PROVINCE OF BRITISH COLUMBIA

REPORT

OF THE

PROVINCIAL FISHERIES DEPARTMENT

FOR THE YEAR ENDED DECEMBER 31ST, 1943

WITH APPENDICES

PRINTED BY
AUTHORITY OF THE LEGISLATIVE ASSEMBLY.

VICTORIA, B.C.:
Printed by CHARLES F. BANFIELD, Printer to the King's Most Excellent Majesty.
1944.

To His Honour Colonel W. C. WOODWARD,
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, 1943, with Appendices.

GEORGE SHARRATT PEARSON,
Commissioner of Fisheries.

Provincial Fisheries Department,
Commissioner of Fisheries' Office,
Victoria, British Columbia.

Honourable George S. Pearson,
Commissioner of Fisheries, Victoria, B.C.

SIR,—I have the honour to submit herewith the Annual Report of the Provincial Fisheries Department for the year ended December 31st, 1943, together with Appendices.

I have the honour to be,
Sir,
Your obedient servant,

GEORGE J. ALEXANDER,
Assistant Commissioner.

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REPORT OF THE PROVINCIAL FISHERIES DEPARTMENT FOR 1943.

VALUE OF CANADIAN FISHERIES AND THE STANDING OF THE PROVINCES, 1942.

The value of the fisheries products of Canada for the year 1942 totalled $75,040,919. During that year British Columbia produced fisheries products to the value of $38,059,559, or 50.7 per cent. of Canada's total.

British Columbia in 1942 led all the Provinces in the Dominion in respect to the production of fisheries wealth. Her output exceeded that of Nova Scotia, the second in rank, by $22,762,113.

The market value of the fisheries products of British Columbia in 1942 was $6,327,522 more than in the year previous. There was an increase in the value of salmon amounting to $1,540,777.

The capital invested in the fisheries of British Columbia in 1942 was $34,848,940, or 55.8 per cent. of the total capital employed in fisheries in all of Canada. Of the total invested in the fisheries of British Columbia in 1942, $11,748,763 was employed in catching and handling the catches and $23,100,177 invested in canneries, fish-packing establishments, and fish-reduction plants.

The number of persons engaged in British Columbia fisheries in 1942 was 19,138, or 24.8 per cent. of Canada's total fishery-workers. Of those engaged in British Columbia, 12,199 were employed in catching and handling the catches and 6,939 in packing, curing, and in fish-reduction plants. The total number engaged in the fisheries in British Columbia in 1942 was 1,007 more than in the preceding year.

The following statement gives in the order of their rank the value of fishery products of the Provinces of Canada for the years 1938 to 1942, inclusive:—

Province.	1938.	1939.	1940.	1941.	1942.
British Columbia	$18,672,750	$17,698,980	$21,710,167	$31,732,037	$38,058,559
Nova Scotia	8,804,231	8,753,548	9,843,326	12,634,832	15,297,446
New Brunswick	3,996,064	5,082,393	4,956,618	6,484,831	7,088,302
Ontario	3,353,775	3,007,315	3,035,100	3,518,402	4,194,092
Quebec	1,957,279	2,010,953	2,002,053	3,233,115	4,103,345
Manitoba	1,811,124	1,655,273	1,988,545	2,842,041	3,577,616
Prince Edward Island	930,874	950,412	714,870	952,026	1,639,539
Saskatchewan	468,646	478,511	450,574	440,444	585,782
Alberta	492,943	430,724	403,510	414,942	492,182
Yukon	5,290	4,867	4,994	6,652	3,056
Totals	$40,492,976	$40,072,976	$45,118,757	$62,258,872	$75,040,919

SPECIES AND VALUE OF FISH CAUGHT IN BRITISH COLUMBIA.

The total marketed value of each of the principal species of fish taken in British Columbia for the years 1938 to 1942, inclusive, is given in the following table:—

Species.	1938.	1939.	1940.	1941.	1942.
Salmon	$14,491,285	$12,994,812	$13,757,091	$20,879,104	$22,419,881
Halibut	1,041,165	1,305,542	1,397,999	1,650,731	1,985,705
Halibut-livers	231,220	193,148	172,999	470,958	243,113
Carried forward	$15,763,670	$14,493,502	$15,328,089	$23,000,793	$24,648,699

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

Species.	1938.	1939.	1940.	1941.	1942.
Brought forward	$15,763,670	$14,493,502	$15,328,089	$23,000,793	$24,648,699
Herring	855,265	2,198,912	4,426,390	4,665,260	8,223,754
Pilchard	867,007	100,693	632,393	1,781,876	2,016,607
Cod, ling	351,324	357,990	359,798	398,316	676,903
Clams	162,508	50,937	77,944	98,970	155,965
Black cod	71,297	79,419	132,822	189,527	193,840
Crabs	54,572	61,633	80,628	83,253	104,021
Soles	37,679	39,826	46,866	30,470	42,670
Shrimps	18,985	12,246	16,354	8,115	7,222
Oysters	37,453	59,976	60,596	116,111	57,862
Abalones	.....	1,340	2,002	.....	.....
Flounders	6,767	5,934	27,851	14,555	24,829
Red cod	22,286	10,693	14,574	15,832	51,375
Perch	3,942	3,752	3,235	3,095	8,042
Smelt	6,884	4,388	7,491	5,920	2,552
Sturgeon	3,013	2,459	2,460	3,675	1,965
Octopus	1,016	441	555	986	390
Skate	2,467	3,026	3,452	2,478	5,235
Oolachans	760	1,792	3,887	1,492	8,960
Whiting	62	32	88	25	7
Sardines	.....	.....	.....	47,086	.....
Trout	.....	.....	.....	.....	.....
Grayfish, etc.—					
Fresh	2,310	.....	.....	13,117	.....
Livers	.....	.....	.....	29,328	23,250
Liver-oil	.....	.....	.....	531,355	1,178,242
Body-oil	.....	.....	.....	29,569	31,135
Oil	68,073	44,072	146,112	.....	.....
Meal	42,807	36,322	63,210	69,062	60,872
Whales	184,074	.....	137,624	298,349	178,667
Fur-seals	3,076	1,465	.....	.....	.....
Miscellaneous	105,453	77,515	14,050	61,686	68,040
Anchovies	.....	10,417	119,035	162,159	80,295
Tuna	.....	40,198	567	804	.....
Shark-livers	.....	.....	2,094	44,860	42,194
Shark-liver oil	.....	.....	.....	23,913	165,966
Totals	$18,672,750	$17,698,980	$21,710,167	$31,732,037	$38,059,559

VALUE OF BRITISH COLUMBIA FISHERIES SHOWS SUBSTANTIAL DECREASE.*

The value of the fisheries of British Columbia in 1943 amounted to $32,477,964, a decrease of $5,581,595 or 15 per cent. as compared with 1942. The salmon-fishery, the most important single fishery in the Dominion, showed a decrease of 407,766 cwt. or 25 per cent. in the quantity caught. The decrease in landed value was $5,592,983 or 44 per cent., and that in marketed value was $7,679,583 or 34 per cent. The total production value of salmon was $14,740,298, or over 45 per cent. of the total value of the fisheries production of the Province.

Herring, the second fishery in point of value, showed a decrease of 496,884 cwt. or 21 per cent. in the quantity landed, an increase in the landed value of $117,958 or 9 per cent., but a decrease in the marketed value amounting to $414,124 or 5 per cent. The total production was valued at $7,809,630.

Halibut registered an increase of 15 per cent. in the quantity caught, 51 per cent. in the landed value, and 24 per cent. in the value as marketed; and pilchards increased 35 per cent. in catch, 112 per cent. in landed value, and 37 per cent. in value marketed.

* NOTE.—These figures are taken from the Advance Report on British Columbia Fisheries, Dominion Department of Statistics, Department of Trade and Commerce.

Grayfish showed a decrease in quantity caught but an increase in the marketed value of liver oil sufficient to more than compensate for declines in the values of meal and industrial oil, the final value of all grayfish products amounting to $2,106,470, or nearly 63 per cent. more than in 1942.

The total value of fish taken, including shell-fish, was 5,230,536 cwt., a decrease of 480,839 cwt. from the 5,711,375 cwt. taken in 1942, and the value to fishermen at the point of landing was $15,475,494, a decrease of 16 per cent. from the previous year.

CAPITAL, EQUIPMENT, AND EMPLOYEES.

Capital.—The value of the capital invested in the fisheries in 1943 was $31,704,610, a decrease of $3,268,754 or 9 per cent. from the 1942 figure of $34,973,364. The amount invested in vessels and gear required for landing operations was $12,800,020 and that in fish-processing establishments was $18,904,590.

Employees.—There were 11,903 persons engaged in primary and 6,011 in secondary operations in 1943, a total of 17,914 for the industry. There were 296 fewer persons engaged in catching and landing the fish and 945 fewer persons in the processing end of the industry.

THE CANNED-SALMON PACK FOR BRITISH COLUMBIA FOR 1943.

The total pack of canned salmon put up in British Columbia in 1943 amounted to 1,258,221 cases, according to returns made by the licensed canners to the Provincial Fisheries Department. The 1943 pack was 553,337 cases less than the pack of the year previous and 416,077 cases below the five-year average. The 1943 pack of British Columbia canned salmon was the smallest pack put up in British Columbia since 1932, when 1,081,031 cases were packed. This latter comparison is most significant when it is remembered that the years 1931, 1932, and 1933 were depression years in which the salmon-canners curtailed their packs because of lack of markets. In 1943 the very opposite pressure was in effect, in that every effort was made to produce as much canned salmon as possible. The small pack in 1943 was due entirely to the small run of salmon appearing in the waters off the British Columbia coast in that fishing season.

As pointed out in the pages of this report for 1942, the canned-salmon industry of British Columbia is now, to all intents and purposes, a war industry, due to the heavy demand for British Columbia canned salmon by the British Ministry of Food as a war ration. To this end the Federal and Provincial Governments again exercised control within their respective jurisdictions over the fishery with a view to diverting to the salmon-canneries as much of the salmon-catch as possible.

The canned-salmon pack in 1943 consisted of 164,889 cases of sockeye, 10,658 cases of springs, 3,095 cases of steelheads, 186,043 cases of cohoe, 530,189 cases of pinks, and 363,347 cases of chums. An examination of the pack figures by species shows the sockeye-catch of 164,889 cases to be the smallest pack of this species since 1921, when 163,914 cases were canned. It will be recalled that the year 1921 was also a depression year, which may account for the small pack. The 1943 pack of 164,889 cases was 104,998 cases less than the pack four years previous, the cycle-year for most British Columbia sockeye runs. It was also 219,720 cases less than the average for the previous five years. A breakdown of the total sockeye-pack figures for 1943 will be found under the section of this report dealing with British Columbia's canned-salmon pack by districts.

In 1943 there were canned 10,658 cases of spring salmon compared with 24,744 cases in the year previous. This was the smallest pack of spring salmon produced in British Columbia in recent past years and was 13,508 cases less than the average for the previous five years.

Steelhead are trout and not salmon, but a few are caught and canned incidental to salmon fishing and canning operations each year and are accordingly mentioned in the

pages of this report. In 1943 there were canned 3,095 cases of steelheads, compared with 4,649 cases in 1942 and 3,454 cases in 1941.

The cohoe-pack in 1943 amounted to 186,043 cases. This was 25,095 cases less than were canned the year previous and 38,479 cases less than in 1940, the cycle-year for this species. The 1943 figure was 73,420 cases less than the average annual pack of this species for the previous five years. Included in the 186,043 cases of cohoe for 1943 are 14,059 cases of bluebacks.

The pink-salmon pack for 1943 was 530,189 cases, compared with 270,622 cases in the year previous and 427,774 cases for the cycle-year. The 1943 pack of this species was 117,572 cases above the average for the previous five-year period.

The canned chum-salmon pack of 363,347 cases in 1943 was disappointing, particularly in view of the Government's desire for a large pack of all species to meet the requirements of the British Ministry of Food. The 1943 pack of chum salmon was the smallest pack of this species since 1933, in which year 293,630 cases were canned. The 1943 pack was 270,487 cases less than in the year previous and 23,243 cases less than were canned in 1939, the cycle-year for this species. The 1943 pack was also 226,188 cases below the average chum-salmon pack for the previous five years.

BRITISH COLUMBIA'S CANNED-SALMON PACK BY DISTRICTS.

Fraser River System.

The total Canadian pack of all varieties of salmon canned from Fraser River caught fish in 1943 amounted to 126,541 cases, compared with the record pack of the year previous when 549,617 cases of all varieties were canned. The 1943 pack consisted of 31,973 cases of sockeye, 3,505 cases of springs, 244 cases of steelheads, 8,809 cases of cohoes, 29,860 cases of pinks, and 52,149 cases of chums.

Sockeye Salmon.—In 1943 the total pack of canned sockeye salmon produced from Fraser River caught fish by Canadian and American canners amounted to 51,089 cases. This was the smallest sockeye-pack on the Fraser River on record. Of the total 1943 catch by Canadian and American fishermen, the Canadian catch was 31,973 cases, while the American fishery in the State of Washington caught sufficient sockeye to fill 19,116 cases. The catch percentages of the fishermen of the two countries are 62.58 for the Canadian fleet and 37.42 for the American fleet. These figures are remarkably close to the percentage catch figures for the year previous when Canadian fishermen took 62.8 per cent. and American fishermen caught 37.2 per cent. For convenience the percentages for the Fraser River sockeye-catch by American and Canadian fishermen are tabulated below:—

	American. Per Cent.	Canadian. Per Cent.
1930	78.00	22.00
1931	68.00	32.00
1932	55.00	45.00
1933	71.00	29.00
1934	72.00	28.00
1935	47.00	53.00
1936	25.00	75.00
1937	38.00	62.00
1938	42.00	58.00
1939	44.50	55.50
1940	37.50	62.50
1941	39.30	60.70
1942	37.20	62.80
1943	37.42	62.58

The Canadian pack of sockeye on the Fraser River in 1943 was the smallest Canadian pack for this cycle since 1923, when 31,655 cases were canned, and was the smallest British Columbia pack of Fraser River sockeye of any cycle since 1928, when 29,299 cases were canned. The sockeye run to the Fraser River in 1943 was derived from the spawning of 1939 and, according to reports from the various spawning areas for that year, a large run could hardly be expected in 1943.

Notwithstanding the small pack in 1943, however, according to the reports submitted to the Chief Supervisor for the Federal Department of Fisheries, the spawning in most of the sockeye-streams in the Fraser River watershed was particularly good. In the Fraser-Francois Lake watershed it is estimated that 13,000 salmon spawned in 1943 as against 2,000 in the brood-year. In the Stuart Lake system the seeding was estimated at five times greater than that of the brood-year, while the increase in the Chilko River system for the brood-year was estimated to be 100 per cent. The Pemberton area also had a heavy seeding. The escapement, however, to the Shuswap area and the Cultus Lake system was reported as disappointing, while the seeding in the Harrison system was described as light. It would appear from the escapement of sockeye to the spawning-beds in the upper reaches of the Fraser River watershed that the runs were not impeded to any extent on their passage through Hell's Gate in 1943.

Spring Salmon.—There were 3,505 cases of spring salmon canned from Fraser River caught fish in 1943, compared with 9,688 cases in 1942. In comparing the figures for these two pack-years the 1943 pack seems small, but if one examines the tables for the pack figures which are listed in the Appendix to this report it will be observed that the 1943 pack of spring salmon was not unduly small. On the Fraser River, as elsewhere in British Columbia, the spring-salmon pack figures are not indicative of the size of the catch.

Cohoe Salmon.—In 1943 the cohoe-pack on the Fraser River was sufficient to fill 8,809 cases. This is compared with 10,542 cases in 1942. The 1943 cohoe-pack was the smallest pack for this cycle since 1931 and was disappointing.

Pink Salmon.—Pink salmon make their appearance on the Fraser River every alternate year, the runs coinciding with the odd-numbered years. The year 1943 was expected to produce a fairly large pack of pink salmon. However, the run was practically a failure and only 29,860 cases of pink salmon were canned from Fraser River caught fish. This was particularly disappointing in view of the very short pack of sockeye produced by this same river system. In 1941, the cycle-year, there were 102,388 cases of pink salmon canned from Fraser River caught fish, while in 1939 the pack was 95,176 cases and in 1937, 94,010 cases. Not since 1931 has the Fraser River produced such a small pack of pinks and in that year the small pack was not due in any way to the run, but purely to depressed market conditions.

The reader is referred to the spawning report of the Chief Supervisor of Fisheries for the Federal Department, published in the Appendix to this report, for details of the escapement of pink salmon to the spawning-beds.

Chum Salmon.—There were 52,149 cases of chum salmon canned from fish caught and credited to the Fraser River. It was hoped that the Fraser River would have produced a larger pack of chums in 1943, particularly in view of the short pack of sockeye and pink salmon, but comparing the 1943 pack with the cycle-year 1939, a large pack was probably too much to hope for as in that year the pack amounted to only 30,150 cases. The 1943 pack was considerably lower than the packs for both the years 1941 and 1942, in which years 95,070 cases and 82,573 cases respectively were packed. The large packs in these two latter years, however, do not necessarily mean that the runs in these years were greater than in previous years, but rather reflect Government policy in diverting as much of the salmon-catch as possible to the canneries for shipment to Britain as canned salmon. In pre-war years large quantities of Fraser River chum

salmon were salted and frozen, which naturally reduced the size of the canned-salmon pack. While salteries have not been permitted to operate in British Columbia since 1939, it is believed that a larger portion of the Fraser River catch of chum salmon was frozen in 1943 than in the immediately preceding years.

In any consideration of the canned-salmon pack as an indication of the size of the run, it is important that the escapement to the spawning areas of the particular river system should also be considered. The reader is referred to the report of the Federal Department's Chief Supervisor of Fisheries on the salmon-spawning beds of the Province, which is published in full in the Appendix to this report.

Skeena River.

The total pack of all varieties of salmon caught on the Skeena River in 1943 amounted to 133,589 cases. This is compared with a pack of 152,418 cases in the year previous and 200,497 cases in 1941. The Skeena River pack in 1943 was composed of 28,268 cases of sockeye, 1,783 cases of springs, 1,952 cases of steelheads, 40,479 cases of cohoe, 54,509 cases of pinks, and 6,597 cases of chums.

Sockeye Salmon.—The 1943 pack of sockeye salmon for the Skeena River, amounting to 28,268 cases, was the smallest pack of this species on record. It was 6,276 cases less than for 1942 and 2,238 cases below the very short pack of 1933, the previous low for this species.

The 1943 pack was largely derived from the spawning of 1938 and 1939, in which years the packs amounted to 47,257 cases and 68,485 cases respectively. Reports from the Chief Supervisor of Fisheries on the spawning conditions in these two years would indicate better than average spawning. For 1938 the Chief Supervisor says, "The sockeye escapements to the most important areas, such as Babine and Lakelse, have been gratifying during the season under review." And in dealing with the escapement to the spawning-grounds for the Skeena River in 1939 the Chief Supervisor's report says, in part, "The local Inspector states that there is no question but that there has been one of the greatest escapements of sockeye in the Babine Lake and River sections of the spawning-grounds this year as has been experienced for nearly a decade." Farther on the Chief Supervisor says, "There is no doubt but that the lowering of the fishing-boundary on the Skeena River some 7 miles four years ago is obtaining the results desired in the way of increased escapement." In view of the apparently satisfactory escapements in the years 1938 and 1939, the short pack in 1943 was doubly disappointing. Of the sockeye escapement to the spawning-beds in 1943 the Chief Supervisor says, in part, "The seeding by this variety, although in general being satisfactory, was below that of 1939."

The reader is referred to the "Spawning Report, British Columbia," which is contributed by the Chief Supervisor of Fisheries for the Federal Government and published in full in the Appendix to this report. The 1943 sockeye-pack on the Skeena River indicates conclusively that strong remedial measures must be immediately applied to this fishery if the Skeena River is to continue as an important sockeye-salmon fishery.

Spring Salmon.—The spring-salmon pack on the Skeena River in 1943, amounting to 1,783 cases, was the smallest pack of this species canned on the Skeena River in the last ten or twelve years. However, as pointed out in previous issues of this report, the canned-salmon pack figures for this species do not necessarily indicate the size of the run, as spring salmon find an outlet in the fresh- and frozen-fish trade. The packs of this species canned on the Skeena River in recent years are as follows: 1942, 6,374 cases; 1941, 4,985 cases; 1940, 6,118 cases; 1939, 4,857 cases.

Cohoe Salmon.—There were packed in 1943, 40,479 cases of cohoe salmon compared with 44,081 cases in the year previous; while in 1940, the cycle-year for this species, only 20,614 cases were canned. The 1943 pack was 3,484 cases above the average for the previous five years.

Pink Salmon.—The catch of pink salmon on the Skeena River in 1943 was sufficient to fill 54,509 cases. This was 7,208 cases greater than the quantity canned in 1940, the cycle-year for this species. The 1943 pack, however, was 5,561 cases less than the average for the previous five-year period.

Chum Salmon.—The chum-salmon pack on the Skeena River is never very large, although usually greater than the 6,597 cases packed in 1943. The packs of this species for recent years were as follows: 1942, 11,421 cases; 1941, 10,707 cases; 1940, 4,682 cases; and 1939, 7,773 cases.

