

COMMERCIAL FISHERIES REVIEW

May 1954

Washington 25, D.C.

Vol. 16, No. 5

OFFSHORE SALMON EXPLORATIONS ADJACENT TO THE ALEUTIAN ISLANDS, JUNE-JULY 1953

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CONTENTS

	PAGE		PAGE
SUMMARY	1	DISTRIBUTION OF THE VARIOUS SPECIES OF SALMON BY	
BACKGROUND INFORMATION	3	SHACKLES	13
OBJECTIVES	4	SELECTIVITY OF THE GILL NETS	13
GENERAL PLAN	4	DETERIORATION OF GILL NETS	13
PART I - EXPLORATORY FISHING	4	INCIDENTAL CATCHES	15
DESCRIPTION OF GEAR AND FISHING METHODS	4	WEATHER	15
GILL NETS	4	PART II - BIOLOGICAL OBSERVATIONS	18
LONG LINE	6	COLLECTION OF BIOLOGICAL DATA	18
FLOATING TRAP	7	OBSERVATIONS DURING GEAR HAULING	18
TROLLING GEAR	9	MEASURING OF SPECIMENS	18
FISHING RESULTS	11	STREAM INSPECTIONS	19
PACIFIC OCEAN SIDE OF ALEUTIAN CHAIN	11	RESULTS	19
BERING SEA SIDE OF ALEUTIAN CHAIN	12	VITALITY OF VARIOUS SPECIES	19
RELATED OBSERVATIONS	13	ENMESHMENT OF VARIOUS SPECIES	20
DEPTH AT WHICH THE VARIOUS SPECIES BECAME ENMESHED	13	MORPHOMETRIC MEASUREMENTS	20
		STREAM INSPECTIONS	20

SUMMARY

The U. S. Fish and Wildlife Service's exploratory fishing vessel John N. Cobb was assigned in 1953 to salmon-fishing explorations in the offshore waters adjacent to the Aleutian Islands, Alaska. Actual fishing operations were carried on between June 9 and July 28. From June 9 to July 17 the vessel fished on the Pacific Ocean side of the Aleutians, from Unalaska Island to near Agattu Island at distances ranging from 15 to 60 miles offshore. From July 17 to July 28 it fished on the Bering Sea side from Umnak Island to Kiska Island at distances ranging from 3 to 45 miles offshore.

Gill nets, a floating long line, a nonstationary floating trap, and trolling gear were fished; except for one salmon taken on the long line, all were taken by the gill nets. None was taken by the trolling gear or the trap. A total of 1,175 salmon was caught in offshore waters during this exploration.

In the Pacific Ocean fishing, 679 salmon were taken in 17 gill-net sets, and only 1 salmon was taken in 4 long-line sets. This catch consisted of 32 percent red, 3 percent silver, 26 percent pink, and 39 percent chum. Catches ranged from 0 to 18 and averaged 6.4 salmon per 100-fathom shackle. Based on random samples weighed at sea under adverse conditions, the average weights of these salmon were as follows: red 5.1 pounds, silver 5.6 pounds, pink 3.6 pounds, and chum 4.9 pounds.

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Fig. 1 - Aleutian Islands area showing fishing locations.

In the Bering Sea fishing, 495 salmon were taken in 8 gill-net sets. This catch consisted of 2 percent red, 1 percent silver, 3 percent pink, and 94 percent chum. Catches ranged from less than 1 to 28 and averaged 11.2 salmon per 100-fathom shackle. Based on random samples weighed at sea under adverse conditions, the average weights of these salmon were as follows: red 4.1 pounds, silver 6.2 pounds, pink 4.3 pounds, and chum 4.9 pounds.

Although salmon were observed enmeshed from near the top to the bottom of the net, most of them were enmeshed in the upper portion. (The gill nets were 75 meshes deep, $5\frac{1}{4}$ -inch mesh, stretched measure.) No evidence was found that the net tended to fish better in certain parts of its length. Red and pink salmon tended to be spaced individually or in pairs at irregular intervals along the length of the net. Chum salmon tended to occur in groups of up to 8 fish along the net. Insufficient silver salmon were caught by the net to warrant conclusions.

The sea conditions caused the gill nets to deteriorate rapidly. Of 19 shackles on board the vessel at the start of the trip, 10 were lost at sea and only $5\frac{1}{2}$ were in serviceable condition at the end of the trip.

Weather conditions seriously curtailed fishing operations during June. During July the weather improved and interruptions to fishing activities were infrequent.

The results of the exploration show that salmon were present over a large area. However, the number of fish taken in individual gill-net sets was small. No attempt was made by the vessel to stay in areas of best fishing, and no conclusions can therefore be drawn as to what the total catch might have been if the vessel had operated only in such areas.

Most of the red, pink, and chum salmon were enmeshed at the nape or the back. Most silver salmon were enmeshed at the head--including gills.

As the net came aboard, the number of dead and live fish was recorded by species. An attempt was made to judge which of the live fish were suitable for tagging. Of the 1,140 fish observed, 875 were dead or nearly dead, and of the live fish, 136 were judged to be taggable and 63 to be possibly taggable and no judgment was made concerning 66 of them. Red salmon appeared to exhibit the most vitality.

Measurements and scale samples were obtained from 1,172 specimens. Fork lengths were obtained from 1,107 salmon. Of these, 179 were red salmon, 706 chum salmon, 197 pink salmon, and 25 silver salmon. The mean length of each species was 564.6 mm., 559.4 mm., 497.9 mm., and 574.7 mm., respectively.

Streams were inspected for salmon in four areas on Unalaska Island and one area on Adak Island. Salmon fry were collected at these localities; however, at the time streams were inspected adult salmon were observed in only one stream. Three male and 2 female chum salmon and 1 male pink salmon were taken in the Chernofski Bay Lagoon stream.

BACKGROUND INFORMATION

The U. S. Fish and Wildlife Service's exploratory fishing vessel John N. Cobb was assigned in 1953 to salmon-fishing explorations in the offshore waters adjacent to the Aleutian Islands, Alaska. The work was part of the preliminary salmon research by the Service in connection with the International Convention for the High Seas Fisheries of the North Pacific Ocean. Actual fishing operations were carried out between June 9 and July 28. The explorations were conducted jointly by personnel and facilities of the Service's Branches of Commercial Fisheries and Fishery Biology. A biologist from the Fisheries Research Institute at the University of Washington also accompanied the vessel.

This report is divided into two parts: Part I pertains to exploratory fishing and Part II to biological aspects of the explorations.

OBJECTIVES

The objectives of the explorations were as follows:

1. to gain as much knowledge as possible regarding the distribution, abundance, life history, and racial composition of North Pacific and Bering Sea salmon in off-shore waters;
2. to test and evaluate the effectiveness of various types of gear for catching salmon on the high seas;
3. to determine the most practical and efficient method of catching salmon in the open sea in suitable condition for tagging;
4. to collect as many specimens as possible for detailed biological studies of sex ratios, stomach analyses, length frequencies, and other morphological and physiological characters; and
5. to inspect, as time permitted, accessible streams in the Aleutian Islands for salmon fingerlings and/or adults.

GENERAL PLAN

The general plan was to fish in the approximate area of four predesignated stations on the Pacific side of the Aleutian Chain starting approximately June 1, and after each station had been occupied at two different time intervals, to fish on the Bering Sea side of the Islands. The four stations on the Pacific side were located at intervals between Unalaska Island and Kiska Island, at distances of approximately 40 to 50 miles offshore. Their positions, from east to west, were (A) 52°30' N. 168°00' W., (B) 51°30' N. 172°40' W., (C) 51°00' N. 177°20' W., and (D) 51°00' N. 178°00' E. (fig. 1).

Part I - Exploratory Fishing

DESCRIPTION OF GEAR AND FISHING METHODS

Gill nets, floating long line, a nonstationary floating trap, and trolling gear were fished. Except for one salmon caught on the long line, all were taken by the gill nets. None were taken by the trolling gear or the trap.

GILL NETS: The gill nets (fig. 2) were made up in 100-fathom shackles. The netting was 6-thread linen, $5\frac{1}{4}$ -inch mesh (stretched measure), 75 meshes deep. The cork line was cotton rope, $7/16$ -inch in diameter, 100 fathoms long. The lead line was cotton rope, $\frac{1}{4}$ -inch in diameter, 105 fathoms long. Breast lines were 54-thread soft-laid cotton twine. Hanging twine was soft-laid cotton, 40 thread on the cork line, and 32 thread on the lead line. Floats were cedar gill-net floats, $3\frac{1}{2}$ x 6 inches, spaced every fourth hanging. Leads were 2 ounces spaced on 10-inch centers. The net was hung 2 meshes to the hanging on the cork and lead lines. It was hung-in 50 percent on the cork line and 47.5 percent on the lead line. Before the net was hung, the netting and twine were treated with a brownish-green preservative; all lines were tanned and run; and the floats were dipped twice in a water-repellent preservative.

