PROVINCE OF BRITISH COLUMBIA

REPORT

OF THE

COMMISSIONER OF FISHERIES

FOR THE YEAR ENDED DECEMBER 31ST, 1934

WITH APPENDICES

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To His Honour JOHN WILLIAM FORDHAM JOHNSON,
Lieutenant-Governor of the Province of British Columbia.

MAY IT PLEASE YOUR HONOUR:

I beg to submit herewith the Report of the Provincial Fisheries Department for the year ended December 31st, 1934, with Appendices.

GEORGE SHARRATT PEARSON,
Commissioner of Fisheries.

Provincial Fisheries Department,
Commissioner of Fisheries' Office,
Victoria, British Columbia, December 31st, 1934.

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FISHERIES COMMISSIONER'S REPORT FOR 1934.

VALUE OF CANADIAN FISHERIES AND THE STANDING OF THE PROVINCES, 1933.

The value of the fisheries products of Canada for the year 1933 reached a total of $27,558,053. During that year British Columbia produced fisheries products to the value of $12,001,471, or nearly 44 per cent. of Canada's total.

British Columbia in 1933 again led all the Provinces in the Dominion in respect to the production of fisheries wealth. This has been the case for over twenty years; her output exceeded that of Nova Scotia, the second in rank, by $5,990,870.

The market value of the fisheries products of British Columbia in 1933 was $2,092,353 more than in the previous year. There was an increase in the value of the salmon, halibut, herring, and cod fisheries in comparison with 1932. For some unknown reason the pilchard-fishery was a failure. Whaling operations were resumed again in 1933 after a lapse of two years.

The capital invested in the fisheries of British Columbia in 1933 was $19,576,822, or nearly 48 per cent. of the total capital employed in fisheries in all of Canada. Of the total invested in the fisheries of British Columbia in 1933, $8,972,195 was employed in catching and handling the catches and $10,604,627 invested in canneries, fish-packing establishments, and fish-reduction plants.

The number of persons engaged in British Columbia fisheries in 1933 was 16,856, or 21 per cent. of Canada's total fishery-workers. Of those engaged in British Columbia, 11,066 were employed in catching and handling the catches and 5,790 in packing, curing, and in fish-reduction plants. The total number engaged in the fisheries in British Columbia in 1933 was 2,034 more than in the preceding year.

The following statement gives in the order of their rank the value of the fishery products of the Provinces of Canada for the years 1929 to 1933, inclusive:—

Province.	1929.	1930.	1931.	1932.	1933.
British Columbia	$23,930,692	$23,103,302	$11,108,873	$9,909,116	$12,001,471
Nova Scotia	11,427,491	10,411,202	7,986,711	6,557,943	6,010,601
New Brunswick	5,935,635	4,853,575	4,169,811	2,972,682	3,061,152
Quebec	2,933,339	2,502,998	1,952,894	1,815,544	2,128,471
Ontario	3,919,144	3,294,629	2,477,131	2,147,990	2,089,842
Manitoba	2,745,205	1,811,962	1,241,575	1,204,892	1,076,136
Prince Edward Island	1,297,125	1,141,279	1,078,901	988,919	842,345
Saskatchewan	572,871	234,501	317,963	186,174	186,417
Alberta	732,214	421,258	153,897	153,789	144,518
Yukon Territory	24,805	29,510	29,550	20,060	17,100
Totals	$53,518,521	$47,804,216	$30,517,306	$25,957,109	$27,558,053

THE SPECIES AND VALUE OF FISH CAUGHT IN BRITISH COLUMBIA.

The total value of each of the principal species of fish taken in British Columbia for the years 1929 to 1933, inclusive, is given in the following table:—

Species.	1929.	1930.	1931.	1932.	1933.
Salmon	$14,265,795	$16,610,834	$7,195,220	$7,586,479	$9,184,090
Halibut	4,317,235	2,446,775	1,373,679	960,166	1,391,941
Herring	1,486,655	1,222,303	1,058,139	536,491	738,522
Pilchard	2,199,834	1,589,609	807,842	383,920	77,464
Cod	418,800	338,172	242,911	172,029	215,796
Carried forward	$22,688,319	$22,207,693	$10,677,791	$9,639,085	$11,607,813

THE SPECIES AND VALUE OF FISH CAUGHT IN BRITISH COLUMBIA—*Continued.*

Species.	1929.	1930.	1931.	1932.	1933.
Brought forward	$22,688,319	$22,207,693	$10,677,791	$9,639,085	$11,607,813
Clams	120,143	155,857	111,690	89,848	52,699
Black cod	118,362	120,583	29,521	38,754	41,443
Crabs	45,447	29,177	27,914	16,832	34,296
Soles	47,777	46,217	25,372	25,936	27,737
Shrimps	26,579	20,426	15,778	19,988	19,609
Oysters	57,908	58,146	61,247	28,800	25,670
Abalones	.....	3,500	4,266	.....	.....
Flounders	25,737	20,268	4,894	3,923	5,208
Red cod	29,216	24,667	10,937	9,333	5,629
Perch	21,691	15,447	3,893	4,707	3,428
Smelt	10,831	18,416	14,928	7,084	4,916
Sturgeon	7,245	5,778	3,774	3,161	5,006
Octopus	2,264	2,569	1,156	1,336	1,048
Skate	4,676	4,241	4,271	2,748	2,483
Oolachans	1,833	4,214	477	470	771
Whiting	69	828	603	135	1,180
Trout	1,517	764	.....	544	1,062
Grayfish, etc.—					
Oil	122,513	44,227	62,648	4,629	13,783
Meal	126,121	17,250	13,256	7,018	26,299
Fertilizer	52,123	61,272	10,272	.....	.....
Whales	387,049	227,993	.....	.....	110,030
Fur-seals	33,272	13,769	7,004	4,885	7,060
Miscellaneous	.....	.....	7,181	.....	4,301
Totals	$23,930,692	$23,103,302	$11,108,873	$9,909,116	$12,001,471

The above statement shows an increase of $1,597,611 in the value of the salmon-fishery in comparison with the preceding year, 1932. A marked increase is also recorded for halibut, herring, and cod, while the pilchard-fishery was practically a complete failure.

Total halibut landings were marketed for $1,391,941, an increase in production of 196,600 lb. and an increase in value of $431,775 in comparison with 1932.

Herring-catches produced $738,522, an increase in value of $202,031 in comparison with 1932.

Pilchard-catches totalled 12,101,300 lb. in comparison with 76,000,000 lb. in 1932, showing a decrease in production of 63,898,700 lb. and a decrease in value of $306,456.

VALUE OF BRITISH COLUMBIA FISHERIES INCREASES IN 1934.

The value of British Columbia's fisheries for 1934 again shows a substantial increase over the preceding year. The total value as marketed, whether sold for consumption fresh or canned, cured, etc., amounted to $15,334,335, which is an increase of $3,332,864 or 28 per cent. over 1933, and an increase over 1932 of $5,425,219 or 55 per cent.

The salmon-fishery is still the greatest single factor in British Columbia's fisheries, contributing $12,351,641 or 81 per cent. of the total value. The canned product alone amounted to $10,426,160, which is an increase in value over 1933 of $2,998,037.

Halibut had a market value of $833,829. The figures for halibut are not comparable with those of previous years for the reason that the quantity taken by United States vessels was previously included with the catch and quantity marketed fresh for British Columbia, while the statistics for 1934 give the landings by Canadian fishermen only. The above total, however, is a substantial increase over 1933, as will be found from reference elsewhere in this report. (*See* under " Halibut Production.")

Herring had a total value of $628,982 in 1934, a decrease from 1933 amounting to $109,540, while the value of pilchards increased from $77,464 in 1933 to $549,910 in 1934.

Whale products show an increase in value in 1934, amounting to $73,708. The value in 1933 was $110,030, while in 1934 the value was $183,738.

CAPITAL EQUIPMENT AND EMPLOYEES.

Capital.—The capital investment of the fisheries of British Columbia in 1934 was valued at $21,143,048, this total comprising $9,641,534, the value of the vessels, boats, nets, traps, piers, and wharves, etc., used in the primary operations of catching and landing the fish, and $11,501,514, the amount invested in fish canning and curing establishments. Compared with the preceding year, the total value shows an increase of $1,566,226.

Employees.—The men employed in catching and landing the fish during the year numbered 11,700, compared with 11,066 in 1933, and the employees of fish canning and curing establishments, 6,181, compared with 5,790. The total number—17,881—shows an increase over 1933 of 1,025.

The above figures are taken from the Advance Report on the Fisheries of British Columbia in 1934 by the Dominion Bureau of Statistics, Ottawa, Canada.

THE CANNED-SALMON PACK FOR BRITISH COLUMBIA IN 1934.

The total canned-salmon pack in British Columbia for 1934 amounted to 1,583,866 full cases, which is 318,817 cases in excess of the pack for 1933, and is the largest total pack since 1930, when the total reached 2,221,819. The pack of 1934 consisted of 377,844 cases of sockeye, 29,776 cases of springs, 1,280 cases of steelheads, 225,431 cases of cohoe, 436,354 cases of pinks, and 513,181 cases of chums. All varieties show substantial increases over 1933 with the single exception of pinks. The increase in the total sockeye-pack for 1934 over that of 1933 amounted to 119,737 cases; while springs increased by 9,510 cases, cohoe by 66,379 cases, and chums by 219,551 cases. The increase in the sockeye-pack is due in no small measure to the return of late-run sockeye to the Shuswap Lake area in the Fraser River watershed. 1934 was an off-year for pinks in the Fraser River watershed and partially accounts for the short pack of this species. The pack of 29,776 cases of spring salmon during 1934 is the largest pack of this variety since 1926, when 32,952 cases were packed. The size of the canned pack of spring salmon, however, is not necessarily indicative of the availability of this species, as large quantities are disposed of as fresh, frozen, and mild-cured salmon.

The total pack of canned cohoes, amounting to 225,431 cases, is the largest pack of this species on record. It exceeds the previous year's pack by 66,379 cases, when the pack amounted to 159,052 cases, and exceeds by 25,438 the previous record pack of 1919, when 199,993 cases were canned.

The pack of pink salmon, amounting to 436,354 cases, was 87,171 cases less than in 1933. A good run was experienced in southern districts, considering that this was not a pink-year on the Fraser River. The Skeena also produced a good pack of this variety. In the Queen Charlotte Islands pink salmon returned again in 1934 after almost a total disappearance in 1932, the last cycle-year. This was particularly so in Masset Inlet, though the runs to the more southerly districts in these islands was less satisfactory. The pink-pack in Queen Charlotte Islands, amounting to 53,398 cases, was a small pack and no doubt would have been much larger but for the timely intervention by the Federal fisheries officers, which permitted a good escapement to the spawning-grounds. The pack of pinks in other areas was light.

Chum salmon in Northern British Columbia were scarce and came in late. Fear was expressed that there would be a shortage of canned chums, but a good run in southern areas developed late in the season, resulting in a total pack of this variety of 513,181 cases. In addition to the canned pack of chums, 4,675 tons were dry-salted.

THE BRITISH COLUMBIA CANNED-SALMON PACK BY DISTRICTS.

Fraser River System.—The Canadian pack of sockeye on the Fraser River amounted to 139,238 cases and is the largest since 1914, exceeding the pack of 1930 by 35,546 cases. The fish, of which the 1934 pack consists, are from the spawning of 1930, and the pack is largely made up of what has become known as "the late run to the Fraser." This late run was largely responsible for a pack of over 100,000 cases in 1930, and it would seem that this run has now been firmly established, as reports from the spawning-grounds indicate that the fish reached the spawning-grounds in sufficient numbers to adequately seed them.

During the early part of the run the American gear obtained heavy catches before the fish reached Canadian waters. These heavy catches for a time overtaxed the capacity of the American canneries and in consequence some sockeye was imported from Puget Sound by

Canadian canners. Later in the season the quality was such that Canadian canners would not accept the sockeye and almost an equal number were exported to United States canners.

The total sockeye production of the Fraser River watershed amounted to 491,817 full cases; 352,579 cases, or 72 per cent. were packed by United States canners.

Of the 139,000 cases (round numbers) of Fraser River sockeye packed by British Columbia canners, 18,000 cases were packed in the month of July, 62,000 cases in August, 57,000 in September, and the balance in October.

The Canadian pack of Fraser River sockeye in 1934 exceeded the pack of the cycle-year 1930 by 35,546 cases, the pack for that year being 103,692 cases, while the total sockeye-pack by both Canadian and United States canners was less than the pack of 1930 by 36,079 cases, when the total pack amounted to 455,886 cases.

The spring-salmon pack on the Fraser amounted to 16,218 cases, compared with a pack of 5,579 cases in 1933 and 28,701 cases in 1932.

Canned cohoe in this district produced 11,392 cases in 1934, as against 13,901 cases in 1933 and 16,815 cases in 1931.

There was no run of pinks to the Fraser River in 1934, this river producing pinks only in the odd-numbered years.

The pack of chums, amounting to 104,092 cases, helped greatly to prevent what looked earlier in the season like a short pack of this variety. This run came in late but developed rapidly. The pack is the largest on the Fraser since 1929, when 144,159 cases were packed. The pack in the year previous, 1933, amounted to 34,391 cases.

In considering the canned-salmon pack in any area, due regard must be given to the escapement to the spawning-grounds. In the Fraser River watershed during 1934 the escapement of sockeye which used to make up the main run on this river was insignificant. Reports from the spawning-grounds indicate that in comparison with the former great runs, when the numbers were so great that it was impossible to enumerate them, the run this year was infinitesimal. On the other hand, the escapement of sockeye composing the "late run" has been most encouraging. The fish composing this late run spawn in the Shuswap Lake area and it is considered that the number of spawners this year was even greater than those spawning four years previous. A detailed report made by the Federal officers is contained in the Appendix of this report.

The spawning of spring salmon in the Fraser River is indicated as being normal.

The Skeena River.—The total salmon-pack in the Skeena River District in 1934 amounted to 284,096 cases of all varieties. This exceeds the pack of 1933 by 98,633 cases, but is far short of the pack of the cycle-year 1930, when the pack reached a total of 450,377 cases.

The sockeye-pack on the Skeena amounted to 70,655 cases, which was more than double the pack in 1933, but in making this comparison one must remember that the pack of 1933 was the smallest ever recorded and amounted to only 30,506 cases. Drs. Clemens point out, in the "Contributions to the Life-history of the Sockeye Salmon," "that the sockeye in the Skeena mature in their fourth and fifth years." A comparison of the pack of 1934 with the packs in 1931 and 1930, the cycle-years, shows a decided decline, amounting to 22,368 cases compared with 1931 and a decline of 61,717 cases compared with 1930.

The sockeye-fishing season on the Skeena River commenced with every indication of producing a big pack, but unfavourable weather set in at what should have been the height of the season, causing catches to fall off to a marked degree. This adverse weather condition no doubt was a factor which helped to bring about a short pack, but can only be considered as a contributing factor, as reports from the spawning-grounds do not indicate an abnormal seeding.

The spring-salmon run to the Skeena in 1934 was exceptionally good. The canned pack of this variety amounted to 8,300 cases, as compared with 3,279 cases in 1933; it was, however, very much less than in 1932, when 28,269 cases were packed. In making comparisons of the canned pack of spring salmon, however, due regard must be paid to the other outlets for this variety. In 1934 large quantities of Skeena River springs found their way into the mild-cure and frozen-fish trade.

Probably the most outstanding feature of the canning season on the Skeena River in 1934 was the exceptionally large pack of cohoes, amounting to 54,476 full cases. This is the largest pack of this variety packed on the Skeena on record; however, not all of these were caught on the Skeena, some having been taken in other districts.

The pink-pack on the Skeena, amounting to 126,123 cases, must be considered as satisfactory. It exceeds the cycle-year of 1932 by 67,902 cases, but is considerably short of the previous cycle-year 1930, when 275,642 cases were packed.

The chum-salmon pack on the Skeena, amounting to 24,388 cases in 1934, was considerably in excess of 1933, when 15,714 cases were packed, but less than 1932, when the pack reached 38,549 cases. However, the figures for the canned-chum pack do not necessarily indicate the amount of fish available unless considered in connection with the demand for this variety, whereas with the other varieties of salmon every effort is made to can all possible. It is submitted that the chum-pack in 1934 reached the proportions it did owing to extra effort, induced by the fear amongst the canners that the pack would be far short of requirements.

While the escapement of sockeye to the Skeena River spawning-beds was not large, reports indicate that the spawning generally was more satisfactory than first expected. Certain of the spawning areas were well seeded, while others were poorly seeded. In the Babine area the sockeye run, while not good, was better than expected, but cannot be considered as adequate. Springs, cohoes, and pinks also in this area were not satisfactory. For more detailed report on the spawning-grounds the reader is referred to Major Motherwell's report in the Appendices.

The Nass River.—The sockeye run to the Nass River in 1934 was outstanding when viewed in comparison with recent years and clearly demonstrates the erratic way in which these runs fluctuate. The pack, amounting to 28,701 cases in 1934, is the largest since 1924, when 33,590 cases were packed, and is almost three times the amount packed in 1933, which was 9,757 cases.

The pack of springs is never large on the Nass, although the 1934 pack, amounting to 654 cases, is unusually small for recent years.

The cohoe-pack on the Nass, as in most other districts, shows a substantial increase over recent years. The pack of 9,935 cases is the largest since 1928 and exceeds the 1933 pack in this district by 6,684 cases.

Pink salmon here as well as in several northern districts were comparatively scarce. The pack of 32,964 cases was 11,342 cases short of the previous year and 11,665 cases less than the cycle-year 1932.

Chum salmon were not packed to any extent, 2,648 cases being put up in connection with the sockeye-canning activities.

Conditions on the Nass River spawning-grounds for sockeye, cohoe, springs, and pinks are considered satisfactory, but the number of chum spawners was not considered adequate.

Rivers Inlet.—The Rivers Inlet pack of sockeye in 1934, amounting to 76,923 cases, was 4,223 cases less than in the previous year, but was 7,156 cases higher than the average for this inlet covering the last five years and may be considered fairly satisfactory for recent years. Bad weather at the height of the season contributed somewhat to reduced catches in this district as well as causing considerable loss in boats and nets.

Other varieties are not packed in Rivers Inlet except those fish taken while fishing for sockeye; these were packed in the following amounts: Springs, 436 cases; cohoe, 4,852 cases; pinks, 2,815 cases; and chums, 895 cases.

Probably the most outstanding feature of the canning operations on Rivers Inlet in 1934 was the enormous amount of equipment engaged in catching what amounted to, at best, only a normal pack. Over 1,800 nets were engaged, resulting in very unsatisfactory earnings to the fishermen, despite the good price paid for fish, also greatly increasing production costs to the canner. No industry can long remain in a sound position and continue such unsound, uneconomical practices. The use of 900 nets in this area could and would have taken all the fish available in 1934, and had only this number of men been engaged in fishing they would have received satisfactory earnings and the canner also would have profited accordingly. Indeed, it is probable that the only persons who did profit by the canning season in Rivers Inlet in 1934 were the manufacturers and suppliers of fish nets and gear, which means that most of the profit was sent out of Canada altogether.

Reports from Rivers Inlet spawning-grounds at Owikeno Lake would indicate that the sockeye spawning in this area was average, although the distribution of spawners was not even, some streams having been lightly seeded while in others unusually heavy seeding took place. Reports also indicate that the supply of cohoes was exceptionally good, while the spawning of fall fish in the Rivers Inlet District is considered average.

Smith Inlet.—The sockeye-catch in Smith Inlet produced a pack amounting to 14,607 cases, compared with 37,369 cases the previous year. This is the smallest pack since 1931 and is 9,086 below the average for the last five years. The short pack in this inlet is no doubt due to unfavourable weather conditions, as reports from the spawning-grounds indicate a most satisfactory run.

The chum-pack in Smith Inlet, amounting to 15,548 cases, is outstanding as the largest pack of this variety here in recent years. Considerable quantities of chums are taken in Smith Inlet each year, but they usually find their way into the dry-salting trade.

Other varieties packed were 6,953 cases of pinks and 3,941 cases of cohoe.

Sockeye-spawning conditions in this area are considered quite satisfactory. The Inspectors reporting on this area have reason to believe that there is a possibility of the run to this area being increased. The run of pinks to the head of Smith Inlet was light, as was also the run of cohoes. The run of chum salmon to Smith Inlet spawning-grounds was considered satisfactory.

Queen Charlotte Islands.—As pointed out elsewhere in this report, the run of pink salmon to the streams in the Queen Charlotte Islands occurs only every second year and corresponds to the even-numbered years. In 1930 there were 224,902 cases of pinks packed, but in 1932 the expected run did not materialize and only 2,415 cases were put up. In 1934 pinks again appeared in good numbers in certain localities, while in other localities fish were scarce. The run of pinks, particularly in Masset Inlet, was very good, although not satisfactory in some of the other east-coast districts.

The pack of pinks in Queen Charlotte Islands in 1934 amounted to 53,398 cases, approximately four-fifths of which were Masset Inlet fish. In order to ensure an adequate number of these fish reaching the spawning-beds, the fishing season was curtailed by action of the Federal Department and a good spawning was reported.

Chum salmon were also canned to some extent in this district in 1934, the pack amounting to 38,062 cases, compared with 39,010 cases packed in 1930. The chum-pack in these islands in 1933 was 6,988 cases, while only 358 cases were packed in 1932. It must be remembered, however, that the canned pack of chums in any year is not necessarily an index to the quantity available.

Vancouver Island.—The canned-salmon production of Vancouver Island in 1934 amounted to a total of 372,347 cases—composed of 27,282 cases of sockeye, 1,630 cases of springs, 78,670 cases of cohoe, 54,526 cases of pinks, and 210,239 cases of chums—compared with 1933, when 18,397 cases of sockeye, 4,875 cases of springs, 60,019 cases of cohoe, 172,945 cases of pinks, and 96,642 cases of chums were canned, showing an increase in all varieties in 1934 with the exception of springs and pinks.

With one or two exceptions the various runs of salmon to the different spawning-grounds on Vancouver Island in 1934 were fairly satisfactory. In Nimpkish River drag-seines were prohibited by the Federal Government, resulting in a larger escapement of sockeye to the spawning-grounds than in recent years. The spawning of springs, cohoes, pinks, and chums in this area was also satisfactory according to reports submitted by the Federal officers.

The run of sockeye to the Somass River on Barkley Sound was very good, but the Anderson Lake run was most disappointing, being much less than in the cycle-year.

Six traps operated on the south end of Vancouver Island in 1934, this district being the only locality where traps are permitted in British Columbia. The trap catch was very small, most of the fish passing well outside the limits of the traps.

REVIEW OF BRITISH COLUMBIA'S SALMON-CANNING INDUSTRY.

In reviewing British Columbia's fisheries for 1934, the salmon-canning industry is probably entitled to first consideration by virtue of the value of the output in relation to the total. The total value of British Columbia's fisheries products in 1933 amounted to $12,001,471, and of this amount canned salmon contributed approximately 62 per cent. The salmon-canning industry is therefore the greatest single factor affecting the welfare of British Columbia's fisheries. There were forty-nine salmon-canneries licensed to operate in British Columbia in 1934, distributed in the various districts as follows: Queen Charlotte Islands, 3; Nass River, 3; Skeena River, 9; Central British Columbia, 5; Rivers Inlet, 8; Smith Inlet, 3; Johnstone Strait, 4; Fraser River and Lower Mainland, 11; and west coast of Vancouver Island, 3.

These forty-nine canneries are owned by nineteen different companies. The same number of canneries operated in 1933, although some changes are noted, particularly the canning activity in 1934 in the Queen Charlotte Islands, where three canneries operated, whereas none operated in 1933. This change was due to the fact that the pink salmon frequent this district in quantity only in the even-numbered years. The salmon packed in the various districts are referred to on another page of this report.

An impartial survey of the salmon-canning industry as it obtains in British Columbia at the present time reveals the very significant fact that this industry has been very much over-expanded when viewed in conjunction with the fact that there is a definite limit to the supply of raw fish available in any given fishing season. Unlike some other industries where expansion depends on economic factors alone, the canned-salmon industry can only be exploited profitably to that extent permitted by the available supply of raw material.

The limit of expansion imposed by the availability of raw material has long ago been reached and further economic expansion need not be looked for until the supply of raw material has materially increased, and at the present rate of exploitation this cannot be expected in the near future.

Notwithstanding the decrease in the amount of fish available for canning, expansion has continued. This expansion is particularly noticeable in the increase in fishing effort, measured by the amount of gear in the water in recent years. This enormous amount of gear has not increased the total production proportionately, again demonstrating, if further proof were necessary, the definite amount of raw fish available. As the result of too much gear, unit production costs have mounted out of all proportion to selling-prices, so that British Columbia canners find themselves in the unenviable position of having put up a large pack at a high cost and of having to dispose of most of it in world markets in competition with much more cheaply produced goods of equal quality from foreign nations.

Lower production costs do not necessarily entail lower prices to the fishermen. Indeed, the plight of the gill-net fishermen in 1934 was equally as undesirable as that of the canner. In 1934 the prices paid to gill-net fishermen were satisfactory; nevertheless individual earnings were far from good. Altogether too many men had to share in the amount of fish that could be caught, resulting in small earnings for the season.

The exploitation of British Columbia's salmon-fisheries is one of this Province's best primary industries judged from a long-range view-point. Properly regulated and controlled it can be made to pay dividends to generations as yet unborn. On the other hand, a short-sighted policy will reduce this valuable asset to the point of economic extinction within a very short space of time. So long ago as 1917 the Special Fishery Commission reporting on British Columbia's salmon-fisheries, after an exhaustive inquiry, said "that to conserve the supply of salmon . . . fishing is and must be restricted . . . that the quantity of salmon caught in recent years is probably the maximum quantity that can safely be taken . . . and unquestionably the existing plants are more than adequate for the canning of that quantity of salmon." These recommendations made in 1917 are even more applicable in 1934 if our salmon-fisheries are to be exploited on a stable and economic basis and still maintain the supply unimpaired. The exploitation of our salmon-fisheries on a stable and economic basis and maintenance of the species should be the constant effort of our Provincial and Federal Governments, so that those engaged in the industry may receive an adequate return for their labour and those who have capital invested may receive an equally adequate return. To accomplish this very desirable result in our canned-salmon industry it is necessary that both Provincial and Federal Governments, together with the canners and fishermen, co-operate whole-heartedly with a single unit of purpose. Neither the ambition of an individual, the business strategy of a company, nor the political aspirations of a Government is sufficient ground to permit the most important of our fisheries to be exploited to the point of economic extinction.

In an endeavour to stabilize the salmon-canning industry the Provincial Government in 1934 adopted the policy of discouraging further unnecessary capital expenditure in the way of new canneries. Applications for cannery licences were considered on their merits, preference being given to those canneries already established. The result of such a policy cannot be measured in one operating season, nor can a single authority accomplish all that is desirable

owing to the peculiar situation arising out of certain clauses in the "British North America Act." The Federal Government, which has jurisdiction over the catching of fish, has announced a policy for 1935 of restricting the amount of gear under penalty of longer weekly close seasons. This action by the Federal Government is for conservation purposes, but, if taken advantage of by the canners and fishermen, should go a long way towards reducing production costs by eliminating a large portion of unnecessary gear. As pointed out in a previous paragraph, if the amount of gear is reduced it should result in increased earnings for the fishermen engaged in catching the fish.

HALIBUT PRODUCTION.

Halibut-fishing in the North-east Pacific in 1934 was again regulated by the International Fisheries Commission, which is composed of four members, two of which are appointed by the Canadian Government and two by the United States Government. The Canadian appointees are Drs. J. P. Babcock and W. A. Found, while Mr. Frank T. Bell and Mr. E. W. Allen represent the United States. Dr. Babcock is Chairman of the Commission, while Dr. W. F. Thompson is Director in charge of investigations.

Halibut landings on the Pacific Coast in 1934, amounting to 47,535,000 lb., show an increase of 678,000 lb. over the amount landed in 1933. In addition to this slight increase in volume must be considered a substantial increase in value over 1933 amounting to approximately 12 per cent.

Of the total Pacific Coast landings, Canadian ports received 18,310,000 lb. or 38 per cent., while the balance was landed in the United States and Alaska. Seattle in 1934 was again the leading world port for halibut landings, receiving 20,586,000 lb. Northern British Columbia ports received 16,426,000 lb. of the total Canadian landings, Prince Rupert again leading all British Columbia ports.

Of the total catch, Canadian vessels took 9,718,000 lb., amounting to 20.4 per cent. This is 1,432,000 lb. more than was taken by Canadian vessels in 1933 and the largest Canadian catch since 1929. The catch by American vessels amounted to 37,817,000 lb., a decrease from the previous year of 754,000 lb. Canadian vessels' catch in 1933 was 18 per cent. of the total. The increase in the Canadian vessels' catch from 18 per cent. in 1933 to 20.4 per cent. in 1934 can be attributed to two principal causes—(1) an increase in the number of Canadian boats fishing, and (2) a shorter length of time spent in port by the Canadian vessels between trips.

Halibut livers were again in demand by the pharmaceutical houses as a source of concentrated vitamins. The price paid for livers has continued to rise and in 1934 halibut livers were in demand at 20½ cents per pound. The price paid in 1933 was 15 cents per pound, while in 1932 the fishermen received 12 cents per pound. Saving the livers when the fish are being dressed is a clear profit to the fishermen, as formerly these were discarded. Livers from other fish than halibut, such as sable fish and ling cod, were also in demand at the above prices, and it is estimated that the Pacific Coast fishermen received in excess of $250,000 from this source. Halibut livers alone returned to the fishermen the sum of $172,600.

SALMON-TROLLING.

Salmon-trollers throughout British Columbia waters enjoyed a particularly good season during 1934. Prices were maintained at a considerably higher level than in recent years and the spring-salmon catch was good.

An exceptionally large run of cohoe appeared off the west coast of Vancouver Island, which added greatly to the fishermen's earnings. Spring salmon were plentiful on the west coast, and, while prices were not as high as in some past seasons, they averaged higher than in 1933, with the result that the trollers in this district had a much more profitable season than for several years.

MILD-CURED SALMON.

The production of mild-cured salmon amounted to 4,447 tierces in 1934. This is an increase of 1,359 tierces over 1933 and is composed almost entirely of spring salmon, largely troll-caught fish. There were seven mild-cure plants operating in British Columbia in 1934.

DRY-SALT SALMON.

Dry-salt-salmon production shows an increase in 1934 over 1933 of 531 tons, or a total of 4,675 tons. Chum salmon are the principal species entering this trade, all of which is exported to the Orient. There were fifteen dry-salteries packing salt salmon in British Columbia in 1934.

FISH OIL AND MEAL.

Pilchard Reduction.—Pilchards again appeared off the west coast of Vancouver Island early in the season of 1934 after almost total absence in 1933. This fish is not native to British Columbia waters, but appears in enormous quantities each year between the months of July and October. A substantial fishery has been built up which relies entirely on the run of pilchards, and for some reason as yet definitely unknown the run of these fish did not materialize in 1933, causing great hardship and losses to those dependent on this fishery. Their return in 1934 added materially to the fisheries' wealth of the Province, although prices paid for fish meal and oil are still exceptionally low.

The bulk of the pilchard-catch is reduced to pilchard oil and meal, although considerable quantities are canned. The production of canned pilchards in 1934 amounted to 35,437 full cases, an increase of 32,491 cases over 1933.

Reduction figures for 1934 compared with 1933 also show a large increase. Pilchard-meal production in 1934 amounted to 7,628 tons, an increase of 6,520 tons over 1933. Pilchard-oil produced in 1934 amounted to 1,612,526 imperial gallons, an increase of 1,336,647 imperial gallons. The large difference in production figures of pilchard products between 1933 and 1934 is due to the almost total failure of this fishery in 1933, as was pointed out in a preceding paragraph.

Six reduction plants were engaged during 1934 in the reduction of pilchards.

Whale Reduction.—Increased activity took place in British Columbia's whaling industry in 1934, two whaling stations operating, while only one operated in 1933. A total of 350 whales were taken in 1934, whereas only 208 were killed in 1933. There were produced in 1934, 719,271 gallons of whale-oil, an increase over the preceding year of 210,210 gallons. Meal production amounted to 341 tons, an increase of 91 tons, and fertilizer amounted to 631 tons, an increase over 1933 of 408 tons.

Sperm whales again composed the biggest share of those killed, amounting to nearly 76 per cent. of the total taken.

Miscellaneous Reduction.—The production of fish oil and meal from other sources shows a decrease in 1934 from the preceding year. Meal production in 1934 was 2,916 tons, a decrease of 2,667 tons. Oil production, amounting to 371,271 gallons, is 126,372 gallons less than in 1933.

Herring.—For purposes of conservation the indiscriminate use of herring for reduction purposes was not permitted during the herring-fishing season of 1934.

DRY-SALT HERRING.

The dry-salt-herring industry during recent years has probably been one of British Columbia's most hard-hit fisheries. The finished product is all exported to the Orient and, due to exchange conditions and the lessened buying-power of the consuming classes in the countries importing this product, the amount exported has dropped from a high of approximately 50,000 tons per annum to less than 20,000 tons. Another factor entering into the distribution of this product has been the practice of consignment shipments. This practice in recent years has caused immense losses to producers and shippers by its adverse effect on prices.

Late in 1934 it was decided by the operators to take advantage of what benefits might offer to this industry under the Federal Government's "Natural Products Marketing Act," and application was made accordingly to have a board set up to control the production and sale of dry-salt herring. The request by the industry was acceded to by the Federal Government and a board set up, but not before the season had already commenced.

By virtue of certain powers vested in the British Columbia Salt Fish Marketing Board, production was limited to that amount which, considered by the Board, the market could absorb in an orderly manner. Consignment shipments were prohibited by a system of export licensing, licences to ship being issued covering firm sales or sales covered by letters of credit, cash against documents.

Production quotas were allocated by the Board to the various licensed operators and a total production of 20,000 tons was permitted. Actual total production for 1934 amounted to 20,666 tons. This was 5,096 tons less than the preceding year. The net result, however, was beneficial, in that no losses were sustained by producers on account of consignment shipments.

With marketing control for this product definitely established, the reaction from foreign importers has been favourable and it would seem reasonable to anticipate a continued improvement in this industry, in so far as can be expected, by the elimination of those practices which have been such a detrimental factor heretofore. Before this industry can be said to prosper, however, a general improvement in the economic condition of the consumer countries is necessary.

There were nineteen licences issued for herring dry-salteries in 1934. Actual operations were confined to sixteen plants.

Reports from the herring-spawning grounds on the east coast of Vancouver Island would indicate a heavy spawning. The spawning-beds in some districts on the west coast, however, cannot be said to be satisfactory. Reports reaching this office from Barkley Sound indicate spawning in this sound very irregular. Herring spawning in Quatsino is said to be satisfactory, and the same may be said regarding Esperanza Inlet, though it would appear from reports that the spawning in Nootka Sound is somewhat below normal.

CONTRIBUTIONS TO THE LIFE-HISTORY OF THE SOCKEYE SALMON (DIGEST).

The twentieth annual contribution to the series of papers on the life-history of the sockeye salmon, issued by this Department, and contained in the Appendix of this report, is again contributed by Drs. W. A. and Lucy S. Clemens. These twenty reports cover the period 1913 to 1934, inclusive; that is, twenty-two years. There is thus available a most valuable record of the sockeye-salmon runs to the four main river systems of the Province. This record is unexcelled in any other fishery and with each year's contribution the record becomes even more valuable in providing a more comprehensive picture of the trends.

A digest of the present report is given in the following paragraphs.

The Fraser River Sockeye Run of 1934.—The total pack of Fraser River sockeye in this year amounted to 491,817 cases, of which 139,238 cases were packed in the Province of British Columbia and 352,579 cases in the State of Washington. The percentages for the two areas are 28 and 72 respectively. This is the largest pack in this cycle since 1914. The large run is, for the most part, the result of a series of successful spawnings in Adams River, tributary to Shuswap Lake. The escapement to this river in 1934 is believed to have been large and has been estimated at probably 500,000 fish.

The samplings obtained at Sooke show that the run consisted of 84 per cent. of four-year-old fish, 11 per cent. of five-year-olds, and the remaining 5 per cent. of fish of the age-groups 3_1, 3_2, 4_1, and 5_3. The fish were of average size both in respect to length and weight and males were considerably in excess of females, the percentages being 55 and 45 respectively.

The run of 1935 will be derived largely from the brood-year of 1931 and the prospect is far from bright The reports of escapements in 1931 state that the total number of sockeye that spawned in the entire river-basin was one of the smallest ever recorded. The authors state that the urgent need for a limitation of catch in 1935 is obvious.

The Rivers Inlet Sockeye Run of 1934.—In the analysis of this run Drs. Clemens point out that the 1934 pack (76,923 cases) failed to reach expectancy because of the low level of productivity of 1929 as a brood-year. The five-year-old fish formed only 21 per cent. of the run instead of slightly over 50 per cent. of it, the percentage which in earlier years was considered normal for the series to which 1934 belongs. The report of only average seeding of spawning-beds is another indication of the mediocrity of the run of 1934.

The two chief age-groups constituted 98 per cent. of the run, a proportion somewhat higher than usual. The fish of both of these classes were of average size. The authors state that the unique size relationship—i.e., practical identity in size of the two sexes in the 4_2 age-group—is an artificial one because of the fact that only the larger-sized individuals of this class are being gilled with the mesh in use. In regard to sex distribution, Drs. Clemens say that previous to the year 1929 the yearly total numbers of males and females fluctuated, with the males being in the majority some years and females others, but since 1930 the females

have consistently predominated, resulting in an average total number of males which exceeds that of the females by 1 per cent. The males have always outnumbered the females in the 4_2 group, while the reverse has always been true of the 5_2 class. In both age-groups, but especially in the 4_2, the males have become relatively fewer as time has passed. The 1934 sex distribution is consistent with those of previous years. The 4_2 males form 55 per cent. of the group, a figure only 1 per cent. greater than the lowest recorded, and the 5_2 males make a new low record at 27 per cent.

The year 1935 falls in the cycle which in the past has been the most productive in this river system, yielding packs considerably more than 100,000 cases But the facts that the usual high percentage of 5_2's in this series dropped to 50 per cent. in 1930, the more important brood-year for the coming run, and that 1931, the other brood-year, was decidedly mediocre, indicate a possibility of a run and pack of lesser size than formerly. It seems reasonable to expect a pack in the neighbourhood of 100,000 cases.

The Skeena River Sockeye Run in 1935.—Drs. Clemens state that the pack of 70,655 cases on the Skeena was slightly below prediction, and in view of the fact that the escapement to the Babine area has been reported as not having been satisfactory, this cycle-year should be considered along with those of 1933 and 1932 as being in a critical condition.

The four-year-old fish predominated, forming 63 per cent. of the run, and were exactly equivalent in length and weight with the average of the past twenty years. The five-year-old fish were exceptionally large.

The authors state that the run of 1935 should be rather large, probably producing a pack in the neighbourhood of 100,000 cases.

The Nass River Sockeye Run of 1935.—Drs. Clemens report that the unexpectedly large pack of 1934 was due very largely to the success of 1929 as a brood-year, in spite of the fact that it had been regarded as a very mediocre year, both as to pack and spawning escapement. This fine pack, together with reports of heavy seeding, make it possible to again regard the years of 1914, 1919, 1924, 1929, and 1934 as the good cycle of this river.

The authors once more call attention to the changing constitution of the Nass runs. The run of 1934 is made up of only the four age-groups which are common to all the river systems instead of the eight classes which were considered characteristic of the Nass in earlier years. The dominant age-group, the 5_3, comprises 74 per cent. of the run, a percentage somewhat greater than those of recent years. Fish of extraordinarily large size characterize the run, nine of the sixteen average measurements being new high records.

For the first time in these reports, Drs. Clemens include a discussion of the Nass sex ratios. They find considerable fluctuation within each age-group and in the yearly total number of males and females In the dominant class, the 5_3, with but a single exception, the females have always outnumbered the males; during early years the males tended to be in the majority in the 4_2 group, but in more recent years the converse has obtained; prior to the last ten years the females of 5_2's exceeded the males, while since that time the sexes have shown alternate abundance. All three groups as well as the yearly sample show a deficiency of males. In 1934 the sexes are equally divided in total numbers and each of the age-groups more nearly approaches sex equality than in any other year.

By reason of the high pack of 1930 and the report of an unprecedented escapement to the spawning-beds Drs. Clemens predict a good return in 1935.

Sex Distribution.—Under this title Drs. Clemens discuss the general question of the sex proportions of the various age-groups in the four river systems and the effect of sampling upon these ratios. The authors summarize the subject as follows:—

Equal sex ratios are considered normal for sockeye salmon.

(1.) The Fraser River sockeyes approach normal sex distribution more closely than do those of the other three river systems. This is to be expected since the method of sampling by traps precludes selection. Both the total yearly samples and the dominant age-group, 4_2, have shown more or less alternate abundance of the two sexes, the amount being in general insignificant. The 4_2's manifest precocious maturity of males which is more pronounced in some years than others.

(2.) The yearly total sex ratios of the Nass sockeyes show a small deficiency of males, but this lack of equality is believed to be due to faulty gill-net sampling. The constant shortage of males in the dominant age-group, the 5_3, is interpreted as precocious development, but these

early-maturing males because of their small size entirely elude capture. The minority of the males in the total average sex ratios of the 4_2 and 5_2 age-groups also suggests early maturity. Since the period of sampling of the Nass run is not coextensive with the period of occurrence of the 6_3 class, the constant excess of females in this group cannot be accepted as a reliable index of the sex proportions of this class.

(3.) The explanation of the peculiar sex ratios of Rivers Inlet is found partly in precocious maturity and partly in inadequate sampling and change of mesh in gill-nets. The 5_2 group appears to be completely sampled and exhibits precocious development to a marked degree. The 4_2 class, because of the small size of its members, is very incompletely sampled, resulting in a high percentage of males. From numerous observations of grilse by fishery inspectors and fishermen it is believed that the 4_2 group also produces early-maturing males. But since there are no grilse in the samplings, and since the excess of males in the 4_2 class is inaccurate, there is no way of judging exactly how the deficiency of males in the 5_2 group is compensated for by the males of the 4_2's and the grilse. The definite decrease in the 4_2 males since 1929 is traceable to change of greater gill-net mesh to lesser.

(4.) What has been said of the sex ratios of Rivers Inlet may be repeated verbatim for the Skeena sockeyes. The only point of real difference lies in a generally lower range of fluctuation of the sex ratios of the Skeena 4_2 class. This is due to the fact that these four-year-olds are larger fish and therefore have not been quite as poorly sampled as the same group in Rivers Inlet.

CONDITION OF BRITISH COLUMBIA SALMON-SPAWNING GROUNDS.

Owing to the discontinuance by the Department of making personal inspections of the spawning areas of the Fraser, Skeena, Rivers Inlet, and Nass systems, we are again indebted to Major Motherwell, Chief Supervisor of Dominion Fisheries, who conducted these investigations, for furnishing us a copy of his report. His courtesy in supplying us with these reports is gratefully acknowledged.

Major Motherwell's report on the condition of the British Columbia salmon-spawning grounds will be found in the Appendix to this report.

THE INTERNATIONAL FISHERIES COMMISSION.

The International Fisheries Commission, set up by authority of a treaty between Canada and the United States, continued to regulate the Pacific halibut-fishery in 1934. Its investigations into the fishery and also the biological investigation of the species were continued.

Regulations.—For the proper regulation of this fishery the coast is divided into four areas. Area No. 1 lies off the coasts of California and Oregon; Area No. 2 is off the coasts of Washington, British Columbia, and South-eastern Alaska; Area No. 3 takes in the coasts of Western Alaska and the Aleutian Islands; and Area No. 4 comprises all other coast waters not included in the other three areas.

The fishing season in 1934 opened on March 1st, one month later than the previous season. Catch-limits for the various districts are imposed. In Area No. 2 the limit set was 21,700,000 lb. of saleable halibut and for Area No. 3 the limit was 24,300,000 lb. These two areas are the principal producing areas. Area No. 1 was to close at the same time as Area No. 3, but it became evident that the quota allowed for Area No. 2 would be reached quite early and that many boats operating in that area would transfer to Area No. 1 as soon as Area No. 2 closed, causing too heavy drain on the stocks in this area. To prevent this happening a limit of 1,400,000 lb. was announced for Area No. 1 in September. Due to improvement in the fishery and notwithstanding the late opening date, the catch-limit for Area No. 2 was reached earlier than in 1933 and the season for Area No. 2 closed at midnight on August 19th, the catch at this time amounting to approximately 22,350,000 lb. The season in Areas Nos. 1 and 3 closed on October 27th with catches amounting to 1,500,000 and 23,600,000 lb. respectively.

Voluntary Curtailment.—In order to obtain the greatest possible economic benefit from the fish caught, the fishermen have made a concerted effort to distribute their landings more evenly throughout the year. To accomplish this all vessel-owners and fishermen agreed to trip-limits and specified tie-ups between trips. This curtailment plan is not imposed by the Commission but is entirely voluntary on the part of the fishermen. The plan has been in

operation in 1933 and 1934, and has been of immense benefit to the fishermen and is encouraged by the Commission by supplying past and current statistics of the fishery to the fishermen.

The Conference Board.—In order to maintain close contact between the industry and the Commission a Conference Board has been set up. The personnel of the Board represents all sections of the fishing fleet, and meetings between the Board and the Commission are held for the purpose of explaining to the fishermen the progress of the Commission's investigations and discussing the various problems and difficulties encountered by the fishermen. The Commissioners attribute the success of the Commission in no small measure to the close contact maintained through the Conference Board.

The Scientific Investigation.—In order that a sound basis for the intelligent control of the fishery may be provided a great deal of scientific investigation is necessary. This is accomplished by a staff of scientific trained investigators under the able direction of Dr. W. F. Thompson, and include a system of observation of the changes occurring as a result of regulation; analysis of previously collected data; the collection and preliminary analysis of data and statistics for the current year as well as the collection of current biological data.

The results of investigation show that the abundance of fish, as indicated by the catch per unit of gear, continued to increase during 1934. The average catch per unit of gear in Area No. 2 amounted to 56.4 lb., an increase of 8 per cent. over the previous year and 61 per cent. greater than in 1930, the last year of unrestricted fishing. In Area No. 3 the increase in 1934 over the previous year amounted to 4 per cent. and was 35 per cent. higher than in 1930.

The increase in abundance has been brought about by the application of scientific knowledge intelligently applied in framing restrictive measures and has been of vital importance to the fishing fleet and the industry. Without the increase and, at current prices, individual trips could not have been successful and the resultant economic conditions would have forced a large portion of the fleet to tie up during 1933 and 1934. Also with the increase in abundance long trips are now unnecessary and consequently the quality has improved.

Reports.—The eighth report of the Commission was published during the year and deals with the effect of change in the intensity of fishing upon the total yield of the fishery and upon yield per unit of fishing effort. The report discusses the basic principles underlying the reactions of stocks of fish to varying intensities of fishing; analyses the changes which have occurred in the halibut stock in the past and which are occurring at present under regulation; and demonstrates that by regulation of the intensity of the fishery the Commission can control the size of the stock on the grounds and the number of fish allowed to reach spawning age without marked reduction of the total catch.

The report shows how a reduction of the intensity of fishing will not only allow a greater number of fish to reach the spawning age and produce a greater number of young, but will actually produce a greater poundage from the same number of young. It also demonstrates how with less effort the fleet is able to make the same total catch, and gives reason to hope that in time the total yield can be increased without danger to the future of the fishery and with benefit to the fishermen and public.

Continuing the investigation of halibut spawning in British Columbia waters, a vessel was again chartered and operated in the neighbourhood of Queen Charlotte Islands during December, 1934, and January and February, 1935, and from the results of a preliminary field examination of the material taken in net-hauls during the early part of the spawning season it would seem that the abundance of eggs and larvæ this year was greater than last.

From what has been accomplished in the last few years considered in conjunction with analysis of the history of the fishery, the Commission has demonstrated its control over the stock of fish on the grounds, and while numerous problems still confront the Commission there is no doubt that these will be solved.

REPORT ON THE SOCKEYE FISHING AND CANNING INDUSTRY IN RIVERS INLET.

