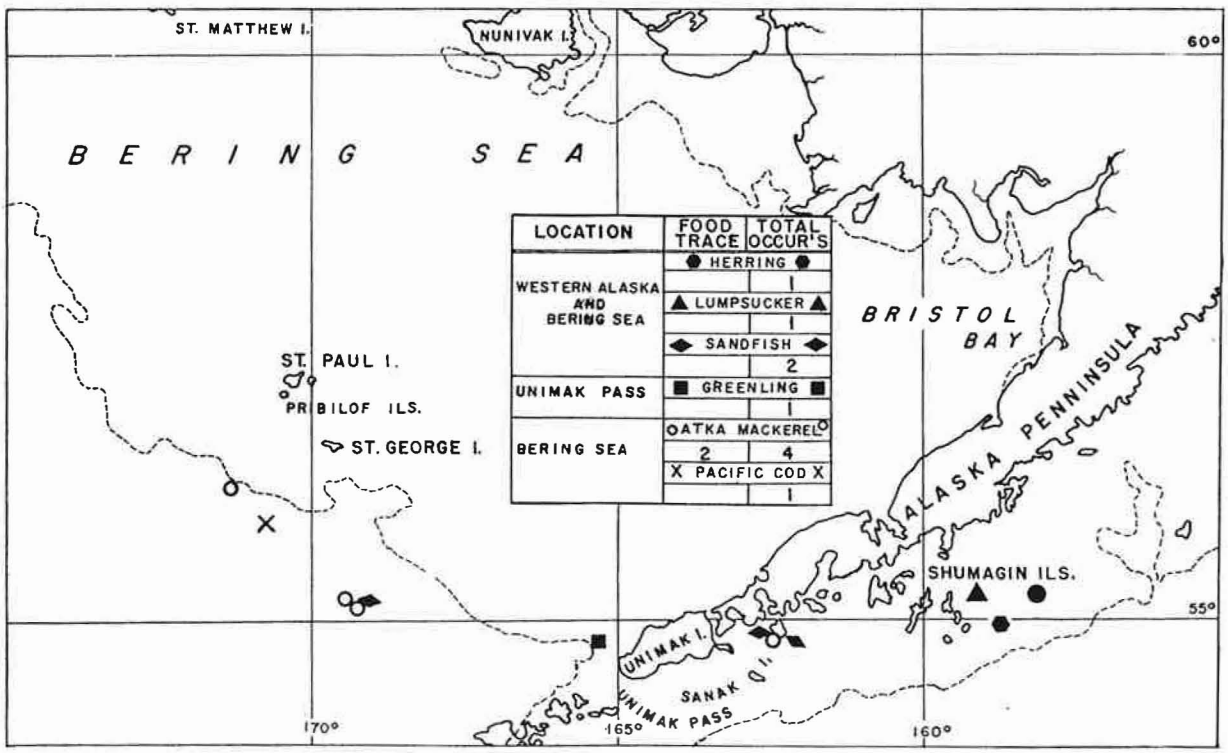

Figure 15. -- Locations from the Shumagin Islands to Bering Sea where Atka mackerel, greenling, sandfish, lumpsucker, Pacific cod, and herring occurred in seal stomachs collected 6 March to 28 August 1960.

Gonatus fabricii has been found in previous seasons and is a common food item both in the southern and northern range of the fur seal.

Gonatus magister, although identified for the first time this year, has undoubtedly been taken by the fur seals in previous seasons. It is much larger than either Gonatus fabricii or Gonatopsis and was the only squid found in stomachs from the Unimak Pass area.

Gonatopsis sp. (probably Gonatopsis borealis Sasaki) also was identified for the first time this season in seal stomachs, but it too must have been a standard item of food in previous years. It was found mainly in the Bering Sea.

No squid other than the preceding three appeared to be present in this season's stomach collection. Often two and once all three squid species were represented in a single stomach. Locations for individual species are shown on figure 16.

Rockfish

Rockfish occurred 11 times in seal stomachs, totaling 1.7 percent of the food items. With one exception, all rockfish were taken in the Gulf of Alaska. Species identification (Sebastodes alutus) was made in four of the stomachs.