Nineteen shackles of gill net were onboard the vessel at the start of the trip. Because of losses and wear, only $5\frac{1}{2}$ shackles of serviceable gear remained at the completion of the trip.

For the first two gill-net sets, 5 shackles were tied together and fished as a string, which measured one-half nautical mile in length. The string was then in-

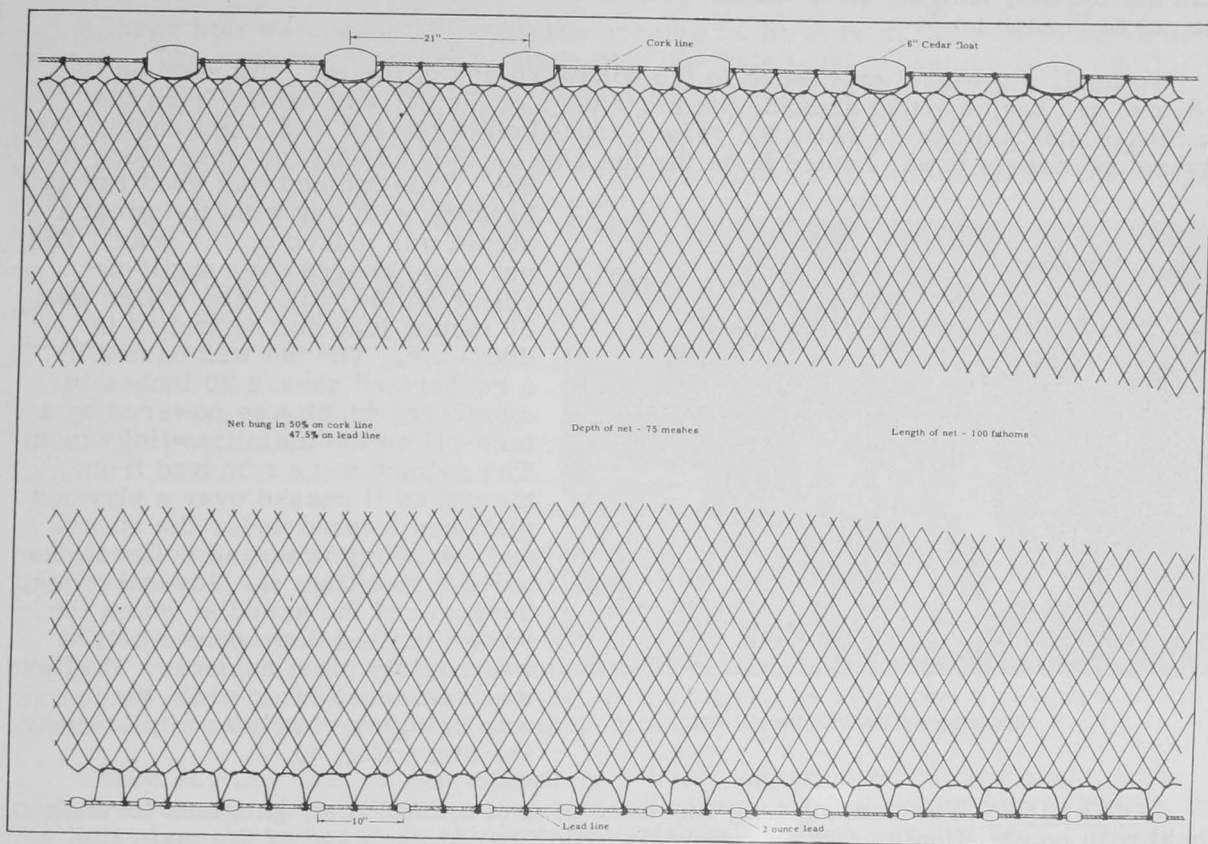


Fig. 2 - Detailed sketch of a gill-net section.

creased for subsequent sets to 10 shackles, which measured one nautical mile in length. After the 10-shackle string was lost in adverse weather, a new string of 5 shackles was fished. Eight sets with these nets left them in poor condition. As much usable gear as possible was salvaged from the worn gear, which combined with the remaining 4 new shackles provided a string of 5½ shackles. The 5½-shackle string was fished for the remainder of the trip.

All sets were made in the evening, usually just before dark. A manila line, 10 fathoms long, with two fabric floats bent on its free end, was attached to one end of the net by means of a bridle. In setting, this end of the net was started out, and as the vessel moved slowly ahead, the rest of the net was allowed to pay out over the stern. A lighted bamboo flagpole and buoy was attached to the other end of the net,

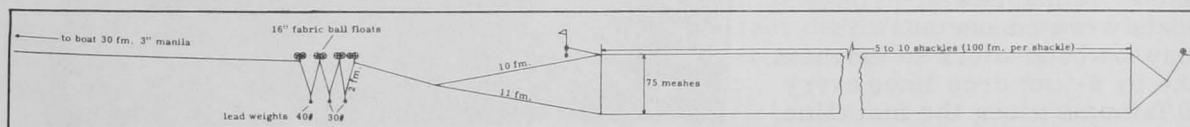


Fig. 3 - Sketch of gill net and "bumper" assembly.

and a bridle from the cork line and lead line was attached to a 3-inch circumference manila line. This manila line was rigged with 16-inch inflated fabric floats and 30- and 40-pound lead weights to act as a "bumper" in order to keep the strain off the net (fig. 3). The line was then made fast to the stern of the John N. Cobb. The net was set with the wind, and was held fast to the John N. Cobb at the downwind end. The net was

attached to the vessel instead of being allowed to drift free, in order to keep it from being lost in fog and heavy weather. Since the vessel tended to drift at a faster rate than did the net, hanging on to the net prevented, to a great extent, the tendency of the net to "bunch up."

To haul, the vessel proceeded to the windward end of the net. As soon as the free end had been brought aboard, the remainder of the net was hauled from the starboard side amidships while the vessel drifted down the net at a right angle. On several occasions it was hauled from the lee side as the vessel proceeded along the



Fig. 4 - Removing salmon from the gill net.

net. This method was used rarely because with any wind too great a strain was placed on the gear. The net came aboard over a gill-net roller on the rail. The roller was 28 inches long and 6½ inches in diameter. The net was hauled by a rubberized sheave 20 inches in diameter, which was powered by a take-off on the main trawling winch. The salmon were removed from the net as it passed over a plywood platform located under the sheave and extending from the roller to the hatch cover (fig. 4). Several times, because of the speed at which the vessel drifted down on the net, it was rapidly piled on deck. The fish were removed later while the net was being overhauled and piled near the stern (fig. 5).

LONG LINE: The floating long line consisted of a main line, gangions (branch lines) with hooks, floats, and a bamboo flagpole float at each end of the main line (fig. 6). The main line was of preformed stainless steel wire

5/64-inch in diameter. It was made of five 200-fathom sections of wire, connected together by bronze trolling swivels, to make an over-all length of 1,000 fathoms. Every 3 fathoms, 2 bronze marking beads were swaged on the main line 4 to 6 inches apart to serve as line stoppers for the gangions. The main line was floated by means of inflated 16-inch diameter fabric floats. These floats were connected with snap-on connectors to the main line by 6-foot drop lines every 30 fathoms along the main line. The gangions, which were made of wire or nylon, had a snap-on connector with a swivel at one end and a hook at the other end. The wire gangions were made of preformed stainless steel, 3/64-inch in diameter and 6 feet in length. The nylon gangions were made of 15- or 20-pound test monofilament and were 5 feet in length. Assorted ringed hooks were affixed to the gangions--size 7/0 to 10/0 on the wire gangions and 4/0 or 5/0 on the nylon gangions.



Fig. 5 - Piling the gill net on the stern.

The main line was spooled on a 19.5-inch diameter galvanized reel having a core 10.7 inches in diameter and 3.5 inches in width.

A large bolt was passed through the opening in the core of the reel to serve as an axle. The reel was then set in place near the hatch and braked by hand. A flagpole buoy was attached to the main line and thrown overboard. While the vessel moved slowly ahead, the main line payed out into the water over a halibut chute on the stern. Men stationed on each side of the main line, just forward of the chute, snapped on gangions baited with either herring or pieces of salmon as the line stops passed by. When the main line was completely out, a second flagpole was dropped overboard, and the gear was allowed to drift freely for the desired amount of time.

Before the gear was hauled, the reel was attached to the power take-off on the winch. One end of the main line was brought in over the gill-net roller on the star-

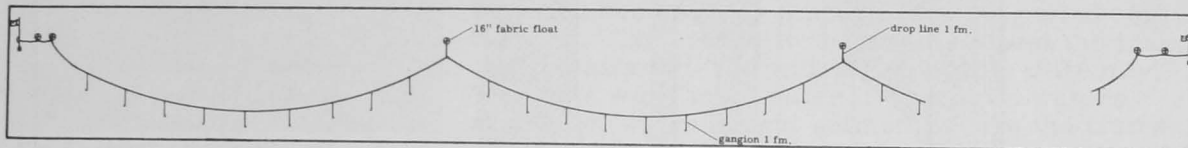


Fig. 6 - Sketch of floating long line.

board rail and secured to the reel, whereupon hauling was commenced. As the main line was reeled in, the gangions were unsnapped as they reached the roller.

