

**EXPERIMENTAL FISHING
TO DETERMINE DISTRIBUTION OF SALMON
IN NORTH PACIFIC OCEAN
AND BERING SEA, 1956**

Marine Biological Laboratory
LIBRARY
SEP 24 1959
WOODS HOLE, MASS.



SPECIAL SCIENTIFIC REPORT-FISHERIES No. 302

**UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE**

SPECIAL NOTE

The International North Pacific Fisheries Commission, established in 1953 by the International Convention for the High Seas Fisheries of the North Pacific Ocean, coordinates the research of the member nations: Japan, Canada, and the United States. The resulting investigations provide data to the Commission for use in carrying out its duties in connection with fishery conservation problems in the North Pacific Ocean. Publication of this scientific report has been approved by the United States Section of the Commission.

United States Department of the Interior, Fred A. Seaton, Secretary
Fish and Wildlife Service, Arnie J. Suomela, Commissioner

EXPERIMENTAL FISHING TO DETERMINE DISTRIBUTION OF SALMON
IN THE NORTH PACIFIC OCEAN AND BERING SEA, 1956

by

Mitchell G. Hanavan and George K. Tanonaka
Fishery Research Biologists
Bureau of Commercial Fisheries

Contribution No. 10 to research conducted with
the approval of the United States Section of the
International North Pacific Fisheries Commission.



United States Fish and Wildlife Service
Special Scientific Report--Fisheries No. 302

Washington, D. C.
May 1959

The Library of Congress has cataloged this publication as follows:

U. S. Bureau of Commercial Fisheries.

Experimental fishing to determine distribution of salmon in the North Pacific Ocean and Bering Sea. 1956-
Washington, U. S. Dept. of the Interior, Fish and Wildlife Service.

v. illus., fold. maps, diagrs., tables. 27 cm. (U. S. Fish and Wildlife Service. Special scientific report--fisheries)

Vols. for 1956- issued as Contribution of the United States Section, International North Pacific Fisheries Commission.

1. Salmon. 2. Salmon-fishing--Pacific Ocean. 3. Salmon-fishing--Bering Sea. I. Title. (Series. Series: International North Pacific Fisheries Commission. United States Section. Contribution)

Int 59-104

U. S. Dept. of the
for Library of Congress

Interior. Library

The Fish and Wildlife Service series, Special Scientific Report--Fisheries, is cataloged as follows:

U. S. Fish and Wildlife Service.

Special scientific report: fisheries. no. 1-
Washington, 1949-

no. illus., maps, diagrs. 27 cm.

Supersedes in part the Service's Special scientific report.

1. Fisheries--Research.

SH11.A335

639.2072

59-60217

Library of Congress

(2)

TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
Description of vessels	2
Gill net construction	3
Operations	
Setting	3
Hauling	5
Sampling and preservation of salmon	5
Catch data	5
Length frequencies	
Catch by mesh size	15
Catch by species	16
Red salmon	16
Chum salmon	17
Pink salmon	18
Silver and king salmon	18
Vertical distribution of salmon catch	18
Surface water temperatures and salmon catch	18
Species other than salmon	19
Literature cited	19
Appendix	21

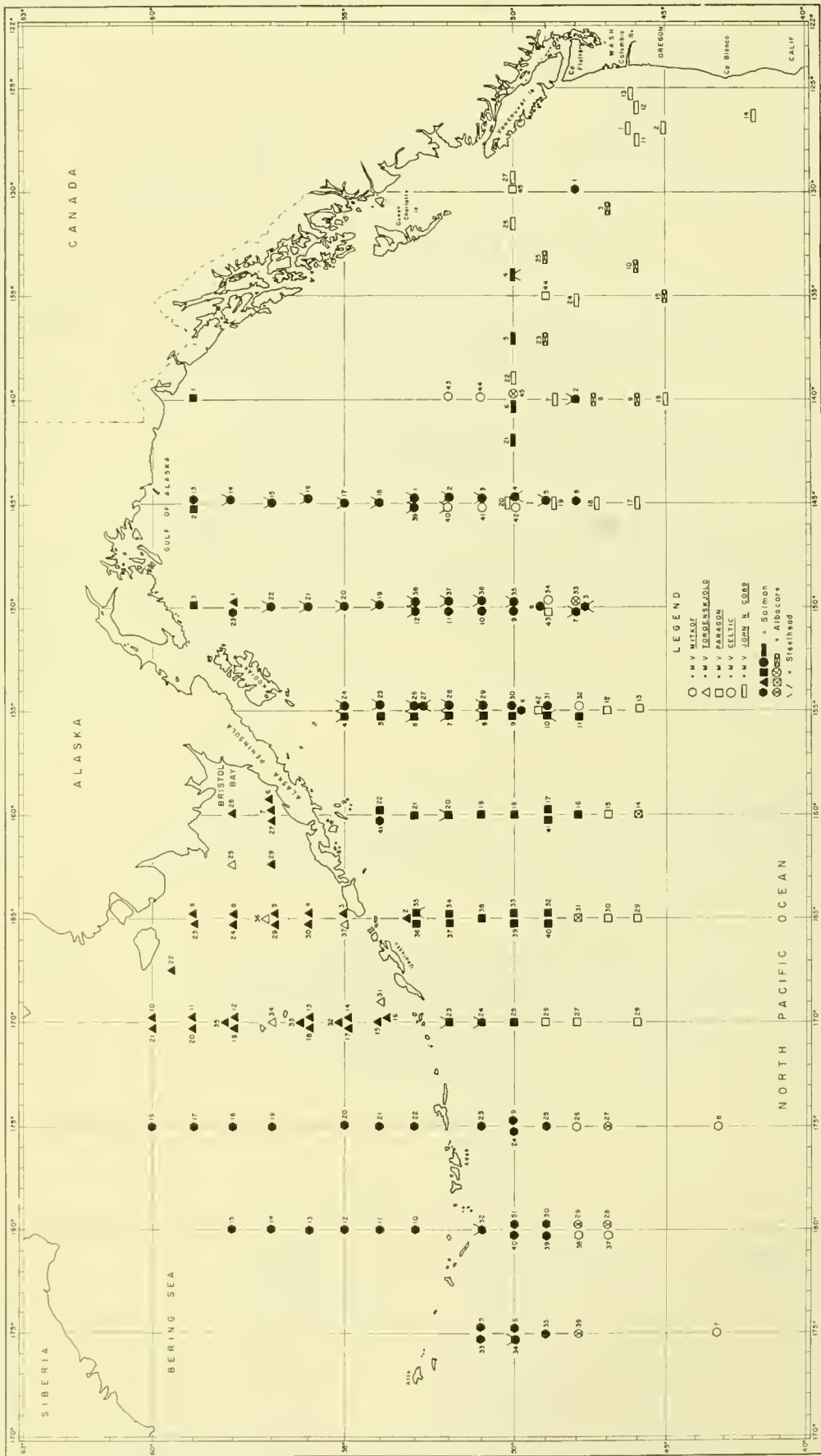


Figure 1.--Distribution of salmon, steelhead, and albacore during the period May to September 1956 as determined by the catches of the vessel Mitkof, Tordenskjold, Paragon, Celtic, and John N. Cobb. Numbers indicate serial order of sets.

EXPERIMENTAL FISHING TO DETERMINE DISTRIBUTION OF SALMON
IN THE NORTH PACIFIC OCEAN AND BERING SEA, 1956

by

Mitchell G. Hanavan and George K. Tanonaka
U. S. Fish and Wildlife Service
Seattle, Washington

ABSTRACT

Five vessels were employed from May to October 1956 to study the distribution of Pacific salmon in the North Pacific Ocean and Bering Sea. The operation was designed to (1) provide samples of fish for racial identification, (2) provide evidence of seasonal movements and changes in the distribution of salmon and (3) study the ocean habitat and conditions that control the distribution, movement and survival of salmon.

The area of operation was approximately 2,000,000 square miles extending from the coast of Washington and Oregon to longitude 175° E. and from latitude 43° N. to 60° N. Within this area 195 gill net sets resulted in the capture of 7,963 salmon.

Salmon were measured aboard the vessels before freezing. Length frequencies are shown graphically by species and area and in relation to the mesh size in which the fish were capture.

INTRODUCTION

The United States Fish and Wildlife Service as a research agency of the International North Pacific Fisheries Commission, is engaged in a study to determine the extent of intermingling in the North Pacific Ocean and Bering Sea of Asian and North American salmon. In part this program requires (1) the collection of large samples of salmon from an extensive oceanic area and the preservation of these samples for racial analysis, (2) detection and measurement of seasonal movements and changes in the distribution of salmon and (3) the study of the ocean habitat and the conditions that control the distribution, movement and survival of salmon.

The report which follows describes the cruises and operations of five vessels engaged in this program during the 1956 season. They include four schooner-type vessels, the Tordenskjold, Mitkof, Paragon, and Celtic, chartered by the Branch of Fishery

Biology ^{1/}, Fish and Wildlife Service, and the John N. Cobb, operated by the Exploratory Fishing and Gear Development Section ^{2/} of the Service.

Figure 1 shows the pattern of this extensive fishing and oceanographic operation, the stations fished by the five vessels, and the distribution of salmon, steelhead and albacore during the period of the study, which extended from mid-May until the first week in October.

During this 4 1/2-month period there was 195 gill net sets in a sampling area of approximately 2,000,000 square miles. The total salmon catch was 7,963 or an average

^{1/} Now Division of Biological Research, Bureau of Commercial Fisheries.

^{2/} Now Branch of Exploratory Fishing and Gear Research.

of 59 salmon per set for the 135 sets which captured salmon. Albacore were taken on 15 sets and 45 sets produced neither salmon nor albacore.

Oceanographic data were collected at each set and at intervals between fishing stations. A summary of these data was reported by Love (1957) and the data will appear in detail elsewhere.

Individual cruise reports describing these operations in detail were prepared by Richard Hajny, George Tanonaka, Douglas Weber, Richard Johnsen, Eugene Hill and Robert Ting, all of whom served as biologists aboard the vessel. The present report summarizes data presented to the Commission in these more detailed cruise reports.

