

DFO - Library / MPO - Bibliothèque



02003805

THE LIBRARY
RESEARCH BOARD OF CANADA
NANAIMO, B. C.

APPENDIX I

HISTORY AND TRENDS OF THE SKEENA RIVER

SALMON FISHERY

Copy No. 1

*Skeena River Salmon investigation,
interim report*

LIBRARY
PACIFIC BIOLOGICAL STATION
FISHING BOATS
NANAIMO, BRITISH COLUMBIA
CANADA V9R 5K6

95422

SH224.5 Milne
P11 Skeena River salmon investisa
48-07 ion: interim report, appendix
01 0.11

INDEX

Appendix 1. History and Trends of the Skeena River Salmon Fishery

	<u>Page</u>
Introduction.	1
1. Value of fishery and the relative importance of each species.	2
2. Development of canneries and fresh fish establishments.	3
3. Trend in fishing effort.	7
(a) Fishing regulations	7
(b) Fishing methods	9
4. Trend in catch.	17
(a) Methods of collecting data	17
(b) Conversion factors	21
(c) Fluctuations in the total annual catch figures for each species:	24
I Sockeye salmon catch	24
II Pink salmon catch	25
III Chum, coho and spring salmon catches	26
5. Detailed catch and effort for sockeye salmon.	31
6. Cycles in the catch as a basis for prediction.	34
(a) Sockeye salmon	34
(b) Pink salmon	38a
7. Effect of fishing effort in causing decline	40
(a) Relationships of effort and catch during the history of the sockeye fishery.	41
(b) Relationships in the sockeye population - 1944 to 1948.	43
8. Selective fishing by gillnet fishery.	50
9. Influence of the Alaskan and Naas fisheries on the Skeena salmon populations.	52
10. Recommendations.	57
11. References	60

History and Trends of the Skeena River Salmon FisheryIntroduction -

As Pacific salmon offer a desirable supply of food, man has exploited this natural resource, first for his own personal use and in recent years on a large commercial scale for the use of others. The history of the commercial salmon fishery and the trends of the catches from the Skeena river prior to the Skeena river salmon investigation, which commenced in 1944, constitutes the only data now available from which a picture of the true fluctuations in these fish populations can be determined. In the past the inadequate figures indicate that in general the fishing effort fluctuates with the size of the catch. As the salmon are exploited assiduously during a relatively short period when they are running up the rivers to spawn, the size of the catch must in some way indicate the size of the population. In this appendix we will study the fluctuations in the commercial catch and indicate how the catch bears a direct relationship to the size of the population.

On the basis of the history of the commercial fishery it will be decided whether there has been a true decline in any of the species or whether only transient declines of a cyclic nature have occurred. In addition all aspects of the fishery will be carefully examined to determine what light may be thrown on the causes of the observed fluctuations in order that logical recommendations may be made either to remedy the declines noted or to increase the present catches without producing a decline. The foundation of a sound management programme must lie in an adequate system of statistics from which can be determined the size of the catch, the intensity of the fishing effort on each species and finally the relative size, periodicity and condition of the stock.

In order to keep within the terms of reference of the Skeena river salmon investigation, only populations which have been shown to spawn in the Skeena river will be considered in detail. However, the influence of neighbouring populations must be indicated as the commercial fishery at the present time derives its catch from a large area and a complete separation of the Skeena salmon populations in the ocean is not possible, particularly in such species as spring and coho.

The Value of the Fishery and the Relative Importance of Each Species

The annual value of the average Skeena river canned salmon pack is approximately \$2,000,000. To this must be added the value of such by-products as oil and meal which amount to about \$25,000. The fresh fish industry which relies in large part on the troll fishing for spring and coho, has an annual value of approximately \$500,000, but as most of these fish can be attributed to populations which do not spawn in the Skeena river they shall not be considered in detail in this investigation. The capital invested over the years in from 6 to 15 canneries and in the 700 to 1300 gill-net boats plus gear is of considerable magnitude.

Due to the variations in economic conditions and in abundance of the various species it is difficult to appraise the true value and the relative importance of each species. The average catch and value of each species as reported in the Dominion Fisheries annual reports for the years 1925-45 is given in Table 1.

Table 1. Average number and value of each species of salmon caught in the Skeena river from 1925 - 25

<u>Species</u>	<u>Average No. of fish</u>	<u>Average No. of cases</u>	<u>Average Wholesale value</u>
Sockeye	800,000	68,000	\$1,000,000
Pink	1,500,000	82,000	500,000
Coho	250,000	27,000	300,000
Spring	13,000	7,500	80,000
Chum	81,000	9,000	50,000
Totals	2,644,000	193,500	1,930,000

It is apparent that the sockeye salmon is the most important species as it comprises about 30 per cent. of the fish taken and 50 per cent. of the total value. This is a higher percentage than the sockeye portion of the total British Columbia pack. Over the years the price of sockeye to the fishermen has varied from about ten cents to one dollar a fish. Both the fishermen and the canneries count on paying their operating expenses from the sockeye catch and adding to their profits by the catch of other species.

The pink salmon is second in importance, but in recent years the catch of this species has been greatly reduced. The spring and coho salmon are also important but are of greater interest to the fresh fish industry. To the value of the salmon canned in table 1 must be added approximately half a million dollars worth of Skeena salmon handled fresh. The chum salmon catch is small and of little importance in the Skeena river fishery.

Development of Canneries and Fresh Fish Establishments.

The first cannery, Inverness, was built on the Skeena river in 1877, in which year 3,000 cases of salmon were canned. The number of canneries increased to a maximum of fifteen which operated between 1917 and 1920. Since then the number has decreased until at the present time there are only seven. The first fresh-fish establishment took out a licence in 1910

but it was not until 1914 that the Canadian Fish and Cold Storage building was completed and the first frozen fish shipped east by rail. Since then the number of fresh fish establishments has increased until at the present time there are ten operating. The number of plant licenses issued from 1877 to 1948 is given in Table II.

Table II. Number of licenses issued to canneries and fresh fish establishments, 1877 - 1948.

<u>Year</u>	<u>Canneries</u>	<u>Fresh fish establishments</u>	<u>Year</u>	<u>Canneries</u>	<u>Fresh fish establishments</u>
1877	1	-	1924	13	3
1878	2	-	1925	13	3
1883	5	-	1926	15	7
1885	2	-	1927	13	7
1890	7	-	1928	11	7
1895	7	-	1929	11	7
1900	10	-	1930	11	7
1905	12	-	1931	8	7
1906	14	-	1932	10	7
1907	13	-	1933	10	7
1908	13	-	1934	9	7
1909	12	-	1935	9	7
1910	12	1	1936	8	7
1911	12	1	1937	7	7
1912	12	1	1938	6	7
1913	13	1	1939	6	7
1914	13	2	1940	7	8
1915	13	2	1941	7	9
1916	14	2	1942	6	9
1917	15	2	1943	8	9
1918	15	2	1944	7	9
1919	15	2	1945	7	9
1920	15	3	1947	7	10
1921	13	3	1948	7	10
1922	13	3			
1923	13	3			

The reduction in the number of canneries operating since 1926 was due to a concentration of equipment in certain canneries with a consequent increase in efficiency and capacity. The introduction in 1905 of the "Iron Chink", an automatic fish cleaner, replaced Chinese labour and speeded up the canning process. As the sockeye catch decreased in size more emphasis was placed on species such as pink and chum, many of which were brought in from other areas. The change in capacity for the twelve canneries operating in 1910 compared to the seven operating in 1945

indicates that more than twice as many fish are now handled and that some canneries can process three times as many fish as previously. The comparison data, given in Table III, shows that although there are now fewer canneries there are actually more lines and retorts. The number of boats is about the same but the number of cases packed is more than twice as great. This is made possible with the decline in Skeena salmon only by a great increase in the number of fish packed in from other areas.

Of the ten fresh fish establishments now operating only three have freezing and cold storage facilities. These facilities were opened by the Canadian Fish and Cold Storage Co. in 1914, by Atlin Fisheries Ltd. in 1935 and by the Prince Rupert Fishermen's Co-op in 1946. The remaining establishments, Royal Fish, Bacon Fisheries, Edmunds & Walker, Pacific Fisheries, Whiz Fisheries, Booth Fisheries and Rupert Fish Co., act as buyers and either ship the salmon fresh in ice or use one of the above freezing plants.

TABLE III. COMPARISON OF CANNERIES, 1910 & 1945

Cannery		Lines	Retorts	Steam Boxes	Boats	Nets	Annual Pack 5 yr. average	Date Built	Present Owners
1910	Balmoral	2	6	4	157	253	25,027		
	British American	2	3	5	65	120	16,139		
	Oceanic	2	3	4	108	198	18,045		
	Claxton	2	2	4	87	277	21,243		
	North Pacific	2	3	3	70	120	12,551		
	Carlisle	1	2	4	60	116	14,061		
	Inverness	2	2	3	69	83	14,801		
	Cunningham	1	2	2	57	117	8,818		
	Dominion	1	3	2	60	85	11,531		
	Skeena R. Commercial	1	2	3	47	78	8,259		
Cassiar	1	2	3	65	70	13,943			
Alexandria	1	1	1	35	37	3,687			
Totals		18	31	38	880	1,554	168,105		
1945	North Pacific	4	8	-	92		37,501	1889	A.B.C. Packing Co.
	Carlisle	5	7	-	160		62,757	1892	Cdn. Fishing Co.
	Inverness	4	8	-	65		45,182	1877	J.H. Todd & Sons.
	Cassiar	2	6	2	80		33,896	1903	Cassiar Packing Co.
	Sunnyside	4	6		120		42,602	1916	B.C. Packers.
	Port Edward	9	11	2	100		86,907	1918	Nelson Bros.
	# Claxton	-	-	-	-		4,228	1903	B.C. Packers
	Millard	1	3	-	-		45,465	-	F. Millard
Totals		29	49	4	617		358,538		
							/ (Total licenses issued in 1945 was 838).		

- Since 1943 Claxton has operated as a fish camp.

Trend in Fishing Effort

(a) Fishing regulations -

Regulations concerning the salmon fishery on the Skeena river are included in "Special Fishery Regulations of B.C. 1947." The present Skeena gill-net area described in these regulations is shown in Figure 1. In the past the gill-net boundaries have been changed by moving the river boundaries downriver and by extending the ocean boundaries. Thus, in 1910 the river boundaries were about 20 miles up the Skeena and 8 miles up the Ecstall, in 1925 about 12 miles up the Skeena and 8 miles up the Ecstall, and in 1935 about 9 miles up the Skeena (Aberdeen) and 3 miles up the Ecstall (Twin Falls). These latter are the present river boundaries for spring and coho, but during the sockeye season the boundary is lowered by about 5 miles to extend between Mowitch and Veitch points. This prohibits the fishing for sockeye in the Ecstall river. With the reduction of the river area in 1935 the ocean was extended from a line running west of Ryan point to one west of Finlayson island. The present Skeena gill-net area extends from the river boundaries to Porcher island on the south, Finlayson and Dundas islands on the north, and Stephens island on the west. The above changes in fishing boundaries are also shown in Figure 1.

Trolling is permitted throughout the whole area except above the river boundaries, but most is done outside Dundas, Stephens and Porcher islands.

In 1926 District No. 2 was divided into 10 purse seine areas. The only one within the Skeena area is Tuck inlet, No. 4, which has not been fished in recent years. Area No. 3 is divided into five parts to the north off the mouth of the Nass River and Area No. 5 lies to the south of the Skeena gill-net area.

Prior to 1935 the sockeye fishing season commenced on June 20. Since then the season has commenced on the last Sunday in June which means that a variation of up to six days may exist in the actual starting date from year to year. The closing date is set each year by the Department of Fisheries in Prince Rupert and has varied from August 13 to August 22. The opening has

been delayed in two instances due to strikes. In 1932 fishing did not start until July 11 (Indians started July 3), a loss of fifteen days fishing, and in 1945 did not start until July 1, a loss of seven days. As dates prior to 1931 are of uncertain accuracy only the opening and closing dates for sockeye from 1931 to the present are given in Table IV.

Table IV. Skeena Sockeye Fishing Seasons, 1931 - 1948

<u>Year</u>	<u>Opening date</u>	<u>Closing date</u>	<u>Year</u>	<u>Opening date</u>	<u>Closing date</u>
1931	June 20	Aug. 21	1940	June 30	Aug. 16
1932	July 11	" 20	1941	" 29	" 22
1933	June 20	" 18	1942	" 28	" 21
1934	" 20	" 17	1943	" 27	" 20
1935	July 1	" 16	1944	" 25	" 18
1936	June 28	" 20	1945	July 1	" 17
1937	July 1	" 13	1946	June 30	" 16
1938	June 26	" 19	1947	" 29	" 15
1939	"	" 18	1948	" 27	" 20

No predetermined dates are set for the spring salmon gill-net fishery, which starts when the first spring net is used, usually in April, and ends when the fishing is over in the latter part of July. The river boundary is lowered as soon as the sockeye season opens. The coho gill-net season opens forty-eight hours after the closing of the sockeye season and closes when fishing is over in the latter part of September. The river boundary is moved upriver one week after the closing of the sockeye season.

The closed season for trolling is from December 1 to December 31 inclusive. The weekend closed period for gill-nets is from Friday at 6 p.m. to Sunday at 6 p.m.

The regulations require that a gill-net shall not exceed two hundred fathoms in length and the depth or vertical breadth thereof shall not exceed fifty meshes of uniform size. There shall be no minimum limit for the mesh of sockeye gill-nets or drift-nets. The mesh of other salmon gill-nets shall not be less than six and one-half inches extension measure when in use. No nets of any kind shall be so used as to enclose any bay, cove, creek or inlet,

and in all cases one-third of the width of such bay, cove, creek or inlet shall remain open and unobstructed for the passage of fish. In commercial fishing no one shall fish for, catch or kill, or have in possession any salmon that weights less than three pounds in the round (or two and one-half pounds dressed), nor shall anyone buy, sell or expose for sale any salmon that weighs less than three pounds in the round. For further details see, "Special Fishery Regulations for B.C., 1947".

When the present regulations are compared with those first laid down in 1894 (Carrothers, 1941) only a few changes appear. For example, in 1894 the weekly closed period was from 6 a.m. Saturday to 6 p.m. Sunday, the spring net mesh was not less than $7\frac{3}{4}$ inches and the sockeye $5\frac{3}{4}$ inches, and the sockeye season was open from July 1 to August 25 and from September 25 to October 31.

(b) Fishing Methods -

Salmon are caught by three types of gear, gill-net, purse seine and troll. As far as the Skeena salmon populations are concerned, particularly the sockeye, the gill-net is the most important method. Trolling with baited hooks in off-shore waters catches mainly spring and coho salmon, while the purse seines catch mainly pink and chum from coastal streams other than the Skeena. Thus only the gill-net fishery will be treated in detail.

A gill-net is a rectangular net of fine twine with a cork line along the upper edge and a lead line along the lower. The mesh sizes at present in use are $8\frac{1}{2}$ in. - 9 in. for spring salmon, $6\frac{1}{2}$ in. - 7 in. for coho salmon and $5\frac{1}{2}$ in. - $5\frac{3}{4}$ in. for sockeye salmon. When set it forms a vertical barrier about 1,200 feet long (200 fathoms) and 20 to 30 feet in depth (varies with mesh size) in the path of the incoming fish, with only the cork line showing on the surface of the water. The size of mesh allows a fish to thrust its head through but is small enough to prevent the body passing. When a fish hits the net it either attempts to back up and so is caught by the gills, or attempts to drive through and is firmly caught around the body ahead of the

dorsal fin. The net is fished at right angles to the direction of flow of the tide or current, and is allowed to drift with it. It is thus called a "drift net". The boats are from 28 to 35 feet long with engines ranging from 10 to 110 h.p., and cost from \$2,000 to \$5,000. A gill-net is valued at from \$300 to \$600.

Around the start of the century all the gill-net boats on the Skeena were equipped with sails and were towed to the fishing grounds by gas driven tugs. There were usually two men on each boat, one of which was called a "boat puller". In 1911 a regulation was passed which prohibited the use of boats other than those propelled by sails or oars for salmon fishing of all kinds in District 2. In 1912 this was changed to apply only to salmon fishing with gill-nets. In 1922 the B.C. Fisheries Commission recommended that this regulation prohibiting the use of motor boats for salmon gill-net fishing in District No. 2 be amended to permit their use, beginning with the 1924 season. Up until 1935 gas engines were installed in the old sail boats but since then new gas boats have been built. Only a few sail boats operated after 1938. In 1942 the power driven drum was in general use. The old and new methods of gill-net fishing are illustrated in Figure 2.

The number of licenses issued each year is given in Table V and presented in Figure 3. It must be remembered that each sail boat used two men while each gas boat is usually operated by one.



Sail Boat



Gas Boat and Drum

Figure 2. The old and new methods of Gill-net fishing.