No difficulty was encountered in hauling, and few snarls were encountered when the gear was set in the manner described. The main line was fairly slack in the water and some of the buoys drifted together as much as 30 percent at times. It is estimated that the gear fished from approximately 2 to 12 fathoms deep.

Three daytime sets of approximately 5-hour duration each were made, with negative results. One silver salmon was taken on a wire gangion and a 7/0 hook during the only nighttime set. In this set, the gill net and long line had been attached together, and the long line was secured to the boat. Since the gill net captured 24 salmon, it is certain that salmon were present in the area the long line was fishing. In this set many gangions became snarled, especially the nylon gangions. It is likely the snarling occurred because in this instance the long line had not been allowed to drift freely.

FLOATING TRAP: The floating trap consisted of a wooden frame, a heart, a spiller, and a lead of netting (fig. 7). Attached to the wooden frame was a framework made of pipe for a small jigger on each side. The heart and the spiller areas were connected by a tunnel of netting. The wooden frame was made of 6-inch by 12-inch spruce timbers and was 16 feet wide and 32 feet long. Each jigger frame was made of 3/4-inch pipe; it extended outward in triangular shape from each side near the heart entrance.

All netting used in the trap was 12-thread cotton netting, 3-inch mesh, stretched measure. The heart and the spiller walls were 30-feet deep, and were lashed to the frames. The heart and the spiller had bottoms cut to the required dimensions established by the frame.

To maintain the rigidity of the walls, lead weights of from 10 to 40 pounds were used. These weights were suspended from manila line that was in turn threaded through seine rings that were attached to breast lines at various places on the trap walls. Lighter weights were used at the jigger and the heart entrances; heavier weights elsewhere.

To keep the tunnel properly set, 2 wooden poles, each 20 feet long, were threaded through seine rings at each side of the spiller entrance. These poles were spread

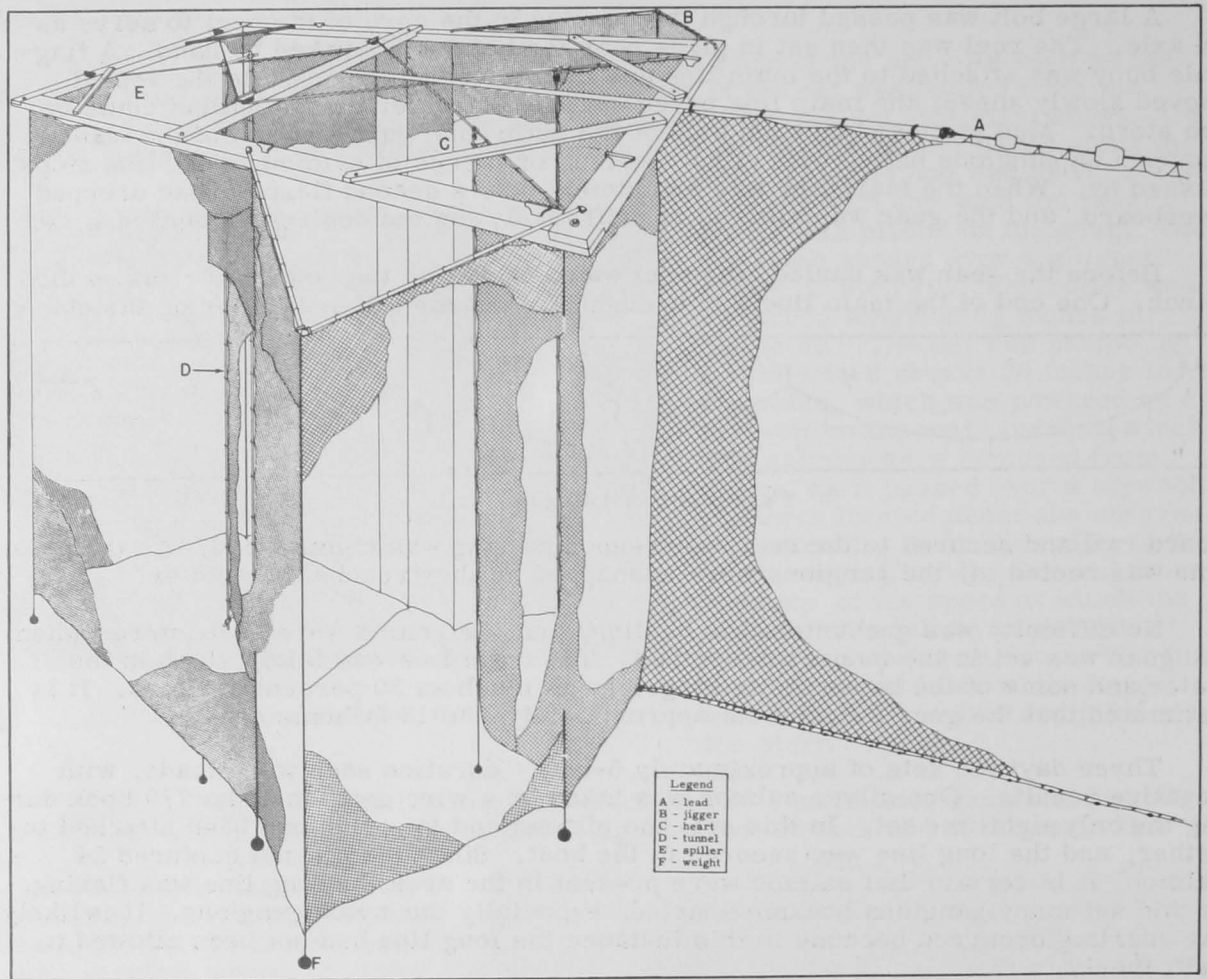


Fig. 7 - Sketch of floating trap.

15 inches apart at the bottom of the tunnel by means of a short spreader stick secured to them horizontally and lashed with seine leads. The poles were spread 15 inches apart at the top by means of lines running from them to the trap frame.

The lead for the trap was made of $3\frac{1}{2}$ -inch mesh (stretched-measure) cotton webbing, 150 meshes deep. Its total length was 500 fathoms, and it was made up in 125-fathom shackles. The cork line was hung-in 25 percent, and the lead line was hung-in 21 percent. The trap lead was hung 3 meshes to each hanging on the cork and lead lines. The cork line was 18-thread manila and the lead line was 15-thread manila. Hanging lines were 24-thread medium cotton-seine twine. Cedar gill-net floats $3\frac{1}{2}$ by 6 inches were spaced 3 per fathom on the cork line as were 4-ounce seine leads on the lead line. The breast lines were 9-thread manila rope. The various lines were tanned and run before being made up into the trap lead. The web of the trap and trap lead were both green in color from the preservative used.

The lower part of one end of the lead was attached to the trap at the bottom of the heart entrance, and the upper part was lashed to a pole that extended 12 feet past the heart-end timber of the trap.

Because of adverse weather conditions, the large fishing area to be explored in limited time, and the large size and complicated nature of the trap, it was set in offshore waters only once and for a short time. The trap frame was completely assembled ashore on a dock, and the web was secured to the frame. The trap was then hoisted aboard the vessel, which proceeded to sea. When the vessel reached the testing location, the trap was hoisted over the side. The lead was passed to men in the motor launch, who made it fast to the trap. As the men were lowering the lead weights and poles, the lead was payed out from the stern of the vessel. There was no wind when the trap was set, and it was necessary to straighten out the free end of the lead with the motor launch. After the trap had been set for 5 hours, a strong wind commenced. This made it necessary to haul the trap, and it was retrieved with considerable difficulty. Two sets were made later in protected waters, neither of which caught salmon. Since the trap was set for an insufficient length of time, the tests of the trap are considered inconclusive.

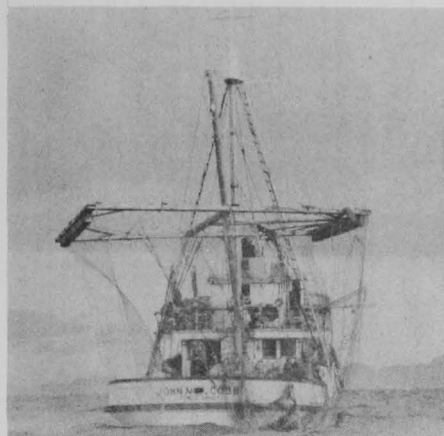


Fig. 8 - Hoisting the floating trap aboard the John N. Cobb.