In the Appendix to this report will be found a report in the form of a brief statistical review of the sockeye fishing and canning industry as it obtains in Rivers Inlet. The report is by Mr. Geo. J. Alexander, Assistant Commissioner of Fisheries, and in view of the information contained therein it has been deemed advisable to publish it in its entirety in order that the information may be available to all interested.

The report shows that the number of boats fishing for sockeye salmon in this area during the past twelve years has increased 60 per cent., while the average sockeye-salmon packs in the same period have decreased over 13 per cent. The report also points out that the prices paid for sockeye by the canners to the fishermen have increased 12 per cent., but, notwithstanding this increase in price, the fisherman's average annual income from sockeye-fishing in this district has decreased nearly 38 per cent. in the period under review. This decrease in individual earnings would appear to be due to two principal causes—the great increase in the number of boats fishing and, to a lesser extent, the smaller packs.

After dealing with the effects of the increased fishing effort and the decrease in the size of the packs on the earnings of the fisherman, the report goes on to point out how these two factors adversely affect the canners in increased production costs, due to the lower fishing efficiency of the nets.

It is pointed out that the efficiency of gill-nets in Rivers Inlet, as measured by the average amount of fish produced per net, has fallen from an index of 100 for the five-year period 1922–26 to 70.3 for the five-year period 1930–34, and that nearly 78 per cent. of this total drop is due to the increase in the number of boats fishing and less than 23 per cent. is due to smaller packs.

It is hoped that the publication of this information may be the means of suggesting to the industry, both fishermen and canners, a way in which some of the ills from which it has been suffering may be rectified.

THE HERRING-FISHERY OF BRITISH COLUMBIA, PAST AND PRESENT (DIGEST).

In the Appendix to this report will be found a paper by Mr. Albert L. Tester, of the staff of the Pacific Biological Station, Nanaimo, on the " Herring-fishery of British Columbia."

Mr. Tester outlines the life-history of the herring frequenting the various waters of British Columbia and traces the development of this fishery through its various stages up to the present time. The various methods of catching and handling the fish in the herring industry are described. The various products originating with the herring-fishery are discussed in some detail, as are the values of these products.

The author also discusses the fluctuations in the abundance of herring which have occurred from time to time in the different localities. The effect of expansion of the fishery on the abundance of herring as well as the effects of intensive fishing also receive the author's attention. In this connection Mr. Tester points out that it is essential that overfishing be guarded against, especially in respect to a non-migratory species such as the herring, as such species is more quickly depleted and the consequences more disastrous than in the case of a migratory species.

In the section dealing with the " Present Condition of the Fishery " Mr. Tester points out that " an intensive biological study of the herring-fishery has been in progress for only a short period and therefore only tentative conclusions with regard to the condition of the fishery have been formed." These conclusions, though tentative, are none the less important, in that they indicate that in at least two of the most heavily exploited districts—i.e., the south-east coast of Vancouver Island and Barkley Sound—the intensive fishing has had a noticeable effect on the length and age composition of the populations of herring in these districts, which effect suggests some degree of overfishing. Mr. Tester also points out that economic conditions during the past few years have been responsible for curtailing fishing activities to some extent, with noticeable beneficial effects on the condition of the stocks of herring in the districts under review.

In dealing with the future possibilities of the herring-fishery the author is of the opinion that under certain conditions the herring-catch in British Columbia may be safely increased, but exploitation must be distributed throughout all areas according to the size of the runs frequenting the various areas, and the intensity of the fishing in any area must not be permitted to endanger the perpetuity of the local stocks. In conclusion the author says: " Local and general depletion must be avoided at all costs, for not only is the fishery itself a great asset, but the intermediate rôle of the herring as food for other species is of inestimable economic importance to the Province."

The Commissioner of Fisheries is greatly indebted to the Biological Board for permission to reprint this article and for the loan of the plates illustrating it.

THE PACIFIC SALMON IN BRITISH COLUMBIA WATERS.

Numerous requests have been received by the Provincial Department of Fisheries for information as to how the various species of salmon frequenting our waters might be properly identified.

Dr. W. A. Clemens, Director of the Pacific Biological Station, Nanaimo, kindly undertook the task of preparing a paper on this subject. The paper points out in non-technical language the various biological differences in the different species of Pacific salmon and contains a brief outline of the life-history of the species dealt with. Certain characters commonly used in the identification of the five species are pointed out in detail and a key is provided which may be used for the identification of the various species.

Dr. Clemens's paper, entitled " The Pacific Salmon in British Columbia Waters," will be found in the Appendix to this report.

In addition to Dr. Clemens's paper dealing with the identification of the adults of five species of British Columbia salmon, there will also be found in the Appendix of this report a paper by Drs. R. E. Foerster and A. L. Pritchard, " The Identification of the Young of the Five Species of Pacific Salmon, with Notes on the Fresh-water Phase of their Life-history." Very little information on this subject is available; therefore the paper will be a valuable addition to the existing bibliography.

The authors have brought together in this paper, for each species, the specific morphological characters, the characteristic external features, and the details concerning development and time of migration—to the end that by a consideration of all the factors identification may be made possible.

The Provincial Department of Fisheries wishes to express its appreciation to Dr. W. A. Clemens and to Drs. R. E. Foerster and A. L. Pritchard for the preparation of these two papers.

APPENDICES.

CONTRIBUTIONS TO THE LIFE-HISTORY OF THE SOCKEYE SALMON. (No. 20.)

By Wilbert A. Clemens, Ph.D., Director, Pacific Biological Station, Nanaimo, and Lucy S. Clemens, Ph.D.

INTRODUCTION.

The runs of sockeye salmon to the four main river systems of British Columbia in 1934 were particularly satisfactory in some respects. Those to the Fraser and Nass Rivers were exceptionally large and those to Rivers Inlet and the Skeena River, though somewhat below expectation, were nevertheless of fair size.

The pack from the run to the Fraser River amounted to 491,817 cases, which is the largest in this cycle since 1914 and approaches the early years when packs of 500,000 and 600,000 were obtained. The escapement to the spawning-beds of the Upper Fraser was small, with the exception of that to Adams River, tributary to Shuswap Lake, while that to the lower areas of the river was fairly large. The fish were predominantly four-year-olds, this group constituting 84 per cent. of the run and being slightly above average in length and weight.

The Rivers Inlet pack of 76,923 cases was less than anticipated and the escapement was not large, being reported as only an average one. The condition is apparently the result of a failure of the five-year-old fish to appear, as was the case in 1929. This age-group formed only 21 per cent. of the run, whereas in early years it constituted over 50 per cent. The fish of this year-class were slightly above average in length and weight, while those of the 4_2 year-class were below their average in both respects.

The pack on the Skeena River was 70,655 cases, which was slightly below prediction. In view of the fact that the escapement to the Babine area has been reported as not having been very satisfactory, this cycle-year should be considered along with those of 1933 and 1932 as being in a critical condition. The four-year-old fish predominated, forming 63 per cent. of the run, and were exactly equivalent in length and weight with the average of the past twenty years. The five-year-old fish were exceptionally large.

The run to the Nass River produced a pack of 28,701 cases, which is the largest of the past ten years, and reports from the spawning-beds indicate an exceptionally good escapement. The fish were of large size in all the age-groups, being above the average in both length and weight.

A special study of the sex proportions in the various age-groups of the four areas has been made and evidence is given to show that there is a definite tendency for the males to mature at an earlier age than the females. Certain inadequacies in the sampling of the runs by gill-nets are brought out.

DESIGNATION OF AGE-GROUPS.

Two outstanding features in the life-history of the fish have been selected in designating the age-groups—namely, the age at maturity and the year of its life in which the fish migrates from fresh water. These are expressed symbolically by two numbers, one in large type, which indicates the age of maturity, and the other in small type, placed to the right and below, which signifies the year of life in which the fish left the fresh water. The age-groups which are met most commonly in these river systems are:—

3_1, 4_1—the " sea-types " or fish which migrate in their first year and mature at the ages of three and four years respectively.

3_2—" the grilse," usually males, which migrate in their second year and mature at the age of three.

4_2, 5_2—fish which migrate in their second year and mature at the ages of four and five respectively.

5_3, 6_3—fish which migrate in their third year and mature at the ages of five and six respectively.

6_4, 7_4—fish which migrate in their fourth year and mature at the ages of six and seven respectively.

1. THE FRASER RIVER SOCKEYE RUN OF 1934.

(1.) General Characteristics.

The total pack of Fraser River sockeye in the season 1934 amounted to 491,817 cases, of which 139,238 cases were packed in the Province of British Columbia and 352,579 cases in the State of Washington (Table I.). The percentages for the two areas are 28 and 72 respectively.

The run to the Fraser River was thus large as was expected. The pack of 491,817 cases represents approximately 6,390,000 fish. The escapement was mainly to Adams River, tributary of Shuswap Lake, where it is estimated that some 500,000 fish spawned. Undoubtedly the run of 1934 was largely the product of the spawning in that river in 1930, when it was estimated that over 400,000 fish reached the spawning-beds. The significance of the massed spawning of such a number of fish is striking when the number of eggs is calculated, which in that case should have been in the neighbourhood of 800,000,000. If half a million fish spawned in 1934 and 50 per cent. of these were females, over a billion eggs were undoubtedly deposited.

An inspection of the spawning-beds was made by Mr. G. J. Alexander, Assistant to the Commissioner of Fisheries, and an additional report is available through the courtesy of Major J. A. Motherwell, of the Dominion Department of Fisheries. From these reports it is apparent that the escapement to the upper areas of the river system, with the exception of Adams River, was small. That to the Stuart-Trembleur-Takla-Fraser-Francois Lake area, while possibly showing a slight increase over that of 1930, was not particularly significant. Very few fish reached Quesnel, Bowron, and Seton Lakes. A smaller number, estimated at 3,500, appeared in the Chilcotin River.

On the lower portions of the system the escapements were relatively good. An encouraging run appeared in Morris Creek, tributary to Harrison Lake. The runs to the Birkenhead River and Pitt Lake are stated to have been very good. At Cultus Lake 19,000 fish appeared at the counting-fence.

A very rough estimate would seem to place the total escapement to the Fraser River in the neighbourhood of 750,000 fish.

The run of 1935 will be largely derived from the brood-year 1931 and the prospect is very discouraging. In 1931 Mr. J. P. Babcock, after making an inspection of the spawning-beds in the Seton, Anderson, Lillooet, Harrison, and Shuswap areas and receiving reports of Dominion Fisheries Officers through Major J. A. Motherwell for other areas, stated that the total number of sockeye that spawned in the entire river-basin was one of the smallest ever recorded. Egg-collections at the Pemberton and Pitt Lake hatcheries were relatively small. In 1931 the total pack was 128,158 cases, which was 30,000 cases less than in 1927. The urgent need for a limitation of catch in 1935 is obvious.

(2.) Age-groups.

The material for this year's study consists of data and scales from 1,059 sockeye salmon selected at random from April 26th to October 12th in forty random samplings obtained from the traps at Sooke, at the south end of Vancouver Island. The 4_2 age-group predominated as usual, there being 892 individuals, representing a percentage of 84.2. The 5_2 age-group consisted of 113 fish or 10.7 per cent. The remaining year-classes were sparsely represented: 5_3, 24 fish; 3_1, 1 fish; 4_1, 13 fish; 3_2, 16 fish; together constituting 5 per cent.

The percentage of four-year-old fish is the highest since the year 1927, when it was 84.6. In recent years there has been a definite tendency toward an increased representation of this age-group. A comparison of the percentages of the various age-groups since 1920 is given in Table II.

(3.) Lengths and Weights.

The fish of the 4_2 age-group are large both in respect to length and weight and slightly above the average of the past twelve years. The average length and weight of the males is 23.9 inches and 6.3 lb. and of the females 23.2 inches and 5.6 lb. A noteworthy feature was

the occurrence of a number of males weighing 11, 12, and 12½ lb. and measuring 28 and 29 inches in length. The largest size recorded in the samplings of the past ten years has been 10½ lb. and 28 inches. Reports from Pitt Lake have mentioned the extraordinary size of some individuals and it is possible that these large fish are of Pitt Lake origin.

In the 5_2 age-group the males are exceptionally small, while the females are of average size. The average lengths of the males and females are 24.2 and 24.1 inches respectively and the average weights 6.5 and 6.4 lb. respectively.

Similarly in the 5_3 age-group, the males are small and practically identical in size with the females. The average lengths of the males and females are 23 and 23 inches and the average weights 5.2 and 5.1 lb. respectively. The complete data are given in Tables III., IV., V., and VI.

Attention should be called to the fact that it was impossible to obtain the weights of sixteen fish in the 4_2 year-class and eleven in the 5_2 age-class and hence the difference in the totals in Tables III. and IV.

(4.) Distribution of the Sexes.

The total number of males in the samplings is 580 and of the females 479, percentages of 54.8 and 45.2 respectively. An excess of males is not exceptional, as shown by the fact that such has occurred in ten of the twenty years of record (Table VII.). Nevertheless, the percentage of 55 has only been exceeded in the year 1928.

Table I.—Fraser River Packs, 1895–1934, arranged in accordance with the Four-year Cycle.

B.C.	1895— 395,984	1896— 356,984	1897— 860,459	1898— 256,101
Wash.	65,143	72,979	312,048	252,000
Total	461,127	429,963	1,172,507	508,101
B.C.	1899— 480,485	1900— 229,800	1901— 928,669	1902— 293,477
Wash.	499,646	228,704	1,105,096	339,556
Total	980,131	458,504	2,033,765	633,033
B.C.	1903— 204,809	1904— 72,688	1905— 837,489	1906— 183,007
Wash.	167,211	123,419	837,122	182,241
Total	372,020	196,107	1,674,611	365,248
B.C.	1907— 59,815	1908— 74,574	1909— 585,435	1910— 150,432
Wash.	96,974	170,951	1,097,904	248,014
Total	156,789	245,525	1,683,339	398,446
B.C.	1911— 58,487	1912— 123,879	1913— 719,796	1914— 198,183
Wash.	127,761	184,680	1,673,099	335,230
Total	186,248	308,559	2,392,895	533,413
B.C.	1915— 91,130	1916— 32,146	1917— 148,164	1918— 19,697
Wash.	64,584	84,637	411,538	50,723
Total	155,714	116,783	559,702	70,420
B.C.	1919— 38,854	1920— 48,399	1921— 39,631	1922— 51,832
Wash.	64,346	62,654	102,967	48,566
Total	103,200	111,053	142,598	100,398
B.C.	1923— 31,655	1924— 39,743	1925— 35,385	1926— 85,689
Wash.	47,402	69,369	112,023	44,673
Total	79,057	109,112	147,408	130,362
B.C.	1927— 61,393	1928— 29,299	1929— 61,569	1930— 103,692
Wash.	97,594	61,044	111,898	352,194
Total	158,987	90,343	173,467	455,886
B.C.	1931— 40,947	1932— 65,769	1933— 52,465	1934— 139,238
Wash.	87,211	81,188	126,604	352,579
Total	128,158	146,957	179,069	491,817

Table II.—Fraser River Sockeyes, Vancouver Island Traps, Percentages of the Year-classes from 1920 to 1934.

Year.	4_2	5_2	5_3	6_3	3_1	4_1	3_2
1920	69.6	21.2	6.2	0.2	1.9	0.9	.....
1921	78.1	14.6	4.1	0.7	0.5	2.0	.....
1922	70.5	9.3	4.5	2.0	6.3	5.6	0.9
1923	67.1	10.8	3.9	1.2	6.7	9.9	0.4
1924	68.2	18.7	9.2	0.5	0.5	2.0	0.8
1925	67.9	24.9	3.4	0.2	2.2	0.0	0.6
1926	66.1	20.3	5.2	1.6	2.0	2.5	2.1
1927	84.6	7.5	3.0	0.8	1.9	2.2	.....
1928	71.4	18.8	5.3	0.5	2.0	0.7	1.0
1929	77.3	11.9	7.8	0.4	0.1	0.1	2.5
1930	75.7	19.6	2.8	0.5	0.2	0.7	0.5
1931	79.0	13.1	1.3	.....	2.0	2.0	2.6
1932	80.7	13.5	2.8	.....	0.8	0.8	1.4
1933	83.6	9.2	1.9	.....	1.4	0.5	3.4
1934	84.2	10.7	2.3	.....	0.1	1.2	1.5

Table III.—Fraser River Sockeyes, 1934, Vancouver Island Traps, grouped by Age, Sex, and Length, and by their Early History.

Length in Inches.	Number of Individuals.												Total.
	4_2		5_2		5_3		3_1		4_1		3_2		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
17½	1	1	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	4
18	5	2	.....	.....	1	.....	.....	.....	.....	.....	4	.....	12
18½	1	1	.....	.....	.....	.....	.....	.....	.....	1	4	.....	7
19	6	1	.....	.....	.....	.....	1	.....	.....	.....	4	.....	12
19½	3	5	.....	.....	.....	1	.....	.....	1	.....	.....	.....	10
20	19	9	2	2	1	1	.....	.....	.....	2	2	.....	38
20½	7	7	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	15
21	10	14	5	1	.....	1	.....	.....	.....	.....	.....	.....	31
21½	5	4	2	3	.....	.....	.....	.....	.....	.....	.....	.....	14
22	16	30	6	4	1	.....	.....	.....	.....	.....	.....	.....	57
22½	18	17	3	2	.....	1	.....	.....	.....	.....	.....	.....	41
23	44	93	4	5	2	2	.....	.....	.....	.....	.....	.....	150
23½	19	61	2	1	.....	1	.....	.....	.....	.....	.....	.....	84
24	111	76	11	5	3	2	.....	.....	1	1	.....	.....	210
24½	48	52	3	4	.....	3	.....	.....	1	.....	.....	.....	111
25	85	23	6	7	3	1	.....	.....	2	2	.....	.....	129
25½	35	8	1	10	.....	.....	.....	.....	.....	.....	.....	.....	54
26	27	6	4	3	.....	.....	.....	.....	.....	.....	.....	.....	40
26½	8	.....	5	3	.....	.....	.....	.....	1	.....	.....	.....	17
27	8	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
27½	1	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
28	2	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
28½	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
29	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
29½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Totals	482	410	63	50	11	13	1	.....	7	6	16	.....	1,059
Ave. lengths	23.9	23.2	24.2	24.1	23.0	23.0	19.0	.....	23.5	22.1	18.6	.....	.....

Table IV.—Fraser River Sockeyes, 1934, Vancouver Island Traps, grouped by Age, Sex, and Weight, and by their Early History.

Weight in Pounds.	Number of Individuals.												Total.
	4_2		5_2		5_3		3_1		4_1		3_2		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
2	-----	1	-----	-----	1	-----	-----	-----	-----	-----	-----	-----	2
2½	6	4	-----	-----	1	-----	-----	-----	-----	-----	10	-----	21
3	21	8	3	1	-----	2	1	-----	-----	1	5	-----	42
3½	8	12	2	1	-----	-----	-----	-----	1	-----	1	-----	25
4	17	32	2	2	-----	3	-----	-----	1	2	-----	-----	59
4½	22	32	4	3	2	-----	-----	-----	-----	-----	-----	-----	63
5	40	81	5	6	1	1	-----	-----	-----	-----	-----	-----	134
5½	28	52	4	4	1	2	-----	-----	-----	-----	-----	-----	91
6	86	60	9	6	2	3	-----	-----	-----	1	-----	-----	167
6½	49	55	5	4	1	-----	-----	-----	1	1	-----	----	116
7	60	39	6	2	1	1	-----	-----	1	-----	-----	-----	110
7½	51	19	1	9	-----	1	-----	-----	1	1	-----	-----	83
8	34	6	2	4	1	-----	-----	-----	1	-----	-----	-----	48
8½	26	5	2	2	-----	-----	-----	-----	-----	-----	-----	-----	35
9	7	1	3	3	-----	-----	-----	-----	-----	-----	-----	-----	14
9½	4	-----	3	-----	-----	-----	-----	-----	-----	-----	-----	-----	7
10	3	-----	-----	-----	-----	-----	-----	-----	1	-----	-----	-----	4
10½	-----	-----	2	-----	-----	-----	-----	-----	-----	-----	-----	-----	2
11	3	-----	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	4
11½	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
12	3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	3
12½	1	-----	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	2
Totals	469	407	55	47	11	13	1	-----	7	6	16	-----	1,032
Ave. weights	6.3	5.6	6.5	6.4	5.2	5.1	3.0	-----	6.6	5.2	2.7	-----	-----

Table V.—Fraser River Sockeyes, Vancouver Island Traps, Average Lengths in Inches of Principal Classes from 1920 to 1934.

Year.	4_2		5_2		5_3		6_3		3_1		4_1	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1920	24.1	23.2	25.7	24.6	24.3	23.2	25.7	-----	23.3	21.8	25.5	24.3
1921	23.7	23.0	25.9	24.6	-----	-----	-----	-----	-----	-----	-----	-----
1922	24.0	23.0	25.8	24.1	23.5	22.7	25.4	24.3	23.0	22.6	25.5	24.2
1923	24.3	23.3	25.8	24.8	24.2	22.9	26.3	24.9	23.3	22.7	25.2	24.1
1924	23.8	22.8	24.9	23.9	23.7	22.7	24.3	-----	21.9	20.4	25.2	24.4
1925	23.5	22.9	25.8	24.6	24.0	22.0	-----	-----	22.5	21.7	-----	-----
1926	22.6	22.3	24.6	24.0	23.2	22.4	25.5	23.7	23.4	22.5	25.4	24.6
1927	24.1	23.1	26.1	24.6	21.7	22.0	25.3	24.6	23.4	22.2	25.1	24.5
1928	23.4	23.0	25.5	24.7	24.2	23.4	27.1	26.0	19.1	18.7	19.8	-----
1929	23.7	22.9	25.5	24.3	24.8	23.7	26.2	24.8	-----	23.0	25.0	24.0
1930	24.4	23.6	26.2	24.6	24.4	23.5	26.7	26.0	22.5	20.7	24.7	23.2
1931	23.4	22.8	25.6	24.6	24.3	24.1	-----	-----	21.5	21.6	25.3	22.5
1932	23.6	22.8	25.3	24.2	24.6	23.2	-----	-----	21.9	21.5	23.0	23.4
1933	23.1	22.7	24.9	24.0	24.0	22.9	27.0	-----	22.5	22.3	24.3	23.8
Average lengths	23.7	23.0	25.5	24.4	23.9	23.0	25.9	24.9	22.4	21.7	24.5	23.9
1934	23.9	23.2	24.2	24.1	23.0	23.0	-----	-----	-----	-----	23.5	22.1

Table VI.—Fraser River Sockeyes, Vancouver Island Traps, Average Weights in Pounds of Principal Classes from 1922 to 1934.

Year.	4_2		5_2		5_3		6_3		3_1		4_1	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1922	6.4	5.7	7.0	6.1	6.1	5.4	7.2	5.5	5.9	5.2	7.9	6.9
1923	6.6	5.8	7.8	6.9	6.0	5.2	7.3	6.5	6.2	5.3	7.3	6.5
1924	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1925	5.8	5.2	7.6	6.6	6.1	5.3	-----	-----	5.3	4.6	-----	-----
1926	5.2	4.9	6.2	5.7	5.4	4.8	7.4	5.7	6.1	5.4	7.3	6.6
1927	6.1	5.5	7.3	6.8	4.5	4.8	6.5	5.5	5.9	5.2	7.2	6.8
1928	6.0	5.5	7.4	6.9	6.5	5.7	8.6	8.0	6.4	5.4	8.0	6.6
1929	6.0	5.3	7.2	6.3	6.7	5.9	7.5	6.5	-----	5.0	6.5	6.0
1930	6.9	6.1	7.7	6.7	6.6	6.0	7.7	6.0	5.5	4.2	6.3	5.8
1931	5.8	5.2	7.3	6.5	6.1	6.3	-----	-----	4.5	4.6	7.3	6.0
1932	6.1	5.4	7.3	6.7	6.6	5.4	-----	-----	4.9	4.4	5.7	5.9
1933	5.4	5.0	7.0	6.3	6.0	5.2	8.8	-----	5.1	4.9	6.5	6.1
Average weights	6.0	5.4	7.3	6.5	6.1	5.5	7.6	6.2	5.6	4.9	7.0	6.3
1934	6.3	5.6	6.5	6.4	5.2	5.1	-----	-----	-----	-----	6.6	5.1

Table VII.—Fraser River Sockeyes, Percentages of Males and Females of the 4_2, 5_2, and 5_3 Age-groups, 1915 to 1934.

Year.	4_2		5_2		5_3		Per Cent. Total Males.	Per Cent. Total Females.
	M.	F.	M.	F.	M.	F.		
1915	55	45	57	43	53	47	54	46
1916	49	51	50	50	38	62	51	49
1917	50	50	50	50	49	51	50	50
1918	51	49	56	44	57	43	52	48
1919	53	47	53	47	48	52	52	48
1920	50	50	47	53	47	53	49	51
1921	48	52	42	58	43	57	47	53
1922	49	51	52	48	46	54	53	47
1923	51	49	55	45	46	54	50	50
1924	51	49	50	50	47	53	51	49
1925	46	54	53	47	43	57	49	51
1926	52	48	48	52	50	50	51	49
1927	48	52	58	42	41	59	48	52
1928	53	47	64	36	66	34	56	44
1929	46	54	55	45	50	50	49	51
1930	42	58	55	45	44	56	45	55
1931	47	53	56	44	42	58	48	52
1932	44	56	58	42	30	70	46	54
1933	49	51	50	50	47	53	51	49
1934	54	46	56	44	46	54	55	45
Average	49	51	53	47	47	53	50	50

2. THE RIVERS INLET SOCKEYE RUN OF 1934.

(1.) General Characteristics.

Perhaps the most outstanding feature which separates the Rivers Inlet sockeyes from those of the other three river systems under consideration is the fact that these sockeyes are a single, unified race. This is probably due to the simplicity of Rivers Inlet basin. It consists of a single lake (Owikeno) which receives short tributary streams and which is drained by a large, short outlet. The salmon spawn under uniform external conditions on the gravel shores of the lake and along the lower reaches of the tributaries, thus producing a population of uniform type. This uniformity is evident both in the external appearance of the fish and in the scales which record the growth of the fish. In general, single populations lend themselves not only to more definite and finer analysis, but also to more complete and satisfactory interpretation. However, in dealing with such a fishery as the sockeye salmon, where by far the greater part of the life-history is spent in the ocean under physico-chemical conditions, concerning the details of which there is at the present time no knowledge, the study of a unified population presents many puzzling aspects. Rivers Inlet runs consist mainly of four- and five-year-old fish which spend one year in fresh water. Although there has been from year to year no definite ratio between these two groups, the five-year class has seemed the more preeminent. In 1928 an attempt was made to interpret the Rivers Inlet data by arranging them in five-year cycles or series. Both the packs (Table A) and the relative proportions of the 4_2's and 5_2's (Table B) were put in sequence on this basis.

Table A.

Sr. 1.	1907,	87,874;	1912,	112,884;	1917,	61,195;	1922,	53,584;	1927,	64,461;	1932, 69,732.
Sr. 2.	1908,	64,652;	1913,	61,745;	1918,	53,401;	1923,	107,174;	1928,	60,044;	1933, 83,507.
Sr. 3.	1909,	89,027;	1914,	89,890;	1919,	56,258;	1924,	94,891;	1929,	70,260;	1934, 76,923.
Sr. 4.	1910,	126,921;	1915,	130,350;	1920,	125,338;	1925,	159,554;	1930,	119,170.	
Sr. 5.	1911,	88,763;	1916,	44,936;	1921,	48,615;	1926,	65,581;	1931,	76,428.	

Table B.

Sr. 1.	1912 (5 years)	79%	1917	67%	1922	18%	1927	17%	1932 29%
	(4 years)	21%		33%		82%		83%	71%
Sr. 2.	1913	20%	1918	43%	1923	24%	1928	42%	1933 55%
		80%		57%		76%		58%	45%
Sr. 3.	1914	65%	1919	54%	1924	56%	1929	19%	1934 21%
		35%		46%		44%		81%	79%
Sr. 4.	1915	87%	1920	95%	1925	77%	1930	50%	
		13%		5%		23%		50%	
Sr. 5.	1916	76%	1921	51%	1926	40%	1931	54%	
		24%		49%		60%		46%	

At that time a fairly satisfactory interpretation was possible and certain generalizations were made. However, in the meantime the data of six additional years have come to hand and have been added to those tabulations. In some instances these more recent data have upset the more or less orderly sequence of earlier years. Nevertheless, the tables have been retained temporarily, both because they serve as a definite basis for discussion and also to await the return of 1935, which falls in the cycle which in the past has been by far the strongest.

The data of 1934 are exceptions, the pack (76,923 cases) being small for the cycle and the percentage (21) of five-year-old fish being very much below the figure which was considered normal for the series in the earlier years (p. 23, Report for 1929). Such a preponderance of four-year-olds as occurred in this year's run has been recorded only a very few times in the history of Rivers Inlet. However, their predominance is not real; their relative proportion is exaggerated because of the failure of the five-year-old fish. It is quite evident, then, that the mediocre pack (76,923 cases) of 1934 is due to the low level of productivity of 1929 as a brood-year. This spawning hatched in the spring of 1930 and after a year's residence in Lake Owikeno the young migrants went to sea. A fair percentage (45) of the run of 1933 was made up of these fish having matured at the age of four, and a small portion (21 per cent.) of the run of 1934 was composed of this same spawning, maturing at the age of five. One can

only conjecture as to the conditions which would result in such an unbalanced return from a single spawning.

That the year 1934 was not a particularly successful one for Rivers Inlet is evident also in the report of only average seeding of the spawning-beds. Furthermore, disregarding the pack in relation to the cycle in which it occurs, and viewing it in comparison with all the other twenty-seven recorded packs, it is found to be approximately 7,000 cases less than the average pack for the period (Table VIII.).

The spawnings of 1930 and 1931 will be the progenitors for the run of 1935. The year falls into the cycle which in the past has been by far the most productive in this river system, yielding packs well over 100,000 cases. However, there are certain features which may be indicative of a run and pack of lesser magniture than formerly. The year 1930 is the more important of the two brood years. In this year the proportion of five-year-old fish in this cycle dropped from the usual high percentage to 50 per cent. If the trend continues the outlook is not good, because large numbers of 5_2's have been closely associated with large packs. The other brood-year, 1931, yielded a pack of less than average size and cannot be counted upon to contribute in a marked degree to the run of 1935. Average seedings were reported on the spawning-beds in both 1930 and 1931. It would seem, then, that a pack in the neighbourhood of 100,000 cases would be reasonable expectancy.

(2.) Age-groups.

The facts concerning the 1934 Rivers Inlet run have been drawn from 1,597 individuals gathered in seventeen samplings between June 27th and August 6th. The distribution of these individuals among the four age-groups which characterize this river system is as follows: 4_2's, 1,229; 5_2's, 330; 5_3's, 29; and 6_3's, 9. The two former groups dominate the run to the extent of 98 per cent. The groups which spend two years in fresh water are always an inconsequential part of the run. During the last two years they have been even slightly less abundant than formerly, their average percentage over the ten years previous to 1934 being 3.3 per cent. Although the relative proportions of the two chief groups vary over a wide range, 1934 is exceptional in that there are only four other years among the twenty-three for which there are records in which the 5_2's have been so conspicuously in the minority. Nineteen hundred and twenty-nine, the brood-year from which the 21 per cent. of the 1934 run was derived, had only 19 per cent. of this year-class present. However, this is more coincident than significant because there is no evidence, direct or indirect, to indicate that five-year-old fish necessarily produce five-year-olds. Age of maturity is no doubt determined in part by the interaction of physico-chemical conditions.

(3.) Lengths and Weights.

The entire sample of 1,597 individuals is listed according to length in Table IX. and according to weight in Table X. The average measurements of the chief age-groups, together with the general averages, form Tables XI. and XII. A glance at these tables shows that the averages of the 4_2 class of 1934 for both sexes and for both length and weight are slightly less than the general averages. The converse is true of the 5_2's, all measurements being a trifle more than the general averages. However, the differences are not sufficiently great in either class to regard the fish other than of average size.

A peculiarity confined almost exclusively to these Rivers Inlet sockeyes, especially to the 4_2 group, is not as marked in 1934 as it often has been. This is the close correspondence in size between the two sexes. A little more than 50 per cent. of the records (Table XI.) show the males and females to be identical or to differ by not more than 0.1 inch. The weights exhibit the same tendency but to a lesser degree. This unique relationship is probably more apparent than real. The average size of the Rivers Inlet four-year-old fish is decidedly less than that of the same age-group in the other river systems. Consequently it is probable that these figures do not represent a complete cross-section of the 4_2 class; they show only that part of the group which it is possible to gill with the mesh in use. Smaller individuals of the group are probably passing through the nets. In view of the fact that the bodies of mature males are deeper than those of females, it is very likely that females predominate among the escaping fish. Evidence for the truth of this supposition is found in all the tables presenting length distributions, such as Table IX. in 1934. A perusal of the 4_2 group shows throughout

the years that the majority of recorded smallest fish are males. Such is not the case in the other age-classes. If the samplings contained representatives of these smaller fish, the average lengths and weights of the group would probably drop and the measurements of the male would exceed those of the female. There is no reason to suppose that the size relationship which exists between the sexes in every other group should be absent in this class.

That the small fish which are not netted form a very considerable part of the runs to Rivers Inlet is evidenced time and again in the reports of the spawning-beds. For instance, the report of the present year contains the following statement: " One factor of the run was found to be the abnormally large proportion of the three-year-old males; in fact, of the whole run the males have considerably exceeded the females in number." Yet the 1934 samplings contained neither a single grilse nor, as the following paragraph indicates, a majority of males.

(4.) Distribution of the Sexes.

Of recent years by far the most interesting and at the same time most perplexing feature in connection with Rivers Inlet sockeyes has been their sex distribution. In preparing the final section of this report it was necessary to go back to the original data in some of the earlier years of Rivers Inlet. In so doing it was discovered that the sex ratios had not always been computed on the entire cross-sections of the runs. Consequently, in order to make the data perfectly comparable throughout the years, all the averages have been checked and changed wherever necessary (Table XIII.). The correct averages do not alter the general trends in the sex proportions, but they make the definite quantitative statements concerning the early years found in former discussions incorrect. In this river system the males have always outnumbered the females in the 4_2 group and the reverse condition has obtained in the other principal class, the 5_2's. Up to and including the year 1929 the yearly ratio of the two sexes in the complete sample has fluctuated; some years the males have been in the majority and other years the females. But since 1930 the females have constantly exceeded the males. In viewing the two age-classes closely, it is evident that the relative proportions of the sexes have changed as the years have passed. In both cases the males have become less abundant. During the earliest five years for which there are records the males constituted 72 per cent. of the 4_2 group and from 1930–34 only 56 per cent. For the same periods the 5_2 males totalled 44 and 31 per cent. respectively. On the one hand the ratio between the sexes has become less extreme and on the other hand more extreme. The average percentages (4_2's, 65 per cent. males and 35 per cent. females; 5_2's, 36 per cent. males and 64 per cent. females) are interesting because they show how very closely over a period of years the excess of males in one group has compensated for the lack in the other. Furthermore, as one would anticipate under the circumstances, the average total number of males and females is very nearly equivalent, the difference being 1 per cent. in favour of the males. In computing the total percentages the entire cross-sections of the runs have been taken into consideration. However, except in a very few instances, the representatives of the other age-groups have not been abundant enough to affect the averages even by 1 per cent.

The 1934 ratios fall regularly into their respective series. The 4_2 males, forming 55 per cent. of the group, have been less abundant by 1 per cent. only in the year 1932 and the 5_2 males have reached a new low level at 27 per cent. Nevertheless, in the total of 1,597 individuals, the females outnumber the males by a mere 27 individuals. The sex ratios of Rivers Inlet as well as those of the other river systems are discussed more fully in the last section of this report.

Table VIII.—Rivers Inlet Sockeyes, Percentages of 4_2 and 5_2 Age-groups in Runs of Successive Years.

Run of the Year.	Percentage Four and Five Years old.	Brood-year from which derived.
1912 (112,884 cases)	5 yrs. 79% 4 yrs. 21%	1907 (87,874 cases). 1908 (64,652 cases).
1913 (61,745 cases)	5 yrs. 20% 4 yrs. 80%	1909 (89,027 cases).
1914 (89,890 cases)	5 yrs. 65% 4 yrs. 35%	1910 (126,921 cases).
1915 (130,350 cases)	5 yrs. 87% 4 yrs. 13%	1911 (88,763 cases).
1916 (44,936 cases)	5 yrs. 76% 4 yrs. 24%	1912 (112,884 cases).
1917 (61,195 cases)	5 yrs. 67% 4 yrs. 33%	1913 (61,745 cases).
1918 (53,401 cases)	5 yrs. 43% 4 yrs. 57%	1914 (89,890 cases).
1919 (56,258 cases)	5 yrs. 54% 4 yrs. 43%	1915 (130,350 cases).
1920 (121,254 cases)	5 yrs. 95% 4 yrs. 5%	1916 (44,936 cases).
1921 (46,300 cases)	5 yrs. 51% 4 yrs. 49%	1917 (61,195 cases).
1922 (60,700 cases)	5 yrs. 18% 4 yrs. 82%	1918 (53,401 cases).
1923 (107,174 cases)	5 yrs. 24% 4 yrs. 76%	1919 (56,258 cases).
1924 (94,891 cases)	5 yrs. 56% 4 yrs. 44%	1920 (121,254 cases).
1925 (159,554 cases)	5 yrs. 77% 4 yrs. 23%	1921 (46,300 cases).
1926 (65,581 cases)	5 yrs. 40% 4 yrs. 60%	1922 (60,700 cases).
1927 (64,461 cases)	5 yrs. 17% 4 yrs. 83%	1923 (107,174 cases).
1928 (60,044 cases)	5 yrs. 42% 4 yrs. 58%	1924 (94,891 cases).
1929 (70,260 cases)	5 yrs. 19% 4 yrs. 81%	1925 (159,554 cases).
1930 (119,170 cases)	5 yrs. 50% 4 yrs. 50%	1926 (65,581 cases).
1931 (76,428 cases)	5 yrs. 54% 4 yrs. 46%	1927 (64,461 cases).
1932 (69,732 cases)	5 yrs. 29% 4 yrs. 71%	1928 (60,044 cases).
1933 (83,507 cases)	5 yrs. 55% 4 yrs. 45%	1929 (70,260 cases).
1934 (76,923 cases)	5 yrs. 21% 4 yrs. 79%	1930 (119,170 cases).

Table IX.—Rivers Inlet Sockeyes, Run of 1934, grouped by Age, Sex, and Length, and by their Early History.

Length in Inches.	Number of Individuals.								Total.
	4_2		5_2		5_3		6_3		
	M.	F.	M.	F.	M.	F.	M.	F.	
20	4	-----	-----	-----	-----	-----	-----	-----	4
20½	24	12	1	-----	1	-----	-----	-----	38
21	85	47	-----	1	1	-----	-----	-----	134
21½	114	116	-----	-----	1	-----	-----	-----	231
22	122	144	1	1	2	5	-----	-----	275
22½	93	99	-----	7	3	2	1	-----	205
23	76	68	4	13	2	3	-----	-----	166
23½	54	35	6	28	2	3	1	-----	129
24	40	19	13	29	-----	1	-----	-----	102
24½	27	7	10	21	-----	-----	1	-----	66
25	27	4	9	46	2	-----	-----	1	89
25½	9	2	3	27	1	-----	-----	-----	42
26	1	-----	5	25	-----	-----	1	-----	32
26½	-----	-----	7	19	-----	-----	1	1	28
27	-----	-----	14	17	-----	-----	-----	-----	31
27½	-----	-----	5	7	-----	-----	-----	1	13
28	-----	-----	5	1	-----	-----	1	-----	7
28½	-----	-----	2	-----	-----	-----	-----	-----	2
29	-----	-----	1	-----	-----	-----	-----	-----	1
29½	-----	-----	1	-----	-----	-----	-----	-----	1
30	-----	-----	1	-----	-----	-----	-----	-----	1
Totals	676	553	88	242	15	14	6	3	1,597
Ave. lengths	22.4	22.2	25.6	25.0	22.9	22.7	25.2	26.3	-----

Table X.—Rivers Inlet Sockeyes, Run of 1934, grouped by Age, Sex, and Weight, and by their Early History.

Weight in Pounds.	Number of Individuals.								Total.
	4_2		5_2		5_3		6_3		
	M.	F.	M.	F.	M.	F.	M.	F.	
3	22	15	-----	-----	-----	-----	-----	-----	37
3½	2	1	-----	-----	-----	-----	-----	-----	3
4	181	188	2	11	2	3	-----	-----	387
4½	110	121	1	-----	3	2	1	-----	238
5	185	133	8	32	4	3	1	-----	366
5½	64	63	4	19	2	3	-----	-----	155
6	59	21	13	38	1	2	-----	-----	134
6½	21	6	9	18	-----	-----	1	-----	55
7	18	5	14	42	2	1	1	1	84
7½	9	-----	1	16	1	-----	-----	-----	27
8	4	-----	9	33	-----	-----	-----	-----	46
8½	1	-----	4	12	-----	-----	1	1	19
9	-----	-----	10	15	-----	-----	-----	-----	25
9½	-----	-----	5	5	-----	-----	-----	1	11
10	-----	-----	4	1	-----	-----	-----	-----	5
10½	-----	-----	1	-----	-----	-----	1	-----	2
11	-----	-----	1	-----	-----	-----	-----	-----	1
11½	-----	-----	1	-----	-----	-----	-----	-----	1
12	-----	-----	1	-----	-----	-----	-----	-----	1
Totals	676	553	88	242	15	14	6	3	1,597
Ave. weights	4.9	4.6	7.3	6.7	5.3	5.1	7.0	8.3	-----

Table XI.—Rivers Inlet Sockeyes, Average Length in Inches of the 4_2 and 5_2 Groups, 1912 to 1934.

Year.	Four-year Males.	Four-year Females.	Five-year Males.	Five-year Females.
1912	23.2	22.8	25.8	24.6
1913	22.9	23.0	25.9	25.2
1914	23.0	22.8	25.9	25.2
1915	22.9	22.8	26.0	25.1
1916	22.9	22.8	25.8	25.0
1917	22.5	22.3	25.0	24.4
1918	22.3	22.5	24.9	24.5
1919	22.4	22.3	24.8	24.4
1920	-----	-----	26.0	25.0
1921	22.9	22.6	25.2	24.2
1922	22.5	22.4	24.6	24.2
1923	22.4	22.3	24.6	24.1
1924	22.3	22.3	24.9	24.3
1925	22.2	22.2	25.5	24.8
1926	22.8	22.9	25.1	24.6
1927	22.1	22.4	24.6	24.2
1928	22.3	22.8	26.1	25.2
1929	22.6	22.2	25.2	25.3
1930	22.7	22.6	26.0	25.2
1931	21.9	22.0	25.2	24.8
1932	22.4	22.4	25.2	24.6
1933	22.1	22.0	25.5	24.7
Average lengths	22.5	22.5	25.3	24.7
1934	22.4	22.2	25.6	25.0

Table XII.—Rivers Inlet Sockeyes, Average Weight in Pounds of the 4_2 and 5_2 Groups, 1914 to 1934.

Year.	Four-year Males.	Four-year Females.	Five-year Males.	Five-year Females.
1914	5.4	5.2	7.3	6.8
1915	5.3	5.1	7.3	6.6
1916	5.5	5.0	7.6	6.7
1917	5.0	4.9	6.6	6.2
1918	4.9	5.1	6.7	6.7
1919	4.9	4.8	6.3	5.9
1921	5.2	4.9	6.9	6.0
1922	6.0	5.9	7.4	7.0
1923	5.0	4.8	6.5	5.9
1924	4.9	4.8	6.6	6.1
1925	4.6	4.4	6.9	6.2
1926	5.2	5.2	6.9	6.3
1927	5.3	5.8	7.3	7.6
1928	4.8	5.0	7.5	6.7
1929	5.0	4.8	6.6	6.7
1930	4.9	4.8	7.5	6.9
1931	4.5	4.6	6.7	6.4
1932	4.7	4.7	6.5	6.5
1933	4.8	4.6	7.3	6.6
Average weights	5.1	5.0	7.0	6.5
1934	4.9	4.6	7.3	6.7

Table XIII.—Rivers Inlet Sockeyes, Percentages of Males and Females of the 4_2 and 5_2 Age-groups, 1915 to 1934.

Year.	4_2		5_2		Per Cent. Total Males.	Per Cent. Total Females.
	M.	F.	M.	F.		
1915	----	----	----	----	45	55
1913	65	35	43	57	49	51
1917	63	37	39	61	48	52
1918	79	21	49	51	66	34
1919	77	23	41	59	58	42
1920	74	26	48	52	49	51
1921	63	37	40	60	51	49
1922	66	34	38	62	61	39
1923	71	29	31	69	62	38
1924	74	26	31	69	50	50
1925	66	34	34	66	41	59
1923	63	37	32	68	51	49
1927	68	32	36	64	62	38
1928	63	37	30	70	50	50
1929	57	43	36	64	53	47
1930	56	44	37	63	47	53
1931	59	41	33	67	47	53
1932	54	46	28	72	47	53
1933	56	44	32	68	42	58
1934	55	45	27	73	49	51
Average	65	35	36	64	51	49

3. THE SKEENA RIVER SOCKEYE RUN OF 1934.

(1.) General Characteristics.

The pack of Skeena River sockeye amounted to 70,655 cases, which was slightly below expectation (Table XIV.).

The reports from the spawning-beds indicate that the escapement to the Lakelse area was very good, while that to the Babine section was not very satisfactory. The reasons for the discrepancy between prediction and actual run are not apparent at the present time.

The run on the Skeena River in 1935 should be rather large. The reports on the spawning-beds in 1930 and 1931 state that the escapements were good and in those years the packs were fairly large—namely, 132,372 cases and 93,023 cases respectively. It would seem that a pack of approximately 100,000 cases may be expected.

(2.) Age-groups.

Scales and length, weight and sex data were obtained from 2,087 fish from June 20th to August 14th in thirty-eight random samplings. The 4_2 age-group is represented by 1,214 individuals or 58 per cent., while the 5_2 group consists of 714 fish or 34 per cent. The numbers in the other two age-groups are relatively small—namely, 5_3's, 141 or 7 per cent., and 6_3's, 18 or 1 per cent. (Table XV.). This distribution is almost identical with that of the year 1933.

(3.) Lengths and Weights.

The average lengths of the two sexes of the 4_2 age-group are exactly equivalent to the averages of the past twenty-two years, while the average weights are slightly above. On the other hand, the averages for both lengths and weights of the 5_2 and 5_3 age-classes are high and distinctly above the averages for the past years. Those for the 6_3 age-group are also decidedly above average.

The average lengths and weights for the year are as follows:—

4_2 males, 23.8 inches, 5.7 lb.; females, 23.2 inches, 5.2 lb.
5_2 males, 26.3 inches, 7.7 lb.; females, 25.2 inches, 6.6 lb.
5_3 males, 25.2 inches, 6.7 lb.; females, 24.1 inches, 5.8 lb.
6_3 males, 26.0 inches, 7.7 lb.; females, 24.9 inches, 6.2 lb.
(Tables XVI., XVII., XVIII., and XIX.)

(4.) Proportions of the Sexes.

The total number of males in the samplings is 816 and of females 1,271, percentages of 39 and 61 respectively. This constitutes the second lowest record for percentage of males and, correspondingly, the second highest for females. The record for the past twenty years is given in Table XX.

In the 4_2, 5_2, and 5_3 age-groups the females outnumber the males, while in the 6_3 group only are the males in excess.

Table XIV.—Skeena River Sockeyes, Percentages of 4_2 and 5_2 Age-groups in Runs of Successive Years.

