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JAPANESE 1952 NORTH PACIFIC SALMON-FISHING EXPEDITION

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INTRODUCTION

Under the provisions of the International Convention for the High Seas Fisheries of the North Pacific Ocean (signed at Tokyo May 9, 1952, but subject to ratification by Japan, Canada, and the United States), Japan agrees to abstain from fishing for the five species of Pacific salmon east of a provisional line of demarcation starting at the edge of territorial waters ~~north~~ west of Atka Island, following meridian 175° west longitude and the International Date Line to Bering Strait, and ending at Cape Prince of Wales, Alaska. A protocol to the Convention further

FIGURE 1 - TYPICAL CATCHER BOAT OF THE TENYO MARU NO. 3 FLEET.

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provides for scientific investigation to determine if there is intermingling of Asian and American stocks of salmon. If areas of intermingling are found, there are to be further studies to locate a line which will best divide salmon of Asian origin from those of American origin.

An initial step in determining the distribution of the salmon in the North Pacific Ocean was made possible by an invitation from the Government of Japan for the United States Government to send a technical observer to accompany the 1952 Japanese North Pacific Salmon Expedition. This invitation was not required of Japan by any previous agreement with the United States, but was made as a gesture of good will and cooperation. In response to this invitation, the Pacific Salmon Investigations of the U. S. Fish and Wildlife Service was directed to place a biologist aboard the mothership of the Taiyo Fishing Company Ltd. fleet. It was in this capacity that I was detailed aboard the mothership Tenyo Maru No. 3, accompanying the expedition from June 1 to July 18, 1952.

Transportation from Adak, Alaska, to the Tenyo Maru No. 3 was provided by the U. S. Coast Guard Cutter Sweetbriar. Removal from the Tenyo Maru No. 3 at the end of the assignment and transportation to Adak, Alaska, was facilitated by the U. S. Coast Guard Cutter Storis. Communication to and from the Tenyo Maru No. 3 was made possible through the facilities of the Seventeenth Naval District. Data of importance to the assignment were also supplied by this organization, and travel in the Aleutian Islands was expedited by the kind attention of its various members.

The hospitality extended, as well as the cooperation and aid rendered by the Chief Inspector of the Japanese Fisheries Agency and various members of the Taiyo Fishing Company fleet is gratefully acknowledged.

In cooperation with biologists of the Japanese Fisheries Agency, who worked on their own vessels, observations were made with the following objectives:

1. Identification of fish landed aboard the mothership and recording the amounts landed.

2. Selection of random samples from representative landings of salmon. Recording the length, weight, and sex and obtaining scale samples.

3. Collection of representative specimens.

4. Interview of fishermen to determine point of origin of fish and amount of fishing effort expended.

5. Observation of fishing methods, with notes on the catches of fish other than salmon.

6. Recording of weather, sea conditions, and surface water temperatures.

7. Notation of obvious differences in appearance of salmon landed or any change in appearance as the vessel moved from one position to another.

8. Securing of all possible information on methods of capturing live fish which could be used in a tagging experiment.

SOURCES OF DATA

Salmon catches aboard the mothership were checked periodically with an official of the company. Fishermen were interviewed daily to determine the point of origin of the fish. Point-of-origin data were secured from the fleet manager's office which received this information by radio from the catcher boats daily at 0600 and 0900 hours.

Several trips were made aboard the catcher boats to observe fishing methods and to determine the distribution of the salmon in the high seas by observing their distribution in the nets. Notes on non-salmon species were made from observations of these hauls and from observations of non-salmon fish brought to the mothership with the daily trips of the catcher boats.

Morphometric measurements of salmon were made of approximately 1,800 fish during the entire journey. Although an attempt was made to select random samples from a representative day's catch, this was not always possible for all work concerning this assignment was conducted so as not to interfere with the fish-handling operations. Therefore, it was not always possible to allocate time to the measuring of specimens when catcher boats with representative catches unloaded.

Scale samples from the measured fish were taken and are being analyzed. A separate report on the age composition of the catch will be prepared. A collection of 160 salmon was frozen and returned to Seattle. The fish were collected aboard the Tenyo Maru No. 3, and when the three fleets were dispersed, specimens were collected aboard the motherships of the remaining two fleets. Meristic counts of the respective species of this sample will be made and the results reported later. Information on methods of tagging fish were obtained in conversations with the Chief Inspector of the Japanese Fisheries Agency.

All specimens measured were selected at random from the catches of single catcher boats. This greatly simplified the establishment of the exact position at which these fish were taken, but on some days it was obvious that at best the salmon selected were representative only of the catch of the particular catcher boat from which the fish were selected, and not at all representative of the entire catch of the fleet for the day. On these days the average size of the fish in the catches from various catcher boats differed noticeably. This situation occurred frequently between June 3 and June 13 while the fleet fished the waters south of Kiska Island and from June 16 to June 30 while the fleet operated in waters south of Agattu Island and westward to 170°E. meridian, and was especially noticeable in the chum salmon.

FISHING FLEETS

Three Japanese salmon-fishing fleets sailed from Hakodate, Hokkaido, Japan, on May 1, arrived at the fishing grounds on May 10, and began operations on May 11, 1952. The largest of these was the fleet of the Taiyo Fishing Co. Ltd., which consisted of the mothership Tenyo Maru No. 3 and 30 catcher boats (fig. 1). Damages resulting from rough seas reduced the number of catcher boats to 27. Three exploratory vessels left Japan five days in advance of the departure of the main fleet. The Nichiro Fishing Co. and the Nippon Marine Products Co. fleets each consisted of 1 mothership, 10 catcher boats, and 2 exploratory vessels. Catch data from the latter two fleets were secured, but precise data concerning operations and disposition of those fleets were unavailable during the voyage. Three Japanese Government Fisheries Inspection vessels patrolled the fleets, and were also engaged in tagging operations and oceanographic investigations.

THE TENYO MARU NO. 3

The Tenyo Maru No. 3 is a 330-ft. whale-rendering ship, with a net tonnage of 3,689, and powered by Diesel engines with a combined rating of 2,250 hp. Three 50-ton compressors refrigerate the sharp-freeze compartments and the holds. Sharp-freeze compartments have a capacity of 54 tons per day. The total capacity of the four refrigerated holds is 2,225.94 cubic meters.

The Tenyo Maru No. 3 was equipped with conventional navigating instruments:

1. Gyro-compass with repeaters on flying bridge, captain's bridge, and in the wireless room for use with the radio direction-finder.

2. Marine radar, which proved invaluable due to inclement weather and the nature of the fishing operation.

3. Although equipped with a loran receiver, reception was very poor in the area of operation and further complicated by almost unceasing transmission by the ship's wireless. Loran readings were, whenever possible, supplemented or confirmed by "sun-sights"--sextant readings were taken at every opportunity, for with few exceptions, the weather conditions were such that extreme alertness was required of the officers on watch to get two or even one "fix" daily.

4. A radio direction-finder was used for checking the bearings of the catcher boats, this being done only on very foggy days and on occasions when the mother-ship drifted extremely far out of position.

No soundings were taken during the entire voyage, the only available instrument for this purpose being a sounding line, the use of which was unfeasable due to the great depths of the waters in which the fleet operated. The sounding line was utilized occasionally in lowering a reversing thermometer attached to a Nansen water bottle to determine subsurface temperatures. Drift was calculated by checking dead-reckoning position against observed position.