In considering the canned-salmon pack on the various streams in British Columbia, due consideration must be given to the escapement to the spawning-beds. For this information the reader is referred to the "Spawning Report, British Columbia," by Major J. A. Motherwell, Chief Supervisor of Fisheries for the Federal Government, which is published in full in the Appendix to this report.

Nass River.

The total canned-salmon pack of all species of salmon caught on the Nass River in 1943 amounted to 52,333 cases. This was the smallest pack of salmon canned from Nass River caught fish since 1937, when 49,042 cases were canned, and was 47,809 cases less than were canned in 1942. The 1943 pack was made up of 13,412 cases of sockeye, 1,002 cases of springs, 335 cases of steelheads, 9,768 cases of cohoes, 17,669 cases of pinks, and 10,146 cases of chums. These figures disregard half cases in each instance.

Sockeye Salmon.—The 13,412 cases of sockeye salmon put up from Nass River caught fish in 1943 was the smallest sockeye-pack for this river system since 1935, when 12,712 cases were canned. The 1943 run of Nass River sockeye was derived from the spawnings of 1938 and 1939, in which years there were packed 21,462 cases and 24,357 cases respectively. In 1938 the Chief Supervisor of Fisheries' spawning report says that "Generally speaking, the seeding of this area was a heavy one." In 1939 the Chief Supervisor reported that "The total sockeye spawning on the Nass River was very satisfactory."

The reader is referred to the Chief Supervisor of Fisheries' report of the Nass River escapement which is published in the Appendix to this report. It will be noted that while the early run to the upper Nass was light, the seeding of the late run was similar to that reported in 1938 and better than the year 1939. In view of the size of the pack and reports from the spawning-grounds, the sockeye run to the Nass River in 1943 was somewhat disappointing, it being 6,096 cases less than the average for the previous five-year period.

Spring Salmon.—There is never a large pack of spring salmon caught on the Nass River. Those canned, generally speaking, are caught incidental to fishing for other varieties. The pack in 1943 of 1,002 cases, while somewhat less than the pack of this variety in 1942, was equal to the average for the previous five-year period.

Cohoe Salmon.—Sufficient cohoe salmon were caught on the Nass River in 1943 to make a pack of 9,768 cases. This was 5,719 cases less than were canned in the year previous and just a few cases less than were packed from Nass River caught fish in 1940, the cycle-year for this species. The cohoe-pack on the Nass River is never particularly large, although the 1943 pack was somewhat less than average.

The escapement to the spawning-beds was reported as being better than average.

Pink Salmon.—The Nass River produced a canned pink-salmon pack amounting to 17,669 cases. The 1943 run was produced from the smaller of the two pink-salmon cycles appearing on the Nass River, but the 1943 pack was somewhat less than the previous pack for this cycle. In 1941, the immediately preceding cycle-year, the pack amounted to 22,667 cases, while in 1939 the pack was 26,370 cases. In 1937 the pink-

salmon pack on the Skeena was only 8,031 cases. In 1943 the pink-salmon pack was 11,328 cases less than the average for this species packed on the Nass for the previous five years.

The escapement of pink salmon to the spawning-beds was reported as being very good.

Chum Salmon.—The Nass River has never been a large producer of chum salmon and the 1943 pack of 10,146 cases is compared with 12,518 cases in 1942, 6,246 cases in 1941, 5,461 cases in 1940, and 2,500 cases in 1939. The seeding of the spawning-beds by chum salmon in 1943 was reported as being above the average.

Rivers Inlet.

In Rivers Inlet in 1943 there were sufficient salmon of all varieties caught to fill 79,697 cases, compared with a total pack of 105,539 cases for the year previous. The 1943 Rivers Inlet salmon-pack was composed of 47,602 cases of sockeye, 765 cases of springs, 69 cases of steelheads, 11,466 cases of cohoe, 8,347 cases of pinks, and 11,448 cases of chums.

Sockeye Salmon.—The Rivers Inlet pack of 47,602 cases of sockeye salmon in 1943 was 31,597 cases less than the pack of this species for 1942, but was only 6,541 cases below the sockeye-pack in Rivers Inlet in 1939, the cycle-year. The Rivers Inlet sockeye-pack in 1943 was disappointing, being 19,956 cases less than the average for the previous five-year period. It is indicated in the Chief Supervisor of Fisheries' spawning report that the escapement to the spawning-beds was not particularly satisfactory.

Spring Salmon.—Spring salmon are caught and canned in Rivers Inlet only incidental to fishing for other varieties. On this account the pack is never large. The 765 cases of spring salmon packed in this district in 1943 is compared with 985 cases in 1942, 1,692 cases in 1941, 1,226 cases in 1940, and 745 cases in 1939.

Cohoe Salmon.—The run of cohoe salmon to Rivers Inlet is never large. The 1943 season produced a pack of 11,466 cases. This is compared with 11,561 cases in 1940, the cycle-year for this species. With the exception of the large pack in 1941, in which year 23,202 cases were packed, the 1943 pack compares quite favourably. The pack in 1942 was 8,467 cases and in 1939, 10,974 cases. It might be well to mention at this point that the 1941 pack of 23,202 cases was the largest pack of cohoes put up from Rivers Inlet caught fish for many years. The escapement to the spawning-beds apparently was light.

Pink Salmon.—Pink salmon do not frequent Rivers Inlet in great numbers but are caught and canned each year to some extent. However, the pack is never large and the 8,347 cases canned from Rivers Inlet caught fish in 1943 was the largest pack since 1939, when 12,095 cases were canned. The 1943 run belongs to the same cycle as the 1939 run. In 1941, the cycle following 1939 and immediately preceding 1943, the pack amounted to 4,807 cases.

Chum Salmon.—Again in 1943 as in 1942 and 1941, the pack of chum salmon from Rivers Inlet caught fish was larger than is ordinarily the case and, no doubt, reflects the increased effort on the part of the fishermen and the canners to supply the British market with as much canned salmon as possible. The 1943 pack of 11,448 cases is compared with 15,874 cases in 1942 and 15,442 cases in 1941. The average annual pack of chum salmon in Rivers Inlet for the five-year period 1936 to 1940 was 8,633 cases. The Chief Supervisor of Fisheries reports a medium escapement to the spawning-beds for this species.

Smith Inlet.

Smith Inlet is primarily a sockeye-fishing area and, while some seining for chum salmon is carried on in this inlet during the fall of the year, the catch of chums has never been a large one. Other varieties of salmon canned from Smith Inlet caught

fish have been taken incidental to fishing for sockeye salmon. The pack of Smith Inlet caught salmon in 1943 was composed of 15,010 cases of sockeye, 118 cases of springs, 24 cases of steelheads, 541 cases of cohoe, 556 cases of pinks, and 5,693 cases of chums.

Sockeye Salmon.—The 15,010 cases of sockeye salmon canned from Smith Inlet caught fish in 1943 is compared with 15,939 cases in 1942 and 21,495 cases in 1941. The Smith Inlet run in 1943 was derived largely from the sockeye run to this inlet in 1939, in which year the pack amounted to 17,833 cases. In 1943 the seeding was reported to have been equal to that of 1938, in which year it was reported as "being most encouraging."

Spring Salmon.—In 1943, 118 cases of spring salmon were caught and canned in Smith Inlet. As mentioned above, this is not a spring salmon area, the catch of this species each year is taken incidental to fishing for sockeye salmon.

Cohoe Salmon.—Cohoe salmon are never taken in large numbers in Smith Inlet. The catch in 1943 was no exception, 541 cases having been canned. This figure is compared with 1,813 cases in 1942, 1,955 cases in 1941, and 1,102 cases in 1940.

Pink Salmon.—Pink salmon are also not taken in numbers in Smith Inlet. In 1943, 556 cases were canned, compared with 527 cases in 1942 and 749 cases in 1941, the cycle-year.

Chum Salmon.—In recent years some seining has been done in Smith Inlet in the fall of the year for chum salmon. This is not a large fishery, however, and the pack of Smith Inlet caught chums in 1943, amounting to 5,693 cases, is compared with the previous years, 1942, 5,490 cases; 1941, 7,741 cases; 1940, 6,015 cases; and 1939, 2,771 cases. The escapement of chum salmon to the spawning-grounds was reported as being only medium.

Queen Charlotte Islands.

Salmon-fishing in the Queen Charlotte Islands, with the exception of trolling, is confined almost exclusively to seining for pinks and chums and some cohoe. The other varieties listed as canned from fish caught in this district are incidental to fishing for the above-named species. Chum salmon are caught in the Queen Charlotte Islands each year but pink salmon run to the streams in these islands only every alternate year, the run coinciding with the even-numbered years. There was no pink-salmon run to the Queen Charlotte Islands in 1943. The total pack of all varieties canned from Queen Charlotte Islands caught salmon in 1943 amounted to 53 cases of sockeye, 14,488 cases of cohoe, 313 cases of pinks, and 35,370 cases of chum salmon.

Cohoe Salmon.—The 14,488 cases of cohoe salmon canned from Queen Charlotte Islands caught fish in 1943 is compared with the 1942 pack of this species, in which year the pack amounted to 16,935 cases. The pack in 1941 was 27,241 cases while the pack in 1940, the cycle-year for this species, was 8,897 cases. A large part of the cohoe salmon comprising the pack of Queen Charlotte Islands cohoe is from troll-caught fish.

Chum Salmon.—The 35,370 cases of chum salmon packed from Queen Charlotte Islands caught fish was definitely disappointing. The 1943 pack was 10,149 cases less than were packed in 1939, the cycle-year, and 37,890 cases less than the average for the previous five-year period which, it will be observed, is not 50 per cent. of the average. The seeding of the various chum-salmon spawning-beds was also quite disappointing, the run in some rivers being reported as practically a failure, while in other streams the seeding is reported as light. In Skidegate Inlet the run to the spawning-grounds was medium to heavy and Salmon Creek was reported to have received the best seeding in the last twenty years.

Central Area.

For statistical purposes the Central area comprises all the salmon-fishing areas off the coast of British Columbia between Cape Calvert and the Skeena River, except Rivers Inlet. The total pack of all varieties of salmon canned from fish caught in this

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area in 1943 amounted to 445,900 cases, comprising the following: Sockeye, 21,101 cases; springs, 547 cases; steelheads, 397 cases; cohoes, 26,645 cases; pinks, 288,109 cases; and chums, 109,101 cases.

Sockeye Salmon.—The principal sockeye-fishing areas in the Central area are Fitzhugh Sound, Burke and Dean Channels, although some sockeye are taken in the vicinity of Banks Island, Principe Channel, and in the Gardner Canal. The 21,101 cases of sockeye caught in the Central area in 1943 were 3,631 cases more than were canned in this area in the year previous, but were 2,424 cases less than the average annual pack of this species for the Central area for the previous five-year period. The sockeye-pack in the Central area in 1943 was disappointing when considered in relation to the pack figures for this area in past years. The reader is referred to the Chief Supervisor of Fisheries' spawning report, published in the Appendix to this report, for information on the escapement to the various spawning areas in this district.

Spring Salmon.—Spring salmon are caught and canned in this area but, as in other areas, this species is caught incidental to fishing for other varieties. There were 547 cases of spring salmon canned from fish caught in the Central area in 1943, compared with 723 cases in 1942, 460 cases in 1941, and 1,518 cases in 1940.

Cohoe Salmon.—The cohoe-salmon catch in the Central area in 1943 was sufficient to fill 26,645 cases. This was 4,629 cases less than were canned in 1942, and 23,241 cases less than in 1940, the cycle-year. The 1943 pack of cohoe salmon in the Central area was 12,845 cases less than the average annual pack of this species for the previous five years.

Pink Salmon.—The Central area is a large producer of pink salmon, although in recent years the pack has varied over wide limits. In the pages of this report for 1942 it was pointed out that in that year and in the year previous the pink-salmon runs were so disappointing as to constitute almost a failure. In 1942 the pack was 69,434 cases and in 1940 the pack amounted to only 54,478 cases. In 1943, the year under review, the pack of 288,109 cases is most encouraging. Notwithstanding the large catch of pink salmon in the Central area in 1943, reports from the principal spawning areas indicate that the escapement was also particularly good. Conditions in the Central area in 1943 in respect to pink salmon illustrate very graphically the recuperative powers of this species when conditions are suitable.

Chum Salmon.—The Central area in 1943 produced a pack of 109,101 cases of chums. This was 29,949 cases greater than the pack for this area in 1942 and was also 29,717 cases more than were packed in 1939, the cycle-year for this species, and was 8,096 cases above the average annual pack for the previous five years.

The reader is referred to the Chief Supervisor of Fisheries' spawning report in the Appendix to this report for details of the escapement to the spawning-beds in the Central area.

VANCOUVER ISLAND.

In 1943 a total of 347,710 cases of all varieties of salmon were canned and credited to the Vancouver Island district. This was 189,093 cases less than in the year previous and was the smallest pack of salmon canned from Vancouver Island caught fish since 1932, in which year it will be recalled canning activities were greatly curtailed due to economic conditions. The Vancouver Island 1943 pack consisted of 7,185 cases of sockeye, 2,937 cases of springs, 74 cases of steelheads, 73,846 cases of cohoes, 130,825 cases of pinks, and 132,843 cases of chums.

Sockeye Salmon.—The 7,185 cases of sockeye salmon canned and credited to the Vancouver Island area was a most disappointing feature of the Vancouver Island salmon-fishery for 1943. The average annual catch for the previous ten years amounted to 26,888 cases. The 1943 pack was 44,776 cases less than the year previous and was the smallest sockeye-pack in the history of the Vancouver Island fishery. The reader is

again referred to a detailed report of the sockeye-salmon spawning areas of Vancouver Island, contained in the Appendix to this report.

Spring Salmon.—Large quantities of spring salmon are caught in the waters off Vancouver Island each year. Most of these fish, however, are taken by troll and enter the fresh- and frozen-fish trade. The canned spring-salmon pack consisted principally of salmon taken in the seines while fishing for other varieties. In 1943 these fish produced a pack of 2,937 cases, compared with 5,407 cases in 1942, 8,038 cases in 1941, 2,454 cases in 1940, and 2,889 cases in 1939.

Cohoe Salmon.—In 1943 the Vancouver Island area produced a pack of 73,846 cases of cohoe salmon. This was the smallest pack of this species from Vancouver Island caught fish since 1937. This is compared with 81,837 cases in 1942, 166,908 cases in 1941, and 88,885 cases in 1940—the cycle-year. In the previous cycle-year, 1937, the pack of cohoes amounted to 58,244 cases. The figures for the Vancouver Island cohoe-pack include 14,059 cases of bluebacks.

Pink Salmon.—In 1943, 130,825 cases of pink salmon were canned from Vancouver Island caught fish, compared with 177,292 cases in 1941—the cycle-year—and 235,119 cases in 1939. In the previous cycle, 1937, there were canned 318,780 cases. The reader will note the downward trend of these figures for the past four cycle-years.

Chum Salmon.—The chum-salmon pack credited to Vancouver Island in 1943 was most disappointing, there having been canned only 132,843 cases of this species. Compared with the records for previous years the 1943 pack constitutes almost a failure. The packs of chums credited to Vancouver Island for recent past years are as follows:—

	Cases.
1942	383,005
1941	593,016
1940	279,064
1939	212,949
1938	266,566
1937	203,900
1936	347,954

In comparing the Vancouver Island pack figures due consideration must be given to the fact that since the outbreak of hostilities the Provincial Government has declined to issue licences for salmon dry-salteries. The Federal Government has only permitted the export of chum salmon under permit. These actions were taken for the purpose of diverting as much as possible of the Vancouver Island chum-salmon catch to the canneries. When this fact is taken into consideration one will appreciate the disappointment in the Vancouver Island chum-salmon production in 1943.

In all cases where not specifically mentioned, the reader is referred to the Chief Supervisor of Fisheries' spawning report, which is printed in full in the Appendix to this report.

REVIEW OF BRITISH COLUMBIA'S SALMON-CANNING INDUSTRY, 1943.

The Provincial Fisheries Department licensed thirty salmon-canneries for operation in British Columbia in 1943. This was the same number as in the year previous. The operating canneries were located as follows:—

Queen Charlotte Islands	1
Skeena River	8
Central area	4
Rivers Inlet	1
Johnston Strait	2
Fraser River and Lower Mainland	11
West coast of Vancouver Island	3

While the same number of canneries operated in 1943 as in 1942, the locations of the operating canneries in 1943 were somewhat altered from the year previous. In the Queen Charlotte Islands one cannery operated in 1943 as in 1942. There were no canneries operating on the Nass River in 1943, although two canneries operated in this district in 1942. In 1943 the Skeena River District had eight operating canneries, while only six operated in 1942. The two new canneries operating on the Skeena River in 1943 were both located at, or in the vicinity of, Prince Rupert. In the Central area, Rivers Inlet, and Johnston Strait there were four, one, and two canneries respectively, operated as in the year previous. On the Fraser River and Lower Mainland in 1943 eleven canneries were in operation, while in 1942 twelve canneries were licensed to operate. On the west coast of Vancouver Island three licensed canneries operated in 1943, one more than in the year previous. The same factors were in effect in 1943 as in 1942 in respect to the smaller than usual number of salmon-canneries operating in the Province. Under ordinary circumstances two canneries would have operated on the Nass River in 1943. The shortage of technical help, however, has forced a consolidation wherever possible. Not only have companies been forced to close down a cannery and can the production in another cannery belonging to the same company, but different companies have been forced to enter into joint operations in different areas. All this, of course, has been voluntary, but it has been brought about by the shortage of labour. One cannery in the Queen Charlotte Islands at Pacofi, belonging to the British Columbia Packers, Limited, was destroyed by fire in 1943.

Probably the most outstanding feature of the salmon-canning operation in British Columbia in 1943 was the exceptionally large run of pink salmon which made its appearance in the vicinity of Namu, in the Central area. The fish were easily available to the fleet and for a time it was necessary to put the fishing-boats on a limit as the canneries were unable to cope with the large catches. The destination of this run of pink salmon was the Bella Coola district.

Another outstanding feature of the 1943 season was the almost complete failure of the run of pink salmon to the Fraser River. It was expected that the pink-salmon run to the Fraser in 1943 would have produced a pack in the neighbourhood of 100,000 cases, whereas the pack amounted to only 29,860 cases.

In 1943 the industry was again advised by the Federal Government that the British Ministry of Food would take the whole of British Columbia's salmon-pack. Later, arrangements were made to retain 200,000 cases for Canadian consumption. This was done and the balance of the British Columbia salmon-pack was taken over by the Canadian Government for the account of the British Ministry of Food. In order that as much as possible of the catch would be canned, similar restrictions, with slight modification, upon the disposal of salmon were in effect in 1943 as were successful in diverting most of the catch to the canneries in 1942. The Provincial Government again refused to permit the operation of salmon dry-salteries and the Federal Government also placed an embargo on the export of fresh salmon in certain categories, except under export permit. As a result of these measures the 1943 salmon-pack, as in the year previous, was, no doubt, larger than would otherwise have been the case. These facts should be taken into consideration when making comparisons between the canned-salmon pack figures for British Columbia for the years 1941 to 1943 with the canned-salmon packs of the years previous to these dates, otherwise the comparison might lead to erroneous conclusions.

OTHER CANNERIES (PILCHARD, HERRING, AND SHELL-FISH).

Pilchard.—The pilchard-canning industry in British Columbia is centred largely on the west coast of Vancouver Island, as it is in the waters off the shores of Vancouver Island where the principal pilchard-fishery is conducted. There are, however, some

pilchards canned in canneries located some distance from the fishing-grounds. The bulk of the pilchard-catch is reduced to meal and oil, but even previous to the war years there was a growing demand for canned pilchards. This demand has increased during the war years. The quantity of pilchards canned in any year is not indicative of the demand for this product, nor does it indicate the size of the pilchard-catch. Pilchards for canning are selected from the regular pilchard-catch and, due to the exigencies of this fishery, there is not always available a sufficient quantity of pilchards suitable for canning.

In 1943 there were five pilchard-canneries operated in British Columbia. In 1942 seven pilchard-canneries operated, while in 1941 five canneries were in operation. The five plants operating in 1943 produced 94,512 cases, compared with a production of 42,008 cases for seven plants in 1942 and 72,498 cases for five plants in 1941.

Herring.—Herring have been canned in British Columbia to some extent for a number of years, but the actual pack has never been large, due to a limited market for canned herring. Previous to 1939 the canned-herring pack averaged between 25,000 and 50,000 cases. In 1939, however, on the outbreak of hostilities, the demand for a high protein food in war-time was the means of stimulating the business of herring-canning and in that year the herring-canning industry of British Columbia assumed the proportions of a major industry, producing 418,021 cases. The continued demand from Britain for a low-cost high-protein food has resulted in maintaining the herring-canning industry at a comparatively high level. In order to assist in promoting as large a canned-herring pack as possible, the Provincial Government has maintained a policy of refusing to issue licences to plants utilizing herring, except herring-canneries, herring-reduction plants, and one or two pickled-herring plants on the understanding that the first call on the herring-catch was for the account of the herring-canneries. In certain localities where herring-reduction plants are permitted to operate, the operation is restricted to herring not suitable for canning or to plants located in districts where herring-canning machinery is not available. All this has had a tendency to increase the canned-herring pack.

In 1943 twenty-two herring-canneries operated, the same number as were licensed to operate in 1942. Only eighteen of these twenty-two licensed plants operated in 1942, however. The twenty-two plants operated in 1943 produced a pack of 1,198,632 cases, somewhat less than the pack of the year previous, when 1,253,978 cases were canned. In 1942 the total canned-herring production was for the account of the British Ministry of Food, but in 1943 a small part of the pack was retained for domestic consumption.