Run of the Year.	Percentage Four and Five Years old.	Brood-year from which derived.
1912 (92,498 cases)	5 yrs. 43%	1907 (108,413 cases).
	4 yrs. 57%	1908 (139,846 cases).
1913 (59,927 cases)	5 yrs. 50%	
	4 yrs. 50%	1909 (87,901 cases).
1914 (130,166 cases)	5 yrs. 75%	
	4 yrs. 25%	1910 (187,246 cases).
1915 (116,533 cases)	5 yrs. 64%	
	4 yrs. 36%	1911 (131,066 cases).
1916 (60,923 cases)	5 yrs. 60%	
	4 yrs. 40%	1912 (92,498 cases).
1917 (65,760 cases)	5 yrs. 62%	
	4 yrs. 38%	1913 (52,927 cases).
1918 (123,322 cases)	5 yrs. 59%	
	4 yrs. 41%	1914 (130,166 cases).
1919 (184,945 cases)	5 yrs. 69%	
	4 yrs. 31%	1915 (116,553 cases).
1920 (90,869 cases)	5 yrs. 82%	
	4 yrs. 18%	1916 (60,923 cases).
1921 (41,018 cases)	5 yrs. 24%	
	4 yrs. 76%	1917 (65,760 cases).
1922 (96,277 cases)	5 yrs. 19%	
	4 yrs. 81%	1918 (123,322 cases).
1923 (131,731 cases)	5 yrs. 34%	
	4 yrs. 66%	1919 (184,945 cases).
1924 (144,747 cases)	5 yrs. 75%	
	4 yrs. 25%	1920 (90,869 cases).
1925 (81,146 cases)	5 yrs. 47%	
	4 yrs. 53%	1921 (41,018 cases).
1926 (82,360 cases)	5 yrs. 30%	
	4 yrs. 70%	1922 (96,277 cases).
1927 (83,996 cases)	5 yrs. 31%	
	4 yrs. 69%	1923 (131,731 cases).
1928 (34,559 cases)	5 yrs. 43%	
	4 yrs. 57%	1924 (144,747 cases).
1929 (78,017 cases)	5 yrs. 33%	
	4 yrs. 67%	1925 (77,784 cases).
1930 (132,372 cases)	5 yrs. 57%	
	4 yrs. 43%	1926 (82,360 cases).
1931 (93,023 cases)	5 yrs. 57%	
	4 yrs. 43%	1927 (83,996 cases).
1932 (59,916 cases)	5 yrs. 49%	
	4 yrs. 51%	1928 (34,559 cases).
1933 (30,506 cases)	5 yrs. 39%	
	4 yrs. 61%	1929 (78,017 cases).
1934 (70,655 cases)	5 yrs. 37%	
	4 yrs. 63%	1930 (132,372 cases).

Table XV.—Skeena River Sockeyes, Percentages of the Principal Year-classes from 1916 to 1934.

Year.	One Year in Lake.		Two Years in Lake.	
	Four Years old.	Five Years old.	Five Years old.	Six Years old.
1916	34	38	13	18
1917	57	29	9	5
1918	51	34	9	6
1919	27	60	9	4
1920	15	71	6	8
1921	69	22	6	3
1922	70	16	12	2
1923	56	29	8	7
1924	23	69	7	1
1925	51	45	3	1
1926	62	26	9	3
1927	62	28	9	1
1928	51	39	7	3
1929	62	30	6	2
1930	39	52	8	1
1931	40	30	28	2
1932	44	37	7	12
1933	57	36	5	2
1934	58	34	7	1

Table XVI.—Skeena River Sockeyes, 1934, grouped by Age, Sex, and Length, and by their Early History.

Length in Inches.	Number of Individuals.								Total.
	4_2		5_2		5_3		6_3		
	M.	F.	M.	F.	M.	F.	M.	F.	
20½	6	5	-----	-----	-----	-----	-----	-----	11
21	24	8	-----	3	-----	-----	-----	-----	35
21½	27	30	-----	-----	-----	-----	-----	-----	57
22	42	52	-----	2	1	7	-----	-----	104
22½	39	114	-----	6	2	6	-----	-----	167
23	35	147	4	16	5	7	1	-----	215
23½	51	139	2	22	-----	9	-----	1	224
24	63	104	12	41	6	18	1	1	246
24½	74	71	10	70	4	10	-----	1	240
25	77	23	20	95	8	9	-----	1	233
25½	36	7	16	73	10	4	1	2	149
26	24	3	42	78	14	6	3	1	171
26½	12	-----	34	39	4	4	1	-----	94
27	1	-----	42	27	4	-----	1	-----	75
27½	-----	-----	23	6	1	1	3	-----	34
28	-----	-----	19	1	1	-----	-----	-----	21
28½	-----	-----	3	1	-----	-----	-----	-----	4
29	-----	-----	7	-----	-----	-----	-----	-----	7
Totals	511	703	234	480	60	81	11	7	2,087
Ave. lengths	23.8	23.2	26.3	25.2	25.2	24.1	26.0	24.9	-----

Table XVII.—Skeena River Sockeyes, 1934, grouped by Age, Sex, and Weight, and by their Early History.

Weight in Pounds.	Number of Individuals.								Total.
	4_2		5_2		5_3		6_3		
	M.	F.	M.	F.	M.	F.	M.	F.	
3½	9	2	-----	-----	-----	-----	-----	-----	11
4	55	41	-----	3	-----	4	-----	-----	103
4½	63	162	-----	10	5	9	-----	-----	249
5	48	190	5	18	2	10	-----	1	274
5½	73	148	6	47	5	19	1	1	300
6	85	94	14	83	6	13	-----	2	297
6½	88	49	19	109	9	14	-----	1	289
7	54	12	36	84	14	6	2	1	209
7½	30	4	39	69	14	4	3	1	164
8	4	1	32	35	2	2	2	-----	78
8½	2	-----	34	17	2	-----	2	-----	57
9	-----	-----	26	5	1	-----	-----	-----	32
9½	-----	-----	13	-----	-----	-----	1	-----	14
10	-----	-----	9	-----	-----	-----	-----	-----	9
10½	-----	-----	1	-----	-----	-----	-----	-----	1
Totals	511	703	234	480	60	81	11	7	2,087
Ave. weights	5.7	5.2	7.7	6.6	6.7	5.8	7.7	6.2	-----

Table XVIII.—Skeena River Sockeyes, Average Lengths in Inches of Principal Age-groups, 1912 to 1934.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1912	24.6	23.5	26.4	25.2	-----	-----	-----	-----
1913	23.5	22.9	25.5	24.7	-----	-----	-----	-----
1914	24.2	23.4	26.2	25.1	-----	-----	-----	-----
1915	24.2	23.5	25.9	25.0	24.5	23.4	25.6	24.4
1916	23.9	23.6	26.2	25.0	24.1	23.8	26.2	24.8
1917	23.6	23.2	25.5	24.7	23.9	23.8	25.4	25.0
1918	24.1	23.3	25.9	25.0	23.9	23.4	25.2	24.7
1919	24.3	23.4	25.7	24.8	24.3	23.4	25.8	24.7
1920	23.8	23.2	26.2	25.3	24.1	23.4	26.2	25.1
1921	23.8	23.1	25.2	24.2	24.2	23.4	24.9	24.2
1922	23.6	23.2	25.3	24.4	23.8	23.3	24.6	24.1
1923	23.7	23.1	25.5	24.5	23.9	23.2	25.6	24.4
1924	24.1	23.3	26.2	25.2	24.7	23.6	25.8	24.8
1925	23.6	22.8	25.6	24.7	24.1	23.3	25.8	24.8
1926	23.8	23.4	25.6	24.8	24.6	23.8	26.0	25.0
1927	23.9	23.3	25.7	24.8	24.1	23.5	25.2	24.9
1928	23.3	22.8	25.3	24.7	23.5	22.8	25.6	24.7
1929	22.9	22.7	25.5	24.7	23.8	22.8	25.5	24.3
1930	23.1	22.7	24.7	23.9	23.5	22.4	24.6	23.2
1931	23.5	23.1	25.7	24.8	23.8	23.1	25.8	24.7
1932	23.4	22.7	25.2	24.4	24.1	22.8	25.4	24.4
1933	23.2	22.8	26.1	25.2	24.3	23.4	26.4	25.3
Average lengths	23.8	23.2	25.7	24.8	24.1	23.3	25.6	24.6
1934	23.8	23.2	26.3	25.2	25.2	24.1	26.0	24.9

Table XIX.—Skeena River Sockeyes, Average Weights in Pounds of Principal Age-groups, 1914 to 1934.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1914	5.9	5.3	7.2	6.3	-----	-----	-----	-----
1915	5.7	5.2	6.8	6.2	5.9	5.2	6.6	6.0
1916	5.4	5.1	7.1	6.3	5.8	5.4	7.1	5.9
1917	5.3	5.0	6.4	6.0	5.5	5.2	6.3	5.8
1918	5.8	5.3	6.9	6.4	5.7	5.3	6.6	6.1
1919	6.1	5.5	7.0	6.2	6.1	5.4	6.9	6.3
1920	5.6	5.1	7.2	6.4	6.3	5.1	7.3	6.3
1921	5.7	5.1	6.4	5.7	5.8	5.1	6.0	5.6
1922	5.4	5.1	6.5	5.7	5.5	5.1	6.2	5.7
1923	5.3	4.9	6.3	5.7	5.3	4.8	6.3	5.4
1924	5.6	5.0	7.0	6.3	5.9	5.1	6.6	5.8
1925	5.1	4.7	6.5	5.8	5.5	4.9	6.9	5.4
1926	5.3	5.1	6.5	5.8	5.9	5.2	6.9	6.2
1927	5.4	5.1	6.5	5.9	5.4	5.0	6.0	5.8
1928	5.0	4.6	6.4	5.8	5.0	4.6	6.5	5.8
1929	4.9	4.7	6.8	6.2	5.6	4.9	6.8	5.7
1930	5.4	5.1	6.7	6.0	5.6	5.0	6.8	5.8
1931	5.4	5.1	6.8	6.3	5.5	5.0	6.9	6.0
1932	5.4	4.9	6.9	6.1	6.0	5.0	6.8	5.9
1933	4.9	4.7	7.1	6.3	5.7	5.0	7.1	6.3
Average weights	5.4	5.0	6.7	6.1	5.7	5.1	6.7	5.9
1934	5.7	5.2	7.7	6.6	6.7	5.8	7.7	6.2

Table XX.—Skeena River Sockeyes, Percentages of Males and Females of the 4_2 and 5_2 Age-groups, 1915 to 1934.

Year.	4_2		5_2		Per Cent. Total Males.	Per Cent. Total Females.
	M.	F.	M.	F.		
1915	56	44	45	55	49	51
1916	70	30	43	57	55	45
1917	66	34	48	52	60	40
1918	63	37	46	54	57	43
1919	53	47	46	54	49	51
1920	41	59	37	63	38	62
1921	44	56	44	56	45	55
1922	52	48	41	59	50	50
1923	60	40	37	63	52	48
1924	50	50	43	57	45	55
1925	57	43	42	58	50	50
1926	40	60	43	57	42	58
1927	45	55	41	59	44	56
1928	48	52	45	55	46	54
1929	50	50	46	54	50	50
1930	47	53	56	44	53	47
1931	43	57	39	61	44	56
1932	47	53	63	37	54	46
1933	48	52	40	60	45	55
1934	42	58	33	67	39	61
Average	51	49	44	56	48	52

4. THE NASS RIVER SOCKEYE RUN OF 1934.

(1.) General Characteristics.

One of the most gratifying of the 1934 sockeye-packs is that of the Nass River, constituting 28,701 cases. In addition, heavy seeding for the early run and a good escapement of late sockeye are reported in the Meziadin spawning area. These facts make it possible, in spite of the poor showing in 1929, to single out again the years of 1914, 1919, 1924, 1929, and 1934 as the good cycle in this river system. The pack of this present year is only 4,000 cases less than the greatest pack in the cycle. In last year's report the possibility of an improved run was suggested on the ground that, if the four-year-old fish continued to form as significant a component of the run as they had during the last six years, they might augment the run very considerably in 1934 because of the unprecedented escapement to the spawning-beds in 1930. However, such was not the case. The percentage of these four-year-olds is more than 50 per cent. less than the average for the preceding six years. In spite of a moderate pack and a supposedly mediocre escapement in 1929, the success of 1934 is due almost entirely to the predominance of the five-year-old fish.

Futile as Nass predictions often are, circumstances seem to warrant a forecast for 1935. The year 1930, which will be the chief brood-year for the coming run, is outstanding for its success both as to pack and escapement. Its commercial yield of 26,405 cases is the only worth-while pack, with the exception of that of 1934, during the last ten years and, as was intimated in the preceding paragraph, the escapement was the greatest which Inspector Hickman had observed in his twenty-three annual inspections of the Meziadin spawning-beds. Therefore there is reason to expect a goodly return in 1935.

(2.) Age-groups.

One of the first characteristics to be pointed out in the study of the Nass River runs was its complex age-group constitution. This was a constant factor in the early analyses and the following eight age-groups were always present: 3_1, 4_1, 4_2, 5_2, 5_3, 6_3, 6_4, and 7_4. Although the sea-types (3_1 and 4_1) and the 6_4's and 7_4's never appeared in great abundance, still they appeared with such regularity that they were regarded as real components of the run. However, since 1927 there has not been a single year in which all four of these age-groups have been found, and in two years—namely, 1929 and 1934—only one of the four has been present and that represented by a single individual. The exact number of individuals present in each of these four groups during the last ten years, together with the inclusive dates of collections of material and the total number of individuals in the analyses, are given in the following tabulation:—

Period of Collection of Data.	Age-groups.				Total No. of Individuals.
	3_1	4_1	6_4	7_4	
1925, July 6–Aug. 22	1	1	30	----	1,621
1926, June 23–Aug. 20	7	16	75	8	1,835
1927, June 20–Aug. 15	9	100	4	2	2,100
1928, June 23–Aug. 16	32	41	7	----	1,760
1929, July 10–Aug. 16	----	----	1	----	1,982
1930, July 1–Aug. 25	----	16	----	----	1,952
1931, June 29–Aug. 17	10	28	5	----	1,757
1932, July 6–Aug. 20	----	6	17	2	1,624
1933, June 22–Aug. 16	1	8	----	2	1,638
1934, June 26–Aug. 3	----	1	----	----	1,245

It is evident that there is a certain amount of correlation between presence of these age-groups and extent of periods of collection. In general, the years in which samplings were started in June have the greatest number of sea-types, and, similarly, the latest August collections are associated with a greater abundance of 6_4's and 7_4's. However, there are some very noteworthy exceptions. For instance, compare the number of sea-types in 1934 with those of 1930 and 1932. Or what of the total absence of 6_4's and 7_4's in the year 1930,

in which the final date of collection was later than in any of the other nine years? This year of 1930 was particularly successful both as to pack and escapement, so that possibly the sample, large as it was (1,952 individuals), was not an adequate cross-section of the run. However, such an explanation does not seem very likely. The fact which this tabulation shows quite definitely is that these four year-groups are becoming of even less importance than formerly, and, if the trend continues, in the near future it may be necessary to restate the composition of the Nass River runs.

As indicated in the above tabulation, 1,245 fish collected between June 26th and August 3rd form the basis for the analysis of the run of 1934. These fish were taken in twenty-one samplings, a number greater than usual, but neither the interval between samplings nor the number of fish in each sample is as uniform as formerly. Also, the total number of individuals is smaller than those of recent years.

With the exception of a single individual, these 1,245 fish are distributed among the four age-classes common to all four river systems—that is, the 4_2, 5_2, 5_3, and 6_3 groups—in the following proportions: 12 per cent., 9 per cent., 74 per cent., and 4 per cent. As has always been the case, the 5_3's form the dominant group and the 4_2's stand next in importance. Although the relative proportions of these two major groups have fluctuated considerably, since 1928 there has been a strong tendency for the 4_2 class to increase (Table XXI.).

(3.) Lengths and Weights.

With the exception of one female 4_1, measuring 22.5 inches and weighing 4.5 lb., complete records of the size relationships of the 1934 sockeyes are given in Tables XXII. and XXIII. Both the average length and weight frequencies for each age-group for each year and the general averages over a period of years are recorded in Tables XXIV. and XXV. Last year the large size of the fish of certain age-groups was pointed out as an unusual feature of the run of 1933. Fish of even greater average size characterize the run of 1934. Of the sixteen average measurements, nine are new high records. Of these nine, two are to be found among the lengths—namely, (1) 25.9 inches, the length of the 5_2 female, which exceeds the previous greatest length by 0.1 inch and the general average by 0.9 inch; and (2) 28.6 inches, the length of the male 6_3, which is greater by 0.2 inch than any former measurement and surpasses the general average by 1.1 inches. The lengths of the other six groups are all greater than the general averages by amounts varying from 0.1 to 0.9 inch. With the exception of the weight of the 5_3 female, which equals the greatest previous weight, all weight measurements are new high levels and all exceed the general averages by at least 0.5 lb., with four of them—namely, both sexes of the 5_2 and 6_3 groups—bettering these averages by a pound or more.

These extraordinarily large-size frequencies cannot be passed over without questioning the reliability of the sample. Although the total number of individuals is somewhat smaller than in any recent year, in checking the number of individuals in each of the various age-groups against previous numbers, not one of these 1934 totals is smaller than totals previously used. It would therefore seem that, from the point of view of numbers, this 1934 sample is strictly comparable with foregoing samples. Unfortunately, the Nass data have not been gathered by the same collector year after year. In fact, recently there has been a different collector each year. Until 1934 the collection of the data was made, in general, in fifteen to eighteen samplings of approximately 125 individuals each, taken at fairly regular intervals of two or three days apart. The present data, in spite of being characterized by less regularity in the samplings, probably represent, for the period they cover, just as accurate a cross-section of the run, if not more accurate than previous cross-sections, because the samples, although small, were taken oftener. To what degree, if any, the personal judgment of the collector affected the samples cannot be definitely said. However, had the average size measurements of the dominant class, which forms 74 per cent. of the entire run of 1934, been new high records, one would be inclined to believe that the sample was not absolutely random. But since, as Tables XXIV. and XXV. show, these measurements, with the exception of the weight of the male, have been equalled or exceeded in several previous years, the data would appear to be unbiased. As additional evidence of this, attention is called to Table XXX., which presents the data of the Meziadin watershed sockeyes gathered by another collector who has performed the same task for a number of successive years. Here again there is evidence of

generally large fish. Because the margins of the scales are badly absorbed, ultimate ages cannot be read, but they have been computed in the following manner: Taking each sex separately, the fish were first segregated into two groups on the basis of the number of years spent in fresh water; then each of these groups was subdivided by allotting the fish, which by their lengths might belong to either of two given age-groups, to these groups in as nearly as possible the same proportion as similarly lengthed fish appear in the same given age-groups in the general Nass run. By the above procedure the Meziadin fish have been separated into age-groups, the average lengths of which are as follows:—

4_2		5_2		5_3		6_3	
M.	F.	M.	F.	M.	F.	M.	F.
25.0	24.3	27.5	25.5	27.0	26.1	29.2	27.5

Since this run of Meziadin fish is known to be composed of fish commonly larger than the general Nass run, the length frequencies of the former group should be greater than those of the latter group if the samplings are random. A comparison of the two sets of figures shows this to be true. Hence the evidence at hand seems to warrant the conclusion that the 1934 Nass sockeyes are especially large fish.

(4.) Seasonal Succession.

The phenomenon of seasonal succession which was so pronounced in the earlier Nass River runs has become less and less significant of recent years, especially since the complexity of age-groups has lessened. Table XXVI. gives a statement of the number of individuals of each year-group running on the different days on which data were collected, but the definite relationships of the past as to appearance, disappearance, and periods of greatest intensity of the various groups no longer exist.

(5.) Proportions of Sexes.

A discussion of the sex ratios of the various year-groups of the Nass sockeyes has not been included in previous reports because in general they were thought to be fairly well balanced. But in view of the changing sex proportions in the runs of the Skeena River and of Rivers Inlet, it seemed well to record the ratios of the four principal age-classes of the Nass runs for purposes of comparison (Table XXVII.). In this tabulation, as in the others of sex distribution, the total percentage of the two sexes is not based on the important year-classes appearing in the tables, but on the total number of males and females present in all age-groups, minor as well as major. This tabulation shows that there has been more or less fluctuation both within each age-group and also in the total number of males and females. However, it should be noted that the fluctuations are least extreme in the dominant class, the 5_3's, and most extreme in the 6_3 group, which is numerically the least important of these four groups.

In the 5_3 class, with the exception of the year 1915, the males have never exceeded the females; in the 4_2 group during the early years the males tended to outnumber the females, while in more recent years, when this class has appeared in greater strength, the reverse has been true; and among the 5_2's, prior to 1924, with the single exception of 1916, the females surpassed the males in numbers, while since that time the sexes have shown alternate excess. All three of these age-groups have a total deficiency of males: the 5_3's, 4 per cent.; the 5_2's, 3 per cent.; and the 4_2's, 1 per cent.

As is stated in section 5 of this report, the extreme sex ratio of the 6_3's in favour of the females is believed to be unreliable, due to imperfect sampling of this class.

As would be expected, the changes in the total number of males and females from year to year reflect in general the changes in the dominant group. Over the period of twenty years the males have totalled 47 per cent. and the females 53 per cent.

The 1934 ratios are interesting because of the 50 per cent. totals of males and females, each of the four age-groups more nearly approaching sex equality than in any other one year.

(6.) The Meziadin and Bowser Sockeye Colonies.

Since 1930, and for several years previous to that time, lack of adequate material has made an actual comparison between the populations of Meziadin and Bowser Lakes impossible. This aspect of the Nass River study, together with the former, complex age-group constitution of the run and the definite seasonal successions of these age-classes, seem to have become things of the past. The futility of continuing to repeat year after year things " as they used to be " is evident, particularly in the case of the comparison of these two colonies, which has always been based partially on assumption and has been entirely drawn from a meagre amount of material. However, as a conclusion to the utilization of the Meziadin data in this form, a brief summary of facts up to date follows.

In 1915 the late Dr. Gilbert expressed the view that the Nass runs were made up of two distinct races. His opinion was based on the following facts: First, that the run was divided sharply into early and late periods; secondly, that the late-running fish were of a conspicuously larger size; and thirdly, that the nuclear areas of the scales of the 5_3 age-group showed two distinct patterns of growth. The natural assumption was that these two races of sockeyes had different early histories in different parts of the Nass watershed. Since Meziadin and Bowser Lakes were the only lakes of importance to which sockeyes were known to have access, it was assumed that the two races of sockeyes represented the populations of these lakes. Unfortunately, the inaccessibility of the Nass watershed, entailing costly exploration, has never made possible a real examination of the spawning population of Bower Lake. However, each September since 1922 the Fisheries Officer inspecting the Meziadin watershed has made an attempt to collect data concerning both the sockeyes returning to Meziadin Lake and those ascending the Nass above its junction with the Meziadin.

In some years, due to high water or scarcity of fish, it has been impossible to get even a single fish at either one or both of these localities. This has been particularly true of the Nass River. Although a gill-net has been fished continuously for seven or eight days, the greatest number of fish ever secured has been forty-five. During the past nine years, except for 1930, when there was a very exceptional escapement on the Nass, the results of the fishing have been too poor to be of value to this study. As has often been said, if Bowser Lake, or any other lake on the Upper Nass, supports a considerable spawning population, it must be composed of early-running fish.

The material collected in the Meziadin River has in general been much more abundant and therefore more satisfactory for purposes of analysis. Nevertheless, it has been used as typical of Meziadin Lake in too broad a sense. In the Fishery Inspector's reports there is always mention of an early and a late run of fish to Meziadin Lake. It is only of the late run that there is any information, the nature of the early one being absolutely unknown.

Such data as have been gathered from year to year at the Meziadin River and the Nass proper have been studied comparatively and two definite differences, more or less in keeping with the original distinctions made by Dr. Gilbert, have been found. The size difference has held, and although two distinct growth patterns in the nuclei of the scales of the 5_3's did not materialize as a valid characteristic, another phase of fresh-water life—namely, the difference in the number of years spent in fresh water—has served as a useful mark of differentiation. The two generalizations which follow concerning the two populations have always been made guardedly because of the obvious danger of error in making deductions from small amounts of material: First, the average size of the Meziadin fish is definitely larger than that of the so-called Bowser colony (Table XXVIII.); and, secondly, the majority of the Meziadin population spends a greater number of years in fresh water than does the major part of the Bowser aggregation (Table XXIX.).

In a previous paragraph reference has already been made to the large size of 1934 Meziadin sockeyes. The total sample, numbering sixty-seven fish, are distributed according to lengths in Table XXX. This table also includes, merely for the purpose of recording them, the three sockeyes intercepted by the gill-net in the Nass River above its junction with the Meziadin.

Table XXI.—Nass River Sockeyes, Percentages of Principal Age-groups from 1912 to 1934.

Year.	Percentage of Individuals that spent			
	One Year in Lake.		Two Years in Lake.	
	Four Years old.	Five Years old.	Five Years old.	Six Years old.
1912 (36,037 cases)	8	27	63	2
1913 (23,574 cases)	15	12	71	2
1914 (31,327 cases)	4	41	45	10
1915 (39,349 cases)	19	14	59	8
1916 (31,411 cases)	9	17	66	8
1917 (22,188 cases)	10	15	71	4
1918 (21,816 cases)	30	16	45	9
1919 (28,259 cases)	7	22	65	6
1920 (16,740 cases)	8	14	72	6
1921 (9,364 cases)	10	7	75	8
1922 (31,277 cases)	6	2	91	1
1923 (17,821 cases)	11	6	77	6
1924 (33,590 cases)	4	3	91	2
1925 (18,945 cases)	23	8	67	2
1926 (15,929 cases)	12	12	63	13
1927 (12,026 cases)	8	7	81	4
1928 (5,540 cases)	30	6	61	3
1929 (16,077 cases)	25	9	60	6
1930 (26,405 cases)	28	15	54	3
1931 (16,929 cases)	10	17	67	6
1932 (14,154 cases)	28	4	61	7
1933 (9,757 cases)	35	7	55	3
1934 (28,701 cases)	12	9	74	4

Table XXII.—Nass River Sockeyes, 1934, grouped by Age, Sex, and Length, and by their Early History.

Length in Inches.	Number of Individuals.								
	4_2		5_2		5_3		6_3		Total.
	M.	F.	M.	F.	M.	F.	M.	F.	
21	-----	1	-----	-----	-----	-----	-----	-----	1
22	-----	1	-----	-----	-----	-----	-----	-----	1
22½	3	6	-----	-----	-----	1	-----	-----	10
23	2	9	-----	-----	1	7	-----	-----	19
23½	9	13	-----	-----	-----	9	-----	-----	31
24	4	16	-----	3	10	40	-----	-----	73
24½	14	13	2	3	16	47	-----	1	96
25	14	10	2	8	35	83	-----	-----	152
25½	13	8	2	10	59	97	-----	2	191
26	11	4	13	14	109	97	-----	2	250
26½	5	1	6	8	95	52	-----	2	169
27	2	-----	14	8	70	24	4	5	127
27½	-----	-----	7	3	40	4	3	3	60
28	-----	-----	8	-----	18	1	4	2	33
28½	-----	-----	1	-----	5	1	6	1	14
29	-----	-----	4	-----	-----	-----	3	-----	7
29½	-----	-----	-----	-----	-----	-----	3	2	5
30	-----	-----	-----	-----	-----	-----	3	-----	3
30½	-----	-----	-----	-----	-----	-----	1	-----	1
31	-----	-----	-----	-----	-----	-----	1	-----	1
Totals	77	82	59	57	458	463	28	20	1,244
Ave. lengths	24.9	24.1	26.9	25.9	26.3	25.4	28.6	27.1	-----

Table XXIII.—Nass River Sockeyes, 1934, grouped by Age, Sex, and Weight, and by their Early History.

Weight in Pounds.	Number of Individuals.								Total.
	4_2		5_2		5_3		6_3		
	M.	F.	M.	F.	M.	F.	M.	F.	
4½	-----	4	-----	-----	1	2	-----	-----	7
5	5	9	-----	-----	1	11	-----	-----	26
5½	11	24	-----	1	4	31	-----	-----	71
6	9	21	-----	3	20	79	-----	1	133
6½	14	14	6	10	44	108	-----	1	197
7	19	10	2	14	79	114	1	3	242
7½	11	-----	7	12	108	85	-----	4	227
8	4	-----	10	10	91	25	1	1	142
8½	4	-----	11	4	65	7	5	5	101
9	-----	-----	8	3	36	-----	9	1	57
9½	-----	-----	9	-----	6	1	3	4	23
10	-----	-----	5	-----	3	-----	2	-----	10
10½	-----	-----	1	-----	-----	-----	2	-----	3
11	-----	-----	-----	-----	-----	-----	5	-----	5
Totals	77	82	59	57	458	433	28	20	1,244
Ave. weights	6.7	5.9	8.4	7.3	7.6	6.7	9.4	8.1	-----

Table XXIV.—Nass River Sockeyes, Average Lengths in Inches of Principal Classes from 1912 to 1934.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1912	24.6	23.3	26.5	25.1	26.2	25.4	27.0	25.6
1913	24.1	23.5	25.6	24.8	26.0	25.2	26.0	26.6
1914	24.6	22.7	26.1	25.1	26.3	25.5	26.9	25.6
1915	24.0	23.5	25.9	25.2	26.5	25.9	26.6	25.3
1916	24.5	23.3	26.4	25.0	26.5	25.6	27.9	25.7
1917	23.4	23.2	25.5	24.7	25.3	24.7	26.5	25.5
1918	25.0	24.3	25.7	24.7	25.9	25.0	27.2	25.2
1919	24.9	24.1	26.2	25.2	26.5	25.8	27.9	26.7
1920	24.0	23.4	26.3	25.0	26.7	25.9	27.4	25.9
1921	24.3	23.5	25.5	24.3	26.2	25.6	27.9	26.2
1922	24.2	23.4	25.6	24.6	25.7	25.0	28.0	25.9
1923	24.3	23.7	25.9	25.3	26.2	25.5	27.2	26.5
1924	24.7	23.8	26.2	24.9	26.3	25.4	28.0	25.4
1925	24.4	23.8	25.9	24.7	25.9	25.0	26.9	25.4
1926	24.9	24.1	26.1	25.3	26.1	25.3	27.9	27.0
1927	24.9	24.2	25.3	25.2	26.3	25.9	27.6	26.5
1928	24.3	23.5	26.0	25.1	25.5	24.6	28.1	26.2
1929	24.1	23.5	26.1	25.2	25.9	24.9	27.2	26.2
1930	24.5	23.7	26.5	25.4	26.4	25.3	27.9	26.8
1931	24.5	23.8	26.5	25.7	26.1	25.3	28.2	27.1
1932	24.9	23.9	26.4	25.2	26.6	25.6	28.3	27.1
1933	24.6	23.7	27.1	25.8	25.9	25.2	28.4	27.9
Average lengths	24.4	23.6	26.1	25.0	26.0	25.3	27.5	26.2
1934	24.9	24.1	26.9	25.9	26.3	25.4	28.6	27.1

Table XXV.—Nass River Sockeyes, Average Weights in Pounds of Principal Classes from 1914 to 1934.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1914	6.2	5.0	7.4	6.5	7.2	6.5	7.9	6.8
1915	5.6	5.2	6.9	6.4	7.0	6.6	7.2	6.5
1916	6.0	5.3	7.2	6.3	7.2	6.2	8.1	6.4
1917	5.3	5.3	6.8	6.2	6.3	5.8	7.3	6.4
1918	6.3	5.8	7.2	6.3	7.2	6.4	8.3	6.7
1919	6.0	5.5	6.6	5.9	6.7	6.1	7.8	6.7
1920	5.6	5.2	7.4	6.3	7.4	6.7	7.9	7.0
1921	6.0	5.4	6.9	6.1	6.9	6.3	7.7	6.6
1922	5.9	5.4	6.8	6.2	6.8	6.3	8.1	6.6
1923	5.8	5.2	6.7	6.1	6.6	6.0	7.2	6.8
1924	5.9	5.4	7.2	6.1	6.8	6.1	8.0	6.5
1925	5.9	5.4	6.8	6.1	6.7	6.0	7.4	6.3
1926	6.0	5.4	6.9	6.2	6.7	6.0	7.8	7.1
1927	6.2	5.8	7.1	6.3	6.9	6.2	7.8	7.0
1928	5.6	5.0	7.0	6.2	6.2	5.5	8.1	6.6
1929	5.7	5.2	7.1	6.6	6.7	5.9	7.6	6.8
1930	5.9	5.2	7.3	6.5	7.1	6.1	8.2	7.2
1931	6.0	5.5	7.4	6.8	6.8	6.2	8.3	7.4
1932	6.3	5.6	7.5	6.6	7.3	6.3	8.7	7.5
1933	6.2	5.4	8.1	7.0	7.0	6.2	8.4	7.9
Average weights	5.9	5.3	7.1	6.3	6.9	6.2	7.9	6.8
1934	6.7	5.9	8.4	7.3	7.6	6.7	9.4	8.1

Table XXVI.—Nass River Sockeyes, Number of Individuals of each Class running at Different Dates in 1934.

Date.	4_2	5_2	5_3	6_3	4_1	No. of Individuals examined.
June 26	6	6	43	.....	1	59
,, 27	6	10	33	1	.....	50
,, 28	3	7	39	.....	.....	49
,, 29	5	7	32	.....	.....	44
July 2	3	14	27	.....	.....	44
,, 4	4	5	40	.....	.....	49
,, 6	9	5	44	2	.....	60
,, 9	6	8	45	.....	.....	59
,, 11	11	4	33	.....	.....	48
,, 12	6	4	38	1	.....	49
,, 13	9	6	34	.....	.....	49
,, 16	8	6	45	1	.....	60
,, 17	7	4	44	4	.....	59
,, 18	20	3	72	3	.....	98
,, 20	10	10	50	5	.....	75
,, 23	7	4	65	2	.....	78
,, 25	15	3	56	6	.....	80
,, 26	9	3	64	4	.....	80
,, 27	5	2	47	6	.....	60
,, 31	8	3	54	10	.....	75
Aug. 3	2	2	13	3	.....	20
Individuals	159	116	921	48	1	1,245

Table XXVII.—Nass River Sockeyes, Percentages of Males and Females of the 4_2, 5_2, 5_3, and 6_3 Age-groups, 1915 to 1934.

Year.	4_2		5_2		5_3		6_3		Per Cent. Total Males.	Per Cent. Total Females.
	M.	F.	M.	F.	M.	F.	M.	F.		
1915	55	45	49	51	52	48	53	47	52	48
1916	61	39	61	39	50	50	68	32	55	45
1917	55	45	47	53	46	54	58	42	47	53
1918	52	48	40	60	50	50	70	30	51	49
1919	53	47	48	52	46	54	54	46	48	52
1920	46	54	39	61	40	60	66	34	42	58
1921	40	60	45	55	47	53	54	46	46	54
1922	36	64	32	68	46	54	64	36	44	56
1923	43	57	43	57	47	53	60	40	46	54
1924	55	45	44	56	47	53	67	33	48	52
1925	58	42	52	48	45	55	68	32	49	51
1926	43	57	44	56	44	56	57	43	46	54
1927	39	61	54	46	45	55	61	39	46	54
1928	50	50	48	52	42	58	62	38	46	54
1929	48	52	51	49	44	56	58	42	46	54
1930	49	51	43	57	40	60	63	37	43	57
1931	49	51	53	47	43	57	70	30	47	53
1932	49	51	46	54	45	55	72	28	48	52
1933	49	51	56	44	47	53	76	24	49	51
1934	48	52	51	49	50	50	58	42	50	50
Average	49	51	47	53	46	54	63	37	47	53

Table XXVIII.—Meziadin and Bowser Lake Sockeyes, Average Lengths in Inches for the Years 1924–34.

Year.	Meziadin Lake.		Bowser Lake.	
	M.	F.	M.	F.
1924	26.8	25.7	25.5	23.6
1925	-----	-----	23.8	23.3
1926	28.1	26.3	25.9	24.8
1927	27.1	25.8	24.7	23.7
1928	-----	-----	-----	-----
1929	27.0	25.3	-----	-----
1930	27.2	25.7	24.9	22.9
1931	27.9	26.3	-----	-----
1932	27.7	25.5	-----	-----
1933	25.9	25.3	24.3	24.7
1934	27.9	26.1	-----	25.7

Table XXIX.—Percentages of Meziadin and Bowser Lake Runs, showing Different Number of Years in Fresh Water.

	Years in Lake.			No. of Specimens.
	One Year.	Two Years.	Three Years.	
Meziadin, 1922	----	80	20	10
Meziadin, 1923	13	84	3	63
Meziadin, 1924	----	76	24	160
Meziadin, 1925 (no collection)	----	----	----	----
Meziadin, 1926	2	93	5	43
Meziadin, 1927	6	94	----	85
Meziadin, 1928 (no collection)	----	----	----	----
Meziadin, 1929	10	89	1	74
Meziadin, 1930	6	94	----	113
Meziadin, 1931	----	100	----	51
Meziadin, 1932	16	80	4	104
Meziadin, 1933	20	80	----	59
Meziadin, 1934	12	88	----	67
Bowser, 1922	40	60	----	15
Bowser, 1923	33	64	3	41
Bowser, 1924	18	79	3	34
Bowser, 1925	16	80	4	45
Bowser, 1926	27	55	18	11
Bowser, 1927	22	78	----	9
Bowser, 1928 (no collection)	----	----	----	----
Bowser, 1929 (no collection)	----	----	----	----
Bowser, 1930	44	56	----	34
Bowser, 1931 (no collection)	----	----	----	----
Bowser, 1932 (no collection)	----	----	----	----
Bowser, 1933	20	80	----	5
Bowser, 1934	33	67	----	3

Table XXX.—Meziadin and Bowser Lake Sockeyes, Lengths of Individuals comprising Runs in 1934.

Length in Inches.	Number of Individuals from			
	Meziadin Lake.		Bowser Lake.	
	M.	F.	M.	F.
23½	----	1	----	----
24	----	1	----	----
24½	----	2	----	1
25	1	1	----	----
25½	1	5	----	----
26	5	6	----	1
26½	1	3	----	1
27	6	1	----	----
27½	5	4	----	----
28	5	3	----	----
28½	3	----	----	----
29	5	----	----	----
29½	3	----	----	----
30	3	----	----	----
30½	2	----	----	----
Totals	40	27	----	3
Average lengths	27.9	26.1	----	25.7

5. SEX DISTRIBUTION.

(1.) General Discussion.

This general discussion of sex distribution of the sockeyes of the four river systems has been especially occasioned by the puzzling, changing ratio of males and females in the 4_2 age-group of Rivers Inlet. As has already been stated, this year-class in this system has shown marked peculiarities in size and sex distributions.

A belief that these differences might be more apparent than real led to a closer analysis of them, and under the section "Lengths and Weights" a discussion of the size peculiarity and a possible explanation has already been given. The following paragraphs deal with the sex ratios of all four river systems:—

Among fish in general, sex distribution approximates equal numbers of males and females. On the basis of the findings of Dr. Gilbert in 1915, 1916, 1918, and 1920, and Drs. Gilbert and Rich in Alaska in 1927, that sockeye seaward migrants run in approximately equal numbers of males and females, it is assumed that a fifty-fifty ratio is normal for adult sockeye. However, absolute numerical sex equality, either in total sex ratios or in individual age-groups, would hardly be expected, but rather a condition which showed more or less alternate differences of slight amounts from year to year. In order to separate the significant differences from the insignificant among all the sockeye data at hand, the actual total numbers of males and females have been compared with theoretical numbers calculated on the assumption that both sexes are present in equal proportion. The significance of the differences was appraised by comparing the differences with standard errors found according to the formula $\sqrt{npq}$ and adopting the 0.05 level of significance. This 0.05 level has been used in determining the significance of natural, i.e. biological differences and also of artificial differences resulting from imperfect sampling. The yearly total ratios and the yearly ratios of every age-group in all four river systems have been treated in this manner.

The results of the application of this procedure to the total ratios show that, among the twenty years of records, there are of the Fraser only five years in which the differences are significant; of the Nass, ten; of the Rivers Inlet, twelve; and of the Skeena, fourteen. Since these total ratios are composite, their differences depend upon the differences of the individual age-groups of which they are composed. In order to have as graphic a picture as possible of the differences in the sex ratios of the age-classes those of the males of the principal groups have been plotted year by year around a mean of 50 per cent. In all four river systems the 4_2 and 5_2 age-groups are presented, the former by a continuous line and the latter by a broken line. The graph of the Nass presents, in addition, the 5_3 class represented by a dot-dash line (Figs. I., II., III., and IV.).

As will be recalled, the 4_2 age-group is dominant in the Fraser River. It forms from 66 to 85 per cent. of the annual runs. The 5_2 class is second in importance, varying in strength from 7 to 25 per cent. of the total run. In Fig. I. the curve of the 4_2's passes back and forth across the mean, and in five years—namely, 1915, 1929, 1930, 1932, and 1934—departs significantly from it. The runs of the years 1930, 1932, and 1934 are associated with unusual abundance of grilse (3_2's) in the preceding years (Table II.). Thus the shortage of 4_2 males in 1930 and 1932 may have been the result of large numbers of individuals which matured precociously in the years 1929 and 1931. The surplus of males in 1934 is the greatest on record and was preceded in 1933 by the largest number of grilse yet recorded. This contradictory relationship would seem to mean one of two things—either that the brood-year 1930 was unique in its extraordinarily prolific production of males or that the sampling of the run of 1934 was faulty in some respect. As evidence of the latter possibility, attention is called to the exceptional size relationships in the 5_2 and 5_3 age-groups where the two sexes are of equal lengths (Table V.). At the present time no explanation can be offered for the significant differences in 1915 and 1929. Over a period of twenty years the total number of males in the 4_2 class has averaged 49 per cent., which is a very close approximation to the theoretical 50 per cent.

The curve of the 5_2 males does not criss-cross the mean to the same extent as does that of the 4_2's and the fluctuations are greater and more numerous. This is a condition which is likely to occur in age-groups which are not strong components of a run. The years 1915 and 1928 are the only years in which the differences between the numbers of the two sexes are

really significant. The significant excess of males in 1928 seems to be explained by faulty sampling. In that year the cross-section of the run was taken in twenty-nine samples instead of from forty to fifty as in other years, and the differences in the sex proportions are significant both in the totals for the year and in all but one of the age-groups. In this 5_2 class of the Fraser the males have averaged 53 per cent. over the period of record.

The 5_3 age-group forms such a small component of the Fraser runs that it did not seem advisable to plot the data. However, it may be pointed out that only three of the sexes' differences are significant, one of them being in the year 1928, which has already been mentioned as exceptional in sampling. Although this age-class is relatively unimportant, its consistent sex ratio in favour of the females suggests early-maturing males. This may well be the case since this class is closely allied to the 4_2's, differing from them only in a second year of fresh-water residence. A precocious male of this type, 4_3, has never been recognized in the samplings, but this is not surprising in view of the very small numbers in the 5_3 class. The 4_3's would be extremely rare.

In the Nass River there are three age-groups to be considered. The 5_3's occupy the place of first importance; the 4_2's, second; and the 5_2's, third. Curiously enough, the number of crossings and recrossings of the mean by the curves which represent the males of these classes is in reverse order of their importance (Fig. II.). In other words, the curve of the 5_3's does not cross the mean, but lies entirely below, except in the year 1915, and with the exception of five years all the differences are significantly great and indicate a shortage of males. The curves of the 5_2's and 4_2's are characterized by their irregularity, especially during the earlier years. However, as in the case of the 5_2's of the Fraser run, the apparent extreme irregularities of these lesser components of runs are less significant than they appear. The 5_2 age-group has only three significant sex differences, two of which indicate deficiency of males, and the 4_2 class has five, four of which also show lack of males. In the matter of total percentages, the dominant group shows a 4-per-cent. excess of females, the 5_2 group a 3-per-cent., and the 4_2 group a 1-per-cent.

Although there is record of only a single grilse (4_3) among the Nass catches, in view of the prevalence of this group in the Alaska sockeye runs, it is highly probable that these fish are also present in considerable numbers in the Nass, but are small enough to pass through the nets. The probable presence of these fish as a definite component of the Nass runs is important in the consideration of sex distribution. Gilbert and Rich found in Alaska in the runs of 1922–26 an excess of females both in the total samples of all the age-groups and also in the three principal age-classes. As explanation for the constant sex inequality of adult sockeyes, they offer the following alternatives: "Beginning their sea-life in equal numbers, the males and females may have a different survival value, with a selective mortality acting in favor of the females; or there may be a very considerable precocious development of the males, which may elude us largely because of their small size, and with these eliminated from the commercially valuable fish the preponderance of females would be assured." While it is impossible to accept or reject either of these alternatives as a positive explanation of excess of females, the second seems more likely. The acceptance of selective survival of either sex would be based entirely on probability or possibility. On the other hand, tendency toward precocious development of males is an established fact to which the presence of grilse in the Karluk, Skeena, and Fraser Rivers and Rivers Inlet attests. The definite knowledge that grilse are present in these runs, particularly in those of the Karluk, makes their presence in the Nass almost a certainty. It may well be, then, that the excess of females in the Nass is due to precocious maturity of the males. It seems a logical explanation both for the total preponderance of females in the total yearly samples and also for their constant majority in the 5_3's, the dominant group. Drs. Gilbert and Rich found in the Alaska sockeyes that the deficiency of males, or excess of females, was greatest in the oldest of three principal age-groups, a fact which was to be expected: "Inasmuch as males show a constant tendency to mature at an earlier age than do the females, it results that early-maturing age-groups very generally show a heavier percentage of males than do the older groups." The sex ratios of the oldest age-group (6_3) of the Nass would seem to be directly opposed to this statement, since the males have shown constant excess, but examination of tables giving the individuals of each class running on different dates shows that this class has never been completely sampled. There is no tapering away of the group at the end of the collecting season as there

is in perfectly sampled age-groups. Consequently one cannot accept this sex ratio as necessarily representative of the entire group. While early maturity of males among the 4_2's and 5_2's does not appear definite from year to year as in the case of the 5_3's, still there is considerable indication of it. In the first place, with a single exception for each group, the significant differences indicate lack of males. Secondly, during the last six years, when the 4_2 class has been present in much greater numbers than formerly, there has been a slight but constant deficiency of males. Thirdly, the total sex ratios of both groups show a shortage of males, with the smaller shortage in the youngest group as in the Karluk.

In the runs of the two remaining river systems, the Skeena and Rivers Inlet, the 4_2's and 5_2's play practically equal rôles, neither one group nor the other being consistently in excess. The Rivers Inlet graph (Fig. III.) presents a curious picture, with the 4_2 males entirely above and the 5_2 males consistently below the mean. The curves are more or less irregular and show decided downward trends. Every difference of the 4_2's and all but two of the 5_2's is significant. The fact that the 5_2 curve lies entirely below the mean, or, to express it differently, the consistent shortage of males, suggests the phenomenon of precocious development. Although there are no actual records of 3_2's (the precocious 4_2's) in Rivers Inlet samples, there are frequent references to them in the Fishery Inspector's reports of the spawning-beds and there is every reason to believe that they exist. According to our present data, whatever deficiency of males there may be in the 4_2's because of precocious development is no doubt partly offset by the early-maturing 5_2's, but, as will be shown later, the sampling of the 4_2 age-group is inadequate and accurate conclusions cannot be arrived at. Just as the 5_2 males have been consistently deficient so the 4_2 males have constantly outnumbered the females. These two age-groups show great lack of equality in total sex distribution, the 4_2's averaging 65 per cent. males and 35 per cent. females and the 5_2's 36 per cent. males and 64 per cent. females. But the excess of males in one age-group corresponds almost exactly to the deficiency in the other.

Attention should be called to an interesting association between the sex ratios and average lengths of the 4_2 group. A comparison of these two variables in the male reveals an almost perfect negative correlation; that is, the peaks away from the mean representing years of greater abundance are associated with smaller average size, and vice versa, the valleys toward the mean, or years of lesser abundance, are linked with greater average size. A similar comparison of the female sex ratios and average lengths shows a positive correlation; the greater sex differences correspond to greater lengths and lesser differences to lesser lengths.