DESCRIPTION OF VESSELS

Specifications for the four chartered schooner-type vessels were as follows:

Vessel	<u>TORDENSKJOLD</u>	<u>MITKOF</u>	<u>PARAGON</u>	<u>CELTIC</u>
Total length	70 feet	72 feet	90 feet	70 feet
Gross tonnage	57 tons	62 toos	88 tons	57 tons
Breadth	18 feet	18' 4"	19' 5"	17' 1"
Draft	9' 1"	9 feet	9 feet	8' 2"
Cruising speed	8.7 knots	9 knots	8.5 knots	8.5 knots
Maximum speed	9.0 knots	9.5 knots	9.0 kaots	9.0 knots
Horse power	150	200	165	135
Number of bunks	8	12	13	12
Freezer capacity (0°F)	925 cu. ft.	440 cu. ft.	500 cu. ft.	450 cu. ft.



Figure 2.-- Salmon charter vessel M/V Mitkof.

The U. S. Fish and Wildlife Service Exploratory Vessel John N. Cobb is described by Powell and Peterson (1957).

Navigational equipment of the four charter vessels included the following: loran, radio direction finder, fathometer, radio telephone, automatic pilot, and radar (except for the M/V Celtic).

Each charter vessel had a complement of seven men: a master, four crewman, an oceanographer from the University of Washington, and a Fish and Wildlife Service biologist.

Figure 2 shows the charter vessel M/V Mitkof, which is similar in appearance to the other schooners described above.

GILL NET CONSTRUCTION

The standard gill net set consisted of 18 shackles (fig. 3). Each shackle of net was approximately 50 fathoms in length (300 feet) and 20 feet deep. Four mesh sizes were used in each set including 6 shackles of 5 1/4 inch, 6 shackles of 4 1/2 inch, 3 shackles of 3 1/4 inch, and 3 shackles of 2 1/2 inch stretched measure. Gill nets were of nylon constructed in the manner described by Powell and Peterson (1957) with the exception that "Spongex" floats were used in place of cedar in nets constructed for the 1956 season. Two to six fabricated seine floats (18" diameter) were placed along the string to supplement the wood and "Spongex" floats.

The 18 shackles were generally arranged in the following order: 5 1/4 inch, 4 1/2 inch, 3 1/4 inch, 5 1/4 inch, 4 1/2 inch, and 2 1/2 inch; the same sequence repeated three times for a total length of approximately 1.05 statute miles.

A 1/2-inch nylon drift cable was attached along the corkline at every 10 feet on the "shock" net and on the first six shackles to help reduce the strain on the corkline. This cable was attached to 200 fathoms of 3/4-inch nylon line, which in turn was secured to the bow of the vessel by a heavy sisal rope which served as a mooring line. The sisal rope and nylon drift line were submerged, acting as a spring line to take up the surge of the vessel.

The Tordenskjold used a 40-foot triangular section of 4-inch cotton trawl net attached at the head of the first shackle to take up the shock of wave action on the gill nets while the Mitkof, Paragon and Celtic used a 180-foot "shark" net for this purpose. Two flagpoles with lights were placed near each end of the string to mark the position of the net during hours of darkness. Figure 3 shows a typical gill net set.

OPERATIONS

Setting

The gill nets were set from the stern while the vessel traveled downwind at a speed of about 4 knots. As the last shackle

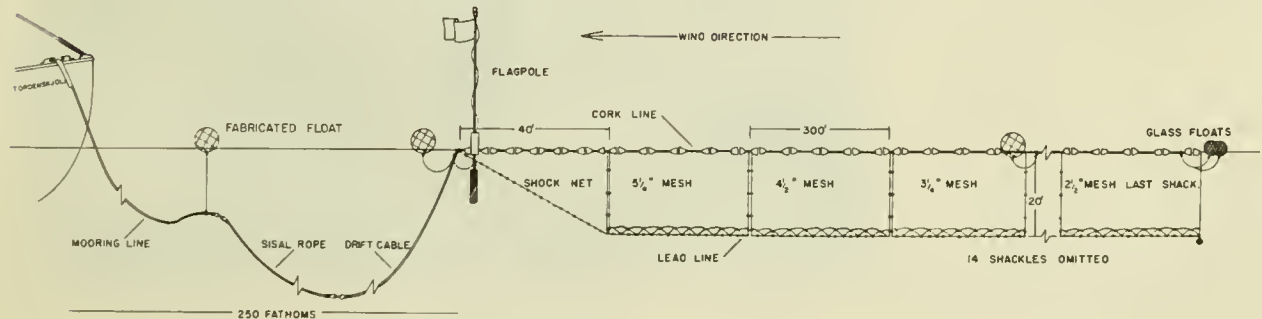


Figure 3.--Typical station set.



Figure 4.--Initial phase of hauling operations on the Mitkof. The nylon drift cable is brought in over the roller, around the gurdy and coiled on the deck.



Figure 5.--Gill net with salmon coming around the gurdy on the Mitkof.

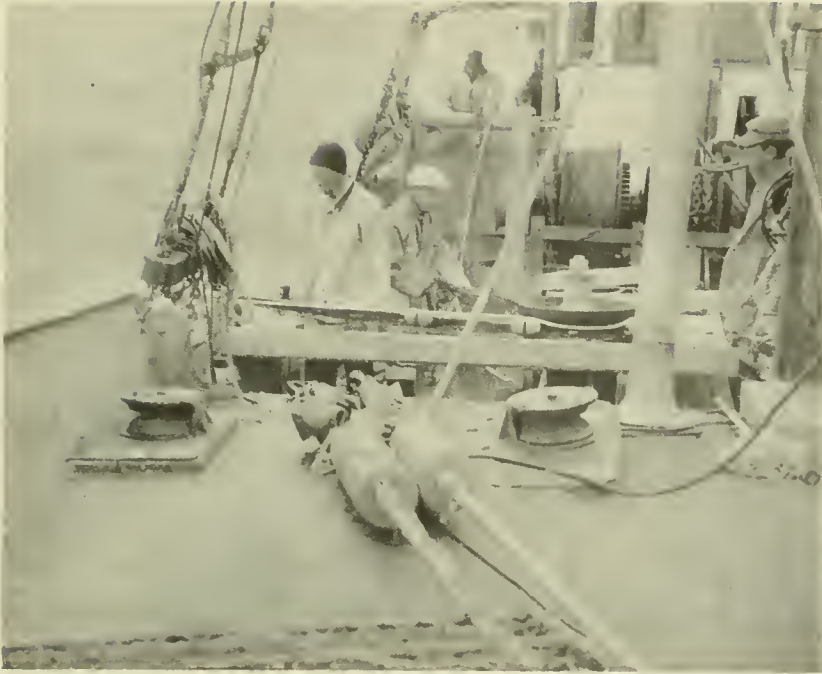


Figure 6.--Two crewmen in background repiling the gill nets beside the pilot house on the Mitkof.

passed over the stern, the boat executed a 180-degree turn, and the mooring line was attached to a cleat on the bow. The setting operation required 15 to 20 minutes.

With few exceptions the nets were fished at night from about five in the evening to six in the morning, a total period of approximately 13 hours.

Hauling

Nets were hauled in over a roller on the starboard side of the well deck. As the nets cleared the powered gurdy, or net-puller (figs. 4 and 5), two crewmen picked the salmon out of the net and cleared the web. The net was then passed to the stern and re-piled in readiness for the next set (fig. 6). Hauling required two to three hours, depending on the size of the catch and sea conditions.

Sampling and Preservation of Salmon

Salmon taken out of the nets during hauling were placed in deck bins in accordance with the mesh size from which they were

removed. They were recorded as to species, apparent direction of movement, and depth in the net. Upon completion of hauling, the salmon were tagged with a numbered, colored strap tag which was attached to the left gill cover to provide future identification. Fork length measurements were recorded from a measuring board and the fish were then placed in the freezer for shipment to the Seattle laboratory for detailed morphometric examination.

When possible, blood from live fish was frozen for serological studies. Blood samples were obtained by cutting through the caudal peduncle and allowing the blood to drop into a sterile jar.

CATCH DATA

Salmon catches by set, date, position of set, species, and mesh size for the five vessels are shown in tables 1 - 5. Included are numbers of hours nets were fished, sea conditions, surface temperatures, incidental fish catches, and observations of sea mammals.