Shell-fish.—Shell-fish, principally clams and oysters, are canned in British Columbia to some extent. The operation, however, is never large, although the production fluctuates considerably. In 1943 three shell-fish canneries were licensed to operate, canning clams and abalone. The total pack of shell-fish canned in British Columbia in 1943 by these three canneries was 17,463 cases. This is compared with the production from four canneries in the year previous, when 22,267 cases of crabs and clams were canned. There was no crab canned in British Columbia in 1943.

MILD-CURED SALMON.

There were three tierced-salmon plants licensed to operate in British Columbia in 1943. In the year previous five plants were licensed to operate but only three got into production. The three plants operated in 1943 produced 856 tierces compared with 969 tierces in 1942. In 1941 four plants operated, producing a pack of 1,481 tierces.

DRY-SALT SALMON.

In each year previous to 1939 there have been varying amounts of chum salmon dry-salted for shipment to the Orient. In some years the production of dry-salt salmon

has reached fairly large proportions and in recent past years this industry has been controlled and regulated by the British Columbia Salt-fish Board, which Board is a scheme set up under the "Natural Products Marketing (British Columbia) Act." Chum salmon, normally, are fished in quantity in the fall of the year. There is, however, a considerable pack of canned chum salmon put up during the summer and early autumn months. Due to the increased demand occasioned by the war for inexpensive protein foods, such as canned salmon, the Provincial Government declined to issue salmon dry-saltery licences in 1939. For similar reasons the licences covering salmon dry-salteries were again refused by the Provincial Government in 1940. In 1941, and again in 1942, the demand of the British Government for a very large portion of the British Columbia salmon-pack made it imperative that as much as possible of the salmon-catch be diverted to the canneries. For this reason the Provincial Government again refused to issue licences covering salt-salmon operations and, as a consequence, no salmon were legally dry-salted in British Columbia in 1942. A small operation, not licensed, resulted in the prosecution of the operator.

For the above-noted reasons the British Columbia Salt-fish Board was again inoperative during the 1943 season and, on that account, no report of the British Columbia Salt-fish Board is included in this report. Again, in 1943, for the reasons stated above, the Provincial Government declined to issue licences covering salmon dry-saltery operations.

DRY-SALT HERRING.

Previous to the 1941 season, production of dry-salt herring was, in latter years, regulated by the British Columbia Salt-fish Board under the "Natural Products Marketing (British Columbia) Act." The total production of dry-salt herring in British Columbia was formerly shipped to the Orient, particularly to Japan, and from there quantities were re-exported to Manchukuo and China. Conditions in the Orient in recent years have reduced the quantity of dry-salt herring shipped to the Orient very considerably. Since 1940 the British Columbia Government has refused to issue herring dry-saltery licences in order to divert as much as possible of the herring-catch to the herring-canneries, which were all operating on British war orders for this commodity. There have been no herring dry-salteries operated in British Columbia since 1940.

PICKLED HERRING.

During World War I. the business of pickling herring in British Columbia attained fairly large proportions, particularly in Scotch cured herring. After the armistice, however, the business deteriorated rapidly and for many years no pickled herring were put up in British Columbia. The pickled-herring industry has been revived since the beginning of World War II., due to the fact that certain markets in the United States, which formerly obtained their supplies from Europe, have had to look elsewhere for this product.

In 1940, 5,500 barrels of pickled herring were put up in British Columbia. In 1941 there were three plants operating, which produced a pack of 3,095 barrels; in 1942 two plants were licensed to operate, producing a pack of 2,240 barrels; and in 1943 seven plants were licensed, five of which operated, producing 2,928 barrels of pickled herring.

In order to divert as much as possible of the east coast of Vancouver Island herring-catch to the herring-canneries for the production of canned herring for Britain, the Provincial Government again declined to permit pickled-herring plants to operate on fish caught on the east coast of Vancouver Island, except under special permission from the Chief Supervisor of Fisheries for the Federal Government.

HALIBUT PRODUCTION.

The halibut-fishery on the Pacific Coast of North America is regulated by the International Fisheries Commission and is shared in by the nationals of both Canada and the United States. The Commission regulates the fishery on a quota basis and on that account there is very little fluctuation in the amount of halibut landed from year to year. For the purpose of regulation the coast is divided into four areas, the principal areas, from the standpoint of production, being Areas Nos. 2 and 3. Area No. 2 comprises the waters off the Washington and British Columbia coasts from the approximate vicinity of Willapa Harbour in the south to Cape Spencer in the north. Area No. 3 comprises the waters from the northern boundary of Area No. 2 to the Aleutians. The other two areas, Nos. 1 and 4, from which production is very small, comprise the waters south of Area No. 2 and the Bering Sea respectively.

In 1943 the catch-limits set by the International Fisheries Commission were: For Area No. 2, 23,000,000 lb. and for Area No. 3, 27,500,000 lb.—a total of 50,500,000 lb., an increase over the year previous of 1,000,000 lb. of saleable halibut, exclusive of that quantity which is permitted to be taken incidental to fishing for other species under permit in Area No. 2 after that area's closure and before the closure of Area No. 3. The increase in the catch-limits in 1943 by areas was: 300,000 lb. in Area No. 2 and 700,000 lb. for Area No. 3. There are no catch-limits set by the Commission for Areas Nos. 1 and 4. These areas automatically close when the catch-limit has been taken in Areas 2 and 3. This is the second year in succession in which the International Fisheries Commission has increased the halibut catch-limits. In doing so in 1943 the Commission pointed out that the action was taken purely on account of the exigencies caused by the war and that there was a distinct possibility of the quotas being lowered when the nation's need for protein food was less demanding at the conclusion of hostilities. In addition to the quota of 50,500,000 lb. allowed by the International Fisheries Commission, permits are issued which allow vessels to land halibut caught incidental to fishing for other species in an area closed to halibut-fishing when halibut-fishing is permitted in another area.

The total landings of halibut by all vessels in 1943 amounted to 53,575,000 lb. Of this amount 24,696,000 lb were reported as being caught in Area No. 2 while 28,417,000 lb. were reported as having been taken in Area No. 3. Area No. 1 produced 462,000 lb., while no halibut were reported from Area No. 4. Canadian ports' share of this total was 25,022,000 lb., of which 11,682,000 lb. were caught in Area No. 2 and 13,340,000 lb. in Area No. 3.

The total halibut landings at Canadian ports by all vessels in 1942 was 24,559,216 lb. This amount was divided between Areas Nos. 2 and 3, Area No. 2 receiving 11,343,578 lb. while Area No. 3 produced 13,215,638 lb. in 1942.

The Canadian fleet in 1943 caught and landed a total of 12,830,000 lb. Of this amount 145,000 lb. were landed in American ports, while the balance, or 12,685,000 lb., was landed in Canadian ports. Of this amount 10,892,000 lb. were reported to have been caught in Area No. 2 while only 1,793,000 lb. were taken by Canadian vessels in Area No. 3. The 1943 Canadian production is compared with a total of 11,128,922 lb. in 1942.

In 1943 the average price of Canadian halibut in Prince Rupert was 17.6 cents per pound and the average price for all Canadian landings in all Canadian ports, including Prince Rupert, was 18 cents per pound.

Halibut-livers are still in high demand as a natural source of vitamins. These livers have been in increasing demand since the outbreak of war. The halibut fleet, in addition to saving the livers, now saves a portion of the viscera as well for the same purpose. Previous to 1942 we were able to give the value received by the fishermen for this commodity but, due to marketing arrangements presently in effect, final settle-

ment for all halibut livers and viscera has not been completed at the time of going to press. It is estimated, however, that the value of the livers to the halibut-fishermen for 1943 will amount to about $1,000,000, while it is estimated that the fishermen will receive in the neighbourhood of $4,000,000 for the viscera. It must be distinctly understood that these latter figures are estimates only.

The above figures are compiled from information supplied by the International Fisheries Commission, which information is gratefully acknowledged.

FISH OIL AND MEAL.

Fish-oil and edible fish-meal have been produced in British Columbia for a number of years, and previous to the war were an important branch of British Columbia's fisheries. Pilchard and herring have been the principal species used for the production of oil and meal but, since the outbreak of the war and the demand for natural sources of vitamins, other species have been found to yield oils of high vitamin content and the sharp demand for these products has increased activity in this field. Dogfish, dogfish-livers, shark-livers, codfish-livers, and cannery waste are all utilized for the production of fish and fish-liver oils, much of which is sold as medicinal oil. In addition to the medicinal oil produced, British Columbia fish-oils find an outlet in many manufacturing processes, such as the making of soaps, paints, linoleums, etc., while large quantities are also sold for the feeding of poultry and live stock.

Fish-liver Oils.—In 1942 the Provincial Fisheries Department for the first time required licences for the operation of fish-liver reduction plants. In that year nine plants were licensed to operate. These nine plants reported a production of 916,723 imperial gallons of high vitamin oils from fish-livers in 1942. Since these figures were published, however, it was noted that an error was made in the return of one of the producing companies and the corrected figure for the 1942 production is 392,612 imperial gallons. In 1943 nine plants were licensed to produce fish-oil from fish-livers. However, in that year only eight plants operated, producing 433,575 imperial gallons of high vitamin oil. The 1943 production, therefore, was 40,963 imperial gallons greater than in the year previous.

Pilchard Reduction.—The pilchard-fishery in British Columbia is conducted principally off the west coast of Vancouver Island and, while the bulk of the pilchard-catch is taken well offshore, in latter years the fishing-vessels have been proceeding farther south to meet the run of pilchards on its northern migration from Californian waters. Much of the early pilchard production was caught off the coast of Washington, but later in the season the bulk of the catch was caught off Vancouver Island shores. Nine pilchard plants were licensed to operate in 1943. These nine plants produced 2,238,987 imperial gallons of oil and 15,209½ tons of meal. The catch which produced the 1943 production was one of the largest pilchard-catches in recent past years. The figures for 1943 are compared with the 1942 figures, in which year 1,560,269 imperial gallons of oil were produced, while 11,003 tons of edible meal were derived from the 1942 catch.

Herring Reduction.—The reduction of herring in British Columbia has become an important branch of our winter fishery. Herring are caught from October to March and while heretofore this industry was conducted largely on the west and south-east coasts of Vancouver Island, and in the vicinity of Prince Rupert, latterly this industry has spread and is now conducted practically over the whole of the coast of Vancouver Island.

In 1941, however, the demand from Great Britain for a high protein food at low cost to meet the exigencies of war caused the Government to take such action as would divert as much as possible of the herring-catch from the reduction plants to canneries. The Provincial Government in 1942, and again in 1943, licensed herring-reduction

plants on the west coast of Vancouver Island on the distinct understanding that no herring caught on the east coast would be utilized for reduction in west coast plants. Plants operated on the east coast were licensed on the distinct understanding that no herring caught on the east coast of Vancouver Island would be used for reduction purposes, except that portion of the catch unsuitable for canning. These Provincial regulations were supplemented by further regulations of the Federal Government which prohibited the delivery of east coast caught herring to any one except a licensed herring-cannery. As a result of the steps taken by the Federal and Provincial Departments of Fisheries and the desire of the canners to can as much as possible of the herring-catch, the thirteen herring plants licensed to operate in 1943 were considerably less than would have been the case had the whole or the bulk of the herring-catch been reduced to meal and oil.

The production of herring-meal in 1943 from eleven operating plants was 7,662 tons of meal and 512,516 imperial gallons of oil. These figures are compared with the production in the year previous when 4,633 tons of herring-meal and 323,379 imperial gallons of herring-oil were produced.

Whale Reduction.—In 1943, as in 1942, only one whale-reduction plant was licensed to operate in British Columbia. The production of this plant in 1942 was somewhat less than in the year previous. In 1943, 91 whales were caught which produced 62 tons of meal, 90 tons of fertilizer, and 134,553 imperial gallons of oil, of which 18,703 imperial gallons were sperm oil.

Miscellaneous Reduction.—Dogfish and fish-offal reduction plants are licensed to operate each year in British Columbia. These plants produce meal and oil from cannery waste and from the carcasses of dogfish. The oil from the dogfish carcasses is not to be confused with dogfish-liver oil, which has been reported in another section of this report.

In 1943 three plants were licensed to reduce dogfish carcasses, while ten licences were issued covering fish-offal reduction plants. In the former case these three plants produced 631 tons of meal from dogfish carcasses and 33,835 imperial gallons of fish-oil. The ten plants operating on fish-offal produced 3,701 tons of meal and 414,840 imperial gallons of oil.

NET-FISHING IN NON-TIDAL WATERS.

Under section 23 of the Special Fishery Regulations for British Columbia, fishing with nets in certain specified non-tidal waters within the Province is permissible under licence from the Provincial Commissioner of Fisheries. This fishery is confined almost exclusively to the residents living within reasonable distance of the lakes in the Interior of the Province. This fishery has been in the past of a very minor nature and for that reason has not been mentioned heretofore in this report. As the number of licences issued has been increasing, and as statistics are now available covering the catch for recent past years, it was deemed advisable that this information should be contained in the annual report of the Provincial Fisheries Department. There will be found in the Appendix to this report a table showing the name and number of lakes in which net-fishing has been permitted, together with the number and approximate weight of the various species of fish taken from each lake.

It will be noted from the statistical data that there are three different kinds of fishing licences issued for net-fishing in the non-tidal waters of the Province—namely, fur-farm, ordinary, and sturgeon. Licensed fur-farmers, under subsection (10) of section 23 of the Special Fishery Regulations for British Columbia, are permitted to take coarse fish by the use of nets of suitable mesh in the non-tidal waters of the Province under licence from the Commissioner of Fisheries.

There were thirty-six licences issued to fur-farmers. The coarse fish so taken are used as food for fur-bearing animals held in captivity. Ordinary licences permit

the licence-holder to use a specified number of pieces of net to take fish in the non-tidal waters of the Province, other than salmon, trout, or sturgeon, for the licensee's own use or, in certain specified cases, the product may be sold within the district. This latter is a war measure. There were sixty-nine ordinary licences issued and it will be noted that forty-six of these were for Okanagan Lake. In the case of Okanagan Lake, the licence permits the use of a dip-net only for the capture of kokanee. One sturgeon licence was issued in the 1943–44 season, making a total of 106 licences for non-tidal fishing in the waters of the Province.

The reader is referred to the table in the Appendix of this report for a detailed account of the catch of fish taken by nets in the non-tidal waters of the Province during the 1943–44 season.

CONDITION OF BRITISH COLUMBIA'S SPAWNING-GROUNDS.

Owing to this Department having discontinued making inspections of the various salmon-spawning areas of the Province, we are indebted to Major J. A. Motherwell, Chief Supervisor of Fisheries, and the officers of his Department who conducted the investigations, for furnishing us with a copy of his Department's report. His courtesy in supplying us with this report is gratefully acknowledged.

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

CONTRIBUTIONS TO THE LIFE-HISTORY OF THE SOCKEYE SALMON (DIGEST). (No. 29.)

There will be found in the Appendix to this report another paper, No. 29, in the series "Contributions to the Life-history of the Sockeye Salmon." Paper No. 29 is again the work of Dr. W. A. Clemens, Department of Zoology, University of British Columbia.

In the introduction to Paper No. 29 Dr. Clemens points out that the total pack of sockeye salmon on the Nass and Skeena Rivers and on Rivers Inlet amounted to only 89,282 cases in 1943, which is an exceptionally small pack and represents only an average pack on either Rivers Inlet or the Skeena River over the past thirty years. In Paper No. 28 it was pointed out that by using as a basis the pack figures, together with the escapement to the spawning-beds, one may judge the extent of the run of salmon to a river system. In 1943 the return of sockeye to each of the three areas covered in Paper No. 29 was apparently exceptionally low because of the small pack reported above and taken in conjunction with reports from the spawning-beds.

The Chief Supervisor of Fisheries, Vancouver, reports that the escapement for Rivers Inlet, with a pack of 47,602 cases, "escapement fair"; for the Skeena River, with a pack of 28,268 cases, "escapement good, but below those of 1938 and 1939, which were reported as very good"; and for the Nass River, with a pack of 13,412 cases, "escapement fairly good, reported as a little under average."

In connection with Rivers Inlet, Dr. Clemens points out that the return was evidently small, probably in part because of the failure of the brood-year 1939 to produce an appreciable number of four-year-old fish, and remarks that "The situation developing on this river seems to demand a period of larger escapements to provide the 'margin of safety' as suggested in the 1938 report."

Of the Skeena River Dr. Clemens comments on the hopeful feature of the scientific investigation being planned and commenced by the Fisheries Research Board of Canada for this river system, whose production in sockeye salmon has reached "the lowest in thirty-seven years of record."

In connection with the Nass River, in the past ten years packs seem to have shown less fluctuation and have averaged higher than those of the preceding ten years, which may indicate a tendency toward a more stabilized condition.

Rivers Inlet Sockeye-salmon Run of 1943.

The pack of sockeye on Rivers Inlet of 47,602 cases was the smallest pack in many, many years. In only three previous years—1916, 1921, and 1936—were the packs lower than 50,000 cases and in 1936 it will be recalled the small pack was due to a strike of fishermen in that year and was not due to lack of fish. In Paper No. 28, published in this report for 1942, Dr. Clemens pointed out that the run in that year was composed largely of five-year-old fish derived from the spawning of 1937; that the run of 1943 would be the result of the spawnings of 1938 and 1939 and, in view of other factors, it was reasonable to expect a good return of five-year-old fish in 1943. In Paper No. 29 Dr. Clemens points out that a feature of the run to Rivers Inlet in 1943 was the exceptionally large number of five-year-old fish. The run in 1943 was composed of 91 per cent. of five-year-old fish and only 8 per cent. of four-year-olds, which exactly duplicated the composition of the 1942 run. It is suggested that the situation on Rivers Inlet will be of interest in 1946 and 1947 because, if the fish of the 1942 and 1943 year-classes have strong tendencies to produce five-year-old fish, there will be very few four-year-old fish in the years 1946 and 1947, and that unless production of young fish from the spawning of 1943 is exceptionally large, the runs of 1947 and 1948 will be adversely affected.

Skeena River Sockeye Run of 1943.

The run of Skeena River sockeye salmon produced a pack of 28,268 cases, which is the lowest in thirty-seven years of record and the report from the spawning-grounds in connection with the Babine area states "although in general being satisfactory, was below that of 1939." In the Lakelse Lake area the escapement was reported to be good. Commenting on the possible return in 1944, Dr. Clemens points out that this run will be the product of the 1939 and 1940 spawnings. In the former year the pack was 68,485 cases and the escapement exceptionally good. In the latter year the pack was 116,507 cases and the escapement was large. There would appear to be a reasonable expectation of a fairly large run in 1944.

The Nass River Sockeye Run of 1943.

The sockeye run to the Nass River in 1943 produced a pack of 13,412 cases and the escapement was described as fairly good but somewhat under average. Dr. Clemens points out that it would seem from these facts that the run to the Nass River system in 1943 was small. Commenting on the possibilities for 1944, Dr. Clemens points out that this run will be the product of the spawnings of 1939 and 1940 and that in the former year the pack was 24,357 cases and the escapement reported as satisfactory. In the latter year the pack was 13,809 cases and the escapement was medium to light. A medium-sized run would seem the most that can be expected in 1944, but, because of the erratic nature of the runs to this river system, attempts at prediction are of little value for the Nass River.

The reader is referred to the report in full, published in the Appendix to this report, for the details of the analyses of the sockeye runs to these three river systems.

PILCHARD INVESTIGATION.

The pilchard-fishery enjoyed a successful season, the total catch being second only to that of 1929. Some fish were taken in areas north of Vancouver Island and, as has been the case during several recent years, the fishery continued with fair intensity into the winter months.

The total catch figures do not give an adequate impression of the availability of pilchards during the regular 1943 pilchard season. In 1929 many more boats were employed to make the record catch. Actually, during 1943 the season's catch per seine

boat was 50 per cent. higher than during the season showing the next highest availability (1942). In order to have information which can be used to estimate the availability of pilchards in the north-east Pacific independent of the number and sizes of boats, detailed catch records are obtained from two sources. Records of landings by day and boat are supplied by the fishing companies. In addition, many seine-boat skippers keep "pilot-house log-books" recording the time, place, and success of every set. The fishing industry has been very co-operative in supplying these records, which will be useful in tracing the changes in availability over the life of the fishery.

The work of sampling the pilchard-catch has been continued. The average length of the fish taken during 1943 was low, due to the predominance of comparatively young fish. However, the average was higher than during the preceding year. Examination of the length frequency curves makes it evident that this increase in average length was associated with the growth of the broods of fish produced by the 1937, 1938, and 1939 spawnings, especially the last. Weights were higher than during the two preceding seasons. In contrast to the conditions in recent years males were again more numerous than females.

Under an arrangement with the United States Fish and Wildlife Service, scales taken in connection with sampling the Canadian catch are mounted immediately and sent to the United States Federal laboratory to be read. After being read the mounted scales are returned for confirmatory reading and storage. The samples show that the greatest contribution to the 1943 fishery was made by the brood of 1939 (four-year-olds) with the 1938 year-class (five-year-olds) second most important.

No new pilchard-tags were put out during the past year. The recoveries made during 1943 and the way in which they affect calculations based on previous returns are shown in the Appendix.