TROLLING GEAR: The trolling poles were of fir, 40 feet long, mounted on the bulwarks just aft of the main house. One side of the vessel was equipped with hydraulic gurdies and was rigged with wire trolling gear. The other side was rigged for hand trolling with cotton line. Two main lines were fished from each pole; the main lines connected to tag lines made of $\frac{1}{4}$ -inch diameter wire of sufficient length to extend from the poles to the after deck; and tag lines connected to spring shock absorbers which were secured to the poles.

The wire main line was 1/16-inch stainless steel and had paired line stops spaced every five fathoms of its length to permit snap-on attachment of individual leaders. On the outer line a 20-pound and on the inner line a 30-pound "cannonball" lead was used. Five individual leaders were fished from each main line. Standard leaders consisted of a snap-on connector, a 14-inch trolling rubber, a swivel, a 3- to 4-fathom length of 60-pound cuttyhunk, a swivel, 3 to 4 feet of No. 12 stainless steel wire, and a lure with hook. Artificial lures (assorted types and sizes of spoons and plugs) and bait (whole herring or strips of salmon) were used. Leader variations were also tried; these were 10- to 20-pound test monofilament nylon in lieu of No. 12 wire, and braided nylon without cuttyhunk.

In the case of the hand gear, an inhaul line was connected to a swivel and spreader bar at the end of the tag line. The main line for the hand gear was made up as follows: 60 to 70 feet of No. 96 hard-laid cotton halibut line ran to a spreader bar, a swivel, and a 5-pound trolling lead. Tied to the ring at the bottom of the lead was 4 fathoms of 300-pound-test nylon line, which ran to a spreader bar, a swivel, and a 10-pound trolling lead. In the same manner, 4 fathoms of additional line ran to the final 10-pound lead; however, there was no spreader bar. Leaders were the same as for the wire gear but were without snap-on connectors. The first two were secured to the spreader bars, and the third to the ring at the bottom of the last lead. Three leaders were fished on each main line.

Trolling was carried on at depths ranging from near the surface to more than 200 feet. Occasionally fishing near the surface was tried with rods and light tackle. The time spent trolling was limited by the great amount of time required to run full speed between stations and by unfavorable weather conditions.

Table 1--Gill-Net Catch Data, 1953

Set No.	Date	Position of set	Station	No. hours net soaked	No. 100-fathom shackles	Number of salmon caught				Total Salmon	Wind direction and force ^{1/}	Surface temperature	Incidental catch
						Red	Silver	Pink	Chum				
1	6/9 - 6/10	51°17' N. 177°09' W.	C	11½	5	42	0	4	14	60	SE-2-E-5	42.6° F.	--
2	6/10 - 6/11	51°03' N. 177°10' W.	C	10	5	25	0	5	9	39	SW-5-E-6	43.0° F.	--
3	6/13 - 6/14	51°17' N. 178°25' W.	C	11	10	41	0	15	21	77	W-3-NW-3	42.5° F.	--
4	6/14 - 6/15	50°41' N. 179°33' E.	D	9½	10	41	0	12	45	98	WSW-4-WSW-6	42.2° F.	--
5	6/20 - 6/21	51°33' N. 174°52' W.	B	11½	10	23	0	41	114	178	SE-3-S-3	44.5° F.	--
6	6/21 - 6/22	51°21' N. 173°11' W.	B	10	10	11	0	36	39	86	SSE-3-SE-4	45.0° F.	1 mackerel shark, 1 greenling
7	6/22 -	51°14' N. 171°31' W.	B	Net lost	10	--	--	--	--	--	SE-5-7	44.0° F.	--
8	6/27 - 6/28	51°17' N. 171°47' W.	B	9½	5	0	0	0	0	0	SE-3-2	46.0° F.	--
9	6/28 - 6/29	51°58' N. 169°30' W.	A	9½	5	2	0	0	1	3	E-2-5	47.5° F.	--
10	7/6 - 7/7	52°48' N. 167°27.5' W.	A	10½	5	3	1	0	6	10	SW-3-4	52.2° F.	1 handsaw fish escaped
11	7/7 - 7/8	51°39' N. 169°31' W.	A	10	5	1	0	2	1	4	N-2-NW-3	50.0° F.	1 steelhead
12	7/8 - 7/9	51°34' N. 172°47' W.	B	10½	5	2	0	2	0	4	SW-2-NW-3	48.0° F.	1 mackerel shark, 1 rockfish
13	7/9 - 7/10	51°34' N. 174°59' W.	B	10½	5	1	0	3	1	5	E-2-3	49.0° F.	1 mackerel shark
14	7/11 - 7/12	51°19' N. 177°13' W.	C	10	5	4	2	3	1	10	NE-3	50.0° F.	1 mackerel shark escaped
15	7/12 - 7/13	50°28' N. 179°44' W.	D	10	5	1	5	33	2	41	N-5-6	46.8° F.	1 steelhead, 1 mackerel shark
16	7/14 - 7/15	50°26' N. 178°06' E.	D	10	5½	1	2	13	1	17	SW-4	46.8° F.	--
17	7/15 - 7/16	51°20' N. 176°36' E.	D	13½	5½	9	6	8	1	24	O-Var.-2	48.5° F.	--
18	7/16 - 7/17	51°27' N. 174°39' E.	D	10	5½	7	6	3	7	23	NW-3-WNW-3	48.2° F.	--
19	7/17 - 7/18	52°19' N. 177°08' E.	-	12½	5½	2	2	2	54	60	WSW-2	48.7° F.	--
20	7/18 - 7/19	51°49' N. 178°43' E.	-	10½	5½	2	0	4	2	8	SW-3-S-2	41.9° F.	--
21	7/19 - 7/20	51°37' N. 179°47' E.	-	9½	5½	0	0	0	2	2	S-3-SSE-4	43.0° F.	--
22	7/21 - 7/22	52°00' N. 178°16' W.	-	10½	5½	0	2	0	77	79	S-5-SW-2	42.3° F.	--
23	7/24 - 7/25	52°06' N. 176°36.5' W.	-	11	5½	3	1	4	148	156	WSW-4	43.0° F.	--
24	7/25 - 7/26	52°29' N. 174°05' W.	-	11½	5½	0	0	2	146	148	W-4-E-3-W-4	48.9° F.	--
25	7/26 - 7/27	53°17' N. 171°34' W.	-	11½	5½	1	1	4	33	39	W-4-WSW-2	49.9° F.	--
26	7/27 - 7/28	53°33' N. 167°51' W.	-	9	5½	2	0	0	1	3	Var.-1-0	44.5° F.	--

^{1/}Wind force is according to Beaufort scale.

Table 2--Long-Line Catch Data, 1953

Set No.	Date	Position	No. hooks	Bait	Time soaked	No. salmon	Wind direction and force ^{1/}	Surface temperature	Incidental catch
1	6/13	51°11' N. 178°20' W.	257	Herring, 184 whole, 30 cut; salmon, 43 pieces	4 hrs. 45 min.	0	SW-4-W-4	42.5° F.	1 Alaska pollock
2	6/14	50°41' N. 179°33' E.	264	Herring, 179 whole, 40 cut; salmon, 45 pieces	5 hrs. 20 min.	0	NW-3-WSW-4	42.3° F.	1 mackerel shark, 2 Alaska pollock
3	6/21	51°21' N. 173°11' W.	265	Herring, 220 whole; salmon, 45 pieces	4 hrs. 55 min.	0	S-3-SSE-3	45.5° F.	---
4	7/15 - 7/16	51°20' N. 176°36' E.	262	Herring, 81 whole, 131 cut; salmon, 50 pieces	11 hrs. 25 min.	1	O-Var.-2	48.5° F.	2 handsaw fish

^{1/}Wind force is according to Beaufort scale.

FISHING RESULTS

Fishing operations were carried on from June 9 to July 17 on the Pacific Ocean side of the Aleutian Chain and from July 17 to July 28 on the Bering Sea side (tables 1 and 2). A total of 1,175 salmon^{1/} were caught during this exploration.

With only one boat, each area could not be simultaneously sampled, and results varied from area to area and within areas at different time intervals. It is possible that if the four stations could be fished at the same time, results would be different from those obtained by the John N. Cobb--both as to total catch and number of each species making up the catch.

PACIFIC OCEAN SIDE OF ALEUTIAN CHAIN: The vessel fished from Unalaska Island to near Agattu Island at distances ranging from 15 to 60 miles offshore.

A total of 679 salmon was taken in 17 gill-net sets, ^{2/} and only 1 salmon was taken in 4 long-line sets. This catch consisted of 32 percent red (Oncorhynchus nerka), 3 percent silver (Oncorhynchus kisutch), 26 percent pink (Oncorhynchus gorbusha), and 39 percent chum (Oncorhynchus keta). Catches varied considerably in the gill-net sets, ranging from 0 to 18 and averaging 6.4 salmon per 100-fathom shackle.