The curves representing the Skeena 4_2 and 5_2 males cross the mean rarely and irregularly (Fig. IV.). The major part of the latter curve is very definitely below the mean with only two peaks above it. Except for the years 1917 and 1918, all differences are significant and in general show a shortage of males. The 4_2 curve, although much more irregular, has a decided downward trend. In the early years of the run the males tended to be more numerous than the females, while the opposite is true of more recent years. Six of the eight years in which the males exceeded the females and six of the ten years in which they were less abundant the differences between them are significant. In the matter of total sex proportion the males have constituted 52 per cent. of the 4_2 group and 44 per cent. of the 5_2 class. As in Rivers Inlet, the interpretation of these unequal sex proportions is to be found in the prenomenon of early maturity of males. The presence of 3_2's in the runs is assumed on the reports of fishermen and Fishery Inspectors. In the present method of sampling the run it is impossible to determine how numerous this group may be, but the excess of males in the 4_2 class suggests that whatever the tendency for early maturity of 4_2 males may be it is offset by a similar tendency among the 5_2's. The length-sex correlations which obtained in the 4_2 class of Rivers Inlet hold also for the 4_2 age-group in the Skeena runs.

(2.) Sampling.

In general discussions and comparisons, the cross-sections of these four river systems have been treated as if they were perfectly comparable and such treatment is legitimate for general purposes. In more detailed studies, however, the consideration of differences is not only necessary, but often helpful. As the legends on the Fraser River tables indicate, samples of this run are always obtained by means of traps, whereas those of the other runs are taken by gill-nets. In comparing the two methods of catch it is obvious that the former one is the

more desirable because no selective process due to netting can affect the sample. It will be as perfect a sample as it is possible to get. Consequently, in this matter of sex ratios, if normal distribution is equal numbers, one would expect to find the closest approach to equality in the Fraser River runs. Such is the case. It is true in regard to the small differences both between the yearly total number of males and females in the run and also between the relative proportion of the two sexes in the dominant age-group. The Nass River resembles the Fraser in these same respects much more closely than it does the Skeena and Rivers Inlet, in spite of the fact that traps are used to obtain the Fraser samples and gill-nets those of the other three rivers. It would seem, then, that netting might in some way be responsible for the lack of correspondence in the sex ratios of the three runs sampled by gill-nets. If sampling is imperfect its effect will be most pronounced in the age-groups which contain fish too small to be constantly captured. Consequently, in order to have a precise picture of all the smaller individuals which have occurred in the runs of the river systems during the history of the fishery, a tabulation has been made recording year by year all the 4_2 individuals measuring 21 inches or less (Table XXXI.).

Since the average lengths of females are less than those of males, one would expect to find in the lower size range of any completely sampled age-group that there exists an excess of females and also that the smallest individuals are females. Examination of the table shows, with some minor exceptions, that: (1) The Fraser River sockeyes conform to these statements; (2) the Nass fish are conspicuously absent throughout the twenty years; (3) Rivers Inlet fish are well represented, but the males, and not the females, are considerably more numerous and are also the smaller fish; (4) the Skeena River sockeyes are also exceptional, in that the males are slightly more abundant than the females and are represented by somewhat smaller sizes.

The Fraser River needs no further comment as the picture is one that would be expected from a random sampling provided by gear such as traps.

As has been previously stated, the Nass sockeyes most closely approach those of the Fraser River in their sex proportions. The almost total absence of 4_2's in Table XXXI. necessitated a careful scrutiny of the lower size range of this group in all the size-frequency tables from 1915 to 1934. In practically every year the smallest individuals are females and there is a majority of them. Thus every cross-section of the run contains the complete range of size for the 4_2's. The distribution of the few individuals occurring in Table XXXI. shows the lowest size level to be 21 inches, a limit considerably higher than that of the Skeena or Rivers Inlet. This of course indicates greater average size of the Nass 4_2's, a fact which is borne out by the following figures, which are the average lengths and weights over the history of the fishery:—

	Males.	Females.	Males.	Females.
	Inches.	Inches.	Lb.	Lb.
Rivers Inlet	22.5	22.5	5.1	5.0
Fraser River	23.7	23.0	6.0	5.4
Skeena River	23.8	23.2	5.4	5.0
Nass River	24.4	23.6	5.9	5.3

Furthermore, examination of the Nass 4_2's in Table XXXI. shows no change from the beginning of the study to the present time either in the relative size or scarcity of these individuals. The normal picture of this age-group in the size-frequency tables indicates the use of gill-nets of such mesh that their efficiency in sampling is not unlike that of traps. Moreover, the uniformity of occurrence of these fish in Table XXXI. shows that nets of sufficient mesh to intercept a complete cross-section of the 4_2's have been used from the beginning of the fishery. What is true of this group is likewise true of all the other recorded age-classes except 3_1, because their average sizes are all greater than that of the 4_2's. As has been previously stated, it is believed that the 6_3 group is only partially sampled because it is a late-running group, and appears to be at its height when the period of collection ends. Furthermore, this may well apply to the 6_4's and 7_4's, classes which also appear late in the season, but are present in such small numbers that it is impossible to get an exact picture of

the extent of their occurrence. Another component of these runs—namely, grilse—does not appear in the cross-sections because the fish are too small to be netted.

Examination of the Rivers Inlet figures in Table XXXI. confirms the previous assertion, that the cross-sections of this age-group are incomplete. Instead of a normal picture with a majority of females at the lower range of the group, the males are consistently in excess. Dividing the series of years arbitrarily into four periods and expressing it more exactly in terms of percentages of total males and females in the group, there were among these smaller 4_2's, during the years 1915–19, 12 per cent. males and 4 per cent. females; 1921*–24, 12 per cent. males and 5 per cent. females; 1925–29, 20 per cent. males and 7 per cent. females; and 1930–34, 19 per cent. males and 13 per cent. females. For these same four periods the sex ratio of these same smaller fish were: (1) 88 and 12 per cent. males and females respectively; (2) 85 and 15 per cent.; (3) 83 and 17 per cent.; and (4) 65 and 35 per cent.

A general scrutiny of the Skeena 4_2 group shows both sexes, especially the females, to be rather sparsely represented up to the year 1928. From this point on there is a definite increase in both sexes. Or expressing it in more exact terms as in Rivers Inlet in percentage of total males and females in the group there were among these small fish, during the years 1915–19, 0.5 per cent. males and 0.4 per cent. females; 1920–24, 1.1 per cent. males and 0.7 per cent. females; 1925–29, 3 per cent. males and 1.8 per cent. females; and 1930–34, 6 per cent. males and 5 per cent. females. As for sex distribution among these same small individuals for the same four periods are found the following: (1) 67 per cent. males, 33 per cent. females; (2) 63 and 37 per cent.; (3) 61 and 39 per cent.; and (4) 50 and 50 per cent.

The significant feature in these two sets of percentages for Rivers Inlet and the Skeena River is the increased number of females in the last period.

If the mesh of gill-nets remains constant from year to year, what, if any, would be the effect upon sex distribution of natural fluctuations in length in age-groups which are not completely sampled because the fish at the lower size limit are too small to be netted? Since the bodies of mature males are deeper than those of females, of a male and female of equivalent lengths, the female is more apt to escape. Among these fish " at large," then, the females are more abundant. If in any one year the general size of both sexes in one of these age-groups should be less, the fish at the lower level of capture would be even less perfectly sampled; more males and females would escape, but males would still be in the majority among the smaller captured fish. If, on the other hand, the general size of both sexes should be greater, these fish at the lower level would be better sampled and the males would be relatively less abundant, varying in degree in proportion to the completeness of the sampling of the smaller fish. If they were perfectly sampled the females would outnumber the males. Attention has already been called to this sex-length correlation in the 4_2 age-group of both Rivers Inlet and Skeena runs. It is simply a natural relationship which exists in classes which are imperfectly sampled at their lower size range.

If the mesh of nets is changed from greater to lesser, what would be the effect upon sex distribution in these imperfectly sampled age-groups? The result would be the capture of more smaller fish with the relative sex ratio increasing in favour of the females in proportion as their lowest size range was reached. Also, if a considerable additional number of females were captured, the altered sex ratio of the sexes at the lower level would be reflected in the sex proportions of the entire age-group. In other words, the females would become relatively more abundant than formerly. Furthermore, if one of these age-groups was materially augmented by smaller-sized individuals the general average lengths of both sexes would be lowered. Smaller-meshed nets would not obscure natural fluctuations in length from year to year with their correlated sex ratios, but these lengths and sex ratios would fluctuate at a lower range than formerly.

Returning now to the 4_2 group of Rivers Inlet as pictured in Table XXXI., the increase in recent years in actual numbers of smaller fish with relatively higher percentages of females is an obvious fact. Furthermore, reference to Table XI. shows that in 1931 the average length of both male and female touched new low levels and the lengths of the other years since 1929 tend to be less than average. The 4_2 class of the Skeena has registered the same sort of change both as to greater numbers of small fish with the females relatively more numerous and as to generally smaller fish. In one year only since 1929 have the general average lengths

* The year 1920 is omitted because of the extremely small sample obtained over an unusually short period.

of the sexes been equalled and heretofore unrecorded low levels are found among other recent years. Looking again at Figs. III. and IV., it will be noticed that since 1929 in Rivers Inlet the males have fluctuated between 54 and 59 per cent. instead of in the sixties and even seventies as formerly, and in the Skeena the spread is also confined to a narrower, lower range. All of the above-mentioned changes seen in this age-group in both Rivers Inlet and the Skeena coincide precisely with the changes which would be expected in an imperfectly sampled age-group when lesser-meshed gill-nets replaced greater.

Unfortunately there are no definite records available as to sizes of mesh actually employed in fishing the several river systems. The Fisheries Department limited the mesh to 5¾ inches up to the year 1929, when all restrictions were removed. However, through the courtesy of the Canadian Fishing Company, The British Columbia Packers, Limited, and Mr. G. J. Alexander in consulting J. H. Todd & Sons, it has been possible to obtain information which is believed to be reasonably accurate. The opinion is as follows:—

Nass River.—1915 to date, 5⅞ inches.

Rivers Inlet.—1915 to 1929 or 1930, 5¾ inches; 1930 or 1931 to date, 5½ to 5⅝ inches (B.C. Packers say as low as 5 inches).

Skeena.—1915 to 1928 or 1929 or 1930, 5¾ inches; 1929 or 1930 or 1931, 5½ to 5⅝ inches.

While there is some difference of opinion as to the first year in which the finer mesh was employed, there is agreement in the belief that it has been in general use from 1931. Thus these years of change to lesser mesh in Rivers Inlet and the Skeena coincide with the years in which the analyses of the runs have noted changes in the 4_2 age-group.

Undoubtedly this newer aspect of the Rivers Inlet 4_2 group is a truer picture than was had formerly, but there are still several indications suggesting incompleteness. The length distribution at the lower level does not yet show the females to be in the majority, nor does it reach as low a level as would be expected in view of the very low range of the Fraser 4_2's, whose average lengths are as great, 23.7 inches and 23 inches respectively for male and female, in comparison with 22.5 and 22.5 for Rivers Inlet. Also the lengths of the two sexes are too nearly equivalent to be normal. Consequently it seems justifiable to conclude: (1) That the extremely unbalanced sex ratio in the early years was more artificial than real and was due to a very incomplete sampling of the age-group; (2) that the real ratio is probably much more evenly balanced than now appears.

The scattered evidences of incomplete sampling in the Skeena are much less glaring than those of Rivers Inlet, but when they are assembled side by side with those of the former river system there is no doubt in the matter. However, it seems safe to assume that this group has always been more adequately sampled both because of the larger average size of the fish and also because of the usual size relationship between the sexes. The addition of the relatively steadier and closer sex ratio of recent years suggests that the present cross-section of the age-group is close to a complete one.

To return to the general question of sampling, would natural fluctuations in length affect the sex ratios of age-groups which are perfectly sampled? Or would change of mesh from greater to less affect the sex proportions in such age-groups? The answer to both questions would seem in general to be in the negative. Unless a natural size reduction should be so great as to allow escape at the lower size level, or an increase so great as to prohibit capture at the upper size range, of a large number of individuals, it seems reasonable to assume that size fluctuations would not be associated in any way with sex-ratio fluctuations.

The exceptional sex ratios of the Skeena 5_2's in the years 1930 and 1932 may be explained on this basis. The average lengths of both sexes in those years were considerably below the general averages, and study of the lower size ranges shows not only that there were present a very unusual number of small individuals, but also that the smallest of these were only 19½ and 20 inches long, lengths common to the smaller individuals at the lower size level of the 4_2's. Consequently it is believed that the high sex proportions of the males in 1930 and 1932 were abnormal; they were due to that type of inadequate sampling in which the smaller lndividuals, especially females, escape capture.

In considering the relative proportions of the two sexes, attention should be called to a structural character, peculiar to the males—namely, the hooked upper jaw with enlarged teeth, which tends to entangle the fish in the nets without gilling. To what extent the number of captured males is increased in this way is unknown, but the factor is probably constant and should not be overlooked.

(3.) Summary of Section.

Equal sex ratios are considered normal for sockeye salmon.

(1.) The Fraser River sockeyes approach normal sex distribution more closely than do those of the other three river systems. This is to be expected since the method of sampling by traps precludes selection. Both the total yearly samples and the dominant age-group, 4_2, have shown more or less alternate abundance of the two sexes, the amount being in general insignificant. The 4_2's manifest precocious maturity of males which is more pronounced in some years than others.

(2.) The yearly total sex ratios of the Nass sockeyes show a small deficiency of males, but this lack of equality is believed to be due to incomplete gill-net sampling. The constant shortage of males in the dominant age-group, the 5_3, is interpreted as precocious development, but these early-maturing males because of their small size entirely elude capture. The minority of the males in the total average sex ratios of the 4_2 and 5_2 age-groups also suggests early maturity. Since the period of sampling of the Nass run is not coextensive with the period of occurrence of the 6_3 class, the constant excess of females in this group cannot be accepted as a reliable index of the sex proportions of this class.

(3.) The explanation of the peculiar sex ratios of Rivers Inlet is found partly in precocious maturity and partly in inadequate sampling and change of mesh in gill-nets. The 5_2 group appears to be completely sampled and exhibits precocious development to a marked degree. The 4_2 class, because of the small size of its members, is very incompletely sampled, resulting in a high percentage of males. From numerous observations of grilse by Fishery Inspectors and fishermen it is believed that the 4_2 group also produces early-maturing males. But since there are no grilse in the samplings, and since the excess of males in the 4_2 class is inaccurate, there is no way of judging exactly how the deficiency of males in the 5_2 group is compensated for by the males of the 4_2's and the grilse. The definite decrease in the 4_2 males since 1929 is traceable to change of greater gill-net mesh to lesser.

(4.) What has been said of the sex ratios of Rivers Inlet may be repeated verbatim for the Skeena sockeyes. The only point of real difference lies in a generally lower range of fluctuation of the sex ratios of the Skeena 4_2 class. This is due to the fact that these four-year-olds are larger fish and therefore have not been quite as poorly sampled as the same group in Rivers Inlet.

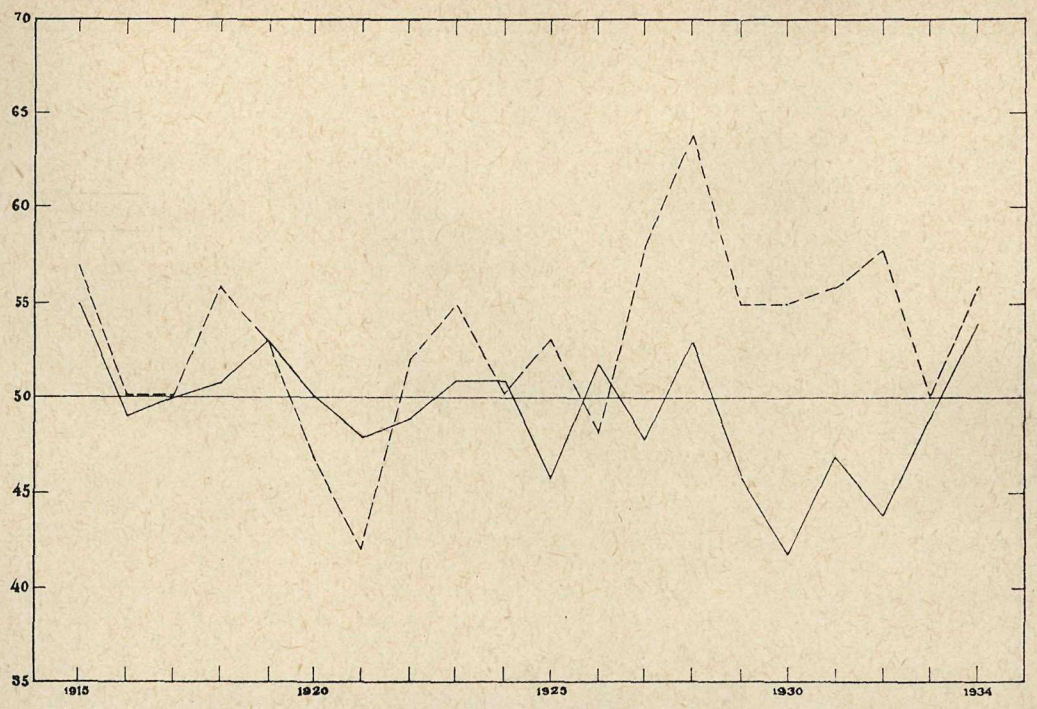

Fig. I.—Graphs showing the percentages of males of the 4_2 and 5_2 age-groups in the Fraser River sockeye runs, 1915 to 1934. (4_2's by the continuous line; 5_2's by the broken line.)

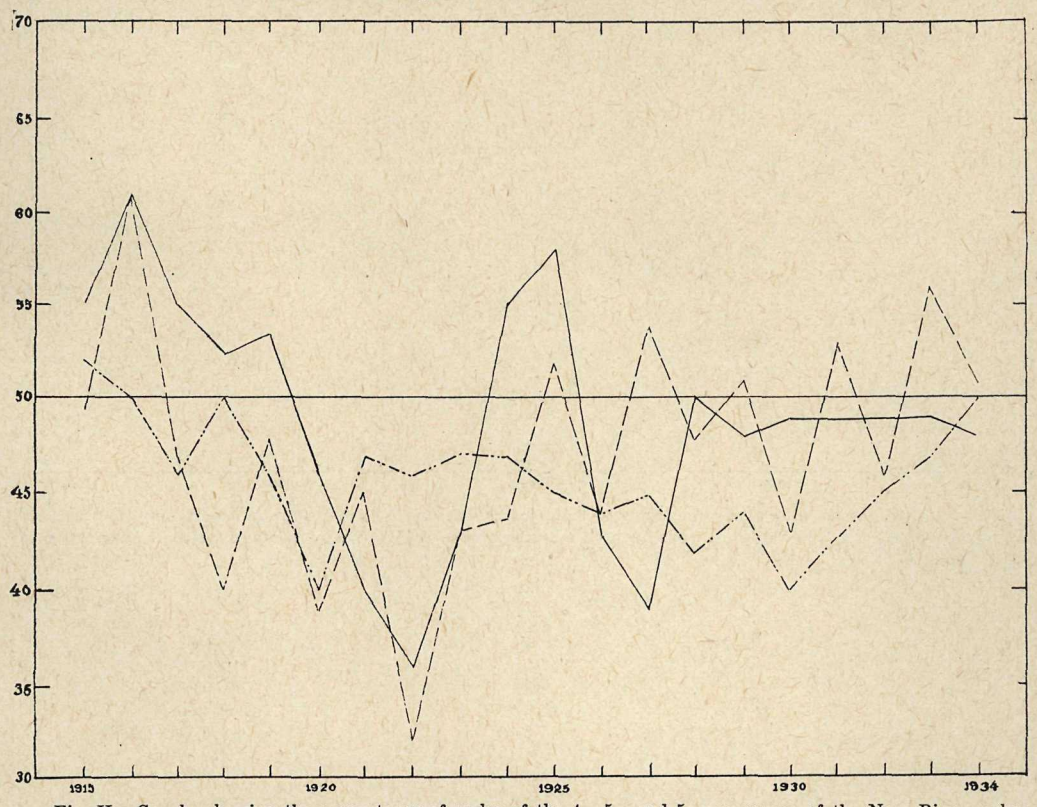

Fig. II.—Graphs showing the percentages of males of the 4_2, 5_2, and 5_3 age-groups of the Nass River sockeye runs, 1915 to 1934. (4_2's by the continuous line; 5_2's by the broken line; 5_3's by the dot-dash line.)

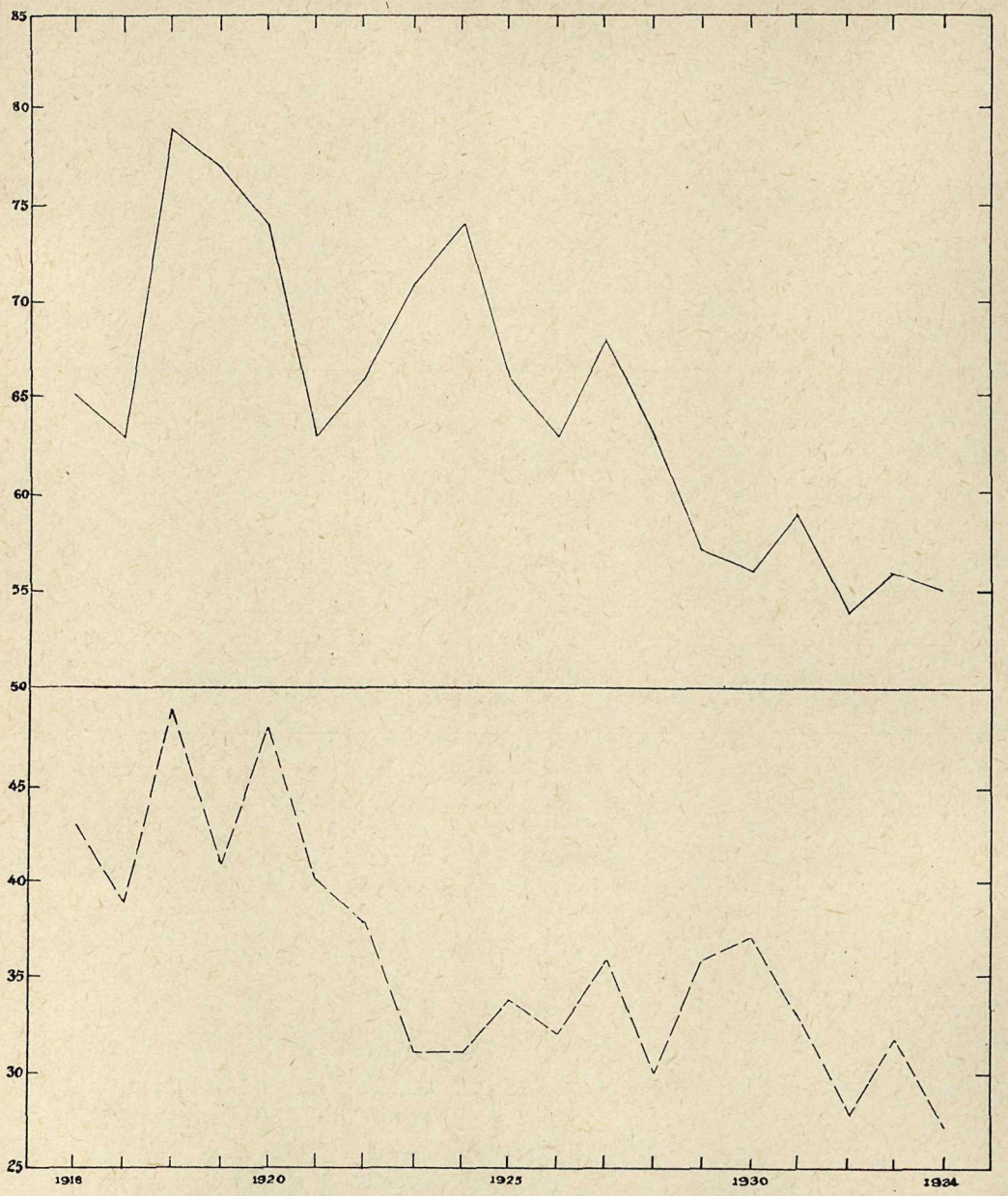

Fig. III.—Graphs showing the percentages of males of the 4_2 and 5_2 age-groups in the Rivers Inlet sockeye runs, 1915 to 1934. (4_2's by the continuous line; 5_2's by the broken line.) The percentage for the 4_2 age-group in 1920 is unreliable.

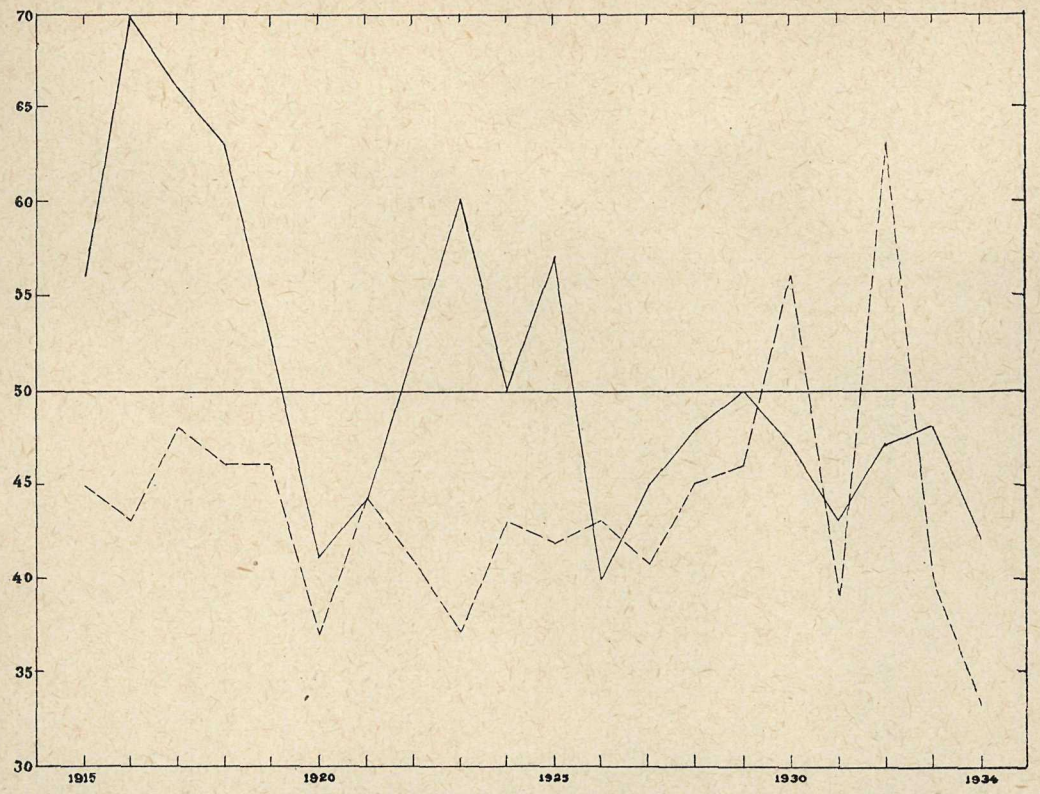

Fig. IV.—Graphs showing the percentages of males of the 4_2 and 5_2 age-groups in the Skeena River sockeye runs, 1915 to 1934. (4_2's by the continuous line; 5_2's by the broken line.)

Table XXXI.—Fraser, Skeena, and Nass Rivers and Rivers Inlet Sockeyes, 4_2 Group, measuring 21 Inches or less, expressed in Percentage of Total Numbers, 1915 to 1934, grouped by Sex and Length.

Year.	Fraser River.				Nass River.				Skeena River.				Rivers Inlet.			
	M.		F.		M.		F.		M.		F.		M.		F.	
	Length Range.	Per Cent.	Length Range.	Per Cent.	Length Range.	Per Cent.	Length Range.	Per Cent.	Length Range.	Per Cent.	Length Range.	Per Cent.	Length Range.	Per Cent.	Length Range.	Per Cent.
1915	21 –21	0.5	17 –21	0.7	21 –21	1.0	21 –21	1.0	.....	.....	.....	.....	19 –21	11.0	.....	.....
1916	16 –21	15.0	18½–21	10.0	.....	.....	.....	.....	21 –21	1.0	.....	.....	19½–21	5.0	20½–21	6.0
1917	18½–21	2.0	18 –21	3.0	.....	.....	.....	.....	21 –21	1.0	21 –21	1.0	21 –21	4.0	21 –21	3.0
1918	19½–21	2.0	20 –21	1.0	.....	.....	.....	.....	.....	.....	21 –21	0.8	19 –21	19.0	20½–21	5.0
1919	20 –21	1.0	20 –21	6.0	.....	.....	.....	.....	21 –21	0.4	.....	.....	91½–21	14.0	20½–21	3.0
1920	19 –21	2.0	19 –21	4.0	21 –21	3.0	.....	.....	.....	.....	21 –21	0.8	*	*	*	*
1921	20 –21	3.0	18½–21	3.0	.....	.....	.....	.....	20½–21	0.3	21 –21	1.0	19½–21	4.0	20½–21	3.0
1922	20 –21	6.0	19 –21	11.0	21 –21	4.0	.....	.....	20½–21	2.0	21 –21	0.2	19½–21	9.0	21 –21	4.0
1923	19 –21	4.0	18½–21	6.0	.....	.....	.....	.....	19 –21	2.0	21 –21	0.4	20 –21	11.0	19½–21	6.0
1924	17½–21	9.0	17½–21	13.0	.....	.....	21 –21	3.0	21 –21	0.4	.....	.....	19½–21	25.0	21 –21	6.0
1925	18 –21	4.0	19 –21	6.0	.....	.....	21 –21	0.6	20½–21	0.5	.....	.....	20 –21	18.0	20½–21	11.0
1926	18 –21	22.0	18 –21	31.0	.....	.....	.....	.....	19½–21	2.0	21 –21	0.4	20 –21	11.0	20½–21	2.0
1927	17 –21	6.0	17 –21	9.0	.....	.....	.....	.....	20½–21	1.0	.....	.....	19 –21	27.0	20 –21	9.0
1928	17½–21	14.0	17½–21	9.0	.....	.....	.....	.....	20 –21	3.0	20 –21	3.0	19½–21	29.0	20½–21	5.0
1929†	17½–21	4.0	17½–21	6.0	21 –21	0.4	.....	.....	20 –21	9.0	19 –21	6.0	20 –21	10.0	20 –21	7.0
1930†	18 –21	0.7	18 –21	5.0	.....	.....	21 –21	0.4	19 –21	8.0	19 –21	9.0	19½–21	9.0	20½–21	5.0
1931†	17 –21	11.0	16½–21	9.0	.....	.....	.....	.....	20½–21	3.0	21 –21	2.0	19 –21	24.0	19½–21	17.0
1932†	17½–21	18.0	16½–21	18.0	21 –21	0.5	.....	.....	18 –21	8.0	18 –21	10.0	19 –21	22.0	20 –21	14.0
1933†	17 –21	4.0	16½–21	9.0	.....	.....	20½–21	1.0	19½–21	5.0	20½–21	3.0	19 –21	25.0	19½–21	22.0
1934†	17½–21	11.0	17½–21	10.0	.....	.....	21 –21	1.0	20½–21	6.0	20½–21	2.0	20 –21	17.0	20½–21	11.0

* Omitted. † Limitation on mesh of gill-nets removed.

CONDITION OF BRITISH COLUMBIA SALMON-SPAWNING GROUNDS.

By Major J. A. Motherwell, Dominion Chief Supervisor of Fisheries.

QUEEN CHARLOTTE ISLANDS.

This is primarily a fall-salmon area, although a few sockeye run to Masset Inlet each year. This run, however, is not important.

It will be remembered that in 1932 what has been, as long as records are available, an enormous run of pink salmon returned in very small quantities. The run in 1930 was heavy, and, although comparatively lightly fished, the seeding in 1932 was only approximately 20 per cent. for no known reason.

During the season under review early precautions were taken to see that a good portion of the run would be enabled to pass to the spawning-grounds, and the result was that all areas in Masset Inlet, including the Yakoun River and Juskatla Inlet, were heavily seeded with pink-salmon eggs and the previous satisfactory conditions appear to have been restored.

Early closing at Naden Harbour also provided a satisfactory escapement of pinks to the spawning-grounds in that district.

The seeding of the streams on the east coast of the Queen Charlotte Islands cannot be considered as satisfactory, although an extra effort was made in the way of protection to see that adequate quantities passed up-stream. Skedans Creek was an exception; a good seeding occurred there and a reasonable one at Tlell River.

The cohoe run generally in this area was one of the most satisfactory in recent years.

The chum seeding generally has been fairly satisfactory, although there are several streams where conditions have not been quite as good as could be desired.

NASS RIVER.

The seeding by the early run of sockeye is reported as heavy and similar to that of the seasons 1929 and 1930 and an improvement over the seeding of 1933. The late run was also good, being very similar to that of 1929.

The cohoe run was also a satisfactory one, but the number of springs observed was not up to the average.

Satisfactory quantities of pinks were found in the spawning areas of the river and its tributaries. This run, in addition to being heavy, was very late in arriving.

The supply of pinks was also found to be satisfactory in the area from the mouth of the Nass River to Dixon Entrance, including the Khutzeymateen River.

The chum-supply was not as good as could be desired.

A jam was removed from the entrance to the fishway at Meziadin Lake and this structure was left in good condition.

SKEENA RIVER.

In view of the small commercial catch of sockeye it was not expected that any large quantity would be observed on the spawning-grounds, but the supply was not as unsatisfactory as feared. In the Babine River the run cannot be considered as satisfactory, although the conditions in this stream have varied from year to year over a very considerable period. The lower portion of the river, however, received a very good seeding, better than in 1933.

At Morrison Creek, on which the hatchery is situated, the supply of spawning sockeye was the largest in the past four years, according to the hatchery superintendent. In the hatchery operations approximately 75 per cent. of the fish were spawned, providing a collection of 3,730,000 eggs. The balance was permitted to spawn naturally. Males exceeded females in the ratio of six to one at this point.

The situation at Fulton River seems to have been more satisfactory and the seeding should be reasonably adequate, although the number of fish was less than in the seasons of 1929 and 1930, the brood-years.

At Pierre, Twin, and 15-Mile Creeks the seeding would appear to be reasonably satisfactory.

Taking the Babine area as a whole, conditions were not found to be as bad as might have been expected, but the quantity of spawning sockeye observed cannot be considered as adequate, having in view the large quantities appearing on these spawning-grounds in previous years.

The quantities of springs, cohoes, and pinks in the Babine area do not appear to have been particularly satisfactory.

In the Lakelse Lake system the return of sockeye was larger than that of 1930 and compared very favourably with the record year of 1926.

The supply of spawning pinks was found to be adequate.

GRENVILLE-PRINCIPE AREA.

Apart from Lowe Inlet, the sockeye-streams in this area were well supplied with spawning fish. Wet weather conditions, coupled with fishing restrictions, permitted a good escapement. At Lowe Inlet precautions are being taken to see that the escapement is more satisfactory in this cycle.

Cohoe were observed in satisfactory quantities throughout the area. This also applies to the pink variety, although the chum situation was not found to be quite so satisfactory.

BUTEDALE AREA.

The sockeye-supply found on the spawning-grounds was a reasonably satisfactory one. Weather conditions were favourable during the first of the season, but later, due to lack of rain, it was necessary to enforce longer closed seasons, which action appears to have obtained the desired results in the way of escapement.

There was a very gratifying escapement of cohoe, particularly to the northern portion of the area.

In the northern portion of the area the pink seeding was fairly satisfactory, but farther south the situation was not so good. The condition of the pink run, while not discouraging, still requires some further protection and the necessary measures are being taken.

Due to the closure of the area to fishing, a fair supply of chum salmon reached the spawning-grounds.

The heavy rains resulted in freshets over the area during October, but apparently there was no great damage done to the spawning area.

BELLA BELLA AREA.

As a result of twenty-eight days' extra closed season enforced during the sockeye season, the escapement of this variety to the spawning grounds was found to be very satisfactory. The quantities of cohoe found were reported as extraordinarily heavy. The pink-supply was not so satisfactory, although by extra closures a better proportion of the run was permitted to reach the spawning-grounds.

The chum-supply was not as great as could be desired, but due to unusual measures in the way of fishing restriction a fair supply was enabled to pass up the streams safely.

BELLA COOLA AREA.

Two trips of inspection were made by seaplane to Kimsquit Lake; two were also made to the Upper Bella Coola and Atnarko Rivers. The second trip in each case was for the purpose of ascertaining the extent of damage done to the spawning-grounds due to flood conditions.

The supply of spawning sockeye observed is stated to be very satisfactory, and, in fact, these remarks apply to the pinks and cohoes as well, whilst the chum-supply was as good as was expected.

The inspecting officer feels that the quantities of sockeye, pinks, and cohoes observed this year are greater than those observed in the brood-years, and in the case of chums, springs, and steelhead the conditions are very similar to the brood-years.

The situation from a standpoint of floods and freshets was unusually difficult during this fall, particularly in the Bella Coola River, the water rising to levels beyond previous records. Undoubtedly much damage has been done to spawning-grounds, although probably this would be confined largely to the areas used by chum salmon; that is, in the lower reaches of the streams. The upper reaches of the streams were not so much affected and it is expected that the damage there was not very great. It is expected that the sockeye will be the least affected by the high-water conditions.

RIVERS INLET AREA.

Examinations of the Owikeno Lake and tributaries would appear to justify the conclusion that the sockeye spawning has been an average one. Several streams have been found lightly seeded, but, on the other hand, other streams have received unusually large supplies and the condition generally is reported as quite satisfactory. One factor of the run was found to be the abnormally large proportion of 3-year-old males; in fact, of the whole run the males have considerably exceeded the females in numbers.

The supply of cohoes observed appears to have been unusually good.

The supplies of fall fish generally in the inlets tributary to Rivers Inlet appear to be average.

SMITH INLET.

Two inspections were made of this area and the observations show that most satisfactory conditions in the way of spawning sockeye appear to prevail again, notwithstanding the unusually high water.

There would appear to be every reason to believe that the sockeye-supply at Smith Inlet can be well maintained and possibly increased.

In the Nekite River, at the head of Smith Inlet, there was a light run of pinks and cohoes and a medium run of chums observed. A heavy escapement of chums occurred in the river at the head of the South-east Arm, however.

In the Takush River and Ahclakerho Channel the conservation measures taken during recent years appear to have been successful in building up the run of chums.

FRASER RIVER WATERSHED.

Prince George District.—In the Stuart-Trembleur-Takla Lake section the local officers report that the number of spawning sockeye appearing this year shows an increase over that of four years ago. The same applies to the Fraser Lake-Francois Lake section.

Whilst this may seem encouraging, yet, when one considers the large runs of years ago, the few returning at present would not appear to be particularly significant.

One pleasing factor is that the Indians at the outlet of Stuart Lake have not depended this season so much on the sockeye for their food purposes. This is due largely to the very considerable increase in the quantity of moose appearing all through the northern section of the Fraser River watershed. Due to this situation a larger percentage of ascending runs should in future years escape to the spawning-grounds.

In the Quesnel Lake-Bowron Lake sections the quantity of sockeye observed has not been encouraging.

The Chilcotin section is very outstanding in a discussion of the spawning conditions in the Fraser, due to the considerable increase shown each cycle for some years past. Whilst it is always impossible to accurately estimate the number of parent fish in any spawning area, yet conditions in Chilko Lake are such as to permit the local officer (who has had many years' experience) to quote figures which, used in a comparative way, can be accepted as being indicative of the situation. He suggests the following numbers of spawning sockeye observed for the past seven years:—

1927	400	1931	2,500
1928	20,000	1932	70,000
1929	70,000	1933	100,000
1930	900	1934	3,500

The returns to the Seton-Anderson Lake system are apparently showing no increase and are not at all encouraging.

Kamloops District.—The North Thompson has not been shown to be a particularly valuable spawning area for sockeye, but there is a quantity each year found in the Raft River.

On the other hand, the Shuswap area, on the South Thompson, has been most encouraging in recent seasons, and this year the number of spawning sockeye found in Adams River and Little River shows an increase of at least 25 per cent. over the exceptionally good brood-year of 1930. No returns were found in Scotch Creek or in the stream at the head of Anstey Arm, and only a few stragglers appeared at Eagle River.

The fish were of unusually large size, a good many running as high as 9 lb. in weight. Male fish predominated in the ratio of four to one.

There has been a dam in the Adams River at the outlet of Adams Lake for many years. Although there is a fishway at each side of the stream, it is felt that conditions have not been entirely satisfactory, but last year high water carried away a section of the dam, which is not now being used, and the result is that the sockeye this year had no difficulty in ascending to the lake above and were observed in several of the tributaries.

It is to the Shuswap area that a very large proportion of the late-run sockeye to the Fraser system proceed; that is, sockeye entering the Fraser River from the Gulf of Georgia after the end of August.

The run of spring salmon to this area was a normal one.

Hope District.—Normally there are not many sockeye found spawning in the tributaries of the Fraser between Lytton and Hope, and as a matter of fact the streams are largely unsuitable for spawning purposes. One exception is Kakawa Lake, where, four years ago, there was a very considerable run of sockeye, over 90 per cent. of which, however, were estimated to be females. The same conditions obtained this year. Also, in 1930, every little stream between Lytton and Hope was reported to be full of spawning sockeye from the late run. These conditions were duplicated in 1934.

Conditions at Hell's Gate all through the season were normal and the ascending fish experienced no more difficulty than previous to the slide of 1913.

Chilliwack District.—In the Chilliwack-Cultus Lake section the expected large number of spawning sockeye arrived. In the brood-year of 1930 there were counted over the fence at Cultus Lake 10,395 sockeye. This year the number was 19,048.

Harrison Lake-Pemberton District.—One of the most satisfactory runs of sockeye in recent years appeared at Morris Lake, which at one time was the most prolific producer of sockeye in the Harrison area. The number appearing in the Pemberton area, however, was below expectations, although, due to the recent arrangements with the officers of the Department of Indian Affairs and special protective measures, there was no question as to there being any molestation of the fish on their way up-stream. The Indians obtained only a very small percentage of the run.

The collection of eggs at the Pemberton Hatchery amounted to 20,400,000.

Apparently very few sockeye ascended past the hatchery fence after its removal, but below that point for a distance of 1¼ miles the Birkenhead River was fairly well seeded naturally.

Pitt Lake District.—This watershed received a heavy seeding of sockeye salmon. The hatchery was quickly filled to capacity, and it is estimated that not more than 10 per cent. of the run was used for this purpose, the rest being permitted to spawn naturally.

It was discovered late in the season that a portion of the late-run sockeye were spawning in the Pitt River below Pitt Lake.

Howe Sound District.—In the Howe Sound District the spawning streams contained large numbers of cohoes and chums and also a satisfactory proportion of springs. The unusually large quantities of the first two mentioned species, however, were quite noticeable.

GENERAL.

A special effort was made to follow the late run of sockeye in order that a complete report might be available as to all the streams used for spawning purposes. An experienced officer was placed in charge of this investigation and found definitely that no portion of the late run passed above the Bridge River Rapids in the Fraser or into the North Thompson River. The principal areas populated by this late run are the Shuswap, Kakawa Lake, Cultus Lake, Chilliwack Lake, and most of the tributary streams between Lytton and Hope, although conditions here are apparently not favourable. A portion also proceeded to the Pitt River area.

ALERT BAY SUB-DISTRICT.

Sockeye.—A satisfactory run of sockeye occurred at Nimpkish River, and due to the abolition of drag-seines from the river and favourable water conditions during the run, the proportionate escapement was larger than in previous years. The numbers of sockeye appear-

ing on the spawning-grounds of Nimpkish Lake and in the streams and lakes tributary thereto are reported to have been larger than for many years.

Normal small runs of sockeye occurred at Glendale Cove, Thompson Sound, Port Neville, Shushartie, and Nahwitti Rivers. The run to Mackenzie Sound stream, which is Keogh River, was better than usual.

Springs.—While the run of this variety to Nimpkish River was light, the seeding was quite satisfactory, as springs were not fished to any extent in that locality. The runs to Kingcome and Knight Inlets were normal, and it is considered that satisfactory numbers ascended the streams to spawn.

Cohoes.—All streams throughout the Alert Bay District frequented by this variety were well seeded, and the Inspector reports that the run was the best for several years and was much heavier than the brood-year.

Pinks.—Spawning conditions were very satisfactory throughout and the number of parent salmon appearing on the spawning-grounds compares very favourably with the brood-year of 1932. Runs were particularly heavy at Glendale Cove and Adams River.

Chums.—This run was considered the best since the brood-year of 1930, in comparison with which it was about equal. All streams of the sub-district are well seeded with this variety.

Steelheads.—The Inspector reports that from information received the run this year appeared to have been the best for several years. As steelheads are not fished commercially to any extent, a good seeding of all the streams frequented by them is assured.

QUATHIASKI SUB-DISTRICT.

Sockeye.—For the fifth year in succession the run to Hayden Bay has been disappointing. Special closure of fishing was put into effect from June 21st until July 15th this year, and due to this the escapement to the spawning-grounds was greater than for several years past. The run to Phillips Arm was light, but as high water occurred during the height of the run the greater percentage of sockeye ascended Phillips River to the spawning-grounds. The Inspector states that the run could be considered to be equal to that of the brood-year.

Cohoes.—Quantities of this salmon were on the spawning-grounds equal to the brood-year. The run throughout the district was a good average one.

Springs.—The run to Campbell River was considered better than the average, and the number ascending to the spawning-grounds there is reported by the Inspector to have been heavier than for several years. A good average run ascended Phillips River.

Pinks.—An excellent run occurred through the whole of the district, and all streams were fully as well seeded as in the brood-year.

Chums.—Good runs occurred everywhere, the escapement was large, and all streams were at least as well seeded as in the brood-year. The run continued much later than usual, and fresh fish ascended many of the streams long after fishing operations ceased.

Steelheads.—The supply of these is being well maintained. They appear to be present in all streams frequented by them just as numerous as usual.

COMOX SUB-DISTRICT.

(This is not a sockeye area.)

Cohoes.—The general run of cohoes throughout the district was noticeably heavier than for several years. They appeared on the spawning-grounds in larger numbers than during the brood-year.

Springs.—An excellent run occurred in the Puntledge River, and the numbers on the spawning-grounds were reported by the Inspector as greater than last year and for several years.

Pinks.—They appeared in greater quantities in the streams usually frequented than during the brood-year and for many years past. These streams are the Oyster, Tsolum, and Tsable Rivers and Cook and Nile Creeks.

Chums.—Although very late in commencing, the run of chums was considered much better than any of the runs of the past four years. The numbers reaching the spawning-grounds were far greater than during the brood-year, intervening years, and for several years previous to the brood-year.

Steelheads.—The number appearing in the various streams can be said to be equal to the usual normal run. The Inspector is of the opinion that the favourable increase in the return of parent salmon to the streams of his district is due to provision of the 2-mile limit on most of the spawning-streams and total closure of Baynes Sound to salmon net-fishing. Establishment of the rectangular boundary at the two Qualicum Rivers, during the period in which fishing is allowed to within half a mile, has given added protection to those streams. The percentage of escapement was noticeably larger.

PENDER HARBOUR SUB-DISTRICT.

Sockeye.—A satisfactory run occurred in the Saginaw area, and the escapement reaching the spawning-grounds was fully equal to that of the brood-year. Catches each year continue to be consistently good, and it is quite evident that the supply of sockeye is being well maintained. The average light run occurred at Narrows Arm, but, as usual, was not fished.

Cohoes.—A good average run appeared in all sections of the sub-district, and all streams received parent salmon in quantities fully equal to the brood-year.

Pinks.—As usual, pink salmon appeared in large numbers in the streams of the upper reaches of Jervis Inlet. A good run occurs here every year and the run of the current year was fully equal to those of all recent years. The run to Vancouver Bay is reported by the Inspector to have shown a slight decrease as compared with the brood-year. All other streams of the district received pinks in quantity about equal to the brood-year.

Chums.—Chums entered all the streams of the district in larger numbers than last year, and were at least equally as plentiful as during the brood-year. The Inspector and his patrolmen report some of the streams as heavier seeded than during the brood-year. Extension of fishery boundaries off the mouths of many of these streams some years ago has had the effect of allowing for a greater escapement.

Steelheads.—These continue to appear each year in the usual average quantities in all streams frequented by them.

NANAIMO SUB-DISTRICT.

More cohoe and chum salmon and steelheads have been observed on the spawning-grounds during the past three years than during many years previous to that period. Spawning conditions this year are far more satisfactory than during the brood-year in each instance.