The pilchard programme has been carried out by Dr. J. L. Hart with the help of two part-time assistants.

HERRING INVESTIGATION.

An investigation of the herring of British Columbia, financed jointly by the Fisheries Research Board of Canada and the Provincial Fisheries Department, was continued in 1943. The work was undertaken by Dr. A. L. Tester, Mr. J. C. Stevenson (since July 1st, 1943), and their assistants.

An extensive tagging and tag-recovery programme has been under way for several years. The results for 1943–44 are included in detail in the Appendix to this report. In general, these conform with the results of previous years in showing the essential independence of runs of herring to major areas, although, as in 1942–43, mixing (16 per cent. on the average) was somewhat more extensive than previously found. The 1943–44 run to Kwakshua Passage, which yielded about 35,000 tons of fish, contained mostly tags which were originally used on adjacent spawning-grounds in the vicinity of Bella Bella. However, the run also contained a relatively large number of tags from Queen Charlotte Strait area and a small number from Discovery Passage and the northern part of the Strait of Georgia, and from the northern part of the west coast of Vancouver Island.

A clearer understanding of the movements and migrations of herring of the Strait of Georgia has been obtained as a result of two years of intensive study. There are two migration routes which can be, and presumably are, used by Strait of Georgia fish in travelling to and from summer feeding-grounds outside the area. Fish which spawn in Discovery Passage and the northern part of the Strait apparently use the northern route, by way of Johnstone Strait, and on their return supply the Deepwater Bay and Deep Bay (in 1942–43) fisheries. Either *en route* or on summer feeding-grounds they may mix to some extent with Queen Charlotte Strait or even Central coast-line fish.

Herring which spawn along the south-east coast of Vancouver Island use the southern route, by way of the Strait of Juan de Fuca, and on their return supply the fishing-grounds from Satellite Channel to Nanoose Bay, chiefly the former. Occasionally, and presumably on their offshore summer feeding-grounds, they mix to a slight extent with herring from the southern part of the west coast of Vancouver Island. Of the herring which spawn along the north-east and north-west shores of the Strait of Georgia, part use the northern and part the southern route. On their return, those using the northern route contribute to the Deepwater Bay and Deep Bay fisheries; those using the southern route contribute to the fisheries from Satellite Channel to Nanoose Bay, chiefly the latter. The exact situation is one of considerable complexity, perhaps even more so than is indicated in the foregoing explanation, and will doubtless vary from year to year.

Sampling of the commercial catches and spawning runs for length, weight, sex, and age was continued in 1943–44 with 93 samples (10,051 fish) from the former and 13 samples (1,415 fish) from the latter. Age studies on the 1942–43 samples were completed during the course of the year. A start was also made on a detailed study of variation in scale pattern with the expectation that it might facilitate scale-reading and perhaps provide additional information on the extent of mixing between runs. This phase of the work is being undertaken by Mr. Stevenson.

Spawning reports, covering herring-spawning conditions in 1943 in all areas, were again collected. These are compiled by fisheries inspectors of the Dominion Department of Fisheries.

Pilot-house record-books were again used as a medium for obtaining detailed daily catch records of the herring-fishery. Considerable progress was made on preparing a comprehensive account of fluctuations in the availability and abundance of herring on the various fishing-grounds over a period of years.

During 1943, Bulletin No. 63 (Fisheries Research Board of Canada, pp. 1–21, 9 fig.) was published. This deals with research on the use of the echo sounder to locate schools of herring in British Columbia waters, and covers in detail the work done with the M.V. " Nishga," which was summarized in the report for last year.

SHELL-FISH INVESTIGATION.

The investigation into the shell-fish of British Columbia, with particular emphasis on clams, was continued in 1943. It will be remembered that this investigation was instituted in order to ascertain the conditions prevailing on some of the clam-beaches of British Columbia, particularly those which had been exploited commercially for some considerable time. The investigation was undertaken by the Fisheries Research Board of Canada at the request of the Provincial Fisheries Department and is financed jointly by these two organizations. The work was commenced by Dr. Roy Elsey and is now being conducted by Mr. Ferris Neave, of the Pacific Biological Station at Nanaimo. While all shell-fish are included in the investigation particular emphasis is being placed on the clams, as it is felt that exploitation of this species has been greater than the others, and, consequently, the need for protection is greater on that account.

In the Appendix to this report there will be found a paper by Mr. Ferris Neave, entitled " Biological Investigations of Commercial Shell-fish." In this paper Mr. Neave discusses the distribution of the 1942–43 clam-catch and compares the annual production of different areas in relation to the fishing effort expended. The investigations show that in most areas there is an increase in availability of butter-clams and littleneck clams. There is now being obtained similar statistical information for razor-clams on the Graham Island beaches of the Queen Charlottes.

The 1943 season was the third season of controlled digging on Seal Island and production for this digging was extended to the whole beach with a limit of about 100

tons for the season. Availability of clams in this area was very high and although the more heavily dug portions of the beach showed reduced productivity, investigations so far lead the investigators to believe that an annual production of 100 tons could be sustained for several years.

From examinations of small butter-clams from several localities indications are that sexual maturity is obtained at an average length of 1½ inches, both in the slower and faster growing populations. In the localities under review, clams become capable of spawning at from three to five years of age and at least two or three years before reaching the minimum legal length of 2½ inches.

Some preliminary experiments on the production of seed oysters were carried out in an open-air tank which gave favourable results in the case of the native oyster. In connection with the Pacific oyster larvæ, only a few were reared to the setting stage. The author indicates that there remains a possibility of future success.

The reader is referred to Mr. Neave's paper in the Appendix for a fuller account of the investigation.

INTERNATIONAL FISHERIES COMMISSION, 1943.

The regulation of the Pacific halibut-fishery was continued by the International Fisheries Commission, as prescribed by the treaty between Canada and the United States. Investigations of the fishery and of the stocks of halibut were continued to ascertain the effect of regulations and to provide a sound basis for future regulation.

Canadian representation on the Commission was changed early in the year when Mr. L. W. Patmore, who became a member in 1938, resigned. Mr. G. W. Nickerson was appointed to fill the vacancy. The other members of the Commission were Mr. A. J. Whitmore for Canada and Mr. Edward W. Allen and Mr. Charles E. Jackson for the United States. Mr. Allen served as chairman and Mr. Patmore and Mr. Nickerson, successively, as secretary.

Meetings of the Commission were held on April 28th at Vancouver and on November 30th and December 1st and 2nd at Seattle. A meeting was held on December 1st with the Conference Board composed of representatives of the halibut-fishing fleets. At this meeting members of the Conference Board were informed of the results of the investigations and the effects of regulation upon the condition of the stocks, and presented their recommendations for the 1944 regulations.

The 1943 halibut-fishery regulations were issued on February 15th. These contained only a few important changes from those of the previous year. The Area 2 catch-limit was increased from 22,700,000 to 23,000,000 lb., and that for Area 3 from 26,800,000 to 27,500,000 lb. The period of validity of permits, under which set-line vessels could retain and land halibut caught incidentally during fishing for other species in closed areas, was extended to November 30th, irrespective of when the grounds closed to regular halibut-fishing. Receivers of halibut were required to report catches of halibut taken under permit to enforcement officers before unloading such catches.

The fishing season opened on April 16th. Areas 1 and 2, including the grounds south of Cape Spencer, Alaska, were closed at midnight June 20th, when the Area 2 catch-limit was attained. Areas 3 and 4, including all fishing-grounds north and west of Cape Spencer, closed on September 8th when the catch-limit for Area 3 was reached. Small amounts of halibut, caught under permit and not chargeable to the catch-limits, continued to be landed until November 30th as provided in the regulations.

Landings of halibut reported on the Pacific coast during the year amounted to 53,575,000 lb. The total from Area 1, which extends south of Willapa Harbour along the Washington, Oregon, and California coasts, amounted to 462,000 lb. Areas 2 and 3, previously defined, produced 24,696,000 lb. and 28,417,000 lb. respectively. No halibut was caught in Area 4, which includes the Bering Sea and Aleutian Island regions. The

Area 2 catch included 842,000 lb. taken under permit after the closure of the area to regular halibut-fishing.

The catch by Canadian vessels from Area 2 was almost 2,000,000 lb. greater than in 1942 and accounted for 45 per cent. of that area's production, compared to 39 per cent. in 1942. From Area 3, the Canadian catch declines about 250,000 lb. A greater increase of the Canadian than of the United States fleet in Area 2 accounted for its larger share of the catch from that area.

The self-imposed curtailment system, adopted some years earlier by the fleets in an effort to secure a more orderly marketing of their catches, was continued. Tie-up periods between trips were markedly reduced from previous years and catch-limits per man per trip were increased, resulting in a curtailment programme that had but little effect in extending the season. However, it did prevent the landing of very large loads by the large halibut-vessels and by the large sardine-boats temporarily engaged in halibut-fishing. It also discouraged the overloading of smaller vessels and the consequent landing of improperly iced fish.

Scientific investigations which have been found by the Commission to be indispensable to the proper management of the fishery were continued. New conditions in the fishery and the changing aspect of the stocks of fish brought about by regulation were observed and measured, as well as war-time conditions permitted, to determine the proper course of future regulation.

The abundance of halibut as measured by the catch per unit of fishing effort showed some improvement during the year. Preliminary figures indicate a considerable increase of 14.6 per cent. in Area 2 and a slight gain of less than 1 per cent. in Area 3 over the corresponding 1942 figures. The catch per unit of effort was 112 and 110 per cent. above the 1930 level in Areas 2 and 3 respectively.

Study of the changes in the size and age composition of the marketable stocks, necessary to understand the changes in abundance, was continued by sampling of the commercial catch. Approximately 25,000 halibut were measured and material for the determination of ages was taken from 2,500 of these.

Analysis of the length samples showed that the improvement in abundance during 1943 had been caused mainly by the occurrence of halibut of the smallest commercial sizes in greater numbers than in any other recent year. This increase in the number of young fish was predicted some years ago on the basis of the unusually successful spawning which the spawning investigations of 1936–37 showed had taken place that winter. This greater replacement should, if carefully husbanded, compensate in part for the lower replacements that are expected from the relatively poor production of spawn in the winters from 1938–39 to 1941–42, inclusive.

Field investigations of the production of spawn, which are normally conducted each winter, were not undertaken in 1943–44 because war-time black-out restrictions did not permit the continuous day-and-night vessel operations which experience has proven to be necessary to cover the spawning-grounds adequately. This respite from winter field-work made it possible to complete the analysis of the spawning data from the previous nine winters and to begin the organization of this material for publication.

Analysis of materials collected during the spawning investigations of the previous winter showed that the production of eggs in 1942–43 was much greater than in the preceding four winters, though it did not reach the high level of 1936–37. This improvement in the spawning should be reflected in the abundance of small fish in the commercial catches of 1949 and following years.

The Commission's investigations prove that the stock of halibut in Area 3 is in good condition and that the annual yield from the area is approaching the maximum that the grounds can produce. They show that the stock in Area 2 is continuing to improve but is still far below the level of abundance which the grounds can support.

They indicate that the annual yields now taken from Area 2 are still considerably below the amount which can be secured by continued rational control of the fishery.

Control of the fishery during the past twelve years has resulted in increased annual yields, now 10,000,000 lb. greater than the unrestricted fishery was able to take immediately preceding regulation and possibly 20,000,000 lb. higher than they would have been to-day if the fishery had been permitted to continue its uncontrolled course. These increased catches, which are taken with about one-third less fishing effort, make an important contribution to the war-time fish production of Canada and the United States and at present prices add about $1,750,000 to the annual incomes of the fishermen of the two nations.

INTERNATIONAL PACIFIC SALMON FISHERIES COMMISSION, 1943.

There will be found in the Appendix to this report a " Report on the Investigations of the International Pacific Salmon Fisheries Commission," covering the work done in 1943. The report is submitted by Mr. B. M. Brennan, Director.

The Commission was set up under treaty between Canada and the United States and is charged with the rehabilitation of the Fraser River sockeye-salmon runs. The Commission is composed of six members, three appointed by the Government of Canada and three by the Government of the United States. The work of the Commission is financed equally by the two countries.

The report for 1943 deals particularly with the findings of the Commission in connection with a serious blockade of salmon at Hell's Gate and other less serious blockades on other parts of the migration route. The report also deals briefly with salt-water tagging and recovery of tags, both in salt and fresh water, and briefly touches on the statistics of the commercial fishery, as well as statistics on the Indian fishery. There is a section in the report which deals with the spawning-grounds and the determination of the escapement thereto, together with the evaluation of the relative success of spawning.

The reader is referred to the report in full for a more complete résumé of the Commission's work, as reported by the Director.

THE PACIFIC SALMON IN BRITISH COLUMBIA WATERS.

In the report of the Provincial Fisheries Department for 1934 there appeared a paper entitled " The Pacific Salmon in British Columbia Waters," by Dr. W. A. Clemens, together with a paper entitled " The Identification of the Young of the Five Species of Pacific Salmon, with Notes on the Fresh-water Phase of their Life-history," by Drs. R. E. Foerster and A. L. Pritchard, of the Pacific Biological Station, Nanaimo, B.C.

Since that time these papers have had a wide circulation and have been unavailable for some time. The demand for reprinting by scientists and laymen alike has been so insistent that it has been deemed advisable to reprint these two papers in the Appendix to this report.

APPENDICES.

CONTRIBUTIONS TO THE LIFE-HISTORY OF THE SOCKEYE SALMON.

(No. 29.)

By W. A. Clemens, Ph.D., Department of Zoology, The University of British Columbia, Vancouver, B.C.

INTRODUCTION.

The total pack of sockeye salmon on Rivers Inlet and the Skeena and Nass Rivers was only 89,282 cases. This is an exceptionally small pack and, in fact, represents only an average pack on either Rivers Inlet or the Skeena River over the past thirty years. The return of sockeye to each of the three areas was apparently exceptionally low, for in no case is there a report of an exceptionally large escapement. The following is the information available, that on escapements being provided by Major J. A. Motherwell, Chief Supervisor of Fisheries, Vancouver:—

Rivers Inlet: Pack, 47,602 cases; escapement fair.

Skeena River: Pack, 28,268 cases; escapement good, but below those of 1938 and 1939, which were reported as very good.

Nass River: Pack, 13,412 cases; escapement fairly good (reported as a little under average).

The return to Rivers Inlet was evidently small, probably in part because of the failure of the brood-year 1939 to produce an appreciable number of four-year-old fish. The situation developing on this river seems to demand a period of larger escapements to provide the "margin of safety" as suggested in the 1938 report.

The extensive scientific investigation being commenced by the Fisheries Research Board of Canada on the Skeena River is a hopeful feature in connection with this river system, whose production in sockeye salmon has reached the lowest in thirty-seven years of record.

The Nass River continues to produce runs of varying sizes from year to year without any clear-cut relation to previous cyclic returns. The packs during the past ten years have shown less fluctuation and have averaged higher than those of the preceding ten years. This may indicate a tendency toward a somewhat stabilized condition in production.

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 migrated 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 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 RIVERS INLET SOCKEYE RUN OF 1943.

(1.) General Characteristics.

The pack of sockeye at Rivers Inlet in 1943 amounted to 47,602 cases. In only three previous years—1916, 1921, and 1936—did the packs reach levels below 50,000 cases. The run of 1943 was composed of 91 per cent. of five-year-old fish and only 8 per cent. of four-year-olds, exactly duplicating the composition of the 1942 run. The brood-years of 1937 and 1938 apparently produced largely five-year-old fish. In the former the run was fairly large, providing a large pack and a " satisfactory " escapement. In the latter year the run was apparently of much the same extent, supplying a large pack and a " better than usual " escapement. However, the two years varied greatly in composition and productivity. The run of the year 1937 was composed of 60 per cent. 4_2's and 37 per cent. 5_2's and produced a large number of 4_2's in 1941 as well as a large number of 5_2's in 1942. On the other hand, the run of 1938 was composed of 27 per cent. 4_2's and 70 per cent. 5_2's and produced very few 4_2's in 1942 and a relatively small number of 5_2's in 1943.

The situation on Rivers Inlet will be of interest in 1946 and 1947, for if the fish of the 1942 and 1943 year-classes have strong tendencies to produce five-year-old fish there will be very few four-year-old fish in the years 1946 and 1947. In any case, unless production of young fish from the spawning of 1943 is exceptionally large, the runs of 1947 and 1948 will be adversely affected.

The return in 1944 will be the result of the spawnings in 1939 and 1940. In the former year the pack was 54,143 cases and the escapement was reported to be an average one, slightly below expectancy. The fisheries inspector also reported rather unusual high-water conditions. Since this brood-year has produced very few four-year-old fish, the " average " escapement in the face of high-water conditions will probably produce a limited number of five-year-old fish in 1944. In 1940 the pack was 63,469 cases and the escapement was stated to be large. There is every reason to expect a fairly good return of four-year-old fish.

(2.) Age-groups.

The data for this year's study are obtained from 1,457 fish obtained in thirty random samplings of the commercial catch from July 1st to August 7th. The 4_2 age-group is represented by 120 individuals forming 8 per cent., the 5_2 age-group by 1,323 or 91 per cent., the 6_3 age-group by 14 or 1 per cent. In addition, there is one 6_2 fish not included in the tabulations or calculations. The above percentages are identical with those of 1942 and are noteworthy because of the predominance of five-year-old fish. (Table I.)

(3.) Lengths and Weights.

The average lengths of the males and females of the 4_2 age-group are 20.5 and 21.1 inches respectively and of the 5_2 age-group 24.3 and 23.7 respectively. These are slightly below the averages of the past years of record. (Table IV.)

The average weights of the males and females of the 4_2 age-group are 4.1 and 4.4 lb. respectively and of the 5_2 age-group 6.8 and 6.3 lb. respectively. These are somewhat below the averages of the past years of record. (Table V.)

The information concerning the distribution of the lengths and weights in 1943 is given in Tables II. and III.

One male of the 6_2 age-group occurs in the sampling. It is 26 inches in length and 7¾ lb. in weight.

(4.) DISTRIBUTION OF THE SEXES.

The total number of males in the samplings is 526 and of females 931, percentages of 36 and 64 respectively. In the 4_2 age-group the males predominate with a percentage of 62 and in the 5_2 age-group the females predominate with a percentage of 66. The distribution of the sexes is almost identical with that of 1942 and again shows a preponderance of females as compared with the 1915–41 averages of 50:50. (Table VI.)

Table I.—Rivers Inlet Sockeyes, Percentages of Age-groups in Runs of Successive Years and Packs.

Year.	Percentage of Individuals.			
	4_2	5_2	5_3	6_3
1907 (87,874 cases)	----	----	----	----
1908 (64,652 cases)	----	----	----	----
1909 (89,027 cases)	----	----	----	----
1910 (126,921 cases)	----	----	----	----
1911 (88,763 cases)	----	----	----	----
1912 (112,884 cases)	21	79	----	----
1913 (61,745 cases)	80	20	----	----
1914 (89,890 cases)	35	65	----	----
1915 (130,350 cases)	13	87	----	----
1916 (44,936 cases)	26	74	----	----
1917 (61,195 cases)	39	61	----	----
1918 (53,401 cases)	57	43	----	----
1919 (56,258 cases)	46	54	----	----
1920 (121,254 cases)	5	95	----	----
1921 (46,300 cases)	49	51	----	----
1922 (60,700 cases)	81	18	1	----
1923 (107,174 cases)	74	24	2	----
1924 (94,891 cases)	43	54	2	1
1925 (159,554 cases)	23	77	----	----
1926 (65,581 cases)	59	38	2	1
1927 (64,461 cases)	81	16	3	----
1928 (60,044 cases)	55	40	4	1
1929 (70,260 cases)	77	18	3	2
1930 (119,170 cases)	49	48	2	1
1931 (76,428 cases)	53	44	2	1
1932 (69,732 cases)	67	27	5	1
1933 (83,507 cases)	44	55	1	----
1934 (76,923 cases)	77	20	2	1
1935 (135,038 cases)	57	41	1	1
1936 (46,351 cases)	53	46	1	----
1937 (84,832 cases)	60	37	2	----
1938 (87,942 cases)	27	70	1	2
1939 (54,143 cases)	67	32	1	----
1940 (63,469 cases)	69	28	3	----
1941 (93,378 cases)	59	40	1	----
1942 (79,199 cases)	8	91	----	1
1943 (47,602 cases)	8	91	----	1

Table II.—Rivers Inlet Sockeyes, 1943, grouped by Age, Sex, and Length, and by their Early History.

Length in Inches.	Number of Individuals.						Total.
	4_2		5_2		6_3		
	M.	F.	M.	F.	M.	F.	
18	1	-----	-----	-----	-----	-----	1
18½	-----	-----	-----	-----	-----	-----	-----
19	2	-----	-----	-----	-----	-----	2
19½	8	2	1	-----	-----	-----	11
20	22	7	1	-----	-----	-----	30
20½	13	8	-----	1	-----	-----	22
21	18	13	3	11	-----	-----	45
21½	3	5	10	21	-----	-----	39
22	4	8	18	48	-----	-----	78
22½	2	1	27	77	-----	-----	107
23	1	1	28	141	1	-----	172
23½	-----	1	51	151	-----	-----	203
24	-----	-----	60	143	-----	3	206
24½	-----	-----	73	156	-----	1	230
25	-----	-----	75	78	2	4	159
25½	-----	-----	45	38	-----	-----	83
26	-----	-----	34	11	1	-----	46
26½	-----	-----	15	1	2	-----	18
27	-----	-----	3	-----	-----	-----	3
27½	-----	-----	2	-----	-----	-----	2
Totals	74	46	446	877	6	8	1,457
Average lengths	20.5	21.1	24.3	23.7	25.3	24.6	-----

Table III.—Rivers Inlet Sockeyes, 1943, grouped by Age, Sex, and Weight, and by their Early History.