The results of fishing operations in each of the four predesignated fishing stations were as follows:

Station C: Fishing operations in the approximate area of Station C commenced on June 9. Three gill-net sets between this date and the morning of June 14 averaged

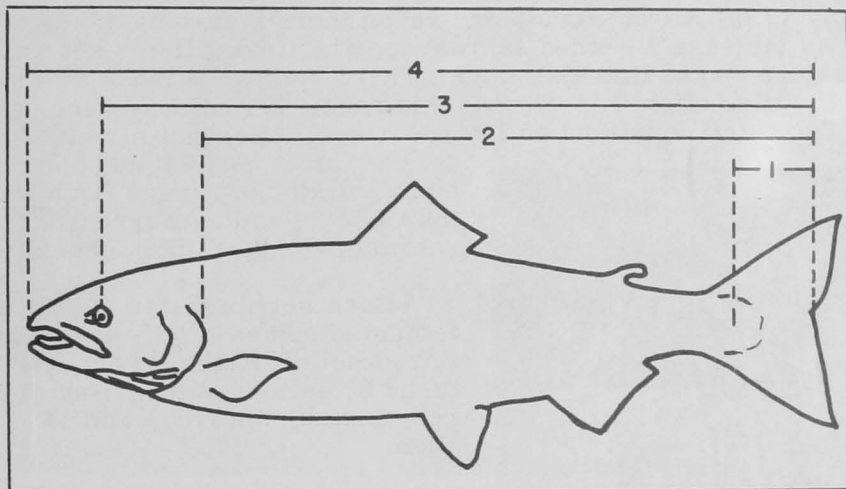


Fig. 9 - Measurements taken of salmon in the catch of the John N. Cobb, 1953. Brackets indicate measurements from fork of tail to: (1) posterior margin of hypural plate, (2) leading edge of cleithrum, (3) middle of eye, and (4) tip of snout.

8.8 salmon per 100-fathom shackle. The catch consisted of 61 percent red, 14 percent pink, and 25 percent chum. A gill-net set in this area on July 11 averaged 2 salmon per 100-fathom shackle. This catch consisted of 4 red, 2 silver, 3 pink, and 1 chum. Negative trolling results were obtained at this station as well as at all other localities where trolling was carried on during this exploration. A single long-line set on June 13 failed to catch any salmon.

Station D: A gill-net set on the night of June 14 averaged 9.8 salmon per 100-fathom shackle. This catch consisted of 42 percent red, 12 percent pink, and 46 percent chum. Four gill-net sets between July 12 and July 17 averaged 4.9 salmon per 100-fathom shackle. The catch consisted of 17 percent red, 18 percent silver, 54 percent pink, and 11 percent chum. On the night of July 15 weather conditions were ideal and 5½ 100-fathom shackles of gill net were attached to one mile of long line, allowing both types of gear to fish simultaneously. A total of 24 salmon were caught in the gill nets, and 1 salmon was caught on the long line. The latter, a silver, was the only salmon taken on the 4 long-line sets made during this exploration.

^{1/} Includes only offshore catches.

^{2/} Set number 7 is not included as the gear was lost.

Station B: One June 20 and 21, two gill-net sets were made in the general area of this station. An average of 13.2 salmon per 100-fathom shackle were taken in these two sets. The catch consisted of 13 percent red, 29 percent pink, and 58 percent chum. Ten shackles of gill net were lost on the night of June 22 when the net broke loose from the vessel in adverse weather. A set was made on the night of June 27 near where the net was lost, with negative results. This was the only gill-net set of the exploration that failed to catch any salmon. Gill-net sets were again made on July 8 and 9 and averaged only 0.9 fish per 100-fathom shackle. The total catch of these two sets was 3 red, 5 pink, and 1 chum.

Station A: Gill-net operations in the general area of this station were carried out on June 28 and again on July 6 and 7. The first set caught 2 red and 1 chum. The two sets in July yielded 4 red, 1 silver, 2 pink, and 7 chum.

Weights of random samples taken at sea under adverse conditions that precluded accurate weighing indicated that on the Pacific side red salmon averaged 5.1 pounds, silver 5.6 pounds, pink 3.6 pounds, and chum 4.9 pounds.

BERING SEA SIDE OF ALEUTIAN CHAIN: On the Bering Sea side of the Aleutian Chain, no predesignated fishing stations were selected, and it was decided to begin operations in these waters after Station D had been fished for the second time. Gill-net sets commenced on July 17 off Kiska Island, and seven more sets were made at localities along the Chain as the vessel headed eastward. The final gill-net set was made on July 27 off the eastern end of Umnak Island. These sets were made at distances ranging from 3 to 45 miles offshore. During this time, 495 salmon were taken in 8 gill-net sets. The catch consisted of 2 percent red, 1 percent silver, 3 percent pink, and 94 percent chum. Catches ranged from less than 1 to 28 and averaged 11.2 salmon per 100-fathom shackle.

Each set consisted of $5\frac{1}{2}$ 100-fathom shackles of gill net. The initial set off Kiska Island captured 60 salmon, consisting of 2 red, 2 pink, 2 silver, and 54 chum.

Two sets off Amchitka Island produced a total of only 10 salmon. As operations shifted eastward, fishing improved in the vicinity of Tanaga, Adak, and Atka Islands, and sets in these localities yielded 79, 156, and 148 salmon, respectively. Of the 383 salmon taken in these three sets, 3 were red salmon, 3 silver, 6 pink, and 371 chum. A set north of Amukta Island on July 26 caught 39 salmon, mostly chum. The final gill-net

Species of Salmon	Portion of Net where Salmon were Enmeshed		
	Upper 30 Meshes	Middle 15 Meshes	Lower 30 Meshes
 (Number)		
Red	149	25	35
Silver	19	0	4
Pink	136	13	27
Chum	480	73	114
Totals 1/.	784	111	180

1/ Of the total caught by the John N. Cobb, the depths at which 99 salmon entered the gill nets were not observed.

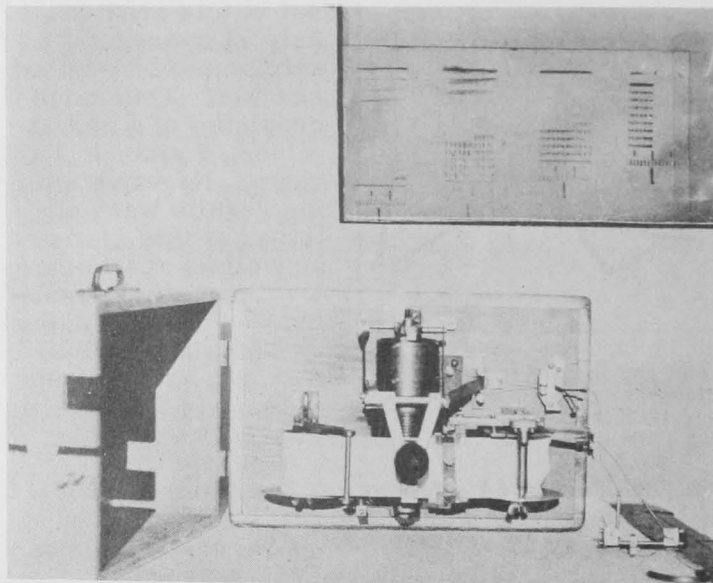


Fig. 10 - Measuring machine used to measure salmon aboard the John N. Cobb. The enlarged inset (upper right) shows the tape on which lengths were recorded.

set and the closest to land of any during the exploration caught only 2 red and 1 chum salmon.

Weights of these salmon taken at sea under adverse conditions averaged as follows: red 4.1 pounds, silver 6.2 pounds, pink 4.3 pounds, and chum 4.9 pounds.

The results of the exploration show that salmon are present over a large area. Only one gill-net set failed to take fish. However, the number of fish taken in individual gill-net sets was small. It should be remembered that no attempt was made by the John N. Cobb to stay in areas of best fishing, and no conclusions can be drawn as to what the total catch might have been if the vessel had operated only in such areas. Much more work is required to determine if United States fishing vessels could economically exploit salmon stocks in the offshore waters adjacent to the Aleutian Islands.

RELATED OBSERVATIONS

Various observations were made as the net came aboard: the depth at which the various species entered the net (table 3), the place on the body at which they became enmeshed, their vitality, and their number per shackle. These observations were verified as the individual salmon were removed from the net. Data concerning the place on the body at which salmon became enmeshed and their vitality are presented in Part II.

DEPTH AT WHICH THE VARIOUS SPECIES BECAME ENMESHED: Although salmon were observed enmeshed from near the top to the bottom of the net, most of them were enmeshed in the upper portion. The observations indicated that a net of less depth would be practical, but comparative tests with nets of various depths should be made before definite conclusions are drawn as to the most suitable depth.



Fig. 11 - Measuring salmon aboard the John N. Cobb.

DISTRIBUTION OF THE VARIOUS SPECIES OF SALMON BY SHACKLES: A record was kept of the catch by species for each shackle of the gill net for all sets. No evidence was found that the net tended to fish better in certain parts of its length.