Table 1 - Gill-net Catch Data --- M.V. TORPENSJULD --- May 14 to October 8, 1956

Set No.	Date	Position of set Lat., Long.	No. hours net soaked 1/	Sea condition	Surface temperature	Number of salmon caught						Season catch by mesh size				Incidental catch	Mammals 2/										
						Red	Chum	Silver	King	Pink	Total	5 1/2"	1 1/2"	3 1/2"	2 1/2"												
1	5/24 - 5/25	58°00'	150°00'	Calm	40.5°	2	1					3	3				Four seals, Sea lions										
2	5/30 - 5/31	53°00'	165°00'	Moderate	39.5°	39	34		2			75	58	15	2		Four seals										
3	6/6 - 6/7	55°00'	165°00'	Moderate	37.5°	62	17					79	75	4			Four seals										
4	6/7 - 6/8	56°00'	165°00'	Moderate	36.5°	2	14		1			17	13	4			Sea lion										
5	6/8 - 6/9	57°00'	165°00'	Calm	34.5°	2	14					16	16				Sea lions										
6 1/2	6/10	59°15'	159°15'	Calm	32.9°		1					1	1														
7	6/10 - 6/11	57°00'	160°00'	Bough	36.8-32.2°	3	1		1			5	5				Sea lion										
8	6/12 - 6/13	58°00'	165°00'	Moderate	36.0-35.2°	2	45		1			51	41	10			1 Herring, 1 Yellowfin sole										
9	6/13 - 6/14	59°00'	165°00'	Calm	35.5°	1	126		1			131	10	40			1 Dolly Varden, 2 Yellowfin sole										
10	6/15 - 6/16	60°00'	170°00'	Calm	34.2°	1	19		2			22	17	5			1 Herring, 4 Yellowfin sole										
11	6/16 - 6/17	59°00'	170°00'	Calm	35.9°	1	57		5			63	45	12	6		Half seal										
12	6/17 - 6/18	58°00'	170°00'	Calm	38.7°	1	31		1			38	30	7	1		Four seals, Sea lions										
13	6/19 - 6/20	56°00'	170°00'	Calm	42.3°	917	62		3			987	549	344	36	8	Four seals										
14	6/20 - 6/21	55°00'	170°00'	Calm	44.6-43.7°	679	67		1			756	356	355	39	6	Four seals, Sea lion										
15	6/24 - 6/25	54°00'	170°00'	Light	45.0°	83	19					102	74	24	4		Four seals										
16	7/28 - 7/29	54°00'	169°58'	Moderate	46.2°	1	2		1			5	4	1													
17	7/29 - 7/30	55°00'	170°02'	Moderate	46.8°	1						1	1				Four seals										
18	7/30 - 7/31	55°59'	170°02'	Calm	46.3°	1	9					10	7	2	1		Four seals										
19	8/1 - 8/2	58°00'	170°00'	Calm	43.8°	4	5					9	8	1			Four seals										
20	8/2 - 8/3	59°00'	170°00'	Moderate	44.4°	31	1		1			32	24	8													
21	8/3 - 8/4	59°59'	170°01'	Calm	47.2-45.6°	6	1		1			8	3	5			Four seals, Sea lion										
22	8/4 - 8/5	59°36'	167°22'	Moderate	44.5°	2	11		1			14	13	1			Four seals, Sea lion										
23	8/5 - 8/6	58°56'	165°12'	Moderate	44.3°	4						4	2	2													
24	8/6 - 8/7	57°57'	165°05'	Light	47.3°	1	11					12	7	5													
25	8/7 - 8/8	58°00'	165°32'	Calm	47.1°	1	1		6			16	8	5	3												
26	8/8 - 8/9	58°00'	159°57'	Calm	50.8-53.2°	1	1		6			8	5	3			1 Herring, 1 Sea pucker										
27	8/10 - 8/11	56°57'	160°04'	Calm	52.7-47.6°	2	1		1			4	1	1	2		1 Yellowfin sole, 4 Dolly Varden, 1 Mackerel shark										
28	8/11 - 8/12	57°05'	162°22'	Light	51.6-50.5°	1						1	1				5 Dolly Varden, 1 Yellowfin sole, 1 Herring										
29	8/12 - 8/13	57°04'	164°58'	Calm	50.9°	1	3		1			7	3	2	1		3 Dolly Varden										
30	8/13 - 8/14	56°04'	164°56'	Moderate	51.5°	11	6		3			20	13	6	1		1 Yellowfin sole, 2 Juvenile wolffsole										
31	9/11 - 9/12	54°00'	169°00'	Moderate	43.5-44.1°																						
32	9/13 - 9/14	55°00'	170°00'	Bough	46.9°	1	12					13	11	2													
33	9/14 - 9/15	55°58'	170°01'	Light	45.6°				1			1	1														
34	9/15 - 9/16	57°00'	170°00'	Moderate	44.1°																						
35	9/16 - 9/17	58°01'	169°58'	Light	43.5°	1						1	1				Four seals, Sea lion										
36	9/18 - 9/19	57°00'	165°00'	Bough	40.3°																						
37	9/20 - 9/21	55°01'	165°04'	Moderate	44.7°												1 Herring										
TOTALS												1822	610	14	23	35	2504	1481	911	96	16						

1/ Does not include setting and hauling time.

2/ Mammals observed or engaged in nets during hauling operations.

3/ Daytime set.

4/ Two temperature readings - 1st reading at set, 2nd reading at haul.

Notes: 900 fathoms of net fished on all sets.

Set No.	Date	Position of set Lat. N. Long.	No. net ceases 1/	Fathoms of net	Sea condition	Surface temperature	Number of salmon caught								Salmon caught by mesh size					Incidental catch														
							Red	Chum	Silver	King	Pink	Total	5 1/2"	3 1/2"	2 1/2"	Stambd.	Albacco	Shark 2/	Penrset	Other fish	Liquid	Mummalo 4/												
1	5/16 - 5/17	48°00' 159°59'	35	600	Light	51.0°	1					2	1																					
2	5/19 - 5/22	48°00' 160°05'	6 1/2	600	Rough	46.9°	9	7	1			18	4	10	3	1	2												Seals					
3	5/24 - 5/25	47°51' 150°00'	17	600	Rough	46.2°	9	5				16	6	6	1	3	2																	
4	5/27 - 5/28	50°00' 157°04'	18	600	Rough	44.5°	6					6																						
5	6/10 - 6/15	51°00' 175°00'	14 1/2	900	Moderate	44.9°	16	45				9	70	30	13	1																		
6	6/15 - 6/16	50°00' 175°00'	14	900	Moderate	44.2°	91	42	1			3	137	29	46	45	17																	
7	6/18 - 6/19	45°12' 175°00'	15 1/2	600	Light	53.1°																												
8	6/21 - 6/22	45°11' 175°00'	17 1/2	600	Moderate	54.5°																												
9	6/25 - 6/26	50°00' 175°05'	16 1/2	600	Calm	44.2°	12	3				1	16	2	11	1	2																	
10	7/5 - 7/6	55°00' 180°00'	16	600	Moderate	43.9°	8	9				17	5	7	4	1																		
11	7/6 - 7/7	54°00' 180°00'	15	600	Moderate	44.1°	21	42				1	64	13	28	45	8																	
12	7/7 - 7/8	55°00' 180°00'	19 1/2	600	Calm	44.0°	13	128				1	143	5	24	55	59																	
13	7/8 - 7/9	56°00' 180°00'	16 1/2	600	Moderate	45.3°	7	88	7			7	102	7	9	16	70																	
14	7/9 - 7/10	57°00' 180°00'	16 1/2	600	Moderate	45.8°	6	21	2			2	29	6	5	6	12																	
15	7/10 - 7/11	58°00' 180°00'	17	600	Rough	44.8°	8	70					78	9	29	39	1																	
16	7/12 - 7/13	60°00' 175°00'	15 1/2	900	Calm	46.2°	3	10					13	6	7																			
17	7/13 - 7/14	59°00' 175°00'	15	900	Calm	45.1°							8	7	1																			
18	7/14 - 7/15	59°00' 175°00'	15	900	Light	49.1°	14	85				3	102	22	23	36	21																	
19	7/15 - 7/17	57°00' 175°00'	15 1/2	900	Rough	47.3°																												
20	8/2 - 8/3	54°55' 170°55'	15 1/2	900	Rough	46.6°	9	5					14	7	7																			
21	8/3 - 8/4	53°59' 170°59'	15	900	Moderate	46.1°	2	36																										
22	8/4 - 8/5	52°57' 170°59'	15	900	Light	50.5°	2	36																										
23	8/7 - 8/8	50°59' 170°57'	16 1/2	900	Light	52.8°	87	20				2	117	36	59	21	1																	
24	8/8 - 8/9	49°59' 170°59'	17 1/2	900	Light	54.3°	4	58				2	64	13	36	12	3																	
25	8/9 - 8/10	49°00' 175°00'	16 1/2	900	Light	56.3°	1	10					11	4	5	2																		
26	8/10 - 8/11	49°00' 175°00'	16	900	Light	56.3°																												
27	8/11 - 8/12	47°00' 175°00'	16	900	Light	57.6°																												
28	8/13 - 8/14	47°00' 180°00'	16 1/2	900	Moderate	62.8°																												
29	8/14 - 8/15	48°00' 179°54'	13	900	Moderate	59.2°																												
30	8/15 - 8/16	49°00' 179°57'	15 1/2	900	Moderate	56.1°	4					4	4																					
31	8/16 - 8/17	50°00' 180°00'	18	900	Rough	56.8°	49					49	18	31																				
32	8/22 - 8/23	51°00' 180°00'	14 1/2	900	Rough	44.8°	162	27	1			6	1	197	34	86	75	5	2															
33	8/24 - 8/25	51°00' 175°00'	14	900	Rough	49.5°	235	88					323	95	181	48	9																	
34	8/25 - 8/26	50°00' 175°00'	15 1/2	900	Rough	52.2°	13	27				5	45	20	21	3	1	3																
35	8/26 - 8/27	49°00' 175°00'	15 1/2	900	Rough	53.8°						1	22	6	16																			
36	8/27 - 8/28	48°00' 175°00'	15 1/2	900	Moderate	56.7°																												
37	9/1 - 9/2	47°00' 180°00'	12	900	Rough	53.1°																												
38	9/2 - 9/3	48°00' 180°00'	15 1/2	900	Rough	53.1°	8																											
39	9/3 - 9/4	49°00' 180°00'	16	900	Rough	52.8°	32																											
40	9/4 - 9/5	50°00' 180°00'	16 1/2	900	Rough	51.8°																												
41	9/15 - 9/16	54°00' 160°00'	16 1/2	900	Calm	51.1°	1	7																										
TOTALS							738	945	4	33	15	1753	440	727	399	217	9	36																

1/ Does not include setting and hauling time.
 2/ Letters: B - blue shark, D - dogfish shark, M - mackerel shark.
 3/ Unable to haul in net due to sea conditions.
 4/ Mummalo observed or engaged in nets during hauling operations. Seals - Fur seals.
 5/ Last 600 fathoms of net parted from set. Harvested after 8 hours of searching.