Weight in Pounds.	Number of Individuals.						Total.
	4_2		5_2		6_3		
	M.	F.	M.	F.	M.	F.	
2½	1	-----	-----	-----	-----	-----	1
3	-----	-----	-----	-----	-----	-----	-----
3½	17	2	1	1	-----	-----	21
4	30	20	2	12	-----	-----	64
4½	17	12	11	36	-----	-----	76
5	6	10	32	83	-----	-----	131
5½	3	1	35	133	1	1	174
6	-----	-----	50	178	-----	-----	228
6½	-----	1	66	154	-----	2	223
7	-----	-----	86	150	-----	-----	236
7½	-----	-----	70	82	2	4	158
8	-----	-----	49	35	1	1	86
8½	-----	-----	25	11	-----	-----	36
9	-----	-----	11	2	1	-----	14
9½	-----	-----	8	-----	1	-----	9
Totals	74	46	446	877	6	8	1,457
Average weights	4.1	4.4	6.8	6.3	7.8	7.1	-----

Table IV.—Rivers Inlet Sockeyes, Average Lengths in Inches of the 4_2 and 5_2 Groups, 1912 to 1943.

Year.	4_2		5_2	
	M.	F.	M.	F.
1912–41	22.4	22.4	25.4	24.7
1912–41 (conversion)	21.6	21.6	24.6	23.9
1942	21.9	21.3	25.0	23.8
1943	20.5	21.1	24.3	23.7

Table V.—Rivers Inlet Sockeyes, Average Weights in Pounds of the 4_2 and 5_2 Groups, 1914 to 1943.

Year.	4_2		5_2	
	M.	F.	M.	F.
1914–41	4.9	4.8	7.0	6.5
1942	5.1	4.6	7.2	6.4
1943	4.1	4.4	6.8	6.3

Table VI.—Rivers Inlet Sockeyes, Percentages of Males and Females, 1915 to 1943.

Year.	4_2		5_2		Per Cent. Total Males.	Per Cent. Total Females.
	M.	F.	M.	F.		
1915–41 (average)	63	37	34	66	50	50
1942	61	39	35	65	38	62
1943	62	38	34	66	36	64

2. THE SKEENA RIVER SOCKEYE RUN OF 1943.

(1.) General Characteristics.

The Skeena River sockeye salmon produced a pack of 28,268 cases, which is the lowest in thirty-seven years of record. The report on the escapement to the Babine area states " although in general being satisfactory, was below that of 1939." In the Lakelse area the escapement was reported to be good. It is hoped that the causes of this serious decline in productivity will be disclosed by the investigation now being undertaken by the Fisheries Research Board.

The return in 1944 will be the product of the 1939 and 1940 spawnings. In the former year the pack was 68,485 cases and the escapement exceptionally good. In the latter year the pack was 116,507 cases and the escapement large. There would appear to be a reasonable expectation of a fairly large run in 1944.

(2.) Age-groups.

The length, weight, and sex data and scale collections were obtained from 2,156 fish in thirty-four random samplings from July 5th to August 19th. The 4_2 age-group is represented by 844 individuals or 39 per cent., the 5_2 by 841 or 39 per cent., the 5_3

by 358 or 16 per cent., and the 6_3 by 113 or 6 per cent. The outstanding feature in the distribution of the year-class percentages is the high representation of 5_3 and 6_3 fish. This suggests the possibility of an admixture of Nass River fish. Furthermore, the scale patterns are identical for the most part with those of the corresponding age-groups in the Nass fish. However, the average lengths and weights of these age-classes in the two rivers are quite different and it would seem therefore that there was no significant influx of Nass River fish. (Table VII.)

(3.) Lengths and Weights.

The average lengths of the males and females in the 4_2 age-group are 21.9 and 21.9 inches respectively and are considerably below the averages of the past years of record. In the 5_2 age-group the averages are 25.1 and 23.9 inches respectively, the latter being somewhat below the general average. The averages in the 5_3 age-group are 23.3 and 22.6 inches and in the 6_3 age-group 25.8 and 24.2 inches respectively. While these are below the averages of 1942, they are essentially equal to those of the past years of record. (Table X.)

The average weights of the males and females in the 4_2 age-group are 4.7 and 4.6 lb. respectively and are considerably below the records of past years. In the other age-groups the weights do not differ significantly from those of previous years. (Table XI.)

The distributions of the lengths and weights are given in Tables VIII. and IX.

Two male individuals of the 3_2 age-group occur in the samplings but are not included in the tabulations or calculations. The data for these are as follows: August 6—15½ inches, 1⅝ lb.; August 19—15¾ inches, 1¾ lb.

(4.) Distribution of the Sexes.

The total number of males in the samplings is 917 and of females 1,239, percentages of 43 and 57 respectively. The percentage of males in the 4_2 age-group is equal to that of the females, which is unusual, since the females usually predominate. There is a high predominance of females in the 5_2 age-group with a percentage of 69. This is somewhat similar to the situation in 1942 and much above the 1915–41 average. (Table XII.)

The distributions of the sexes in the 5_3 and 6_3 age-groups are almost equal.

Table VII.—Skeena River Sockeyes, Percentages of Age-groups in Runs of Successive Years and Packs.

Year.	Percentage of Individuals.			
	4_2	5_2	5_3	6_3
1907 (108,413 cases)	----	----	----	----
1908 (139,846 cases)	----	----	----	----
1909 (87,901 cases)	----	----	----	----
1910 (187,246 cases)	----	----	----	----
1911 (131,066 cases)	----	----	----	----
1912 (92,498 cases)	57	43	----	----
1913 (52,927 cases)	50	50	----	----
1914 (130,166 cases)	25	75	----	----
1915 (116,553 cases)	36	64	----	----
1916 (60,923 cases)	34	38	13	18
1917 (65,760 cases)	57	29	9	5
1918 (123,322 cases)	51	34	9	6
1919 (184,945 cases)	27	60	9	4
1920 (90,869 cases)	15	71	6	8
1921 (41,018 cases)	69	22	6	3
1922 (96,277 cases)	70	16	12	2
1923 (131,731 cases)	56	29	8	7
1924 (144,747 cases)	23	69	7	1
1925 (77,784 cases)	51	45	3	1
1926 (82,360 cases)	62	26	9	3
1927 (83,996 cases)	62	28	9	1
1928 (34,559 cases)	51	39	7	3
1929 (78,017 cases)	62	30	6	2
1930 (132,372 cases)	39	52	8	1
1931 (93,023 cases)	40	30	28	2
1932 (59,916 cases)	44	37	7	12
1933 (30,506 cases)	57	36	5	2
1934 (54,558 cases)	58	34	7	1
1935 (52,879 cases)	49	31	18	2
1936 (81,973 cases)	67	20	11	2
1937 (42,491 cases)	45	40	11	4
1938 (47,257 cases)	64	15	16	5
1939 (68,485 cases)	50	35	11	4
1940 (116,507 cases)	80	15	4	1
1941 (81,767 cases)	39	52	8	1
1942 (34,544 cases)	36	54	7	3
1943 (28,268 cases)	39	39	16	6

Table VIII.—Skeena River Sockeyes, 1943, 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.	
18½	2	-----	-----	-----	-----	-----	-----	-----	2
19	2	-----	-----	-----	-----	1	-----	-----	3
19½	4	1	-----	-----	-----	-----	-----	-----	5
20	22	3	-----	-----	1	1	-----	-----	27
20½	42	15	-----	-----	-----	2	-----	-----	59
21	42	46	-----	-----	2	7	-----	-----	97
21½	57	113	-----	1	10	27	-----	-----	208
22	70	129	2	17	20	25	-----	2	265
22½	80	73	5	38	16	34	-----	4	250
23	58	30	6	72	37	35	1	6	245
23½	34	10	15	116	36	20	4	8	243
24	7	1	35	124	23	12	4	12	218
24½	2	1	43	114	21	9	4	11	205
25	-----	-----	37	61	10	3	5	4	120
25½	-----	-----	37	25	3	1	11	4	81
26	-----	-----	32	11	1	-----	7	5	56
26½	-----	-----	29	2	1	-----	4	-----	36
27	-----	-----	9	-----	-----	-----	5	2	16
27½	-----	-----	7	1	-----	-----	5	-----	13
28	-----	-----	2	-----	-----	-----	3	-----	5
28½	-----	-----	-----	-----	-----	-----	1	-----	1
29	-----	-----	-----	-----	-----	-----	-----	-----	-----
29½	-----	-----	-----	-----	-----	-----	1	-----	1
Totals	422	422	259	582	181	177	55	58	2,156
Ave. lengths	21.9	21.9	25.1	23.9	23.3	22.6	25.8	24.2	-----

Table IX.—Skeena River Sockeyes, 1943, 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.	
2½	2	-----	-----	-----	-----	-----	-----	-----	2
3	3	-----	-----	-----	-----	-----	-----	-----	3
3½	28	12	-----	-----	1	3	-----	-----	44
4	95	115	1	2	9	27	-----	-----	249
4½	101	153	6	38	24	47	-----	3	372
5	108	106	15	97	35	46	2	8	417
5½	69	28	22	131	40	29	1	9	329
6	13	7	32	127	37	18	6	10	250
6½	3	-----	49	97	18	4	8	16	195
7	-----	1	54	63	15	2	7	8	150
7½	-----	-----	35	20	1	-----	14	3	73
8	-----	-----	23	5	1	1	5	-----	35
8½	-----	-----	10	1	-----	-----	6	-----	17
9	-----	-----	8	1	-----	-----	3	1	13
9½	-----	-----	2	-----	-----	-----	3	-----	5
10	-----	-----	2	-----	-----	-----	-----	-----	2
Totals	422	422	259	582	181	177	55	58	2,156
Ave. weights	4.7	4.6	6.8	5.9	5.5	4.9	7.3	6.1	-----

Table X.—Skeena River Sockeyes, Average Lengths in Inches of Principal Age-groups, 1912 to 1943.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1912–41	23.7	23.1	25.8	24.9	24.2	23.4	25.8	24.8
1912–41 (conversion)	23.0	22.4	25.1	24.2	23.5	22.7	25.1	24.1
1942	22.6	22.3	25.2	24.3	24.1	23.7	26.3	24.9
1943	21.9	21.9	25.1	23.9	23.3	22.6	25.8	24.7

Table XI.—Skeena River Sockeyes, Average Weights in Pounds of Principal Age-groups, 1914 to 1943.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1914–41	5.4	5.0	6.8	6.1	5.7	5.1	6.8	6.0
1942	4.9	4.7	6.7	6.0	5.8	5.4	7.2	6.6
1943	4.7	4.6	6.8	5.9	5.5	4.9	7.3	6.1

Table XII.—Skeena River Sockeyes, Percentages of Males and Females, 1915 to 1943.

Year.	4_2		5_2		Per Cent. Total Males.	Per Cent. Total Females.
	M.	F.	M.	F.		
1915–41 (average)	48	52	43	57	46	54
1942	42	58	25	75	33	67
1943	50	50	31	69	43	57

3. THE NASS RIVER SOCKEYE RUN OF 1943.

(1.) General Characteristics.

The run of sockeye salmon to the Nass River produced a pack of 13,412 cases and an escapement described as fairly good but somewhat under average. It would seem from these facts that the run was small.

The return in 1944 will be the product of the spawnings of 1939 and 1940. In the former year the pack was 24,357 cases and the escapement reported as very satisfactory. In the latter year the pack was 13,809 cases and the escapement was medium to light. A medium-sized run would seem the most that could be expected, but attempts at prediction are of little value on this river system.

(2.) Age-groups.

The material for the 1943 study consists of data for 1,304 fish obtained in thirty-three random samplings from July 6th to August 21st. The representation of the various age-classes is as follows: 4_2, 69 or 5 per cent.; 5_2, 171 or 13 per cent.; 5_3, 874 or 67 per cent.; and 6_3, 190 or 15 per cent. (Table XIII.). The outstanding feature in the distribution is the very low percentage of four-year-old fish and the rather high representation of fish in the 5_2 and 6_3 age-groups. It would appear that there had been a tendency for the Nass fish to remain an additional year in the sea.

(3.) Lengths and Weights.

The average lengths of both males and females of the 4_2 and 5_3 age-groups are approximately 1 inch below the averages of the past years of record (Table XVI.). On the other hand, the average lengths of the fish in the 5_2 and 6_3 age-groups are slightly above the average of the past years.

The average weights of both the males and females of the 4_2 and 5_3 age-groups are much below the averages of the past years of record; in fact, in the 5_3 age-class are a pound below.

The average weights in the 5_2 and 6_3 age-groups are approximately equivalent to the averages of the past years. (Table XVII.)

The distributions of the lengths and weights are given in Tables XIV. and XV.

(4.) Proportions of the Sexes.

The total number of males in the samplings is 702 and of females 602, percentages of 54 and 46 respectively. This is a decided reversal of conditions, since the females are usually represented by the higher percentage. The situation results from the preponderance of males in the 5_2 and 6_3 age-groups.

Table XIII.—Nass River Sockeyes, Percentages of Principal Age-groups from 1912 to 1943 and Packs.

Year.	Percentage of Individuals.			
	4_2	5_2	5_3	6_3
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 (36,242 cases)	13	9	74	4
1935 (12,712 cases)	11	10	73	6
1936 (28,562 cases)	16	7	67	10
1937 (17,567 cases)	22	4	68	6
1938 (21,462 cases)	21	4	70	5
1939 (24,357 cases)	14	13	66	7
1940 (13,809 cases)	23	8	59	10
1941 (24,876 cases)	37	7	52	4
1942 (21,085 cases)	22	7	66	5
1943 (13,412 cases)	5	13	67	15

Table XIV.—Nass River Sockeyes, 1943, 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	-----	1	-----	-----	-----	-----	-----	-----	1
21	1	4	-----	-----	2	1	-----	-----	8
21½	2	5	-----	-----	3	4	-----	-----	14
22	3	7	-----	-----	9	27	-----	-----	46
22½	9	10	-----	-----	17	62	-----	-----	98
23	9	3	-----	3	46	95	-----	1	157
23½	7	3	-----	2	61	96	-----	-----	169
24	2	-----	-----	11	84	102	-----	1	200
24½	2	1	7	15	86	51	1	6	169
25	-----	-----	19	7	51	19	4	7	107
25½	-----	-----	19	9	36	4	11	8	87
26	-----	-----	18	6	13	2	11	11	61
26½	-----	-----	21	1	3	-----	21	4	50
27	-----	-----	16	1	-----	-----	25	5	47
27½	-----	-----	8	1	-----	-----	30	5	44
28	-----	-----	3	-----	-----	-----	14	1	18
28½	-----	-----	3	-----	-----	-----	18	-----	21
29	-----	-----	1	-----	-----	-----	6	-----	7
Totals	35	34	115	56	411	463	141	49	1,304
Average lengths	22.8	22.2	26.1	24.8	24.1	23.5	27.1	25.8	-------

Table XV.—Nass River Sockeyes, 1943, 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	-----	1	-----	-----	2	-----	-----	-----	3
4	3	3	-----	-----	4	9	-----	-----	19
4½	4	17	-----	-----	21	79	-----	1	122
5	11	8	-----	3	56	140	-----	-----	218
5½	12	3	-----	7	94	130	-----	1	247
6	4	2	8	16	111	79	3	8	221
6½	1	-----	10	15	70	21	9	11	137
7	-----	-----	26	8	40	3	20	13	110
7½	-----	-----	21	4	11	2	25	6	69
8	-----	-----	22	2	2	-----	26	4	56
8½	-----	-----	11	1	-----	-----	34	5	51
9	-----	-----	13	-----	-----	-----	16	-----	39
9½	-----	-----	2	-----	-----	-----	7	-----	9
10	-----	-----	1	-----	-----	-----	-----	-----	1
10½	-----	-----	-----	-----	-----	-----	1	-----	1
11	-----	-----	1	-----	-----	-----	-----	-----	1
Totals	35	34	115	56	411	463	141	49	1,304
Average weights	5.2	4.7	7.6	6.4	5.9	5.3	7.9	6.9	-------

Table XVI.—Nass River Sockeyes, Average Lengths in Inches of Principal Age-groups, 1912 to 1943.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1912–41	24.5	23.7	26.3	25.2	26.1	25.3	27.7	26.4
1912–41 (conversion)	23.8	23.0	25.6	24.5	25.4	24.6	27.0	25.7
1942	23.9	23.2	26.1	24.9	24.9	24.3	26.9	26.0
1943	22.8	22.2	26.1	24.8	24.1	23.5	27.1	25.8

Table XVII.—Nass River Sockeyes, Average Weights in Pounds of Principal Age-groups, 1914 to 1943.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1914–41	6.0	5.4	7.3	6.4	6.9	6.2	8.0	7.0
1942	5.8	5.1	7.1	6.3	6.2	5.6	7.5	6.7
1943	5.2	4.7	7.6	6.4	5.9	5.3	7.9	6.9

Table XVIII.—Nass River Sockeyes, Percentages of Males and Females, 1915 to 1943.

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.		
1915–41 (average)	49	52	47	53	45	55	63	37	47	53
1942	42	58	48	52	44	56	70	30	45	55
1943	51	49	67	33	47	53	74	26	54	46

PILCHARD-TAGGING AND PILCHARD-TAG RECOVERY FROM 1936 TO 1943.

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INTRODUCTION.

A technical account of the pilchard-tagging work in British Columbia from 1935 to 1941 has been published in the Journal of the Fisheries Research Board of Canada (Hart, 1943*a*), based on tagging and recoveries recorded in Appendices of the Reports of the British Columbia Provincial Fisheries Department from 1936 to 1941. The present report attempts a condensation of the earlier paper, with alterations to include:—

(1.) Recovery in 1941 in the State of Washington of two Canadian tags, one put out in each of 1939 and 1940, erroneously omitted from the Journal account.

(2.) Recoveries in British Columbia in 1942 (Hart, 1943*b*).

(3.) Recoveries made in British Columbia in 1943, as follows:—

Canadian tags—

One tag put out in 1938—out five years.

One tag put out in 1940—out three years.

Oregon tags—twelve tags.

California tags—thirty-five tags.

No Canadian tags were recovered in the United States during 1942.

Throughout the report tags recovered since 1941 are separated from earlier recoveries by placing them after a plus sign in brackets. These tags are included in calculations involving numbers of recoveries, but are excluded from the calculation of the concentrations of tags in the populations where their inclusion would lead to distortion of the results and from other calculations.

TAGGING.

Fish for tagging were obtained from the seines of commercial fishermen and with minor exceptions were tagged directly from the nets and released on the fishing-grounds. The tags were serially numbered strips of nickel-plated iron, 19 by 4 by 0.86 mm., weighing 0.44 gram. They were applied internally, in the body-cavity, either by manually inserting the tag through a slit cut with a fine chisel or by the use of a so-called " gun " which combined the functions of cutting and insertion with carrying 100 tags in a magazine.

During six years 20,391 pilchards were tagged in connection with the regular summer (July to September) fishery working from the west coast of Vancouver Island, as follows: 1935, 978; 1936, 2,535; 1937, 6,936; 1938, 4,982; 1939, 2,370; 1940, 2,590. Of these, 14,185 tags were used in connection with Canadian fishing operations carried on off the coast of Washington and Oregon, as follows: 1937, 6,736; 1938, 2,489; 1939, 2,370; 1940, 2,590. The remainder of the tags were used either off the Vancouver Island coast or in the inlets of the west coast of Vancouver Island.

In making use of tagging results it must be kept in mind that the total number of tags put out is not effective. Substantial numbers of tagged fish die as a result of handling and others are destroyed immediately after release by the accumulation of predators around the pursed-up net.

RECOVERY.

Tags from recaptured fish were collected by magnets placed between grinders and driers in the meal lines of reduction plants. In Canada they were obtained for exami-

nation by paying rewards for sending the tags, together with a statement of the source of the fish producing the return, to the proper authorities. In California tags were picked out in the laboratory from the scrap-metal collected on the magnets. Some tags were recovered from various traps or crevices in the reduction machinery.

Returns made by magnets involve two sources of error: (1) Not all tags are recovered—some pass over the magnet and are lost. Tests of efficiency in recovery of reduction plants (Brock, 1940; Hart, 1938; Janssen, 1938*b*; Shuman, 1939) permit quantitative compensation for the deficiency. (2) Some tags are detained in their passage from the fish-bins to the magnets for considerable periods. The fact that such tags are frequently reported as coming from an incorrect source must be constantly kept in mind in interpreting results.

TREATMENT OF DATA.

In making calculations of the concentrations of tags in different fishing areas and seasons, adjustments were made for the size of the fish in the catches since fish less than 220 mm. standard length were seldom, if ever, available for tagging in connection with the Canadian investigation. The number of fish more than 220 mm. length was calculated on the basis of the tonnage landed and of the sizes encountered in each year and region as found by sampling. Weighting was then completed by multiplying this number by the composite tag-recovery efficiency for the region to give the number of fish more than 220 mm. standard length which would have produced the number of returns recorded with perfect recovery. These values were used to calculate (1) the weighted concentrations of tags per 100,000 metric tons (0.907 metric ton equals 1 short ton) of fish more than 220 mm. and (2) the weighted concentration of tags per 100,000,000 fish more than 220 mm.