FISHING AREA

The fishing area of this expedition was designated by the Japanese Government and limited the operations of the fleets to waters bounded by lat. 50° N. and lat. 55° N. and long. 177° W. and 170° E. (fig. 2). The catch in this area fell below expectation and consequently on July 3 the Japanese Fisheries Agency enlarged the fishing area to include waters bounded by the lines intersecting at the following points: lat. 53° N. and long. 170° E.; lat. 53°30' N. and 163° E.; lat. 48° N. and 156° E.; lat. 48° N. and 170° E.; lat. 50° N. and long. 170° E. Although the greater part of the area originally authorized lay in the Bering Sea, fishing was confined to the North Pacific Ocean.

Fishing efforts were concentrated most heavily in two general areas. From May 11 to June 13 the three fleets fished the waters bounded by lat. 50°30' N. and lat. 51° N. and long. 177° E. and 178°20' E., the locus of which is ~~400~~ 300 miles south of Kiska. From June 5 to June 14 of this period a supply ship of the Taiyo Fishing Company Ltd., serving as mothership for seven catcher boats, fished waters southeast to southwest of the Near Islands. The fleets moved westward, and from June 15 to June 26 activity was concentrated in the waters south of Agattu Island bounded by lat. 51° N. and lat. 52° N. and long. 170° E. and long. 171° E. On June 26 the fleet moved westward. With the authorization of the new fishing area, fishing was conducted west of long. 170° E. between lat. 52°15' N. and 50°20' N.

CATCH

A total salmon catch up to July 18 of 828,888 fish was reported by an official of the Tenyo Maru No. 3 fleet. However, computed by the addition of catch

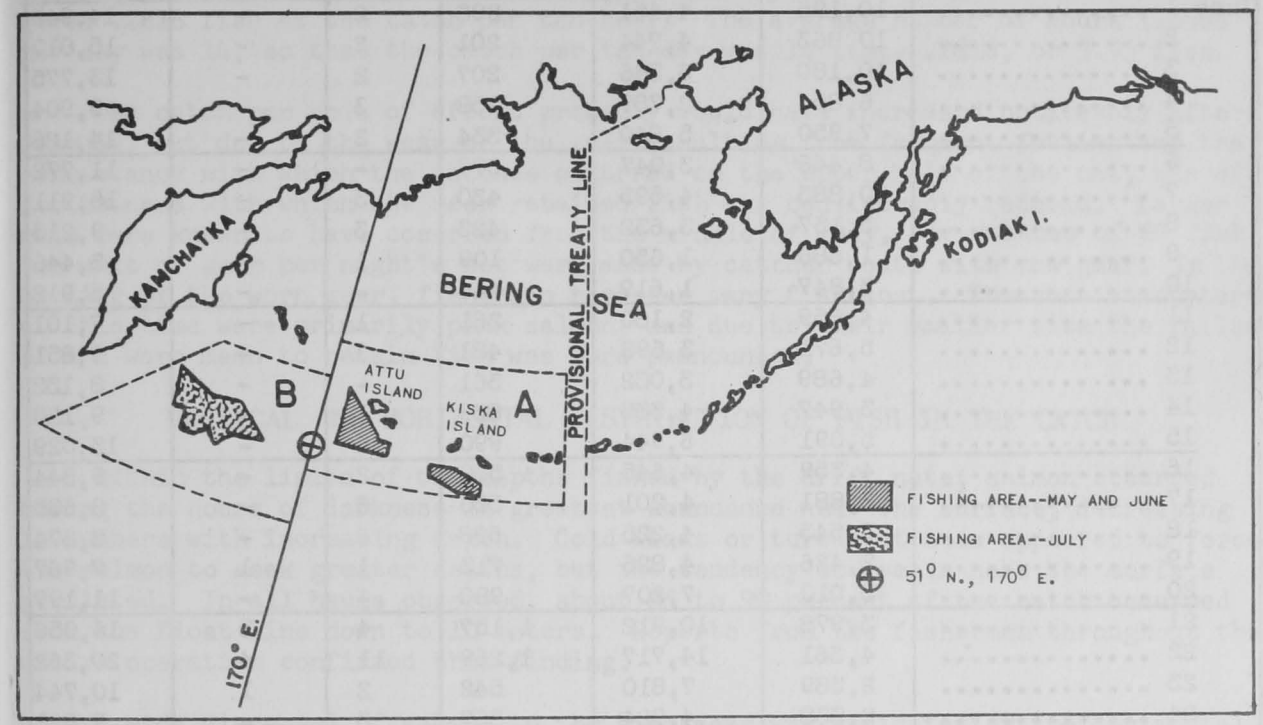

FIG. 2 - THE NORTH PACIFIC OCEAN AND BERING SEA, SHOWING JAPANESE SALMON FISHING AREAS IN 1952.

data transcribed from the catcher-boat journals for June 1-July 18 and added to figures of the catch from May 11-May 31 obtained from another source, the total catch amounted to 750,265 fish (table 1). A discrepancy of 78,623 fish exists between the two totals. A small part of this discrepancy is accounted for by the occasional absence of entries in the journals of the catcher boats. The catch of the exploratory vessels is also excluded from this total, for no data was obtainable from these vessels. The remaining part of the discrepancy has so far not been fully explained.

The catches of the other two fleets operating in 1952 are given in tables 2 and 3.

CATCH PER-UNIT-OF-EFFORT

Drift gill nets were used exclusively in the fishing operations. One unit of gear is called a "tan" (shackle) and has an area of .25 acres. The records of six catcher boats selected at random were used in the computation of the catch per unit of effort (table 4). On some days the operators of these catcher boats neglected to enter part of the data, and in the computations these days were excluded. In the 48 days for which data on these vessels are available, none omitted entries on more than 5 days. The number of hours fished per set is considered to be the period between the time the first "tan" entered the water, initiating the set, to the time the last "tan" was out of the water, terminating the retrieving of the gear.