Salmon

Salmon occurred in 22 seal stomachs, making up 1.5 percent of the food items, by volume. One salmon occurrence was from Southeastern Alaska, 15 in western Alaska, and 6 in Bering Sea. Salmon in 10 stomachs were identified from their scales by Mr. Kenneth H. Mosher, Mr. Richard A. Hajny, and Mr. Kenneth H. Liscom of the Bureau of Commercial Fisheries Biological Laboratory. Five of the identified occurrences were in the Shumagin locality from 10 to 36 miles off Simeonof Island, during the period 8-12 June. Chum salmon (Oncorhynchus keta) occurred three times, sockeye salmon (Oncorhynchus nerka) once, and king salmon (Oncorhynchus tschawytscha) once. One occurrence of pink salmon (Oncorhynchus gorbuscha) and one of silver salmon (Oncorhynchus kisutch) were identified from the Sanak locality on 20 and 22 June. Two occurrences of chum salmon were identified from Bering Sea; one on 13 July 34 miles east of St. George Island, the other on 14 August 48 miles southwest of St. Paul Island.

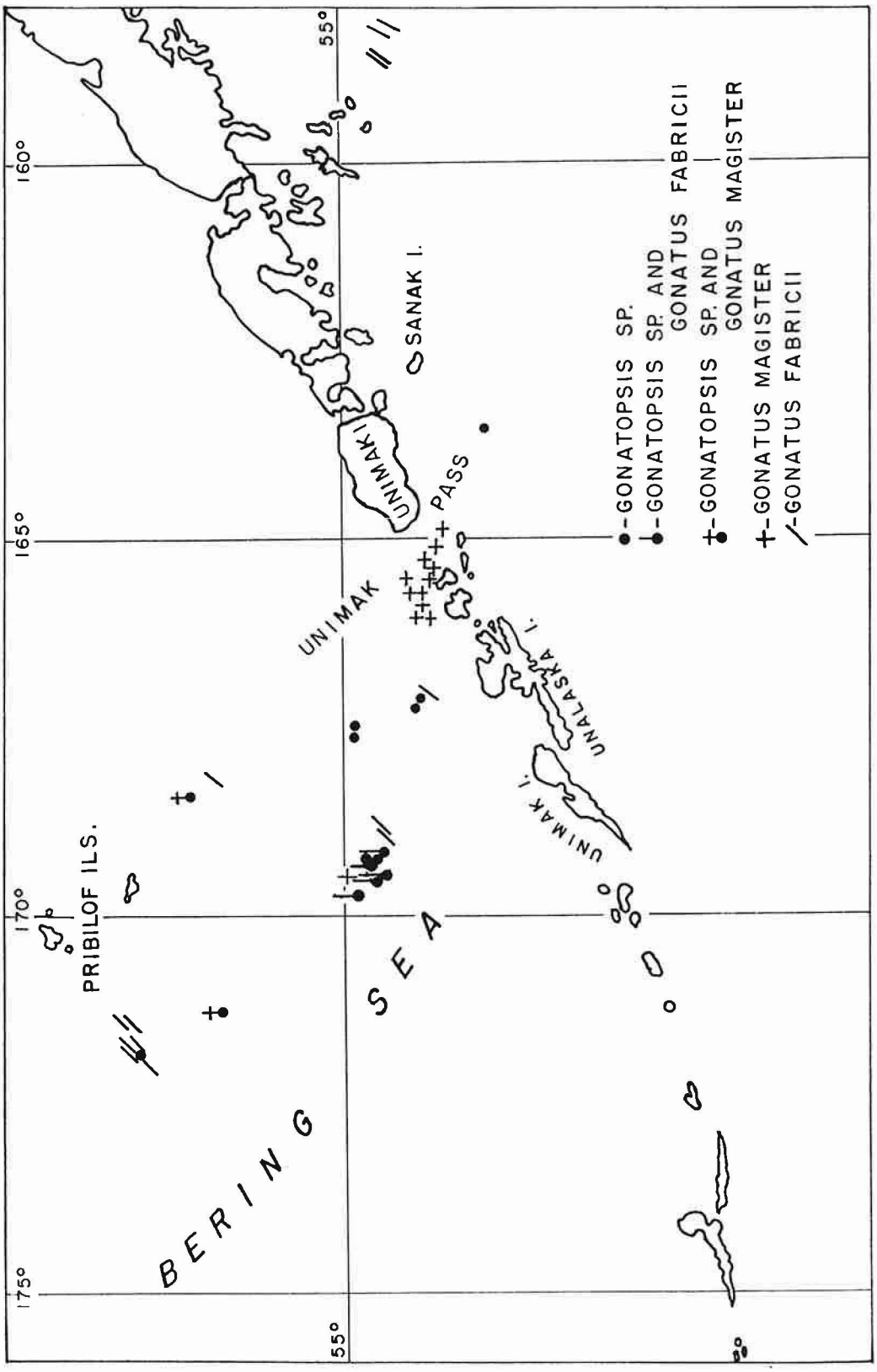

Figure 16. -- Locations where squid, identified to species, were taken by seals.