LADYSMITH SUB-DISTRICT.

For purposes of this report Nanaimo River is included with Ladysmith District, as patrol of that stream has been undertaken to some extent by the Inspector for the Ladysmith Sub-district, but also by other officers when available.

Cohoes.—These salmon appeared in satisfactory quantities, and all streams of the sub-district frequented by them had good average runs, which were considered at least equal to those of the brood-year.

Springs.—Spring salmon reaching the Nanaimo River seemed to be on the increase during the past few years, and the run to Chemainus River compared very favourably with the runs of all recent years.

Pinks.—These do not run in quantity, but the numbers appearing in the few streams frequented by them were this year about equal to the light runs of two years ago.

Chums.—Chums appeared in large quantities in Nanaimo and Chemainus Rivers and in all the smaller streams. These runs can be said to have been considerably heavier than those of the brood-year.

Steelheads.—The usual small numbers were in all streams frequented by them, and it is quite evident that the numbers were equally as good, if not slightly better than during recent years.

COWICHAN SUB-DISTRICT.

Springs.—Springs appeared in very satisfactory numbers in the Cowichan River. The Inspector reports that the number ascending that river was considerably greater than during the brood-year and that the usual light run occurred in the Koksilah River.

Cohoes.—The cohoe run was considered light in the Cowichan River, but was estimated to be equal to that of the brood-year. In Koksilah River there was a good early run of cohoes, but the late run is reported as lighter than the brood-year.

Chums.—To date the run has been lighter than during the past two years in the Cowichan River, but it compares quite favourably with the brood-year. Chum salmon were still entering the river in quantities at the time of inspection.

Steelheads.—The run in the early part of the year in both Cowichan River and Koksilah River was considered heavy. Owing to high water it was difficult to determine the extent of the late run, which was just commencing at time of inspection.

VICTORIA SUB-DISTRICT.

Cohoes.—The number of parent cohoe salmon on the spawning-beds of the various streams in the Victoria District is quite similar to previous years. At Demanuel Creek, in the Sooke District, conditions are more favourable than usual, and more cohoes reached the upper stretches of the river than in previous years, due chiefly to removal of the large log obstruction which has caused so much difficulty in recent years.

Chums.—A good average run appeared in Goldstream, Sooke River, and all other streams of the Victoria District.

Steelheads.—These fish were seen in about the usual average quantity in the few streams frequented by them.

BARKLEY SOUND SUB-DISTRICT.

Sockeye.—The run of sockeye to Somass River was considered much heavier than the brood-year, and very satisfactory numbers ascended to the spawning areas of Great Central and Sproat Lakes. The Anderson River run was again disappointing, the estimated numbers reaching the spawning-grounds being much lighter than the brood-year. The run to Nitinat Arm was equally as good as that of the brood-year, and there was a satisfactory escapement to the spawning-grounds of Hobarton Lake, which is the sockeye-spawning area of Nitinat.

Cohoes.—Cohoes appeared in the streams of Barkley Sound District in larger numbers than for several years, and it is quite safe to say that the streams were equally as well seeded as in the brood-year. The Inspector reports just one exception, Anderson River, where the run was light.

Springs.—Very good runs occurred in all of the large streams of the district, with the exception of Anderson River. These fish appeared on the spawning-grounds in numbers equal to any of the runs of many years past.

Chums.—All the streams of the district were well seeded by this variety, with the exception of Sarita and Toquart Rivers and the small stream at Dutch Harbour. Owing to extreme low-water conditions and poor escapement of chums to the Barkley Sound streams it was necessary to place special closure on all net-fishing in Barkley Sound, exclusive of Alberni Canal, from October 20th to 28th. Special protection was given to the chum runs to the three streams mentioned above by shifting out boundaries and providing large closed areas off the mouths. Spawning conditions were excellent in Nitinat area, and all streams throughout the whole of the district were at least as well seeded as during the brood-year.

Pinks.—These salmon do not run in appreciable quantities in the district and practically none was seen this year.

Steelheads.—The usual good runs appeared in the Somass River watershed, at Nahmint, and other large streams of the district.

CLAYOQUOT SOUND SUB-DISTRICT.

Sockeye.—There was an excellent run to the Kennedy Lake watershed and a good average run to Megin Lake. The Inspector reports an increase of parent sockeye on the spawning-beds of Kennedy Lake area over the brood-year and the run to Megin Lake about equal to the brood-year.

Cohoes.—Marked increase in the number of cohoes in all the streams was noticeable in comparison with the brood-year.

Springs.—This year's run to the main streams of the district is reported by the Inspector as the heaviest he has seen for many years and the streams frequented by them are well seeded.

Chums.—A very good run occurred and each stream received parent chums in quantities fully equal to the brood-year.

Pinks.—Do not run in large quantities in this sub-district. The numbers appearing this year were about equal to those of two years ago.

Steelheads.—These were in the streams in apparently the usual quantities.

NOOTKA SOUND SUB-DISTRICT.

Sockeye.—The run to Gold River and the several smaller streams frequented by sockeye was just about the usual average. The Inspector states there is never much fluctuation in these runs from year to year.

Cohoes.—The usual light run occurred again this year and the quantities reaching the spawning-grounds can be said to have been fully equal to the brood-year.

Springs.—A good run occurred at Burman River, but the runs to other streams of the district were lighter than the past year. The Inspector states that the numbers of springs in the streams throughout the district would average as well as previous runs of light years.

Chums.—The numbers reaching the spawning-grounds were definitely heavier than during the brood-year. Owing to dry weather and low-water conditions in the streams it was necessary to enforce special closed periods, but after the advent of heavy rains chum salmon appeared on the spawning-grounds of all the streams in large numbers. The whole area was then opened again to fishing and operations continued until the seiners automatically ceased fishing.

Pinks.—Do not run in quantity in this sub-district. The usual very small numbers appeared in the few streams frequented by them.

Steelheads.—The usual numbers returned to the different streams of the district.

KYUQUOT SOUND SUB-DISTRICT.

Sockeye.—Light runs of creek sockeye appeared in the few streams usually frequented. The runs were of about the same proportions as those of the brood-year.

Cohoes.—The numbers appearing in the streams were considerably lighter than those of the brood-year.

Springs.—A very satisfactory run appeared in the main streams of the district. The Inspector reports that the numbers in the streams compares very favourably with the runs of last year and those of previous years.

Chums.—The numbers on the spawning-grounds throughout the district were much smaller in comparison with those of the brood-year. The run was of short duration, and as heavy freshets coincided with the main run it was impossible to determine the extent of the escapement. This area will require to be given special attention four years hence.

Steelheads.—Are reported in the Kyuquot District streams in their usual small numbers.

Pinks.—The run is not commercially important. The Inspector reports a 40-per-cent. decrease from that of the brood-year.

QUATSINO SUB-DISTRICT.

Sockeye.—The light runs to the district do not fluctuate greatly. The numbers appearing this year equalled about the usual average.

Cohoes.—A satisfactory increase over the brood-year was noticeable in the streams of Rupert Arm area. In other parts of the district cohoes ascended the streams in quantities equal to the brood-year, except at Brooak Bay, where the run was reported as lighter.

Springs.—A heavy run occurred at Marble Creek, where conditions were very favourable, and spawning was equally as good as for several years previous.

Chums.—There was a good average spawning in all streams throughout the district. The spawning was fully as heavy as during the brood-year.

Pinks.—Throughout the whole of the Quatsino Sound area a heavy increase of pinks was noticeable over the previous two brood-years. All streams frequented by this variety were heavily seeded. In the outside portion of the area the runs appearing were about equal to previous cycle-years.

Steelheads.—Appeared in Marble Creek in large numbers and the other streams of the district received the usual average run.

STATEMENT OF SALMON-EGG COLLECTIONS, BRITISH COLUMBIA HATCHERIES, 1934.

Hatchery.	Sockeye.	Springs.	Cohoe.	Total.
Anderson Lake, V.I.	6,741,000	464,250	.....	7,205,250
Sproat River, V.I.	.....	429,000	.....	429,000
Kennedy Lake, V.I.	8,897,300	.....	.....	8,897,300
Babine Lake, Skeena River	4,985,000	.....	.....	4,985,000
Lakelse, Skeena River	8,000,000	.....	.....	8,000,000
Cowichan Lake, V.I.	.....	630,000	732,000	1,362,000
Cultus Lake, Fraser River	41,341,240	.....	.....	41,341,240
Pemberton, Fraser River	20,400,000	.....	.....	20,400,000
Pitt Lake, Fraser River	3,925,000	.....	.....	3,925,000
Rivers Inlet	11,390,540	460,320	.....	11,850,860
Totals	105,680,080	1,983,570	732,000	108,395,650

We are indebted to Major J. A. Motherwell for the foregoing statement giving the number of salmon-eggs collected in the Province this year and placed in the hatcheries.

Sockeye-salmon egg collections for the whole of the Province in 1934 were 105,680,080, an increase of 52,262,280 in comparison with the previous year. The sockeye-egg collections in the Fraser River system for 1934 were 65,666,240, as compared with 18,481,400 in 1933 and 49,719,270 in 1930, its brood-year.

A BRIEF STATISTICAL REVIEW OF THE SOCKEYE FISHING AND CANNING INDUSTRY IN RIVERS INLET.

By Geo. J. Alexander, Assistant Commissioner of Fisheries.

A successful salmon-canning season is largely dependent on the success of the sockeye-pack, and while it is a general rule that the unit cost of production varies inversely as the size of the pack, nevertheless other important factors enter and must be considered.

Owing to varying conditions in the different sockeye-producing areas and dissimilar factors depending upon the different kinds of salmon, each producing area and each species must be dealt with separately. The sockeye fishing and canning industry in Rivers Inlet has been selected for the purpose of this brief survey. The survey is intended to indicate the effect on the individual fisherman's earnings during the sockeye-fishing season in Rivers Inlet, due to the constantly increasing numbers of boats fishing, and also to indicate to the industry what effect this has on the cost of production. It is not intended to draw conclusions relating to the state of abundance of sockeye in this district, but if a decline in the average annual pack is part of the evidence it must be considered. The survey compares the average seasonal earnings per boat for the five-year period 1922–26 with the average seasonal earnings per boat for the five-year period 1930–34.

It should also be pointed out that when individual seasonal earnings are mentioned, only the individual earnings derived from fishing sockeye in Rivers Inlet during the six or seven weeks' season have been considered. As most of the fishermen fish in other districts when the season is over at Rivers Inlet, the fishermen's actual season's earnings are much greater than are here indicated.

The following table shows the annual total pack of sockeye in Rivers Inlet and the total number of gill-nets fished annually from 1922 to 1934, inclusive. The column giving the number of boats is the actual number of boats fished in Rivers Inlet in the respective years. The average catch in fish per boat is obtained by calculation, thus: $\frac{a \times 13}{b}$, where a = the total pack in cases; b the number of boats fishing; and 13 the number of fish to the case. The prices quoted in column 5 are actual prices paid for the year in question, except that the prices quoted for the years 1930 to 1934, inclusive, have been adjusted to compensate for the change in fishing method from cannery gear to independent gear. The average season's earnings per boat are the result obtained by multiplying the average catch per boat by the prevailing prices in the year in question.

Table I.—Showing Rivers Inlet Catch of Sockeye, Number of Boats Fishing, Average Catch per Boat, Prices, and Average Season's Earnings from 1922 to 1934.

(1.) Year.	(2.) Total Pack.	(3.) No. of Boats.	(4.) Average Catch of Sockeye.	(5.) Price.	(6.) Average Season's Earnings.
				Cents.	
1922	53,584	1,012	689	30	$206.70
1923	116,850	965	1,574	30	472.20
1924	94,891	736	1,676	22.5	377.10
1925	159,554	891	2,328	25	582.00
1926	65,581	1,115	765	35	267.75
1927	65,269	1,273	667	35	233.45
1928	60,044	1,117	699	35	244.65
1929	70,260	1,149	795	35	278.25
1930	119,170	1,449	1,069	40	427.60
1931	76,428	1,144	869	20	173.80
1932	69,732	1,451	620	20	124.00
1933	83,507	1,603	678	40	271.20
1934	76,923	1,899	527	40	210.80

Note.—Prices from 1930 to 1934 have been adjusted to compensate for change from cannery gear to independent gear.

In the graphs the broken line in each case indicates the actual fluctuation from year to year, while the continuous line represents the average and is calculated by moving averages of 5 over the period 1922 to 1934. This line necessarily stops at the year 1932 owing to the method of calculation. In other words, the curve represented by the continuous line is the same curve represented by the broken line, except that the latter has been smoothed once by moving averages of 5.

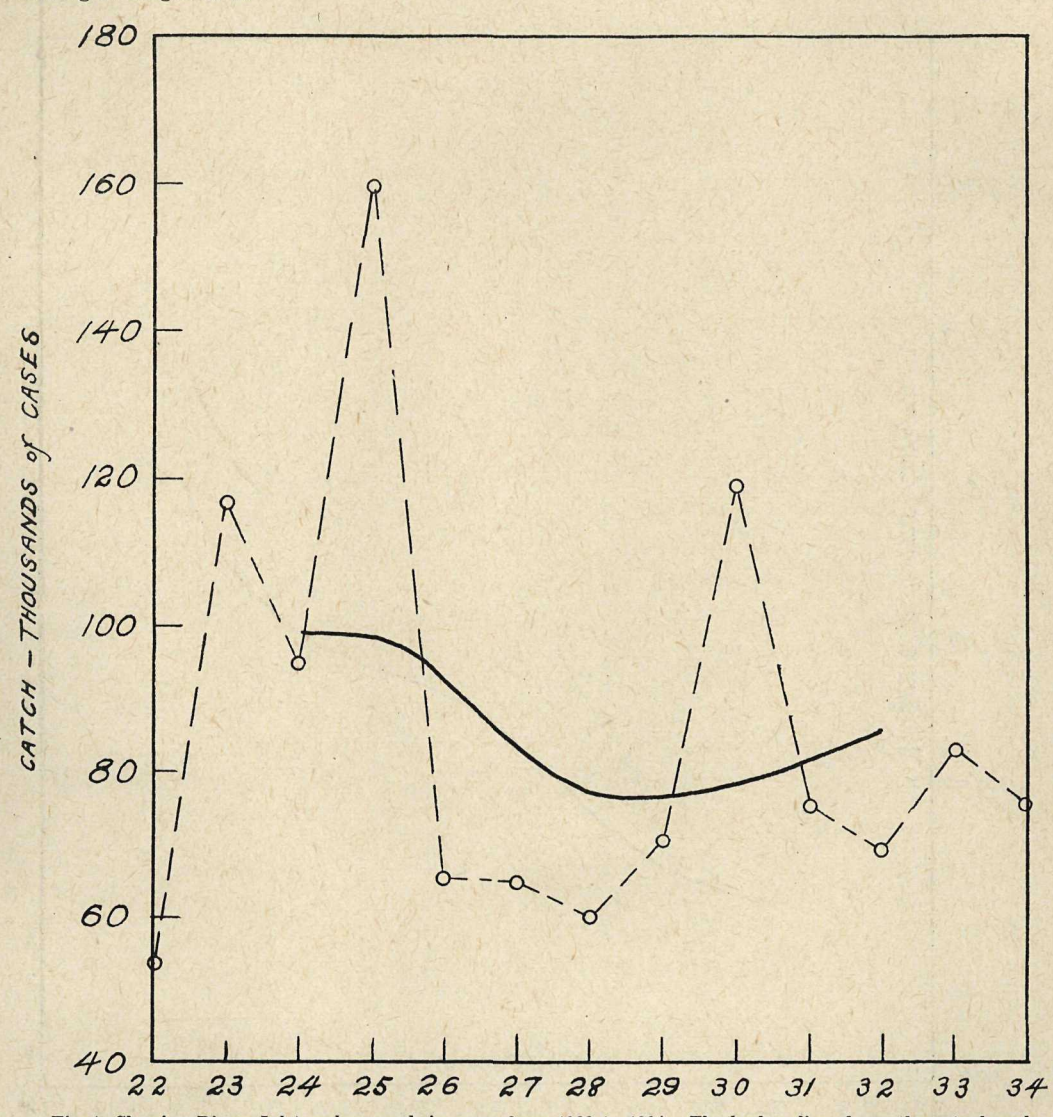

Fig. 1. Showing Rivers Inlet sockeye-pack in cases from 1922 to 1934. The broken line shows the actual pack from year to year. The heavy line indicates the trend and is the broken line smoothed once by moving averages of 5.

An examination of the pack records shown in column 2 in Table I. over the period 1922 to 1934 shows unmistakably that the amount of fish canned in the latter years is less than formerly. This is best illustrated in the graph, Fig. 1, where the broken line represents the actual pack in the years 1922 to 1934, inclusive, and the continuous line represents the averages on a five-year basis.

For a survey of this nature and owing to the cyclic nature of the runs of sockeye, the average rather than the actual fluctuations from year to year is most important. This does not alter the true picture which it is desired to present; i.e., that the trend in the amount of

fish canned is downwards and that the increasing number of boats fishing is economically unsound both to fishermen and canners. These factors are equally important to fishermen and canners alike, as obviously both interests are affected. That the pack figures are indicative, in a general way, of the amount of sockeye available for canning in any given year will readily be appreciated by the reader when it is understood that in the sockeye-fisheries every effort is made to catch all the fish possible while the season lasts.

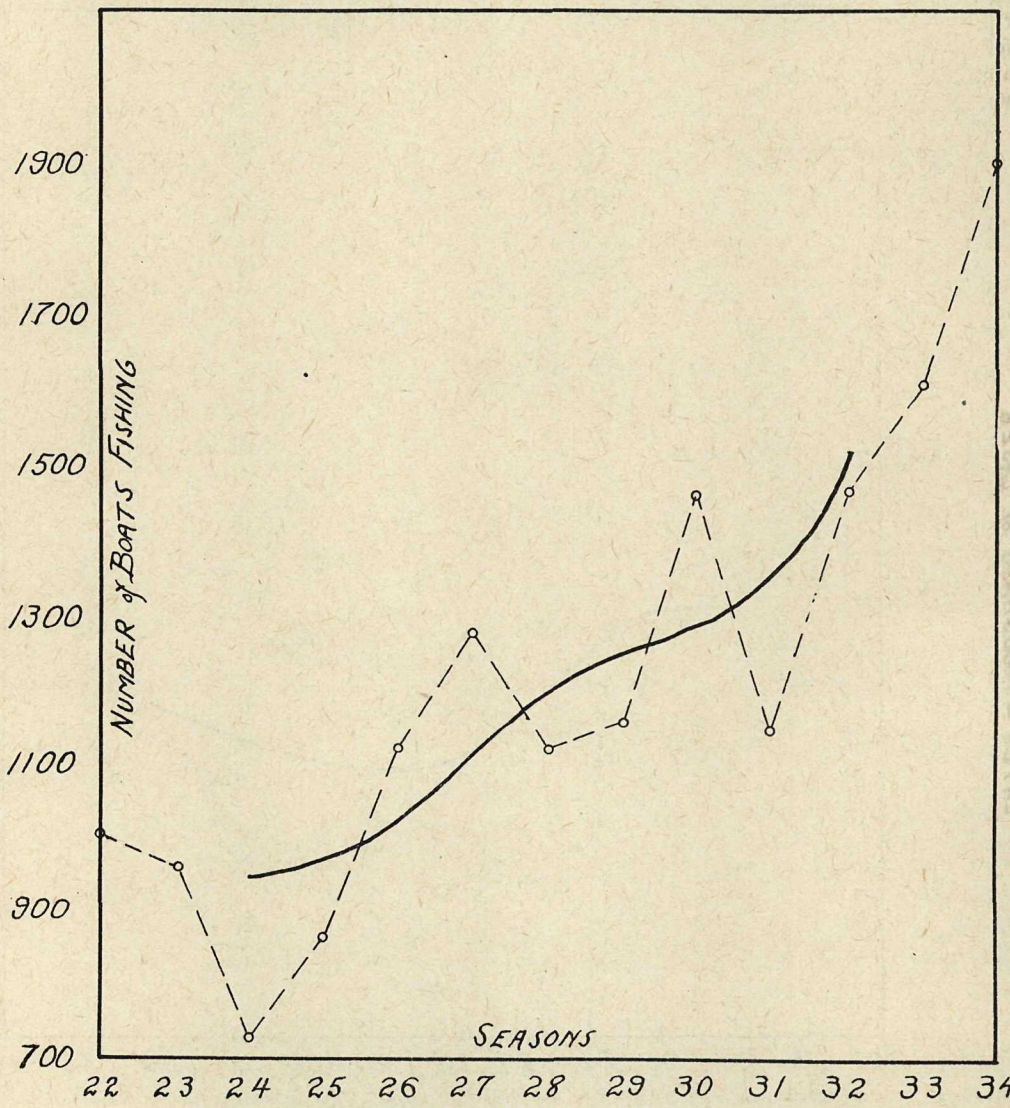

Fig. 2. The broken line shows the number of boats fished in Rivers Inlet from 1924 to 1934. The heavy line indicates the trend and is the broken line smoothed once by moving averages of 5.

On examination of the graph, Fig. 1, representing the average pack in Rivers Inlet, we find that whereas the average pack for the five-year period 1922 to 1926, inclusive, was 98,092 cases, the average pack for the five-year period 1930 to 1934, inclusive, was 85,152 cases. Expressed in another way, the decline in the average pack from 1922 to 1934 amounts to 13.2 per cent. More significant, however, is the enormous increase in the number of boats fishing in recent years. A further examination of Table I., column 3, will show the increase in the amount of fishing effort as represented by the comparative number of boats fishing in this

area from year to year. This increase is illustrated graphically in Fig. 2. Again, we have the actual number of boats fishing, as represented by the broken line, while the continuous line is based on a five-year average. It will be noticed that the increase in the number of boats fishing from 1924 to 1934, as represented by the average, is almost a continuous increase. We find that whereas in the five-year period 1922 to 1926, inclusive, the average number of boats fishing amounted to 944, the average for the five-year period 1930 to 1934, inclusive, amounted to 1,511, or an average increase of 60 per cent. over the ten-year period under review. So far we find the pack decreasing and the number of boats increasing.

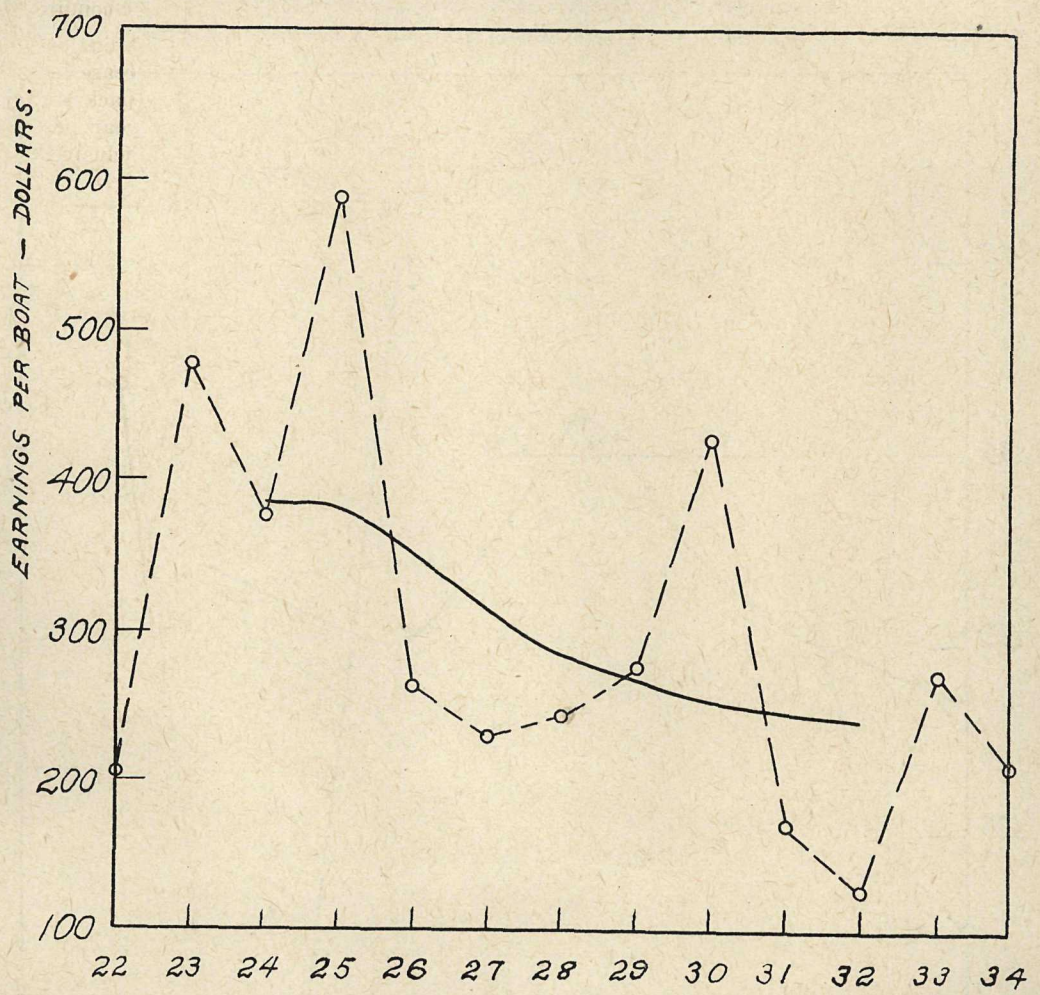

Fig. 3. Showing the individual fisherman's average earnings in dollars for the sockeye-fishing seasons in Rivers Inlet from 1922 to 1934. The broken line shows the fluctuations from year to year. The heavy line indicates the trend and is the broken line smoothed once by moving averages of 5.

In order to maintain, or increase, the size of his pack with a view to lowering unit production costs, or to increase profits, or both, or possibly forced by competition, the canner has constantly utilized more and more gear, apparently reasoning that if a given number of nets will produce a certain sized pack, increasing the number of nets will effect a corresponding increase in the number of fish caught. To reason thus is false, because the amount of fish available in any given season is definitely limited and is the controlling factor governing the size of the pack. Various other causes have no doubt contributed to the increase in the amount of gear in recent years. Depressed economic conditions forcing many out of other lines of work have no doubt been partly responsible for greater numbers seeking gainful employment

in fishing, but this must be considered as a minor factor, as an examination of the graph, Fig. 2, representing the average number of boats, shows that the amount of gear fishing in Rivers Inlet was increasing at an alarming rate previous to 1929, when depressed economic conditions did not exist.

So far we have only considered the size of the average pack compared with the number of boats fishing. If we now examine Fig. 3 we shall find that the effect of the increase in the number of boats fishing from year to year and the decrease in the average yearly pack is that the average fisherman's seasonal earnings have steadily declined over the ten-year period. This decline amounts to nearly 38 per cent. In the five-year period 1922 to 1926, inclusive, the average individual fisherman's earnings in Rivers Inlet amounted to $382, compared with $241

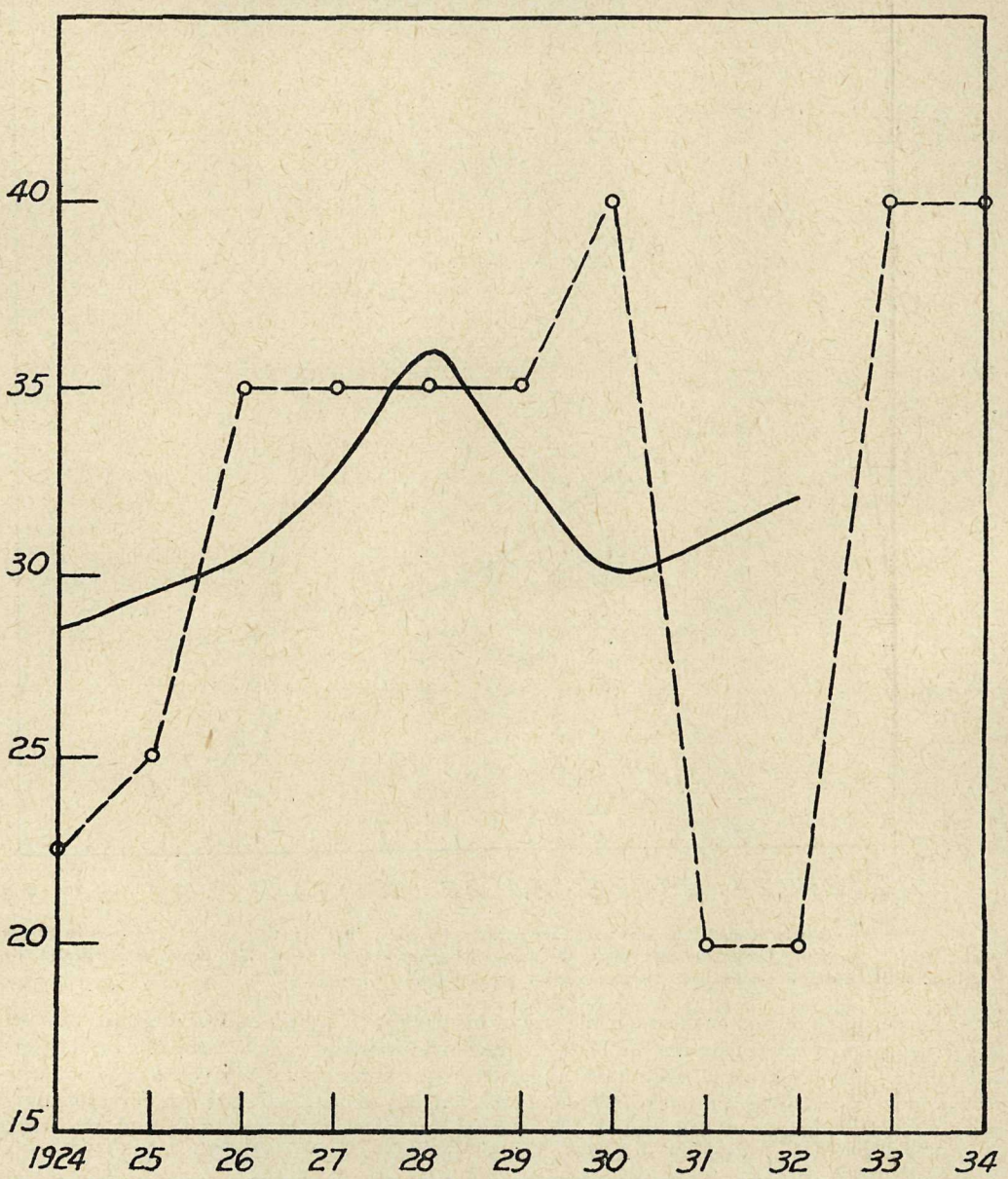

Fig. 4. Represents the prices paid for sockeye in Rivers Inlet from 1924 to 1934. Prices shown for 1930 to 1934, inclusive, have been adjusted to compensate for the change from *cannery gear* to *independent gear*. The broken line represents prices from year to year. The heavy line indicates the trend.

for the average earnings over the five-year period 1930 to 1934, inclusive. This decline of nearly 38 per cent. has taken place in spite of the increase of 12 per cent. in the average prices paid for fish.

The average gross earnings over the same period have changed very little; the average for the five-year period 1922 to 1926, inclusive, amounted to $351,840, while the average gross earnings for the five-year period 1930 to 1934, inclusive, amounted to $366,787, or an increase of less than 2 per cent. The increase in the gross earnings of the fishermen in Rivers Inlet is no doubt due to the increase in price paid for fish. The increase in the price paid for sockeye, amounting to 12 per cent., is graphically represented in Fig. 4. The broken line, as in the other graphs, represents the actual fluctuations from year to year, while the continuous line represents the averages. The individual fisherman will be more interested in the average individual earnings than he will be in the gross annual earnings; and the canner, also, will be vitally interested, as all these factors have a direct bearing on the unit cost of production.

The adverse effect on individual fishermen's earnings in Rivers Inlet, due partly to the enormous increase in the number of nets fishing and to a lesser extent to a decrease in the availability of fish, has been pointed out in the preceding paragraphs. In the following paragraphs it is proposed to deal with the effects of increased fishing effort and decreased availability on production costs to the canner.

It might be well at this point to interject a remark on the term " availability " as used in this paper. By availability is meant the number, or quantity, of fish available for catching during the time specified and must not be confused with the term " abundance." Fish might be exceedingly abundant but, due to numerous causes, be unavailable to the fishermen.

Fish required to seed the spawning-grounds are of course not available to the fishermen. These spawners, together with the fish caught, make for what is understood as " abundance." The greater the abundance in any given year the greater will be the measure of availability for that year providing the number of spawners is not increased; and, conversely, if the abundance remains constant and the number of spawners is increased, the availability will be decreased. It will readily be appreciated that, in order to maintain an adequate escapement to the spawning-grounds, restrictive fishing measures must be increased as fishing effort increases. Annual reports from the spawning-beds would indicate that the escapement has been fairly well maintained, although when considered in relation to the average packs over the last twelve years a decline in abundance is indicated. It is desired to make clear that as all the sockeye running to Rivers Inlet in any given season eventually reach the spawning-grounds, or are caught, and as all sockeye caught are canned, then the total pack of canned sockeye for this area in a given season is a measure of availability for that season regardless of restrictive fishing measures or other factors tending to limit the catch. Restrictive fishing measures such as weekly close time, bad weather, and numerous other causes will make the sockeye less available to the fishermen, when the pack will decrease accordingly, but these factors do not alter the relationship between total pack and availability. The total pack still remains the measure of availability.

It is not the purpose of this article to go into the details of the unit cost of production to the canner, as this would be beyond the scope of a brief survey of this nature; and, also, the data necessary are not available in sufficient detail.

It must be pointed out, however, that the cost of producing a case of canned salmon is governed to a large extent by what it costs to produce the raw fish, the cost of the raw fish being the largest single item making up the total cost of the finished product. The cost of raw fish is directly affected by the amount of fish produced by each net. The production efficiency of each net therefore becomes of paramount importance in relation to production costs. The measure of efficiency of a unit of gear is taken as the amount of fish produced by one net in a given season. If the unit efficiency is high the investment is an asset, but as the efficiency decreases the asset diminishes, and where efficiency becomes low the money invested in nets may become a liability. This potential liability or decreased asset is eventually a charge to the owner of the net. Even though the fisherman in recent years is paid on the basis of what is known as " independent gear," the fact remains that in the great majority of cases the owner of the net is the canner. It is the canner's money which is tied up, and, if the efficiency of the net is reduced, the net-owner's asset, as represented by the net, is decreased accordingly and becomes a charge on the pack.

It is difficult to measure the production efficiency of any machine or appliance except in relative terms, but for the purpose of this survey we may compare the relative efficiency of a gill-net in Rivers Inlet in 1924 with the relative efficiency of a gill-net in the same area in 1934. In a comparison of this kind two factors of equal importance must be considered—i.e., the availability of fish and the amount of gear fishing. Seasonal fluctuations of both these factors make it desirable to use averages over a period rather than the figures for any given year.

From Table I. for the period 1922 to 1926, inclusive, the average annual catch of sockeye in Rivers Inlet amounted to 98,092 cases, while for the same period the average number of boats fished annually amounted to 944. We find, therefore, that the average annual production in cases per boat for the five-year period amounted to nearly 104 cases. By using the total pack as a measure of availability and the production per boat as the other factor and substituting values, we may call the sum of these two values the efficiency index for a unit of gear. (*See* Table II.)

Table II.

Five-year Period.	Average Pack.	Availability Value.	Average Catch, Boat.	Production Value.	Efficiency Index.
	Cases.		Cases.		
1922–26	98,092	50	104	50	100
1930–34	85,152	43.4	56	26.9	70.3
Total drop	12,940	6.6	48	23.1	29.7

In the above table for the period 1922–26 the availability, as represented by the average annual catch in cases, has been given a value of 50 and the average annual catch per boat has been given a value of 50. The efficiency index for a unit of gear for this period using these values is therefore 100. In the period 1930–34 the average annual catch in cases amounted to 85,152, and the availability number for this period must bear the same relationship to 85,152 as 50 does to 98,092. The number representing availability for the latter period is 43.4. The average annual catch per boat fell from 104 cases in 1922–26 to 56 cases in the period 1930–34 and the production number fell accordingly from 50 to 26.9. The efficiency index dropped from 100 for the five-year period 1922–26 to 70.3 for the five-year period 1930–34, a total drop in efficiency of 29.7. By further examination of Table II. it will be noted that this drop is made up of a drop in availability of 6.6 and a drop in unit production of 23.1. Expressed another way, the production efficiency per unit of gear in Rivers Inlet has fallen from 100 to 70.3, and nearly 78 per cent. of this drop is due to the number of boats fishing and less than 23 per cent. is due to decreased availability.

What this lessened efficiency means to the canner in increased production costs must be determined by the individual canner, as he alone knows what his costs are, but, assuming a net to cost $250 when ready to fish and depreciation at 50 per cent., it means that in order that no loss be incurred the net must earn $125 a year for two years over and above what fish it produces. If a net making these earnings is considered 100 per cent. efficient, then a net working at 70 per cent. efficiency would only earn $87.50, or a loss of $37.50 per year for two years compared with the more efficient net.

Summary.—(1.) The sockeye-packs in Rivers Inlet, as represented by five-year averages over the past twelve years, are less than they were in 1922 by over 13 per cent. That this decline in pack is not due to curtailment on the part of the industry itself is evidenced from the fact that fishing effort has continuously increased.

(2.) Fishing effort as measured by the number of boats fishing has increased 60 per cent. during the period under review.

(3.) As a result of smaller packs and increased effort, the individual fisherman's earnings for the sockeye season in Rivers Inlet have decreased nearly 38 per cent.

(4.) Prices paid for fish in this district based on five-year averages have increased 12 per cent., but, due to smaller packs as under (1), the total amount distributed has increased very little.

(5.) The efficiency of gill-nets in Rivers Inlet as measured by the average amount of fish produced per net has fallen from an index of 100 for the five-year period 1922–26 to 70.3 for the five-year period 1930–34. Nearly 78 per cent. of this total drop in efficiency is due to the increase in the number of boats fishing, while less than 23 per cent. is caused by fewer fish available for catching.

No attempt is made to appraise the actual amount lost to the industry due to lessened efficiency, but attention is called to the fact that this loss is considerable, which fact might be profitably considered by both fishermen and canners.

THE HERRING-FISHERY OF BRITISH COLUMBIA— PAST AND PRESENT.*

By Albert L. Tester, Pacific Biological Station.

INTRODUCTION.

Within the last twenty years the herring-fishery of British Columbia has grown to such an extent as to become one of the most important fishing industries of the Province. In 1927 the catch amounted to 1,724,246 cwt., with a marketed value of $1,867,429. While the unfavourable economic conditions which have prevailed during the last few years have exerted a retrogressive effect, the catch in 1933 still amounted to 1,077,373 cwt., although the marketed value had dropped to $738,522. At present the catch is considerably greater than, and the value approximately equal to, that of the Atlantic herring-fishery of the Maritime Provinces and Quebec. These statistics serve to illustrate the commercial importance of the herring of British Columbia.

The direct monetary returns from the herring-fishery, although considerable, form only a part of the true economic value of the species. The rôle of the herring as a food for larger fishes must also be taken into consideration. As several important food-fishes, among which might be mentioned the halibut, spring salmon, cohoe salmon, and ling cod, feed on the herring, its total value cannot be readily estimated in dollars and cents.

It is the purpose of this bulletin to outline briefly the life-history of the herring; to trace the development of the various methods of fishing and to describe those which are at present

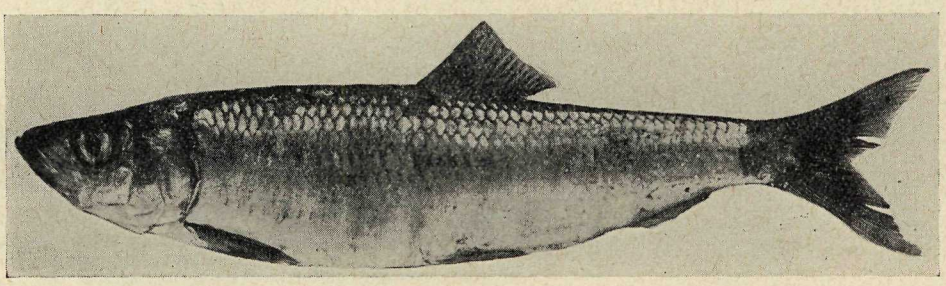

Fig. 1. The Pacific herring (*Clupea pallasii*).

in use; to trace the development of each phase of the industry with reference to the preparation of the products; to discuss fluctuations which have occurred in quantity and value of the marketed products; to discuss fluctuations in the availability and size of herring; and to comment on the present condition of the fishery and its future possibilities.

In the preparation of this article, members of both the Federal and the Provincial Departments of Fisheries and of the fishing industry have contributed much useful information and their assistance is gratefully acknowledged. Figs. 4, 8, and 16 are photographs taken by Mr. W. J. Oliver, Calgary, and published with the kind permission of Mr. J. C. Campbell, National Parks of Canada, Department of the Interior, Ottawa.

LIFE-HISTORY.

The commercial herring-fishery is most active during the fall and winter months, when numerous schools of adult fish appear in the bays and inshore channels. The fish remain in these waters throughout the winter and spawn during the following spring. While spawning takes place in the vicinity of Vancouver Island usually between the latter part of February and the first part of April, the exact time of reproduction varies both with locality and season. In the more northern waters of the Prince Rupert District the herring spawn at a slightly later date, some time between the first week in March and the end of April.

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At spawning-time the schools of herring come into the comparatively shallow water along the shore and deposit their eggs on the eel-grass or rockweed in or just below the intertidal zone. Spawning activity on any particular bed may last from one to several days. The eggs are cemented by the hardening of a sticky mucilaginous coating to the vegetation forming thick clusters (Fig. 2). At the time of deposition they are fertilized by the milt of the males which is discharged freely into the water. So large is the quantity of milt liberated that it forms a dense greenish-white " cloud " in the water, sometimes as great as a mile in length and one-quarter of a mile in width (Fig. 3). The eggs, containing the developing young, are usually exposed at low tide and are preyed upon by thousands of gulls, ducks, and other birds (Fig. 4). Sun and wind in the daytime and frost at night also take their toll when the eggs are exposed, although their resistance to these agencies is remarkable. Storms are one of the worst hazards of the spawning-grounds, for they cause a large percentage of the eggs to become detached from the vegetation and washed up on the beach. A recent investigation of the extent of mortality on herring-spawning grounds by Hart and Tester (*Trans. Amer. Fish. Soc., Vol. 64, 1934*) has shown that at least 70 per cent., and probably more, of the eggs thus

Fig. 2. Eggs of herring on eel-grass.

washed on the beach fail to survive, whereas, under ideal weather conditions, the mortality due to natural causes such as infertility and desiccation averages only about 5 per cent.

During a period of from ten to twenty days, the length of time depending on the temperature of the water, the larval herring gradually develops within the egg, deriving its nourishment from the supply of yolk material. It gradually begins to show signs of life, wriggling and squirming inside the egg membrane until it finally breaks through and is set free in the water. When first hatched the larva shows a slight bulge on its under-surface below the front fins which marks the position of the " yolk-sac." This contains the remaining supply of yolk which is sufficient to nourish the young fish for only a short period after hatching. Each spawning-ground yields several billions of larval herring. Although they can swim feebly, they are carried along by currents and back and forth by tidal action during this stage. In all probability this is the most critical period in the whole life-history, for not only are the larvæ the easy prey of many fishes both large and small, but large numbers may also die from lack of suitable food when their embryonic supply has been used up and they must start to feed.

By the time the larvæ have grown to an inch in length, a month or so after hatching, they are no longer at the mercy of the tide and move about in compact schools. These soon acquire the habit of appearing at the surface at dusk. In the evening when the water is calm they may be detected close to shore by the fine ripples which they cause at the surface and by the

silvery flash when an occasional individual jumps clear of the water. In the daytime they may be seen frequently some distance below the surface.

The young herring are present in shallow inshore water throughout the summer, and during this period grow to a length of from 3 to 4 inches, measured from the tip of the closed lower jaw to the end of the tail. In the winter they are rarely seen and presumably seek deeper water. In the next fall and winter when they are in their second year and are about 7 inches in length a few of these immature individuals may join the schools of mature fish when the latter come in to spawn. When the young herring are in their third summer, they may be found sometimes in large schools in inshore water where food is plentiful. They remain here during the summer, and in the fall and winter join the adult schools in force to form from 20 to 60 per cent. of the commercial catch. The following spring these fish, now exactly three years old and approximately 8½ inches in length, spawn for the first time. This holds true in Southern British Columbia. In the northern waters of the Province a small proportion of the new recruits join the adult schools in their third year, but the majority do not appear in the commercial fishery until they have entered their fourth year.

Herring do not die after spawning; the gonads have fully recovered by the following spring, when reproduction again takes place. Normally, it is repeated once every spring throughout the remaining life of each fish.

Fig. 3. The shore of Departure Bay at spawning-time. The milt may be seen as a light area close to the shore.

The commercial catch consists mostly of fish in their third, fourth, fifth, and sixth years, with a small percentage of older individuals. In the southern waters the bulk of this catch is usually composed of fish in their third and fourth years. The fishery here is therefore mainly dependent on younger age-groups than that of Alaska and Europe. In the Prince Rupert District the rate of growth is slower than in Southern British Columbia, and consequently, even though the spawning run consists of fish of about the same average length as those to the south, it is made up of older individuals. The age-groups which are present in the northern runs are similar to those in the commercial fishery of South-eastern Alaska. Naturally, the percentage in each age-group in the run to any locality will vary from year to year, depending on the relative success of and survival from each spawning. The significance of the age composition of the run in regard to the condition of the fishery will be discussed later.

The importance of an adequate supply of suitable food for the newly hatched larvæ was indicated above. They subsist at first on the minute plankton organisms in the water. The microscopic eggs of small marine animals sometimes comprise over 50 per cent. of their food;

minute floating plants called diatoms are eaten very extensively; the young or nauplii of small shrimp-like animals known as copepods are also a very important food item; the larvæ of clams, snails, oysters, and of other lower animals are also eaten, but to a smaller extent. As the fish grow larger the type of food which they take changes somewhat. At the fingerling stage, when the young fish frequent inshore water, it is varied and depends largely on the kind of shallow-water organisms that are present. However, juvenile and adult copepods generally comprise a large percentage. Mature herring appear to feed mostly during the spring after spawning and during the summer, as specimens obtained at other times of the year very rarely contain food. Large copepods and other shrimp-like forms known as schizopods are the chief food organisms taken by herring of commercial size.

Throughout the whole life-span the enemies of the herring are many. The developing eggs on the spawning-grounds are devoured by seagulls, ducks, and crows. The larvæ are easily captured by small fishes and other marine animals. Young and adults are preyed upon by dogfish, salmon, trout, halibut, ling cod, and other fishes; they are also eaten by gulls and other birds; they form a large part of the food of sea-lions and seals. Thousands of tons of

Fig. 4. Typical spawning-grounds at low tide, Nanoose Bay. The gulls are feeding on the eggs.

adult fish are removed annually by possibly the most formidable of all predators, man. Considering the enemies that are present at all stages of development and considering the dangers of the critical larval period, it is not astonishing that only about one in ten thousand of the eggs which are deposited on the spawning-grounds survives to become an adult fish and to propagate the species.

FISHING METHODS.

Drag-seines.

In the early days of the industry, from its beginning about 1877 to about 1905, fishing was carried on almost entirely by the use of drag or beach seines. These are large nets, from 10 to 30 fathoms in length and from 2 to 5 fathoms in depth, which are operated from the shore. The middle portion of the seine is made of small-meshed web, sometimes as small as ½-inch stretched measure, while the two outer portions or wings consist of web of larger mesh. The central part is hung somewhat more fully than the wings to form a "bag" or

" pocket." The web is fastened to ropes running along the top and bottom. The top one, or " cork-line," has distributed along it at regular intervals floats of cork or wood, which keep it afloat; the bottom one, or " lead-line," has weights clamped to it at regular intervals, which sink the lower part of the net and keep it vertical in the water. At either end of the seine a rope bridle joins these two lines, and to its middle is attached a long line by means of which the net may be hauled ashore. The seine is piled in the stern of a skiff ready for use. When a school of herring is located close inshore, one man retains the line fastened to one end of the seine on the shore, the skiff is rowed so as to encircle the school of fish as quickly as possible, and the net is paid out over the stern. The crew lands, and the lines attached to both ends of the net are hauled in simultaneously until the fish are enclosed between the encircling net and the shore. The ends of the lead-line are brought close together, forming a pocket in which the fish are completely enclosed. The herring are then landed either on the beach or into the skiff.