Table 1 - Daily Salmon Catch, Tenyo Maru No. 3 Fleet, 1952

Date	Red	Chum	Pink	King	Silver	Total
	(Number of Fish)					
May 11-31	93,892	58,827	-	-	-	152,719
June 1	10,195	4,451	292	2	-	14,940
2	10,863	4,744	201	2	-	15,810
3	10,180	3,386	207	2	-	13,775
4	6,854	2,789	258	3	-	9,904
5	7,950	5,840	334	2	-	14,126
6	8,446	3,047	279	-	-	11,772
7	10,883	4,595	430	3	-	15,911
8	5,157	3,632	423	3	-	9,215
9	1,686	1,650	109	1	-	3,446
10	3,847	1,619	446	-	-	5,912
11	4,659	2,180	261	1	-	7,101
12	5,671	3,698	481	1	-	9,851
13	4,689	3,082	361	-	-	8,132
14	3,947	4,333	839	1	-	9,120
15	5,091	6,944	990	4	-	13,029
16	4,359	4,645	538	2	-	9,544
17	3,881	4,201	550	3	-	8,635
18	3,545	4,225	598	6	-	8,374
19	2,426	4,826	713	1	1	7,967
20	3,010	7,207	980	-	-	11,197
21	3,978	10,912	1,157	4	5	16,056
22	4,361	14,717	1,269	11	4	20,362
23	2,389	7,810	542	2	1	10,744
24	2,338	4,924	557	3	-	7,822
25	3,148	4,506	624	5	13	8,296
26	3,440	5,099	1,586	6	11	10,142
27	3,827	5,384	2,193	4	10	11,418
28	6,228	4,617	2,829	3	14	13,691
29	5,506	3,631	1,299	7	10	10,453
30	5,525	3,713	1,546	4	24	10,812
July 1	7,209	4,005	2,928	5	53	14,200
2	5,339	2,760	3,046	5	16	11,166
3	5,248	1,434	845	2	4	7,533
4	6,490	2,174	3,004	18	13	11,699
5	9,121	2,731	5,604	12	16	17,484
6	8,896	3,306	5,641	24	21	17,888
7	5,765	2,322	2,691	32	13	10,823
8	5,662	3,253	4,957	42	36	13,950
9	4,258	2,133	3,446	17	38	9,892
10	3,036	1,008	1,397	6	18	5,465
11	3,036	1,338	2,588	14	17	6,993
12	3,956	1,406	4,556	14	34	9,966
13	6,383	2,117	7,052	22	36	15,610
14	9,682	3,961	10,703	29	63	24,438
15	7,108	3,055	12,393	59	63	22,678
16	4,542	2,740	11,396	34	77	18,789
17	4,629	5,720	15,922	60	221	26,552
18	2,512	7,331	14,478	27	517	24,865
Total	260,951	199,201	135,539	508	1,349	750,265

"-" NONE.

The unit of effort used in the calculations is the tan-hour. The average number of tans per set is 134.5, obtained by dividing the total number of tans by the total number of sets (table 4). Multiplying this by the total number of hours fished (table 4) gives the total number of tan-hours, which is 456,139. Dividing the total catch for the 6 boats of 128,538 fish by the total number of tan-hours gives .2818 fish as the catch per tan-hour. The average number of hours fished per day was 14, so that the catch per tan-day was 14 times .2818, or 3.95 fish.

The catch per unit of effort probably would have increased noticeably after July 14, but due to the wear of the gear resulting from frequent fouling and the consistency with which the catches occurred on the upper half of the net, the effectiveness with which the mesh retained fish was considerably reduced. Larger runs were known to have occurred from the middle of July, for catches of 20 fish per unit of gear per night's set were made by catcher boats with new gear. In the hauling of the worn gear, fishermen reported many fish lost. The runs encountered at this time were primarily pink salmon, and due to their smaller size the failure of the worn mesh to retain fish was more pronounced.

VERTICAL AND HORIZONTAL DISTRIBUTION OF FISH IN THE CATCH

Within the limits of the depths fished by the drift nets, salmon occurred during the hours of darkness in greatest abundance near the surface, decreasing in numbers with increasing depth. Cold winds or turbulent seas appeared to force the salmon to seek greater depths, but the tendency to remain near the surface persisted. In all hauls observed, about 85 to 90 percent of the catch occurred from the float line down to 10 meters. Reports from the fishermen throughout the entire operation confirmed this finding.

A wide dispersal of salmon in the high seas was indicated by the horizontal distribution of the fish in the gear. From May 11 to June 14 little grouping of salmon was reported by the fishermen, the fish being distributed at random across the entire length of the net. Distinct grouping of the salmon later became apparent in fish taken from the waters south and southwest of Agattu Island.

Observations of two hauls in this general vicinity were made. The entire catch of one haul was taken on 75 of the 100 units of gear set. Fourteen distinct groups of salmon occurred at irregular intervals, each group composed of 10 to 15 fish spread widely over a unit of gear. These groups were not often homogeneous as to species.

A second haul at another location was made from a power launch drifting 20 units of gear. The entire catch of this haul was taken on the upper half of the net and the fish were distributed horizontally at almost regular intervals--approximately three fish to a "tan." The five pink salmon captured in this set were found to be distributed on one "tan" of gear. No noticeable grouping of red salmon was observed.

RED SALMON (Oncorhynchus nerka)

The daily catch of red salmon by the Tenyo Maru No. 3 fleet is shown in figure 3.

Red salmon predominated in the catch from the waters of the area south of Kiska Island. The bulk of these red salmon presented a slender appearance. The average length of specimens measured between June 3 and June 9 was 21.77 inches; the average weight of these same specimens being 5.34 pounds. The stomachs of all fish taken from these waters were markedly distended. Superficial analysis

Table 2 - Daily Salmon Catch, Fleet X, 1952

Date	Red	Chum	Pink	King	Silver	Total
	(Number of Fish)					
May 11-31	1/	1/	1/	1/	1/	52,595
June 1	3,379	1,541	76	1	-	4,997
2	5,916	3,120	202	-	-	9,238
3	5,636	1,491	117	-	-	7,244
4	4,976	1,888	205	-	-	7,069
5	4,811	1,275	149	-	-	6,235
6	5,429	1,992	261	5	-	7,687
7	4,530	1,033	134	2	-	5,699
8	6,494	2,082	455	2	-	9,033
9	2,603	1,605	146	-	-	4,354
10	338	234	14	-	-	586
11	291	383	64	-	-	738
12	1,351	951	82	-	-	2,384
13	2,007	1,278	164	-	-	3,449
14	1,650	980	344	1	2	2,977
15	1,162	1,216	197	1	-	2,576
16	1,413	2,881	542	-	-	4,836
17	1,549	3,323	310	1	-	5,183
18	991	1,084	80	1	-	2,156
19	1,430	1,968	488	1	-	3,887
20	1,224	2,772	429	3	1	4,429
21	1,135	4,129	452	1	1	5,718
22	890	6,082	1,010	-	6	7,988
23	1,158	6,908	854	5	8	8,933
24	264	469	62	-	-	795
25	1,245	2,114	331	1	5	3,696
26	1,661	1,564	691	4	8	3,928
27	1,278	3,342	1,069	1	2	5,692
28	1,697	3,735	1,115	2	-	6,549
29	2,618	2,330	1,243	1	1	6,193
30	1,870	2,768	442	2	1	5,083
July 1	1,893	2,984	659	1	9	5,546
2	3,344	3,201	1,417	1	18	7,981
3	2,248	806	309	-	5	3,368
4	2,391	823	255	-	8	3,477
5	4,197	1,914	2,399	1	9	8,520
6	4,234	1,145	2,812	3	3	8,197
7	5,314	2,366	3,658	20	9	11,367
8	1,976	1,041	1,011	12	5	4,045
9	2,669	1,332	3,006	13	7	7,027
10	2,310	867	1,181	5	25	4,388
11	2,688	1,003	2,091	8	17	5,807
12	1,606	1,168	4,619	13	64	7,470
13	3,065	1,905	7,692	10	56	12,728
14	2,927	1,342	4,792	9	103	9,173
15	2,213	1,112	7,377	11	49	10,762
17	1,935	1,153	9,551	11	79	12,729
Total June 1-July 17	116,006	90,700	64,557	153	501	271,918
Grand Total	1/	1/	1/	1/	1/	324,513

1/ BREAKDOWN BY SPECIES NOT AVAILABLE.
"-" NONE.
NOTE: NO CATCH SHOWN FOR JULY 16.