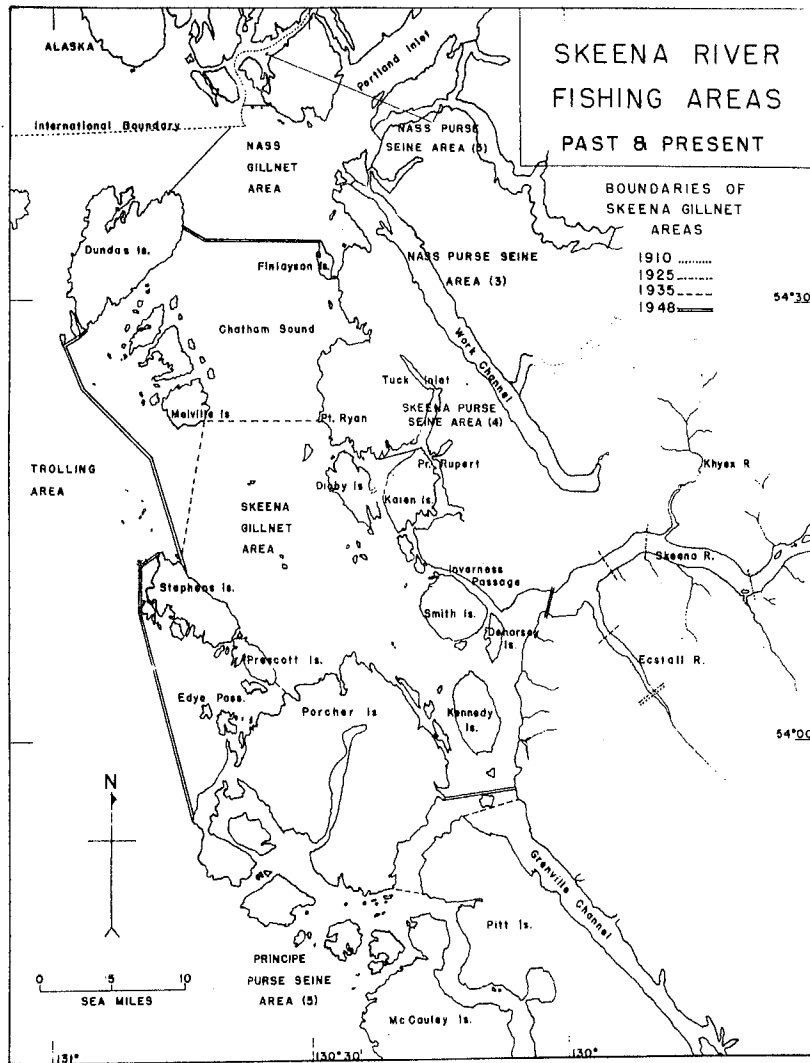


Figure 1. Map of the Skeena river commercial salmon fishing areas past and present.

Table V. Skeena gill-net license data from 1877 to 1948

<u>Year</u>	<u>Total</u>	<u>Year</u>	<u>Total</u>	<u>Japanese</u>	<u>Gas boats</u>
1877	40	1922	1079	640	-
1878	80	1923	905	578	-
1883	160	1924	1335	385	18
1890	269	1925	1067	295	65
1900	448	1926	1129	295	75
1905	781	1927	1195	295	162
1906	870	1928	1208	295	257
1907	700	1929	1143	295	263
1908	863	1930	1219	295	637
1911	850	1931	1118	295	607
1912	850	1932	1164	295	750
1913	850	1933	1218	295	669
1914	850	1934	1164	295	740
1915	962	1935	1053	295	842
1916	868	1936	970	295	882
1917	973	1937	850	295	824
1918	1111	1938	1049	295	817
1919	1159	1939	844	295	806
1920	1303	1940	846	295	842
1921	1179	1941	981	295	978
		1942	775	-	774
		1943	749	-	749
		1944	725	-	725
		1945	787	-	787
		1946	877	-	877
		1947	750	-	750
		1948	827	-	827

Note: The above data was obtained from the Dominion Department of Fisheries, Prince Rupert.

Prior to 1946 a forty-eight hour weekly closed period was put into effect when there were less than \$50 licences, and a sixty hour period when there were more than \$50. In 1947 the period changed when there were more or less than 1,000 licenses issued.

The number of gill-net boats that were either used or proposed by each cannery is given in Table 6 from data supplied by Mr. Salter, manager of Carlisle cannery.

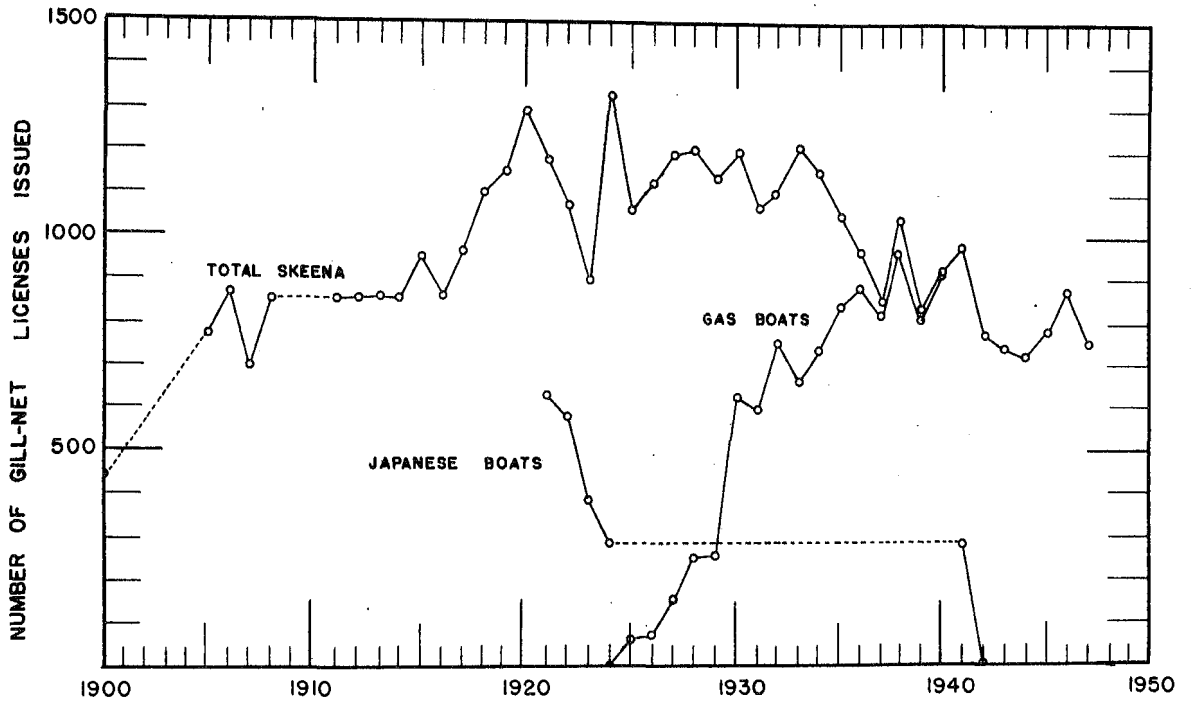


Figure 3. The total number of gill-net licenses issued in the Skeena river area up to 1947 showing the introduction of the gas boats and the reduction of the Japanese boats.

TABLE VI

GILL-NET BOAT RATINGS ON THE SKEENA RIVER

Cannery	1903	1908	1910	Proposed		Proposed			1939		Sockeye 1947	
				1911	1918	1929	1929	1937	1939	Japanese Rating	Indian	White
Balmoral	125	115	115	115	222	80	68	-	-	32	-	-
Br. American	90	85	85	89	80	-	68	? (ABC)	?	26	-	-
Oceanic	100	90	89	89	80	75	64	-	-	30	-	-
Claxton	76	105	89	89	80	80	68	? (BCP)	?	23	-	-
North Pacific	81	60	69	70	72	-	59	162(ABC)	154	17	69	39
Carlisle	67	70	69	70	72	80	68	230(CFC)	210	19	49	115
Inverness	71	70	69	70	72	80	68	85	85	23	34	36
Cunningham	70	55	55	60	-	70	59	-	-	12	-	-
Dominion	-	60	60	57	-	75	63	-	-	11	-	-
Skeena R. Commercial	38	55	55	55	62	200	43	-	-	17	-	-
Cassiar	32	60	65	55	72	75	68	78	73	18	61	26
Alexandria	-	25	35	31	-	-	-	-	-	5	-	-
Port Edward	-	-	-	-	62	75	68	?	?	10	37	24
Sunnyside	-	-	-	-	72	65	65	230(BCP)	210	25	112	26
Haysport	-	-	-	-	51	60	64	? (CFC)	?	12	-	-
CF & Cold Storage	-	-	-	-	72	-	-	-	-	-	-	-
Millerd	-	-	-	-	-	75	64	-	-	-	8	4
Forcher	-	-	-	-	-	60	68	-	-	-	-	-
Prince Rupert	-	-	-	-	-	-	-	-	-	15	-	-
Totals	750	850	855	850	1069	1150	1025	785	732	295	370	270

NOTE: In 1937 and 1939 the total boats for each company (ABC, BCP and CFC), are not kept separate for each cannery.

In 1947 in addition to these cannery boats licenses were issued to 110 other boats.

It is apparent from the number of licenses issued that the effort increased up to 1920 and since 1933 has fallen off. The latter is associated with a reduction in the number of Japanese as well as a reduction in the number of fish caught.

The introduction of the gas boat in 1924 brought about a change in fishing methods, in that the boats were able to move around faster and make more sets on the ebb and flow tides by doubling back and resetting. From a comparison of the records available at Claxton cannery there appeared to be some increase in the efficiency of gas over sail boats. For example during the years 1930 to 1933 inclusive, 96 gas boats averaged 1260 sockeye per boat year and 41 sail boats average 1163. When the drum was brought in an increase of as many as four times the number of sets could be made within an equal period. The result is that more sets can now be made at each high and low tide with a great reduction in manual labour.

A comparison of the efficiency of the three nationalities of fishermen, viz. Japanese, Indian and white, is shown in Table VII for the period 1930-36.

Table VII. Average number of sockeye caught by Japanese, Indian and white fishermen at Claxton and Sunnyside canneries for 1930 - 36.

<u>Year</u>	<u>Claxton</u>			<u>Sunnyside</u>		
	<u>Japanese</u>	<u>Indian</u>	<u>White</u>	<u>Japanese</u>	<u>Indian</u>	<u>White</u>
1930	3030	1562	2590	2755	933	1023
1931	2244	1018	1640	2000	900	1200
1933	-	-	-	600	275	306
1934	1258	675	1170	1016	717	652
1935	1390	705	1119	1019	644	502
1936	2144	1130	1728	1749	1024	665
Average :	2023	1018	1649	1523	749	727
Ratio :	1.98	1.00	1.63	2.04	1.00	.97

During the period 1930-36 the Japanese comprised about one-third of the fishermen and caught about twice as many sockeye per boat as the Indians. This difference in efficiency was cut down when the Indians acquired and learned to operate the new gas boats, as shown by the data in Table VIII.

Table VIII. Average number of sockeye caught by Japanese, Indian and White fishermen at Sunnyside and at all canneries for 1937 - 41

Year	Sunnyside			All canneries (Av.)		
	Japanese	Indian	White	Japanese	Indian	White
1937	930	629	917	925	660	743
1938	1039	743	624	1090	704	795
1939	1389	1135	883	1403	1080	978
1940	2048	1567	1588	1648	1405	1453
1941	1467	1036	1142	1456	962	1073
Average :	1375	1022	1031	1320	962	1090
Ratio :	1.37	1.00	1.01	1.36	1.00	1.05

The Japanese still fished a longer season (by 2 to 10 days) and longer each day as shown by a daily catch higher by 5 to 8 fish. In 1922 the Fisheries Department reduced the number of Japanese licenses by 10% and the B.C. Fisheries Commission recommended a reduction of 40% for 1923. The removal of the Japanese in 1941 lowered the fishing intensity during 1942 and 1943 while new Indian fishermen were being recruited. This no doubt accounts for the extremely low catch in these two years.


Within the Skeena gill-net area the majority of the sockeye fishing occurs at the locations shown in Figure 4. That is, in the river mouth, Inverness Passage, west of Smith island, Edge passage and off Finlayson island. These fishing sites are of interest when related to the migration routes based on tagging (appendix 2) and the path of the fresh water runoff (Appendix 12).


Dundas I.


Skeena Gillnet Boundary


Finlayson Is.


Please mark on fishing locations with following key:


Sockeye 

Pink 

Coho 

Spring 

Chum 

Steelhead 

30'

Melville Is.

Tuck Inlet

Tugwell

Digby I.

Fresh Fish House Seal Cove

Rupert

Kaien I.

Port Edward

Stephs Is.

Inverness North Pacific Sunnyside

Cassiar

Prescott I.

Smith Is.

Skeena R.

Eye Pass

Glory Hill

Carlisle

Porcher Is.

Kennedy I.

Gibson I.

54°

130°

Figure 4. Location of fishing sites and processing establishments in the Skeena gillnet area.

Any interference in the fishing effort for sockeye will change the catch. The fishermen believe that the weather affects sockeye fishing in the following manner: Southeasterly winds bringing rain, fog and storms drive the fish deeper so that they are caught near the lead line or miss the nets altogether. Westerly winds bringing good weather cause the fish to leap at the surface and to be caught near the cork line. In bright weather it has been found advantageous to camouflage the nets by dyeing them green.

The records of Carlisle cannery for 1943-46 were examined to check on the effect of weather on fishing. These records give the daily average fish per boat and the type of weather on the fishing grounds. It was noted that in general the best days fishing are bright, and that a continued period of rainy weather results in low catches. One week of bad weather at the peak of the season in 1945 was particularly striking in this regard. The catch data were empirically split into high, medium and low, and the weather split into rainy, dull and bright. The results shown in Table IX are the totals for the four-year period.

Table IX. Chi square test on weather and catch for Carlisle cannery, 1943 - 46

<u>Catch</u>	<u>Weather</u>			<u>Total</u>	
	<u>Bright</u>	<u>Dull</u>	<u>Rain</u>		
<u>heavy</u> - Observed total	22	15	11	48	$x^2 = 10.98$ $df = 4$
- Calculated total	18.2	12.2	17.8		
<u>medium</u> - Observed total	11	9	9	29	$P = .03$
- Calculated total	11	7.3	10.7		
<u>Low</u> - Observed total	15	8	27	50	
- Calculated total	18.9	12.6	18.5		
Observed grand total	48	32	47	127	

It is evident that the bright and dull days yielded about equal catches, which are higher than those on rainy days. This difference is statistically significant by the chi square test and could be expected to occur only three times in 100 by chance alone. Whether rainy days affect the movements of the

fish or the effort of the fishermen is still an open question. It is of interest that 1943 had the fewest days of rain yet the lowest catch, and that 1946 had the most rain, and about twice that of 1943, yet almost twice the catch.

In conclusion, as the salmon run a gauntlet during their migration and every effort is made to catch as many as possible while the season lasts, the catch per unit effort tends to equal the abundance of the population. The effort directed toward the other species is largely determined by the success of the sockeye catch. For example, during the large sockeye run in 1945 the boats fished the Skeena relentlessly; and despite a strike of a week's duration at the start of the season about 40% more boat days were fished than in 1947 when the run was small and many boats moved off to fish neighbouring areas such as the Nass and even as far south as Rivers inlet. In 1945 there was also a large run of pinks, but the effort directed to catch them appeared proportionately less than in 1947 when both the pink and sockeye runs were small. Over longer periods such economic factors as the depression in the 1930's and the two world wars had noticeable effects on the fishing effort. Thus, it is apparent that it is a very difficult task to ascertain, on the basis of the data available, a comparative index over the years for effort. This index would have to consider the number of boats, the changes in efficiency of gear and fishermen, changes in fishing areas (river fishing compared to outside fishing), effects of weather and economic conditions and the number of boat days of fishing each year in the river.

4. Trend in Catch

(a) Methods of collecting data -

The Skeena catch and pack figures of the Dominion Department of Fisheries have been examined and compared with the cannery records. Prior to 1938 the fisheries inspectors collected all the data. Since then each cannery has reported the catch to the Prince Rupert Fisheries office on monthly and annual forms. All weekly pack figures are sent to the Supervisor of Fisheries in Vancouver and the total Naas and Skeena pack appears weekly in the British Columbia Canned Salmon Pack Bulletin. The appendix to the monthly statistical report showing a breakdown of the catch from the Skeena river of both canned salmon and that marketed fresh or mild cured, was the only form which gave a complete picture of the Skeena catch. Starting in 1947 this form was virtually abandoned and replaced by one for the Bureau of Statistics which gives the total pack and by-products in cwts. for each firm but which is not broken down into the catch for the Skeena river. Thus the annual supplemental schedule with appendix forwarded direct to the Vancouver office is the present basis for the Skeena catch figures published by the Federal Fisheries Department. Unfortunately these forms do not cover the salmon that are handled fresh. The Provincial Fisheries Department also publishes an annual return of the canned salmon from each area.

Prior to 1924 the salmon caught in the Skeena area were not separated from the total pack in the Skeena area, which included few fish from other districts. The Skeena-caught fish have always been packed on the Skeena, but since 1924 many fish have been brought in and packed in the Prince Rupert area. Thus the number of cases recorded as packed in this area prior to 1924 is comparable to the number of cases of salmon recorded as caught since that date, rather than to the total number of cases recorded as packed. This presents the problem of accurately separating the Skeena catch from the Skeena pack. In the case of sockeye care is taken to separate the catch as accurately

as possible. In recent years the proper assignment of the fish caught in the Finlayson island area has been impossible, but the results from tagging experiments and the oceanographic survey should help in this regard. For the other species less care is taken and usually an approximate breakdown suffices.

In this appendix the catch figures published in the Annual Reports of the Dominion Department of Fisheries will be used, but it should be admitted that many errors no doubt are incurred. The following examples will suffice for the past records. Prior to 1933 the published Provincial and Dominion annual figures are in poor agreement. The reason appears to be in the distinction between the Skeena catch and pack. In the low year 1942 the Skeena catch as published by the Dominion Fisheries is 34,544 cases, by the Provincial Fisheries 29,976 cases and by the files in the Prince Rupert Fisheries office 31,976 cases. When the total catch figure is broken down for individual canneries, similar discrepancies frequently occur. For recent years a comparison of the Skeena catch figures obtained by various methods will now be presented.

A detailed examination of the monthly and annual catch returns submitted by the industry to the Department of Fisheries leaves much to be desired as to the accuracy of the catch of each species in the Skeena area. A comparison of the total Skeena catch figures for 1946 so obtained is as follows:

		<u>Sockeye</u>	<u>Pink</u>	<u>Coho</u>	<u>Chum</u>	<u>Spring (Red)</u>	<u>Spring (White)</u>
Canneries (cases)	Monthly	52,650	10,614	16,093	13,859	1,122	462
	Annual (1)	48,852	9,942	13,370	9,829	1,218	690
	# (2)	52,928	10,737	26,281	11,161	2,029	410
Fresh Fish Establish- ments (cwts)	Monthly	326	809	9,835	2,337	10,761	1,349
	Annual	233	810	9,605	2,340	7,417	995

Note : # The first annual figure is from the original cannery return, while the second total is that published in the Dominion Annual Report.