Table 3 - Oil-Cont Catch Data --- M.V. FARMOR --- July 1 to September 27, 1956

Set No.	Date	Position of set Lat., Long.	No. hours of net towed	Bottom condition	Surface temperature	Number of eel caught			Salmon catch by size class			Incidental catch			Mammals														
						Red	Chum	Silver	King	Pink	Total	5 1/2"	5 1/4"	5"		Revald.	Albacore	Dark	Other fish	Liquid									
1	7/1 - 7/12	59°00' N, 146°00' W	16	900	Light	52.0°F.	11	24		57	52	16	67	9	6-M	1 Sable fish, 1 Boarfish													
2	7/13	59°00' N, 145°00' W	14 1/2	900	Cal.	54.3°F.	12	137	2	20	171	63	61	17	7-M			Porpoise, Red Lion											
3	7/14 - 7/15	59°00' N, 150°00' W	14 1/2	900	Cal.	53.6°F.	2			3	5				1-M	1 Herring													
4	7/15 - 7/20	59°00' N, 155°00' W	17	900	Light	50.7°F.	65	91	6	35	175	30	127	13	5	10													
5	7/20 - 7/21	54°00' N, 155°00' W	15	900	Moderate	50.9°F.	41	41	4	8	100	36	52	10	3			Pur ems											
6	7/21 - 7/22	53°00' N, 159°00' W	15 1/2	900	Cal.	50.9°F.	13	8	1	1	25	5	18	2	2														
7	7/22 - 7/23	52°00' N, 159°00' W	16 1/2	900	Light	48.9°F.	26	19	1	5	51	13	36	7	1														
8	7/23 - 7/24	51°00' N, 159°00' W	16 1/2	900	Light	48.9°F.	37	10	4	1	52	11	22	14	5	2													
9	7/24 - 7/25	50°00' N, 159°00' W	15	900	Light	48.9°F.	3	29	6	1	40	13	18	9															
10	7/25 - 7/26	49°00' N, 159°00' W	16 1/2	900	Light	48.5°F.	2	33	1		36	4	12	19	1	1		Present											
11	7/26 - 7/27	48°00' N, 154°53' W	13 1/2	900	Cal.	52.0°F.	2	1			3				4														
12	7/27 - 7/28	48°51' N, 159°00' W	15	900	Cal.	54.3°F.									1-B	1 Squid													
13	7/28 - 7/29	48°51' N, 154°53' W	15 1/2	900	Cal.	54.7°F.									1-B	1 Giant oilfish		Present											
14	7/30 - 7/31	48°51' N, 146°00' W	19 1/2	900	Light	51.7°F.									8	6 Giant oilfish, 1 Boarfish, 1 Squid, 1 Squid, 1 Squid, 1 Squid		Present											
15	7/31 - 8/1	47°00' N, 146°00' W	13 1/2	900	Light	54.1°F.									100	1 Giant oilfish, 1 Squid, 1 Squid, 1 Squid		Present											
16	8/1 - 8/2	48°00' N, 146°00' W	17	900	Moderate	53.1°F.	5				5	3	2		63	5 Giant oilfish		Present											
17	8/2 - 8/3	48°50' N, 146°00' W	16 1/2	900	Moderate	52.6°F.	2	27	3	1	33	10	20	3	33			Present											
18	8/3 - 8/4	50°00' N, 146°00' W	14 1/2	600	Moderate	50.7°F.	10	28			38	7	31																
19	8/4 - 8/5	51°00' N, 146°00' W	14 1/2	600	Light	50.5°F.	6	32	1		39	7	24	8															
20	8/5 - 8/6	51°57' N, 146°00' W	17	900	Moderate	50.5°F.	44	35			47	9	36	3	2														
21	8/6 - 8/7	53°02' N, 146°00' W	13 1/2	600	Moderate	50.7°F.	23	10	1		34	7	24	2	1														
22	8/7 - 8/8	54°00' N, 146°00' W	17 1/2	900	Light	51.8°F.	21	80		3	104	31	66	7	1														
23	8/8 - 8/9	52°00' N, 170°00' W	14 1/2	900	Light	48.8°F.	26	5			31	1	5	13	12	2													
24	8/9 - 8/20	51°00' N, 170°00' W	13	600	Light	50.7°F.	23	21			44	7	29	6	2	2													
25	8/20 - 8/21	50°00' N, 170°00' W	15	600	Light	51.4°F.	11	40	1		52	13	30	9				Present											
26	8/21 - 8/22	49°00' N, 170°00' W	14	600	Light	53.6°F.									4														
27	8/22	48°00' N, 170°00' W	5	600	Light	51.6°F.									3														
28	8/25	48°00' N, 170°00' W	5	850	Moderate	53.6°F.									6-B														
29	8/26 - 8/27	48°00' N, 169°00' W	12 1/2	600	Rough	53.9°F.																							
30	8/28	47°00' N, 169°00' W	8 1/2	600	Light	53.6°F.									49														
31	8/28 - 8/29	48°00' N, 169°00' W	8 1/2	600	Light	51.8°F.									205	1 Giant oilfish		Present											
32	8/29 - 8/30	48°00' N, 169°00' W	12 1/2	600	Light	50.5°F.	7				7	1	6		52														
33	8/30 - 8/31	50°00' N, 169°00' W	12 1/2	850	Light	48.4°F.	4	51			55	11	14	3	1-B	1 Giant oilfish		Present											
34	9/1 - 9/2	52°00' N, 169°00' W	9 1/2	850	Light	48.3°F.	24	31			55	8	33	14	1-B														
35	9/2 - 9/3	53°00' N, 169°00' W	11 1/2	850	Light	48.7°F.	14	17	2	1	2	36	13	16	4	3	7												
36	9/7	53°00' N, 165°00' W	7 1/2	850	Light	50.4°F.	2	4			6	1	5		1-B, 4														
37	9/7 - 9/8	52°00' N, 169°00' W	8 1/2	850	Rough	48.5°F.	4				4	1	3																
38	9/9 - 9/10	51°00' N, 169°00' W	11 1/2	800	Rough	50.7°F.	5	16			21	1	18	1	1														
39	9/10 - 9/11	50°00' N, 169°00' W	7 1/2	800	Rough	50.5°F.	1	10			11	2	9																
40	9/11 - 9/12	49°00' N, 169°00' W	8 1/2	800	Moderate	51.8°F.	1	28			29	8	12																
41	9/13 - 9/14	49°00' N, 169°00' W	13 1/2	800	Light	52.0°F.	4				4				1-B	1 Giant oilfish, 1 Subsp. Phano		Present											
42	9/15	49°00' N, 159°00' W	14 1/2	800	Light	53.8°F.									1-B														
43	9/16 - 9/17	49°00' N, 159°00' W	12	800	Light	53.9°F.									1-B	2 Boar fish													
44	9/21 - 9/22	49°00' N, 135°00' W	12 1/2	650	Light	53.6°F.									1-B	1 Giant oilfish, 1 Boarfish		Present											
45	9/23 - 9/24	50°00' N, 134°00' W	13 1/2	850	Light	53.6°F.									200-B	40 Boar (returned)													
TOTALS													357	837	31	6	135	1394	351	822	206	32	32	9	33-B, 1-B, 10-B, 1-B	64 1/2			

1/ Does not include setting and hauling time.
 2/ Letters: B - blue shark, O - orange shark, M - mackerel shark, M - mud shark.
 3/ Mammals observed or caught in nets during hauling operations.
 4/ Byline set.

Table 4 - Gill-net Catch Data - B.T. CERIC - July 5 to September 24, 1956

Set No.	Date	Position of set, Lat., Long.	No. hours of set, min. / hr.	Sea condition	Sea temperature	Wind direction & force	Barometer	Number of minnows caught	Salmon catch by each set	Albacore	Shark 2/	Incidental catch	Mammals 3/	
								Red Chin Silver King Flank Total	3 1/4 3 1/2 3 3/4 4 1/2 5 1/2	Steady		PomPret	Other fish	Rept
1	7/12 - 7/13	35°00' - 145°00'	15	900	50.0°F.	Light	30.0	12	128	7	2	2		
2	7/13 - 7/14	35°00' - 145°00'	11	900	51.0°F.	Light	31.0	1	55	5	16	1	1-3	
3	7/14 - 7/15	35°00' - 145°00'	33 1/2	900	51.0°F.	Buoy	31.0	5	124	7	31	4		
4	7/16 - 7/17	35°00' - 145°00'	15 1/2	900	51.0°F.	Moderate	31.0	1	2	124	22	34	10	
5	7/17 - 7/18	35°00' - 145°00'	12 1/2	900	52.2°F.	Light	32.0	1	27	1	19	6	1-4	
6	7/18 - 7/19	35°00' - 145°00'	13 1/2	900	54.1°F.	Calms	34.0	4	8	2	1	1		
7	7/20 - 7/21	35°00' - 145°00'	20 1/2	900	52.1-51.2°F.	Moderate	30.7	1	39	6	18	11		
8	7/21 - 7/22	35°00' - 145°00'	12 1/2	900	50.7°F.	Moderate	30.7	1	78	8	27	43		
9	7/22 - 7/23	35°00' - 145°00'	12	900	50.5°F.	Calms	30.5	3	89	31	36	40	2	
10	7/23 - 7/24	35°00' - 145°00'	13 1/2	900	51.0-50.3°F.	Light	31.0	1	86	6	29	49	2	
11	7/24 - 7/25	35°00' - 145°00'	13 1/2	900	50.3°F.	Light	30.3	5	49	4	36	9		
12	7/25 - 7/26	35°00' - 145°00'	12 1/2	900	51.0-50.2°F.	Light	31.0	10	57	12	41	2		
13	7/26 - 7/27	35°00' - 145°00'	11	900	51.5°F.	Moderate	31.5	4	53	106	22	46	30	
14	7/27 - 7/28	35°00' - 145°00'	12 1/2	900	55.5°F.	Moderate	35.5	7	48	86	50	50	2	
15	8/1 - 8/2	35°00' - 145°00'	12 1/2	900	54.0-55.0°F.	Moderate	34.0	1	48	97	10	43	2	
16	8/2 - 8/3	35°00' - 145°00'	15	900	54.0-55.0°F.	Moderate	34.0	4	15	70	12	50	6	
17	8/3 - 8/4	35°00' - 145°00'	11	900	51.0°F.	Light	31.0	2	1	35	2	26	5	
18	8/4 - 8/5	35°00' - 145°00'	15	850	52.0°F.	Moderate	32.0	2	44	3	46	1		
19	8/5 - 8/6	35°00' - 145°00'	20 1/2	900	52.5°F.	Moderate	32.5	1	96	10	68	17	1	
20	8/6 - 8/7	35°00' - 145°00'	12 1/2	900	54.0°F.	Calms	34.0	6	46	8	50	8		
21	8/7 - 8/8	35°00' - 145°00'	12 1/2	900	55.0°F.	Calms	35.0	1	12	28	8	16	7	
22	8/8 - 8/9	35°00' - 145°00'	11 1/2	900	55.5°F.	Calms	35.5	7	19	9	16	10	1	
23	8/10 - 8/11	35°00' - 145°00'	12 1/2	900	56.1°F.	Calms	36.1	9	74	105	47	46	5	
24	8/16 - 8/17	35°00' - 145°00'	11 1/2	900	54.0°F.	Buoy	34.0	2	84	84	23	44	15	2
25	8/17 - 8/18	35°00' - 145°00'	11	900	55.0-54.0°F.	Light	35.0	3	34	15	54	27		
26	8/18 - 8/19	35°00' - 145°00'	13 1/2	900	55.0-54.0°F.	Buoy	35.0	20	87	37	6	3		
27	8/19 - 8/20	35°00' - 145°00'	17 1/2	900	55.0-53.0°F.	Moderate	35.0	5	48	15	26	3		
28	8/20 - 8/21	35°00' - 145°00'	11 1/2	900	53.0-52.0°F.	Light	33.0	1	47	33	52	1		
29	8/21 - 8/22	35°00' - 145°00'	14	900	53.0-52.0°F.	Moderate	33.0	1	76	10	51	34	1	
30	8/22 - 8/23	35°00' - 145°00'	11	900	52.0°F.	Calms	32.0	18	51	2	21	26	2	
31	8/23 - 8/24	35°00' - 145°00'	6 1/2	900	53.0°F.	Buoy	33.0	1	19					
32	8/27 - 8/28	35°00' - 145°00'	12 1/2	850	53.0°F.	Buoy	33.0							
33	8/29 - 8/30	35°00' - 145°00'	8 1/2	850	55.0-54.0°F.	Light	35.0							
34	8/30 - 8/31	35°00' - 145°00'	11	850	53.0°F.	Light	33.0	6	1	4	1			
35	8/31 - 9/1	35°00' - 145°00'	13 1/2	850	52.8°F.	Light	32.8	3	65	3	11	22		
36	9/1 - 9/2	35°00' - 145°00'	12	850	52.0°F.	Calms	32.0	16	51	5	29	33		
37	9/2 - 9/3	35°00' - 145°00'	11	850	52.3°F.	Light	32.3	44	45	89	22	34	13	
38	9/3 - 9/4	35°00' - 145°00'	13 1/2	850	52.3°F.	Light	32.3	2	14	5	5	4		
39	9/4 - 9/5	35°00' - 145°00'	15 1/2	850	54.5°F.	Light	34.5							
40	9/5 - 9/6	35°00' - 145°00'	12 1/2	900	55.6°F.	Calms	35.6							
41	9/12 - 9/13	35°00' - 145°00'	12 1/2	900	56.5°F.	Moderate	36.5							
42	9/14 - 9/15	35°00' - 145°00'	13 1/2	900	57.2°F.	Light	37.2							
43	9/16 - 9/17	35°00' - 145°00'	14 1/2	900	57.7°F.	Light	37.7							
44	9/17 - 9/18	35°00' - 145°00'	12 1/2	900	57.7°F.	Buoy	37.7							
45	9/18 - 9/19	35°00' - 145°00'	12 1/2	850	57.6°F.	Buoy	37.6							