Ronquil

A ronquil was identified for the first time from seal stomachs in 1960. It occurred once in a seal collected in western Alaska on 11 June, 14 miles southeast of Simeonof Island, Shumagin Islands in 48 fathoms of water.

Pacific halibut

Halibut made its first appearance as a fur seal food in 1960. It was found in the stomach of one seal collected in Bering Sea, on 14 August, 60 miles west of St. George Island, Pribilof Islands, in 70 fathoms of water.

Pacific cod

Cod occurred five times in seal stomachs from the Gulf of Alaska and once in Bering Sea. Cod made up less than 1 percent of the total stomach contents. It has been reported from fur seal stomachs from time to time, beginning with Lucas (1899), Wilke and Kenyon (1954), and Kenyon (1956), but has never been important as a seal food.

Smelt

Three occurrences of smelt from seals collected in Bering Sea could be identified only to family Osmeridae.

Lumpsucker

Lumpsucker was identified from seal stomachs for the first time this season. It occurred six times in the Gulf of Alaska and once in western Alaska. Because of the condition of the specimens they could only be identified to the family Cyclopteridae.

Arrow-toothed halibut

Arrow-toothed halibut was found in five seal stomachs collected in the Gulf of Alaska. In 1958 it was recognized in four seal stomachs, two from the Gulf of Alaska, and one each from Sitka Sound and near Sanak.

Eulachon

Eulachon was identified in two stomachs collected in the Gulf of Alaska.

Atka mackerel

Atka mackerel also was identified from seal stomachs

for the first time this season. It was found in one stomach collected near Sanak, and from three stomachs collected in Bering Sea from deep water south and west of St. George Island.

Sculpin

Sculpin occurred in two seal stomachs, but was identifiable only to the family Cottidae. One occurred near Sanak and the other in Bering Sea midway between St. George and St. Paul Islands, Pribilof group. Cottids have been reported previously as seal food by Lucas (1899).

Sablefish

Sablefish occurred twice in the 1960 collection, once from the Gulf of Alaska and once from Bering Sea.

Threespine stickleback

Stickleback was found in late April in seven seal stomachs from Albatross Bank about 30 miles off Sitkalidak Island (near Kodiak Island).

Pacific lamprey

The lamprey was found in one stomach taken near Sanak in western Alaska.

Greenling

A greenling was identified from one stomach collected in Unimak Pass on 23 July. Identification could not be carried past the family Hexagrammidae.

Sandfish

Sandfish occurred once in a stomach from the Gulf of Alaska about 15 miles southwest of Marmot Island, and twice from western Alaska near Sanak Island. Sandfish had been reported previously by Kenyon (1956) in an examination of stomachs at St. Paul Island, Pribilof Islands.

Lanternfish

Lanternfish was found in one stomach from Bering Sea in deep water about 90 miles northwest of Unalaska Island. Identification could not be carried past the family Myctophidae.

Daggertooth

The daggertooth was identified in one stomach from a seal collected 55 miles southwest of Cape Spencer in Southeastern Alaska. So far as is known, this is the first time daggertooth has been identified in fur seal stomachs.

Miscellaneous items

Two birds were found in seal stomachs in 1960. A common murre (Uria aalge), made up 65 percent of the contents of a stomach from Sitka Sound, which also contained 12 herring. The other bird, a slender-billed shearwater (Puffinus tenuirostris) was found in a stomach from the Sanak area. The shearwater made up 20 percent and sandlance 80 percent of the stomach contents.

Crustaceans were found in three stomachs from the Bering Sea. Molluscs were found in one stomach, and with the exception of a hermit crab did not contain living animals.

Stones and pebbles were found in 14 stomachs, 1 from Southeastern Alaska, 4 from the Gulf of Alaska, 5 from western Alaska, and 4 from Bering Sea.