When each establishment is compared in detail, the differences are greater but many errors cancel each other in the final totals. Which are the most accurate figures is debatable. Similar data were extracted from the files for the period 1940 to 1948 and like discrepancies occurred. The catch figures for the species which are largely canned (sockeye and pink) show smaller discrepancies than the other species. Many of the errors are due to the fact that the fish are transferred so often (particularly those handled fresh) that the bookkeepers who compile the returns do not know the exact area of capture. For this reason the Skeena pack figures show fewer discrepancies than the Skeena catch figures.

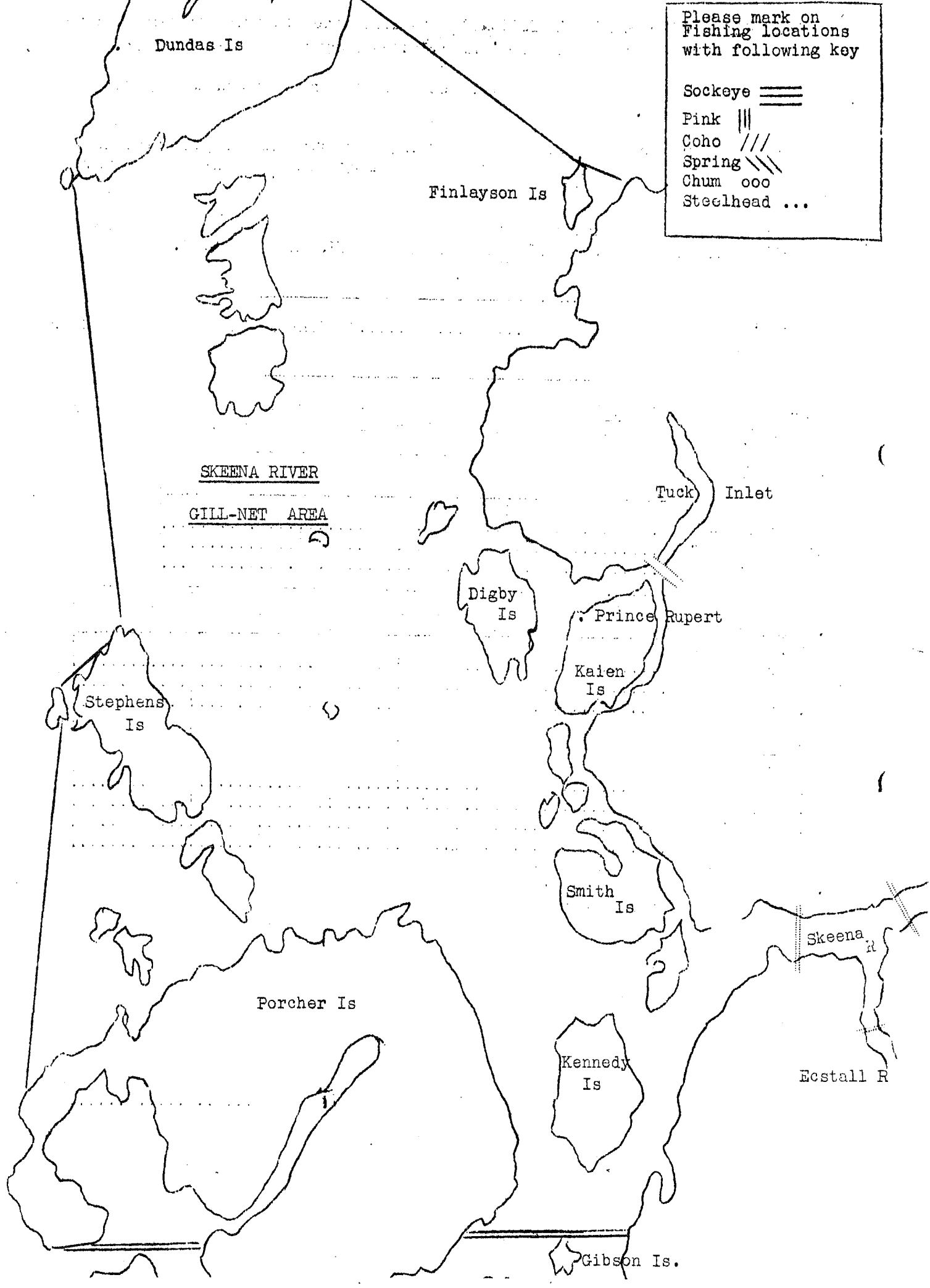
In 1947 the monthly and annual catch returns from the canneries were supplemented by our own collection from the bookkeepers. This check on the catch, using the form in figure 5, was obtained from the companies involved as it appeared impractical to place log books on each gill-net boat due to the large number of boats and the high percentage of illiterate fishermen (mostly Indians). Many of the difficulties in obtaining the catch of salmon in the Skeena area became apparent. After repeated requests returns were finally received from all but one cannery. It became apparent that the number of salmon, other than sockeye, caught in this area was not readily obtainable from the existing breakdown of the cannery records. The data on effort was also not available with any degree of accuracy. A comparison of the total number of cases canned in 1947 by four of the seven canneries is as follows:

	<u>Sockeye</u>	<u>Pink</u>	<u>Coho</u>	<u>Chum</u>	<u>Red Spring</u>	<u>White Spring</u>
Monthly totals :	22,287	8,370	16,203	7,126	1,012	301
Annual totals :	21,222	8,887	7,432	7,114	1,141	251
F.R.B. totals :	21,669	9,608	6,084	7,708	712	76

Discrepancies are again apparent and the data were incomplete for the remaining three canneries.

Please mark on
Fishing locations
with following key

- Sockeye ≡≡≡
- Pink |||
- Coho |||
- Spring |||
- Chum ooo
- Steelhead ...



THE SKEENA RIVER SALMON INVESTIGATION requires the following information to obtain an accurate picture of the Commercial Fishery on the Skeena River.

All data will be considered as confidential and are to be used only for statistical analysis.

Your co-operation in completing this form, as accurately as possible, is essential in setting up a sound conservation policy such that the fishery may yield at a maximum for years to come.

Please return the completed form at the end of the season to the FISHERIES RESEARCH BOARD OF CANADA, PACIFIC BIOLOGICAL STATION, NANAIMO, B. C.

RECORD OF SKEENA RIVER SALMON AT.....CANNERY DURING THE 194_ SEASON.

NOTE- Supply data for ONLY the Skeena River Gill-net Area, which is bounded by Finlayson, Dundas, Stephens and Porcher Islands (See Map).

1. EFFORT	Number of Boats		Period of Fishing		Total Number of Boat days
	Whites	Indians	Start	Finish	
Spring Gill-Nets
Sockeye " "
Coho " "

2. CATCH	Sockeye	Pink	Springs			Coho	Chum	Steelhead
			Red	White	Jacks			
Total
Number of Fish
Weight of Fish
No. of Cases 48lbs.....
3. CALCULATIONS								
Average								
No. of fish per boat.....
No. of lbs per case
No. of fish per case.....
Weight per fish

4. Any general remarks on the fishing conditions or suggestions for the better management of the fishery will be appreciated.

Compiled by.....

Figure 5. Skeena salmon catch form used in 1947.

In connection with the 1948 program to recover marked fish from the catch during July, the total number of fish caught in the Skeena area was obtained from the cannery tally sheets and checked against the monthly returns submitted by the cannery to the Fisheries Department. As the tally sheet figures are in numbers of fish and the monthly returns are in cases, a comparison of the number of fish per case will indicate the discrepancies in the figures as the number of fish packed in each case are in general similar from cannery to cannery. The number of fish per case for five of the canneries are as follows:

	<u>Sockeye</u>	<u>Pink</u>	<u>Coho</u>	<u>Chum</u>	<u>Red Spring</u>	<u>White Spring</u>
1.	16.3	30.0	12.1	10.0	3.2	3.4
2.	13.4	17.4	10.6	7.2	17.6	5.6
3.	13.2	21.1	5.2	.4	3.4	1.2
4.	12.7	11.4	4.0	7.0	3.4	2.7
5.	13.2	11.3	1.2	2.3	1.7	1.2
Average conversion factors based on data of previous years						
	12.0	18.0	8.0	8.0	6.0	4.0

It is clear that there is poor agreement between the number of fish on the tally sheets and the number of cases reported, particularly in species other than sockeye. In the case of sockeye, the errors which came to light were: (1) One cannery was still using the 1935 area for Skeena caught fish or in other words was including all fish caught north of Tugwell island as Nass fish, (2) Another cannery had canned 200 cases of sockeye which were transferred on their books to another cannery but the latter failed to report them. It is again clear that for species other than sockeye the bookkeepers must guess-estimate the Skeena catch.

With the above criticisms in mind, it is obvious that the Skeena catch

figures, as published, cannot be accurate but that they may serve in a general way to show the relative Skeena catch from year to year. Since these figures are the only ones available for past years they must be used to decide the trend in the fishery. Thus, although a check has been made on their absolute accuracy, no concerted attempt was directed to collect completely accurate figures for any one year. If accurate figures are to be obtained in the future they must be collected directly from the fishermen as soon as the fish are caught. It is apparent that bookkeepers are not in a position to separate the fish landed into the area in which they are caught. In addition the Fisheries Research Board has no legal authority to collect the figures with the result that inaccurate and incomplete returns can be and are sent in. The multiple sales slip system at present in use in the Western States and recently recommended by Dr. G.L. Burton should result in better catch per area figures as the data is recorded at time the original purchase is made from the fishermen on the fishing grounds. If this system is adopted by the Fisheries Department then many of the forms at present in use could be profitably eliminated and probably better cooperation solicited from both the industry and the fishermen. (See recommendations re Statistical Programme).

(b) Conversion factors -

In order to convert number of cases and cwts. of salmon into numbers of fish the numbers shown in Table X have been found to represent the average conditions over the years.

Table X. Average weight per fish and number of fish per case for
Skeena river salmon

<u>Species</u>	<u>Weight per fish</u>	<u>Fish per case</u>
Sockeye	6.	12
Pink	4	18
Chum	9	8
Cono	9	8
Red Spring	12	6
White Spring	18	4
Jack Spring	4	18

Using the above figures, 72 lbs. of raw fish are required to fill a 48 pound case of canned salmon. The government conversion figures for the number of pounds of raw salmon that are equivalent to a 48 lb. case were 84 prior to 1939, 80 from 1939 to 1943, and 75 from 1944 to the present.

Table XI The Pack and catch of canned salmon (in number of cases) for the Skeena River, 1904 - 1947 as Published in the Annual Reports of the Department of Fisheries.

Year	Sockeye	Pink	Coho	Chum	White Spring	Red Spring	Steel Head	Pink & Jack Spring	
1904	93,404	30,529	10,315			20,261			
05	84,717	7,523	7,247			14,598			
06	86,394	38,991	16,867			20,138			
07	108,413	25,217	15,247			10,378			
08	139,846	45,404	10,075			13,374			
09	87,901	28,120	11,249		742	11,727			
10	187,246	13,423	11,531		239	9,546			
11	131,066	81,956	23,376	70	2,428	15,514			
12	92,498	97,588	39,835	504	4,501	19,332			
13	52,927	66,045	18,647		3,186	23,215			
14	130,166	71,021	16,378	8,329	211	11,529			
15	116,553	107,578	32,190	5,769	204	15,069	1,798		
16	60,723	73,029	73,029	17,721	2,561	18,272	3,743		
17	65,760	148,319	38,456	21,516	2,699	13,586	1,883		
18	123,322	161,727	38,759	22,573	6,828	16,013	4,994		
19	184,945	117,303	36,559	31,457	2,656	19,651	2,672	3,624	
20	90,869	177,679	18,068	3,834	3,123	37,403	1,218	2,198	
21	40,018	124,457	45,033	1,993	445	18,599	498	2,722	
22	100,615	203,555	24,673	17,668	1,805	7,080	1,050	5,591	
23	131,731	145,973	31,967	16,527	499	8,863	418	2,885	
24	144,732	181,338	26,907	25,603	1,301	9,511	214	1,361	
25	/	77,785	127,226	38,029	10,687	2,457	17,811	700	1,657
	#	81,149	130,083	39,168	74,308	2,603	19,185	713	1,657
26	/	82,307	170,586	30,153	46,382	1,750	17,896	764	966
	#	82,357	210,064	30,209	63,527	1,750	17,896	764	966
27	/	83,988	38,903	25,209	9,656	1,609	13,595	646	1,609
	#	83,984	38,761	25,623	18,659	1,609	14,856	580	3,567
28	/	34,524	191,812	18,751	11,792	397	4,121	231	988
	#	34,559	209,579	30,194	17,751	354	5,043	241	988
29	/	77,714	94,846	37,138	3,625	383	3,795	13	441
	#	78,014	95,305	37,456	4,835	383	3,795	13	441
30	/	130,952	214,266	24,191	3,327	322	6,589	60	1,047
	#	132,372	275,642	29,203	5,057	324	6,674	48	1,047
31	/	93,029	44,807	10,737	3,610	534	7,040	768	2,284
	#	107,936	41,264	20,146	3,893	534	7,040	768	2,284
32	/	52,624	32,519	20,549	28,756	2,472	14,268	365	9,419
	#	59,916	58,261	48,312	38,549	2,472	16,378	404	9,419
33	/	27,692	79,932	21,366	10,970	828	6,805	201	444
	#	30,506	95,783	39,896	15,714	227	2,626	267	444

Year		Sockeye	Pink	Coho	Chum	White Spring	Red Spring	Steel Head	Pink & Jack Spring
1934	/	54,553	27,623	21,298	6,242	360	6,809	131	592
	#	70,654	125,163	54,470	24,388	860	6,844	114	492
35	/	52,879	81,368	8,122	23,498	188	3,422	14	429
	#	64,140	99,412	45,512	31,807	188	3,443	12	429
36	/	81,960	92,997	32,142	15,343	356	3,781	33	414
	#	97,323	178,299	55,198	36,892	435	4,883	33	455
37	/	41,023	57,623	14,573	10,027	315	3,704	21	382
	#	55,811	72,455	34,502	37,431	315	3,788	21	382
38	/	46,988	69,299	38,542	14,668	259	2,916	42	1,141
	#	73,520	146,676	100,658	34,785	259	3,361	42	1,165
39	/	68,388	91,559	27,115	6,360	336	3,124	55	1,396
	#	96,358	127,521	48,973	15,666	348	3,227	55	1,488
40	/	116,505	46,687	19,196	4,684	396	4,708	130	1,017
	#	133,854	91,612	62,516	62,114	571	5,884	133	1,113
41	/	31,183	51,389	45,891	12,138	368	3,929	1,890	641
	#	110,544	73,896	126,557	54,457	448	4,695	2,261	703
42	/	29,976	47,819	36,396	10,611	617	5,305	3,117	699
	#	57,539	146,322	70,335	31,481	832	5,850	3,670	374
43	/	23,259	53,203	40,281	6,408	379	964	1,953	441
	#	51,476	122,040	63,639	57,580	623	1,443	2,323	339
44	/	67,855	45,833	18,810	7,173	193	899	2,395	468
	#	92,203	190,872	38,160	37,072	289	1,176	2,725	664
45	/	103,940	69,149	33,673	9,121	363	1,208	1,538	735
	#	117,860	211,140	51,905	44,104	389	1,324	1,612	827
46	/	52,928	10,737	26,282	11,161	410	1,591	2,358	438
	#	72,319	50,799	33,534	31,633	551	1,864	2,523	579
47	/	32,511	13,184	12,166	8,224	414	1,376	2,051	326
	#	65,429	47,831	35,522	37,476	531	1,688	2,237	398

Note: / - Catch - Pack of fish caught at Skeena regardless of where canned.

- Pack - Pack at Skeena regardless of where caught.

(c) Fluctuations in the total annual Skeena catch figures for each species -

The number of cases of each species of salmon packed on the Skeena from 1904 to 1947 and the number of cases caught from 1925 to 1947 are published in the annual reports of the Dominion Department of Fisheries. The data are presented in Table XI. It must be recalled that the catch of the salmon populations spawning in the Skeena is represented by the pack figures up to 1924 and the catch figures since that date. As each species presents a separate problem they will be discussed one at a time.