TOTALS

576	1357	64	11	305	2305	379	1248	654	44	64	5	17-4, 2-3	542
-----	------	----	----	-----	------	-----	------	-----	----	----	---	-----------	-----

1/ Does not include setting and hauling time.
 2/ Letters B - blue shark, G - English shark, M - megalodon shark.
 3/ Mammals observed or caught in nets during hauling operations.
 4/ Unable to haul in nets earlier due to sea conditions.
 5/ Sea temperature readings - 1st reading at set, 2nd reading at haul.

Table 5 - Gill-net Catch Data --- N.Y. John N. Cobb --- Cruise 28 --- July 16 to August 30, 1956 **

Station No.	Date	Position of set Latitude N. Longitude W.	Surface temperature	Wind direction and force	Fathoms of net	No. hours soaked	Number salmon caught			Number incidental catch					
							Red	Silver	Total	Blue shark	Jack mackerel	Pomfret	Squid	Other	
1	7/17 - 7/18	46°17' 126°58'	60.5°F.	NW-4	900	6½	0	0	0	2	9	2	1	1 brown ragfish	
2	7/18 - 7/19	45°05' 126°54'	62.1°F.	NW-5-7	900	8	0	0	0	3	0	0	0	---	
3	7/20 - 7/21	43°04' 130°17'	59.0°F.	SE-4 - SW-7	900	8½	0	0	2	11	17	5	0	---	
4	7/22 - 7/23	50°01' 133°58'	56.0°F.	SSE-4	900	9	2	0	2	2	0	33	0	1 steelhead trout	
5	7/23 - 7/24	50°00' 137°00'	55.0°F.	SW-3	900	8	2	1	3	0	2	41	3	---	
6	7/24 - 7/25	50°00' 140°00'	54.0°F.	W-4	900	8½	1	0	1	0	3	206	2	---	
7	7/25 - 7/26	48°40' 140°00'	54.0°F.	W-5	900	8½	0	0	0	1	5	27	0	---	
8	7/26 - 7/27	47°20' 140°00'	55.5°F.	NW-4	900	9½	0	0	0	3	2	13	2	---	
9	7/27 - 7/28	46°00' 140°00'	58.0°F.	NE-2	900	8	0	0	0	6	0	0	97	---	
10	7/29 - 7/30	46°00' 133°30'	58.0°F.	WSW-4	900	8½	0	0	0	8	8	44	10	---	
11	7/31 - 8/1	46°00' 127°28'	61.0°F.	NW-4-5	900	8	0	0	0	9	0	1	0	---	
12	8/1 - 8/2	45°58' 125°49'	61.0°F.	WNW-5	900	7½	0	0	0	11	1	0	0	---	
13	8/6 - 8/7	46°12' 125°13'	62.5°F.	NW-4	900	8½	0	0	0	14	2	0	0	1 mackerel shark, 2 sablefish	
14	8/8 - 8/9	44°50' 126°24'	61.0°F.	NW-6-7	400	8½	0	0	0	4	0	0	0	---	
15	8/14 - 8/15	45°00' 135°00'	63.0°F.	ESE-4	900	10½	0	0	0	8	96	47	4	---	
16	8/16 - 8/17	45°00' 140°00'	62.2°F.	SSW-4-7	900	10½	0	0	0	19	0	7	7	---	
17	8/18 - 8/19	46°00' 145°00'	59.0°F.	SW-8	400	12½	0	0	0	7	0	0	0	---	
18	8/19 - 8/20	47°20' 145°00'	57.3°F.	SW-6	900	10½	0	0	0	31	0	1	5	---	
19	8/20 - 8/21	48°40' 145°00'	56.5°F.	SSW-6	900	11½	0	0	0	27	5	9	1	---	
20	8/21 - 8/22	50°00' 145°00'	56.5°F.	SSW-4	900	10½	0	0	0	3	0	59	0	---	
21	8/22 - 8/23	49°59' 142°48'	58.2°F.	NW-3	900	10	0	1	1	4	52	58	13	1 giant eel/fish, 1 mackerel shark	
22	8/23 - 8/24	49°58' 139°00'	58.3°F.	W-5	900	11½	0	0	0	3	76	62	43	1 giant skiffish	
23	8/24 - 8/25	49°00' 137°07'	59.0°F.	SSE-4	900	9½	0	0	0	9	38	5	5	---	
24	8/25 - 8/26	48°06' 135°10'	61.5°F.	SSW-5	900	9½	0	0	0	15	148	22	6	---	
25	8/26 - 8/27	49°06' 137°11'	61.0°F.	WSW-5	900	10½	0	0	0	12	31	25	0	---	
26	8/27 - 8/28	50°01' 134°31'	61.7°F.	SSW-3	900	10½	0	0	0	11	0	0	0	---	
27	8/28 - 8/29	50°00' 135°30'	61.5°F.	WSW-5 - WNW-6	900	10½	0	0	0	2	0	0	0	---	
TOTALS						23,300	253	5	2	7	25	225	497	667	199

1/ All gill-net sets were made at night

2/ Wind force is according to Beaufort scale

3/ Does not include setting and hauling time

** Prepared by Exploratory Fishing and Gear Development Section, Fish and Wildlife Service, Seattle.

Table 6.--Summary of catch statistics.
(Numbers of fish)

	V E S S E L S							Totals	Percent of total catch
	TORDENSKJOLD	MITKOF	PARAGON	CELTIC	COBB				
Species of salmon	1822	738	387	570	5		3522	44.2	
Red	610	963	837	1357	0		3767	47.3	
Chum	35	15	133	303	0		486	6.2	
Pink	14	4	31	64	2		115	1.4	
Silver	23	33	6	11	0		73	0.9	
King									
Total	2504	1753	1394	2305	7		7963	100.0	
Catch by mesh size	1481	410	334	379	5		2609	32.7	
5 1/4 inches	911	727	822	1248	2		3710	46.6	
4 1/2 "	96	399	206	634	0		1335	16.8	
3 1/4 "	16	217	32	44	0		309	3.9	
2 1/2 "									
Total	2504	1753	1394	2305	7		7963	100.0	
Types of set	36	41	41	45	27		190		
Night	1	0	4	0	0		5		
Day									
Total	37	41	45	45	27		195		
Sets with fish catch	32	32	31	36	4		135		
Salmon	0	4	2	2	7		15		
Albacore	5	5	12	7	16		45		
None									
Total	37	41	45	45	27		195		
Average number hours net fished	12½	15½	13½	14½	10½		13½		
Catch of salmon per salmon set	78.4	54.8	45.0	64.2	1.7		59.0		

Table 7.--Catch per shackle of salmon by species and mesh size.

M/V TORDENSKJOLD

[Including only the 32 sets which captured salmon]

Species	Catch	Percent of total	5½-inch mesh		4½-inch mesh		3¾-inch mesh		2¾-inch mesh		All mesh	
			No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle
Red	1822	72.8	975	5.08	746	3.88	86	.90	15	.16		3.16
Chum	610	24.4	477	2.48	131	.68	2	.02	0	0		1.05
Pink	35	1.4	9	.04	24	.12	2	.02	0	0		.06
Silver	14	0.6	8	.04	6	.03	0	0	0	0		.02
King	23	0.9	12	.06	4	.02	6	.06	1	.01		.03
Total	2504	100.1	1481	7.71	911	4.74	96	1.00	16	.17		4.35

Table 8.--Catch per shackle of salmon by species and mesh size.

M/V MITKOF

[Including only the 30 sets which captured salmon]

Species	Catch	Percent of total	5½-inch mesh		4½-inch mesh		3¾-inch mesh		2¾-inch mesh		All mesh	
			No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle
Red	738	42.1	157	1.03	368	2.42	167	2.20	46	.61		1.62
Chum	963	55.0	234	1.54	335	2.30	227	2.99	167	2.20		2.11
Pink	15	0.9	1	.01	10	.07	4	.05	0	0		.03
Silver	4	0.2	1	.01	3	.02	0	0	0	0		.01
King	33	1.8	17	.11	11	.07	1	.01	4	.05		.07
Total	1753	100.0	410	2.70	727	4.88	399	5.25	217	2.86		3.84

Table 9.--Catch per shackle of salmon by species and mesh size.