Red and pink salmon tended to be spaced individually or in pairs at irregular intervals along the length of the net. Chum salmon tended to occur in groups of up to 8 fish along the net. Insufficient silver salmon were caught by the net to warrant any conclusions.

SELECTIVITY OF THE GILL NETS: As the gill nets used were of only one mesh size, $5\frac{1}{4}$ -inch (stretched measure), the catches by these nets were probably selective. Experimental fishing with nets of various mesh sizes is required to establish the proper sizes to adequately sample the salmon population in these areas.

DETERIORATION OF GILL NETS: The sea conditions during these explorations caused the gill nets to deteriorate rapidly. As the cork line worked in the sea, the hanging line quickly frayed the meshes. After a maximum of 4 sets the top row of

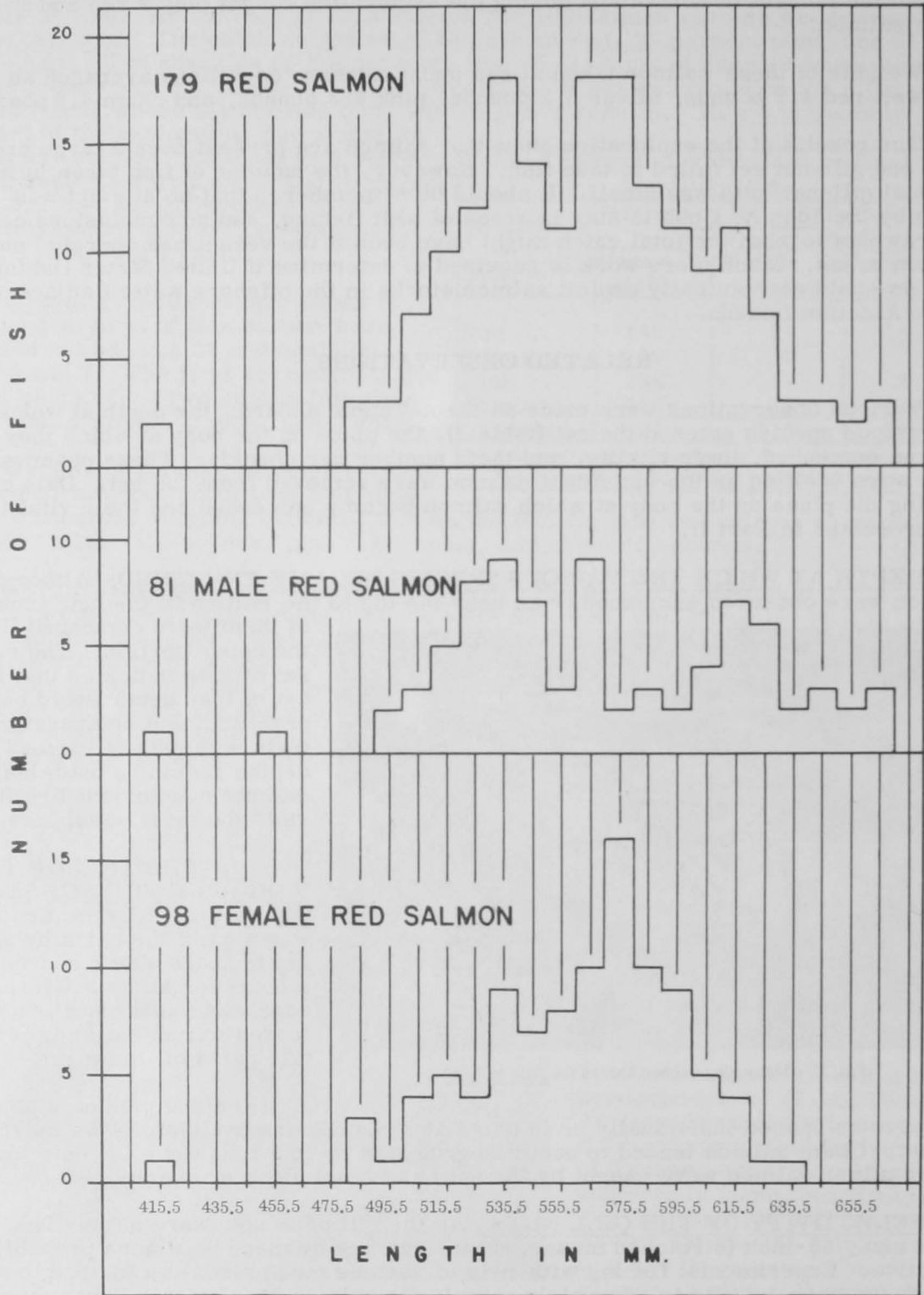


Fig. 12 - Red salmon length frequencies.

meshes had parted at close intervals along the hanging line. This damage was hastened by the strain placed on the nets as they were being hauled. Corks frequently hung up on the roller, and as the vessel rolled in the sea, meshes were ripped loose from the hanging line. To help eliminate this difficulty, the use of a "double"

Table 4 - Vitality of Various Species of Gill-Net Caught Salmon

Species	Total Catch ^{1/} Number	Observed ^{1/} Number	Dead or Nearly Dead Number	Taggable Number	Possibly Taggable Number
Red	224	217	124	68	25
Silver	28	27	24	1	2
Pink	196	188	158	2/11	2/ 7
Chum	726	708	569	56	2/29
Totals	1174	1140	875	136	63

^{1/}Errors in observation account for the difference between the total catch and the observed catch figures.

^{2/}In addition to these, 11 taggable and 7 possibly taggable pink salmon, some or all of 12 other live pink salmon might have been so classified. In addition to these, 56 taggable and 29 possibly taggable chum salmon, 54 other live chum salmon might have been so classified. Owing to difficulties encountered at the time of their capture, observations were not made as to whether these other live pink and chum salmon were taggable. No data could therefore be entered for them here.

cork line should be tried in the future. This "double" cork line would be formed by running a heavy line along the actual cork line and lashing the two together at frequent intervals. In hauling, the strain would be borne by both lines instead of the cork line alone. It is possible that this method would lessen the tendency of the meshes of the net to rip loose from the hanging line.

Fraying of meshes by action of the sea might be alleviated by removing the corks from the cork line and attaching them to it by drop lines a foot long. The net

would then be slightly beneath the surface while fishing and therefore subject to less fraying action.

Table 5 - Place on Body at which Various Species of Salmon Became Enmeshed in Gill Nets

Species	Head Includ- ing Gills	Nape	Back	Loose
.....(Number of Fish)				
Red	52	91	60	4
Silver	18	7	2	None noted
Pink	6	41	139	None noted
Chum	191	276	225	None noted
Totals ^{1/}	267	415	426	4

^{1/}Of the total caught by the John N. Cobb, 62 salmon were not observed as to place of enmeshment and are not included in this table.

In an attempt to reduce wear on the net in hauling, a typical Bristol Bay hydraulic gill-net roller was tried. Although the roller operated properly, it proved unsatisfactory;

the large size of the John N. Cobb prevented adequate control of its angle with the net and its rate of drift.

INCIDENTAL CATCHES: Few fish other than salmon were caught in the gill nets. Several mackerel shark (Lamna ditropis), 1 greenling (Hexagrammidae), 2 steelhead trout (Salmo gairdneri), and 1 rockfish (Sebastes melanops) were caught. One handsaw fish (Alepidosaurus aesculapius) escaped from the net. On the long line a total of 3 Alaska pollock (Theragra chalcogramma), 1 mackerel shark, and 2 handsaw fish were taken.

WEATHER: Weather conditions seriously curtailed fishing operations during June. Gale force winds occurred frequently. During July the weather improved and interruptions to fishing activities were infrequent.