Table 3 - Daily Salmon Catch, Fleet Y, 1952

Date	Red	Chum	Pink	King	Silver	Total
	(Number of Fish)					
May 11-31	1/	1/	1/	1/	1/	82,794
June 1	4,629	1,951	84	-	-	6,664
2	4,972	2,032	137	-	-	7,141
3	6,755	2,404	125	3	-	9,287
4	4,700	1,751	108	-	-	6,559
5	3,269	2,456	201	-	-	5,926
6	3,819	3,255	310	-	-	7,384
7	3,993	1,343	103	-	-	5,439
8	3,893	3,417	273	1	-	7,584
9	2,151	1,865	107	-	-	4,123
10	748	907	17	-	-	1,672
11	1,212	1,422	193	-	-	2,827
12	1,837	2,151	158	-	-	4,146
13	1,853	2,771	210	-	-	4,834
14	3,112	3,501	163	-	1	6,777
15	3,251	3,464	521	3	-	7,239
16	2,144	3,692	465	-	-	6,301
17	1,582	3,629	399	-	-	5,610
18	594	900	35	-	-	1,529
19	1,216	1,717	460	-	1	3,394
20	1,584	1,698	454	2	-	3,738
22	1,992	2,846	490	-	1	5,329
23	1,524	4,365	684	-	-	6,573
24	518	793	114	-	1	1,426
25	2,732	3,313	470	-	-	6,515
26	2,641	3,900	1,378	-	2	7,921
27	2,404	3,350	1,789	-	5	7,548
28	3,639	3,453	1,870	-	5	8,967
29	3,425	3,229	2,570	6	33	9,263
30	3,238	1,493	358	5	1	5,095
July 1	4,099	2,570	1,524	5	23	8,221
2	2,817	2,413	2,162	2	25	7,419
3	2,300	1,095	715	2	3	4,115
4	3,417	775	290	3	11	4,496
5	3,565	2,116	3,007	14	15	8,717
6	2,650	1,529	3,024	2	18	7,223
7	4,021	1,670	3,343	34	5	9,073
8	2,215	1,544	1,671	23	33	5,486
9	3,439	1,305	3,293	23	32	8,092
10	7,216	1,086	2,203	3	32	10,540
11	2,667	780	2,462	1	8	5,918
12	2,636	1,409	6,318	4	36	10,403
13	1,732	1,271	3,346	3	39	6,391
14	722	1,370	2,337	9	58	4,496
15	1,763	1,623	4,713	35	44	8,178
16	1,496	1,430	6,540	22	58	9,546
17	1,688	1,378	8,198	19	123	11,406
Total June 1-July 17	127,870	98,432	69,392	224	613	296,531
Grand Total	1/	1/	1/	1/	1/	379,325

1/BREAKDOWN BY SPECIES NOT AVAILABLE.
"-" NONE.
NOTE: NO CATCH SHOWN FOR JUNE 21.

showed that the stomachs of the red salmon contained squid up to five inches in length, adult lantern fish (family Myctophidae) up to five inches in length, larval lantern fish with yolk sacs still attached, and several species of adult and larval crustaceans.

Data obtained from interviews with fishermen indicated a considerable randomness of movement of the fish in this area. Throughout the month of May the fish

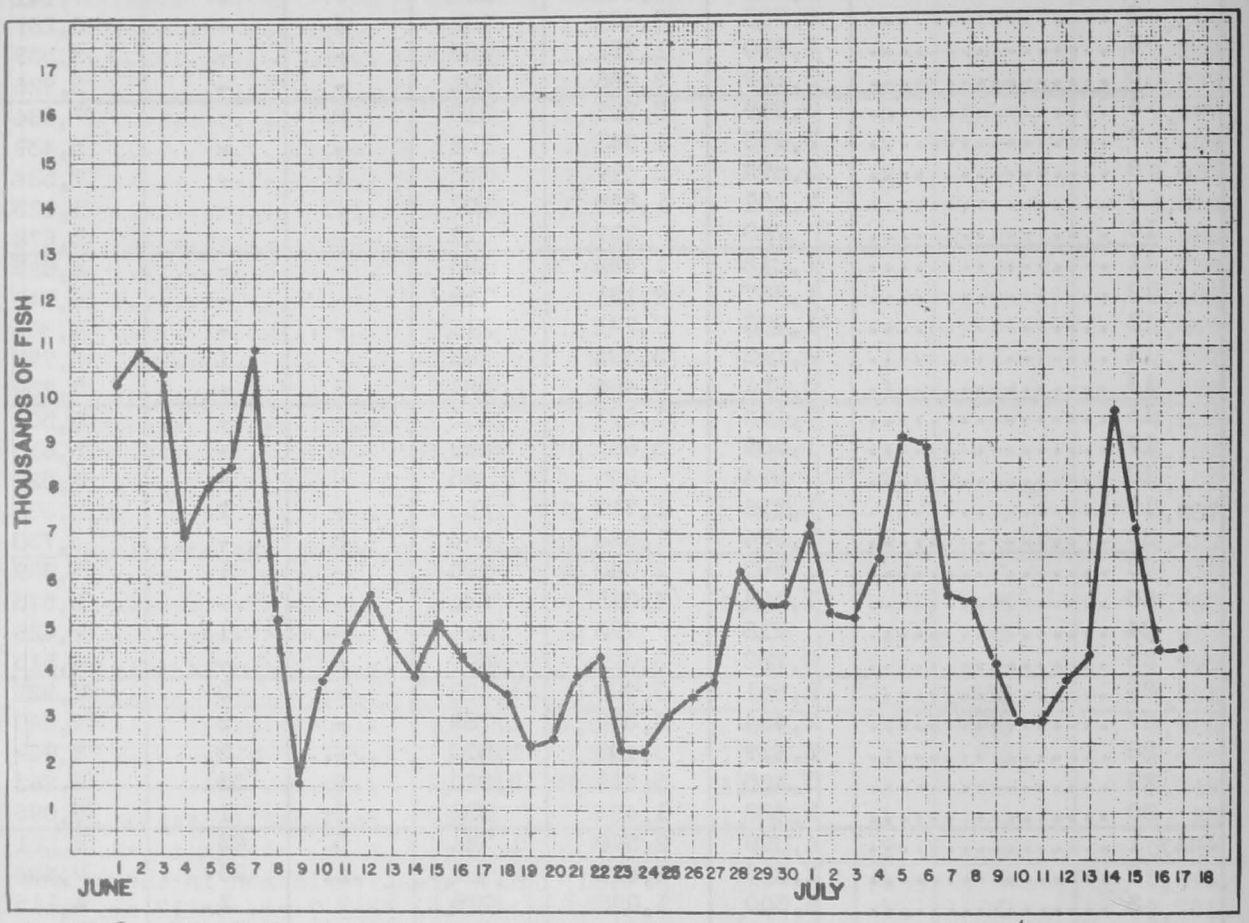

FIGURE 3 - RED SALMON CATCH OF TENYO MARU NO. 3 FLEET, JUNE 1-JULY 18, 1952 (IN NUMBERS OF FISH PER DAY).

were frequently caught in equal numbers on both faces of the net, regardless of the direction of the set. From June 1 to June 8, randomness was still evident, the fish approaching from the N., NE., ENE., ESE., S., SW., and W. From June 9 the direction of approach of the fish was from the south to the east.