M/V PARAGON

[Including only the 31 sets which captured salmon]

Species	Catch	5½-inch mesh		4½-inch mesh		3½-inch mesh		2½-inch mesh		All mesh	
		No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle
Red	387	76	.64	195	.97	86	.84	30	.35	509	.76
Chum	837	212	1.80	525	2.61	98	.95	2	.02		1.64
Pink	133	18	.15	94	.47	21	.20	0	0		.26
Silver	31	24	.20	6	.03	1	.01	0	0		.06
King	6	4	.03	2	.02	0	0	0	0		.01
Total	1394	334	2.82	822	4.10	206	2.00	32	.37		2.74

Table 10.--Catch per shackle of salmon by species and mesh size.

M/V CELTIC

[Including only the 36 sets which captured salmon]

Species	Catch	5½-inch mesh		4½-inch mesh		3½-inch mesh		2½-inch mesh		All mesh	
		No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle	No. fish	Catch per shackle
Red	570	116	.53	304	1.40	129	1.19	21	.21		.88
Chum	1357	140	.65	705	3.26	493	4.56	19	.18		2.11
Pink	303	81	.37	215	.99	7	.06	0	0		.47
Silver	64	39	.18	17	.07	5	.04	3	.02		.10
King	11	3	.01	7	.03	0	0	1	.01		.02
Total	2305	379	1.76	1248	5.75	634	5.85	44	.42		3.58

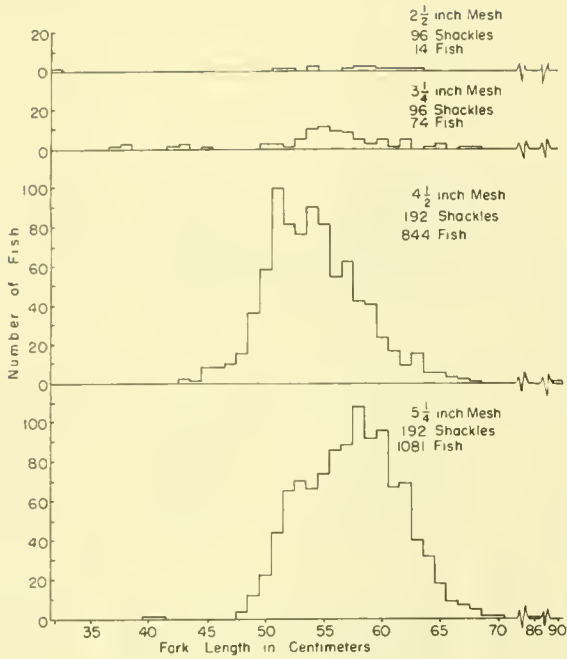


Figure 7.--Catch by Tordenskjold of all species of salmon. Length frequency of 2,013 salmon in relation to mesh size.

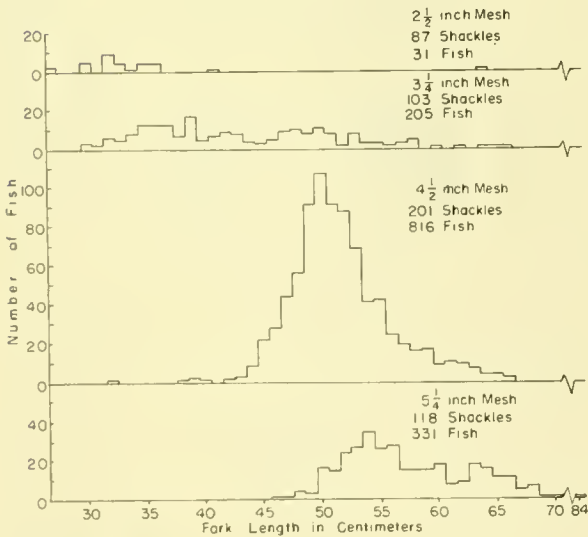


Figure 9.--Catch by Paragon of all species of salmon. Length frequency of 1,383 salmon in relation to mesh size.

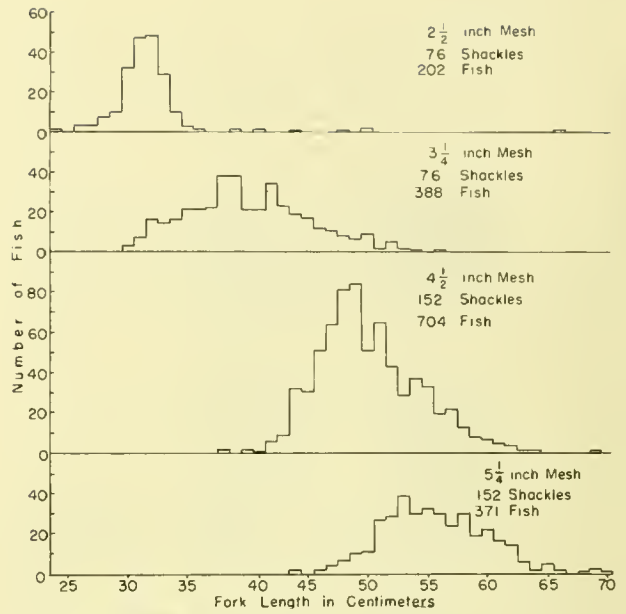


Figure 8.--Catch by Mitkof of all species of salmon. Length frequency of 1,665 salmon in relation to mesh size.

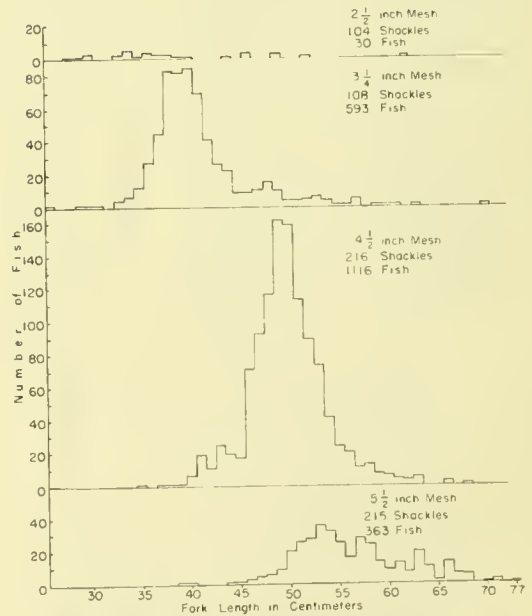


Figure 10.--Catch by Celtic of all species of salmon. Length frequency of 2,102 salmon in relation to mesh size.

Table 6 (page 11) is a summary by vessels of the total salmon catch by species and mesh size, total number and types of gill net sets, the average number of hours nets were fished, and the catch of salmon per set.

The Tordenskjold operated in the eastern Bering Sea and Bristol Bay (fig. 1) from May 24 to September 21 with two periods (June 26 to July 23 and August 15 to September 10) spent in king crab studies in the eastern Bering Sea. A total of 36 night and 1 day set was made by the Tordenskjold with salmon catches ranging from 1 to 987 fish.

The Mitkof operated in central Bering Sea and in the North Pacific Ocean, south of the western Aleutians (fig. 1). Fishing extended from May 16 to September 16. A total of 41 night sets were made with salmon catches ranging from 2 to 323 fish.

The Paragon operated in the area south of the Alaska Peninsula and the eastern Aleutians (fig. 1) and fished from July 11 to September 24; a total of 41 night sets and 4 day sets were made within this period. Salmon catches ranged from 3 to 175 fish per set.

The Celtic's area of operation was in and south of the Gulf of Alaska on longitude 140°, 145°, 150°, and 155° W. (fig. 1). Fishing extended from July 12 to September 19 and catches ranged from 4 to 150 salmon per set.

The Fish and Wildlife Service's John N. Cobb operated in the area off Washington and Vancouver Island between latitude 45° and 50° N. westward to longitude 145° W. (fig. 1). The primary purpose of this cruise was to locate areas of albacore abundance. Of the 27 gill net sets made during the period July 17 to August 29, four caught salmon. Catches ranged from 1 to 3 fish.

Catch per-unit-effort data for the four charter vessels are shown in tables 7 - 10 (pages 12 and 13). Effort data for the John N. Cobb are not included because of the small number (7) of salmon taken.

In eastern Bering Sea, where the Tordenskjold encountered mature reds migrating to Bristol Bay, the 5 1/4-inch mesh proved most efficient, accounting for more than half the total catch. The area occupied by

the Mitkof, central Bering Sea and south of the Aleutians, produced smaller fish and a greater proportion of juvenile reds and chums. Significant numbers of juveniles were taken in the 2 1/2-inch mesh, most of them in central Bering Sea. The 3 1/4-inch mesh proved most efficient for the Mitkof. The Paragon, fishing south of the Aleutians and the Alaska Peninsula, took few juveniles. The 4 1/2-inch mesh proved most efficient in this area. Further to the east, south of Kodiak and the Gulf of Alaska, the Celtic's catch was largely immature-adult chums. Adjusting catch to number of shackles fished shows that 4 1/2-inch and 3 1/4-inch meshes were equally effective in this area.

Combined catches from all areas show that the 4 1/2-inch mesh was most effective, with a catch of 4.87 fish per shackle; 5 1/4-inch mesh was second with 3.85 fish per shackle; followed by 3 1/4-inch mesh with 3.49 fish per shackle; and 2 1/2-inch mesh with 0.85 fish per shackle.

LENGTH FREQUENCIES

Catch by Mesh Size

Figures 7 - 10 and Appendix table 1 show the fork lengths of salmon caught in the 5 1/4-, 4 1/2-, 3 1/4-, and 2 1/2-inch mesh nets. These are listed by vessel or area since the vessels fished separate areas.^{3/} The mean fork length of salmon taken in the 5 1/4-inch mesh nets by the Tordenskjold (fig. 7) was 57.4 centimeters, in the 4 1/2-inch mesh the mean length was 54.2 centimeters, in the 3 1/4-inch mesh - 55.2 centimeters, and in the 3 1/4-inch mesh - 55.8 centimeters. The 5 1/4-inch and 4 1/2-inch meshes, which took over 95 percent of the total catch, showed selectivity for size of fish. Apparently very few small fish were available for capture in eastern Bering Sea as few were taken in the smaller mesh nets. Predominantly the fish taken in this area were mature red salmon.