Relation of Fur Seals to Commercial Fisheries

The effect of fur seals upon the commercial fisheries of Alaska at the present rate of utilization is negligible. Only three fish found in the 1960 collection, herring, salmon, and halibut, are fished commercially in Alaskan waters.

Herring is not important in the diet of fur seals except in the Baranof Island area, where fur seals follow the herring into Sitka Sound and a few other bays and inlets in the winter and early spring months. During that time, the fur seals in the area feed almost entirely upon herring. The number of seals and the length of time they spend in the area varies from year to year.

Salmon made up 1.5 percent of the total food, by volume, of the 1,489 stomachs examined. Of the 22 occurrences of salmon, 15 were from the western Alaska area collected during the period 2-25 June, when large numbers of salmon could be expected in this area. Seven of the fifteen occurrences were identified as to species and, in view of the fact that this is an important sockeye salmon area,

it is of interest that only one sockeye salmon was found in the sample. Chum salmon was identified three times from the area. The six occurrences of salmon in seal stomachs from Bering Sea were taken in July and August and the two identified fish were both chums.

Halibut was found in one stomach from Bering Sea. This was the first occurrence of halibut in fur seal stomachs. In view of the fact that many fur seal stomachs collected on the halibut grounds have now been examined without finding halibut, it is apparently an incidental item that will never become important as a seal food.

The greatly increased take of fish in Bering Sea by foreign trawl fleets may possibly have some effect upon the feeding habits of the fur seal in this area. Japanese trawl catches between Unimak Pass and the Pribilof Islands have been reported to include walleye (Alaska) pollack, in addition to other species (Anonymous, 1960). The walleye pollack is the most important single food of the fur seal in Bering Sea and at the present time is not fished commercially by fishermen of the United States or Canada.

Predators

No predation on fur seals has been observed during the 1960 pelagic season. The only potential predator in northern waters -- the killer whale (Grampus rectipinna) -- is fully capable of preying on seals but so far proof of predation is lacking. Incidental to sealing research, a 17-foot, 3000-pound, male killer whale was harpooned in Chiniak Bay, Kodiak (fig. 17). The only food in the stomach was a fairly large halibut in half-digested stage. No fur seals were sighted in Chiniak Bay on this particular day or on other trips through the area.

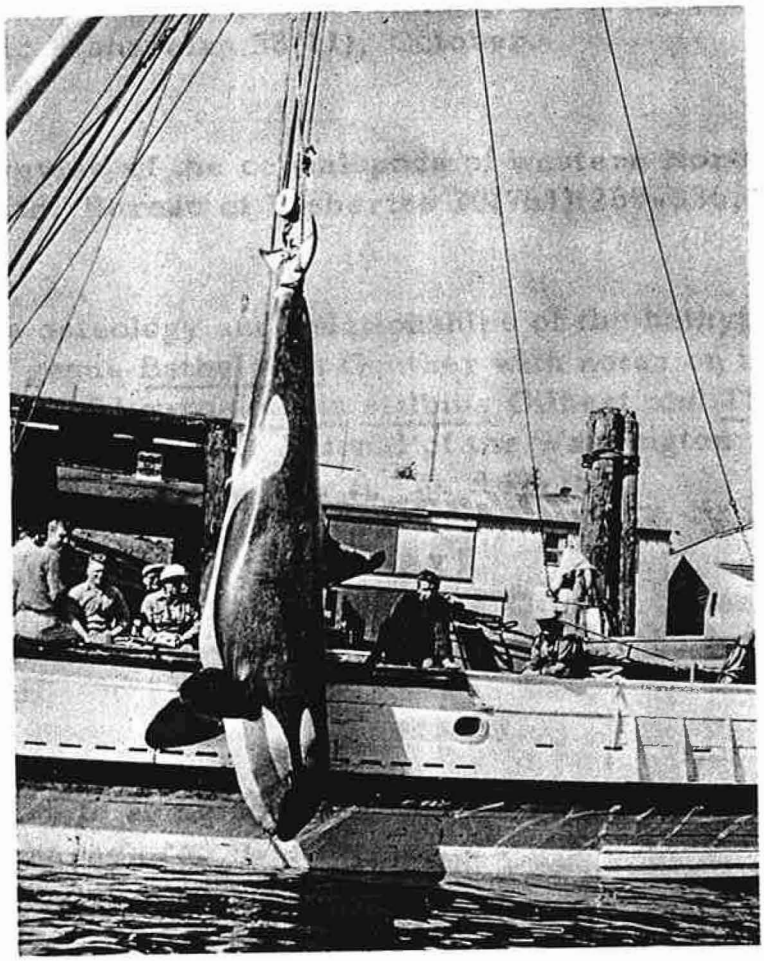

Figure 17.--Male killer whale harpooned from fur-seal research vessel in Chiniak Bay, Kodiak, Alaska.