On June 14 the composition of the catch changed, with the number of red salmon decreasing and the number of chum salmon increasing (fig. 4). Also, an abrupt difference in the body proportions of the red salmon was noticed. Red salmon caught on that day were noticeably stouter and deeper-bodied than those previously encountered. The average length between June 14 and June 20 was 22.15 inches and the mean weight 6.2 pounds. Red salmon showing greater depth through the body from dorsal to ventral surface persisted in all catches until July 5.

Red salmon taken on June 14 and 15 were feeding very lightly or not at all. Heavy feeding was indicated in all of these fish landed from June 16 to July 18. Stomach contents of these fish showed a marked decrease in squid, and lantern fish were no longer seen. Many of the stomachs of salmon taken in the fishing area south of Agattu contained juvenile cod (species unknown).

On June 28 red salmon regained predominance over the chum salmon and retained it until July 19. A decrease in the number of the stouter-bodied red salmon was noticeable with this change in catch composition. No detailed study concerning the

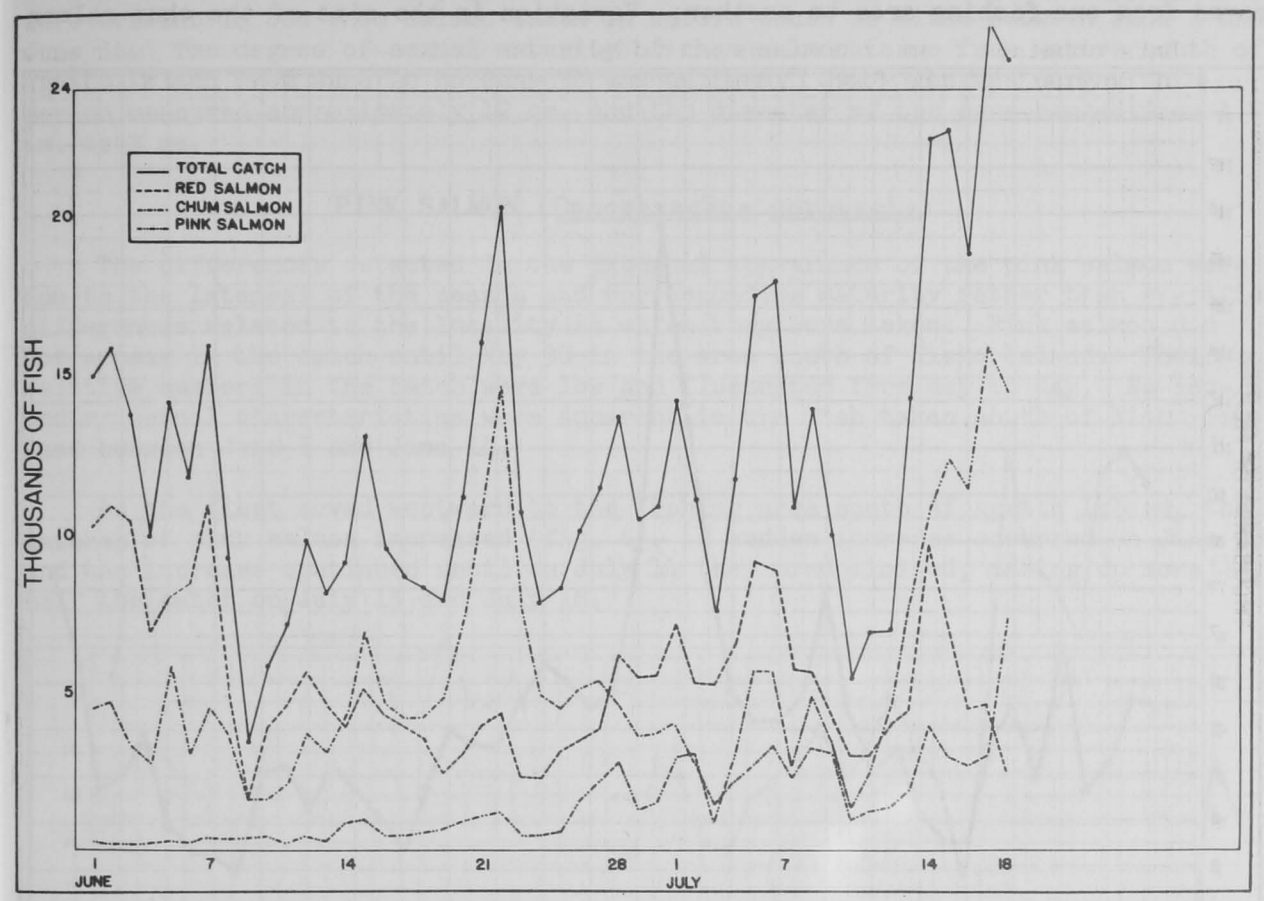

FIG. 4 - TOTAL CATCH OF TENYO MARU NO. 3 FLEET, JUNE 1-JULY 18, 1952 (IN NUMBERS OF FISH PER DAY BY SPECIES).

sexual maturity of these fish was attempted, but a great variation in the extent of ovary development was observed. Ovary lengths were from 7 cm. to 12 cm. and the diameter of single eggs ranged from 1.1 mm. to 4 mm. No fully mature specimens were encountered at any time.

In the areas fished south of Kiska Island and south of Agattu Island, red salmon 12 inches long and under were occasionally taken. Although few of these were brought aboard the mothership, all specimens were males, the gonads of which were noticeably undeveloped, presenting the appearance of a string. On the evidence of the few specimens examined these fish were juvenile rather than precocious males.

Table 4 - Salmon Catch-Effort Data for Six Selected Catcher Boats

Catcher Boat	No. of Sets	Total No. of Hours Fished	No. of "Tans" of Gear Set	No. of Fish Caught
1	41	571.42	5,735	20,560
2	38	514.25	4,875	21,130
3	40	539.11	4,700	14,511
4	44	644.42	6,255	29,264
5	39	535.75	5,550	20,873
6	40	586.42	5,435	22,200
Total	242	3,391.37	32,550	128,538

CHUM SALMON (Oncorhynchus keta)

A peak in the catch of this species occurred on June 22 (fig. 5). No difference in the general appearance of the chum salmon was detected as the fleet moved from one fishing area to another. Variation in the size of the chum salmon