The fork lengths of salmon caught by the Mitkof (fig. 8) show a more pronounced mesh-size selectivity, indicating that the stocks fished in the Mitkof's area of

^{3/} John N. Cobb's length frequency data omitted in figures.

operation were composed of individuals with a wide range in size. The mean fork length of salmon caught in the 5 1/4-inch mesh was 55.6 centimeters; 4 1/2-inch mesh - 50.1 centimeters; 3 1/4-inch mesh - 40.1 centimeters; and 2 1/2-inch mesh - 31.8 centimeters. The bulk of the catch in the 2 1/2-inch mesh were juvenile chum salmon taken in the central Bering Sea.

Mesh-size selectivity is also evident in catches of the Paragon and Celtic (figs. 9 and 10). This again indicates that the stocks fished by these two vessels in their respective areas of operation were composed of individuals with a wide range in size. The mean fork length of salmon caught in the 5 1/4-inch mesh by the Paragon was 57.2 centimeters; 4 1/2-inch mesh - 51.5 centimeters; 3 1/4-inch mesh - 43.2 centimeters; and 2 1/2-inch mesh - 33.8 centimeters. For the Celtic, the mean fork length for the 5 1/4-inch mesh was 56.1 centimeters; 4 1/2-inch mesh - 49.7 centimeters; 3 1/4-inch mesh - 40.9 centimeters; and 2 1/2-inch mesh - 38.3 centimeters.

Figure 11 shows the two extreme sizes of red salmon taken in one set by the Mitkof.

Catch by Species

Figures 12 - 14 and Appendix table 2



Figure 11.--Maximum and minimum sizes of red salmon taken in one set by the Mitkof. The smaller is a one-winter-in-ocean fish while the larger may have spent either two or three winters at sea.

show the fork length frequencies of red, chum, pink, silver and king salmon captured by the four vessels.

Red salmon.--The red salmon length distributions (fig. 12) show two or more modes indicating the presence of different age groups within the areas fished by the Celtic, Paragon and Mitkof. In the Celtic's catch the mode falling between 29 and 42 centimeters is composed of 1-year-in-ocean reds and the mode in the 43- to 60-centimeter interval of 2-year-in-ocean reds. Red salmon of 61 centimeters and above are largely 3-year-in-ocean fish with an increasing degree of overlapping lengths in the older age groups.

The Paragon's catch shows a similar pattern; the 27- to 43-centimeter interval is composed of 1-year-in-ocean reds and the 44- to 60-centimeter interval mode of 2-year-in-ocean reds. Fish 61 centimeters and above are largely 3-year-in-ocean reds.

The Mitkof's 1-year-in-ocean reds fall in the 26- to 40-centimeter interval and the

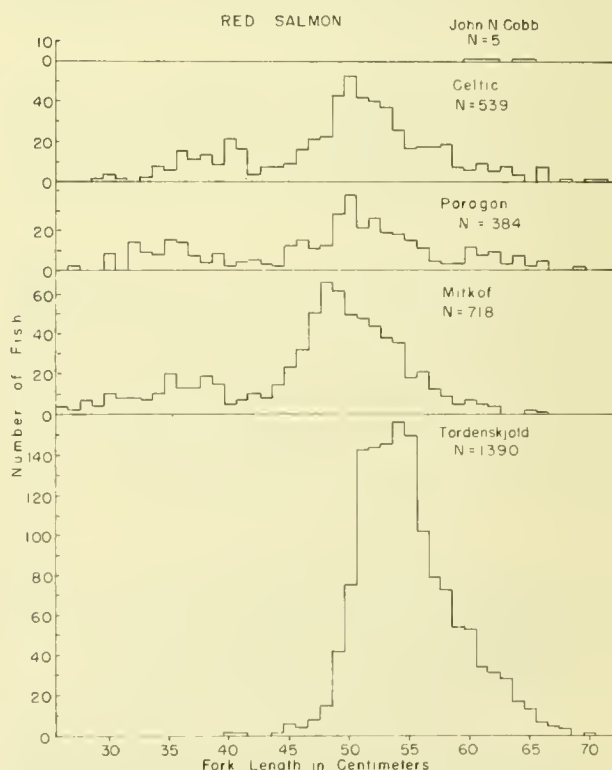


Figure 12.--Length frequency distributions of red salmon taken by five vessels.

2-year-in-ocean reds in the 41- to 62-centimeter interval. The bulk of the Mitkof's reds were taken in the North Pacific, south of the western Aleutians.

The Tordenskjold's red salmon catch exhibits a definite unimodal curve. Of the 1,390 red salmon measurements, approximately 76 percent were those caught on the two stations south of the Pribilof Islands on June 20 and 21. These were in the majority 2-year-in-ocean reds. The absence of small reds during the period from May to September and the capture of large numbers of migrating adult fish at two stations suggest that the eastern Bering Sea and the Bristol Bay area are a migratory path rather than a major feeding ground for red salmon.

The John N. Cobb's red salmon catch included five fish ranging from 60 to 65 centimeters in fork length.

Chum salmon.--There are several modes in the length frequencies of chum salmon captured by the Celtic, Paragon and Mitkof,

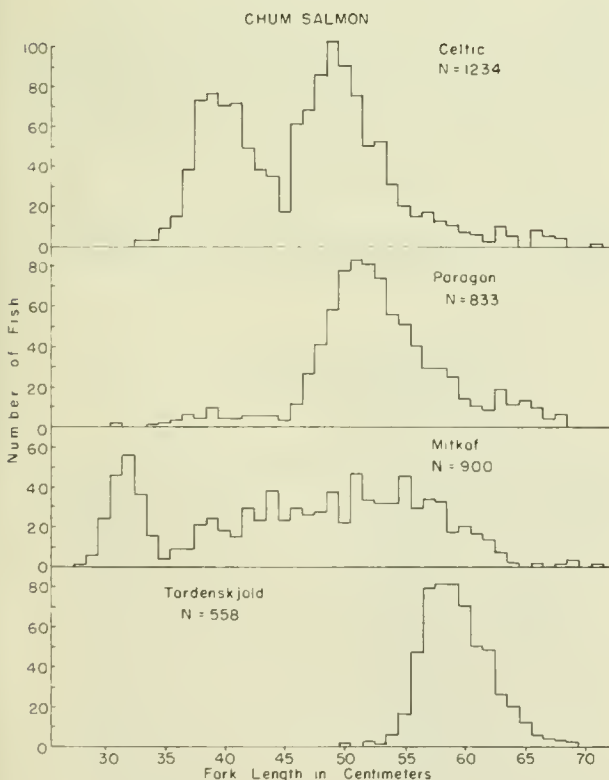


Figure 13.--Length frequency distributions of chum salmon taken by four vessels.

indicating the presence of different age groups within their areas of operation.

Age analysis indicates that the Celtic's pronounced bimodal curve is made up of 2nd-year chums in the 33- to 45-centimeter interval and 3rd-year chums in the 46- to 61-centimeter interval, with a very small number of 4th-year fish overlapping the latter in length.

Chums caught by the Paragon operating south of the Alaska Peninsula and eastern Aleutians, during the same period as the Celtic (mid-July to mid-September), exhibit a pronounced mode in the 43- to 70-centimeter length interval. This mode includes 63 percent 3rd-year chums and 37 percent 4th-year chums. The 2nd-year chums fall in the 31- to 42-centimeter interval.

A distinct group of 2nd-year chums is found in the 28- to 35-centimeter interval of the Mitkof's catch. These fish, with the exception of one, were caught in the central Bering Sea from July 6 to 15. The remaining group, in the 36- to 71-centimeter interval, is composed of 2nd-, 3rd- and 4th-year chums with a great degree of overlap in length.

The unimodal curve of the Tordenskjold's catch is composed largely of mature 4th-year chums. The absence of small chums from May

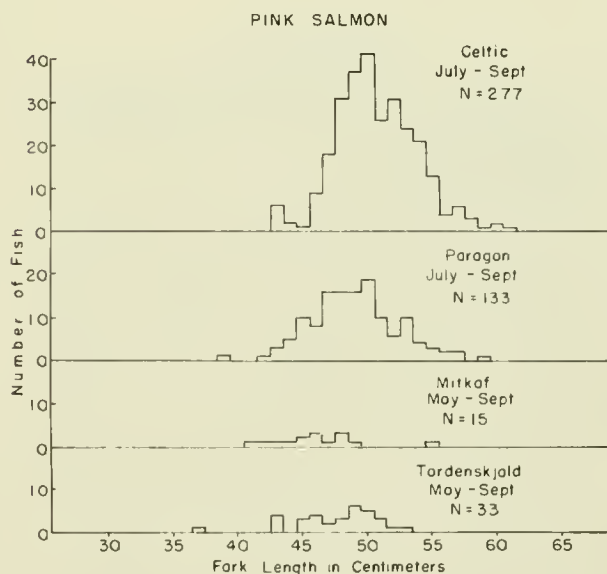


Figure 14.--Length frequency distributions of pink salmon taken by four vessels.

to September in the eastern Bering Sea and Bristol Bay is as marked as the absence of small reds, lending further evidence that eastern Bering Sea is not a feeding area for immature salmon.

Pink salmon.--The greater part of a small catch of pink salmon was taken in the Gulf of Alaska and the general vicinity of Kodiak Island in late July and early August; more than half of the total by the Celtic (fig. 14). Small numbers were taken in mid-June by the Mitkof in the central Aleutians and by the Tordenskjold in eastern Bering Sea.

Silver and king salmon.--As shown in tables 1-6 (pages 6-11), silver and king salmon were taken in small numbers and were widely distributed. Six juvenile silvers, 26 to 34 centimeters in length, were taken near Kodiak Island. Most of the silvers captured were in the 50- to 70-centimeter length range.

King salmon ranged from 27 to 90 centimeters in length with no clearly dominant size evident in the small numbers captured. The Mitkof operating in the westernmost areas made the largest catch, 33. A few small kings, 27 to 38 centimeters in length, were taken by the Mitkof and the Tordenskjold, all of them in Bering Sea.

VERTICAL DISTRIBUTION OF SALMON CATCH

It has been observed that most gill-netted salmon are taken near the surface. The Tordenskjold, with a predominance of maturing red salmon in the catch, captured 1,366 or 55 percent in the upper 1/3, 699 or 28 percent in the middle 1/3, and 408 or 17 percent in the lower 1/3 of nets which are approximately 20 feet in depth. This vertical distribution is in conformity with the observations of Barnaby in 1939 (Barnaby, 1952) who reported that with a net some 90 feet in depth at least 95 percent of the catch was taken within 30 feet of the surface and "many of the fish were caught in the top fathom". His catches were made at the entrance to Bristol Bay on a line from Cape Seniavin to Cape Newenham, and consisted of maturing red and chum salmon. Barnaby's sets were made during the day while the Tordenskjold's were made at night.