The early method of capturing herring in a drag-seine could be used only when the schools came into the shallow water of bays and inlets in the winter or when they came along the shore to spawn in the spring, but the yield was quite adequate to meet the local demands. With the development of the industry, it became more and more difficult to secure a sufficient quantity by this method. Moreover, the schools were broken up and gradually deserted bays where they were formerly easily obtained. A new method of capture which could be used in deep water was indicated.

Drift Gill-nets.

As early as 1900 fishermen began to consider the possibilities of the use of drift gill-nets and purse-seines for the capture of herring in deep water. By 1905 the use of gill-nets was well established at Point Grey, near Vancouver, and on the east coast of Vancouver Island, particularly at Departure Bay and Nanaimo. In 1915 a failure of the Point Grey fishery resulted in an influx of gill-netters to Pender Harbour, where a fishery, similar in extent to that of Point Grey, has gradually developed.

The boats used by the drift gill-netters are from 30 to 40 feet in length with a 9- or 10-foot beam, and are usually propelled by small gasoline-engines. A cabin containing the engine and living-quarters is situated forward. Abaft the cabin is a hold covered by a hatch. Behind this is a cockpit in which the nets are piled. Sometimes an iron rack is placed between the hold and the cockpit and is used for segregating sections of the net which need repairing. The boats are similar in size and structure to salmon-trolling craft and some are convertible into the latter. The crew usually consists of two men.

The web is made of cotton twine from 2- to 2½-inch stretched mesh. Each " piece " is 20 fathoms in length and 3 to 4 fathoms in depth, with a cork-line along the top and a lead-line along the bottom. The corks are situated at intervals of about 2 feet and the leads at intervals of 1 foot along these two lines, the numbers and intervals being so arranged that the net just sinks below the surface of the water. Usually from ten to twenty pieces are fastened together at a set, making a total length of from 200 to 400 fathoms or up to half a mile of web. The number of pieces used depends on the abundance of the fish. An inflated canvas bag, called a " Scotch buoy," or a suitable float consisting of a sealed tub or a group of corks, is attached at the juncture of the cork-lines of successive pieces on about a fathom of rope. Immediately below these large floats, at the juncture of two lead-lines, is attached a weight, usually consisting of a rock or stone at the end of half a fathom of line. These additional floats and weights cause the web to be suspended about a fathom below the surface.

Fishing usually takes place at dusk and at daybreak or during the intervening hours of darkness. When fish are very plentiful or there is a large demand, sets are also made in the daytime, but these are usually not as successful as those made during the twilight hours or at night. In the case of the Point Grey fishery, the boats run offshore until sounding shows that a sufficient depth has been attained. The net is then set towards the shore, the exact direction depending on the wind. In other instances nets may be set offshore in deep water. First a float carrying a lighted kerosene-lamp, and attached to the first piece of web by about 10 fathoms of line, is thrown overboard. The first buoy and weight then follow and the whole net is gradually set over the stern while the boat travels slowly ahead, one fisherman paying out the net and freeing snags while the other is navigating the boat. When the entire web is out the last piece is attached to the stern by about 10 fathoms of line. Usually boat

and net are then allowed to drift with the current for a half an hour or more. Sometimes, however, the net may be set at dusk and lifted at dawn. In attempting to pass through the net the herring become entangled, the twine getting behind the cheek-bone or operculum which covers the gills. This method of capture is therefore known as " drift gill-netting."

After the net has been out a sufficient length of time it is hauled back into the boat by both men; the fish, if any, are shaken from the web; torn portions of the net are looped free of the main pile in the cockpit, to be repaired during the daytime. The herring are placed in baskets in the hold and are later sold to the public either direct or through a fish-buyer. Herring caught in this manner are favoured as food by the local market, as the gill-net selects only the larger fish.

The present gill-net fisheries are located at Point Grey in the summer, at Pender Harbour in the summer and fall, and occasionally at Nanaimo, Departure Bay, and Nanoose Bay in the spring (Fig. 9).

Purse-seines.

Purse-seines first came into extensive use on the east coast of Vancouver Island about 1910. Previous to that time they were opposed by many fishermen as destructive to small fish. However, the drag-seines and gill-nets did not supply a sufficient quantity of fish to meet the demands of the growing export trade, particularly in dry-salted herring. The British Columbia Fisheries Commission, 1905–07, had recommended either the prohibition or limitation of purse-seining. However, after much controversy local objections were finally overcome and the use of purse-seines became established by law in 1913 outside of certain restricted areas. Since that time an enormous fishery has been gradually built up on both the east and west coasts of Vancouver Island.

The early methods of purse-seining were naturally somewhat crude as compared to those of the present day. At first, a small purse-seine manipulated by means of a small power-boat and skiff was used. While the principle of the method of capture was similar to that of the more modern methods which are described in the following pages, there has been an increase in the size and efficiency of the boats and gear and an increase in the skill of the fishermen with the development of the industry.

The boats, crews, equipment, and methods of the herring and pilchard fisheries of British Columbia are very similar. In the following description of the herring-fishery any outstanding differences between the two will be pointed out. For more detailed information on the pilchard-fishery the reader is referred to a bulletin by Dr. J. L. Hart (*Biol. Bd. Can. Bull. 36, 1933*).

Boats.—A modern herring seine-boat is about 65 feet in length with a beam of from 16 to 18 feet, and is usually propelled by a full-Diesel engine. The essential equipment consists of a seine, a turntable with a power-driven " live " roller, a brailer, and, for single-seining, a sturdy flat-bottomed skiff. Each seine-boat has a hold for stowing fish, the capacity of which may be from 30 to 40 tons. Herring and pilchard seine-boats are identical and the same boats are often used in both fisheries.

Tenders, boats used for " hauling-off " during a set, or for carrying fish, vary considerably in size and construction. They are usually larger than seine-boats but are built along the same lines. Sometimes seine-boats which are not actively engaged in fishing are used as tenders.

Scows.—The scows used in transporting fish are of two kinds—" well " and " deck." Well-scows are essentially large water-tight boxes with a float built on either end and with a capacity of from 50 to 100 tons of fish. They float lower in the water than deck-scows and so are favoured by the Japanese fishermen who brail by hand. They are also cheaper in construction, but can only be used in protected waters. Deck-scows (Fig. 8), as the name implies, consist each of a flat-bottomed hull, on the deck of which is built an enclosure with a capacity of from 30 to 80 tons. They float higher in the water than well-scows and so can stand rougher weather.

Nets.—A herring purse-seine may be 275 fathoms in length on the east coast and 200 fathoms in length on the west coast of Vancouver Island. It is usually deeper than a pilchard-seine, the depth ranging from 30 to 50 fathoms or more. In the Prince Rupert District, however, seines with a depth not exceeding 10 fathoms are used, as fishing takes place in comparatively shallow water.

Essentially, a seine consists of a large expanse of web bounded by lines and manipulated by means of other sets of lines. To a narrow strip of heavy web at the top of the net is attached the cork-line and along this are threaded disks of cork at short intervals. A number of Scotch buoys are also attached to the cork-line in such a way that their positions may be readily changed during a set. A heavy lead-line, on which are strung numerous small lead weights, is fastened to the bottom of the web. Brass purse-rings, through which runs the purse-line, are distributed along the bottom of the net about 4 fathoms apart. These are fastened to the middle of short pieces of rope which are lashed at both ends to the lead-line. The purse-line may be either a heavy rope or a wire cable. Breast-lines, running through smaller rings which are lashed to ropes bounding the ends of the net, are joined to the lead-line below each end.

The dimensions, structure, and web of herring-seines vary according to the preferences of the operators and also according to whether the single- or double-seine method of fishing is used (*see* below). The size of the thread and the arrangement of the web of a double seine

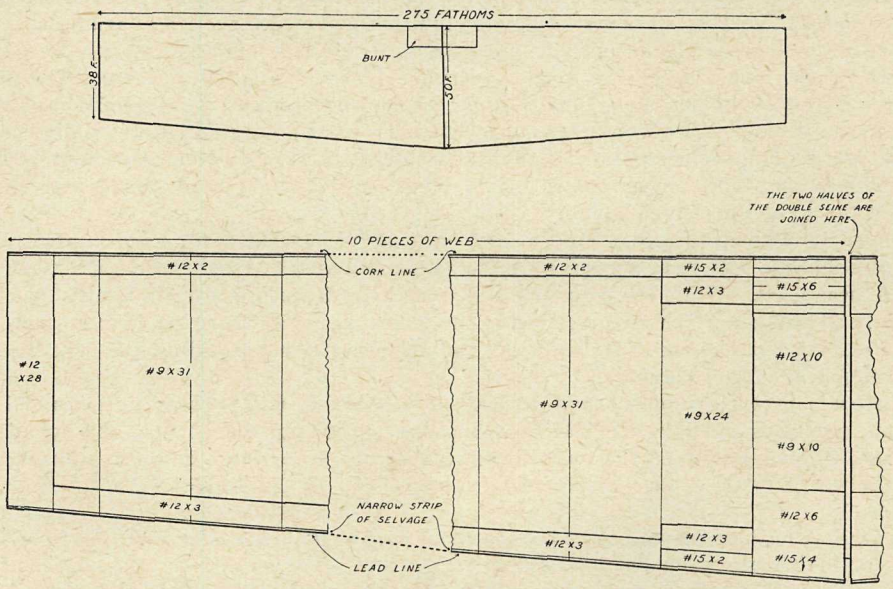

Fig. 5. Arrangement of web of a double purse-seine used by an operator on the east coast of Vancouver Island. Numbers indicate size of twine and number of pieces of web; e.g., No. 12×2 means 2 pieces of 12-thread web. Each piece is 20 fathoms long and about 2 fathoms (100 meshes) deep when stretched.

used by one operator on the east coast of Vancouver Island is shown in Fig. 5. The web consists of numerous pieces laced together, each piece with a stretched length of 20 fathoms and a stretched depth of about 2 fathoms (100 meshes). After the web is hung, the total length of the double seine is 275 fathoms (20 pieces). Similarly the depth at the central portion or " bunt " of the net is about 50 fathoms (36 pieces) and tapers to about 38 fathoms (28 pieces) at the outer edges of the " wings." The whole web, except the narrow strip of heavy selvage along the cork and lead lines, is of 1½-inch stretched mesh. From the figure it may be seen that the size of the twine is different in the various parts of the net. The wings consist mostly of 9-thread twine, but this is bounded at the top, bottom, and end by strips of heavier web, consisting of 12-thread twine. The bunt of the double seine, in which the fish are enclosed after pursing, and other parts of the web which are subjected to the greatest strain are made of still heavier twine, 15-thread.

The arrangement of the web of a single seine is essentially similar to that of either half of the double seine described in the preceding paragraph. Again, however, the exact arrangement and the size and strength of the web varies according to the preferences of individual operators. In a single seine the bunt is at one end of the net and along its edge runs the

second breast-line. On the west coast of Vancouver Island, frequently the same seines are used for both pilchard and herring fishing.

Locating the Fish.—In contrast to pilchard-fishing, purse-seining for herring is mostly done inshore. On the south-east coast of Vancouver Island the activities take place in the channels and bays among the numerous islands; on the west coast, fishing takes place within all the larger sounds and inlets. The grounds are fished usually at night, from dusk to daybreak. When the schools are at the surface they are located either by watching for the flipping of the fish or by listening for the sound caused by this activity. When they are below the surface they are located by " feeling." This consists of dropping a heavy weight attached to a fine wire from a skiff or from the bow of the seine-boat while the latter is under way at slow speed. An experienced fisherman can tell by the feel of the wire when it passes through a school of fish. Moreover, having located the school by feeling back and forth he can determine the direction and the speed at which the fish are travelling, knowledge that is essential for a successful set.

Setting.—The method of fishing on the east coast of Vancouver Island is somewhat different to that employed elsewhere. Two seine-boats drift side by side on the fishing-grounds. Although each has an individual seine, the ends of the two are laced together at the bunt end to form one long net, half of which is piled on the turntable at the stern of each boat. When the scout has located a school of herring he signals with his lantern; the boats are cut apart and move at first in almost opposite directions, each paying out its portion of the net over the stern (Fig. 6, 1A); both boats quickly describe a half-circle around the scout in the skiff and come together again when all the net has been set (Fig. 6, 1B).

To some extent on the east coast of Vancouver Island and exclusively in all other localities, seine-boats operate individually, as in the pilchard-fishery. A skiff is towed behind the seine-boat while scouting for fish. The skiff-line is fastened to a loop in the cork-line of the net, to which is also fastened the breast-line and the lead-line. The lines from the other end of the seine, which is piled on the turntable with the roller facing aft, are made fast to the boat. When fish are located the skiff is set free from the boat and its occupant rows in the opposite direction to which the boat is going. This drags the net off the turntable into the water and the seine-boat describes a complete circle to starboard at full speed, passing around the school of fish (Fig. 6, 2A). The lines fastened to the skiff are then taken aboard the seine-boat and both sets of lines are hauled as quickly as possible.

Pursing.—In the double-seine method of fishing, once the net has been set, both boats quickly haul on their own ends of the purse-line by means of power-winches until the net is completely pursed and the lead-line is brought to the surface and finally to the boats.

In the single-seine method, after the set has been made, the seine-boat must be hauled off by its tender by means of a steady pull on a line attached amidships on the opposite side to which the net is being pursed in order to prevent the seine-boat from drifting over the seine (Fig. 6, 2B). The two ends of the purse-line are passed over a roller at the middle of the boat and are hauled with a power-winch until the whole lead-line is brought aboard.

While pursing is in progress the fish are gradually enclosed on all sides except for the opening between the two ends of the net. Until the process is complete the fish are scared away from this opening by agitating the water with a long pole, an oar, or a board. Hauling on the breast-lines prevents the ends from bellying out and enlarging this opening. When finally the ends of the net and the whole purse-line are brought aboard, the fish are completely enclosed on the bottom and on all sides by the web.

Drying-up.—In " drying-up," part of the net is hauled aboard until the fish are closely confined in the bunt. This is done by " fleeting in " the net, hauling it with the live roller, or hauling it by hand. In fleeting, a sling is put under a portion of the net close to the water; this is raised by means of the boom and winch to a position above the turntable; it is then lowered and the net is piled on the turntable ready for another set.

In the double-seine method, during the process of drying-up, the bows of the two seine-boats are lashed together and the sterns are held apart by a well-scow. The bunt of the net, containing the fish, is thus suspended in a triangular opening, held up on two sides by the seine-boats and on the third side by the scow. The latter is hauled off by a small power-boat until the process of drying-up is complete (Fig. 6, 1C).

In the single-seine method, as the net is being dried up, the Scotch buoys are adjusted by a man in the skiff to support those portions of the net subjected to the greatest strain by the weight of the fish. A considerable length of the cork-line is supported by the skiff (Fig. 6, 2C).

Brailing.—Japanese fishermen on the east coast of Vancouver Island brail by hand into a large well-scow which is alongside supporting the net. The brailers consist essentially of

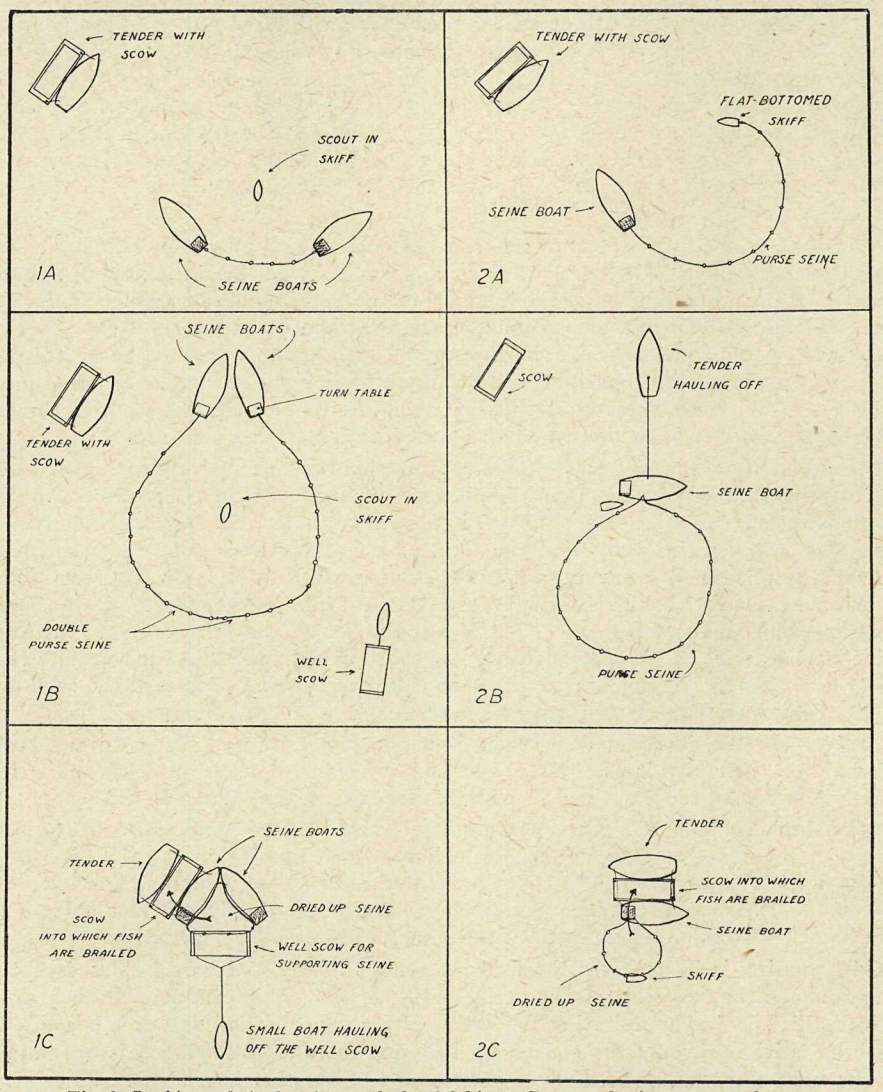

Fig. 6. Double- and single-seine methods of fishing. Boats and seines are not drawn to same scale.

a pocket of netting and two sturdy wooden handles attached to a rectangular metal hoop (Fig. 7). Two fishermen operate each brailer, one at either handle. As many as thirty men line the side of the scow and scoop the fish from the net into it.

The usual type of brailer used by white operators consists of a large dip-net on the end of a long pole. The bottom of the net is opened or closed by means of a trip-line attached to a brailing-block. It is lowered into the mass of fish from a boom and is guided by means of the long handle. When full of herring it is raised with the power-winch, moved across the seine-boat by the boom and tripped when above the scow which is tied alongside the seine-boat on the opposite side to the dried-up net (Fig. 8).

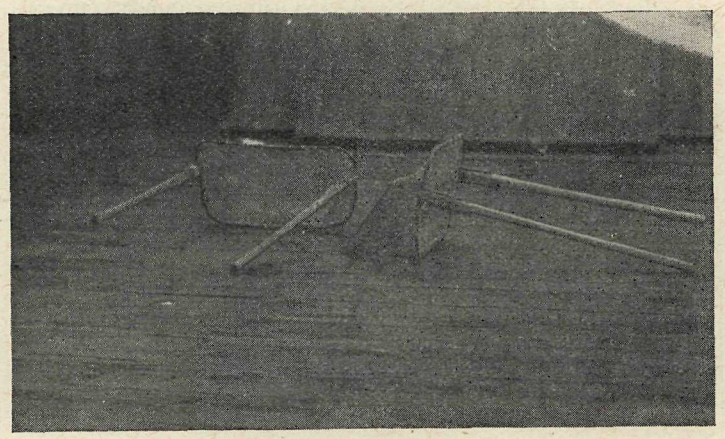

Fig. 7. Hand-brailers used by Japanese fishermen on the east coast of Vancouver Island.

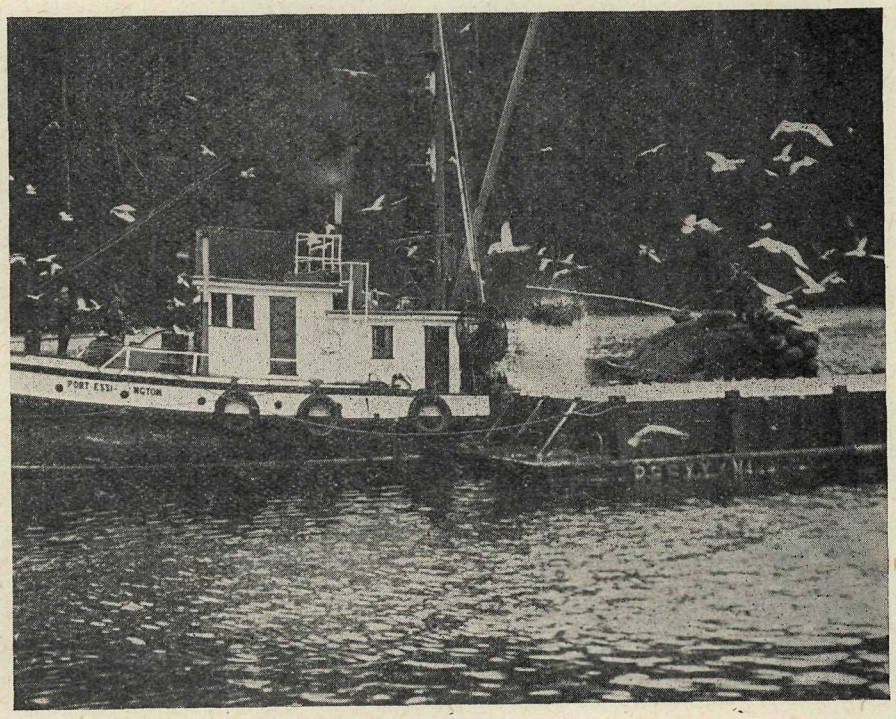

Fig. 8. Fish being brailed from the net, across the seine-boat and into the awaiting deck-scow, Barkley Sound.

Transporting the Fish.—When the well or deck scows are loaded, they are towed either behind or alongside the tender to the plant. They are usually covered with netting to prevent the thousands of gulls which are congregated on the fishing-grounds from getting at the fish.

Scows are preferred for transporting fish, but if they are not available, or if the fish are to be carried any great distance in the open sea, they are loaded into the holds of tenders or seine-boats.

In purse-seining for herring a single set usually captures from 25 to 100 tons of fish, the quantity depending on the size of the school and on whether the single or double type of gear

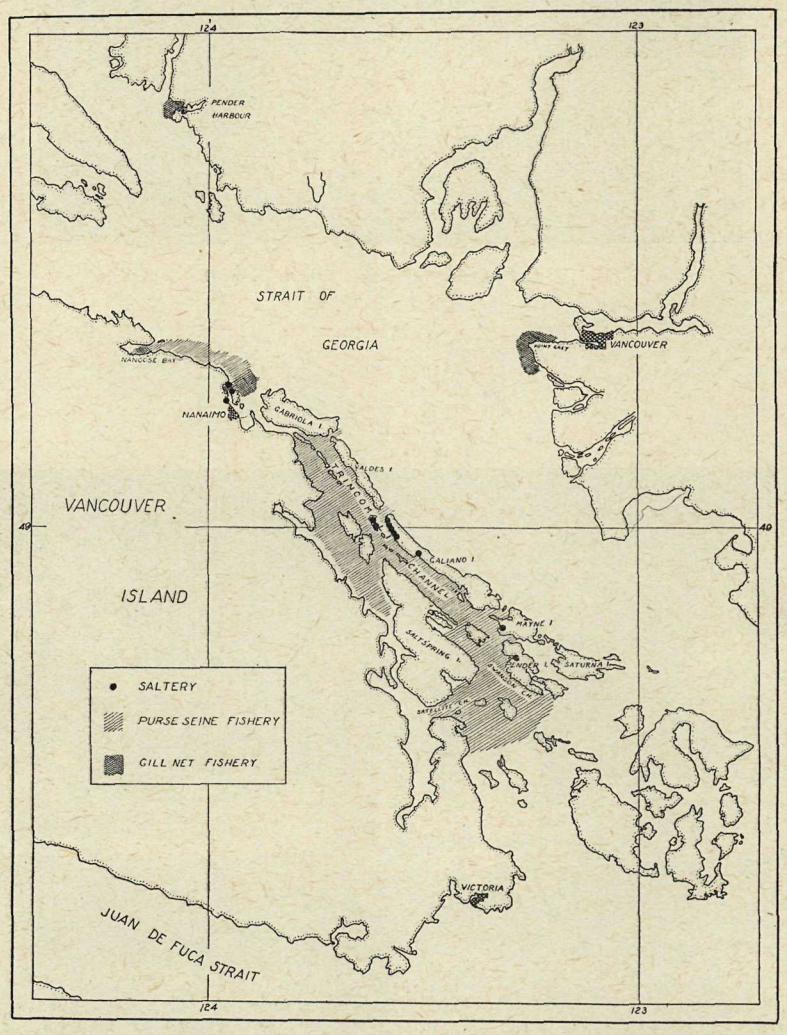

Fig. 9. Location of fishing areas and salteries on the Strait of Georgia. Only plants that have been active at some time during the past five years are indicated.

is used. In some instances catches of over 200 tons have been landed, but when such a set is made the chances of bursting the net are considerable.

The purse-seine fishery of the east coast of Vancouver Island is usually active from October to the beginning of January, and of the west coast from the beginning of November to February 5th, when the season is officially closed. In the Prince Rupert District the fish appear somewhat later and the fishery is active during March and April. The locations of the fishing-grounds in these three areas are shown in Figs. 9, 10, and 11.

MARKETED PRODUCTS.

The beginning of the herring-fishery of British Columbia on a commercial basis is described in the *Report of the British Columbia Fisheries Commission, 1905–07*, as follows:—

"The superabundance of herring on the coasts of British Columbia has been recognized from early times; but as the local demand was insignificant, no herring-fishery can be said to have existed until about thirty years ago, when the pioneers in the business, Messrs. Holbrook & Co., of New Westminster, cured (in 1887) between 500 and 600 barrels of herring, which they exported to South America."

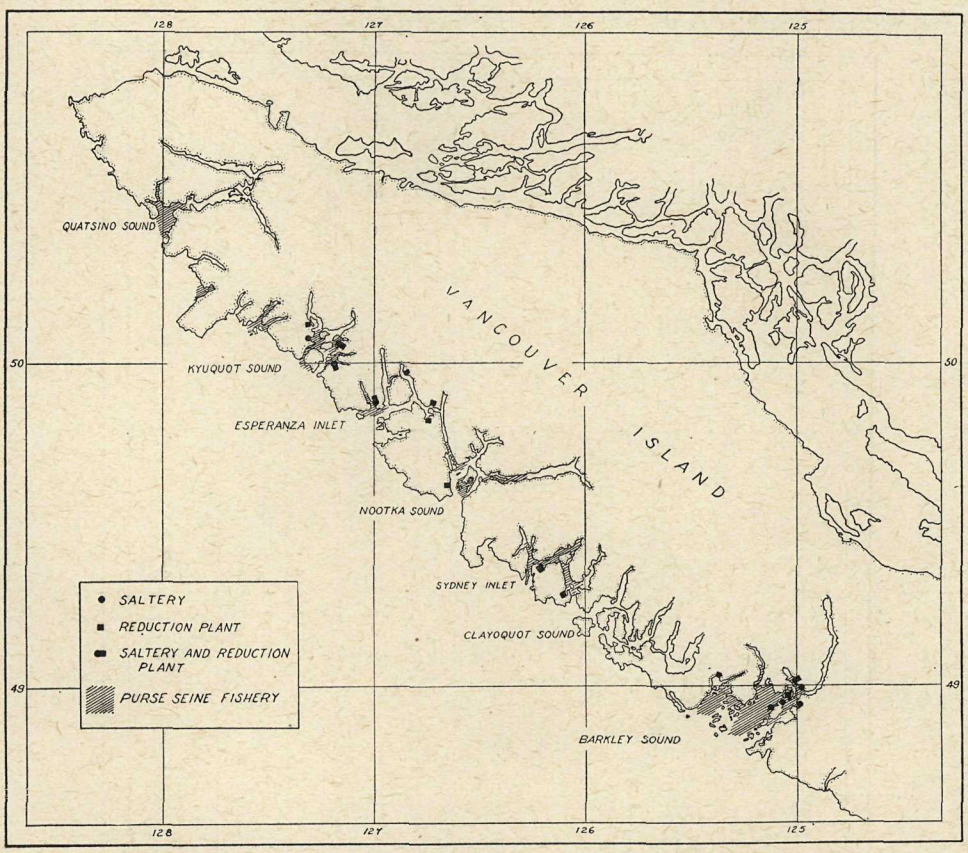

Fig. 10. Location of fishing areas, salteries, and reduction plants on the west coast of Vancouver Island. Only plants that have been active during the past five years are indicated.

From 1887 to 1900 the quantity of "green" (raw—as landed) fish used in the industry slowly increased from about 1,500 to 10,000 cwt. Since the beginning of the present century the annual catch has undergone a phenomenal increase from 10,000 to over 1,000,000 cwt., with a corresponding increase in the marketed value. At the present day the quantity and value of this catch depend almost entirely on the demand and, hence, on existing economic conditions. A decrease in marketed value from $1,867,429 in 1927 to $536,491 in 1932 has been largely due to these causes.

The annual catch in green weight and the corresponding value of each marketed product and of the total are shown in Figs. 12 and 13. These figures are compiled from data given in the *Annual Reports of the Fisheries Branch, Department of Marine and Fisheries* and *Fisheries Statistics of Canada*. As the records from 1900 to 1910 are inadequate, the proportions used for various purposes shown in Fig. 12 are only approximate. The records from 1909 to 1916 represent the catch for the fiscal year which includes an entire herring-fishing season, but the records for all other years represent the catch for the calendar year. As fishing takes place

mostly from October to February, inclusive, the catch for the calendar year includes the latter half of one season and the first part of the next. For the sake of uniformity, the quantity used for each product is expressed in green weight using the following conversion factors:—

1 cwt. dry-salted	=1.25 cwt. green.
1 barrel bait	=2 cwt. green.
1 barrel pickled or salted	=2×1.25 cwt. green.
1 cwt. smoked	=2 cwt. green.
1 ton meal	=110 cwt. green.

These approximate conversion factors are sufficiently accurate to enable the proportions of raw herring used for various purposes to be traced from 1900 to 1933.

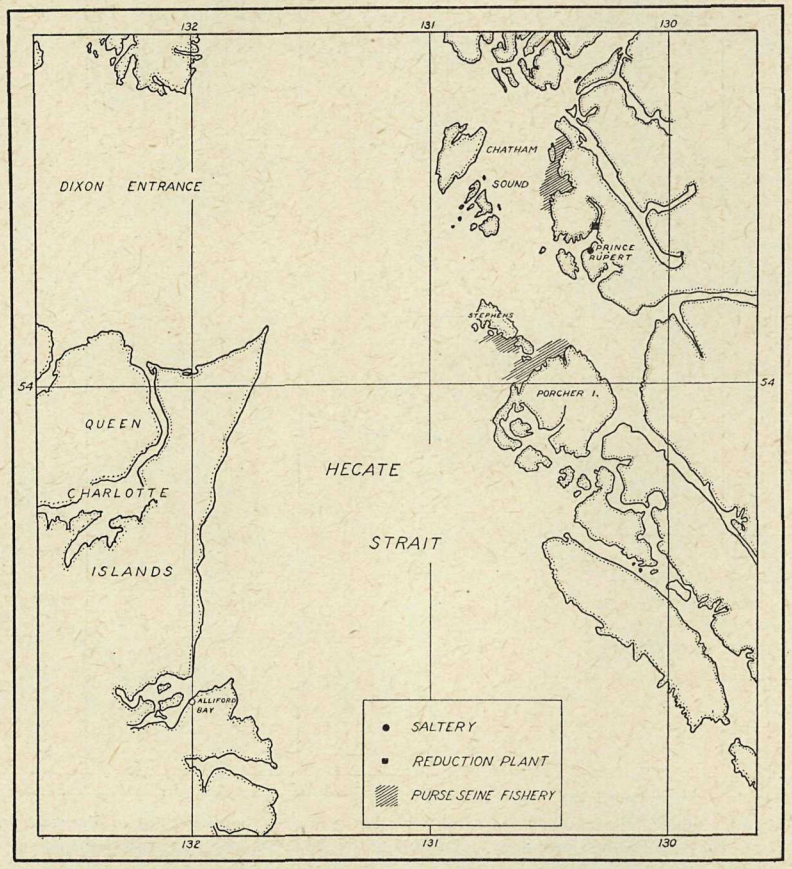

Fig. 11. Location of fishing areas, salteries, and reduction plants in the Prince Rupert District. The saltery indicated at Alliford Bay was the first erected in this district but has not been active for several years.

In the following pages the historical development and fluctuation of each marketed product is discussed under a separate heading.

Fresh.

Fresh herring have been used as food since early times. The commercial fishery for fresh herring was at first dependent on drag-seines, but since 1905 gill-nets have been used almost exclusively to supply the local markets. Previous to 1905 large quantities were occasionally shipped to Seattle in a fresh or frozen state, but, because of the difficulties of proper preservation, the Fisheries Commission (1905–07) recommended that this practice be prohibited. At the present day, with the development of faster boats and better facilities for preservation, a few tons are occasionally exported fresh or frozen to this market. The quantity used in a

fresh state has varied from 10,000 to 100,000 cwt., the demand being greatest from 1913 to the close of the Great War in 1918. A slight increase in the quantity consumed occurred in 1929, but it has fallen off since that year. From 1912 to 1918 the marketed value of fresh herring averaged about $350,000. In recent years, however, the value has been lower, averaging $68,000 from 1919 to 1930 and $26,000 from 1931 to 1933.

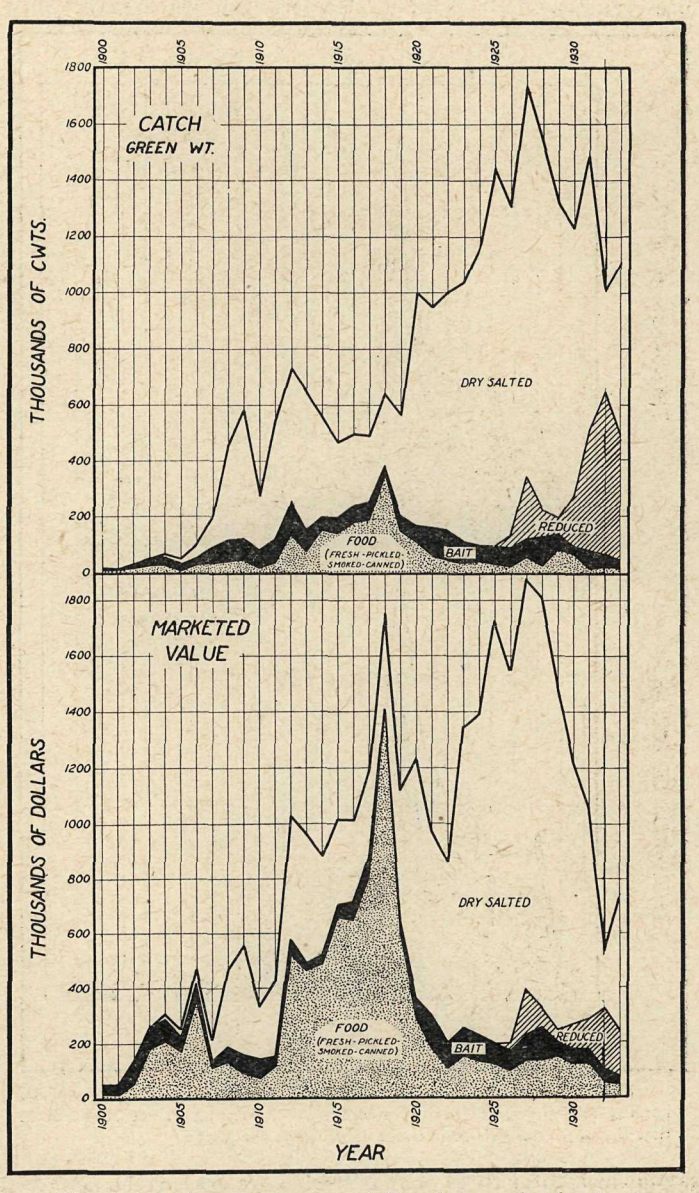

Fig. 12. Annual catch in green weight and its marketed value from 1900 to the present. The proportions used for food, bait, dry-salting, and reduction are indicated.

Smoked.

Ever since fishing began on a commercial scale there has been a limited local market for smoked products, including bloaters, kippers, and boneless herring. *Bloaters* are herring which are smoked in the round, without gutting. Large fish, preferably not too fat, are selected; these are first salted, either dry or in brine, for a few hours; they are then placed

in a smoke-house and smoked lightly, using the sawdust or shavings of alder, although birch is preferable if it is available. *Kippered herring* are first split down the back from head to tail and are cleaned; they are then placed in a brine for about an hour, after which they are smoked lightly. The amount of salting and smoking depends on the preferences of the consumer and the length of time the product is to be kept before marketing. Frequently kippers are frozen for preservation. " Hard-cured " bloaters, fish which have been pickled in brine,

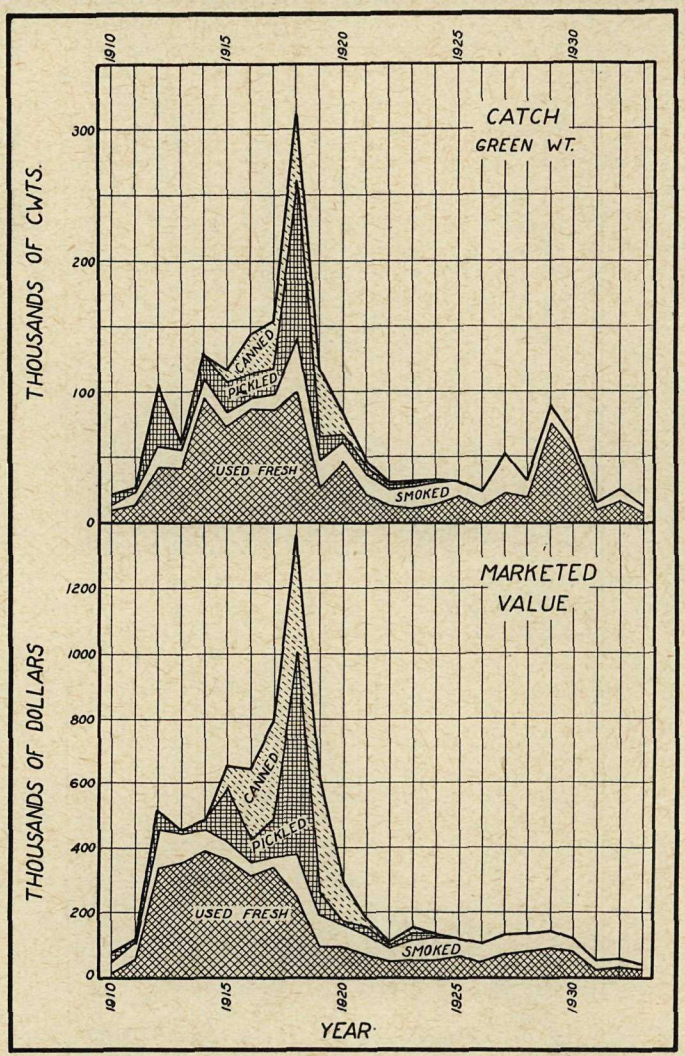

Fig. 13. Quantities in green weight and the marketed values of various herring food products (exclusive of dry-salted herring) since 1910. Note that the upper scale is four times as great as the lower.

drained, and heavily smoked for three or four weeks, are used in the manufacture of *boneless herring*. By removing the head, backbone, belly-bones, skin, and fins from a hard-cured bloater, two strips of flesh are left which are practically boneless. The method of preparation of the above and other herring food products are described in more detail in the August (1934) issue of the periodical *Western Fisheries*.

The quantity of herring used for these purposes has averaged annually about 15,000 cwt., with a marketed value of $60,000. The largest pack, 39,000 cwt., with a value of $131,766, was put up in 1918. Since that time the quantity of fish used and the marketed value has decreased to about 5,000 cwt. and $20,000 in 1933.

Pickled.

Although there are several methods of pickling herring, the most satisfactory results seem to be obtained by that which has been in use for many years in Scotland. According to the Scotch method, the herring are first graded according to size and condition and are then cleaned by removing the head, gills, front fins, and intestine with one stroke of a short, sharp knife. The fish are then roused or turned over in salt and are packed in barrels in layers, each layer being sprinkled with salt. The barrels are allowed to stand for three days, after which more fish which were processed at the same time are packed in the tops; and the barrels headed. After ten days or so the barrels are opened, the brine drained from a bung-hole in the side, the barrels filled tight with herring of the same day's curing, the head replaced and the brine put back through the bung-hole.

The pickling industry in British Columbia received a considerable impetus in 1905 and 1906, when the Government sent Mr. J. J. Cowie and a staff of expert Scotch-curers to Nanaimo to demonstrate the Scotch method of curing. During the war, when almost any kind of herring were in demand, markets for British Columbia Scotch-cured herring were developed in Puget Sound, San Francisco, Chicago, New York, and Australia. The quantity of fish used in this process and the value of the marketed product increased rapidly until 1918, when 123,000 cwt. (49,127 barrels), with a value of $623,169, were put up. In this year the value of pickled herring surpassed that of any other herring product. Over half of the total pack was cured in Barkley Sound on the west coast of the island, a relatively new fishery which had made great progress since 1910. Other centres of the pickling industry at this time in order of importance were Vancouver and Pender Harbour, Nanaimo District, and the Queen Charlotte Islands.

Following 1918, the industry suffered a severe slump and from 1925 to 1933 but a negligible portion of the catch has been used in pickling. The value of the industry has dwindled from over half of one million dollars in 1918 to less than one thousand dollars at the present day. The immediate cause of the decline is summed up in the following quotation:—

"Unfortunately, however, market conditions following the signing of the armistice were greatly changed. During the war the Canadian trade with the United States and Australia improved greatly owing to the lack of European supplies. This drew a number of inexperienced packers into the trade during the winter season of 1917–18, with the result that a large proportion of the output was badly cured. With the ending of hostilities and the expected immediate resumption of trading in herring with Europe, the demand for Canadian herring fell off in the United States and much of the poorly packed fish remained unsold." (*Ann. Rep. Dept. Mar. Fish. Branch, 1918, p. 43.*)

The export trade suffered a final blow when the United States erected the Fordney-McCumber tariff, which permitted herring to be shipped to the Eastern States from Alaska at 1 cent per pound lower than the British Columbia product. It is stated by those having long experience in curing herring in this country and in Great Britain that another factor may be the unsuitability of winter-caught herring generally for the markets using Scotch-cured herring. Since that time the output of Scotch-cured herring has been limited to the demands of the local markets.

Canned.

The first experiment in canning herring was made in 1903 with a pack of 3,500 cases. The experiment, however, was undertaken merely to utilize cans left over from a poor salmon season rather than to establish a canning industry. No further attempts were made until 1915, when the Wallace Fisheries, Limited, operating in Barkley Sound, put up 11,468 cases, with a value of $68,808. This industry made rapid progress in Barkley Sound until 1919, when 46,156 cases were produced. Other canneries also became active at Vancouver and on the east coast of Vancouver Island, increasing the yield in 1919 to 64,002 cases, with a value of $345,571, and utilizing about 51,200 cwt. of green fish or 44 per cent. of the total quantity used as food exclusive of dry-salted herring. In the years following the Great War this industry also suffered a severe decline, however, and by 1924 had dwindled to negligible proportions. With the exception of 43 cases in 1931, no herring have been canned from 1927 to 1933.

Dry-salted.

Dry-salted herring have usually been regarded as an inferior product and the value per hundredweight of green fish has always been considerably lower than that of other herring food products. Fish prepared in this way are marketed only in the Orient, chiefly in China.

The industry began in 1904, when 4,500 cwt. of salted fish were shipped to Japan for the first time. In the following years the quantity of fish used for this purpose increased rapidly. One of the most important centres of the industry from early days to the present has been the south-east coast of Vancouver Island. Numerous salteries were erected in the vicinity of Nanaimo. Smaller quantities of fish were used in dry-salting at plants located near Victoria on the island and at Pender Harbour, Vancouver, and New Westminster on the mainland. However, the fishery on the south-east coast of Vancouver Island has always surpassed these others and has been of paramount importance.

In 1911 dry-salting began on the west coast of Vancouver Island at Clayoquot Sound and Barkley Sound. The industry in the latter area increased rapidly and from 1918 to 1925 rivalled that of the east coast. Since 1925, however, the pack from Barkley Sound has gradually decreased. From 1923 to 1931 small quantities of herring were dry-salted in other localities on the west coast—Kyuquot Sound and, to a lesser extent, Esperanza Inlet and Clayoquot Sound.

The first saltery was erected in the northern part of the Province in 1912, at Alliford Bay on the Queen Charlotte Islands. Following this, others were built on the mainland near Prince Rupert. Although small quantities were exported in subsequent years, mostly from 1923 to 1929, the industry has never proven a success in this locality.

Unlike other food products, the dry-salt pack suffered a decline during the period of the Great War. Even in these four years, however, the quantity of green fish used for this purpose averaged almost 50 per cent. of the total catch. With the decline of markets for Scotch-cured herring following the war, more attention was paid to the dry-salted product. The quantity of green fish used increased rapidly from 216,000 cwt. in 1918 to 1,340,000 cwt. in 1928 and the value from $346,908 to $1,489,501. In 1925, 94 per cent. and in 1928, 86 per cent. of the total catch was dry-salted. From 1928 to 1933, as a result partly of the unsettled political situation in China and Japan, partly of the economic depression, and partly of uncontrolled marketing conditions, both the quantity of fish used and value of the product decreased considerably.

It was mentioned previously that from 1918 to 1925 the output from Barkley Sound rivalled that of the east coast of Vancouver Island, but had decreased in recent years. In Fig. 14 is given the seasonal catch of herring used in dry-salting on the east and west coasts of Vancouver Island from 1926–27 to 1933–34 (compiled from bulletins issued by the Department of Fisheries at Vancouver). The seasonal catch is more representative of the fishery each year than that of the calendar year, for the latter includes the second half of one season and the first half of the next. The curve for the east coast dry-salt production shows a decrease from 1928–29 to 1932–33, with a slight increase during 1933–34. The curve for the west coast of the island, while reflecting mostly the catches made in Barkley Sound during the seven seasons, also includes fairly large catches landed at Kyuquot Sound from 1927 to 1931 and small catches landed at Esperanza Inlet from 1928 to 1930. The catch for 1931–32, while landed and cured at Barkley Sound, was obtained in part at Sydney Inlet. This curve illustrates a more or less steady decrease in dry-salt production in Barkley Sound from 1926–27 to 1933–34. This decrease has been partly the result of economic conditions. In the struggle for markets during the last few years, east-coast operators have been favoured by the fact that fishing usually starts about a month earlier on the east coast as compared with the west coast of Vancouver Island. However, it must be pointed out that, during certain fishing seasons in recent years, herring have been rather scarce in Barkley Sound. The run appears to be more erratic both in regard to abundance of fish and time of appearance than that of the east coast. This factor may have contributed partly to the decline illustrated in Fig. 14.

Dry-salted herring are cured " in the round." Under the present regulations they must be in the salting-tanks within twenty-four hours after being taken from the sea. The fish are removed from the boats or scows by means of conveyors, into which they are pushed or shovelled (Fig. 15). In the process of unloading the water must be allowed to drain from

the fish. The conveyor is usually an adjustable elevator of some kind. In the type of conveyor usually employed the fish are moved up an incline into the saltery by a series of parallel wooden or metal bars fastened to an endless chain in a trough (Fig. 16). From the elevator they are conveyed along the under-surface of the roof of the saltery to the tanks. The tanks are usually arranged in one or two series on either side of this aerial conveyor and are filled by means of inclined chutes leading from it (Fig. 17).