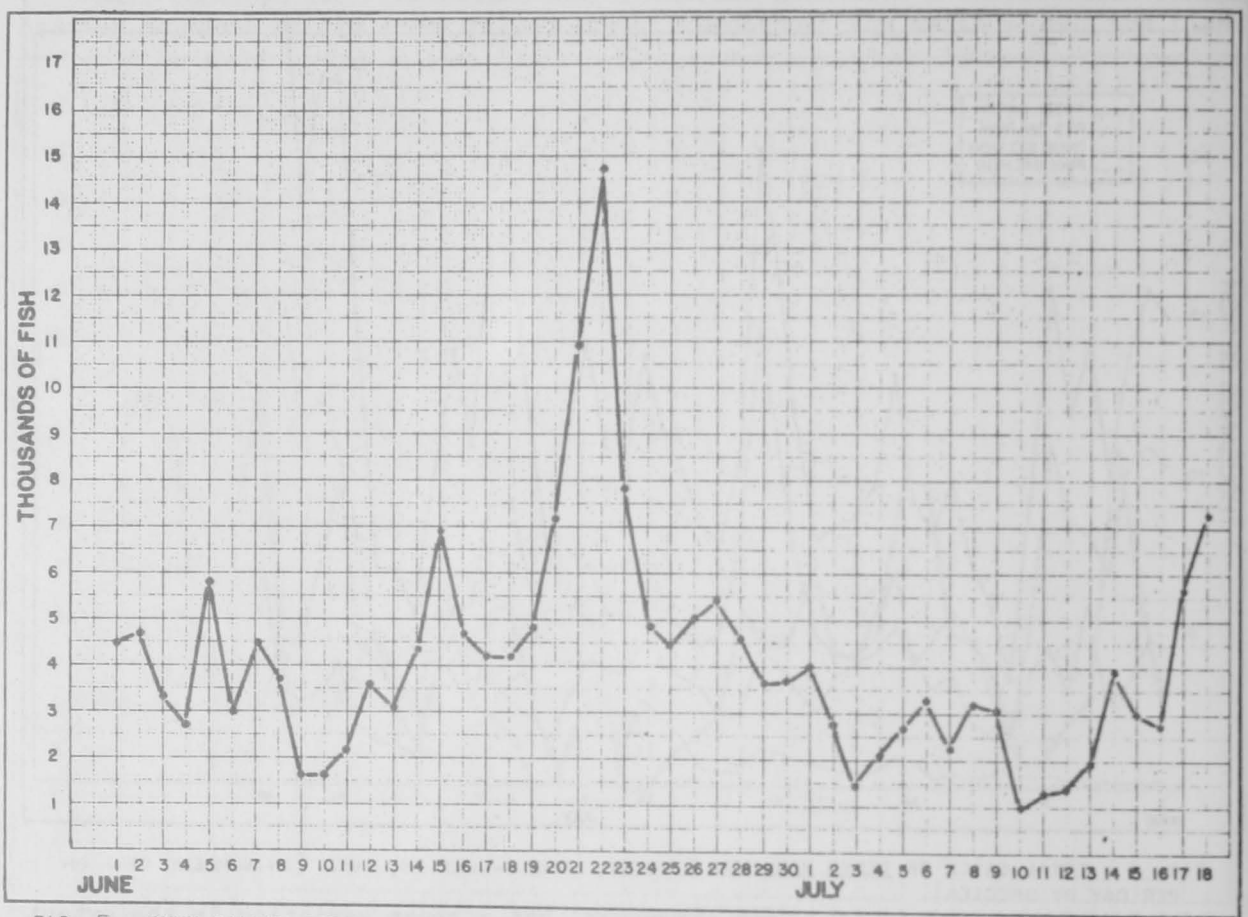

FIG. 5 - CHUM SALMON CATCH OF TENYO MARU NO. 3 FLEET, JUNE 1-JULY 18, 1952 (IN NUMBERS OF FISH PER DAY).

caught was striking in the area south of Kiska Island. On June 19 the variation in size became less noticeable. Average size of the fish (average length 21.1 inches and weight 4.1 pounds) appeared to be less than that of the chum salmon taken previously in waters south of Kiska Island (average length 22.1 inches and weight 5.1 pounds). Beginning July 1 a great variation in the size of the fish in the catch became apparent, and although small chum salmon were still present, the number of salmon with a length greater than 23.6 inches increased. The average length of the chum salmon measured from July 5 to July 16 was 19.8 inches and the average weight was 5.0 pounds.

All stomachs examined showed evidence of heavy feeding until June 26. On superficial examination, stomachs were found to contain large amounts of mysidaceans with lantern fish and squid occurring less frequently than in the stomachs of the red salmon. Almost no food was evident in most specimens taken from June 27 to July 4.

A great variation in size of chum salmon was evident in the catches from July 1 to July 18; there was seemingly a greater proportion of large specimens (23.6 inches or longer) on days when the catch of chums was relatively large.

Invariably the stomachs of larger specimens were empty or nearly so, while those of the smaller specimens contained large amounts of food.

As with the red salmon, great variations in the degree of gonad development were evident in the chum salmon taken in waters south of Kiska between June 1 and June 14. The degree of sexual maturity of chum salmon taken from waters south of Agattu Island from June 26 to June 30 was uniform. Ovary lengths during this period measured approximately 12 cm. and the diameter of the eggs ranged from 1.5 mm. to 3 mm.

PINK SALMON (Oncorhynchus gorbuscha)

The differences detected in the external appearance of the pink salmon were due to the lateness of the season and corresponding maturity rather than specific differences related to the locality in which they were taken. Pink salmon did not appear in the catch until May 30 in the area south of Kiska Island. Their relative numbers in the catch were low and fluctuated from day to day. No secondary sexual characteristics were apparent in the fish taken south of Kiska Island between June 1 and June 14.

As the fleet moved westward to the fishing area south of Agattu Island, the catches of pink salmon increased (fig. 6). A sudden increase occurred on June 26, and the increase continued until on July 14 they predominated, making up more than half the catch on July 15 and July 18.