Sockeye Salmon Catch

As all sockeye are eventually canned the number of cases given in Table XI represents the relative catch from year to year. As a limited supply of sockeye are fished intensively each year the catch in a general way must indicate the size of the population. The relationship of catch and population size for the last few years will be presented later. The Skeena sockeye catch from 1904 to 1947 is shown in Figure 6. The trend is shown by means of straight lines fitted by the method of least squares. Prior to the turn of the century the catches increased with the development of the fishery to approximately 1,000,000 cases per year. For the period 1904 - 1924, although the catch fluctuated around an average of 107,000 cases to a figure of over 187,000 cases in 1910 and to a figure under 53,000 cases in 1913, the trend line indicates that an over-all decrease of 3,000 cases occurred in the catch. Similarly, the catch from 1925 to 1945 fluctuated greatly with an over-all decrease of about 12,000 cases. For some reason the trend line for this latter period is about 30,000 cases below the 1904 - 1924 period. Thus, when the whole period 1904 - 1945 is considered, there is a sharp decline of about 50 per cent. or 59,000 cases in 41 years. Much of this is due to the decrease of 23,000 cases during the period 1915 - 1935. It was in this period around 1925 when the number of Japanese licenses was decreased from 640 to 295, the river boundaries were

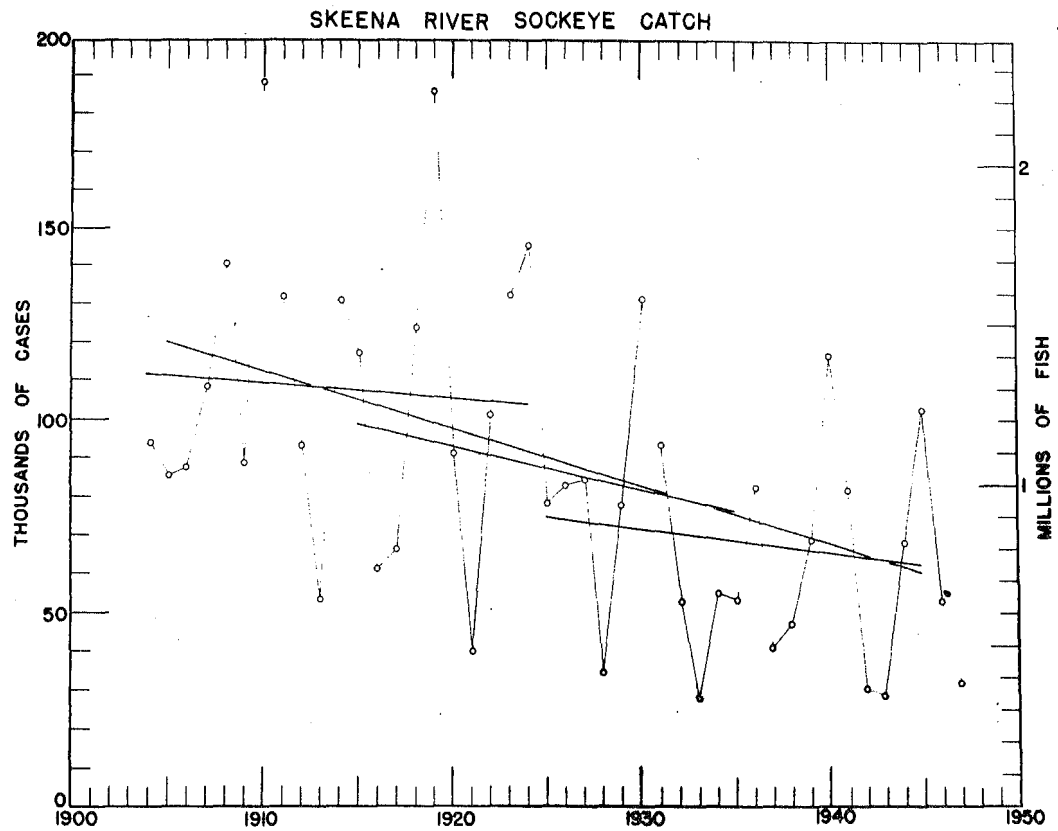


Figure 6. The catch of sockeye salmon from the Skeena river area, 1904 to 1947. The heavy trend lines were fitted by the method of least squares.

lowered and when the first attempt was made to separate the Skeena catch figures from the total Skeena pack figures. From the foregoing it is evident that there has been a gradual decline in the sockeye catch since 1910. It is of interest that although the total Skeena pack figures (table XI) indicate an upward trend (16,000 cases) for the period 1925 to 1945, the pack figures for the whole period also show a marked decline despite the fact that fish have been brought in from other areas in recent years. The average sockeye catch for the last 20 years is 68,000 cases and the average sockeye pack is 81,000 cases. Thus the sockeye catch has declined greatly from what it was at the peak of the fishery.

The large annual fluctuations of the Skeena catch, which have varied as much as four times from one year to another, have followed a regular five year cycle since 1930 except for the failure in 1935 and the success in 1948. This is surprising as it is known that the four and five-year age groups approximately of equal size. The cycles in the Skeena catch follow in a general way those in the total British Columbia pack if due consideration is given to the large catches on the Fraser every four years. This similarity is not apparent to the same degree when the Skeena catch is compared with the Alaska pack. From a study of the weekly sockeye catches the run is under way when the fishing season starts on the last Sunday in June, reaches a peak in the latter part of July and is almost over by the middle of August.

Pink Salmon

Over 90 per cent. of the pink salmon in this area are canned and the few which are handled fresh are either used for bait or filleted. The effort devoted to the catch of Skeena pinks varies from year to year as it is affected to some degree by the size of the preceding sockeye catch. As the majority of the pinks packed on the Skeena in recent years have been brought in from other areas, the splitting of the Skeena pack into those caught within the Skeena area is of little consequence to the canneries and the result is that

the Skeena catch figures are less reliable than those for sockeye.

With these reservations the catch figures of Skeena pinks presented in Table XI are shown in Figure 7 to portray the general trends for this species. The pink catch commenced about 1910, rising to a peak from 1920 to 1930 with the even year population the largest one. For some reason, probably biological rather than economical, the large run in 1930 resulted in the drastic failure of 1932. In this regard the Skeena catch is similar to the total British Columbia pack and it is probable that the cause was the same in each case. Since 1930 the catch has been greatly reduced and in the last few years the catch in the odd years has been larger than in the even. In the last two years, 1946 and 1947, a new low for each cycle has been caught but the larger catch in 1948 indicates that the average year cycle may have recovered. The average Skeena catch for the period 1925 - 45 is 82,000 cases, while the Skeena pack is more than twice this figure.

The pink run starts about the middle of July and is over by the end of August. Many cannery managers feel that since the lowering of the river boundary in 1935 the best gill-net fishing grounds for pinks in the river proper have been closed off. If this is true it is surprising that the pink escapement has not noticeably increased in recent years.

Chum, Coho and Spring Salmon

As a larger proportion of chum, coho and spring salmon are handled fresh it is necessary to determine these quantities and add them to the quantity canned. Unfortunately the fresh fish data are not published, and it was necessary to obtain the quantities caught in hundredweights from the files of the Department of Fisheries at Prince Rupert. As the Skeena catch was not separated out for all fresh fish establishments prior to 1941 an estimate of the number of salmon handled fresh during this period (1930 to 1940) was obtained by deducting the number of canned from the total catch figures in hundredweights given in Table XII. This necessitates the use of the

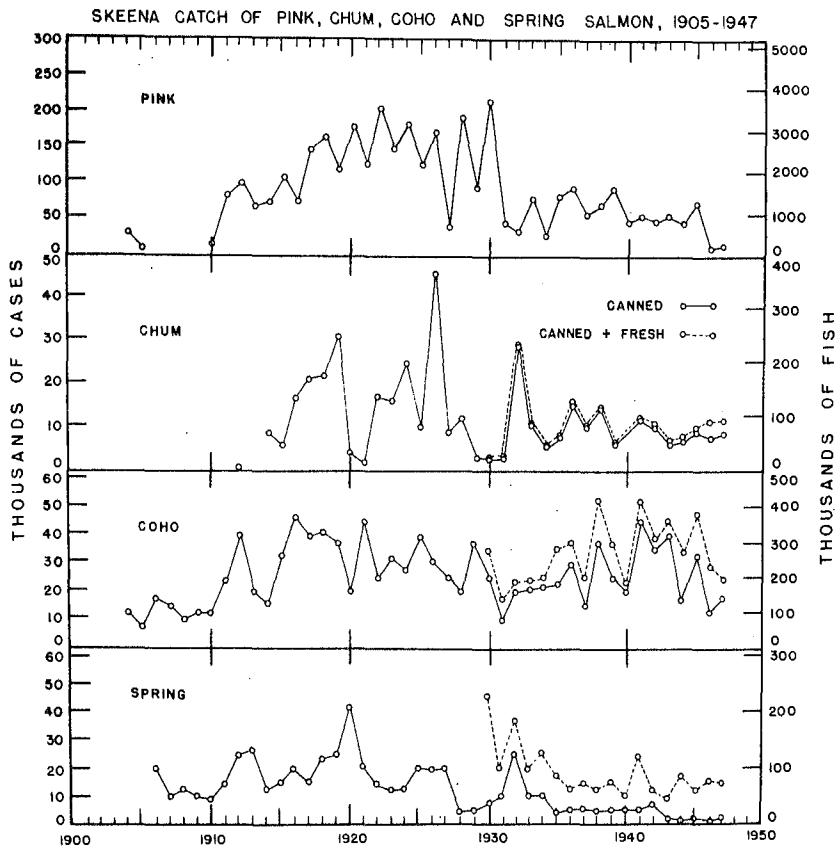


Figure 7. The catch of pink, chum, coho and spring salmon from the Skeena river area, indicating the proportions used by the fresh fish and canning industries.

conversion factors in table X. In the process many discrepancies came to light so that the data from 1930 to 1940 should not be considered too accurate. Since 1941 the Skeena fresh fish catch figures, in hundredweights, were obtained from the annual returns submitted to the Department of Fisheries. These data are more accurate but there still remains the problem of the proper splitting of the Skeena pack into the Skeena catch. The best estimates (in thousands of fish) of the number of Skeena-caught fish which are handled fresh are presented in Table XIII.

Table XII. Total Skeena Catch in Cwts for 1930-47

<u>Year</u>	<u>Sockeye</u>	<u>Pink</u>	<u>Coho</u>	<u>Chum</u>	<u>Spring</u>
1930	109,990	167,020	28,818	3,364	35,931
31	78,067	38,052	14,299	5,285	16,447
32	44,853	28,045	19,195	25,667	29,961
33	23,266	67,277	19,887	10,192	15,536
34	45,917	23,752	19,990	5,667	21,210
35	44,478	69,656	28,803	8,268	13,860
36	69,566	64,629	32,141	12,038	9,193
37	34,485	48,751	21,560	9,289	10,804
38	39,601	59,479	43,573	12,706	10,366
39	54,978	74,914	30,845	5,875	13,054
40	93,299	38,746	17,474	4,029	8,445
41	64,983	42,509	39,171	9,748	7,932
42	23,989	39,720	31,308	8,641	8,234
43	20,669	44,336	30,419	6,243	6,482
44	51,051	37,018	26,106	5,995	12,010
45	78,091	56,337	34,762	7,560	8,090
46	39,619	9,533	33,184	13,719	11,758
47	24,399	10,826	15,590	8,111	12,148

Table XIII. Skeena Catch Handled Fresh in Thousand of Fish
1930 - 47.

<u>Year</u>	<u>Sockeye</u>	<u>Pink</u>	<u>Coho</u>	<u>Chum</u>	<u>Spring</u>
1930			37	5	150
31			60	15	36
32		12	22	15	34
33			22	10	38
34		12	22	5	64
35		25	100	15	48
36			55		23
37		12	105	10	30
38		25	120	5	30
39		50	105	5	40
40		35	28	5	16
41	1	35	54	-	96
42	-	37	23	2	23
43	1	20	45	2	38
44	3	68	134	7	76
45	2	118	105	8	49
46	4	21	106	26	78
47	1	7	67	22	70

The trends in the catches of chum, coho and spring salmon are shown in Figure 7 based on the number of cases canned, presented in Table XI, and the numbers of fish handled fresh, presented in Table XIII.

It is apparent that most of the chums are canned and that less than 10 per cent. are used fresh. From the start of the fishery about 1915 up to 1932 the chum catch fluctuated greatly. Since 1932 it has remained more uniform. In this regard it is similar to that of the pike, except that during the latter period the catch has not fallen off to such a marked degree. The average Skeena chum catch for the period 1925 - 45 is 9,000 cases, or about 2 per cent. of the total British Columbia pack. The run starts in July, has a peak in September, and is over in November.

Since 1904 the coho catch has increased steadily up to the present, with the largest catches recorded in 1938 and 1941. In recent years the fresh fish houses have handled more fish, which has varied from 25 to 60 per cent. of the catch. Because of the long migration of this species and the use of the trolling method of capture far out in the ocean, it is difficult to obtain a true picture of the Skeena population from the total pack

figures. The average Skeena coho catch for the period 1925-45 is 27,000 cases (15 per cent. of the total British Columbia pack). The Skeena pack is more than twice this amount. The run starts in June, with a peak in August, and ends in October.

The spring catch increased in size from 1906 to a peak in 1920 and since then it has fallen off. As in the case of coho, it is difficult to obtain a true picture of the Skeena population for in recent years the fresh fish industry has handled from 60 to 90 per cent. of the fish. The exceptional number handled in 1930 by the fresh fish houses was probably composed of a large number of springs from rivers other than the Skeena. The percentage mild cured varies from 1 to 25, while that canned varies from 5 to 30. From 5 to 30 per cent. of the springs caught have white flesh and market at a greatly reduced price. The average catch of springs on the Skeena for the period 1925-45 is 8,000 cases, (35 per cent of the total British Columbia pack) while the spring pack on the Skeena has been more than twice this amount.

On the basis of tagging returns the spring and coho salmon may be captured in an area 100 or more miles in any direction from the Skeena mouth. The sockeye have a more local distribution of 30 miles except in a north-westerly direction from whence they may come at least 150 miles. The pinks and chums have a still more restricted range. Thus, for all species of salmon it is difficult to separate the Skeena population from the ocean catches. However, the existing figures for the Skeena catch indicate that the sockeye, pink and probably the chum populations have declined over the years, while those of coho and spring appear to have remained more constant.

During the investigation certain detailed records (daily, monthly and annual figures) for each cannery and fresh fish establishment in the area and covering the period from 1940 to the present were extracted from the files of the Fisheries Office in Prince Rupert. Catch data were also obtained from several cannery offices. However, as these data are of a

confidential nature they will not be presented in detail but have been deposited in the files of the Skeena river salmon investigation. In summary, when these data are converted from cases and cwts. to numbers of fish (using the conversion factors given in Table X) they represent the best estimate of the number of salmon caught in the Skeena area. With full knowledge of the inaccuracies involved the total numbers of fish caught each year since 1940 are represented in Table IV.

Table XIV. Annual number of salmon caught in the Skeena in
Thousand of fish, 1940 - 1947.

<u>Year</u>		<u>Sockeye</u>	<u>Pink</u>	<u>Coho</u>	<u>Chum</u>	<u>White Spring</u>	<u>Red Spring</u>
1940	Canneries	1,374	832	135	33	1	27
	Fresh Fish	--	?	?	--	?	?
	Totals	<u>1,374</u>	-	-	<u>33</u>	-	--
1941	Canneries	961	360	357	90	1	21
	Fresh Fish	<u>1</u>	<u>35</u>	<u>54</u>	<u>--</u>	<u>6</u>	<u>90</u>
	Totals	962	895	411	90	7	111
1942	Canneries	382	913	300	85	2	41
	Fresh Fish	-	<u>37</u>	<u>23</u>	<u>2</u>	<u>1</u>	<u>22</u>
	Totals	<u>382</u>	950	323	87	3	63
1943	Canneries	337	499	316	51	1	8
	Fresh Fish	<u>1</u>	<u>20</u>	<u>45</u>	<u>2</u>	<u>3</u>	<u>35</u>
	Totals	338	519	361	53	4	43
1944	Canneries	804	826	152	58	1	5
	Fresh Fish	<u>3</u>	<u>68</u>	<u>134</u>	<u>7</u>	<u>5</u>	<u>71</u>
	Totals	807	894	286	65	6	76
1945	Canneries	1,224	1,262	268	73	1	9
	Fresh Fish	<u>2</u>	<u>118</u>	<u>105</u>	<u>8</u>	<u>3</u>	<u>46</u>
	Totals	<u>1,226</u>	1,380	373	81	4	55
1946	Canneries	586	145	107	63	1	7
	Fresh Fish	<u>4</u>	<u>21</u>	<u>106</u>	<u>26</u>	<u>6</u>	<u>72</u>
	Totals	590	166	213	89	7	79
1947	Canneries	384	209	140	68	1	8
	Fresh Fish	<u>1</u>	<u>7</u>	<u>67</u>	<u>22</u>	<u>5</u>	<u>65</u>
	Totals	385	216	207	90	6	73

5. Detailed catch and effort data for Sockeye salmon

Lacking accurate detailed data for the total Skeena catch and effort, a group of fishermen, from one of the larger canneries and for which daily sockeye catch records were available back to 1935, was used as a representative sample of the total fishery. A comparison of the catch and effort data for this sample (Figure 8) should be made with that for the whole fishery (Figures 3 and 6).

The data for the whole fishery used in the figures were presented in tables V and XI, while that for the sample is given in table XV. It is evident that the sample which comprises about one-quarter of the total catch, is in general similar to the whole fishery.