Each tank is made of heavy 3-inch planking and is 19 to 20 feet long, 8½ to 10½ feet wide, and 3 to 4 feet deep, with a capacity of about 12 to 14 tons. There may be as many as forty or more individual tanks to a saltery. They must be water-tight and so the cracks between the planks are caulked; frequently they are lined with canvas. As the tanks are filled, about seventy sacks, each containing 125 lb. of coarse-ground commercial salt, are added. The salt extracts water from the fish, forming a brine which must be kept over 90 per cent. saturated. The fish must remain in the brine for five or six days, depending on the season, and must be stirred or trampled frequently to ensure perfect pickling of the upper layers.

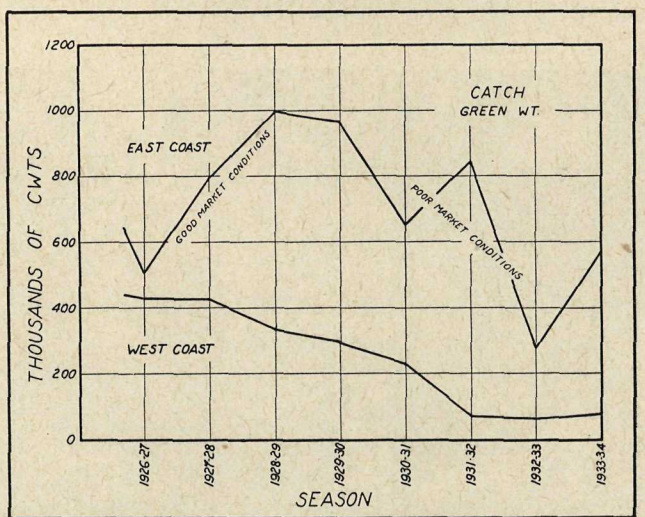

Fig. 14. Seasonal catch of herring used for dry-salting on east and west coasts of Vancouver Island from 1926–27 to 1933–34.

At the end of this period the herring have lost about 30 per cent. of their moisture content and present a shrivelled or shrunken appearance. Their proper preservation depends on this dehydration and on the permeation of salt into the tissues. They are then removed from the tanks, allowed to drain for twenty-four hours, and are ready for packing.

The boxes for shipment are of standard size, 42 inches long, 24½ inches wide, and 14 inches deep, with a capacity of about 4 cwt. The cured fish are shovelled into these boxes, sprinkled with salt, packed tightly by trampling underfoot or by a specially constructed machine, and the lid is nailed in place. The boxes are then ready for shipment.

In the early years of the dry-salting industry the pack was of inferior quality. There were no regulations governing the methods of curing and frequently the fish reached the Oriental market in a poor state of preservation. Within the last few years, however, the value of the industry has been realized and the herring have been subject to a rigid Government inspection throughout the whole dry-salting process, from the time they leave the scows or holds until they are packed in the boxes. The brine saturation is checked daily. A record is kept of the date on which each tank is filled and emptied. Before exportation, the packer must obtain a formal certificate of inspection from the local Government official. The present regulations ensure the proper preservation of the marketed product.

Reduced.

The first reduction of herring into oil and meal—or guano as it was then called—in British Columbia dates back as early as 1890. In 1905 about 40,000 cwt. were seined and used

for this purpose " to the great detriment of the legitimate fishermen and packers, as the immature fish were taken in large quantities, and the schools broken up on their way to the spawning-grounds. Large quantities of fish were also killed and left to decompose, thus fouling the waters " (*B.C. Fish. Comm. Rep. and Rec., 1905–1907, p. 47*). Thus the practice was considered a " useless waste " and was forbidden by law following the investigation of the commission.

In recent years science has discovered new uses for oil and meal which have enhanced their value and have created a demand for them (*see* Bulletins 36 and 37 of this series). The reduction of fish can no longer be described as a " useless waste." This fact was realized in 1925 and in January of that year the use of herring for reduction was permitted in localities where fish were not used extensively for other purposes. This included the Vancouver and Prince Rupert Districts but excluded Vancouver Island, the centre of the dry-salting industry. Since 1927 the reduction industry has developed in the vicinity of Prince Rupert. The greatest production up to the present occurred in 1930, when 182,000 cwt. of green fish were reduced, the resulting oil and meal having a combined market value of $85,471.

Fig. 15. A scow-load of herring waiting to be unloaded at Kildonan, Barkley Sound. Planks (A) are removed from the side of the scow and the fish are unloaded into a trough at the base of the conveyor (B). The gulls constitute a real nuisance to the industry and scows must be covered with nets to prevent these birds from foraging.

In the fall of 1926 reduction privileges were extended to include the west coast of Vancouver Island, where pilchard-reduction plants were already located and where only a limited amount of dry-salting took place. Operations were restricted, however, to the period between the beginning of the season in the fall and the end of December. In the fall of 1927, 154,000 cwt. and in the fall of 1928, 39,000 cwt. of green fish were reduced in this region. During the year 1929 no reduction was permitted. The following year it was again allowed, and, as the herring were unusually late in arriving on the fishing-grounds, the time limit was extended to February 5th, with additional extensions beyond this date in 1931 and 1932. In the last few years, until the recent closure to reduction (1934–35), the output from this area increased considerably and exceeded that of Prince Rupert.

It might be pointed out that the reduction of herring on the west coast of Vancouver Island is not an independent industry and is only incidental to pilchard-reduction. The latter is active during the summer months. The fishing and reducing of herring in the winter months, using the same boats, gear, and equipment as the pilchard-fishery, enables the operators to keep the plants in operation and to keep men employed during several months of

the winter, and, at the same time, to make a small margin of profit on the winter's activities. The profit in herring-reduction as compared to pilchard-reduction is relatively less because of the low oil content of herring in the winter season.

A detailed description of a reduction plant and the processing of fish has been given in *Bulletin 36*.

It has been shown that there are two centres of the reduction industry in British Columbia—the Prince Rupert District and the west coast of Vancouver Island. In 1932 the quantity of herring reduced, for the most part in the latter locality, formed 60 per cent. of the total catch of herring in the whole Province. This high percentage was caused by an actual increase in the quantity reduced and by a decrease in the quantity used for dry-salting. In 1933 the quantity reduced formed 41 per cent. of the total catch of herring. In this year the meal amounted to 4,078 tons, with a value of $127,416, and the oil to 316,213 gallons, with a much smaller value, $38,073. The chief markets for these products have been in Canada, United States, South America, Europe, and Australia.

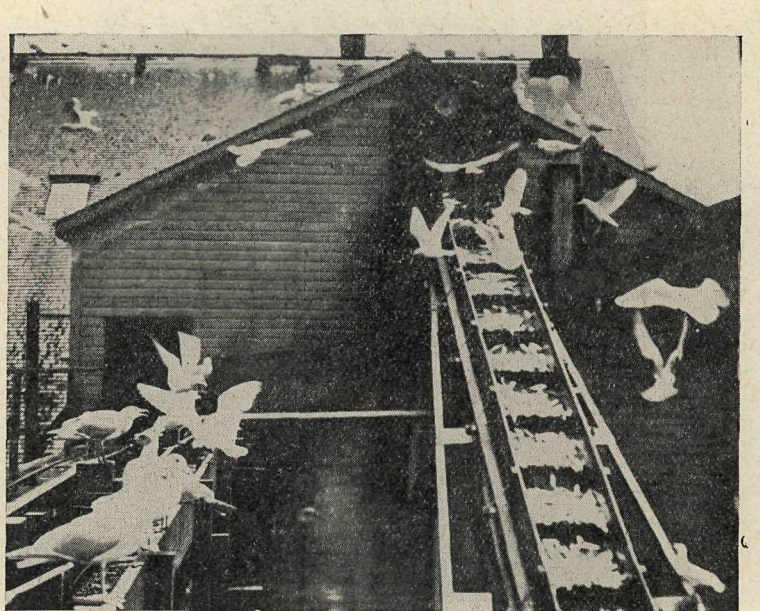

Fig. 16. Herring being conveyed into a saltery at Kildonan in Barkley Sound.

Bait.

Since early times there has been a steady annual demand of herring for bait by halibut-fishermen, and to a lesser extent by ling-cod fishermen and salmon-trollers. From 1900 to 1933 the quantity used annually for this purpose averaged 50,000 cwt., with a value of $60,000. In the Prince Rupert District in past years there have been acute scarcities of herring for bait, but these occurred when the operators used drag-seines and waited for the fish to enter the shallow water of Prince Rupert Harbour. The purse-seine fishery of recent years has usually supplied a sufficient quantity to meet the yearly demand. The availability of herring to the halibut-boats has also been increased by the use of cold-storage plants at Prince Rupert and at Kildonan in Barkley Sound, and by the establishment of several bait-pounds located on the south-east and north-west coasts of Vancouver Island and in the Prince Rupert District. Bait-pounds are large enclosures in shallow water in which up to 200 tons of live herring may be kept until they are needed by the fishermen.

COMPARATIVE VALUES OF MARKETED PRODUCTS.

In the preceding section it was shown that the history of the development of the herring-fishery of British Columbia has involved a constant struggle for markets. The Great War stimulated an enormous development of herring food products consisting of pickled, smoked, canned, and fresh herring, the quantity of green fish used for these purposes amounting to over three hundred thousand hundredweights and the marketed value reaching a peak of one and one-quarter million dollars in 1918. Since the war the quantity of fish used in this way has dwindled to negligible proportions. The annual catch has continued to increase, however, and during the last ten years it has averaged over one and one-quarter million hundredweights. This increase has been the result of the phenomenal development of the dry-salting and, more recently, of the reduction industry. It may be of interest now to consider briefly the economic phase to obtain some idea of the comparative values of the marketed products and to decide which should be encouraged from this point of view.

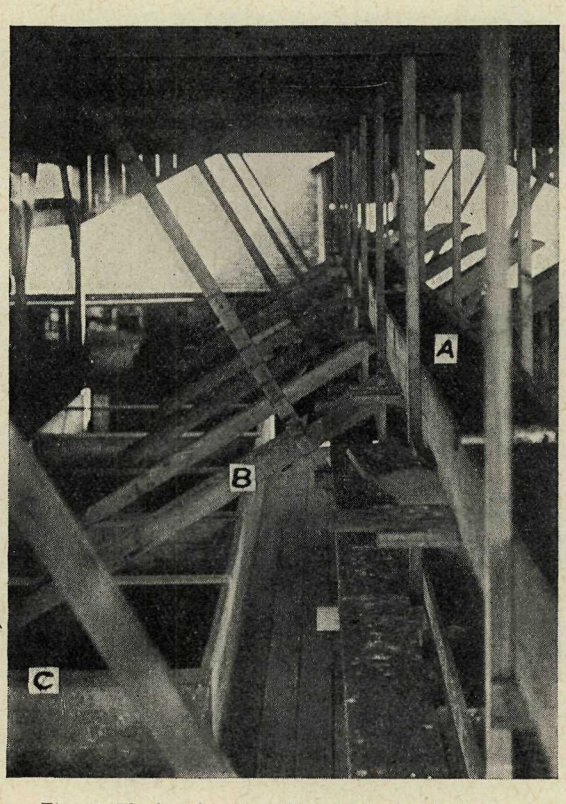

Fig. 17. The interior of a saltery at Jessie Island, showing the aerial conveyor (A) and the chutes (B) leading to the salting-tanks (C), Departure Bay.

Using data contained in *Fisheries Statistics* and the conversion factors given on page 88, the marketed values per hundredweight of green fish were calculated for each year from 1924 to 1933. The results for the principal products are shown by a series of graphs in Fig. 18. It is very apparent from the figure that the ultimate value of 1 cwt. of green fish varies greatly according to how it is prepared for the market. Aside from minor fluctuations, over the ten-year period the products may be arranged in order of marketed value as follows: pickled, smoked, fresh, bait, dry-salted, and reduced.

Pickled, smoked, and fresh herring bring the highest values of the six products under consideration, although at present the quantity of herring used for these purposes forms but a very small portion of the total catch. For the most part these products are sold locally and the retail prices have fluctuated greatly according to the demands of the local market and the

local availability of herring. From an economic point of view the production of these three commodities should be encouraged. The herring caught by gill-netters off Point Grey are among the largest, fattest, and best herring found in British Columbia and are therefore ideal for use as food. If additional markets could be developed there is little reason why the cured-herring industry at least should not flourish and increase far beyond its present output and value.

Herring sold for bait rank fourth in value per hundredweight of green fish. As small firm fish are most suitable for this purpose, this commodity fits into any scheme for the most advantageous utilization of the catch. Both the halibut-fishery and the spring- and cohoe-salmon fisheries are partly dependent on an adequate supply of herring. The price has varied according to the availability of fish and the demands for bait.

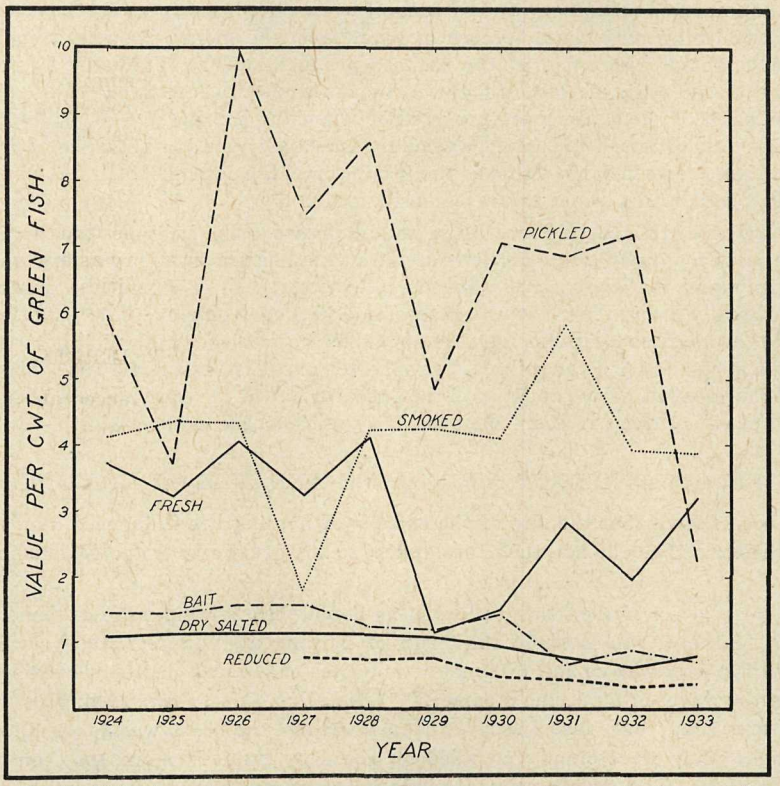

Fig. 18. Ultimate marketed values of various herring products per cwt. of green fish.

Over the ten-year period dry-salt herring have averaged about $1 per hundredweight of green fish and have ranked fifth in value. The graph in Fig. 18 shows a relatively stable market with a steady fall in value during the recent " depression " years to a minimum of 64 cents in 1932. It must be remembered, however, that the total marketed value of this product has exceeded all others during all years except 1932.

The marketed value of the reduced products—oil and meal—per hundredweight of green fish has been consistently the lowest of all product values. The combined price of oil and meal has fallen gradually from 79 cents in 1927 to 34 cents in 1932, increasing slightly in 1933. Again it must be pointed out, however, that the total marketed value has increased greatly during this period and in 1932 exceeded that of the dry-salt product.

It is clear, therefore, that while almost the entire catch is absorbed by the dry-salt and reduction industries, and while the total marketed values of the products of these two industries greatly surpass all others, the ultimate values per hundredweight of green fish are the lowest. Nevertheless, because of market conditions, they are at present of prime importance and the

relative merits of each from the point of view of the most advantageous utilization of the supply of herring should be considered in detail. This would involve a comprehensive investigation of the total cost price of each commodity and a comparison of cost price with selling-price. The cost price should include such expenses as the initial cost of fish as purchased from the fishermen; cost of unloading; cost of labour during processing; depreciation on machinery, boats, and gear; cost of upkeep, fuel and repairs; insurance on plants and boats; cost of salt and boxes for the dry-salt product and cost of sacks for the meal. Such a survey, however, is beyond the scope of this paper. A rough idea of the money actually brought into the country by the sale of each commodity may be obtained by deducting from the selling-price, expenditures made in other countries in connection with the processing of the fish. Without taking into consideration capital expenditures such as the purchase of machinery, the main items include the cost of commercial salt in the case of the dry-salted herring and the cost of repairs to the imported machinery and of fuel-oil to run this machinery in the case of reduced herring. Considering only these foreign expenditures, the money brought into the country per hundredweight of green fish by the reduced product was, in 1932, only 40 per cent. and in 1933 only 58 per cent. of that brought in by the dry-salted product. The returns, from an economic point of view, are therefore greater when the herring are dry-salted even under present market conditions which are particularly unfavourable to this product. Were these market conditions remedied, the value of the product and the returns both to the operators and to the country as a whole would increase considerably.

If herring occur in a certain locality in an abundance sufficient to supply the fishery there seems to be no reason why all or any one of the various methods of processing should not be employed, providing the stock is not being depleted unduly. For it must be remembered that fish are continually dying from natural causes, and if the surplus over the quantity necessary to propagate the species satisfactorily were not taken by the fishery it would be wasted. However, if there is competition for a limited supply of fish, it is reasonable that those industries which yield the greatest profit, not only to the operator but to the country as a whole, should be encouraged, provided there is a sufficient market to absorb the commodities.

FLUCTUATIONS IN ABUNDANCE AND SIZE OF HERRING.

It has been shown that the size of the catches of herring are influenced almost wholly by market conditions. They do not, therefore, reflect to any great extent fluctuations in abundance of the fish.

In the early years of the fishery there is no doubt that herring were extremely abundant in Nanaimo Harbour. In 1903–04 the "run of herring at Nanaimo was very large. The water of the harbour was so full of them at one time that large numbers were washed upon the beach by the waves of a passing steamer." (*Ann. Rep. Dept. Fish., 1904, p. 216.*) Another reference states that "only last January, near Nanaimo, the coast was for 2 miles knee-deep with herrings; they were simply crowded on shore by millions more, on their way to the spawning-grounds. The people were at their wits end as to what to do with them. They were carted to farms for manure, used for fuel, burned in heaps, buried, yet millions of fish lay on the shore to the danger of health." (*B.C. Fish. Comm. Rep. and Rec., 1905–07, p. 46.*)

The superabundance of herring in Nanaimo Harbour persisted for several years. Since 1910 there have been several noticeable fluctuations in the supply both at Nanaimo and in other localities. Seasons of marked scarcity and great abundance have both occurred.

In 1910–11 there was a serious scarcity of herring at Nanaimo and in Barkley Sound. In the former locality, although fish were reported in the Strait of Georgia, they failed to enter the harbour. In 1915–16 there was a general scarcity in all localities, particularly at Prince Rupert and at Point Grey. Poor runs to Barkley Sound are reported during the fall of 1925, 1929, and 1931, although in the spring of 1930 the spawning-grounds were well stocked with eggs by late runs of fish.

Seasons of exceptional abundance are recorded in 1912–13 at Prince Rupert Harbour and in more southerly localities; and also in 1918–19 and in 1924–25 on the east coast of the island and in Barkley Sound.

Noticeable fluctuations in the size of herring have also occurred. In 1907–08 at Nanaimo and in 1912–13 at Point Grey, the fish were reported to be unusually large. When Sydney Inlet, on the west coast of Vancouver Island, was first exploited extensively in the season of 1931–32 the catches consisted of exceptionally large herring. During the early summer of 1933 and 1934 the gill-netted fish taken at Point Grey were also unusually large.

Undoubtedly, the abundance and size of herring in the various fishing areas fluctuates from season to season through natural causes over which, at present, there is no control. On the other hand, the intensive fishing activities of the last twenty years may have been partly responsible for certain downward trends which may therefore represent a real depletion. Hence it is necessary to examine the fishery and its fluctuations from this point of view.

MOVEMENTS AND EXPANSIONS OF THE FISHERY.

The onset of depletion through overfishing is frequently disguised by the exploitation of new areas. In other words, the fishermen are gradually forced to go farther afield for their catches. In the herring-fishery of British Columbia, movements and expansions have taken place to some extent and must be investigated critically to determine the motivating causes.

As mentioned in the preceding pages, prior to 1910 fishing activities on the east coast of Vancouver Island were centred at Nanaimo Harbour and Departure Bay. Herring entered these waters in such abundance each year that fishermen had no difficulty in meeting the current demand. Following the scarcity of fish in the season 1910–11, with the exception of an occasional run (as in 1918–19), herring no longer returned to these areas in their former abundance. At the present day they are no longer piled "knee-deep" on the shores of Nanaimo Harbour and Departure Bay at spawning-time. There is but little doubt that the agency of man has either caused a partial destruction of the run or has caused a large part of the herring which formerly frequented these waters to spawn elsewhere.

With the employment of purse-seines, fishing became possible in deeper water and the centre of activity moved to the more open waters of the Strait of Georgia, to Nanoose Bay, and to the channels between the islands immediately south of Nanaimo. In recent years the fishery has moved still farther to the south. In 1929 it was stated that a feature of the operations on the east coast was "the seiner's practice, during the last three years, of going farther south and meeting the herring as they come round the south end of the island." (*Ann. Rep. Dept. Fish., 1929–30, p. 97.*) Although scientific evidence at present does not support that part of the statement concerning the migration of herring from the open sea to the Strait of Georgia, the quotation serves to illustrate the changes which have taken place in the scene of fishing activities. While the increased catch has been accompanied by a slight expansion of the area of fishing, and while the herring do not appear to be as numerous in certain localities at the present day as in the early years of the fishery, there has been no pronounced scarcity in this area as a whole in recent years, and the size of the catches are at present limited only by market conditions.

A local decline similar to that at Nanaimo Harbour and Departure Bay has also occurred in Prince Rupert Harbour. In 1912–13 and previous seasons, herring entered the harbour sometimes as early as November or December in large numbers, and were easily taken in drag-seines. In the season 1914–15 the schools came into the harbour, remained for two weeks, and then disappeared. In the following season, 1915–16, the fishing was a total failure and there was an acute scarcity of bait for the halibut-boats. Since that time the fish have not arrived in this vicinity until late in the season, usually in March. Purse-seines have replaced drag-seines and the fishery has moved from Prince Rupert Harbour to localities to the north and south. In February, 1935, however, for the first time in many years, good catches were made in Prince Rupert Harbour.

On the west coast of Vancouver Island, fishing operations in Barkley Sound until 1931–32 were confined to the channels, bays, and inlets of the sound proper. In 1931–32 local scarcities of fish led to the temporary expansion of the fishing-grounds to include Sydney Inlet, some distance to the north, where excellent catches were made.

The scene of fishing operations of seine-boats supplying reduction plants and salteries in Esperanza Inlet and Nootka Sound has also undergone several changes in recent years. The following figures (furnished by Mr. A. Park, Fishery Inspector, Nootka, B.C.) show the

estimated percentages of the catch taken each year in localities extending from Quatsino Sound southward to Barkley Sound:—

	1927–28.	1928–29.	1929–30.	1930–31.	1931–32.	1932–33.	1933–34.
Quatsino Sound	.....	.....	.....	.....	.....	.....	14
Kyuquot Sound	100	70	50	5	20	49	19
Nootka Sound	.....	30	50	95	20	8	1
Sydney Inlet	.....	.....	.....	.....	60	38	+
Barkley Sound	.....	.....	.....	.....	.....	5	66

It is evident that there has been a gradual expansion of the fishery and a southward trend of fishing activities. Each year the centre of activity has tended to move to the area of greatest abundance. The great expansion in the last two seasons has been the result of actual scarcities of fish in Nootka Sound and adjacent waters.

From the above discussion it would appear that, in several cases, the movements and expansions of the herring-fishery have been definitely associated with local scarcity or unavailability of herring. The poor fishing encountered in certain localities might quite possibly have resulted from the intensive fishing in preceding years.

CRITERIA OF DEPLETION.

The degree or extent of migration of schools of herring has an important influence on the way in which overfishing will affect the fishery. If herring wander for considerable distances along the coast and free intermingling of the stock on a large scale takes place, the schools in a locality subject to intensive fishing would be supplemented by the migration of fish from other localities. Overfishing in one locality would gradually drain the stock of herring in all waters and would gradually result in a general depletion. If, on the other hand, extensive migrations do not take place and herring in each general fishing area are more or less localized, overfishing in a particular area would be manifested more quickly by a local depletion, as the local supply would not be replenished by the immigration of fish from adjacent waters.

Again, the reaction of a fishery dependent on a highly migratory species will be somewhat different to that dependent on one which is non-migratory. If a migratory species were being exploited over-intensely, fishing would continue until inadequate catches were made; more efficient gear might then be devised; fishing would continue until the species could not be further exploited profitably and a condition of *economic* extinction would be reached. In the case of a non-migratory species, however, the more accessible populations would first be fished to the point of economic extinction; gradually the fishery would expand to include the less accessible stocks; in the meantime the old fishing-grounds would be traversed again and again and the remaining schools gradually captured until finally a condition of or approximating *biological* extinction would be reached.

Recent research by the author (*Trans. Amer. Fish. Soc., Vol. 63, 1933*) has demonstrated that the herring of British Columbia is essentially a non-migratory species. Extensive migrations up or down the coast do not take place. The run to each locality tends to form a " local population " which is sometimes distinct in many ways from similar local populations in adjacent areas. Therefore, it is essential that overfishing be guarded against, for, as pointed out above, such a species is more quickly depleted and the consequences may be more disastrous than in the case of a species of the migratory type. The condition of the fishery should therefore be investigated with this in mind.

There are at least two methods by means of which the condition of a fishery may be investigated. The first of these depends on the complete analysis of catch records to obtain the reward per unit of fishing effort. In the case of the herring-fishery this would be expressed as the average catch per seine per day's fishing. A decrease of this unit over a period of years would indicate depletion. Until quite recently the method of collecting and recording catch statistics in this Province has not yielded sufficient data to make use of this valuable measure of availability. At the beginning of the season 1933–34 the Biological Board, in collaboration with the Department of Fisheries, initiated a system of collecting herring-catch statistics from which the reward per unit of fishing effort could be calculated.

This system involves the recording of the daily catch of each seine-boat in operation and the locality in which the fish were captured. When additional seasonal data have been gathered it should be possible to determine the condition of the fishery in each locality.

A second test of the condition of a fishery is afforded by a consideration of the length and age composition of the runs. Intensive fishing tends to reduce the numbers of larger and older fish in the catches. Naturally this results in an apparent increase in the abundance of smaller and younger fish. Over a period of years the effects of intensive fishing might appear as: (1) a decrease in average length; (2) a decline in length and age composition, the fishery becoming dependent on smaller and younger fish; and (3) a smaller spread in length and age distribution.

As the herring in British Columbia tend to form a series of local populations, any changes in length and age composition due to intensive fishing might be expected to appear more quickly than in the case of a highly migratory species. In our waters the rate of natural mortality is evidently higher than in Alaska or Europe, for the normal age distribution is considerably smaller and the herring on the average are considerably younger. If a decline in length and age composition should take place, the fishery would come to depend more and more on the three-year-olds which have just entered the fishery and are ready to spawn for the first time.

A study of length and age composition to determine the condition of the fishery is complicated by variation in the abundance of members of each year-class caused by natural causes over which at present there is no control. Exceedingly well-represented or " dominant " year-classes frequently appear in the catches. In other fisheries these may persist and form the bulk of the catch for many years; in the herring-fishery of this Province they also occur but are less pronounced and usually do not persist for more than three or four years because of the high rate of natural mortality and the resultant small spread in age composition. Consequently it may be possible for intensive fishing to reduce the predominance or even obliterate such a dominant group prematurely, a possibility which must also be taken into account in investigating the condition of the fishery by a study of this kind.

PRESENT CONDITION OF THE FISHERY.

An intensive biological study of the herring-fishery has been in progress for only a short period and therefore only tentative conclusions with regard to the condition of the fishery have been formed. The length and age compositions of the runs to the two most important localities, the south-east coast of Vancouver Island and Barkley Sound on the west coast of Vancouver Island, have been subject to considerable investigation in this regard.

Data have been accumulated which show that certain changes in length and age composition have taken place in the fishery of the south-east coast which are very probably the result of fishing effort. Since 1915, apart from annual fluctuations, there has been a slight decrease in average length, a decrease in the spread of lengths about the average, and a decrease in the number of older fish present in the catches. Moreover, there is also evidence that the frequency of occurrence and the persistence of dominant year-classes have been somewhat reduced in recent years. It seems, therefore, that the fishery has had some effect on these characters, but it is not known with certainty as yet what the ultimate outcome would be, should fishing be maintained at a level of intensity similar to or higher than that of recent years. Age compositions of the catches for 1932–33 and 1933–34 have indicated some degree of recovery, possibly as a result of the curtailment of fishing activities due to economic conditions.

In Barkley Sound three-year-old fish have predominated in the catches each season from 1929–30 to 1933–34. The fishery during these years, therefore, has been largely dependent on the new recruits which have been caught before they have had an opportunity of spawning. This young age-group has not always predominated in this locality. In 1916 Dr. W. F. Thompson (*Rep. B.C. Comm. Fish., 1916*) found that five-year-old fish formed the bulk of the catch and that older fish were relatively better represented than at the present day. It would seem, therefore, that the herring population in Barkley Sound has suffered a decline in length and age composition similar to or even greater than that in the case of the east-coast herring. Again, however, the ultimate outcome is not known with certainty and the whole problem must be subject to additional research.

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It is interesting to note that, in localities such as Quatsino Sound on the west coast of Vancouver Island and the coastal waters to the north of Vancouver Island, older fish predominate in the runs, a condition which might be expected as these areas have been exploited only to a limited extent as yet.

Thus it would appear that the intensive fishing of recent years has had some effect on the length and age compositions of the runs and possibly on the abundance of the herring in the two localities exploited most intensely, in a manner which suggests some degree of overfishing. However, fishing activities in the last three or four years have been curtailed by unfavourable market conditions and this temporary relief may be of benefit in rebuilding the runs and in increasing the abundance and size of herring, particularly in Barkley Sound.

FUTURE POSSIBILITIES.

There exist many possibilities in regard to the development of markets and the improvement of methods of curing and canning of herring for food purposes. With modern refrigeration, the markets for large fresh or frozen herring could be extended inland from the coast, provided that suitable regulations regarding freshness, packing, and refrigeration were promulgated and enforced. By means of graders the larger and fatter herring could be selected from the purse-seine catches to be used for food purposes as bloaters, Scotch-cured, kippered, boneless, Holland, Bismarck, or spiced herring. Canning alone offers many possibilities and improved methods should facilitate the production of a variety of low-priced, wholesome, and, at the same time, delectable canned products which would find ready sale both at home and abroad. As the population of the country increases there will be a corresponding increase in the demand for superior sea-foods, and among these the herring, if suitably prepared, should assume a prominent position. With increased production the utilization of by-products from herring should become practical and present wastes such as herring roe, scales, and livers may have economic possibilities as table delicacies, for the manufacture of artificial pearls and therapeutic extracts respectively.

With regard to the herring-fishery of British Columbia, it seems highly probable that the fishing-grounds are capable of considerable expansion to the northward. There are several areas which have not been exploited commercially to any great extent as yet and which offer many possibilities. Of these might be mentioned the region between the north-east coast of Vancouver Island and the mainland, the coastal waters between this region and Prince Rupert, and the west coast of the Queen Charlotte Islands. These potential fisheries await investigation and development should future economic conditions yield markets for the products.

Therefore it is possible that, under suitable administration and biological supervision, the catch could be increased with safety to even a greater extent than that of recent years. Exploitation, however, must be distributed throughout all areas according to the size of the runs and the intensity of fishing which each will withstand without endangering its perpetuity. Local and general depletion must be assiduously avoided, for not only is the fishery itself a great asset, but the rôle of the herring as a food for other species is of inestimable economic importance to the Province.

THE PACIFIC SALMON IN BRITISH COLUMBIA WATERS.

By W. A. Clemens, Director, Pacific Biological Station, Nanaimo, B.C.

The Pacific salmon belong to a genus or group known scientifically as *Oncorhynchus*. Along the North American Coast, and therefore in British Columbia waters, there are five species or kinds, namely:—

Oncorhynchus gorbuscha—pink, humpback.
Oncorhynchus tschawytscha—spring, tyee, king, chinook, and the young sometimes called "Jacks."
Oncorhynchus kisutch—cohoe, silver, and the immature, particularly in the Strait of Georgia, known as "bluebacks."
Oncorhynchus nerka—sockeye, red in Alaska, blueback in the Columbia River, and the landlocked form known as kokanee, little redfish or Kennerly's salmon.
Oncorhynchus keta—chum, dog.

Pink Salmon.—The pink salmon is remarkable in that it matures at the end of its second year. The young go to sea as fry and fifteen months later the mature fish appear off the mouths of various streams in large schools. They usually do not proceed great distances up-stream to spawn. The extent of the ocean movements is not known, but, in relation to the Fraser River, tagging experiments have shown that schools pass through both the Strait of Juan de Fuca and Johnstone Strait on their way to that river. The pink salmon reaches a weight of 3 to 6 lb. and is taken commercially in purse-seines, gill-nets, and traps.

Spring Salmon.—The adults ascend practically all of the large streams and spawn usually in the upper reaches of the tributaries. The young go to sea very soon after emerging from the gravel or at any time during the following twelve to fifteen months. In Alaskan waters some are known to remain two years in fresh water. In the sea they grow rapidly, maturing in three to eight years and reaching a very large size, a weight of 100 lb. being recorded. Tagging experiments have shown that they may travel long distances, as, for example, from the fishing-banks off Barkley Sound to the Sacramento River, California; from near Hippa Island off the Queen Charlotte Islands to Marshfield, Oregon; and from Alaskan waters to the Columbia River. The commercial fishermen take them by troll, purse-seine, gill-net, and trap, and the sport fishermen by troll, as, for example, off Campbell River, where they constitute the widely known tyee-fishery.

Cohoe Salmon.—The cohoe salmon enter innumerable streams and may spawn a short distance from the sea or may proceed to the upper tributaries of the larger rivers. The young usually remain a year in fresh water; a few may remain for two years and a considerable number may go to sea during the first year. They increase rapidly in size and mature at the end of the third, occasionally at the end of the second, and rarely in the fourth year. The size at maturity varies from 5 to 15 lb. Cohoes range throughout the coastal waters and, judging from tagging results, there is indication that some never leave the Strait of Georgia. They are captured by troll, purse-seine, gill-net, and trap and provide a considerable amount of sport-fishing in trolling and fly-casting.

Sockeye Salmon.—The sockeye salmon is the most prized of the Pacific salmon because its high oil content, the colour of its flesh, and its rather uniform size make it an excellent fish for canning. The adults usually ascend those streams on which there are lakes and pass through the lakes to spawn in the tributary streams. A few spawn along the shores of lakes and a few in streams on which there are no lakes. Some young sockeye go to sea very soon after hatching, but the majority descend to the lakes, where they spend usually one, frequently two, and occasionally three years and eventually pass out to the ocean. They return as adults after three or four summers in the sea when they are thus four or five years of age. A few, for the most part males, mature at three years of age and are frequently referred to as grilse. A few mature at six years of age and fewer still at seven and eight years. While the weight at maturity is usually between 5 and 7 lb., weights as high as 12 lb. are recorded. Information concerning the movement in the ocean is meagre. Tagging experiments in 1915 at Haystack Island off Portland Canal showed that, while the bulk of the fish migrated to the Nass River, a considerable number travelled as far north as Earnest Sound, Alaska, and as far south as Union Passage (Grenville Channel). In that year also, tagging at Seymour Narrows showed

a definite migration to the Fraser River, indicating a movement from the north-west through Queen Charlotte and Johnstone Straits. The sockeye are taken chiefly in gill-nets at the mouths of rivers, in traps at the south end of Vancouver Island, and to some extent in purse-seines.

Chum Salmon.—The chum salmon ascends practically all streams, spawning generally at no great distance from the salt water. The young go to sea soon after emerging from the gravel and maturity is reached usually in the fourth year, but also in the third and fifth. The species attains an average weight of approximately 10 lb. and forms the basis of an extensive purse-seine fishery. The fish are also taken by gill-net and trap. Little is known of the ocean movements, but tagging has shown that many chum salmon enter the Strait of Georgia through Johnstone Strait as well as through the Strait of Juan de Fuca.

As far as is known, all the individuals of the five species of Pacific salmon spawn but once. In the case of the spring salmon some individuals may return to the sea after spawning a short distance above tidal waters, but so far there is no evidence to show that they survive to spawn a second time. There is a tendency for the fish of all the species to return to spawn in the stream in which they lived as young. This return to the so-called " Parent Stream " has been well established for sockeye and spring, and to some extent for pink and cohoe, by means of experiments involving the removal of various fins from young fish at the time of their seaward migration.

Young salmon in fresh water feed largely on small shrimp-like animals and insects. In the sea they substitute marine shrimp-like forms. The sockeye, pink, and chum continue to feed on this type of food throughout their lives, while the spring and cohoe turn to a fish diet of herring, pilchard, sand-lance, etc. It is because of this habit that the latter two species are readily taken by trolling.

In the identification of the five species certain characters are commonly used. These are:—

(1.) Scales in rows along the side of the body. Frequently the number of scales in the lateral line is used. The latter is a conspicuous structure commencing behind the head and terminating at the base of the tail-fin. Each scale along this line is penetrated by a pore. A count of the total number of scales along this line may be made, but owing to some scales being very small and therefore readily overlooked, accuracy is sometimes difficult to attain. It has been found that the number of scales in the first row above the lateral line is more reliable. The pink salmon has 170 to 229 scales in this row, which number is much above that of the other species.

(2.) Fin-rays. Each fin, except the little adipose or " fat " fin, is supported by a number of rods of cartilage. The number of the rods or rays in the anal fin, which is located behind the anus or vent, has been used for purposes of identification. In making the count, the small rays at the front of the fin, less than half the length of the longest ray, are not considered. The spring salmon has a range of 15 to 19, which is higher than in the other species and the uppermost numbers are useful in confirming identification.

(3.) Gill-rakers. Under the gill-cover are V-shaped structures or arches bearing the filamentous gills. On the inner side of each arch, opposite the gill-filaments, are stiff spines somewhat resembling the teeth of a comb. These are the gill-rakers which serve to strain out food-particles from the water which flows from the mouth out past the gills. The count is made of the number on the first or foremost arch. The sockeye salmon has a range of 30 to 39, with only a slight overlap with that of the pink salmon.

(4.) Branchiostegals. The membrane under the head and forming the lower margin of the gill-cover is supported by narrow curved and flattened rods of cartilage which are known as the branchiostegals. The number of these structures is frequently useful in making an identification. The spring salmon has a range of 13 to 19, which, as in the case of the anal fin-rays, is higher than in the other species.

(5.) Pyloric cæca. Attached to the intestine in the region where it joins the J-shaped stomach are a large number of small, slender, finger-like pouches. The cohoe possesses only 45 to 80 pyloric cæca and is readily distinguished by this character from the other species except the sockeye.

(6.) Colour-markings. The spring, cohoe, and pink have distinct large black spots on the back and tail-fin. Those on the spring salmon are numerous and rather round in shape; those on the cohoe sparse, more or less oblong in shape, and absent from the lower half of the tail-fin; those on the pink are relatively very large and oval in shape. The sockeye and chum have fine black specklings in place of the heavy spotting of the other three species.

Using the characters described above, the following key may be used for the identification of the various species:—

A. Back and tail fin with distinct black spots.
  B. Scales in first row above lateral line 170 or more. — Pink salmon.
  BB. Scales in first row above lateral line less than 155.
    C. Black spots on tail-fin on both upper and lower halves; anal rays 15 to 19; branchiostegal rays 13 to 19. — Spring salmon.
    CC. Black spots on tail-fin on upper half only; anal rays 12 to 16; branchiostegal rays 12 to 15. — Cohoe salmon.
AA. Back and tail-fin without black spots but with fine black specklings.
    D. Gill-rakers on first arch 30 to 39. — Sockeye salmon.
    DD. Gill-rakers on first arch 20 to 26. — Chum salmon.

The following table may also be helpful:—

	Scales in Lateral Line.	Scales in First Row above Lateral Line.	Gill-rakers.	Anal Rays.	Branchiostegals.	Pyloric Cæca.
Pink	150 to 198	170 to 229	27 to 33	13 to 17	10 to 15	165 to 195
Spring	131 to 151	140 to 153	20 to 28	15 to 19	13 to 19	140 to 185
Cohoe	121 to 136	120 to 145	19 to 25	13 to 16	12 to 15	45 to 80
Sockeye	125 to 139	125 to 143	30 to 39	13 to 16	11 to 15	66 to 92
Chum	126 to 151	130 to 153	20 to 26	13 to 17	12 to 16	140 to 185

It will be noted that there are certain outstanding characteristics for each species and it is usually possible, by a process of elimination, to arrive at an accurate identification. It should be pointed out, however, that all the characters are variable and it is unwise to rely entirely upon one character alone in making a decision.

The writer is much indebted to Drs. R. E. Foerster and A. L. Pritchard for the ranges in the various characters except those of the pyloric cæca.

THE IDENTIFICATION OF THE YOUNG OF THE FIVE SPECIES OF PACIFIC SALMON, WITH NOTES ON THE FRESH-WATER PHASE OF THEIR LIFE-HISTORY.

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The correct and ready identification of the young of the five species of Pacific salmon, genus *Oncorhynchus*, is of particular importance not only to the specialist in fisheries biology who studies in detail the life-history of these forms, but also to the fish culturist and enforcement officer who are charged with the duty of conserving and protecting the fishery. It may be of considerable interest, also, to the angler and the naturalist who pursue the general study of aquatic organisms, their habits and relationships.

Two publications have already appeared which have dealt with this problem. The earlier of these, published in 1907 by F. M. Chamberlain, naturalist on the United States Fisheries steamer "Albatross," was a rather comprehensive study of the various species, young and adult, in the Naha and Karluk Rivers, Alaska. Although it contains excellent detail concerning the early stages of salmon, this work is now out of print and hence no longer available. The second paper, a study by Donald R. Crawford (1925), avoids detail but contains a useful qualitative key and illustrations.

The present paper includes the more pertinent information given in the two previous publications and, in addition, embodies further detailed data gathered during various researches on the Pacific salmon in British Columbia. It brings together for each species the specific morphological characters, the characteristic external features, and the details concerning development, time of migration, etc., to the end that, by a consideration of all the factors, identification may be made possible.

The material has been more or less rigidly divided into three parts. The first of these, the discussion of variable characters, records, mainly for the fisheries scientist, certain detailed observations which are now at hand concerning various body characters. The second, a general description of species, gives in detail general information concerning habits and appearance of each species; while the third presents a "key," by means of which the various species may be readily separated, and a plate illustrating the typical markings characteristic of each species.

The separation of the adults of the five species of Pacific salmon has been based upon either general appearance—namely, shape, colour, markings, etc.; or upon differences observed in certain morphological characters—namely, number of fin-rays, of scales, of gill-rakers, etc. In the young, general appearances may not alone suffice as a means of separation, due to the fact that environment is known to affect to some extent the colour and markings, nor has it been definitely established that the counts of certain morphological characters, which in these small fish are by no means easy, will serve as a means of identification. It has been found that both qualitative and quantitative characteristics have to be considered.

Fig. 1 is a diagram of a salmon in which the various morphological characters considered and studied in detail are clearly shown. The inset demonstrates the position of the gill-arches on which are found the *gill-rakers*.

To obtain a count of the *gill-rakers*, the first gill-arch on the left side of the fish should be removed carefully by cutting away the ends from the gill-cover and from the second gill-arch which lies immediately beneath it. In this operation care should be exercised in making the incision so as not to destroy the ends of the arch and thus inadvertently remove some of the small gill-rakers. The arch can then be spread out by pinning the ends apart on a piece of cardboard. All rakers visible under moderately high magnification should be enumerated.

In making a determination of the number of *scales along the lateral line*, the fish should be placed on its right side under a lens of moderately high magnification. Through this it is moderately easy to see and prick with a pin the scales or scale-pockets, beginning immediately behind the edge of the operculum and following the lateral line to the end of the vertebral column. This latter boundary may be found by palpating with a needle.

Fin-rays, those bony supports which project into the fins, which are not at least half as long as the longest ray should be considered as undeveloped and not be counted. The last ray of the anal and of the dorsal fin is branched and appears to be double. Each should be counted as one only.

The *branchiostegal rays* are those cartilaginous flattened rods or flaps which form the lower margin of the operculum and cover the gills on the ventral side. They may be easily spread apart for enumeration by holding open the gill-cover. All those visible should be counted.

In determining the number of *vertebræ* the flesh should be carefully removed from one side of the fish, thus exposing the backbone. After careful cleaning, the segments beginning with the one immediately behind the skull and ending with the one immediately in front of the long vertebræ projecting up into the tail can be counted. For accurate determination the vertebræ should be kept slightly wet. Some degree of magnification is necessary.

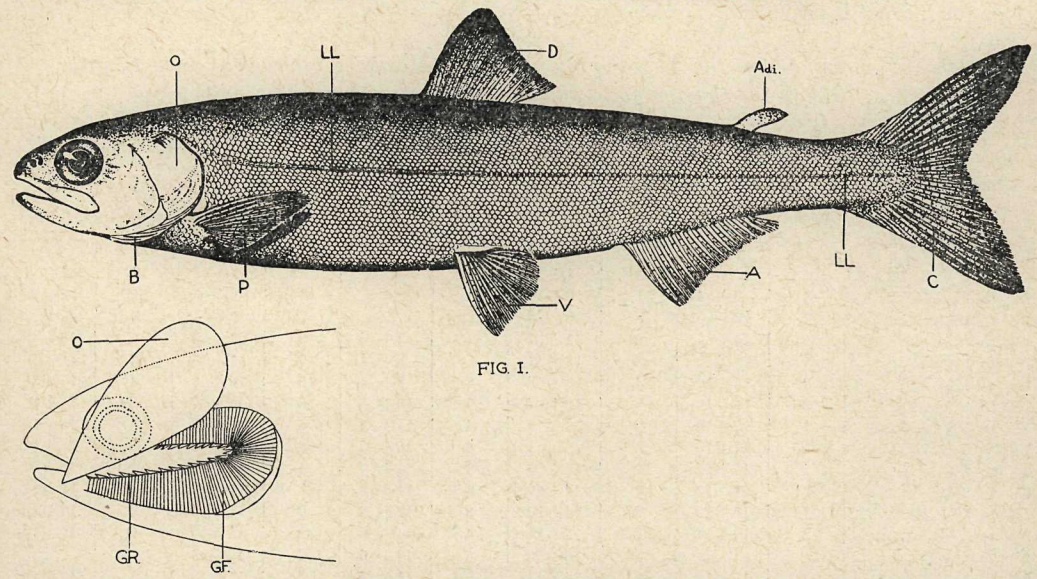

FIG. I.

Fig. 1. Diagram of a salmon showing the various morphological characters considered in this paper. Inset shows left operculum bent back to expose first gill-arch with gill-rakers. A—anal fin; Adi.—adipose or fatty fin; B—branchiostegal rays; C—caudal fin; D—dorsal fin; GF—gill-filaments; GR—gill-rakers; LL—lateral line; O—operculum or gill-cover; P—left pectoral fin; V—left ventral or pelvic fin.

The material for examination, obtained chiefly from the salmon-retaining ponds at Smith Falls Hatchery, Cultus Lake, British Columbia, consisted of 69 chum salmon (*Oncorhynchus keta*), 69 spring salmon (*O. tschawytscha*), 68 cohoe salmon (*O. kisutch*), and 63 sockeye (*O. nerka*). As a sample of pink salmon (*O. gorbuscha*), 37 were taken from a collection made at McClinton Creek eyeing-station, Masset Inlet. The individuals used were selected at random from samples taken at regular intervals throughout the autumn, winter, and early spring. While the authors realize that this material is too limited to be the basis of exhaustive conclusions, nevertheless they feel that the counts made thereon are sufficient as an indication of the use of the various characters as an aid to the separation of the species. In addition the data are presented as one contribution to a more complete and comprehensive survey which is much to be desired.