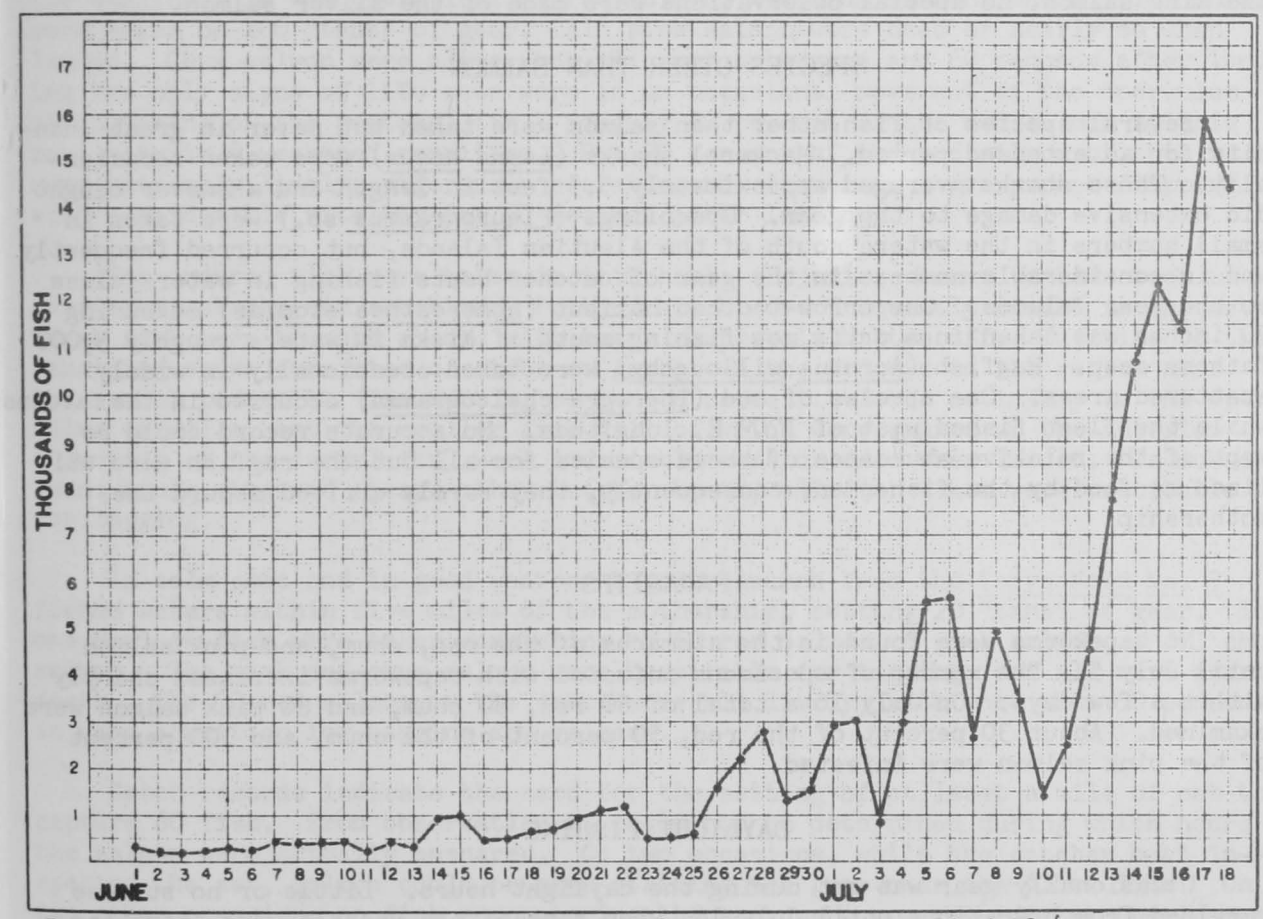

FIGURE 6 - PINK SALMON CATCH OF TENYO MARU NO. 3 FLEET, JUNE 1-JULY 18, 1952 (IN NUMBERS OF FISH PER DAY).

Pink salmon with humps began to appear on July 1, but in relatively small numbers at that time. Beginning July 4, an increase in the number of humped-back specimens occurred. The pink salmon taken after July 7 with few exceptions were humped, and scattered individuals showed crimson mottling on the pelvic and caudal fins. Feeding was extremely heavy in all specimens examined throughout the period of observation. Only 14 of the 345 specimens measured and examined were females. Gear with smaller mesh, set by the Fisheries Inspection vessels, caught a relatively larger number of females than the fishing fleet. This indicates the presence in the area of females not taken in the regular catch because of the selectivity of the gear fished. Females only 10 to 12 inches long were also taken occasionally on hand lines with hook and bait.

KING AND SILVER SALMON

King salmon (Oncorhynchus tshawytscha) from the start of the fishing operation were caught in small numbers throughout the season. Those taken in May and in the early part of June were large, weighing up to 35 pounds. The average weight of immature specimens taken subsequently was approximately 15 pounds. No measurements or other observations were made of king salmon for they occurred in relatively small numbers and the handling of them was such that they were not always recognizable when mixed with a large load of red salmon or chum salmon.

Silver salmon (O. kisutch) occurred in the catches only erratically after June 18; they were few and hardly noticeable in the landings. As in the case of the king salmon, no special observations were made of the silver salmon.

SPECIES OTHER THAN SALMON

Several species of fish other than salmon were taken but never in great quantity for an extended period. Mackerel sharks (Lamna nasus) were taken occasionally. These sharks averaged approximately 5.5 feet in length and whenever caught did extensive damage to the gear. Greenlings (Pleurogrammus sp.) were taken in small numbers in the waters south of the Aleutian Islands, but occurred frequently and in considerable numbers in the gear of catcher boats fishing in waters close to the Near Islands. One arrow-toothed halibut (Atheresthes stomias) measuring 20 inches was taken in a drift net fishing south of Kiska in waters roughly 3,000 fathoms deep. Ragfish (Acrotus willoughby) were taken occasionally in widely scattered areas. One species of cod (Theragra chalcogramma) occurred in the catches while the fleet fished west of 170° E. longitude. No accurate record could be kept of the relative abundance of these species for all but the ragfish were utilized as food by the fishermen; consequently, they rarely arrived aboard the mothership.

PARASITES

No tapeworms were found in the stomachs of the red, chum, and pink salmon until July 5. The number of specimens infested with tapeworms increased sharply within a few days. On July 16 a total of 80 red, 80 chum, and 80 pink salmon were examined. About 30 percent of the red, 50 percent of the chum, and 100 percent of the pink salmon were infested.

DAYLIGHT FISHING

Occasionally gear was set during the daylight hours. Little or no success resulted from operations until July 16, when some of the vessels were operating in the western area. Catches of seven fish per "tan" were made in this area during the daylight hours. Possibly perception of the gear by the salmon accounts for the low catches made in daylight sets. On moonlight nights fish were seen grouped on one side of the gear, swimming along its length and avoiding the net.

Similar occurrences were reported by many fishermen, some of whom made attempts to drive the fish into the nets on these occasions. Observations and reports of this nature occurred only after July 5; weather and sea conditions before this would not permit such observations.

DATA PERTINENT TO A TAGGING PROGRAM

Biologists on vessels of the Japanese Fisheries Agency conducted tagging operations. Great difficulty was encountered in capturing salmon in large enough quantities and in good enough condition to tag and release. Initially fish were captured with gill nets, but the fish were in too weak a condition to release. Attempts were made to patrol the net and remove the fish within a short time after capture, but due to rough seas and darkness this procedure was abandoned. Most fish captured for tagging by the Japanese were taken on long lines, set during the daylight hours, using salmon meat as bait. Few fish were captured by this method: only 2,000 fish were reported tagged and released up to July 18, or 29 fish per day. Records of the exact number of each species were unobtainable. The amount of effort expended in the capture of fish for tagging or the time devoted to it was not learned, although the fishery biologist in charge expressed concern over the lack of fish taken for tagging. Although the long line did not take fish in great quantity, the fish taken were said to be in much better condition for release than those taken by gill nets.

Few fish taken in the hauls of the catcher boats were in suitable condition for tagging. In one operation, 89 red salmon, 456 chum salmon, and 47 pink salmon were taken on 100 "tans" of gear. All pink salmon were dead or nearly so when landed. Chum salmon were alive, but all were exhausted and 60 seconds after landing the only signs of life seen were in an occasional movement of the operculum or quivering of the pectoral fin. Roughly 80 percent of the red salmon in this haul were in a weakened condition. But 20 percent of the red salmon of this catch were extremely lively, vigorously resisting the fishermen's grasps and flipping with considerable vitality for 90 seconds after landing.

Ten injured fish were taken in this haul. Injuries seemed to have been inflicted by sharks and sea birds, both of which were frequently caught in the nets. Three fish were brought aboard with heads completely bitten off. Injuries to the remaining seven consisted of stabs or gashes on the abdomen in the region near the caudal peduncle. The webbing seemed to cause little or no injury to the operculum or gills, but the smaller fish (all of which were snared at the anterior insertion of the dorsal fin) were invariably weak or dead when landed. In subsequent hauls observed aboard other catcher boats, all fish taken were unsuitable for tagging.