TABLE XVSUMMARY

	<u>1935</u>	<u>1936</u>	<u>1937</u>	<u>1938</u>	
<u>CATCH - Number of fish</u>					
Japanese	40,776	125,957	66,008	75,827	98
Indian	39,579	64,514	32,709	37,143	62
White	<u>13,550</u>	<u>11,299</u>	<u>3,667</u>	<u>5,016</u>	<u>5</u>
	93,905	201,770	102,384	117,986	166

Weekly total catch

1st week ending:

	<u>July 7</u>	<u>July 4</u>	<u>July 7</u>	<u>July 2</u>	<u>Jul</u>
Week 1 -	10,000	23,000	5,000	16,000	13
" 2 -	10,000	29,000	10,000	12,000	21
" 3 -	23,000	40,000	21,000	13,000	27
" 4 -	20,000	39,000	17,000	24,000	25
" 5 -	15,000	32,000	24,000	20,000	36
" 6 -	9,000	18,000	11,000	15,000	24
" 7 -	7,000	15,000	14,000	13,000	16
" 8 -	-	6,000	-	5,000	4
Total -	<u>94,000</u>	<u>202,000</u>	<u>102,000</u>	<u>118,000</u>	<u>166</u>

<u>EFFORT -</u>	<u>1935</u>	<u>1936</u>	<u>1937</u>	<u>1938</u>	<u>19</u>
-----------------	-------------	-------------	-------------	-------------	-----------

Number of Boats -

Japanese	40	72	71	73	
Indian	63	63	52	50	
White	<u>27</u>	<u>17</u>	<u>4</u>	<u>8</u>	
Totals	130	152	127	131	3

Total Boat Days Fishing

Japanese	1,309	2,602	2,075	3,006	3,
Indian	1,884	1,902	1,416	1,962	2,
White	<u>701</u>	<u>418</u>	<u>110</u>	<u>252</u>	<u>5,</u>
Totals	3,854	4,922	3,601	5,220	5,

Average days fishing per boat

Japanese	33	36	29	41	
Indian	29	30	27	39	
White	26	24	28	32	

Total Weekly Days Fishing

week - 1				663	
" 2				640	
" 3				703	
" 4				710	
" 5				677	
" 6				666	
" 7				648	
" 8				<u>513</u>	
Total				5,220	5,

CATCH PER UNIT EFFORTAverage fish caught per boat-season

Japanese	1,019	1,749	930	1,039	1,3
Indian	644	1,024	629	734	1,3
White	502	665	917	624	8

Average number of fish per boat-day

Japanese	31	49	32	25	
Indian	22	34	23	19	
White	19	28	32	20	

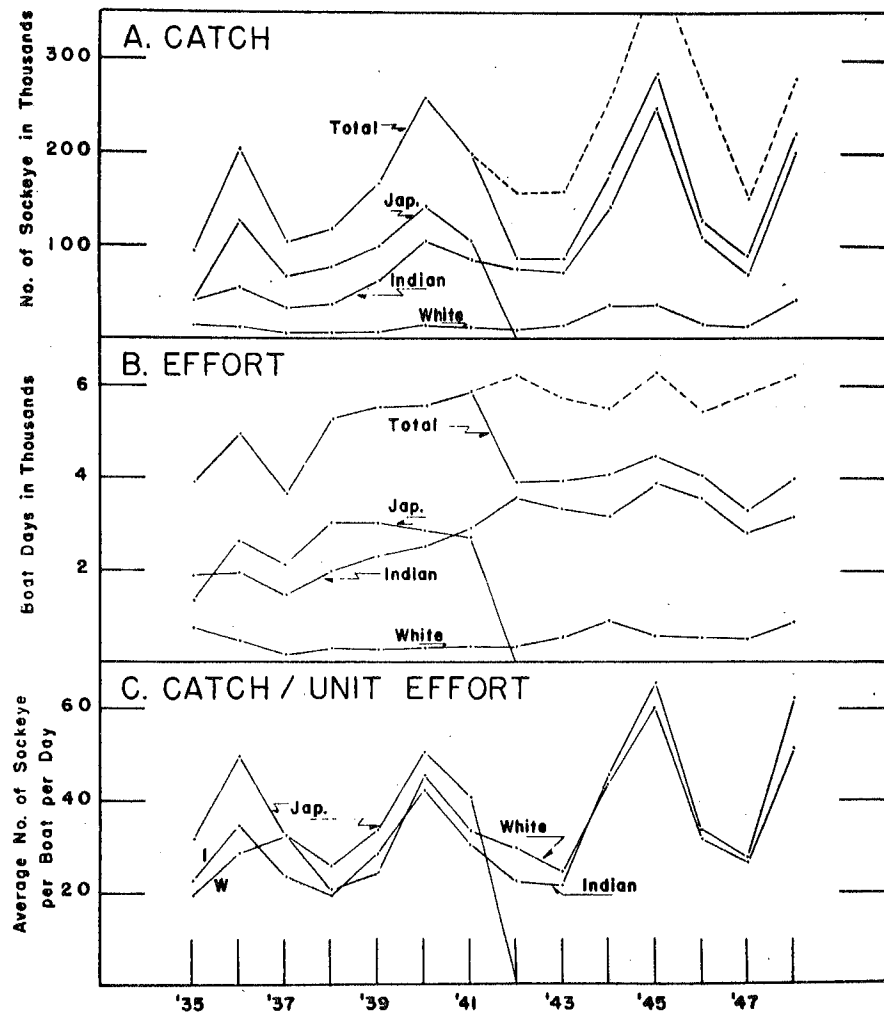


Figure 8. Detailed catch (a) effort (b) and catch per unit effort (c) for sockeye salmon based on data from the sample cannery. The dotted line in A and B indicates the probable totals if the Japanese had continued fishing.

It should be noted that up until 1942 about 50 per cent. of the fishermen in the sample were Japanese. Since their removal the Indians and whites have only partially replaced them so that the effort shown by the total number of days fishing each year has been reduced (Figure 8 - b). On the average the Japanese fished a longer season (2 to 4 days more than Indians and 2 to 9 days more than whites). They also fished harder each day as shown by their consistently greater efficiency (higher daily catch per boat - Figure 8 - c). The average daily catch from 1935 to 1941 for the Japanese is 37, for the whites 29 and for the Indians 29 fish. During the same period the Japanese caught an average of 1,378 fish per season, the Indians 1,023 and the whites 922. Thus since the removal of the Japanese in 1941 the intensity of the fishing effort and the resulting number of fish caught must be lower. In this regard the extremely low catch in 1942 and 1943 is probably due in part to this fact. If the Japanese had been allowed to continue fishing the total 1942 and 1943 catch would probably have been higher (see dotted line in Figure 8 - a) and allowing for the competition between gear the catch by the Indians and whites would have been correspondingly lower.

In this sample only gas boats are involved and the drum which was introduced in 1942 after the Japanese left, was in general use by 1944. The fluctuations in the number of fish (Figure 8 - a) and the catch per unit (Figure 8 - c) have given peaks four, five and three years apart respectively. Nineteen forty-five was the highest year, and if there had not been a strike at the first of the season an additional 40,000 fish would probably have been caught.

The total number of fish caught per week, given in Table XV is shown accumulatively in Figure 9. From these weekly totals it would appear that the run is usually under way (particularly in 1945) when the fishing season starts and is virtually over around the middle of August when the fishing season is finally closed. This unequal utilization over the years must have some effect

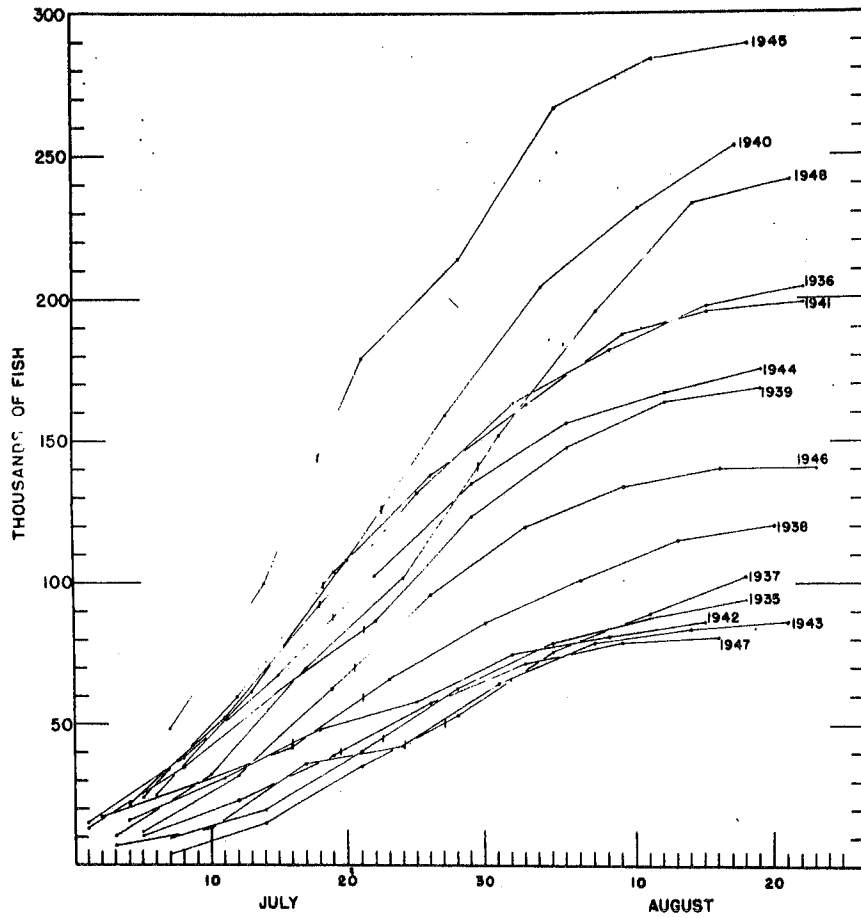


Figure 9. Seasonal occurrence of the Skeena sockeye run based on the cumulative weekly catches from the sample cannery, 1935 to 1948. Short vertical lines mark the mid-point of the season's pack.

on the conservation of the runs to individual tributaries. It is evident that there is considerable variation in the catch from week to week, sometimes due to weather conditions adversely affecting the fishing and other times apparently due to fluctuations in the size of the run. Thus analysis of the first few weeks of the fishing season gives only a general prediction of the size of the run that is in progress. The time at which fifty per cent. of the run has been taken has varied from July 18 to 23 with the exception of 1948 which was July 25 the latest year since 1935. At present it would appear that the exceptionally large and late run in 1948 was associated in part with abnormal weather conditions as well as with the occurrence of a large number of jacks in the 1947 spawning escapement.

The number of boat days fishing each week given in Table XV remains relatively constant from about July 10 to August 10. Prior to this period the fishing effort is somewhat reduced and following it the effort falls off rapidly. It would appear wise to curtail the season in August and spread the effort more equally over the run.

6. Cycles in the Catch as a Basis for Prediction

(a) Sockeye -

The only age data available from the past for Skeena salmon are the scale collections from sockeye. These data are published annually in the Provincial Fisheries Department's reports. The age and the proportionate number of sockeye cases caught in the Skeena river from 1917 to 1946 are presented in Table XVI. It is evident that the majority of the fish are either 4 or 5 years of age. From 1917 to 1936 the four year olds comprised 50% of the catch, but the average for the last ten years has dropped to 42.3%. For this latter period the 5 year olds averaged 53.6% of the catch.

In order to determine the accuracy of predicting the catch on the basis of the age groups and the size of the catches, the predicted catch given in Table XVI, was calculated by totalling the number of cases of each age class that were packed in the year of the spawning cycle, four, five or six years

previously. This assumes that the age composition of the sample is representative of both the catch and the spawning escapement. Also that the size of the ocean return is directly related to the size of the previous escapements, or in other words that the age classes show a repeatability in the size of the class. That the accuracy of prediction is poor is shown by the plottings of these predicted catches against the actual catches in Figure 10. The coefficient of correlation is .48 which is just significant ($P = .02$). For example a predicted catch of 50,000 cases has resulted in catches in the past of from 25,000 to almost 100,000 cases.

The poor relationship is no doubt the result of errors in both the data and the assumptions. It may be conceded that the random sampling of about 2,000 sockeye each year represents the age composition of the commercial catch. However, it will be shown later that the catch is a selected part of the sockeye population. This is due both to the selective action of the gear as well as the time of the fishing season. It is sufficient here to state that more of the older males than females escape prior to the opening of the fishing season and that more of the younger males, "jacks", pass through the gill-nets with the result that in recent years about 65% of the commercial catch is composed of females. That the number of fish of one age class fail to propagate themselves in a predictable manner is indicated by the fact that the proportionate size of the catches of 4₂ or 5₂ fish does not show a regular four or five year cycle respectively. The coefficient of correlation based on the data in Table XVI for the size of the four year olds in the catch of one year compared to that of four years previously is .43 (P is greater than .02). Similarly the coefficient of correlation for five year olds is .50 (P is less than .02).

Such factors as the great regenerative powers of a fish population, the apparent low efficiency resulting from a heavy spawning, the intense weeding out that takes place in a large ocean run, all contribute to the complicated relationship which must exist between the escapement and the resulting ocean return.

Table XVI

The percentage of each age class and the proportionate number of sockeye caught in the Skeena river from 1917 to 1946

Year	4 ₂		5 ₂		5 ₃		6 ₃		Total Catch	Predicted Catch
	%	Cases	%	Cases	%	Cases	%	Cases		
1917	57	38	29	19	9	6	5	3	66	-
18	51	62	34	42	9	11	6	7	123	-
19	27	50	60	110	9	17	4	7	185	-
20	15	14	71	65	6	5	8	7	91	-
21	69	28	22	9	6	2	3	1	40	-
22	70	71	16	16	12	12	2	2	101	-
23	56	74	29	38	8	10	7	9	132	106
24	23	33	69	100	7	10	1	1	145	148
25	51	40	45	35	3	2	1	1	78	105
26	62	51	26	21	9	8	3	2	82	89
Average:	48.1	46.1	40.1	45.5	7.8	8.3	4.0	4.0	104.3	
1927	62	52	28	23	9	8	1	1	84	103
28	51	18	39	19	7	2	3	1	25	83
29	62	48	30	24	6	5	2	2	78	159
30	39	51	52	68	8	10	1	1	131	89
31	40	37	30	28	28	26	2	2	93	82
32	44	23	37	20	7	4	12	6	53	51
33	57	16	36	10	5	1	2	1	28	64
34	58	32	34	19	7	4	1	1	55	81
35	49	26	31	16	18	10	2	1	53	117
36	67	55	20	16	11	9	2	2	82	78
Average:	52.9	35.8	33.7	23.7	10.6	7.9	2.8	1.8	69.2	
1937	45	18	40	16	11	5	4	2	41	42
38	64	30	15	7	16	8	5	2	47	49
39	50	34	35	24	11	8	4	3	68	50
40	80	93	15	17	4	5	1	1	117	82
41	39	32	52	42	8	6	1	1	81	44
42	36	11	54	16	7	2	3	1	30	53
43	39	11	39	11	16	4	6	2	28	51
44	37	25	52	36	7	5	4	3	68	127
45	20	21	63	66	12	12	5	5	104	57
46	13	7	70	37	8	4	9	5	53	60
Average:	42.3	28.2	43.6	27.2	10.0	5.9	4.2	2.8	63.7	
1947										30
48										41
49										64
50										88
Grand										
Average:	47.6	36.7	39.1	32.1	9.5	7.4	3.7	2.9	79.1	

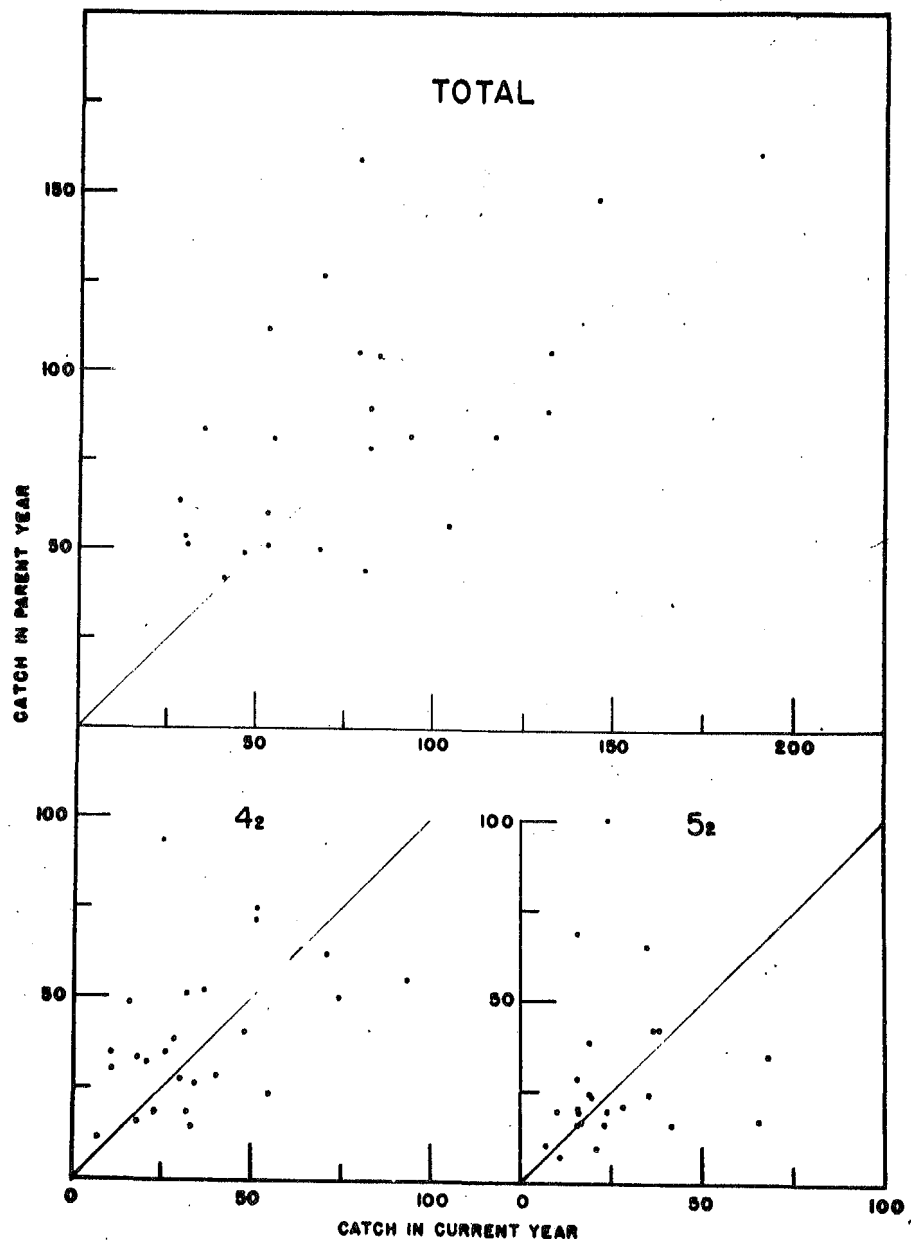


Figure 10. Relationship of the current year catches with parent year catches plotted from data in Table XII. The correlation coefficient (r) for the total catch from 1923 to 1946 is .48. That for the 4₂ catch from 1921 to 1946 is .43, and for the 5₂ catch from 1922 to 1946 .50.