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Appendix A

FEEDING GROUNDS OF NURSING FEMALES

Jordan and Clark (1898) stated that "the feeding grounds of fur seals in Bering Sea be to the south and west of the Pribilof Islands, just off the 100-fathom curve, at a distance of from 100 to 200 miles."

A method that can be used to indicate if a seal is on a feeding trip and will return to the rookery islands is to examine the reproductive tract of females collected at sea. If the reproductive tract shows that the female has given birth to a pup in the current season, the animal could have been expected, in most instances, to return to the islands to feed her pup.

Figure 18 gives the points of collection for 211 post-partum females. The data are too few to indicate a difference, if any, in the feeding range of primiparous and nulliparous animals. Feeding seals move out in many directions and are not confined to grounds south and west of the Pribilof Islands, although these are apparently the directions of greatest abundance. In 1960, post-partum females were collected in all areas hunted in the Bering Sea. The maximum distance at which such seals were collected was in Unimak Pass, 206 nautical miles from St. George Island and 248 miles from St. Paul Island.

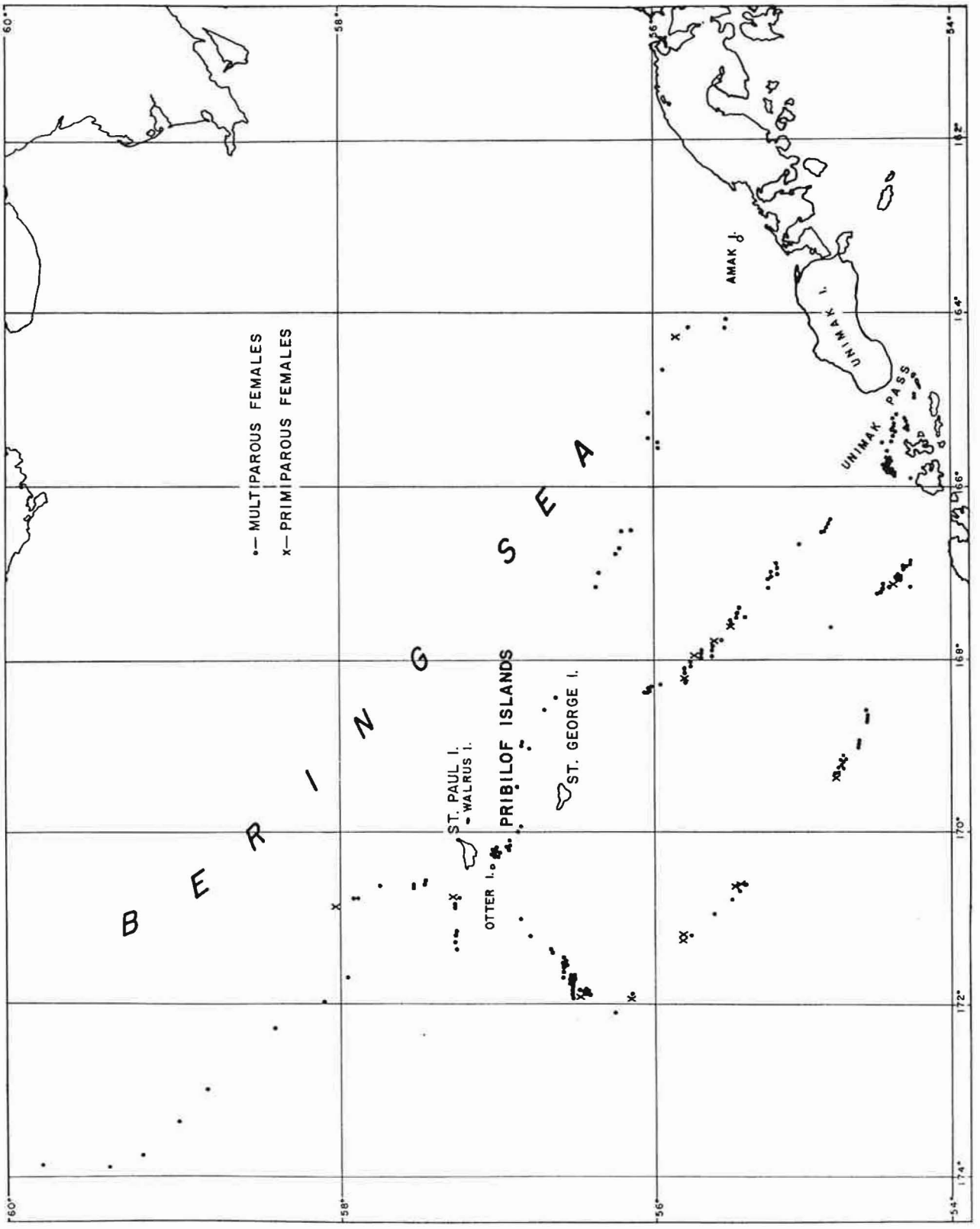

Figure 18. -- Collection points in Bering Sea for 211 post-partum females in 1960; 196 were multiparous and 15 were primiparous.

APPENDIX B

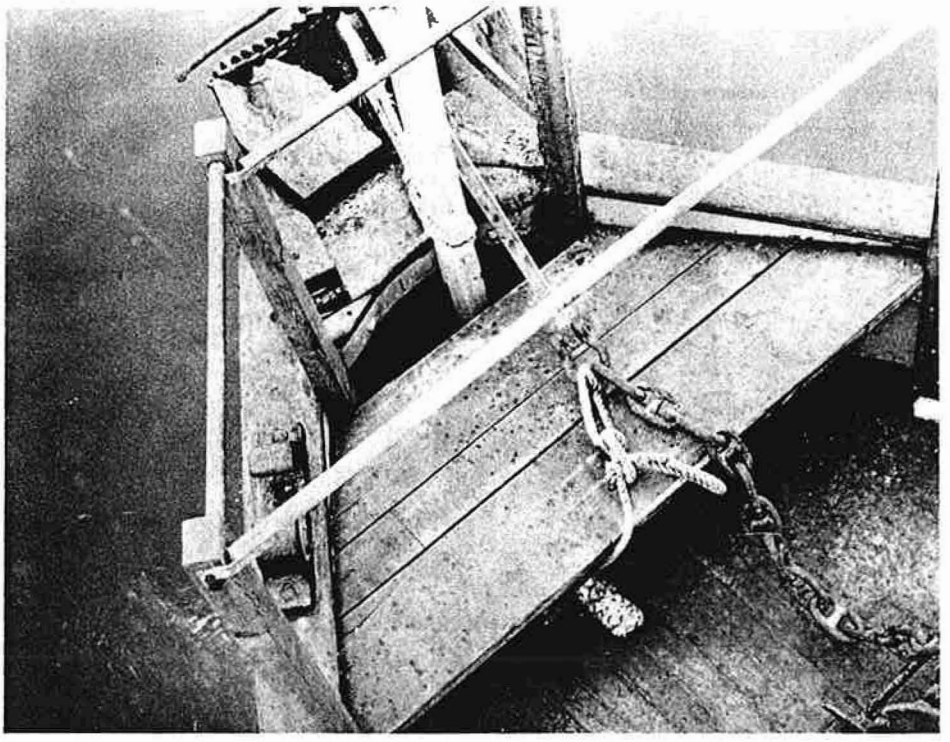

Figure 1.--Platform and crude guardrail in bow of purse seine vessel as used for shooting fur seals.