In calm seas and in good weather a power launch from the Tenyo Maru No. 3 fished waters within five miles of the mothership, setting 20 "tans" of gear. In one haul 56 fish were taken consisting of 50 red salmon, 5 pink salmon, and 1 chum salmon. The pink and chum salmon were unsuitable for tagging, for all were near death. The 50 red salmon in the catch were all lively, with more than 50 percent in good condition for tagging and release.

Catch records indicate the need for the setting of at least a mile of net to capture 60 fish. From observation it could not be determined during which hours the salmon were actually ensnared. On two occasions, while the catcher boat inspected the set, salmon could be seen striking the gear near the float line. On two other occasions no fish encountering the gear were apparent during the inspection run and it was evident from the vitality of many of the fish landed in these hauls that they became ensnared during the early morning hours. Therefore, the

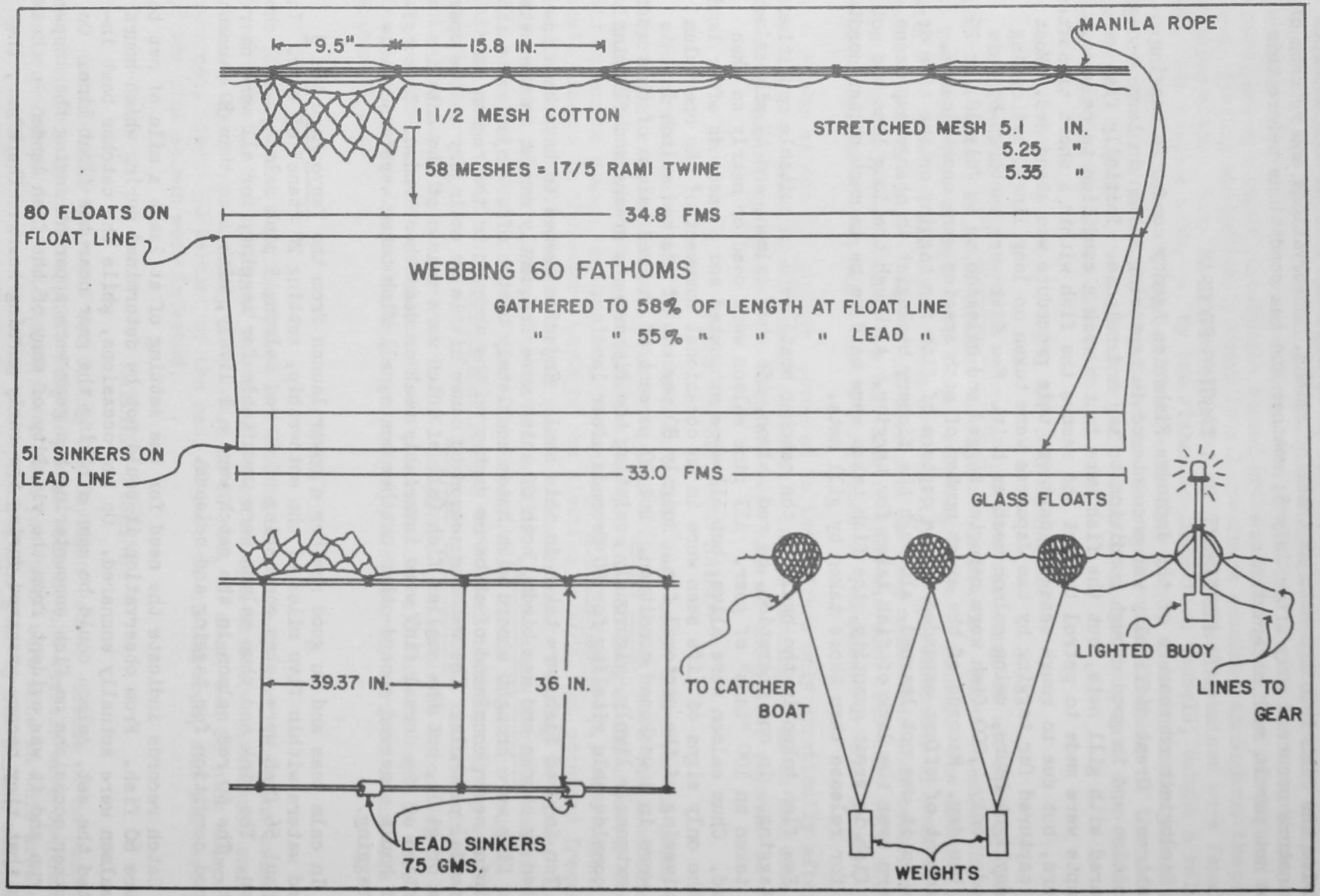

FIGURE 7 - DIAGRAM OF JAPANESE DRIFT GILL NET USED FOR SALMON FISHING. THIS TYPE OF GEAR USED EXCLUSIVELY BY THE EXPEDITION. LOWER RIGHT- "BUMPER" APPARATUS RIGGED TO KEEP SLACK ON LINES.

possibility of good results from retrieving a mile of drift net fished for short hours without inspection of the gear is questionable. But as mentioned previously, inspection of gear can become difficult during inclement weather with heavy seas, and would be further complicated by the necessity for conducting all operations during the hours of darkness.

CONCLUSIONS

The observations made on this assignment were limited by the nature of the facilities and the necessity for conducting the biological study incidentally to a commercial fishing enterprise. It would be premature to venture a firm opinion as to the origin of stocks encountered on the basis of studies for a single season. Nevertheless, several observations indicate a mixing of stocks in the vast expanse of the area fished.

Diverse degrees of gonad development were consistently observed in red and chum salmon examined in daily landings throughout the duration of the assignment. These degrees of development seem to indicate distinct stocks or age classes of salmon, rather than deviations within a common stock.

The chum salmon taken in waters south of Kiska before June 14 were relatively small and feeding heavily. The appearance of a greater percentage of large chum salmon on days when the total chum salmon catch was relatively large suggested a migrating stock of large chum salmon passing through an area in which a stock or stocks of smaller chum salmon were feeding, for the percentage of feeding individuals on these days was noticeably less and invariably the stomachs of the larger chum salmon were found to be empty or nearly so.

Red salmon constituted the largest percentage of the landings from the waters south of Kiska Island. On June 14 as the fleet approached the waters south of Agattu Island, the catch composition changed abruptly, and chum salmon predominated in the catches.

The small amount of research into the biology of the Pacific salmon in its oceanic habitat and the limited facilities with which the duties aboard the Tenyo Maru No. 3 were conducted leaves only recourse to theories. The rate of gonad development of salmon in the oceanic habitat has not been determined. Therefore, spawning in the current year by individuals possessing immature gonads is possible but improbable.

The nature of group behavior of salmon in the high seas is unknown. The presupposition that a stock of salmon maintains its identity as a group throughout the entire duration of oceanic migration might well be erroneous, for the apparently great dispersal of the salmon as evidenced by their distribution on the gear gives no marked indication of schooling. It is possible that the indication of dispersal of salmon in the high seas from observation of the pattern of the catch on the gear may be misleading, for the disturbance created by fish snared in the gear alters the distribution of the other fish.