It is pertinent that at Karluk, Barnaby (1944), no correlation was found to exist between the counted escapement and the resulting commercial return over 16 years and for the years 1921-26 the ratio of catch to escapement varied from .8 to 1.2. Thus the age and catch data does not provide a usable basis for prediction of the escapement or the resulting catch.

As the catch indicates the exploitation by the fishery it is interesting to examine the cycles in the catch alone. Since 1928 a five year ^h rhythm is evident in the catches (Figures 6 & 7) except for the failure in the 1935 and the success in 1948. The coefficient of correlations are ^{.85 (P < .01) omitting 1935 and 48} ~~.44 (P > .10) including 1935 and 48~~ for predicted catch based on the catch five years previous. Thus in the last 21 years a regularity has occurred in spite of the seasonal variations in physical, biological and economic conditions which effect the catch. The catch figures alone form a reasonable basis for future prediction on the basis of a five year cycle with only 2 exceptions in ^{the} last 21 years.

An alternative method of using the age and catch data in Table XVI has been demonstrated by W.F. Thompson (1945) wherein a ratio is calculated and termed the "index of success of return". Following this method the years of depletion are those in which the catch failed to repeat itself on the basis of age composition and the size of catch of the parent year or years. The ratios of the catch of the return years for each age class divided by the catch of the parent years x 100 were calculated from Table XVI and the resulting index presented in Figure 11. In the 24 years from 1933 to 1946 there was a total of 14 years of depletion in which the predicted catch was too high. The 1925 to 1929 period involved all age classes and is most critical in causing the overall decline in the sockeye catch. The 1933 to 1935 period also involved all age classes and the depletion of the 5₂'s and 6₃'s persisted to cause a small decline in 1937 and 1938. In the 1942-44 period only the 4₂'s and 5₃'s failed to return. The failure in 1946 was again due to all classes except the 6₃'s. In general the 4₂ group has controlled the time of

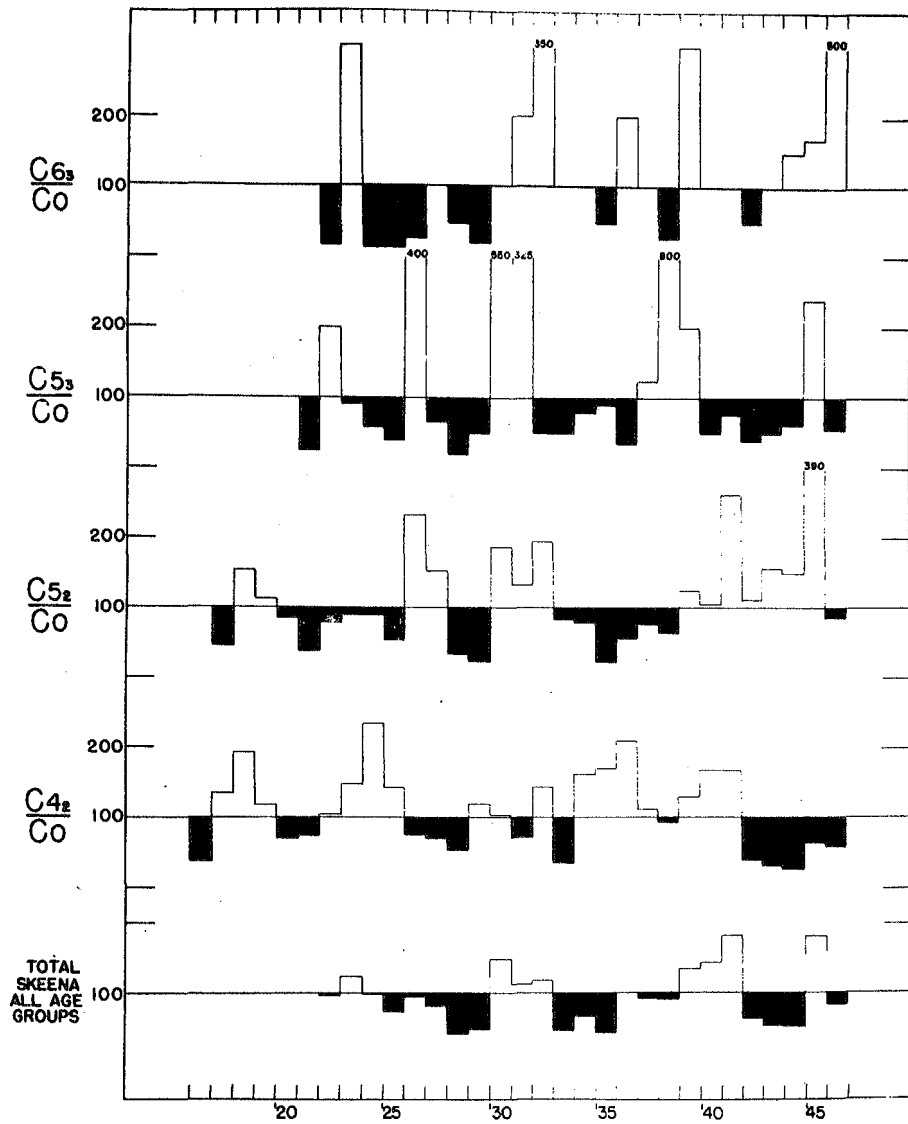


Figure 11. The index of success of return (current catch / parent catch) for Skeena river sockeye based on Clemens data, 1916 to 1946.

depletion but the other groups, particularly the 52's, have added variations to the size and duration of the periods. Over the years the older age groups have been most adversely affected as indicated by the ratio of the number of years of abundance to years of depletion, $5_3 = .23$; $6_3 = .9$; $5_2 = .76$; $4_2 = 1.0$. The five and six year classes accounted for the peak catches in 1930 and 1945, while the 1940 high was due to the abundance of 4-year olds. The 1935 peak did not materialize as all age classes failed, although the catches in 1934 and 1936 indicate that a peak should have been expected.

(b) Pink Salmon -

As these salmon always mature at two years of age, the two cycle years, odd and even, represent distinct populations. When the correlation between catch in one year and the resulting return two years hence is considered, a low correlation value is found for the odd year cycle (coefficient correlation = .5 **significant** with $P = .02$), and a highly one for the even year (coefficient correlation = .93). In the even year cycle the outstanding difference occur in the good returns from the years 1910, 1916 and 1934; and the drastic failure from the year 1930 and 1945.

The application of the index of success of return applied to pink salmon is shown in Figure 12. It is evident that the catch of one year gives a poor indication of the size of the catch two years hence. This means that the catch is either a poor indication of the size of the escapement and hence the population, or that the factors which influence catch, escapement and resulting return are extremely variable. Since the failure of the large cycle of 1930 to repeat itself in 1932 the even year cycle has had only one success - 1936 - and six failures, while the odd year cycle has increased the importance with three successes and three failures. The catch in 1946 and 1947 has produced a record low in both cycles, but in 1948 the catch would indicate that the even year cycle has reverted to an average condition. The catches of pinks in

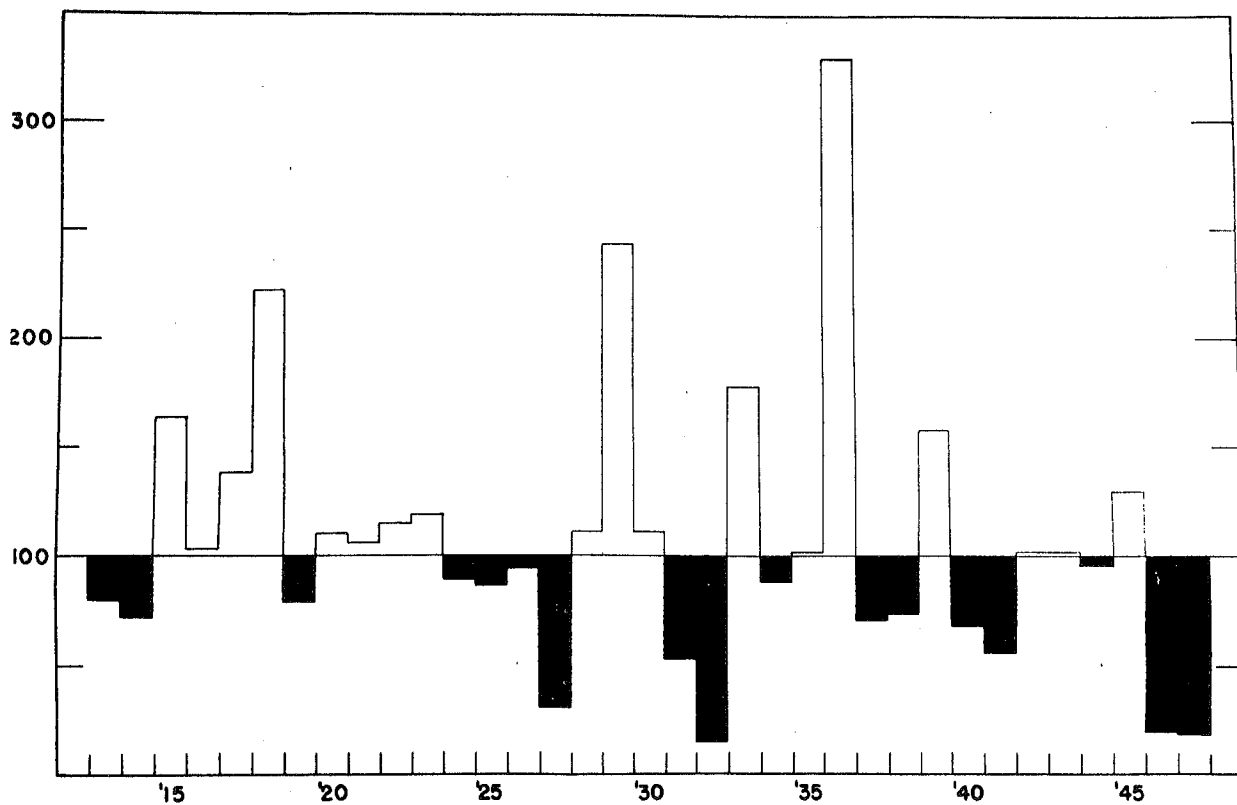


Figure 12. Index of success of return for Skeena river pink salmon, 1913 to 1947.

Southeastern Alaska do not show the same cycles, for the failure during the 1930's was not as bad as in northern British Columbia and all the last few years have been low with the exception of 1941 and 1942.

From the above it is evident that any prediction based on catch alone will be inaccurate. In pink salmon it would appear logical to apply a correction, to any prediction based on catch, for the effect of the stream discharges during the spawning year. When one realizes that the last two pink catches are the lowest on record yet the seedings were good, especially in 1945, and that the condition is more general than in the Skeena area alone, it is evident that the cause should be sought in meteorological conditions.

The rainfall data indicates that August and September 1945 were dry, which corroborates the field observations that the pinks had difficulty getting from the main Skeena river into the tributary streams and that the areas available for spawning were reduced. Following this dry period exceptionally high rainfall around Terrace in October and November resulted in extreme freshets which undoubtedly scoured the spawning beds quite thoroughly. In 1944 the conditions were reversed as the rainfall was high during July, August and September and low for October, November and December. This would result in easy access to the spawning beds with probably later drying out and frost damage to the eggs, as reported from Gold creek during the winter of 1945-46.

The catch plus escapement of the Skeena river pinks has been compared with the sum of the means of the stream discharges in August and September. The following sources of error must be kept in mind. In pinks the Skeena catch is poorly separated from the total Skeena pack. The escapement figures are quite inaccurate as they are based on subjective estimates. It is of interest that in the odd years the escapement estimates vary with the size of the catch but in the even years a similar relationship does not exist. The best stream discharge records available are for the Bulkley river where comparatively few of the pinks spawn. However, in general they show

were available for the pink spawning areas, rather than for the Bulkley river, a better correlation between catch and stream discharge of the spawning year should be achieved.

The cycles in the catch and predictions therefrom for the chum, coho and spring salmon will not be attempted. A thorough study of the fresh fish establishments and a more accurate separation of the Skeena catch figures would have to be made before any cycles could be established.

7. Effect of Fishing Effort in Causing Decline

As a study of the mature sockeye and the spawning grounds of the Skeena has disclosed no evidence of a change which might be considered as imposing any new restrictions on the success of spawning in recent years, we must examine the effect of man's exploitation as the chief possible cause of the decline in the population. To quote from Barnes and Gregory 1939, "conservation of natural resources is coming to be accepted as a necessity if such resources are not to vanish from the earth. Past experience has demonstrated the vital nature of this conservation, constituting as it does a restraint on exploitation of the natural resource in order that a future supply may be assured. A competitive industrial system has made it virtually impossible for a brake to be applied on exploitation except by government control. Thus the function of conservation is to offset the dangers to supply inherent in technological advance. Social control of fish resources is now an accepted philosophy; it is within the province of the government to protect and supervise yields and it is its duty to do so. Fishing should be allowed only to the escapement limit. "paradoxical though it may appear, it is nevertheless true that none are more anxious to save and perpetuate the salmon than the canners themselves and yet their methods are such as, if continued, will very soon destroy them"."

(a) Relationship of effort and catch during the history of the sockeye fishery

The number of gill-net licences issued each year have been presented in Table V and Figure 3. It should be realized that these data do not adequately represent the true fishing intensity for each year. First, the boats may not fish with the same intensity from year to year, so that in a year with a small population the fishermen become quickly discouraged and either stop fishing or move on to more productive areas, or vice versa in a year with a large population. Data to correct this error such as number of days fishing are not available for the whole fishery, but one is left with the impression that the size of the catch is probably the best indication of the size of the population present and that it regulates the intensity of the effort within each fishing season. Secondly, the effect of the different relative efficiencies of the Japanese, Indian and white fishermen (Tables VII and VIII) should be considered especially in the two periods 1921-24 and 1942, when the numbers of Japanese were greatly reduced.

The sockeye catch figures presented in Table XI and Figure 6 are considered to represent the commercial exploitation with reasonable accuracy.

It is evident from Table V that from 1877 to 1920 the effort was increasing. Since then it levelled off up to 1933 after which time it has been declining. It would appear from Table XI that the catch reached its peak about 15 years earlier, namely 1905 to 1920. This time, when about 1,200 gill-net boats operated in the Skeena (many above the present boundaries) should be considered when the most serious overfishing occurred. Since then in the face of a decline in the catch, a reduction in the effort has followed naturally probably due to economic considerations. It is of interest to compare the catches obtained by 800 gas boats in recent years to the catches of about twice as large made by 800 sail boats in 1910. This indicates the change that has taken place in the size of the sockeye population between the two periods.

The fact that both the catch and effort are still gradually declining rather than maintaining an equilibrium would suggest that each year's effort is still too large on the average for the present sockeye population to support.

When the number of licences is weighted for the different relative efficiencies of Japanese (1.8), Indian (1.0) and white (1.0), and a regression equation is computed for the period from the peak effort (1922) to the present (1946), the effort has decreased from 1,584 to 829 units of fishing effort or a drop of 47.5%. In recent years the introduction of the drum may be considered to offset some of this reduction in effort. During the comparable period for the catch, using the regression equation computed from the peak catch in 1905 to 1945, a drop from 93,000 to 57,000 cases or 38.8% is obtained. If the regression equation from 1925 to 1945 is used the decrease is only 16.5%, or from 74,000 to 62,000 cases. Thus it would appear that during the periods of decline in both catch and effort the latter has fallen off at the faster rate. This is the reverse of what occurred during the early period of the fishery when the catch increased at a faster rate than the effort. The chief factor governing the events were probably the fishing of a limited population, competition between gear and the economic necessity of operating at a profit.

When the annual fluctuations in the effort and catch are examined together it is apparent that the effort fluctuates much less than the catch and that the only seasons which show a similar trend are those in which the drastic reduction in effort was made by curtailing the Japanese in 1921-24 and eliminating them in 1942. When the catch and effort data are plotted in Figure 13 to show their relationship to each other, the years become arranged in curved lines with represent years of equal availability (an approximate measure of population size). Along these lines an increase in effort produces a disproportional increase in the catch. The years 1928, 1933, 1942, 1943 and 1947 produce a catch which is low for the effort expended and such years as 1930,

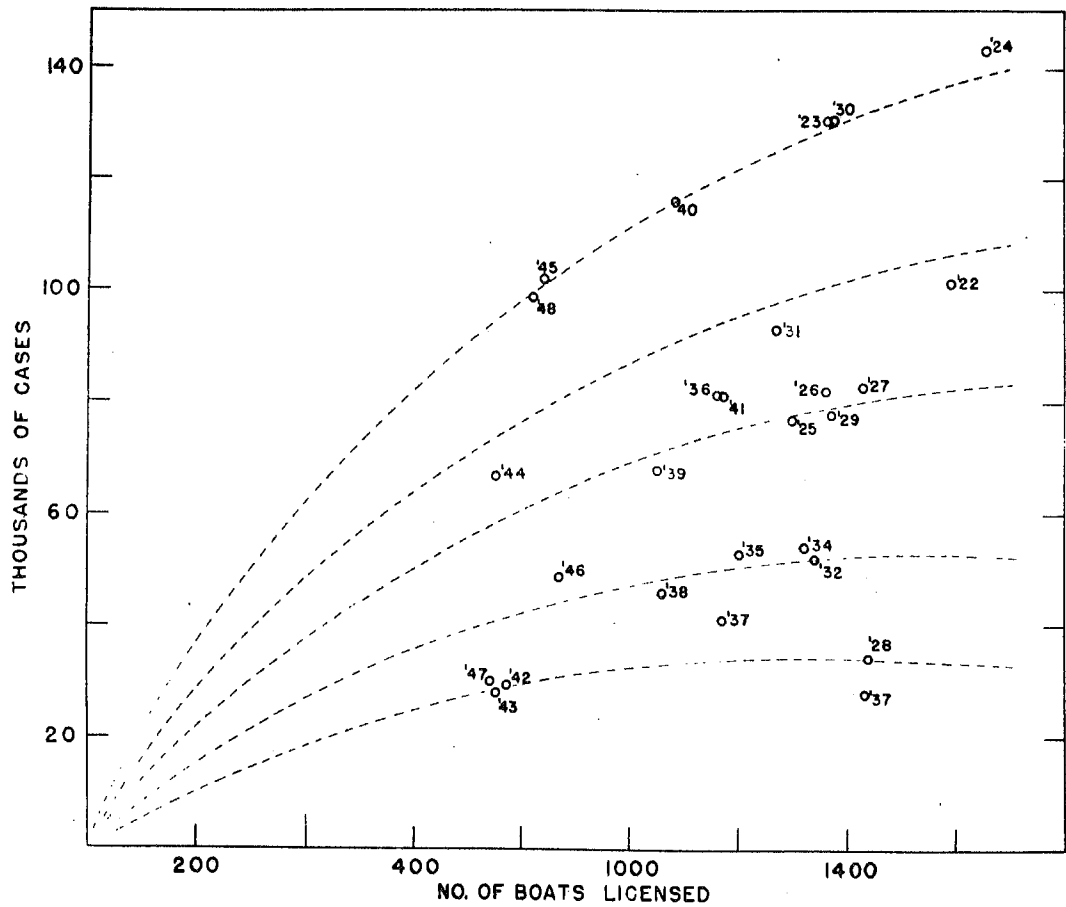


Figure 13. Relation of catch and effort for the Skeena river sockeye fishery, 1922 to 1948.