Where numbers of tags are considered the weighted numbers have been obtained by multiplying the actual number of recoveries by the reciprocal of recovery efficiency for the appropriate year and region.

RESULTS.

Number of Recoveries.

In all, 483 (+5) Canadian tags have been recovered at plants in the following political divisions: British Columbia—357 (+3), Washington—55, Oregon—33 (the three referred to collectively hereinafter as the "North-east Pacific"); and California —38 (+2).

A large proportion of recoveries from the North-east Pacific were made very soon after tagging. These recoveries are believed to be not representative of conditions among pilchards in general and they have, accordingly, not been used in making calculations. The numbers of quick recoveries are: 1936, 18; 1937, 59; 1938, 268; 1939, 28; 1940, 41.

In addition to Canadian tags, magnets installed in British Columbia plants recovered 127 (+42) tags used by the California Bureau of Marine Fisheries off the California coast (Janssen, 1938*a*, 1938*b*, 1939, etc.) and 7 (+17) tags used by the Oregon Fish Commission in connection with operations of the Oregon fishing fleet (Brock, 1940, etc.).

Movements between Canadian and Californian Grounds.

The recovery of 38 (+2) Canadian tags by California plants and of 127 (+42) California tags by British Columbia plants shows unquestionably the movement of pilchards from Canadian fishing-grounds to Californian and the reverse. That the

movement is fairly general is indicated by comparing 38 (+2) with the number of North-east Pacific recoveries of Canadian tags exclusive of quick returns 31 (+3). (British Columbia, 20 (+3), including 2 recoveries made in 1936; Washington, 9; Oregon, 2.)

Comparative Concentrations on the Whole Coast.

Conclusions based upon comparisons of the small numbers of returns indicated must be accepted with caution. Certain comparisons between weighted concentrations are, however, of interest.

Recoveries made during the season immediately following that of tagging:—

Region.	Tags recovered.	Tags per 100,000 Metric Tons, weighted.	Tags per 100,000,000 Fish, weighted.
North-east Pacific	25	17.0	3.6
California	29	7.8	1.3

Recoveries made during seasons subsequent to the one immediately following that of tagging:—

Region.	Tags recovered.	Tags per 100,000 Metric Tons, weighted.	Tags per 100,000,000 Fish, weighted.
North-east Pacific	4 (+3)	2.7	0.58
California	10 (+1)	2.7	0.46

It will be noted that pilchard-tags are more concentrated in the North-east Pacific than in California waters during the season immediately following that of tagging. This difference in the concentrations of tags in different regions does not continue into subsequent years.

The change from differential concentration to near uniformity may be explained in several ways. The excess of tags in the North-east Pacific may be those which entered reduction plants as quick recoveries and were retained until the following season. It is likely that a few such tags were unrecognized, but it is unlikely that all or even much of the observed difference can be attributed to them.

The larger concentration of tags in the North-east Pacific may be a result of the weighting methods employed. Careful consideration of the sizes of pilchards tagged and exploited in the North-east Pacific and in California and calculations based on different assumptions indicate that it is unlikely that the weighting methods employed can have been responsible for more than part of the observed difference, although it is likely that they are responsible for some of it. Finally, incomplete migration can produce a difference of the kind observed. It is known that some pilchards remain in the inlets on the west coast of Vancouver Island during the winter and some tags have been recovered from them. It is believed that many others fail to make the complete migration to Californian waters during the winter months and that incomplete migration is the chief source of discrepancy. All three sources of difference play a part in producing the difference between concentration of tags in the North-east Pacific and off California.

The difference in the locality (California or North-east Pacific) of return of tags recovered in the season following that of tagging and those recovered in subsequent seasons could occur by chance as often as not ($p=0.6$).

Concentrations in California.

The weighted concentrations of Canadian tags are different for different Californian ports. This difference appears to be confined to the first season following

tagging in which the concentration is higher in the San Pedro region than in the San Francisco-Monterey region as follows:—

Region.	Tags recovered.	Tags per 100,000 Metric Tons, weighted.	Tags per 100,000,000 Fish, weighted.
San Francisco and Monterey	17	5.5	0.96
San Pedro	12	18.4	3.13

As compared with the results for tags out after longer periods:—

Region.	Tags recovered.	Tags per 100,000 Metric Tons, weighted.	Tags per 100,000,000 Fish, weighted.
San Francisco and Monterey	9 (+1)	2.9	0.46
San Pedro	1	1.5	0.26

A difference as great as that noticed between the two regions could have arisen by chance only once in about twenty times.

Speed of Southward Migration.

Canadian tags recovered in California during the season following that of tagging were reported between the following dates: San Francisco, December 27th to January 29th; Monterey, December 30th to January 31st; San Pedro, February 23rd to March 25th. Corresponding data for tags out longer are: San Francisco, December 5th to February 5th; Monterey, December 15th and January 11th; and San Pedro, March 12th. The San Francisco and Monterey data agree very closely and differ from those for San Pedro. They are in line with an hypothesis of orderly migration down the coast. Examination of the data for San Francisco shows that the variation in recovery dates is greater for the tags out for the longer time to an extent which would be expected by chance only once in about seven trials. It is probable that the hold-over tag recovered in 1941 but returned in 1942 at San Francisco was recovered quite late in the season and would increase the observed discrepancy. It is not, however, possible to assign exact dates for the purpose of including it in the calculations.

Tags recovered during the first season following that of tagging differ from those recovered subsequently (1) in the concentrations in the catches landed at different California ports and (2) in the recovery dates in different regions of California. The differences are so large that they would occur jointly by chance only once in about twenty-four trials. Accordingly there would appear to be a real difference in behaviour. There was no evidence of differential behaviour in the relative concentrations off North-east Pacific and California fishing-grounds.

Given tagging dates and locations and the approximate date and localities of recovery, minimum speeds of migration can be calculated and the following approximate results in kilometres per day are obtained:—

Time and Place of Tagging.	Place of Recovery.		
	San Francisco.	Monterey.	San Pedro.
August, 1936; off Vancouver Island	7.1, 8.5	----------	9.2, 8.7, 8.9
July–August, 1937; Washington coast	----------	6.3	6.6, 6.8, 6.8
July–August, 1938; Washington coast	----------	6.8, 8.4	----------
September, 1938; Vancouver Island	11.6, 12.9, 10.6, 11.4, 12.4, 13.7	10.1, 11.7, 14.3	12.6, 12.7, 12.4, 12.4, 12.1, 11.2
August, 1939; Washington coast	----------	7.1	----------

In spite of the errors inseparable from the method the rates indicated are remarkably consistent within seasons and recovery ports. Some of the differences between seasons are no doubt accountable to the fact that the fish were tagged at the height of the season some time before the commencement of their southern migration. The higher rates indicated for migration to San Pedro in 1936 and 1937 would support this suggestion, since the influence of the period when no active migration is under way would have less effect in distorting calculated speeds to that port than for others for which the free time was less. Fishing continued into October in 1936 and 1937, so it may be assumed that no southward mass migration began until then. If forty days and sixty days respectively are subtracted from the migration period, the estimated speeds will be increased by about 30 per cent. for San Francisco and Monterey and about 20 to 25 per cent. for San Pedro recoveries. Application of these justifiable corrections brings the rates of migration as calculated for different years closer together.

The speeds indicated correspond rather closely with those indicated by Janssen (1937, 1938*a*) (average approximately 6 nautical miles or 11.1 km. per day) for the northern migrations in 1937 and 1938.

The southward migration down the coast would appear to be at a relatively uniform speed since the difference between average dates for pilchard-tag recoveries at San Francisco-Monterey, and at San Pedro, January 12th and March 12th, fifty-nine days, divided into the approximate distance between the respective fishing-grounds, 560 km., indicates a migration speed of about 9.5 km. per day.

Total Mortality Rates.

If mortality rates are constant from year to year, and if the tagged fish after recovering from the first shock of handling and tagging die at the same rate as untagged individuals, the total annual percentage survival rate, i.e., the complement of the mortality rate, from all causes should be the same as the percentage of tags recovered in any one year is of the number of tags recovered in the year immediately preceding. Consequently, logarithms of tags recovered plotted against year of recovery should lie along a straight line whose slope is indicative of mortality and whose y-intercept is the logarithm of the number of tags which could have been expected as recoveries in the first year had there been no sharp break in conditions (Fig. 1). The numbers of recoveries made have been corrected for efficiency of recovery since cumulative changes in recovery efficiency would have vitiated the results. California recoveries made during the season immediately following tagging and therefore out for a period between four and seven months have been included with tags recovered in the North-east Pacific after having been out for approximately a complete year. From the line fitted by least squares to the data using all recoveries and weighted according to the number of recoveries during each interval the annual mortality rate can be calculated as approximately 69 per cent. and it will be seen that the number of tags to be expected for the year of tagging is 316 (= antilog 2.50). This figure may be compared with the number of tagged fish estimated as having been processed, 799, and the difference regarded as the number of true "quick recoveries" corrected for recovery efficiency. Considering California returns alone the mortality rate is indicated as being approximately the same but the North-east Pacific returns alone give a lower result, 60 per cent., which may differ significantly from the others. The mortality rates indicated are in reasonable agreement with those based on age analysis by the South Pacific Investigations of the United States Fish and Wildlife Service. The number of recoveries involved is not large enough to assure more than one-figure accuracy in estimated mortalities.

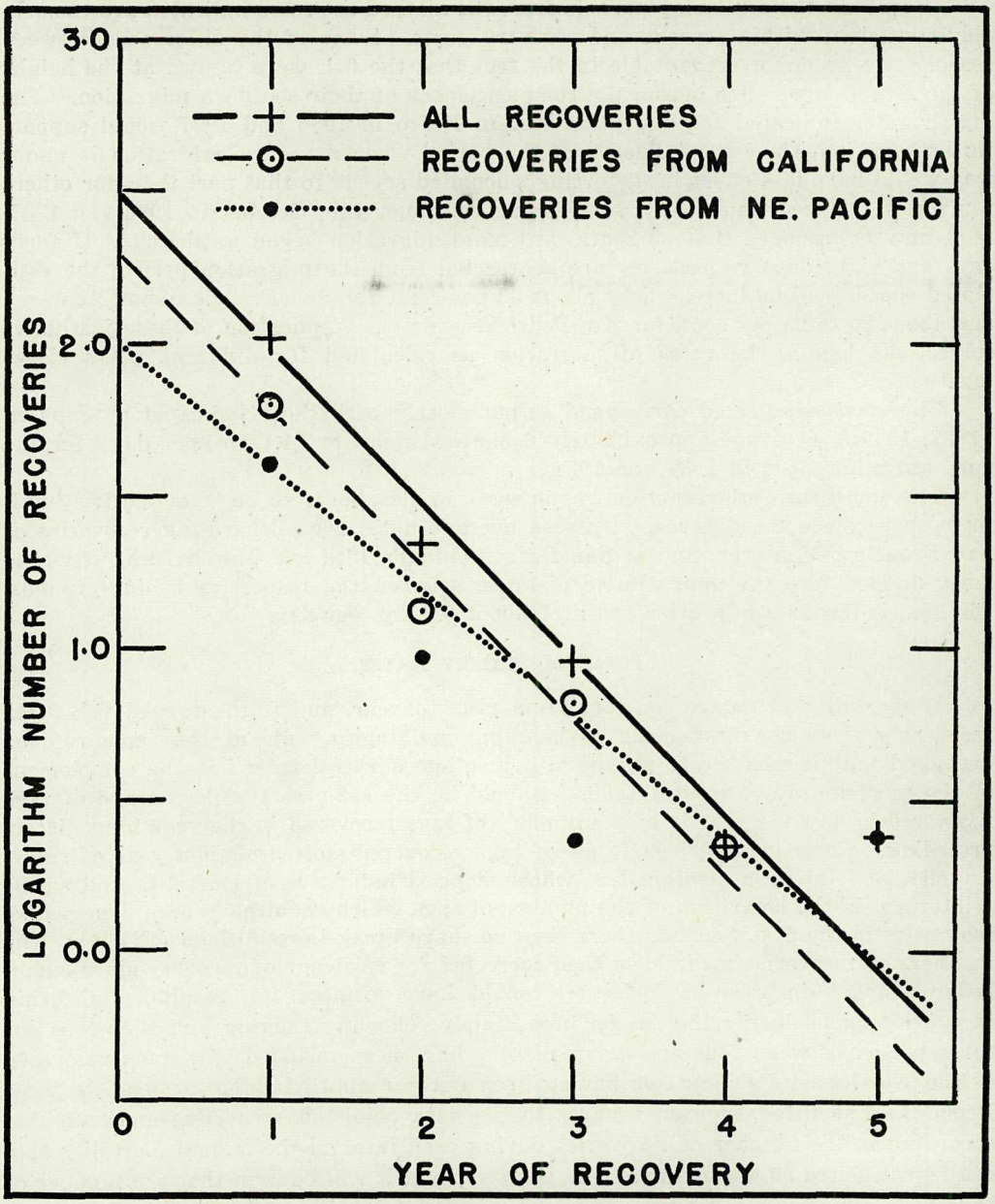

Fig. 1. Decline in recovery of pilchard-tags.

Local Movements.

Indications of local movements of pilchards have been described in the various Appendices of the Reports of the British Columbia Provincial Fisheries Department. These are compiled in the following subsections, for the most part quoting Hart (1943*a*) :—

Movements on Canadian Fishing-grounds.—For reasons outlined in an earlier section, the means of tag-recovery is not well adapted to the study of short migrations. In some cases, however, evidence of mixing of fish on the fishing-grounds appears

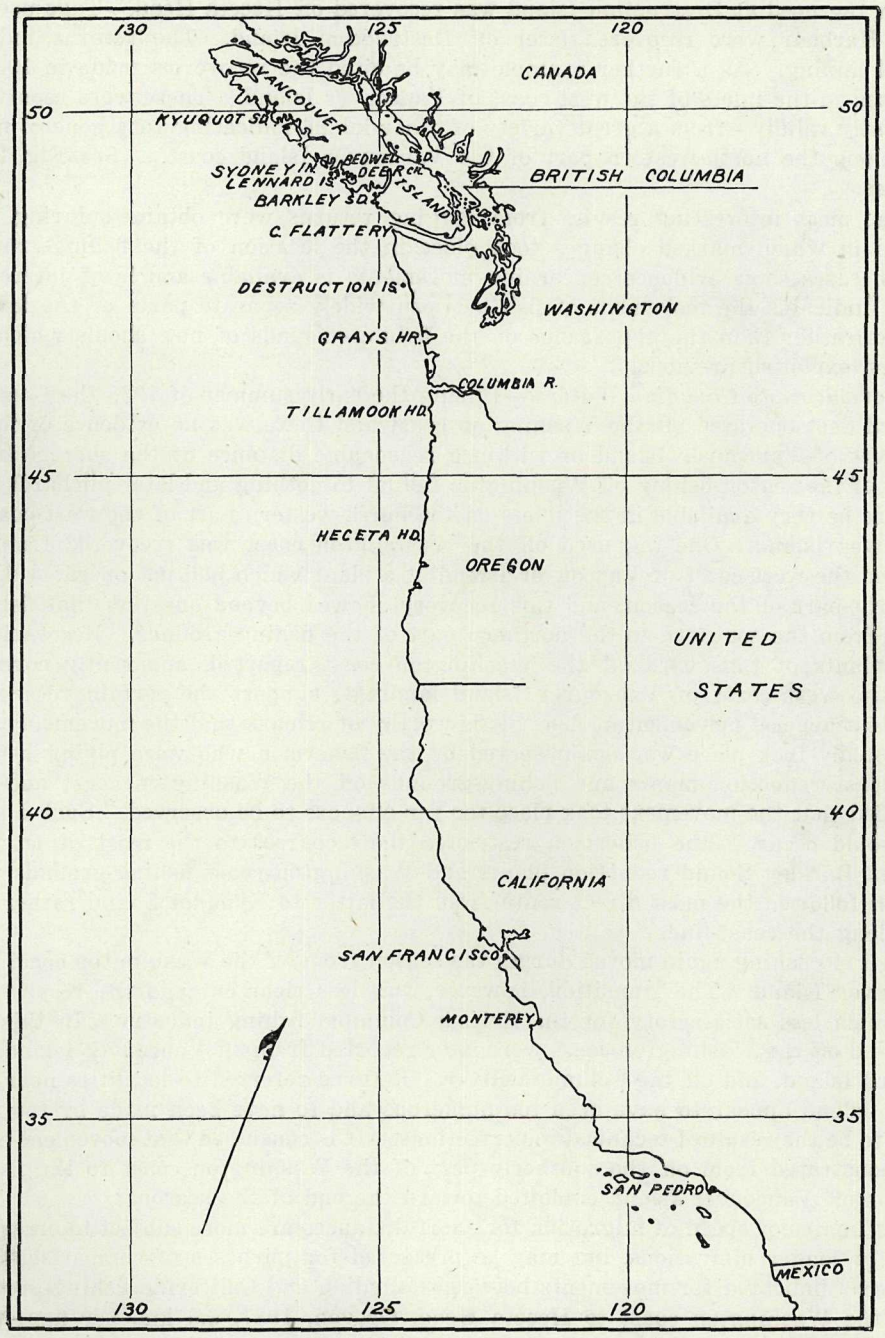

Fig. 2. Part of the west coast of North America.

beyond question. In 1937, for example, tags used near Cape Flattery were recovered around Destruction Island and Grays Harbour. Some tags used at Destruction Island were recovered at the same place two months later; one was taken off the mouth of the Columbia after nine days, and others continued to be taken off the area between Tillamook Head and the mouth of the Columbia River. Nine weeks after tagging

another tag used at Destruction Island was recovered off Heceta Head. Tags used off Grays Harbour were recovered later off Destruction Island. The returns indicate general mixing. As a further example may be cited the recoveries made in 1938 of tags used in the inlets of the west coast of Vancouver Island. These were reported—apparently validly—from a great variety of other inlets, indicating very general movement along the north-western part of the Vancouver Island coast. (*See* Fig. 2 for localities.)

The most interesting results from tagging returns were obtained during some seasons in which marked changes took place in the location of the fishing-grounds. In such cases some evidence concerning movements is available and is of interest in that it indicates the movement of fish between widely separate parts of the fishing-grounds rather than the appearance on the fishing-grounds of new shoals which had not been exploited previously.

Movements to Canadian Waters.—During the early summer of 1938 the Canadian pilchard fleet operated off the Washington coast and there was no evidence of fish in the inlets of Vancouver Island or within a reasonable distance of the shore. In the middle of the season fishing off Washington fell off to nothing and later pilchards were found to be very available in the inlets on the north-western part of the west coast of Vancouver Island. One tag used off the Washington coast was recovered from fish taken on the west coast of Vancouver Island at a plant which had not operated during the early part of the season, and this recovery showed beyond question that fish had moved from the southern to the northern part of the fishing-grounds. Recoveries by other plants of tags used off the Washington coast reported, apparently correctly, from the west coast of Vancouver Island landings, support the certain return and indicate a general movement of fish. It is worthy of remark that the movement which undoubtedly took place was not observed by the fishermen who were plying between west coast reduction plants and fishing-grounds off the Washington coast and it is concluded that the movement took place too far offshore to be observed. Such a situation would occur if the fishermen restricted their courses to the most direct route between Barkley Sound reduction plants and Washington coast fishing-grounds while the fish followed the most direct route from the latter to Kyuquot Sound rather than that along the coast-line.

In 1940 fishing again moved during the season from off the Washington coast to off Vancouver Island. The transition, however, was less clear cut and the results were very much less satisfactory for the British Columbia fishing industry. In this year tags used off the Washington coast were later reported from off Vancouver Island, near Lennard Island, and off the Columbia River. Returns referred to localities near Vancouver Island appear to have been too numerous and to have been made by too many plants to be the result of technical imperfections. It is concluded that movement of fish is demonstrated from off the southerly part of the Washington coast to the fishing-grounds off Vancouver Island exploited toward the end of the season.

Estimates of speed of migration for short distances are more subject to error than those for longer migrations, but may be presented for purposes of comparisons with the speeds indicated for movements between Canadian and California fishing-grounds: From the Washington coast to Heceta Head, Oregon, 1937, 6.6 km. per day; from Destruction Island to the mouth of the Columbia River, 1937, 18 km. per day; from the Washington coast to Vancouver Island, 1938, 7.9 km. per day; from the Washington coast to off Vancouver Island, 1940, 5.1, 5.1, 5.3, 7.4 km. per day; from the Washington coast to Lennard Island, 1940, 4.8, 5.5, 4.8, 8.0 km. per day; and from the Washington coast to the mouth of the Columbia River, 1940, 4.5, 9.7 km. per day.

Fish taken in Inlets in Winter.—Although the main body of pilchards leaves northern fishing-grounds in the autumn, some fish frequently remain in the inlets throughout

the winter, where they are occasionally captured during the winter herring-fishing season and where they sometimes provide early inshore fishing before the main pilchard shoals approach the Vancouver Island coast in the summer. Some of the tag-recoveries indicate that these pilchards are a part of the general population cut off from participation in the general movement by local conditions rather than a special local population.