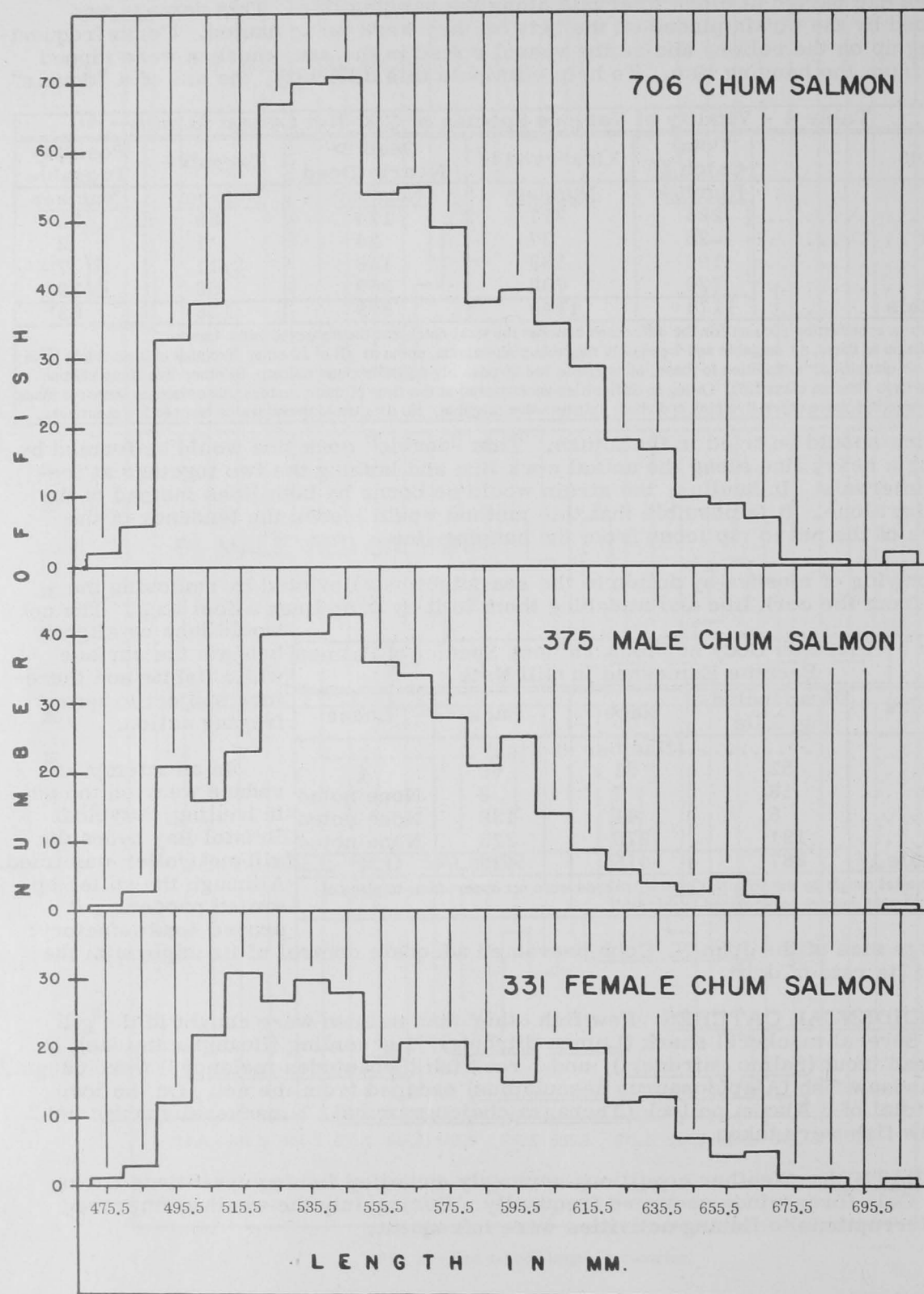


Fig. 13 - Chum salmon length frequencies.

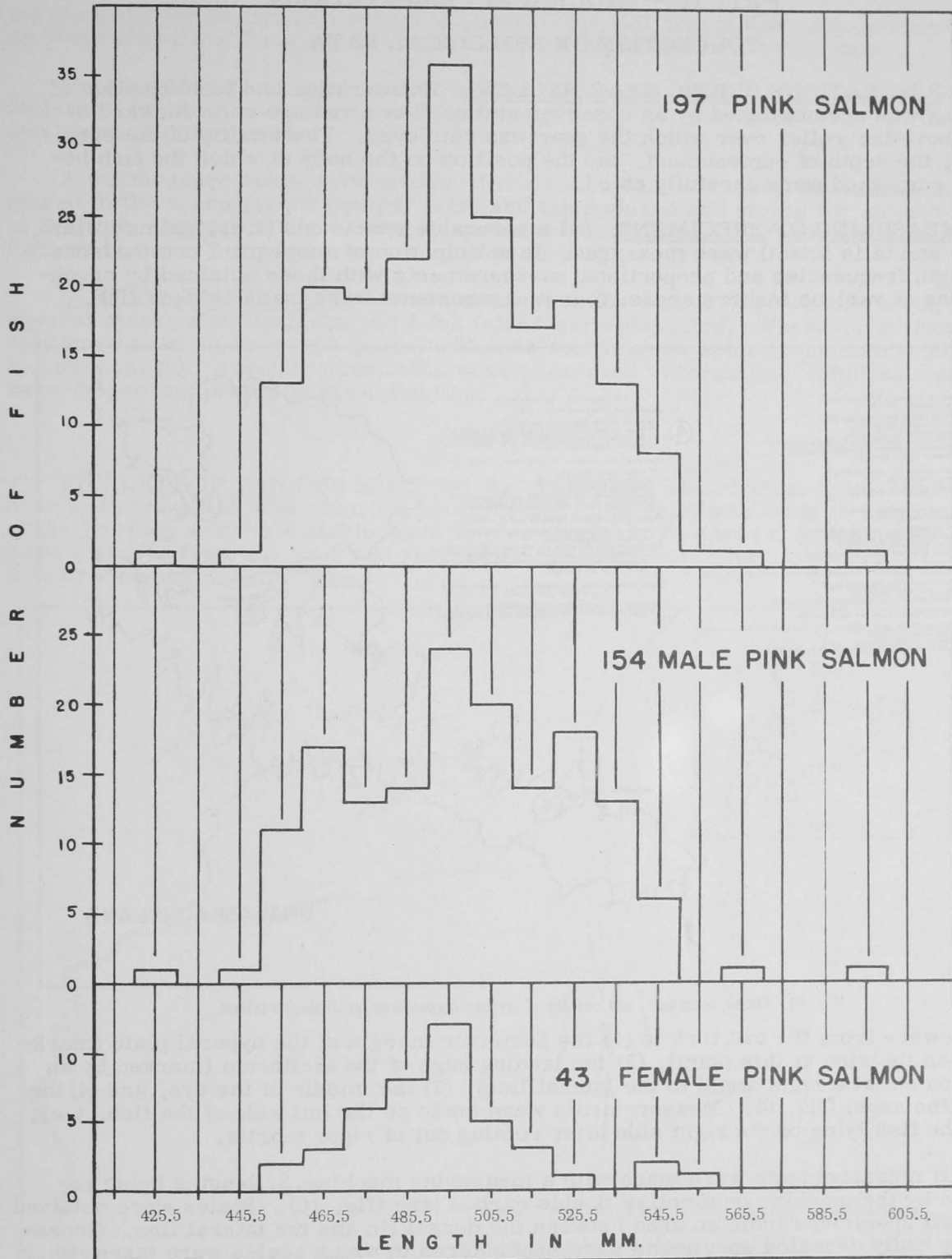


Fig. 14 - Pink salmon length frequencies.

Part II - Biological Observations

COLLECTION OF BIOLOGICAL DATA

OBSERVATIONS DURING GEAR HAULING: Enumeration and identification of species was accomplished by an observer stationed at a vantage point forward of and above the roller over which the gear was retrieved. The vitality of the specimens, the depth of enmeshment, and the position on the body at which the fish became enmeshed were carefully noted.

MEASURING OF SPECIMENS: All measurable specimens (i. e., salmon with heads and tails intact) were measured. In anticipation of subsequent comparisons of length frequencies and proportional measurements with those obtained by organizations at various inshore areas, four measurements were made on each fish.

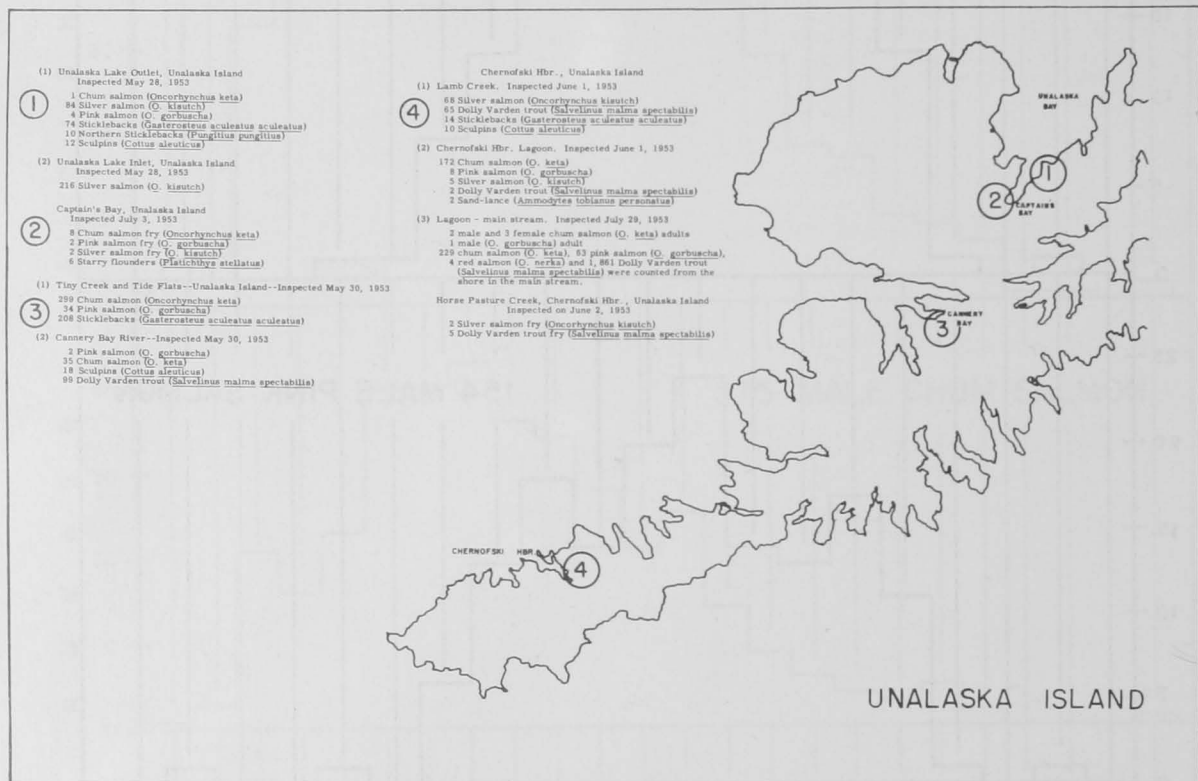


Fig. 15 - Dates, locations, and results of stream inspections on Unalaska Island.