DISCUSSION OF VARIABLE CHARACTERS.

In the present section are set down the results of the examination of those variable characters which are utilized chiefly in the identification of the adult salmon, the object being to discover whether they have any significance in the separation of the young of the species.

Gill-rakers.—From Table I., in which is presented a summary of the average numbers of gill-rakers for each ⅛-inch length group for all species, it appears that in the very early stages up to a length of 1¾ inches, there is an increase in the number of gill-rakers with increase in size. Such a change might be attributed to the overlooking of some of the rudimentary rakers on the very small arches, but in view of the fact that all counts were carefully made under comparatively high magnification, it is unlikely that such an error would have occurred.

The counts for individuals from 1¾ to 3¾ inches in length have been averaged at the bottom of the table. Correspondence of these averages with those for the adults taken from Jordan and Evermann (1896) is very close in the case of the pink, chum, and cohoe, but not in the case of the spring and sockeye. This disagreement may be due either to the difference between the populations sampled or to differences in the technique of counting. Whether the pink, chum, cohoe, and spring have their full quota of gill-rakers at 3¾ inches could not be ascertained, due to lack of material from the same environment. It has been definitely proven, however, that those of the sockeye do increase from the fingerling to the yearling stage, and from comparison of the latter with adult counts there appears to be another increase before the adult period is reached.

Table I.—Summary of the Average Numbers of Gill-rakers for each ⅛-inch Length Group for the Young of the Five Species of Pacific Salmon.

Lengths in Inches.	Pink.		Chum.		Spring.		Cohoe.		Sockeye.	
	No. used.	Gill-rakers.	No. used.	Gill-rakers.	No. used.	Gill-rakers.	No. used.	Gill-rakers.	No. used.	Gill-rakers.
⅞ to 1	----	----------	3	7+ 2	----	----------	3	6+ 2	12	14+ 4
1 to 1⅛	3	9+ 4	11	8+ 4	----	----------	3	6+ 3	9	12+ 6
1⅛ to 1¼	7	12+ 5	5	10+ 5	----	----------	7	9+ 4	3	15+ 7
1¼ to 1⅜	4	14+ 7	5	11+ 7	7	7+ 4	9	9+ 5	7	15+ 8
1⅜ to 1½	----	----------	3	13+ 7	5	8+ 4	7	11+ 6	7	16+10
1½ to 1⅝	3	15+10	4	13+ 8	8	9+ 5	10	12+ 7	1	17+11
1⅝ to 1¾	2	16+10	3	13+ 7	9	10+ 6	3	11+ 7	3	17+11
1¾ to 1⅞	1	17+10	5	13+ 9	4	11+ 7	5	12+ 7	3	18+11
1⅞ to 2	1	17+10	----	----------	6	10+ 7	2	11+ 8	3	18+11
2 to 2⅛	1	17+11	3	14+ 9	2	11+ 7	1	12+ 8	1	19+11
2⅛ to 2¼	3	18+13	4	14+ 9	5	11+ 8	3	11+ 9	4	18+11
2¼ to 2⅜	1	15+10	2	14+10	3	12+ 9	2	11+10	4	17+12
2⅜ to 2½	2	17+11	3	15+11	4	11+ 9	2	11+ 9	2	18+12
2½ to 2⅝	----	----------	2	16+10	5	11+ 9	4	12+ 9	----	----------
2⅝ to 2¾	2	17+13	3	14+11	6	11+ 9	3	11+ 9	1	19+12
2¾ to 2⅞	1	17+13	5	14+10	4	11+ 9	----	----------	----	----------
2⅞ to 3	----	----------	2	13+11	1	12+ 9	1	12+ 9	3	17+12
3 to 3⅛	1	18+11	1	18+12	----	----------	2	13+ 9	----	----------
3⅛ to 3¼	1	19+12	4	15+11	4	15+11	----	----------	----	----------
3¼ to 3⅜	1	18+11	----	----------	----	----------	----	----------	----	----------
3⅜ to 3½	1	18+12	----	----------	----	----------	1	13+10	----	----------
3½ to 3⅝	1	20+13	1	14+11	----	----------	----	----------	----	----------
3⅝ to 3¾	1	18+13	----	----------	----	----------	----	----------	----	----------
Av. (from 1¾ inch up)	----	17+12	----	14+10	----	11+ 8	----	12+ 9	----	18+11
Adults (Jordan)	----	15+13	----	15+ 9	----	14+ 9	----	13+10	----	22+14

"No. used" refers to the number of individuals examined in each case.

The first figure given for the gill-rakers is the number on the long side of the arch; the second that on the short side. The plus sign indicates that the two should be added to obtain the total number.

It is noteworthy that the gill-raker counts for young pink and sockeye salmon are very similar, a relationship which is quite different to that which holds in the adult stage. Such a circumstance would make questionable any differentiation between young of these two species on the basis of this character. It might be possible to distinguish the young of the pink and the sockeye from those of the other three species for partial separation, but in such a comparison only fish of similar size should be employed.

Scales.—The number of scales along the lateral line of salmon has long been used as a ready means of identification of the adults of some of the species. In the young, however, this character is of much less value, since in the early stages the scales are merely forming. The length at which it is possible to make counts varies with the species. In the pink it is about 2¼ inches; the chum, 1⅜ inches; the spring, 1⅝ inches; the cohoe, 1⅜ inches; and the sockeye, 1¼ inches.

Table II. gives the average lateral line scale-counts for the various ⅛-inch length groups.

Table II.—Summary of the Average Numbers of Scales on the Lateral Line for each ⅛-inch Length Group for the Young of the Five Species of the Pacific Salmon.

Lengths in Inches.	Pink.		Chum.		Spring.		Cohoe.		Sockeye.	
	No. used.	No. Scales.	No. used.	No. Scales.	No. used.	No. Scales.	No. used.	No. Scales.	No. used.	No. Scales.
⅞ to 1	----	-----	----	-----	----	-----	----	-----	----	-----
1 to 1⅛	----	-----	----	-----	----	-----	----	-----	----	-----
1⅛ to 1¼	----	-----	----	-----	----	-----	----	-----	----	-----
1¼ to 1⅜	----	-----	----	-----	----	-----	----	-----	1	126
1⅜ to 1½	----	-----	7	140	----	-----	5	131	7	127
1½ to 1⅝	----	-----	4	134	----	-----	9	126	1	127
1⅝ to 1¾	----	-----	3	135	9	134	2	127	3	127
1¾ to 1⅞	----	-----	5	134	4	135	4	126	3	126
1⅞ to 2	----	-----	----	-----	6	139	2	127	3	125
2 to 2⅛	----	-----	3	134	2	138	1	125	1	130
2⅛ to 2¼	----	-----	4	137	5	141	3	128	4	128
2¼ to 2⅜	1	170	2	135	3	139	2	125	4	129
2⅜ to 2½	2	168	3	139	4	144	2	130	2	131
2½ to 2⅝	----	-----	2	138	5	143	4	130	----	-----
2⅝ to 2¾	2	177	3	138	6	141	3	132	1	135
2¾ to 2⅞	1	178	5	138	4	141	1	127	----	-----
2⅞ to 3	----	-----	2	138	1	145	1	130	3	135
3 to 3⅛	1	185	1	139	----	-----	2	132	----	-----
3⅛ to 3¼	1	175	4	134	----	-----	----	-----	----	-----
3¼ to 3⅜	1	178	----	-----	----	-----	----	-----	----	-----
3⅜ to 3½	1	172	----	-----	----	-----	----	-----	----	-----
3½ to 3⅝	1	177	1	144	----	-----	1	130	----	-----
3⅝ to 3¾	1	177	----	-----	----	-----	----	-----	----	-----
Av. (of averages)	----	176	----	137	----	139	----	129	----	128
Adults (Jordan)	----	170	----	150	----	146	----	127	----	133

In some cases it appears from the averages as if an increase in number of scales with increase in the total length of the fish were indicated. It is felt, however, that such a small difference may be entirely due to the difficulty in separating the small, closely packed scales at the posterior end, on the caudal peduncle.

Taking the range for each species as a distinguishing character, it is apparent that the same separation can be made for young salmon as Jordan and Evermann have applied for adults. Pink salmon, with the highest count, 168 to 185, are quite clearly separated from the next group, consisting of chums and springs, possessing 134 to 140 and 134 to 145 scales respectively. The third group, cohoes and sockeye, have still fewer, 125 to 132 and 125 to 135 respectively. When there is but slight difference in scale-count between species, such as chum and spring or cohoe and sockeye, the separation must be based on other differences. As will be shown later, the division of these particular species by other means is quite easy.

Fin-rays.—As stated previously, the fin-rays are those cartilaginous supports which project into the fins. Those which are not one-half as long as the longest rays should be considered as undeveloped and should not be counted. The last ray of the dorsal and anal fins appears to be double but it is counted as one.

No correlation of the average number of fin-rays for each length group is included in this paper, since it has been found that there is no significant variation with increase in size. Both anal and dorsal fins are dealt with and comparison is made with the counts given by Jordan and Evermann for adult individuals.

Anal Fin.—There is tabulated below the number of individuals of each species in the sample possessing the designated number of anal fin-rays:—

Species.	Number of Rays.					Adults (Jordan and Evermann).
	14.	15.	16.	17.	18.	
Pink salmon	14	30	....	....	....	15
Chum salmon	8	41	20	....	....	13–14
Spring salmon	....	....	13	48	8	16
Cohoe salmon	....	29	37	3	....	13–14
Sockeye salmon	5	42	20	1	....	14–16

There is no significant difference between the anal fin-ray counts for young and adult salmon. Even in the case of the cohoe, where the greatest apparent difference is found, the discrepancy may have arisen because of the inability to distinguish, in the young, those fin-rays which, in the adult, are classed as undeveloped and not counted. The point to be emphasized is that the close similarity of the counts for all species precludes the use of this character as a reliable means of separation. It may here be noted, however, that there should arise no difficulty in separating Pacific salmon young from young trout. The latter are distinguished by having *not more than* 12 anal fin-rays, whereas Pacific salmon have *more than* 12. The counts made on the young of the Pacific salmon for this paper in no case showed less than 14 anal fin-rays.

One of the most characteristic features of the young of the cohoe salmon is that of having the first two or three rays of the anal fin distinctly longer than the remainder. This elongation produces a concave margin to the free edge of the fin. In the other four species there is a gradual decrease in the length of the rays toward the tail, resulting in a straight margin to the fin. Further, it might be noted that the first anal ray in the cohoe fin is whitish in colour as opposed to the normal darkened appearance in all others.

Dorsal Fin.—Treating the dorsal fin-ray counts in a similar manner to the anal rays, there follows a table showing the number of fin-rays possessed by the individuals of each species in the collection examined:—

Species.	Number of Rays.						Adults (Jordan and Evermann).
	10.	11.	12.	13.	14.	15.	
Pink salmon	....	....	12	15	16	1	11
Chum salmon	....	13	50	6	....	....	9
Spring salmon	....	1	36	28	2	....	11
Cohoe salmon	....	30	38	1	....	....	10
Sockeye salmon	1	20	43	4	....	....	11

In every species the young were found to have more dorsal fin-rays than has been indicated for adults. The difference, as in the case of the anal fin, is probably due to a difference in criterion for estimating developed and undeveloped rays. The dorsal fin-ray count would appear to be of little use in separating the various species.

Branchiostegal Rays.—The branchiostegal rays are sometimes used to assist in the identification of adult salmon. Consequently the counts for small salmon have been made for comparison and use, if possible. The following table indicates for each species the number of individuals possessing a certain number of such rays. The Jordan and Evermann record for adult individuals has been added in the last column.

Branchiostegal Rays.

Species.	Number of Branchiostegal Rays per Fish.								Average.	Adult Average.
	9.	10.	11.	12.	13.	14.	15.	16.		
Pink salmon	1	5	12	16	3	....	....	....	11–12	11 or 12
Chum salmon	....	3	5	35	24	2	....	....	12–13	13 or 14
Spring salmon	....	....	....	....	5	16	40	4	14–15	15 or 16 to 18 or 19
Cohoe salmon	....	....	4	27	29	7	....	....	12–13	13 or 14
Sockeye salmon	....	1	5	37	17	2	....	....	12–13	13 to 15

It is quite obvious that the variation existing in each species results in overlapping between species. It appears from the tabulation that the only use to which the data may be put is to show that if a small fish has 15 or 16 branchiostegal rays it is a young spring salmon. Use of this character, therefore, as an aid to separation of the species is not recommended.

Vertebræ.—The numbers of vertebræ making up the vertebral columns of individuals of each species were counted. The counts obtained are tabulated below, showing for each species the number of individuals possessing a given number of vertebræ:—

Species.	Number of Vertebræ in Vertebral Column.																
	56.	57.	58.	59.	60.	61.	62.	63.	64.	65.	66.	67.	68.	69.	70.	71.	72.
Pink salmon	....	....	....	....	1	....	....	1	2	14	11	16	4	1	....	....	....
Chum salmon	....	....	....	1	....	3	2	2	7	8	21	17	6	....	....	....	....
Spring salmon	....	....	....	....	....	....	....	....	....	1	1	2	15	25	18	6	1
Cohoe salmon	....	....	1	1	5	5	2	18	21	10	5	....	....	....	....	....	....
Sockeye salmon	2	....	2	3	3	....	6	9	5	12	13	7	....	....	....	....	....

It is at once seen that vertebral counts are not satisfactory for definite separation of species of Pacific salmon. With the possible exception of the spring salmon young, there is too much overlapping to allow much reliance upon this character for identification purposes. In the various samples ranging from ⅞ inch to 3 inches there was no definite evidence obtained to indicate that the number of vertebræ changed with increase in size. The smallest fry were found to have as many vertebræ as the larger fingerlings, but, of course, the size of the individual segments varied with the total length.

Parr Marks.—These consist of wide, vertical bars or round or oval, black patches appearing on the sides of the fish and are formed by the laying-down of black pigment in the skin in certain areas and in certain patterns. They remain with the fish until the latter have attained a certain size, not accurately determined, whereupon the silvery pigment overlays them and conceals them. Parr marks are not to be confused with the ordinary black-spotting appearing on the fins or the back of the fish.

Since many instances are known in which colouring and speckling vary with change in environment, it would be unwise to place too much reliance upon such features for identification purposes in the case of Pacific salmon. Parr marks, however, have been shown by experience to differ little in a given species in different localities, and thus may be safely used as an aid in the separation of the species.

Pink salmon may be definitely distinguished by the complete absence of any parr marks. They possess a clear and unbroken silvery sheen along both sides. Of the other four species a definite division can be made between those possessing large parallel vertical bars and those having large round or oval spots. The spring and cohoe have the vertical bars and the sockeye and chum the round or oval markings. Unquestionable separation of groups of species can be made to this extent, but, as will be shown below, the further separation of springs from cohoes and sockeye from chums must be based on other characteristics.

GENERAL DESCRIPTIONS OF SPECIES.

There now follows a general description of each species covering life-history, habits, rate of growth, colour and markings, and those morphological characters referred to above, all of which when considered together will assist in or confirm the identification of young salmon where the " key " at the end of this paper is not sufficiently precise.

Pink or Humpback Salmon (Oncorhynchus gorbuscha).—Pink salmon, when they return from the sea to spawn, frequent chiefly the small coast streams or the lower tributaries of the large river systems. They do not penetrate far inland. Observations made by the junior author have indicated that hatching of eggs usually occurs in late December and the young alevins remain in the gravel for some two or three months, passing to sea as free-swimming fry during February, March, April, and May. While the water temperatures prevailing during the winter and spring months control and influence the rate of development and the time of migration, it is found that the main pink salmon seaward migrations usually take place in the latter part of April and early May. These observations coincide with those of Chamberlain for Alaska and apply also fairly generally to Southern British Columbia waters and Puget Sound (Davidson, 1934).

At the time of migration the fry are from 1¼ to 1½ inches in length. Hatched in streams not far removed from the sea, the fry drop down at once to salt water and may be said to have no fresh-water residence. Definite scales have not developed by the time of seaward exodus. Feeding in fresh water is very incidental, but once in salt water active ingestion of the abundant marine food-organisms commences and growth is very rapid. Although Chamberlain records instances of pink salmon young being recovered in shore waters in June and July, it is generally assumed that these fish pass immediately offshore to the deeper waters of the ocean. In the Masset Inlet area, pinks are noted moving out of the inlet in June and July, but they are not commonly found previously in the shallow waters and they are not seen subsequently until they return in the fall of the succeeding year as " two-year-old " adults.

It is thus obvious that there is but a short time each year when pink salmon young will be found in fresh water or in inshore areas of the coast. As noted above, young pink salmon are completely devoid of parr marks and this characteristic should separate them immediately from other species. If there is any doubt a count of the number of scales along the lateral line should confirm the identification since pink salmon have a high scale-count, 168 to 185.

Chum or Dog Salmon (Oncorhynchus keta).—The chum salmon resemble the pink in general spawning habits. They come in from the sea shortly after the latter and populate all the accessible coast streams and lower tributaries of the main river systems. They are to be found frequenting cohoe- and sockeye-spawning areas both above and below lakes in the Harrison, Cultus, and Pitt River systems. All chum salmon fry, even those hatched in streams above lakes, appear to migrate to sea the first spring. None are found in fresh water after June or July. Upon reaching the river-mouths the young migrants gradually pass to the sea, Chamberlain reporting them as having been captured in June and July in seine hauls in relatively shallow water in the vicinity of the Karta and Karluk Rivers and Gilbert (1913) observing them in Puget Sound. No scales are formed at the time the fry leave the rivers.

In life, the chum salmon is a long, slim, gracefully shaped fry, mottled grass to dark green on back, silvery on lower parts with a rather pale-green iridescence. The back is heavily spotted with small black dots, sometimes fusing together. Parr marks on the sides vary in number from 6 to 10, but they are found chiefly above the lateral line and are elliptical to oval in shape.

The only other species with which the chum salmon fry might be confused is the sockeye. The green colour of the back of the chum is quite different from that of the sockeye, being somewhat darker and extending lower on the sides, and the faint-green iridescence of the silvery sides is also characteristic. In size the chum is quite distinct, being consistently considerably larger than the sockeye at the same time of year. An examination of the gill-rakers and a count of the scales will readily separate these two species. The sockeye has a greater number (average, 18+11 or 12) and longer and finer gill-rakers than the chum (average, 14+10) and possesses fewer scales, 125–135, as compared with 134–144 for the chum.

In the sea-run individuals whose parr marks have begun to fade out there may be some confusion as to their separation from pinks, but here, as noted above, the scale-count will readily distinguish them.

Sockeye Salmon (Oncorhynchus nerka).—Although there are some varieties of sockeye, commonly called " creek " sockeye, that spawn in coast streams, the vast majority possess the peculiarity of spawning only in streams above lakes. That is to say, on their return from the sea they select those streams or tributaries of rivers which have lakes at their head and then proceed to pass through the lakes to spawn in the streams above. Some spawn on the beaches of lakes where there is a certain degree of seepage-flow.

Sockeye also are noted for the great variation in period of fresh-water residence. Commonly the fry emerging from the gravel drop down immediately to the lake and disappear in the depths, there to remain unseen until they appear at the lake outlet the following spring prepared to migrate seaward. This is the general habit in the Fraser and other Southern British Columbia streams, though in certain cases, particularly with " creek " sockeye, the fry may repair immediately to sea, while in other instances some individuals remain for an extra year in fresh water, migrating seaward as two-year-olds. In more northern waters the period of fresh-water residence is extended. In the Skeena and Southern Alaska streams the proportion of two-year-old migrants exceeds that of the yearlings, while in Northern Alaska three years' residence in fresh water is common. There occurs also the landlocked form of this species, popularly called the kokanee or kickininee, which remains in fresh water throughout its entire life-cycle.

The chief difficulty in identification of the sockeye occurs at the fry stage, when, as remarked above, there is possible confusion with the chum fry. The former are generally smaller in size than chum fry at the same period but are rather similarly marked. The sockeye have, however, silvery sides with no green iridescence, the back is uniformly olive to grassy green, not mottled as in the chum, and the fine, black punctulations are more numerous and more definite. The parr marks are more evenly distributed than in the chum and are situated chiefly immediately above the lateral line, though at times they may project down below it. A second row of narrower marks may be found above and alternated with the regular parr marks; but they are not always present or conspicuous.

When the sockeye have remained in fresh water for a year and commence their spring migration to the sea they are from 3 to 5 inches long. The same markings are present and the tips of the caudal fin are dusky. There may arise at this time some confusion with cohoe yearlings, which are much the same size and have the same general appearance. The most readily observed difference, however, is in the shape of the anal fin. In the sockeye the margin of the anal is quite regular, the rays growing uniformly shorter from anterior to posterior ends, but in the cohoe the first two or three rays are longer than the remainder, producing a concave outer margin. Frequently the first few rays are sufficiently longer than the remainder to produce a spike at the anterior end of the fin. Final identification can always be made by counting the gill-rakers, of which the sockeye possess, at the yearling stage, around 18+12, whereas the cohoe have only 12 or 13+9 or 10.

Spring Salmon (Oncorhynchus tschawytscha).—Upon their return to fresh water the spring salmon select the larger rivers and the larger tributaries of those rivers, including those far inland.

The young may migrate to sea immediately after hatching, as fry, or they may remain in fresh water for the summer, dropping down to salt water with the onset of the autumn freshets. Yearlings, those individuals remaining in fresh water for the winter and migrating the following spring, are not common.

As noted elsewhere in this paper, spring and cohoe young are immediately separated from other salmon by the possession of long, conspicuous, vertical bars as parr marks. The bars lie about equally on either side of the lateral line. There are numerous other small spots or blotches between and above the parr marks. Both spring and cohoe fry may exhibit a brownish colour on the back and upper half of the sides, with a brassy iridescence overshadowing the silver of the lower half of the sides, and the ventral surface and the fins may have a reddish tinge. In general, however, the spring salmon is not as brownish as the cohoe, nor are the fins as deeply coloured, but for accurate separation of spring from cohoe, reliance must be placed again upon the shape of the anal fin or upon the number of scales along the lateral line. As explained in the section on sockeye immediately above, the anal fin of the cohoe is quite characteristic in having a concave outer margin by reason of the greater length

of the first few rays, a feature which is lacking in the spring salmon. The scale-counts may be compared as follows: spring salmon, 134–145; cohoe salmon, 125–132.

Cohoe Salmon (Oncorhynchus kisutch).—The most generally distributed, the cohoe salmon are found throughout the Pacific Coast drainage system from the smallest coast stream to the most remote inland tributary.

The young may migrate down-stream as fry, fingerlings, or yearlings, but whether they pass on out to sea at stages younger than yearling is still a matter of some doubt. They have been definitely observed leaving the inland streams and lakes as fry, while others have remained in the streams throughout the summer and fall. A fall migration has not been definitely established, but in the following spring a down-stream migration of yearlings has been found to occur. It is quite possible that the early fry or fingerling migrants drop down-stream only to some more favourable feeding and resting area, perhaps to the river-mouth itself, there to remain until the following spring, when they continue out to sea. Examination of scales has shown definitely that cohoes with a complete first year's residence in fresh water are by far the most numerous.

Cohoe fry and fingerlings populate most of the streams and lakes of the Pacific Coast and their correct identification is of some importance. As already noted, the fry may be separated from all others except the spring through the possession of large vertical bars as parr marks. These bars extend almost as far below the lateral line as above it. From the spring fry, cohoes may be separated because of the possession of elongated first rays of the anal fin, fins tinged with brownish-orange, the lower fins, pectorals, pelvics, and anal sometimes edged with white. As for fingerlings, since the pink and chum salmon repair directly to sea as fry and are not normally found in fresh water during the summer, it is only necessary to distinguish between the cohoe, the spring, and sockeye. The sockeye may be set apart due to the fact that the parr marks are short, elliptical or oval spots and not definite vertical bars, but should these marks be indistinguishable it has been found that the sockeye has more, longer and finer gill-rakers than the cohoe, approximately 18+11 as opposed to 12+9. From the spring fingerling the cohoe may be set apart on the basis of the same characters used for the fry.

It should be pointed out that these colour-markings as well as the long vertical parr marks are also possessed by the young of some of the Pacific trout. The cut-throat and particularly the brook cut-throat very closely resemble the young cohoe, but the latter is usually much larger at the same period of year. The number of anal fin-rays will at once separate the cohoe from the trout, since the former have 14 or more rays, whereas the trout have 12 or less. The anal fin, by reason of the smaller number of rays, is much shorter in the trout than in the cohoe. Among trout, the dorsal and occasionally the caudal fin are conspicuously spotted.

KEY FOR THE IDENTIFICATION OF YOUNG SALMON.

On the basis of observations which have been recorded and from practical experience gained in handling Pacific salmon young over a period of years, the following key has been constructed by which the young of the Pacific salmon can be readily identified. The key is for use only in rapid separation of the species, and where doubt arises as to the distinction between certain species, reference to the more detailed descriptions contained in the paper should be made.

A. ANAL RAYS, 9 to 12. DORSAL FIN WITH LARGE BLACK SPOTS. — Trout and Chars.

AA. ANAL RAYS MORE THAN 13. DORSAL FIN WITH NO LARGE BLACK SPOTS. — Pacific salmon.

B. No parr marks present. Scale-count approximately 175 (168 to 185). Fry deep blue to greenish on back in life. Belly silvery. — *Pink.*

BB. Parr marks present as vertical bars or oval blotches. Scale-count 150 or less.

C. Parr marks short, elliptical or oval, extending little, if any, below lateral line.

D. Gill-rakers about 18+11. Scales 125 to 135. Row of definite black spots on back. Colour, bluish or greenish tinge on back, no green iridescence on sides below lateral line. Belly silvery. — *Sockeye.*

DD. Gill-rakers about 14+10. Scales 134 to 144. Black spots on back may be present but not as large and position irregular. Colour, bright, mottled green on back. Sides below lateral line silvery with faint-green iridescence. Belly silvery. — *Chum.*

CC. Parr marks large vertical bars, almost bisected vertically by the lateral line.

E. First rays of anal fin not elongated. Colour, darkly stippled with black on back. Some brownish on back and upper half of sides. No brassy iridescence. Silvery belly. Fins not usually coloured. — *Spring.*

EE. First rays of anal fin elongated, producing a concave outer margin to fin. Colour, brown to brownish-orange. Sides and belly silvery, tinged with brassy iridescence. Lower fins tinged with orange and tipped with white. First ray of anal whitish in colour. — *Cohoe.*

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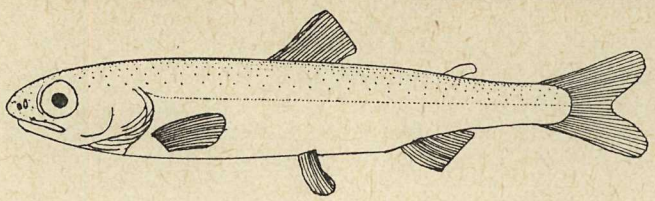
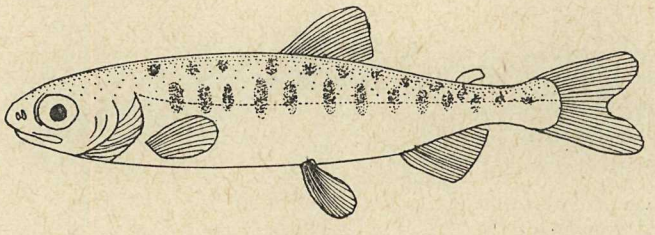
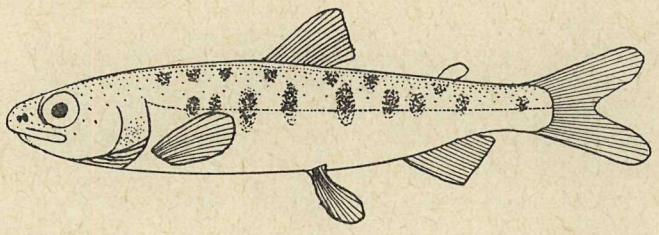


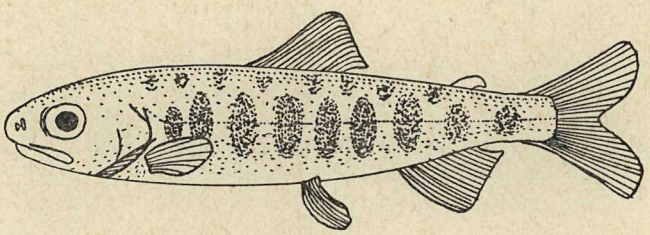
PINK SALMON



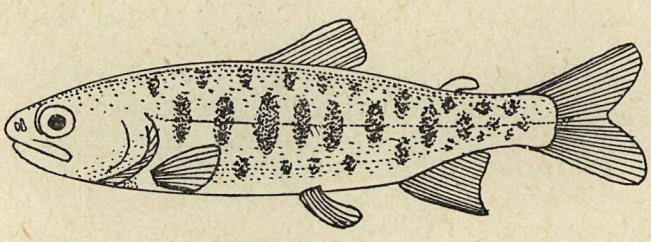
SOCKEYE SALMON



CHUM SALMON



SPRING SALMON



COHOE SALMON

Plate displaying example of each of the five species of Pacific salmon.

PACK OF BRITISH COLUMBIA SALMON, SEASON 1934.

SHOWING THE ORIGIN OF SALMON CAUGHT IN EACH DISTRICT.

District.	Sockeye.	Springs.	Steel-heads.	Cohoes.	Pinks.	Chums.	Grand Total (Cases).
Fraser River	139,238	16,218	.....	11,392	2,199	104,092	273,139
Queen Charlotte Islands	8	258	.....	8,315	53,398	38,032	100,041
Nass River	28,701	654	311	9,935	32,964	2,648	75,213
Skeena River	70,655	8,300	114	54,476	126,163	24,388	284,096
Rivers Inlet	76,923	436	79	4,852	2,815	895	86,000
Smith Inlet	14,607	164	43	3,941	6,953	15,548	41,256
Outlying Districts	20,430	2,116	733	53,850	157,336	117,309	351,774
Vancouver Island	27,282	1,630	.....	78,670	54,526	210,239	372,347
Totals	377,844	29,776	1,280	225,431	436,354	513,181	1,583,866

29,567 cases of bluebacks are combined with cohoes in this table.
6,117 cases of sockeye packed at Esquimalt are credited to the Fraser.
1,797 cases of sockeye packed at Outlying Districts are credited to the Fraser.
3,326 cases of sockeye packed in the Vancouver Island District are credited to the Fraser.
9,223 cases of sockeye packed on the Fraser are credited to Rivers Inlet.
6,117 cases of sockeye packed at Smith Inlet are credited to Rivers Inlet.
520 cases of sockeye packed at Smith Inlet are credited to the Fraser.
8,840 cases of sockeye and 191,409 cases other than sockeye packed on the Fraser are credited to Vancouver Island District.

STATEMENT SHOWING THE SALMON-PACK OF THE PROVINCE, BY DISTRICTS AND SPECIES, FROM 1919 TO 1934, INCLUSIVE.

FRASER RIVER.

	1934.	1933.	1932.	1931.	1930.	1929.	1928.	1927.
Sockeyes	139,238	52,465	65,769	40,947	103,692	61,569	29,299	61,393
Springs, Red	5,150	5,579	18,298	9,740	11,366	3,305	1,173	7,925
Springs, White	11,068	.....	10,403	.....	9,761	6,699	3,909	10,528
Chums	104,092	34,391	14,948	251	68,946	144,159	193,106	67,259
Pinks	2,199	92,746	385	13,307	30,754	158,208	2,881	102,536
Cohoes	11,392	13,901	16,815	8,165	25,585	40,520	27,061	24,079
Bluebacks and Steelheads	.....	.....	23	657	27,879	12,013	795	10,658
Totals	273,139	199,082	126,641	73,067	277,983	426,473	258,224	284,378

	1926.	1925.	1924.	1923.	1922.	1921.	1920.	1919.
Sockeyes	85,689	35,385	39,743	31,655	51,832	39,631	48,399	38,854
Springs, Red	12,783	7,989	2,982	3,854	10,561	11,360	10,691	14,519
Springs, White	20,169	25,701	4,648	4,279	6,300	5,949	4,432	4,296
Chums	88,495	66,111	109,495	103,248	17,895	11,233	23,884	15,718
Pinks	32,256	99,800	31,968	63,645	29,578	8,178	12,839	39,363
Cohoes	21,783	36,717	21,401	20,173	23,587	29,978	22,934	39,253
Bluebacks and Steelheads	13,776	5,152	1,822	15	817	1,331	4,522	15,941
Totals	274,951	276,855	212,059	226,869	140,570	107,650	136,661	167,944

STATEMENT SHOWING THE SALMON-PACK OF THE PROVINCE, BY DISTRICTS AND SPECIES, FROM 1919 TO 1934, INCLUSIVE—*Contd.*

Skeena River.

	1934.	1933.	1932.	1931.	1930.	1929.	1928.	1927.
Sockeyes	70,655	30,506	59,916	93,023	132,372	78,017	34,559	83,996
Springs	8,300	3,297	28,269	9,857	7,501	4,324	6,420	19,038
Chums	24,388	15,714	38,549	3,893	5,187	4,908	17,716	19,006
Pinks	126,163	95,783	58,261	44,807	275,642	95,305	209,579	38,768
Cohoes	54,456	39,896	48,312	10,637	29,617	37,678	30,194	26,326
Steelhead Trout	114	267	404	768	58	13	241	582
Totals	284,096	185,463	233,711	162,986	450,377	220,245	298,709	187,716

	1926.	1925.	1924.	1923.	1922.	1921.	1920.	1919.
Sockeyes	82,360	81,146	144,747	131,731	96,277	41,018	89,364	184,945
Springs	30,594	23,445	12,028	12,247	14,176	21,766	37,403	25,941
Chums	63,527	74,308	25,588	16,527	39,758	1,993	3,834	31,457
Pinks	210,081	130,079	181,313	145,973	301,655	124,457	177,679	117,303
Cohoes	30,208	39,168	26,968	31,967	24,699	45,033	18,068	36,559
Steelhead Trout	754	713	214	418	1,050	498	1,218	2,672
Totals	407,524	348,859	390,858	338,863	477,915	234,765	332,887	398,877

Rivers Inlet.

	1934.	1933.	1932.	1931.	1930.	1929.	1928.	1927.
Sockeyes	76,923	83,507	69,732	76,428	119,170	70,260	60,044	65,269
Springs	436	449	459	325	434	342	468	608
Chums	895	677	944	429	492	989	3,594	1,122
Pinks	2,815	5,059	3,483	5,089	18,023	2,386	16,546	671
Cohoes	4,852	3,446	7,062	6,571	756	1,120	868	2,094
Steelhead Trout	79	82	29	32	105	29	7	9
Totals	86,000	93,220	81,709	88,874	138,980	75,126	81,527	69,773

	1926.	1925.	1924.	1923.	1922.	1921.	1920.	1919.
Sockeyes	65,581	192,323*	94,891	116,850	53,584	48,615	125,742	56,258
Springs	685	496	545	599	323	364	1,793	1,442
Chums	11,727	11,510	4,924	3,242	311	173	1,226	7,089
Pinks	12,815	8,625	15,105	10,057	24,292	5,303	25,647	6,538
Cohoes	7,286	4,946	1,980	1,526	1,120	4,718	2,908	9,038
Steelhead Trout	11	.....	.....	.....	82	97	.....	.....
Totals	98,105	217,900	117,445	132,274	79,712	59,272	133,248	80,367

Smith Inlet.†

	1934.	1933.	1932.	1931.	1930.	1929.	1928.	1927.	1926.
Sockeyes	14,607	37,369	25,488	12,867	32,057	9,683	33,442	22,682	17,921
Springs, Red	164	354	46	122	268	18	108	270	73
Springs, White	.....	.....	2	.....	22	60	178	79	39
Cohoes	3,941	5,068	273	112	1,460	275	230	2,990	164
Pinks	6,953	19,995	1,148	824	16,615	853	167	732	689
Chums	15,548	8,841	165	133	1,660	113	19	2,605	31
Bluebacks and Steelheads	43	87	20	36	103	12	6	8	.....
Totals	41,256	71,714	27,142	14,094	52,185	11,014	34,150	29,366	18,917

* Including 40,000 cases caught in Smith Inlet and 20,813 cases packed at Namu.
† Previously reported in Queen Charlotte and other Districts.

STATEMENT SHOWING THE SALMON-PACK OF THE PROVINCE, BY DISTRICTS AND SPECIES, FROM 1919 TO 1934, INCLUSIVE—*Contd.*

Nass River.

	1934.	1933.	1932.	1931.	1930.	1929.	1928.	1927.
Sockeyes	28,701	9,757	14,154	16,929	26,405	16,077	5,540	12,026
Springs	654	1,296	4,408	1,439	1,891	352	1,846	3,824
Chums	2,648	1,775	14,515	392	3,978	1,212	3,538	3,307
Pinks	32,964	44,306	44,629	5,178	79,976	10,342	83,183	16,609
Cohoes	9,935	3,251	7,955	8,943	1,126	1,202	10,734	3,966
Steelhead Trout	311	49	10	.....	84	.....	36	96
Totals	75,213	60,434	85,671	32,881	113,460	29,185	104,877	39,828

	1926.	1925.	1924.	1923.	1922.	1921.	1920.	1919.
Sockeyes	15,929	18,945	33,590	17,821	31,277	9,364	16,740	28,259
Springs	5,964	3,757	2,725	3,314	2,062	2,088	4,857	3,574
Chums	15,392	22,504	26,612	25,791	11,277	2,176	12,145	24,041
Pinks	50,815	35,530	72,496	44,165	75,687	29,488	43,151	29,949
Cohoes	4,274	8,027	6,481	7,894	3,533	8,236	3,700	10,900
Steelhead Trout	375	245	1,035	595	235	413	560	789
Totals	92,749	89,008	142,939	99,580	124,071	51,765	81,153	97,512

Vancouver Island District.

	1934.	1933.	1932.	1931.	1930.	1929.	1928.	1927.
Sockeyes	27,282	18,397	27,611	22,199	24,784	10,340	14,248	24,835
Springs	1,630	4,875	10,559	4,055	3,431	1,645	2,269	6,769
Chums	210,239	96,642	70,629	16,329	177,856	162,246	303,474	220,270
Pinks	54,526	172,945	33,403	81,965	89,941	74,001	41,885	52,561
Cohoes	78,670	60,019	35,132	26,310	30,206	35,504	23,345	58,834
Steelheads and Bluebacks	.....	147	28,596	24,638	14,177	11,118	5,249	10,194
Totals	372,347	353,025	205,930	175,541	340,395	294,854	390,470	373,463

Queen Charlotte and other Districts.

	1934.	1933.	1932.	1931.	1930.	1929.	1928.	1927.
Sockeyes	20,438	26,106	21,685	29,071	39,198	35,331	59,852	60,533
Springs	2,374	4,416	3,514	1,608	1,852	1,020	2,806	7,826
Chums	155,371	135,590	167,011	34,570	143,781	111,263	341,802	252,230
Pinks	210,734	101,701	82,449	55,825	600,986	136,758	438,298	36,481
Cohoes	62,165	33,471	44,977	16,141	61,418	56,938	58,455	47,433
Steelheads and Bluebacks	733	827	591	446	1,204	575	609	973
Totals	451,815	302,111	320,227	137,661	848,439	341,873	901,822	405,476

	1926.	1925.	1924.	1923.	1922.	1921.	1920.	1919.
Sockeyes	62,383*	49,962	40,926	24,584	47,107	18,350	64,473	54,677
Springs	3,650	5,002	4,245	2,711	4,988	4,995	15,633	14,766
Chums	348,682	305,256	195,357	148,727	80,485	21,412	30,946	165,717
Pinks	380,243	120,747	141,878	146,943	113,824	14,818	247,149	110,300
Cohoes	47,183	40,269	26,031	29,142	31,331	18,203	33,807	35,011
Steelheads and Bluebacks	973	1,520	497	732	409	2,790	3,721	702
Totals	844,114	522,756	408,934	352,839	278,144	80,568	395,728	381,163

* Including 17,921 cases of sockeye packed at Smith Inlet.

STATEMENT SHOWING THE SALMON-PACK OF THE PROVINCE, BY DISTRICTS AND SPECIES, FROM 1919 TO 1934, INCLUSIVE—*Contd.*

TOTAL PACKED BY DISTRICTS IN 1919 TO 1934, INCLUSIVE.

	1934.	1933.	1932.	1931.	1930.	1929.	1928.	1927.
Fraser	273,139	199,082	123,641	73,067	277,983	426,473	258,224	284,378
Skeena	284,096	185,463	233,711	162,986	450,377	220,245	298,709	187,716
Rivers Inlet	86,000	93,220	81,709	88,874	138,980	75,126	81,527	69,773
Smith Inlet	41,256	71,714	27,142	14,094	52,185	11,014	34,150	29,363
Nass River	75,213	60,434	85,671	32,881	113,460	29,185	104,877	39,828
Vancouver Island	372,347	353,025	205,930	175,541	340,395	294,854	390,470	373,463
Other Districts	451,815	302,111	320,227	137,661	848,439	341,873	901,822	405,476
Grand totals	1,583,866	1,265,049	1,081,031	685,104	2,221,819	1,398,770	2,035,629	1,360,634

	1926.	1925.	1924.	1923.	1922.	1921.	1920.	1919.
Fraser	274,951	276,855	212,059	226,869	140,570	107,650	136,661	167,944
Skeena	407,524	348,859	390,858	338,863	477,915	234,765	332,787	398,877
Rivers Inlet*	98,105	217,900	117,445	132,274	79,712	59,272	157,522	80,367
Smith Inlet	18,917	33,998	11,776	11,979	5,862	.....	.....	.....
Nass River	92,749	89,008	142,939	99,580	124,071	51,765	81,153	97,512
Vancouver Island	347,722	263,904	277,267	191,252	185,524	69,528	84,170	267,293
Other Districts	844,139*	522,756	604,745	352,839	278,144	80,568	395,223	381,163
Grand totals	2,035,190	1,719,282	1,745,213	1,341,677	1,285,946	603,548	1,187,616	1,393,156

* Including 17,921 cases of sockeye packed at Smith Inlet.

STATEMENT SHOWING THE SOCKEYE-PACK OF THE ENTIRE FRASER RIVER SYSTEM FROM 1894 TO 1934, INCLUSIVE.

	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Fraser River, B.C.	363,967	395,984	356,984	860,459	240,000	486,409	170,889	974,911	293,477
State of Washington	41,781	65,143	72,979	312,048	252,000	499,646	228,704	1,105,096	339,556
Totals	405,748	461,127	429,963	1,172,507	492,000	986,055	399,593	2,080,007	633,033

	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.
Fraser River, B.C.	204,809	72,688	837,489	183,007	59,815	74,574	585,435	150,432	58,487
State of Washington	167,211	123,419	837,122	182,241	96,974	170,951	1,097,904	248,014	127,761
Totals	372,020	196,107	1,674,611	365,248	156,789	245,525	1,683,339	398,446	186,248

	1912.	1913.	1914.	1915.	1916.	1917.	1918.	1919.	1920.
Fraser River, B.C.	123,879	719,796	198,183	91,130	32,146	148,164	19,397	38,854	48,399
State of Washington	184,680	1,673,099	335,230	64,584	84,637	411,538	50,723	64,364	62,654
Totals	308,559	2,392,895	533,413	155,714	116,783	559,702	70,420	103,200	111,053

	1921.	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.
Fraser River, B.C.	39,631	51,832	31,655	39,743	35,385	85,689	61,393	29,299	61,569
State of Washington	102,937	48,566	47,402	69,369	112,023	44,673	97,594	61,044	111,898
Totals	142,598	100,398	79,057	109,112	147,408	130,362	158,987	90,343	173,464

	1930.	1931.	1932.	1933.	1934.				
Fraser River, B.C.	103,692	40,947	65,769	52,465	139,238	.....	.....	.....	.....
State of Washington	352,194	87,211	81,188	126,604	352,579	.....	.....	.....	.....
Totals	455,886	128,158	146,957	179,069	491,817	.....	.....	.....	.....

STATEMENT SHOWING THE SOCKEYE-PACK OF THE PROVINCE, BY DISTRICTS, 1919 TO 1934, INCLUSIVE.

	1934.	1933.	1932.	1931.	1930.	1929.	1928.	1927.
Fraser River	139,238	52,465	65,739	40,947	103,692	61,569	29,299	61,393
Skeena River	70,655	30,506	59,916	93,023	132,372	78,017	34,559	83,996
Rivers Inlet	76,923	83,507	69,732	76,428	119,170	70,260	60.044	65,269
Smith Inlet	14,607	37,369	25,488	12,867	32,057	9,683	33,442	22,682
Nass River	28,701	9,757	14,154	16,929	26,405	16,077	5,540	12,026
Vancouver Island	27,282	18,397	27,611	22,199	24,784	10,340	14,248	24,835
Other Districts	20,438	26,106	21,685	29,071	39,198	35,331	26,410	37,851
Totals	377,844	258,107	284,355	291,464	477,678	281,277	203,542	308,052

	1926.	1925.	1924.	1923.	1922.	1921.	1920.	1919.
Fraser River	85,689	35,385	39,743	31,655	51,832	39,631	48,399	38,854
Skeena River	82,330	81,146	144,747	131,731	96,277	41,018	89,064	184,945
Rivers Inlet	65,581	192,323	94,891	116,850	53,584	48,615	125,742	56,258
Smith Inlet	17,921	33,764	11,435	11,864	.....	.....	.....	.....
Nass River	15,929	18,945	33,590	17,821	31,277	9,364	16,740	28,259
Vancouver Island	25,070	14,757	15,618	12,006	15,147	6,933	6,987	6,452
Other Districts	44,462	16,198	20,579	12,720	47,107	18,350	64,473	54,677
Totals	337,012	392,518	369,603	334,647	295,224	163,914	351,405	369,445

STATEMENT SHOWING THE PILCHARD INDUSTRY OF THE PROVINCE, 1920 TO 1934, INCLUSIVE.

Year.	Total Catch.	Canned.	Used in Reduction.	Oil.	Meal.	Bait.
	Cwt.	Cases.	Cwt.	Gals.	Tons.	Bbls.
1920	88,050	91,929	.....	.....	.....	9,937
1921	19,737	16,091	.....	.....	.....	4,232
1922	20,342	19,186	.....	.....	.....	3,125
1923	19,492	17,195	.....	.....	.....	3,625
1924	27,485	14,898	.....	.....	.....	923
1925	318,973	37,182	220,000	495,653	2,083	4,045
1926	969,958	26,731	940,000	1,898,721	8,481	2,950
1927	1,368,582	58,501	1,310,000	2,610,120	12,145	1,737
1928	1,610,252	65,097	1,560,000	3,997,656	14,502	2,149
1929	1,726,851	98,821	1,654,575	2,856,579	15,823	1,538
1930	1,501,404	55,166	1,438,840	3,204,058	13,934	926
1931	1,472,085	17,336	1,456,846	2,551,914	14,200	1,552
1932	886,964	4,622	876,700	1,315,864	8,842	1,603
1933	65,353	2,946	63,251	275,879	1,108	20
1934	860,103	35,437	845,849	1,612,526	7,628	40

PRODUCTION OF FISH OIL AND MEAL, 1920 TO 1934 (OTHER THAN FROM PILCHARD).

Year.	From Whales.			From other Sources.	
	Whalebone and Meal.	Fertilizer.	Oil.	Meal and Fertilizer.	Oil.
	Tons.	Tons.	Gals.	Tons.	Gals.
1920	503	1,035	604,070	466	55,669
1921	-----	------	----------	489	44,700
1922	326	230	283,314	911	75,461
1923	485	910	706,514	823	180,318
1924	292	926	645,657	1,709	241,376
1925	347	835	556,939	2,468	354,853
1926	340	666	468,206	1,752	217,150
1927	345	651	437,967	1,948	250,811
1928	376	754	571,914	3,205	387,276
1929	417	780	712,597	3,626	459,575
1930	273	581	525,533	3,335	243,009
1931	-----	------	----------	5,647	352,492
1932	-----	------	----------	6,608	231,690
1933	249	223	509,310	5,583	497,643
1934	340	631	813,724	2,916	371,271

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