In 1936 tags used on fish released off Vancouver Island were recovered in inlets indicating an inshore movement. During this year 100 tags were put out in Bedwell Sound on the west coast of Vancouver Island. One of these tags was recovered two days later from the same locality and three months later during the herring season a landing of pilchards from Deer Creek yielded another tag, indicating that part at least of the tagged fish were remaining in the inlets throughout the winter. Early in the 1937 season a few pilchards were found in Sydney Inlet, far removed from the main body of pilchards which did not approach the Canadian coast during that season, and some observers were of the opinion that these fish were moving out from the deeper inlets. This opinion was confirmed by the recovery from these fish of a tag used on a fish released in Bedwell Sound during the previous summer.

SUMMARY.

The paper constitutes a condensation of and includes quotations from a technical report on pilchard-tagging in British Columbia (Hart, 1943*a*). Tags recovered in British Columbia plants during 1943 are reported and minor alterations to incorporate additional data are included.

More than 20,000 magnetic belly-tags were used to investigate movements of pilchards. These tags were recovered by electromagnets situated in reduction plants.

In comparing concentrations of tagged pilchards in different localities consideration was given to the influence on the results of (1) deficiencies in the methods employed, (2) the tonnage of pilchards taken on different fishing-grounds, and (3) the sizes of pilchards taken in different fishing regions.

Four hundred and eighty-eight Canadian tags were recovered, most of them in British Columbia but significant numbers in each of the Pacific Coast United States. Many recoveries from fish captured in the North-east Pacific were made very soon after tagging. Such "quick recoveries" are not regarded as being indicative of general conditions among the pilchard population. Magnets in British Columbia recovered considerable numbers of tags put out in connection with California and Oregon fishing operations.

There is considerable movement of pilchards between northern fishing-grounds and those of California. This interchange of individuals is too great to be the result of casual movements and definite migration is indicated.

During the first season following that of tagging, tagged fish appear to be more concentrated on northern fishing-grounds than off the California coast. This observation may be accounted for in three different ways and it is believed that each of them plays a part in producing the difference; namely (1) deficiencies in the method of recovering tags, (2) errors in adjusting for length frequency in different regions, and (3) lack of completeness in the migration from northern to California fishing-grounds during the first year after tagging.

During the first year after tagging, tagged fish are relatively more concentrated on fishing-grounds off San Pedro than off Central California. Later this condition does not hold.

Recovery dates for Canadian tags taken at different California ports in the season following that of tagging give evidence of an orderly migration down the coast.

Average minimal speeds of southward migration range from 6.3 to 14.3 km. per day. Errors involved in the method of calculation are responsible for part of the variation between the results for different years and to different ports. All errors would tend to make the estimates of speed of migration lower than the correct ones.

Pilchard-tag recovery data can be used in calculating survival and total mortality rates. A total mortality rate of approximately 69 per cent. per year is indicated by the data at hand.

Fish move about considerably on northern fishing-grounds. In some cases these movements appear to be more or less random, but in others general movements appear to take place which accompany changes in the locality of the fishing-grounds. Part of the general pilchard population moves in and out of the inlets on the west coast of Vancouver Island and a few individuals frequently spend the winters in inside waters, thus failing to take part in the general southward migration.

ACKNOWLEDGMENTS.

The pilchard-tagging programme has been jointly financed by the Fisheries Research Board of Canada and the Department of Fisheries of the Province of British Columbia. It has enjoyed the encouragement of the directors and staffs of both organizations and the employees of the various fishing companies who have assisted both with tagging and tag-recovery. The state fisheries organizations of California, Oregon, and Washington have co-operated fully in recovering tags and supplying information concerning recovery efficiency, their commercial fisheries, and the length characteristics of the fish.

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TAGGING OF HERRING (*CLUPEA PALLASII*) IN BRITISH COLUMBIA: INSERTIONS AND RECOVERIES DURING 1943–44.

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INTRODUCTION.

This article represents the eighth in a series of annual reports dealing with herring-tagging and tag-recovery. As already outlined (Tester and Boughton, 1943), the investigation was originally designed (1) to add to the general knowledge of the life-history of herring in British Columbia waters, (2) to determine the extent of herring movements, and (3) to determine the strength of the tendency of herring to form local populations. In addition, it was hoped that some information might be obtained on the rates of exploitation of the populations supplying the various fishing-grounds.

The methods of tagging and recovery have been described in detail in previous reports (Hart and Tester, 1937, 1938, 1939, and 1940; Hart, Tester, and McHugh, 1941; Hart, Tester, and Boughton, 1942; and Tester and Boughton, 1943) and are only briefly referred to in the present report.

TAGGING.

In all previous years the internal tags used have been made of nickel-plated iron. In 1943–44, because of war-time difficulties, it was necessary to resort to silver-plating for several of the series (as indicated in Table IX.). It is believed that this change will not affect the comparability of the results with those of previous years.

The tagging methods of 1943–44 were similar to those previously employed. Fish were caught during the spawning period in the spring by bait-seines or beach-seines and were tagged and released either immediately or after being held overnight in bait-boxes made of wooden slats or in a collapsible pound made of web attached to a float. In one case (8J, Table IX.) the fish were taken from a set made by commercial fishermen

supplying a bait-pound and in another (8L) the fish were tagged directly from a commercial bait-pound. In some cases (8B, 8C, 8D, and 8H) the tagging was made in part from a tub, following a method previously described (Tester and Boughton, 1943, p. 46). On two occasions (8A and 8B) the fish were tagged into bait-boxes and were towed a short distance and then released over deep water to prevent their immediate capture by large numbers of gulls and divers which were attracted to the scene of tagging.

The policy adopted in 1943–44 was similar to that in previous years, namely, (1) to curtail tagging during the fall and winter fishing season, (2) to concentrate the spring tagging in two major areas, the Strait of Georgia and Queen Charlotte Strait, but with some tagging in adjacent major areas as time warranted, and (3) to use a relatively large number of tags (3,000 or more) in each individual tagging.

Efforts were made to tag herring at the Sooke salmon-traps in the Strait of Juan de Fuca during the early fall, but these were unsuccessful owing to failure of the fish to appear in the traps in sufficient quantity.

The spring tagging operations in the Strait of Georgia met with good success with six large taggings in various localities along the south-east coast of Vancouver Island, two along the west shore of the mainland, and one in the Discovery Passage area. No taggings were made in the vicinity of Satellite Channel, at Cortes Island, nor within the long inlets of the mainland, although the first two areas were visited fairly frequently during the spawning period. In the Queen Charlotte Strait area two large taggings were made, both in the vicinity of Retreat Passage. No fish were encountered on other potential spawning-grounds in the area during the times at which they were visited. A trip to the Central coast-line resulted in two large taggings, one at the head of Rivers Inlet and the other in Gunboat Passage. Similarly, a quick trip to the west coast of Vancouver Island produced one large tagging at Matilda Inlet, Clayoquot Sound. The total number of tags used in 1943–44 (45,965) is the largest of any one season over the period of investigation (*see* accompanying tabular recapitulation of tags used, and also previous reports).

Locality.	Number of Tags used in each Year.				
	1939–40.	1940–41.	1941–42.	1942–43.	1943–44.
Fall and Winter.					
Strait of Juan de Fuca	897	--------	496	697	--------
South-east coast of Vancouver Island	495	1,197	--------	--------	--------
West coast of Vancouver Island	--------	--------	--------	--------	--------
Central British Columbia	1,799	--------	--------	--------	--------
Northern British Columbia	--------	--------	--------	--------	--------
Queen Charlotte Islands	400	--------	--------	--------	--------
Spring.					
Strait of Georgia (including Puget Sound and north to Nodales Channel)	9,077	4,947	15,559	21,561	29,590
Queen Charlotte Strait and south to Nodales Channel	3,796	200	5,465	5,077	6,023
West coast of Vancouver Island	8,437	9,759	--------	--------	4,220
Central British Columbia	2,497	5,977*	1,497	3,493	6,132
Northern British Columbia	2,299	2,491	--------	--------	--------
Totals	29,697	24,571*	23,017	30,828	45,965

* Correction to number given in previous reports.

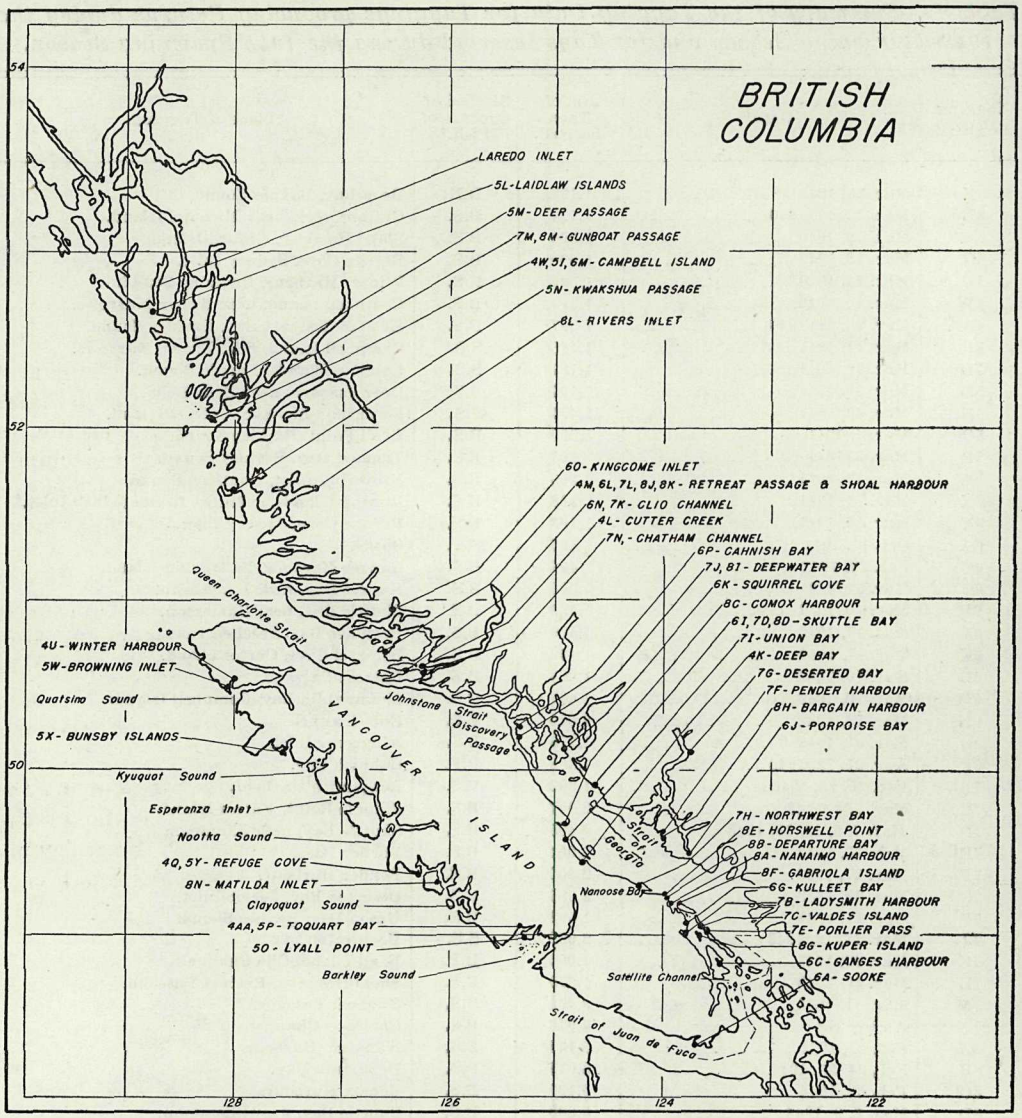
Summarized data on the 1943–44 taggings are given in Table I., along with similar data for other taggings which produced returns in 1943–44. Tagging localities are shown on the accompanying map. Following the custom of former years, detailed data on the 1943–44 taggings, for use in identifying recoveries, are included in Table IX. at the end of this report.

Table I.—Summary of the Tagging Data for Taggings producing Returns during the 1943–44 Fishing Season and for Tags inserted during the 1944 Spawning Season.

Tagging Code.	Date.	No. of Tags inserted.	Method of Capture of Fish.*	Place of Tagging.
4K	Mar. 13, 1940	1,197	D.N.	Deep Bay, Baynes Sound.
4L	Mar. 17, 18, 1940	1,797	B.S.	Cutter Creek, near Minstrel Island.
4M	Mar. 19, 1940	1,000	B.S.	Shoal Harbour, Gilford Island.
4Q	Mar. 18, 1940	1,000	B.S.	Refuge Cove, Sydney Inlet.
4U	Mar. 24, 1940	1,595	B.S.	Winter Harbour, Quatsino Sound.
4W	Mar. 18, 1940	1,399	B.S.	Campbell Island, near Brown Narrows.
4AA	Mar. 28, 29, 1940	1,397	B.S.	Head of Toquart Bay, Barkley Sound.
5I	Mar. 17, 1941	1,488	S.S.	Campbell Island, near Brown Narrows.
5L	Mar. 28, 1941	1,797†	S.S.	Laidlaw Islands, Laredo Sound.
5M	Mar. 29, 1941	1,197	S.S.	Deer Passage, near Bella Bella.
5N	Mar. 30, 1941	1,495	S.S.	Kwakshua Passage, Calvert Island.
5O	Mar. 4, 1941	1,200	B.S.	Lyall Point, Barkley Sound.
5P	Mar. 5, 1941	995	B.S.	Toquart Bay, Barkley Sound.
5W	Mar. 13, 1941	1,989	B.S.	Browning Inlet, Quatsino Sound.
5X	Mar. 14, 1941	998	B.S.	Bunsby Islands, entrance to Ououkinsh Inlet.
5Y	Mar. 16, 1941	1,193	B.S.	Refuge Cove, Sydney Inlet.
6A	Oct. 17, 1941	496	S.T.	Sooke.
6C	Feb. 26, 1942	497	B.S.	Ganges Harbour, Saltspring Island.
6G	Mar. 9, 1942	1,000	B.S.	Kulleet Bay, near Ladysmith.
6I	Mar. 10, 1942	1,489	B.S.	Skuttle Bay, near Sliammon.
6J	Mar. 12, 1942	1,579	B.S.	Porpoise Bay, Seechelt Inlet.
6K	Mar. 27, 1942	1,499	B.S.	Squirrel Cove, Cortes Island.
6L	Mar. 15, 1942	1,689	B.S.	Retreat Passage.
6M	Mar. 19, 1942	1,497	B.S.	McLaughlin Bay, Campbell Island.
6N	Mar. 28, 1942	2,000	B.S.	Clio Channel.
6O	Mar. 30, 1942	1,776	B.S.	Kingcome Inlet.
6P	Apr. 21, 22, 1942	1,498	B.P.	Cahnish Bay.
7B	Feb. 25, 26, 1943	1,892	B.S.	Ladysmith Harbour.
7C	Mar. 1, 3, 1943	2,997	B.S.	Shingle Point, Valdes Island.
7D	Mar. 7, 8, 12, 13, 1943	2,495	B.S.	Skuttle Bay, near Sliammon.
7E	Mar. 16, 1943	2,004	B.S.	Porlier Pass.
7F	Mar. 27, 1943	2,500	B.S.	Pender Harbour.
7G	Mar. 29, 1943	2,989	B.S.	Deserted Bay, Jervis Inlet.
7I	Apr. 11, 1943	1,693	B.S.	Union Bay, Baynes Sound.
7J	Mar. 17, 18, 1943	2,989	S.S.	Deepwater Bay.
7K	Mar. 22, 1943	1,000	B.P.	Bend Island, Clio Channel.
7L	Mar. 28, 1943	1,099	B.P.	Shoal Harbour, Retreat Passage.
7M	Mar. 31, 1943	3,493	B.S.	Gunboat Passage.
7N	Apr. 5, 1943	2,978	B.S.	Chatham Channel.
8A	Feb. 21, 1944	2,138	B.S.	Nanaimo Harbour.
8B	Feb. 24, 25, 1944	3,017	B.S.	Departure Bay.
8C	Feb. 29, 1944	3,190	B.S.	Comox Harbour.
8D	Mar. 2, 3, 1944	3,830	B.S.	Skuttle Bay, near Sliammon.
8E	Mar. 7, 1944	1,178	B.S.	Horswell Point, Departure Bay.
8F	Mar. 10, 11, 1944	3,174	B.S.	Gabriola Island, near Entrance Island.
8G	Mar. 12, 13, 14, 15, 1944	5,021	B.S.	Kuper Island, near Clam Bay Spit.
8H	Apr. 2, 3, 4, 1944	4,043	B.P., B.S.	Bargain Harbour.
8I	Mar. 31, 1944	3,999	B.S.	Deepwater Bay, Discovery Passage.
8J	Mar. 6, 1944	2,997	C.B.S.	Retreat Passage.
8K	Mar. 27, 1944	3,026	B.S.	Shoal Harbour, Retreat Passage.
8L	Mar. 18, 1944	3,121	B.P.	Rivers Inlet, head.
8M	Mar. 20, 1944	3,011	B.S.	Gunboat Passage.
8N	Mar. 26, 27, 1944	4,220	B.S.	Matilda Inlet, Clayoquot Sound.

* B.S.=bait-seine; S.S.=shore-seine; S.T.=salmon-traps; D.N.=dip-net; B.P.=bait-pound; C.B.S.=commercial bait-seine.

† Correction to number given in previous reports.



RECOVERY METHODS.

As in previous years, tags were recovered mechanically by two methods, induction detectors and magnets. No incidental recoveries were made in canneries, although reward placards were displayed near heading-machines and filling-tables.

INDUCTION DETECTORS.

As in 1942–43, two induction detectors were operated throughout the fishing season, one at the Imperial Cannery and the other at the Gulf of Georgia Cannery, Steveston.

Owing to changes in the unloading system at the Imperial Cannery, a new tag-detector installation was necessary. However, the same recovery principle as in 1942–43 was used. Fish dropped from an overhead conveyer to a chute. In sliding down the chute they passed through a " pick-up " detector coil and thence over a trap-door which

was pivoted transversely at its centre on an axle. When an impulse was received from the detector coil—e.g., from a metal tag—the trap-door momentarily opened to a position at right angles to the flow of fish, allowing a few, including the one with the tag, to fall to a bin below. The distance of the coil to the trap-door was increased over that in 1942–43 to compensate for a slightly greater slope of the chute. A new control-room, adjacent to the chute, was built.

The Imperial detector gave satisfactory performance during its period of operation, October 8th to February 1st, apart from minor breakdowns. It ran efficiently on 80 per cent. of the fish passing into the cannery.

In the Gulf of Georgia installation the tagged fish were recovered from a belt-conveyer in the same manner as last year. This belt ran through the detector coil and past a hinged gate system which swept and led the fish off the belt when activated. Unfortunately, prior to the opening of the season the belt-conveyer had been rebuilt at a greater incline than in 1942–43; when tested, it was found necessary to rivet a series of transverse strips of belting at intervals along the belt to give sufficient traction to carry the fish up the slope. Successive trip-loads of fish (from the weighing-machine) tended to pile deep on the belt with the upper layers continuously sliding backwards, thus making accurate timing of the recovery system very difficult. The fish also tended to lie crosswise on the belt to a greater extent than last year, so that any tags which they contained would pass through the coil with their long axes parallel to the coil face, in which position only a weak impulse was generated to the tag detector. Difficulties were also experienced because of poor connections within the balancing and pick-up coils which had been rebuilt to conform with those of the Imperial detector; moisture also penetrated one of the coils when oil from the fish partially dissolved the pitch with which it was impregnated, thus changing its electrical properties and making balancing impossible.

Although the Gulf of Georgia detector ran on 78 per cent. of the fish entering the cannery its efficiency at recovering tags was very low as compared with that of the Imperial detector for reasons discussed above. This is illustrated by the following tabulation showing the number of recoveries per 100 tons of fish passing through each of the two detectors while they were in effective operation:—

Fishing-ground.	A. Imperial Detector.	B. Gulf of Georgia Detector.	A/B.
Satellite Channel	0.48	0.26	1.8
Porlier Pass vicinity	0.57	0.19	3.0
Nanoose Bay	0.51	0.05	10.2
Deepwater Bay	2.32	1.18	2.0
Bones Bay	10.00	2.00	5.0

The relatively poor recovery of the Gulf of Georgia detector from Nanoose Bay fish is probably due to excessive operational difficulty during the period in which these fish passed through the tag detector. An average for the season, weighted to the quantity of fish from each fishing-ground, would indicate that the Imperial detector was about five times as efficient as the Gulf of Georgia detector in recovering tags. Last season (Tester and Boughton, 1943, p. 51) it was 1.4 times as efficient. The difference is believed due entirely to the increased difficulties experienced with the Gulf of Georgia detector in 1943–44.

MAGNETS.

Electromagnets already installed in the meal-lines of reduction plants were again instrumental in recovering herring-tags. A new installation was made in the offal-

reduction plant of the Redonda Bay Cannery. No returns resulted from the magnets at Kildonan and Ceepeecee, presumably because they were not in effective operation during the season. The Butedale magnet, although recovering tags, developed a short-circuit towards the end of the season; it has since been repaired.

It may be pointed out again that magnets are less satisfactory than induction detectors because usually there is considerable uncertainty regarding the fishing locality from which the fish bearing the tag originated. Recoveries from cracks and crevices in the plant machinery, from driers, and from traps for tramp-metal are included as magnet returns.