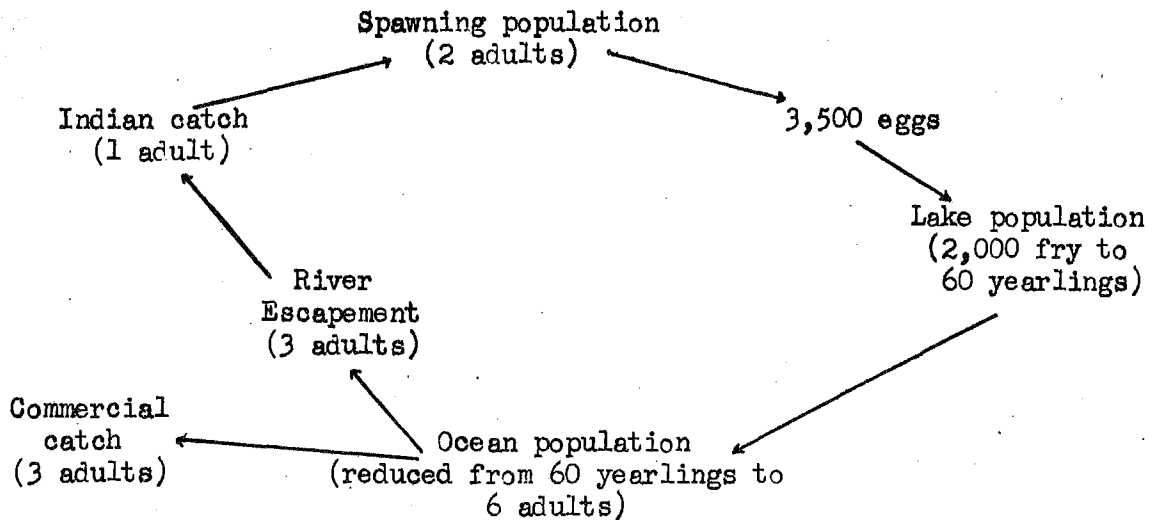
1940 and 1945 give a high catch per effort. The former periods of extraordinarily low returns are probably the result of extremely unfavourable conditions in the life history of these populations, while the latter periods are probably the result of extremely favourable conditions.

If the population were unlimited then a linear relationship whereby an increase in effort would result in a proportionate increase in catch should apply. However, the population is limited and the effort is uniformly high and regulated by the catch, since it is economically unsound for more than a limited number of boats to operate during the short fishing season. It would appear at the present time that the reduced effort now operating may further reduce the population below its present level and an equilibrium between effort and catch may never be reached until the fishery is either drastically depleted or economic considerations and conservation measures greatly curtail the effort.

In the other species of salmon a similar situation possibly exists but the catch and particularly the effort data is too inaccurate to hazard an opinion. It might be pointed out that the sudden decline of pinks in 1932 and again in 1946 is probably biological and cannot logically be attributed to fishing effort.

(b) Relationships in the Sockeye Population - 1944 to 1948

The general relationship of the commercial and Indian catches, escapement and size of population may be pictured as follows: The figures, based on tagging and marking experiments, indicate the number of fish involved from a spawning pair.



One of the most important objectives of any investigation of Pacific salmon should be to obtain the relationship between catch and escapement so that a basis for setting the proper balance between these two can be set forth and optimum exploitation result, yet the run be guaranteed for perpetuity. The catch - commercial and Indian - while not at present set down with absolute accuracy (commercial catch may have a possible error of 10% either way and the Indian catch a 50% error) can be recorded more accurately by making such a condition mandatory. The absolute estimation of escapement to a large river system such as the Skeena has always been a difficult task which so far has baffled investigators although the ultimate goal is gradually being approached.

Each year on the Skeena, the spawning grounds have been closely inspected and counts made of the fish thereon in accordance with definite procedures. The construction and operation of a counting fence on the Babine river, however, has made possible a count of all the fish entering this, the most important sockeye spawning area on the system, and has enabled comparison between the observational estimates and the actual counts. The observational estimates were found to be approximately one-half of the actual counts (escapement 100% error).

The returns from tagging at the mouth of the Skeena have provided a means of estimating roughly the spawning escapement and the Indian catch on the basis of the number of tags recovered in the commercial catch. It is difficult to reconcile the high percentage of tags returned by the Indian fishery, unless they bring tags which have been caught in the ocean and sell them upcountry, or unless they fish selectively for tags. The percentage of tags left for the escapement after the commercial and Indian tag returns have been made is usually high, because it includes all tags which have been lost from the fish, not seen or not turned in. Thus, estimates of the Indian catch and escapement based on tagging are unaccountably high, while the previous estimates based on observation are low. More probable figures for the Indian catch and escapement are no doubt to be found part way between these two extremes. The Indian fishery would appear from general observations to maintain itself at a fairly constant level each year, thus fluctuating less than either the commercial catch or the escapement (the Indians catch only what they need for food). For the period 1944 to the present, the estimates for the commercial and Indian fisheries and the escapement based on observational and tagging data as well as more probable figures are given in Table XVII.

Table XVII Summary Data on Skeena Sockeye Population

	<u>1944</u>		<u>1945</u>		<u>1946</u>		<u>1947</u>		<u>1948</u>	
<u>Observational Estimates</u>										
Commercial	807,000	70%	1,227,000	71%	621,000	62%	385,000	50%	1,200,000	75%
Indian fishery	58,000	5	56,000	3	39,000	4	41,000	5	50,000	3
Escapement	<u>285,000</u>	<u>25</u>	<u>447,000</u>	<u>26</u>	<u>341,000</u>	<u>34</u>	<u>345,000</u>	<u>45</u>	<u>350,000</u>	<u>22</u>
	1,150,000	100	1,730,000	100	1,001,000	100	771,000	100	1,600,000	100
<u>Tagging Estimates</u>										
Commercial	807,000	41	1,227,000	26	621,000	30	385,000	19	1,200,000	22
Indian Fishery	138,000	7	425,000	9	207,000	10	243,000	12	600,000	11
Escapement	<u>1,020,000</u>	<u>52</u>	<u>3,060,000</u>	<u>65</u>	<u>1,240,000</u>	<u>60</u>	<u>1,400,000</u>	<u>69</u>	<u>3,700,000</u>	<u>67</u>
	1,965,000	100	4,712,000	100	2,068,000	100	2,028,000	100	5,500,000	100
<u>More Probable Estimates</u>										
Commercial	807,000	53	1,227,000	40	621,000	45	385,000	34	1,200,000	48
Indian fishery	90,000	6	150,000	5	75,000	5	70,000	6	150,000	6
Escapement	<u>620,000</u>	<u>41</u>	<u>1,360,000</u>	<u>50</u>	<u>680,000</u>	<u>50</u>	<u>690,000</u> #	<u>60</u>	<u>1,150,000</u>	<u>46</u>
	1,517,000	100	2,737,000	100	1,376,000	100	1,145,000	100	2,500,000	100

- In considering this item, it must be remembered that the escapement in 1947 was constituted of just over 45% jacks - precocious three-year-old males under 19 inches in length. Since the sexes in the remaining normal-sized sockeye were about equal, these jacks were unnecessary for efficient fertilization and the effective escapement must be considered as only one-half this figure.

It is easy to see that the estimates based on observations are large for the commercial catch (50 to 70%) but when based on tagging are small (19 to 41%), while the Indian catch and spawning escapement are small when based on observations (3 to 5% and 25 to 45% respectively), and are large when based on tagging (7 to 12% and 52 to 69% respectively). The tagging estimates are the most erratic and difficult to rationalize. It must be borne in mind that the tags are not randomly distributed throughout the population but are placed on the fish during the first half of the run and when the fish are part way through the fishery the true situation is probably close to a spawning escapement of 50%, a commercial catch of 45% and an Indian catch of 5%. Why such a condition should result in a gradual decline is not clear in the face of the statements issued regarding the success of the White Act in Alaska which provides for a 50% escapement. The size of the population determines the size of the catch and the spawning escapement but has not such a marked effect on the Indian catch. The latter is due to the fact that the Indians require a certain number of fish each year so that they tend to fish heavier in a poor year and lighter in a heavier year.

The more detailed data from the sample cannery and that from the total fishery is summarized in Table XVIII and Figure 14.

Table XVIII Summary of the catch effort of sockeye tagging data for the total fishery and the sample cannery 1944-48

Total Skeena Sockeye data

<u>Year</u>	<u>Catch</u> <u>No. fish</u>	<u>Effort</u> <u>No. boats</u>	<u>Catch/Effort</u>	<u>Rate of</u> <u>Exploitation</u> <u>(% Tag Returns)</u>
1944	807,000	749	1070 (1340)#	.41
1945	1,227,000	838	1460 (1425)#	.26
1946	621,000	878	710 (811)#	.30
1947	385,000	750	520 -	.22
1948	1,200,000	827	1450 -	.22

Sample Cannery Sockeye Data

<u>Year</u>	<u>Catch</u> <u>No. fish</u>	<u>Effort</u> <u>No. boats</u>	<u>Boat</u> <u>Days</u>	<u>Weighted Catch</u> <u>per Boat Day</u>	
1944	177,000	126	4012	44	-
1945	285,000	149	4421	64 (7 day strike)	-
1946	140,000	151	4034	35	-
1947	81,000	138	3222	27	.054
1948	242,000	135	3960	61	

- Average number of fish per boat from Prince Rupert Fisheries Office

It is customary to use an index of relative abundance (catch per unit effort) to indicate population size. However, in this data, it is noted that catch and catch per unit effort indicate the same relative abundance especially in the more accurate data from the sample cannery.

Ricker (1940) prefers to use rate of exploitation or per cent. fishing mortality to calculate population size rather than catch per unit effort. Many of the assumptions which he postulates for his theoretical fishery hold approximately except that there is probably some competition between gear in both space and time, and that the population varies greatly from year to year in an unpredictable fashion. In addition there is a continual interchange of fish in and out of the fishing area and to a certain extent the effort is regulated by the catch from year to year and week to week, rather than the reverse condition. This fundamental equation (19), page 49, relating effort

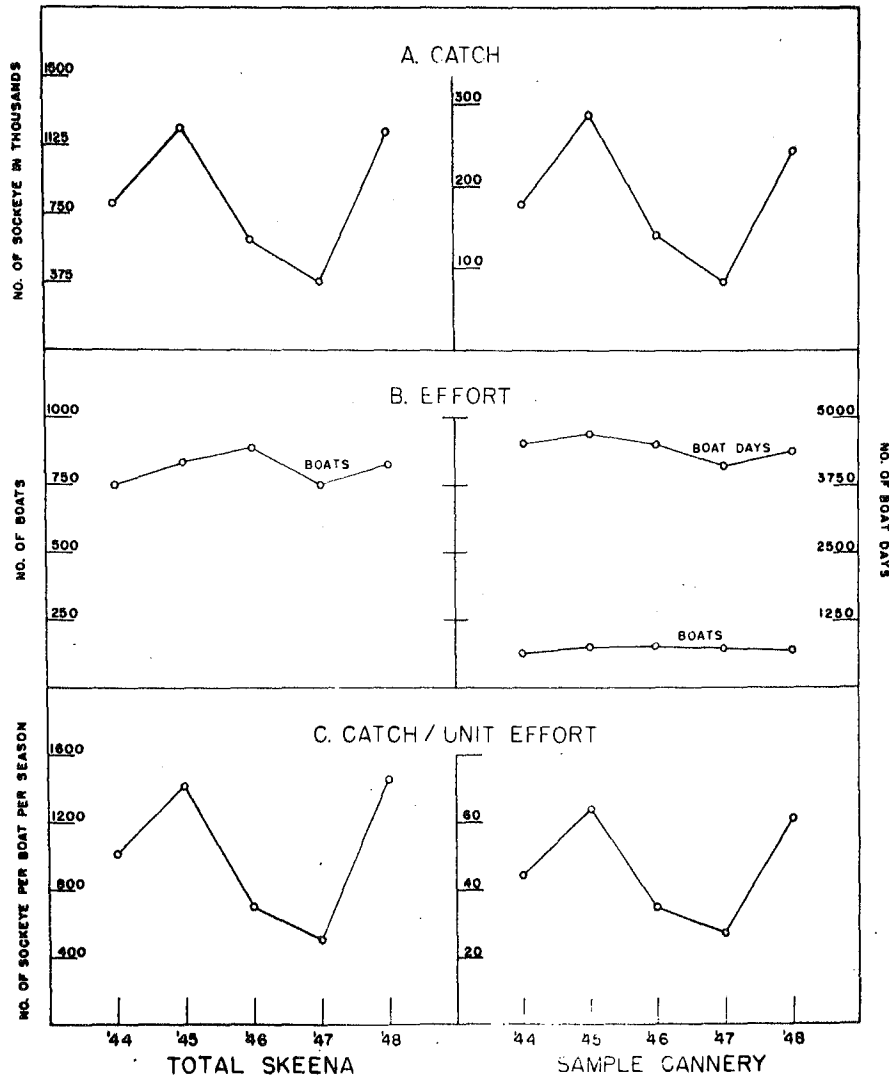


Figure 14. Relationship of catch (A) effort (B) and catch per unit effort (C) for the total Skeena sockeye fishery and for the sample cannery, 1944 to 1948, based on data in table XVIII.

and rate of exploitation is as follows. "The logarithm of the complement of the rate of exploitation (m) varies directly as the fishing effort." When the above data are considered in the light of the various approximations suggested on page 50 for the above relationship, poor agreement was found.

(a) In the years in which the effort is the same, the fishing mortalities should be equal and the ratio of the catches should equal the ratio of the populations (catch proportional to population). For example, 1944 and 1947 have equal effort but unequal (m), namely .41 and .22.

In summary the catch figures which are the most accurate and easily obtainable are probably as good an indication of the size of the population as any other index. Thus, the years in rank order of population size, 1945 is the largest and 1947 the smallest. On the basis of catch, catch per unit effort and observed escapement estimates, 1944 was larger than 1946, but on the basis of fishing mortality 1946 was slightly larger than 1944. (2,070,000 as against 1,940,000). The estimated escapement figures indicate the size of the population in all years except 1947, when the surplus of jacks must be taken into consideration.

The important thing is that the present catch, of between 35 and 55% of the run, is apparently too large for the present population to support. On the basis of what is already known, a quota system based on the size of the catch during the first few weeks of fishing might be instigated. The spawning escapement counts would provide a check as to the fishing mortality so that over the years a sound basis could be arrived at to adjust the catch to assure the optimum escapement necessary for this river.

8. Selective fishing by the gill-net fishery

In nature, predators often serve a useful purpose by weeding out the weak and aberrant members, thereby controlling and strengthening the population. The effect of the gill-net fishery on the Skeena salmon population can hardly be considered to be of this nature. It would appear to be a heavy drain on the larger and more productive members of the population. The fishery is selective both because of the mesh size used in the gill-nets and the time of the fishing in relation to the time of the run. This results in the commercial catch or any samples taken from it being unrepresentative of either the total population or the spawning escapement both for age and sex.

Withler (1945) from a study of the age and sex distribution throughout the fishing season has shown that the percentage of the 4₂ age group (particularly the females) increases while the 5₂'s decrease (particularly the males) with the result that the total females comprise an increasing proportion of the catch. In other words the males of each age group run prior to the females, and the older age groups precede the younger ones. From data on sockeye recorded by Clemens (1935, 1947) the males appear to have a tendency to mature earlier than the females so that there is a higher proportion of females in the older age groups (5's and 4's) while the 3-year-olds are almost all males. These small precocious males, less than 19 inches in length, are usually called "jacks" and are not easily caught in the gill-nets, but readily show up on the spawning grounds as runts. Disregarding the jacks the males are on the average about an inch longer and show more variation in length than do the females.

In the Skeena fishery the commercial sockeye catch has always contained more females than males in the 5₂ age group. Up to 1935 when the season opened on June 20, the average percentage of females was 56, and since then, with the opening date as the last Sunday in June, it is 63 per cent. This is apparently due to the fact that more males than females in the group run prior to the opening of the fishing season. In the case of the 4₂ age group

which runs later, the males average 53 per cent. up to 1930 at which time the mesh size was reduced so that the smaller females might be caught. Since then the male average dropped to 43 per cent. which means that some of the males either run prior to the fishing season or many mature a year earlier to become jacks. The jacks appear to run later in the season than the other groups.