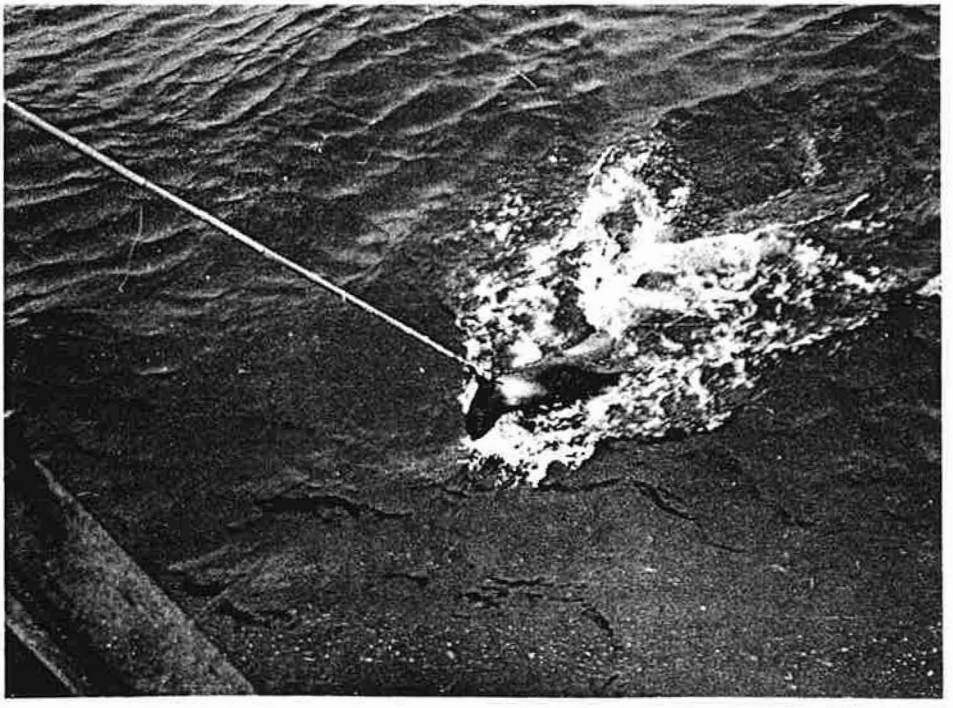

Figure 2.--A fur seal is pulled aboard by use of a four-pronged gaff copied after a Japanese type.

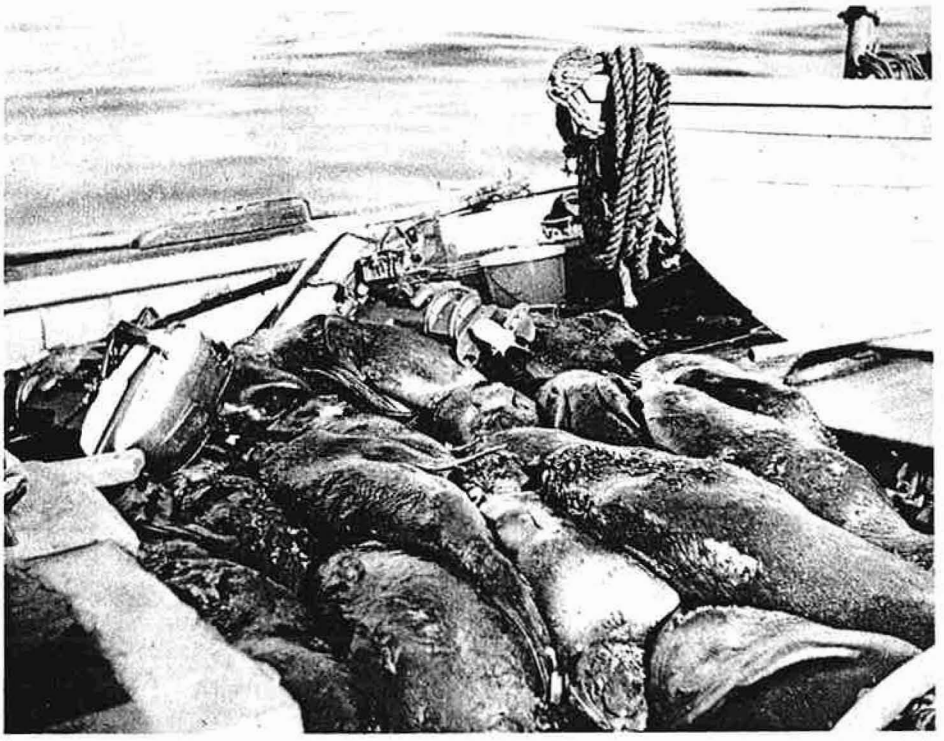

Figure 3.--A good collecting day on Portlock Bank in the Gulf of Alaska.

Figure 4.--Unloading M/V Windward in Seattle in early September after completion of field season.