Total season's catch of the Mitkof in 1956 shows 47 percent (523) in the top, 40 percent (447) in the middle, and 13 percent (144) in the bottom third of the nets; the Paragon, 42 percent (586), 44 percent (614), and 14 percent (195); and the Celtic, 51 percent (1,045), 26 percent (523), and 23 percent (462). cursory inspection of the record sheets indicates that catches tend to be greater near the surface in clam or moderate seas, increase in the lower portion of the nets during periods of rougher weather.

An evaluation of vertical distribution of salmon on the basis of this evidence might, however, be misleading. While errors of observation and record should be minor and compensatory, there is little doubt that a bias does exist in the nets themselves resulting from the fact that fish can swim under but not over them. This tends to increase the efficiency of the upper portion of the net in relation to the deeper portion.

The evidence does suggest, however, a surface tendency on the part of the salmon which may be most pronounced in migrating mature fish and may be influenced in some degree by the condition of the sea. Fukuhara (1953) notes that it is the experience of the extensive Japanese high seas gillnet fishery that 85 to 90 percent of the salmon are taken in the upper 10 feet of net, and Powell and Peterson (1957) observe that 53 percent of the salmon taken by the John N. Cobb in 1955 were gilled in the upper third of the nets.

SURFACE WATER TEMPERATURES AND SALMON CATCH

Surface water temperatures in the region in which salmon were captured ranged from 32.9° to 58.2° F. Variations relating to both area and season contribute to this temperature range of 25.3°. Lower temperatures were encountered in eastern Bering Sea and warmer temperatures near the southern boundary of salmon distribution in the North Pacific. No juvenile red or chum salmon were captured in temperatures below 40° F. and, in Bering Sea, the largest catches of mature red salmon were associated with water temperatures of 42° and 44° F. In warmer waters south of the Aleutian

Islands the largest salmon catches were made in waters ranging from 49° to 55° F. with the largest total catch associated with a 50° F. surface temperature.

SPECIES OTHER THAN SALMON

Catches of species other than salmon, by vessels and by sets, are shown in tables 1- 55 (pages 6 - 10). These data also are summarized in table 11, below.

The range of steelhead (Salmo gairdneri gairdneri) generally coincides with that of the salmon. However, most steelhead were taken in the Gulf of Alaska and none were taken in Bering Sea. In contrast, a small number of charrs (Salvelinus malma) were caught in Bering Sea, but none were taken in other areas.

Albacore (Thunnus alalunga) were taken near the juncture of sub-Arctic and central Pacific waters. The Mitkof recorded the largest catch, 26 albacore on set number 27 at 47° N., 175° W.

Next to salmon, the pomfrets (Brama raii) were the most numerous species taken. They were caught in large numbers in both salmon and albacore waters of the North Pacific

Ocean with the apparent center of abundance near the southern limits of salmon distribution. None was taken in the Bering Sea.

Of the four species of sharks taken on the high seas, blue shark (Prionace glauca) were the most numerous, the greatest number occurring in the southern waters. The Mitkof caught 92 blue sharks on set number 28 at 47° N., 180° W.

The capture of five boarfish (Pseudopentaceros richardsoni) by the Paragon and Celtic is the first reported occurrence of this species in the North Pacific Ocean, and is an extension of its known range by 5,000 miles (Welander et al., 1957).

One of the John Dories (Alloctytus verrucosus) captured by the Celtic is the first of this species recorded from the northern hemisphere (Welander et al., 1957).

LITERATURE CITED

- BARNABY, JOSEPH T.
1952. Offshore fishing in Bristol Bay and Bering Sea. U. S. Fish and Wildlife Service, Special Scientific Report--Fisheries No. 89, 30 pp. October.

Table 11.--Incidental catch.

Common name	Scientific name	VESSELS					Total
		TORDENSKJOLD	MITKOF	PARAGON	CELTIC	COBB	
Steelhead	<u>Salmo gairdneri gairdneri</u>		9	32	64	1	106
Albacore	<u>Thunnus alalunga</u>		38	9	5	25	77
Pomfret	<u>Brama raii</u>		426	644	542	667	2279
Jack mackerel	<u>Trachurus symmetricus</u>			40	85	497	622
Giant skilfish	<u>Erilepis zonifer</u>			19	20	2	41
Atka mackerel	<u>Pleurogrammus monopterygius</u>		5		8		11
Three-spined sticklebacks	<u>Gasterosteus sp.</u>				25		25
Handsaw fish	<u>Alepidosaurus aesculapius</u>				1		1
Boarfish	<u>Pseudopentaceros richardsoni</u>			4	1		5
John Dory	<u>Alloctytus verrucosus</u>				1		1
Snapper	<u>Sebastes sp.</u>			1			1
Squaretail	<u>Tetragonurus cuvieri</u>		5	36			41
Sablefish	<u>Anoplopoma fimbria</u>			1		2	3
Brown ragfish	<u>Acrotus willoughbyi</u>					1	1
---	<u>Anotopterus pharao</u>		4	2	1		7
---	<u>Taractes princeps</u>			1			1
Blue shark	<u>Prionace glauca</u>		181	33	47	225	486
Mackerel shark	<u>Isurus nasus</u>	2	13	19	9	2	45
Dogfish shark	<u>Squalus acanthias</u>		2	1	2		5
Mud shark	<u>Hexanchus griseus</u>			1			1
Herring.	<u>Clupea pallasi</u>	24		1			25
Yellowfin sole	<u>Limanda aspera</u>	12					12
Dolly Varden trout	<u>Salvelinus malma</u>	34	1				35
Juvenile wolf-eels	<u>Anarrhichas orientalis</u>	2					2
Sea poacher	<u>Agonus acipenserinus</u>	6					6

FUKUHARA, FRANCIS M.

1953. Japanese 1952 North Pacific salmon-fishing expedition. U. S. Fish and Wildlife Service, Commercial Fisheries Review, 15(2): 1-17. February.

LOVE, CUTHBERT M.

1957. Oceanographic observations in the North Pacific aboard vessels of the U. S. Fish and Wildlife Service, summer and fall, 1956. University of Washington, Department of Oceanography, Special Report No. 27. 42 pp. January.

POWELL, DONALD E., AND ALVIN E. PETERSON

1957. Experimental fishing to determine distribution of salmon in the North Pacific Ocean, 1955. U. S. Fish and Wildlife Service, Special Scientific Report--Fisheries No. 205. 30 pp. July.

WELANDER, ARTHUR D., RICHARD C. JOHNSEN,
AND RICHARD A. HAJNY

1957. Occurrence of the boarfish, Pseudopentaceros richardsoni, and the zeid, Allocyttus verrucosus, in the North Pacific. Copeia, 1957, no. 3: 244-246. August.

Table 1. Fork Length Frequencies of Total Salmon Catches by Mesh Size

Vessel Fork Length in Cms.	TORDENKJOLD			MITROP			PARAGON			CALTIC			COBB			TOTALS											
	54	64	Total	54	64	Total	54	64	Total	54	64	Total	54	64	Total	54	64	Total									
24				1		1												1									
25				3		3												3									
26				3		3												3									
27				7		7												7									
28				10		10												10									
29				32		32												32									
30				47		47												47									
31				54		54												54									
32				16		16												16									
33				14		14												14									
34				10		10												10									
35				21		21												21									
36				22		22												22									
37				38		38												38									
38				21		21												21									
39				21		21												21									
40				6		6												6									
41				34		34												34									
42				9		9												9									
43				23		23												23									
44				17		17												17									
45				34		34												34									
46				11		11												11									
47				64		64												64									
48				8		8												8									
49				12		12												12									
50				58		58												58									
51				100		100												100									
52				27		27												27									
53				91		91												91									
54				70		70												70									
55				90		90												90									
56				81		81												81									
57				62		62												62									
58				42		42												42									
59				40		40												40									
60				23		23												23									
61				16		16												16									
62				69		69												69									
63				40		40												40									
64				5		5												5									
65				18		18												18									
66				9		9												9									
67				7		7												7									
68				5		5												5									
69				2		2												2									
70				2		2												2									
71																											
72																											
73																											
74																											
75																											
76																											
77																											
78																											
79																											
80																											
81																											
82																											
83																											
84																											
85																											
86																											
87																											
88																											
89																											
90																											
Total	1081	844	74	14	2013	371	704	368	202	1665	331	816	203	31	1383	563	1116	593	50	2102	5	2	7	2131	3432	1860	277

Table 2. Fork Length Frequencies of Total Salmon Catches by Species

Vessel Fork Length in Cms.	TORPEN FJORD				VITVØY				PARAGON				CELTIC				COBE				TOTALS								
	R	C	P	K	Total	R	C	P	K	Total	R	C	P	K	Total	R	C	P	K	Total	R	C	P	K	Total				
24					1																				1				
25					3																				3				
26					2																				4				
27					6																				6				
28					4																				4				
29					10																				10				
30					8																				8				
31					6																				6				
32					8																				8				
33					7																				7				
34					10																				10				
35					20																				20				
36					13																				13				
37					13																				13				
38					19																				19				
39					15																				15				
40					5																				5				
41					7																				7				
42					10																				10				
43					8																				8				
44					4																				4				
45					3																				3				
46					4																				4				
47					8																				8				
48					19																				19				
49					48																				48				
50					82																				82				
51					147																				147				
52					146																				146				
53					150																				150				
54					166																				166				
55					150																				150				
56					79																				79				
57					159																				159				
58					73																				73				
59					54																				54				
60					81																				81				
61					34																				34				
62					31																				31				
63					28																				28				
64					17																				17				
65					13																				13				
66					6																				6				
67					4																				4				
68					3																				3				
69					1																				1				
70																													
71																													
72																													
73																													
74																													
75																													
76																													
77																													
78																													
79																													
80																													
81																													
82																													
83																													
84																													
85																													
86																													
87																													
88																													
89																													
90																													
Total	1390	558	33	14	18	2013	718	900	15	3	29	1665	384	833	133	27	6	1383	539	1234	277	43	9	2102	3036	3525	458	89	62

Letters R - Red, C - Chum, P - Pink, S - Silver, K - Kilar indicate the species of salmon.

MBL WHOI Library - Serials



5 WHSE 01299