The selective action of the fishery was most striking in 1947 when a large proportion of the population came in to spawn as jacks. Dr. Clemen's scale samples, taken from sockeye caught by the commercial fishery using gill-nets with a mesh size of $5\frac{3}{4}$ inches, contained only 6 jacks in 664 males, or .3 per cent. The females made up 66 per cent. of the samples or 1,305 fish. The number of jacks caught by the tagging boat, using a mesh size of $3\frac{1}{2}$ inches, was 360, or 15 per cent. They increased in numbers as the season progressed, constituting 4 per cent. of the 422 sockeye tagged in June and 29 per cent. of the 678 caught from July 23 to 27. Our own sampling of the commercial catch also indicate a scarcity of jack sockeye (6%) and a higher percentage of females (59%). When the fish passed upriver the selection by the Indian fishery, using gaffs and set nets, was not marked. From the return of tagged fish the Indians took about four times as many jacks as did the commercial fishery; namely 14.1 per cent. of the tags returned by the Indians and 3.9 per cent. returned by the commercial fishermen were jacks. The number of jacks estimated in the escapement was still higher or about 25 per cent. at Moricetown and 45 per cent. at Babine.

In recent years the sockeye season has opened when the run is at least 15 per cent. under way and lasts until the end. If the present season which opens on the last Sunday in June and closes between August 15 and 25, were shortened from July 1 to August 1 or lengthened from June 15 to August 15 it would fish the run more evenly as a whole. In view of the depleted condition of the run, the former should be more strongly recommended.

The effect of selection was reversed for pinks and chums as the males were more frequently caught in the commercial gill-nets. In pinks the sex selectively is high. The samples in 1946 contained 90 per cent., in 1947 - 75 per cent., and in 1948 - 65 per cent. males. In spring and coho the sex ratio in the commercial catch is approximately equal but more jacks are observed upcountry.

To date no net selection experiments have been performed on the Skeena salmon but a proposed experiment has been drawn up to determine the size, sex, and migration periods by experimental netting so that the fish now caught by the standard commercial gill-nets may be evaluated. That the sizes and sexes are selected by different meshes is evident from work done on the Fraser salmon in 1947. From this it might be inferred that an increase in the present maximum mesh size for sockeye of about one inch would probably equalize the sexes in the catch if the fishing season was also adjusted earlier to cover the spawning run more evenly. In the case of pink salmon the mesh size would probably have to be lowered about one inch. However, before any recommendations to alter the size of the mesh or the period of fishing could be made much experimentation would have to be done. The ultimate goal would be to have a more uniform fishing of the population in the interest of conservation so that both the large and small fish will be allowed to escape equally to each tributary and yet have the industry catch fish with the same or greater efficiency.

9. Influence of the Nass and Alaskan Fisheries on the Skeena River Populations

In recent years the practice has been to catch salmon by means of highly mobile gear at increasingly greater distance from the mouths of the rivers in which they spawn. With this in mind and with the knowledge gained from past tagging programmes which indicate that fish tagged in southeastern Alaska and off the Nass river have been caught later in the Skeena, we will now examine

a few features of the salmon fisheries in these areas to see what possible drain they might exert on the Skeena salmon populations.

(1) Nass Fishery

Up to the early 1930's the Nass salmon catch was packed on the river itself at four canneries, Kincolith (closed prior to 1936), Mill Bay, closed in 1936, Arrandale (closed in 1943) and Wales island (closed in 1945). Thus an increasing number of Nass fish has been canned on the Skeena, making it more difficult to keep the Nass and Skeena catches separate. In the last two years, 1947 and 1948, all the fish have been transported to the Skeena under a cooperative packing effort from the area around Finlayson island off the mouth of the Nass. Most canneries consider these fish to be bound for the Skeena and the limited amount of tagging seems to bear this out, but there is no general agreement as to the splitting of these fish into Nass and Skeena catches. A similar situation, in which the fishing effort shifts north at the first of the season and the split of the catch is uncertain, has occurred each year since 1935. Prior to this the seasons opened earlier (on June 20) and an eight-mile closed area existed between the Nass and Skeena fishing areas from Point Ryan to Finlayson island, so that the catches could be kept separate. At the present time fish allotted to the Nass catch are those caught in Portland inlet or well within the mouth of the Nass river itself.

On the basis of our recent tagging programme only about one per cent. of the fish tagged off the Skeena mouth are returned from the Nass, but from ten to twenty per cent. of the fish tagged off the Nass in Steamer passage are taken at the mouth of the Skeena. A generalization as to the possible migration routes which the salmon take is shown in Figure 15. The oceanographic survey carried out in 1948 appears to substantiate the view that the fresh waters from the Nass and Skeena flow mainly northwestward in the direction from which the returning salmon appear to come as deduced from tagging

experiments and fishing experience.

When the catches from the Nass and Skeena rivers are compared the general downward trend in recent years is similar, although the Nass catch is only about one-third that of the Skeena. The Nass catches fluctuate more widely than the Skeena. This may be due to supplementing the effort of a constant number of Nass Indian fishermen by a large influx of fishermen into the area when there is a good run. In general the cycles are similar, both having lows in 1921, 1928, and 1933, and highs in 1925, 1930 and 1936. In recent years marked exceptions have occurred in 1940 and 1945 when the Skeena catch was high and the Nass low, and in 1934 when the reverse was true.

On the basis of Dr. Clemens's yearly age determinations from the commercial catches of both rivers since 1912, there seems to be little possibility of crediting the Skeena with Nass fish. For example, the large Skeena catch in 1940 was due to a large 4₂ age class and in 1945 to a large 5₂ age class, yet the Nass failures in these years were due to the small size of the dominant age group, the 5₃'s. On the average the two populations are significantly distant, with 54 per cent. of the Skeena fish being 4₂'s and 11 per cent. 5₃'s, whereas the Nass are 17 per cent. 4₂'s and 64 per cent. 5₃'s. The Nass 4₂'s average about .7 inches longer and .6 pounds heavier and the 5₃'s are two inches longer and 1.2 pounds heavier than those from the Skeena. Dr. Clemens in the 1932 Provincial Report of Department of Fisheries has compared the Nass and Skeena data for the years 1917 to 1932.

When the traps in nearby Alaska start operating in the latter part of July or the early part of August, the Nass fishery does not show a noticeable loss in catch and it is generally considered that the traps catch more Skeena fish than Nass. The latter may be true as the Nass sockeye appear to run earlier than the Skeena.

(ii) Alaskan Fishery

It is common knowledge that the salmon populations along the Siberian coast have fallen far below their original level of abundance owing to the

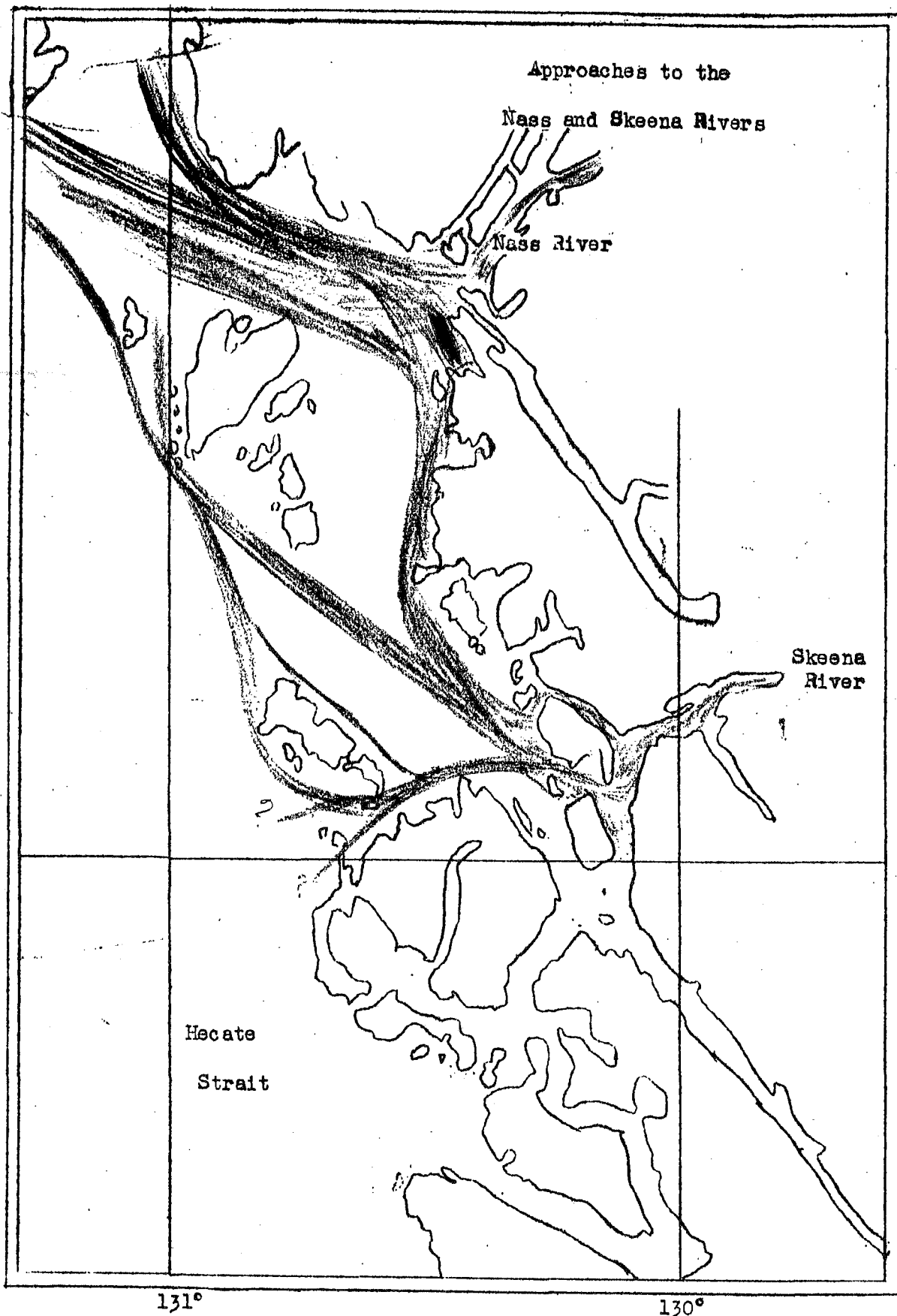



Figure 15. Probable Migration Routes of Sockeye Salmon.

Skeena 

Nass 

imposition of an unrestricted offshore as well as inshore fishery upon them. This also occurred in Alaska up to 1919. Economic factors reduced the fishing intensity around 1921 and since 1924 the White Law, providing for a 50% escapement to all streams, prevention of fishing within 500 yards of any stream, and the limitation of fishing to define periods during the migration of the salmon, built the populations up until by 1930 they had reached their former level of abundance. This has entailed a great many sacrifices on the part of the industry and has forced it to forego the making of large profits in better times in order to provide for future runs of salmon. For example, the gill-net fishery at Bristol Bay only remains open for 20 to 22 days each year and in 1935 was virtually closed for the season.

The Alaska pack is about four times that of British Columbia and the major cycles are similar with sharp dips downward in 1921, 1927 and 1935. Some of these cycles are probably due to economic reasons, for example, the poor salmon prices in 1921. There are 113 canneries in Alaska (46 in S.E. Alaska) compared to 37 in British Columbia. In South Eastern Alaska 65% of the salmon are caught by 284 traps, 30% by seines, 3% by gill-nets and 3% by lines. From a comparison of the catch data it is evident that the major cycles for Skeena and South Eastern Alaska are related and such things as the collapse of the salmon market in 1921, the war booms and the recent failures are evident in both.

The present situation would appear to be that the sockeye or reds in southeastern Alaska have been declining in recent years (1943 smallest on record) despite the fact that the trap fishery now opens from four to five weeks after the start of the sockeye season on the Nass and Skeena. In other words the season is regulated so that few reds will be caught and that most of the fish handled are pinks.

The pinks in southeastern Alaska appeared to be on the increase up to 1936 and the highest catch which was recorded in 1941 failed to materialize in Canadian waters. The failure of the pinks in the Skeena and neighbouring areas following 1930 was not reflected as markedly in the southeastern Alaska catches, but the 1946-47 failures were general throughout the whole area. The pink catch was also low in southeastern Alaska from 1938 to 1940.

Past tagging experiments have shown that considerable numbers of fish tagged in southeastern Alaska have been picked up in Canadian waters (Appendix 2). However, the recent tagging programme carried out during 1947 in southeastern Alaska does not appear to substantiate this from the data at present available. Of the 25,000 fish tagged (23,000 were pinks) 48% were returned, of which only 106 plus were returned from the Nass and 12 plus from the Skeena. This gives only .5% recaptures in Canadian waters. In 1948 the tagging was done further north and no returns were made in Canadian waters. Further tagging will be necessary to decide how much the Alaska fishery exploits the Skeena populations, but it would appear that the present drain on the sockeye run to the Skeena is not heavy.

10. Recommendations

1. Statistical Programme (See Dr. Burton's report, 1948)

The establishment of an adequate system of statistics is primary, and other administrative, economic and biological questions are secondary in building a foundation for the proper administration of a natural resource. Any such system should involve the whole coast, be centralized either under the Fisheries Department or Fisheries Research Board, with a qualified statistician in charge. The statistical fishing areas should be popularized by means of maps and the value of accurate returns from each area emphasized to the industry.

It has proved impractical to examine the Skeena salmon population alone, as the Skeena salmon industry now embraces all salmon fisheries from the 53rd parallel north to the Alaskan boundary. Thus, for species other than sockeye the separation of the Skeena population is done by guess and, even in sockeye, there is an overlap with the Nass and other smaller streams. The terms of reference for the Skeena survey should be clarified as to whether it is the catch or pack of all species of salmon that is involved.

In the Skeena salmon fishery, log books may be practical for the purse seine boats but at present it seems impractical, considering the high percentage of illiterate fishermen, to place books on each gill-net boat or on each troller. It seemed more practical to require returns from the buyers, but as there are already weekly, monthly and annual forms submitted by the canneries and fresh fish houses to both the Federal and Provincial Fisheries Departments, another form might appear superfluous and receive the same inaccurate treatment. Such a form was drawn up and after testing it around the salmon industry and consulting the Fisheries Office, it was apparent that it was too complicated to be filled out with any accuracy under present conditions. It was therefore decided that we must collect the data personally from the records of the industry and fill out the form ourselves. This ~~is being done this year and~~ should act as a check on the present system and yield additional detail which is not otherwise available.

To allocate the fish more efficiently to each river system the statistical areas should be popularized by making available copies of the statistical map and guide referred to on government forms. In the case of the Skeena the north boundary should be moved south to where it was prior to 1935 to create a gap between the Nass and Skeena fisheries so that the catch figures could be more accurately separated.

2. Regulation of the Commercial Fishery

- (a) Open the sockeye season June 15 to 20 in order to exploit the earlier runs to catch more of the older age groups, especially the males. The season should also close earlier, August 1 to 10. This should relieve the fishing intensity on the 4₂'s which run late and should result in a more equal sex ratio particularly in the catch of 5₂'s.
- (b) Increase the week-end closed periods by at least one day. In the big years the number of days fishing should extend over a longer period than in the small years. If necessary closed periods of a full week should be instigated to assure an adequate escapement.
- (c) Restrict the number of gill-nets operating in the Skeena area to 700.
- (d) In conjunction with a prediction programme a quota system should be formulated. At present the catch limit in the large years would be approximately a million fish or 80,000 cases and in the small years a quarter million fish or 20,000 cases. This should result in escapements of 50 and 75 per cent. respectively.
- (e) Changes in the mesh sizes should be considered but much experimentation is necessary before the regulation can be properly stated. It would appear that the minimum mesh size should be increased by about one inch for the sockeye and lowered by an equal amount for pinks to equalize the sex ratios. At present the catch of sockeye is composed of approximately 65% females and that of pinks 75% males. For gill-net fish the minimum size limit of three pounds should be cancelled.

(f) The runs to coastal lakes and streams, Ecstall, Shawatlan, Useless creek, etc. which were once productive should be protected and restored.

(g) The wastage of catching mature pinks and chum to be used as frozen bait should be eliminated.

Note: It is realized that many of the above restrictions have been applied in the past but the fact that the runs are still declining under the present exploitation indicates that they were not prosecuted in a coordinated manner long enough to achieve the desired result.

REFERENCES

- 1910 - The British Columbia Boat Rate Commission-Manuscript.
- 1922 - The British Columbia Fisheries Commission.
- 1946 - Annual Report of the Dominion Department of Fisheries
- 1946 - Annual Report of the British Columbia Provincial Department of Fisheries.
(Clements W.A. - Contributions to the life history of the sockeye salmon).
- 1947 - British Columbia Special Fishery Regulations, Dominion Department of Fisheries.
- Barnaby, J.T. - Fluctuations in abundance of Red Salmon, Oncorhynchus nerka (Walbaum) of the Karluk River, Alaska. U.S. Bur. Fish. Bull. 39 - 1944.
- Carrothers, W.A. - The British Columbia Fisheries. Univ. of Toronto Press - 1941.
- Clemens, W.A. - On the ages at maturity and sex proportions of sockeye salmon in British Columbia waters. Trans. Roy. Soc. Can. Sect. V - 1935.
- Gregory, H.E. and K, Barnes - North Pacific Fisheries. American Council of the Institute of Pacific Relations. 322 pp. 1939.
- Rieker, R.E. - Relation of "Catch per Unit Effort" to Abundance and Rate of Exploitation. J. Fish. Res. Bd. Can. 5(1) - 1940.
- Rounsefell, G.A. and G.B. Kelez - The salmon and Salmon Fisheries of Swiftsure Bank, Puget Sound and the Fraser River. U.S. Bur. Fish Bull. 27. 1938.
- Thompson, W.F. - Effect of the obstruction at Hell's Gate on the sockeye salmon of the Fraser river. International Pacific Salmon Fisheries Commission Bull. 1. 1945.
- Withler, F.C. - An Investigation of the Distribution of Age Groups and Sexes of Sockeye Salmon throughout the Fishing Season at the Skeena River. Manusc. Dept. of Zoology. U. of B.C. Vancouver. 1945.