These were from the tail fork to (1) the posterior margin of the hypural plate (marked by an incision at this point), (2) the leading edge of the cleithrum (marked by an incision cut at a right angle to the lateral line), (3) the middle of the eye, and (4) the tip of the snout (fig. 9). Measurements were made on the left side of the fish, i. e., with the fish lying on its right side after coming out of rigor mortis.

All measurements were made with a measuring machine, $\frac{3}{4}$ lengths being recorded by the machine on a roll of double carbon tape (fig. 10). Scales were obtained from all specimens from an area between the dorsal fin and the lateral line. Occasionally badly descaled specimens were encountered in which scales were taken either from an area between the lateral line and the pelvic fin or from the region between

$\frac{3}{4}$ Developed by Dr. W. F. Thompson of the Fisheries Research Institute.

the back and the lateral line behind the dorsal fin. All scales were dry-mounted on glass slides and their surface sculpture was impressed on plastic plates.

Positive identification of the sex of each fish was made by cutting a small (1- to 2-inch) incision below the lateral line just posterior to the tip of the pectoral fin, and examining the gonads.

After measurements were made and scale samples collected, the salmon were placed in the sharp-freeze compartment and later glazed and stored for shipment to Seattle. Approximately 1,035 specimens were collected. The viscera from most fish not in the collection were preserved in formalin or frozen.

STREAM INSPECTIONS: On occasions when the vessel was "weathered in," several streams on Unalaska and Adak Island were inspected. Whenever salmonoids were seen the area was seined with a 25-foot minnow seine ($\frac{1}{2}$ -inch stretched-measure mesh). Juvenile specimens were preserved in formalin. Adult salmon were frozen and placed in the collection.

RESULTS

VITALITY OF VARIOUS SPECIES: As the net was hauled aboard, the number of dead and live fish was recorded by species. An attempt was made to judge which of the live fish were in suitable condition for tagging. This was done before the fish were removed from the gear and represents the judgment of the recorder. These data are summarized in table 4.

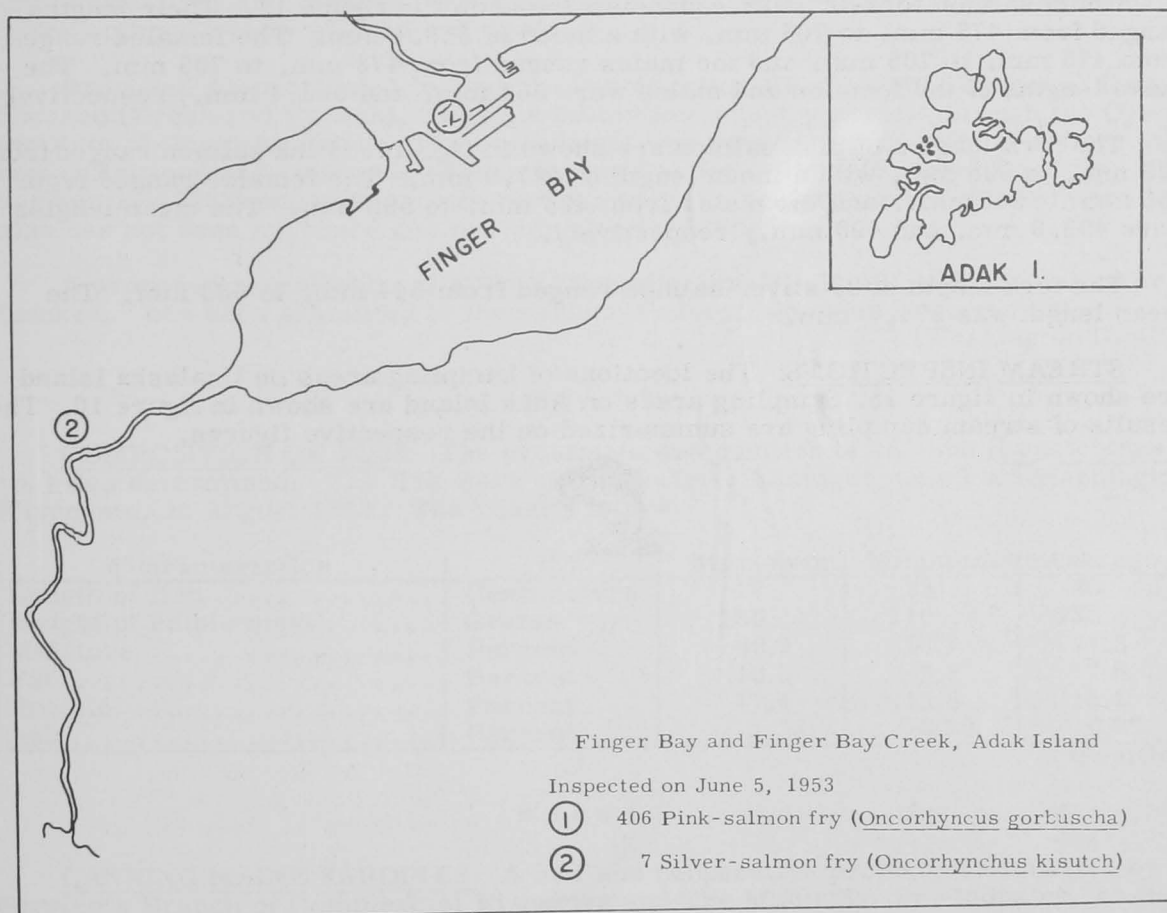


Fig. 16 - Location and results of sampling on Adak Island.

Red salmon appeared to exhibit the most vitality of the various species. Of the 1,140 fish observed, 875 were dead or nearly dead. Of the fish caught in live condition, 136 were judged to be taggable and 63 to be possibly taggable.

ENMESHMENT OF VARIOUS SPECIES: The place on the body at which salmon became enmeshed was noted for as many individuals as possible in order to determine the effect of this factor on the vitality of the salmon. However, variables such as sea conditions and the length of time the salmon were in the net also affect their vitality. Since these variables and their effect could not be evaluated the results are inconclusive. In general, most of the red, pink, and chum salmon were enmeshed at the nape or the back. Most silver salmon were enmeshed at the head (table 5).

MORPHOMETRIC MEASUREMENTS: A total of 1,172 salmon were measured from the catch of the John N. Cobb, of which 219 were red salmon, 725 chum salmon, 201 pink salmon, and 27 silver salmon. However, fork lengths could not be obtained for all specimens due to the absence of or damage to heads and tails of some specimens.

The fork-length frequency distributions of 179 red salmon are shown on the histograms in figure 12. The range in lengths was from 420 mm. to 667 mm. with a mean length of 564.6 mm. Females ranged from 420 mm. to 635 mm. with a mean length of 561 mm. and the males ranged from 420 mm. to 667 mm. with a mean length of 569 mm.

Chum salmon fork-length frequencies are shown in figure 13. Their lengths ranged from 475 mm. to 705 mm. with a mean of 559.4 mm. The females ranged from 475 mm. to 705 mm. and the males ranged from 475 mm. to 705 mm. The mean lengths of the females and males were 564 mm. and 555.4 mm., respectively.

The fork lengths of pink salmon are shown in fig. 14. Pink salmon ranged from 425 mm. to 595 mm. with a mean length of 497.9 mm. The females ranged from 455 mm. to 555 mm., and the males from 425 mm. to 595 mm. The mean lengths were 493.9 mm. and 499 mm., respectively.

The fork length of 25 silver salmon ranged from 544 mm. to 633 mm. The mean length was 574.7 mm.

STREAM INSPECTIONS: The locations of sampling areas on Unalaska Island are shown in figure 15. Sampling areas on Adak Island are shown in figure 16. The results of stream sampling are summarized on the respective figures.