The reduced opportunity for recovering tags in reduction plants because of extensive canning operations has already been pointed out (Hart, Tester, and Boughton, 1942, p. 58). Most of the tags either fall from the fish during heading and gutting or they enter the cans with fish; in any event, very few are recovered when herring-offal is reduced. During 1943–44 practically the entire catch from the lower east coast of Vancouver Island and Discovery Passage, part of the catch from the west coast of Vancouver Island, and a small part of the catch from Queen Charlotte Strait and the Central coast-line was canned.

RECOVERIES.

Reference is again made to qualifications which must be considered in interpreting the recoveries and in drawing conclusions regarding the populations involved (Hart, Tester, and McHugh, 1941, p. 54; Hart, Tester, and Boughton, 1942, p. 59).

Table II.—Tags recovered by the Imperial Detector (A) and the Gulf of Georgia Detector (B) during 1943–44.

Code.	Place and Time of Tagging.	Place of Capture.													Total.
		Barkley Sound.	Satellite Channel.		Porlier Pass to Dodd Narrows.		Nanoose Bay.		Deep Bay.	Deepwater Bay.		Clio Channel.		Kwakshua Passage.	
		A.	A.	B.	A.	B.	A.	B.	B.	A.	B.	A.	B.	A.	
5P	Toquart Bay, March, 1941	1	----	----	----	----	----	----	----	----	----	----	----	----	1
6C	Ganges Harbour, February, 1942	----	----	----	1	----	----	----	----	----	----	----	----	----	1
7E	Porlier Pass, March, 1943	----	----	1	1	----	2	----	----	----	----	----	----	----	4
7C	Valdes Island, March, 1943	----	4	1	----	----	2	----	----	----	----	----	----	----	7
7B	Ladysmith Harbour, February, 1943	----	9	4	5	1	8	----	1	----	----	----	----	----	28
6G	Kulleet Bay, March, 1942	----	----	----	----	1	1	----	----	----	----	----	----	----	2
4K	Deep Bay, March, 1940	----	1	----	----	----	----	----	----	----	----	----	----	----	1
7I	Union Bay, April, 1943	----	----	----	----	----	----	----	----	1	----	----	----	----	1
7F	Pender Harbour, March, 1943	----	1	----	----	----	1	1	----	----	----	----	----	----	3
7G	Deserted Bay, March, 1943	----	----	----	----	----	2	----	----	----	----	----	----	----	2
6I	Skuttle Bay, March, 1942	----	----	----	----	----	----	----	----	3	----	----	----	----	3
7D	Skuttle Bay, March, 1943	----	----	----	1	----	2	----	----	8	1	----	----	----	12
6J	Porpoise Bay, March, 1942	----	----	----	----	----	2	----	----	----	1	----	----	----	3
6K	Squirrel Cove, March, 1942	----	----	----	----	----	----	----	----	1	----	----	----	----	1
7J	Deepwater Bay, March, 1943	----	----	----	----	----	2	----	----	8	3	----	----	2	15
6P	Cahnish Bay, April, 1942	----	----	----	----	----	----	----	----	1	----	----	----	----	1
7N	Chatham Channel, April, 1943	----	----	----	----	----	----	----	----	8	----	----	1	----	9
6N	Clio Channel, March, 1942	----	----	----	----	----	----	----	----	1	----	2	----	----	3
7K	Clio Channel, March, 1943	----	----	----	----	----	----	----	----	----	----	----	----	1	1
6O	Kingcome Inlet, March, 1942	----	----	----	----	----	----	----	----	----	----	----	----	1	1
4W	Campbell Island, March, 1940	----	----	----	----	----	----	----	----	----	----	----	----	1	1
6M	Campbell Island, March, 1942	----	----	----	----	----	----	----	----	----	----	----	----	1	1
7M	Gunboat Passage, March, 1943	----	----	----	----	----	----	----	----	----	----	----	----	10	10
	Totals	1	21		10		23		1	36		3		16	111

Induction Detectors.

Data on detector recoveries are summarized in Table II. Of one hundred and eleven tags, ninety-five were taken by the Imperial detector and sixteen by the Gulf of Georgia detector. All of the tags recovered had been out for a period of six months or more. The 1943–44 results are enhanced by the fact that fish from several different fishing-grounds, including four major areas, passed through the detectors. The following pertinent observations arise from the table:—

One tag originally used in Barkley Sound (5P) was recovered from Barkley Sound fish.

The Satellite Channel catches contained nineteen tags originally used among the islands on the south-east coast of Vancouver Island (7E, 7C, and 7B); one from Deep Bay (4K), near Comox, on the south-east coast of Vancouver Island; and one from Pender Harbour (7F), on the north-east shore of the Strait of Georgia. Thus most of the recoveries from Satellite Channel catches (90 per cent.) came from spawning-grounds close to that fishing-ground.

The catches made between Porlier Pass and Dodd Narrows contained nine tags from the islands on the south-east coast of Vancouver Island (6C, 7E, 7B, and 6G) and one tag from the north-east shore of the Strait (7D). Again, most of the recoveries from this area (90 per cent.) came from spawning-grounds close to the fishing-ground.

The Nanoose Bay catches contained thirteen tags from the lower south-east coast of Vancouver Island (7E, 7C, 7B, and 6G); eight from the north-east shore of the Strait of Georgia (7F, 7G, 7D, and 6J), including four from within the long inlets leading from it (Porpoise Bay and Deserted Bay); and two from Deepwater Bay, Discovery Passage (7J). It is evident that in 1943–44 fish which spawned in many different parts of the Strait of Georgia contributed to the Nanoose Bay fishery.

Only a relatively small tonnage was taken from Deep Bay in contrast to last season. One tag from Ladysmith Harbour (7B) was recovered.

The catches made at Deepwater Bay, Discovery Passage, contained twelve tags originally used in Discovery Passage (7J and 6P), one from the northern end of the Strait of Georgia (6K), thirteen from the north-east shore of the Strait of Georgia (6I, 7D, and 6J), and one from the north-west shore of the Strait of Georgia (7I). In addition, the catches contained nine tags from the Queen Charlotte Strait area (7M and 6N). It is clear that most of the tagged fish caught at Deepwater Bay (75 per cent.) came from spawning-grounds in the northern part of the Strait of Georgia, including the north-east and north-west shores of the Strait and Discovery Passage, but that some (25 per cent.) came from the Queen Charlotte Strait area.

A small tonnage of fish from Clio Channel yielded three tags, all from spawning-grounds in that general area (Queen Charlotte Strait).

The Kwakshua Passage catches contained twelve tags (75 per cent.) from the Central coast-line and two tags (12.5 per cent. each) from the Queen Charlotte Strait area and the Discovery Passage area.

As in 1942–43, there is evidence of a partial segregation of the populations supplying the fisheries along the south-east coast of Vancouver Island. Assuming a dividing line between "southern" spawning-grounds and "northern" spawning-grounds to lie roughly between Parksville and Sechelt, and omitting the one recovery from Deep Bay, the results can be summarized as follows:—

Fishing-ground.	Number of Recoveries.	Per Cent. Recoveries.	
		Southern.	Northern.
Satellite Channel to Dodd Narrows	31	90	10
Nanoose Bay	23	57	43
Deepwater Bay	27	----	100

These results, almost identical with those of last year apart from the exclusion of Deep Bay, again indicate that fish which spawn in the southern part of the Strait of Georgia (the south-east coast of Vancouver Island) return mostly to southern fishing-grounds (Satellite Channel and from Porlier Pass to Dodd Narrows), whereas those which spawn in the northern part of the Strait of Georgia (particularly the north-east shore and Discovery Passage) return mostly to northern fishing-grounds (Deepwater Bay and, in 1942–43, Deep Bay). Fish which spawn in both the southern and northern part of the Strait appear to supply the Nanoose Bay fishing-grounds. However, the results for Nanoose Bay may be distorted by lack of taggings in the immediate vicinity in 1943 and the unusual mortality, probably including tagged fish, in 1942.

The mixture of fish originally tagged in the Queen Charlotte Strait area with those caught at Deepwater Bay is worthy of note and supports the suggestion offered last year that the Deepwater Bay fish arrived on that fishing-ground by way of Discovery Passage and Johnstone Strait rather than by way of the Strait of Juan de Fuca. The mixture of Deepwater Bay and Queen Charlotte Strait fish with those caught at Kwakshua Passage, which is demonstrated by the detector recoveries, will be referred to later.

Table III.—Calculations of Percentage Recovery for Tags used in the Spring of 1942 and 1943 and recovered from Satellite Channel (A), Porlier Pass to Dodd Narrows (B), Nanoose Bay (C), Deepwater Bay (D), Clio Channel (E), and Kwakshua Passage (F).

(For explanation *see* text.)

Code.	Place and Time of Tagging.	Calculated Total Number of Recoveries from Fishing-grounds at:							Number of Tags used.	Percentage Recovery.
		A.	B.	C.	D.	E.	F.	Total.		
7E	Porlier Pass, March, 1943	.....	6.9	8.1	.....	.....	.....	15.0	2,004	0.7
7C	Valdes Island, March, 1943	22.2	.....	8.1	.....	.....	.....	30.3	2,997	1.0
7B	Ladysmith Harbour, February, 1943	49.9	34.3	32.2	.....	.....	.....	116.4	1,892	6.2
7H	Northwest Bay, April, 1943	.....	.....	.....	.....	.....	.....	.....	2,002	.....
7I	Union Bay, April, 1943	.....	.....	.....	3.4	.....	.....	3.4	1,693	0.2
7F	Pender Harbour, March, 1943	5.5	.....	4.0	.....	.....	.....	9.5	2,500	0.4
7G	Deserted Bay, March, 1943	.....	.....	8.1	.....	.....	.....	8.1	2,989	0.3
7D	Skuttle Bay, March, 1943	.....	6.9	8.1	27.5	.....	.....	42.5	2,495	1.7
7J	Deepwater Bay, March, 1943	.....	.....	8.1	27.5	.....	54.6	90.2	2,989	3.0
7N	Chatham Channel, April, 1943	.....	.....	.....	27.5	.....	.....	27.5	2,978	0.9
7K	Clio Channel, March, 1943	.....	.....	.....	.....	.....	27.3	27.3	1,000	2.7
7M	Gunboat Passage, March, 1943	.....	.....	.....	.....	.....	273.0	273.0	3,493	7.8
6C	Ganges Harbour, February, 1942	.....	6.9	.....	.....	.....	.....	6.9	497	1.4
6G	Kulleet Bay, March, 1942	.....	.....	4.0	.....	.....	.....	4.0	1,000	0.4
6I	Skuttle Bay, March, 1942	.....	.....	.....	10.3	.....	.....	10.3	1,489	0.7
6J	Porpoise Bay, March, 1942	.....	.....	8.1	.....	.....	.....	8.1	1,579	0.5
6K	Squirrel Cove, March, 1942	.....	.....	.....	3.4	.....	.....	3.4	1,499	0.2
6P	Cahnish Bay, April, 1942	.....	.....	.....	3.4	.....	.....	3.4	1,498	0.2
6N	Clio Channel, March, 1942	.....	.....	.....	3.4	267.0	.....	270.4	2,000	13.5
6O	Kingcome Inlet, March, 1942	.....	.....	.....	.....	.....	27.3	27.3	1,776	1.5
6M	Campbell Island, March, 1942	.....	.....	.....	.....	.....	27.3	27.3	1,497	1.8

Calculations of the total number of tags probably taken by the fishery and of the probable percentage recovery from individual taggings are included in Table III. for detector returns from six fishing-grounds. Because of the small number of recoveries and the erratic performance of the Gulf of Georgia detector, the calculations are based on returns from the Imperial detector only. Following the method used last year (Tester and Boughton, 1943, p. 53), the number of tags recovered from each fishing-ground is multiplied by the total tonnage taken by the fishery (Satellite Channel, 15,400; Porlier Pass to Dodd Narrows, 9,600; Nanoose Bay, 17,400; Deepwater Bay,

4,603; Clio Channel vicinity, 2,670; and Kwakshua Passage, 37,661), and divided by the tonnage " efficiently " operated on by the detector (Satellite Channel, 2,774; Porlier Pass to Dodd Narrows, 1,398; Nanoose Bay, 4,324; Deepwater Bay, 1,337; Clio Channel, 20; and Kwakshua Passage, 1,379). A small tonnage (about 1,000) from Deep Bay is not included, as fish from that locality did not pass through the Imperial detector. The accuracy of the calculations is based on the assumptions that the Imperial detector was 100-per-cent. efficient at recovering tags and that the recoveries from each fishing-ground were distributed in the total catch in the same proportion as in that part passing through the detector.

There is considerable variation in the calculated percentage recovery of tags from each tagging. Considering those used in 1943 on the lower south-east coast of Vancouver Island it would seem that the fish which spawned at Ladysmith Harbour (7B) contributed to a much greater extent to the south-east coast fishery than those spawning at Valdes Island (7C) and Porlier Pass (7E). The difference is probably due to lack of random mixture of the tagged fish with the population. No recoveries resulted from the tagging at Northwest Bay (7H), and the percentage recoveries from Union Bay (7I), Pender Harbour (7F), and Deserted Bay (7G) are low, suggesting that fish from these areas did not contribute to as great an extent as those from other tagging areas in the Strait of Georgia to the fishery along the south-east coast of Vancouver Island and Discovery Passage. The apparently large percentage recovery of Gunboat Passage tags (7M) from Kwakshua Passage is worthy of note.

Percentage recovery calculations are included in Table III. for 6-series tags, used in 1942 and recovered in 1943–44 (not correcting for those already recovered in 1942–43). The percentage recoveries are for the most part relatively low, as might be expected with tags out for more than one year. However, that for Clio Channel (6N) is exceptionally high. This might be due to chance as the calculation is based mostly on two tags recovered from a small tonnage (20).

Considering only taggings of the 6-series which were made in the lower south-east coast of Vancouver Island area (south of Dodd Narrows), the probable number taken in 1942–43 was 104 and in 1943–44, 11, indicating a total mortality rate of 89 per cent. This is similar to the total mortality rate of 88 per cent. as calculated for the 5-series last year (Tester and Boughton, 1943, p. 65). However, it should be pointed out that this estimate may be high, as any migration in or out of the area will increase the apparent mortality rate.

It is interesting to note that in 1943–44 there were no recoveries of 6-series tags used along the east coast of Vancouver Island from Nanaimo to Comox in 1942. This corroborates the evidence received last year that most of the fish tagged in that area during a period of mortality died, probably along with a fair percentage of the spawning population (Tester and Boughton, 1943, p. 54).

MAGNETS.

The number of tags recovered from reduction plants, chiefly by means of electromagnets, is shown in the following tabulation:—

Location of Plant.	Name of Plant.	Number of Recoveries.
West coast of Vancouver Island	Ucluelet	9
	Nootka	4
Strait of Georgia	Imperial	4
	Gulf of Georgia	4
	Redonda Bay	6
Queen Charlotte Strait	Alert Bay	222
Central coast-line	Namu	168
	Butedale	125
Northern coast-line	Port Edward	63
Total		605

The small number of tags (13) from plants on the west coast of Vancouver Island is due to several factors, including (*a*) no tags were used in west coast areas in 1941–42 and 1942–43, (*b*) the west coast catch in 1943–44 was relatively small (9,195 tons), (*c*) part of the west coast and all of the east coast of Vancouver Island fish landed at the plants were canned, and (*d*) the magnets at two west coast plants (Kildonan and Ceepeecee) were apparently not in effective operation. The small number of recoveries (14) from plants in the Strait of Georgia is due chiefly to the fact that these operated almost entirely on offal from canneries associated with them, and that at two of the three plants with magnets tag detectors removed the tagged fish from the catches entering the canneries, and hence from the offal. The large number of tags (578) recovered by four plants located north of the Strait of Georgia is explained partly by the following facts: (*a*) That almost the entire catch landed at the plants was reduced, (*b*) that one of the plants (Alert Bay) handled most of the catch (2,670 tons) from Queen Charlotte Strait where tagging has been relatively intensive in recent years, (*c*) that all plants operated extensively on a large catch (37,661 tons) from the Central coast-line (mostly from Kwakshua Passage) where tagging has been maintained on a moderate scale annually and where there has possibly been an accumulation of tagged fish because of relatively small catches during the 1940–41, 1941–42, and 1942–43 fishing seasons (about 10,500, 12,800, and 4,900 tons respectively). The latter possibility has not been investigated as yet.

Following the custom of earlier reports there is given below a discussion of the magnet recoveries for individual taggings; namely, an unbiased interpretation of the probable fishing-grounds from which the fish bearing the tag originated. The interpretation is based on knowledge of the plant history (daily tonnage reduced, canned, or otherwise handled, and the fishing-ground from which each load came), the efficiency and "lag" of the magnets in recovering tags, and the date and place of recovery as reported by the person returning the tag. In all cases, unless otherwise specified, the interpreted place of recovery agrees with that reported with the return.

To save space and avoid repetition, the following remarks apply to all recoveries designated A, B, C, or D in the account to follow:—

A = Tags almost certainly from Kwakshua Passage catches, but with the remote possibility that they may have entered the plant with small loads of herring from Fish Egg Inlet, Drainey Inlet, or Clio Channel, which were processed at the beginning of the season.

B = Tags almost certainly from Kwakshua Passage, but with Passage Island as a remote possibility. Several loads from the latter locality were reduced during July and August.

C = Tags almost certainly from Kwakshua Passage, but with Clio Channel vicinity as a remote possibility. The plant operated on Clio Channel and Kwakshua Passage fish during the first part of the season, but exclusively on Kwakshua Passage fish during the second part (after the Christmas holiday period). Tags indicated as "C" were recovered during the latter period.

D = Tags practically certain to have come from Kwakshua Passage. The only other fish processed by the plant prior to running on herring were pilchards from the Queen Charlotte Islands during September.

It might also be noted that tags recorded as coming from "Clio Channel" in the account which follows were variously reported as coming from Serpentine Pass, Bones Bay, Minstrel Island, and Knight Inlet. These fishing-grounds are all at or adjacent to Clio Channel and this one name is used to avoid confusion.

Cutter Creek (4L): Of six recoveries, two came from Clio Channel, one from Kwakshua Passage (A), and three (reported from Clio Channel vicinity) could equally well have come from either Clio Channel or Kwakshua Passage.

Shoal Harbour (4M): Two recoveries, both from Kwakshua Passage (A and B).

Refuge Cove (4Q): One recovery, probably from Sydney Inlet, but with Barkley Sound and the lower east coast of Vancouver Island as less likely alternatives.

Winter Harbour (4U): Two recoveries, both from Kwakshua Passage (A and D).

Campbell Island (4W): Four recoveries, all from Kwakshua Passage (A, B, C, and D).

Toquart Bay (4AA): Three recoveries. It is almost certain that two came from Barkley Sound, but with Sydney Inlet and east coast of Vancouver Island fishing-grounds as less likely alternatives. The third almost certainly came from Sydney Inlet, but with the east coast of Vancouver Island and Quatsino Sound as possibilities.

Campbell Island (5I): Twenty-two recoveries. One came from either Clio Channel or Kwakshua Passage. The remainder are considered to have come from Kwakshua Passage (A—8, B—7, C—3, D—3).

Laidlaw Islands (5L): One recovery from Kwakshua Passage (C).

Deer Passage (5M): Four recoveries from Kwakshua Passage (A—3, D—1).

Kwakshua Passage (5N): Fifteen recoveries. One came from either Clio Channel or Kwakshua Passage catches. The remainder came from Kwakshua Passage (A—4, B—5, C—2, D—3).

Lyall Point (5O): One recovery, almost certainly from Barkley Sound, but with Sydney Inlet and east coast of Vancouver Island localities as less likely alternatives.

Toquart Bay (5P): Two recoveries, both probably from Barkley Sound, but with Sydney Inlet and the east coast of Vancouver Island as less likely alternatives.

Browning Inlet (5W): One recovery from Kwakshua Passage (A).

Bunsby Islands (5X): One recovery which probably came from Kwakshua Passage, but with the east coast of Vancouver Island as a rather likely alternative.

Refuge Cove (5Y): One recovery, probably from Sydney Inlet. Barkley Sound and east coast of Vancouver Island fishing-grounds are less likely possibilities.

Sooke (6A): One recovery reported from Kwakshua Passage. It is equally likely, however, that this tag came from west coast of Vancouver Island fishing-grounds and there is a possibility that it came from Nanoose Bay. As no Sooke tags were recovered by plants processing large quantities of Kwakshua Passage fish, it is considered most likely that the tag came from some locality on the west coast of Vancouver Island, possibly Barkley Sound.

Skuttle Bay (6I): One recovery from Kwakshua Passage (D).

Squirrel Cove (6K): Two recoveries. One came from Kwakshua Passage (D). No interpretation is offered for the other which was found in the drier and which was reported from either the east coast of Vancouver Island, Deepwater Bay, or Clio Channel.

Retreat Passage (6L): Nine recoveries. One came from Clio Channel and five from Kwakshua Passage (A—2, B—2, D—1). Two reported from Clio Channel vicinity may equally well have come from Kwakshua Passage. One, presumably coming from herring mixed with a load of pilchards caught at Safety Cove in September, is included with Kwakshua Passage returns in the tables.

Campbell Island (6M): Forty-two recoveries. One came from either Clio Channel vicinity or Kwakshua Passage, as reported. One probably came from Kwakshua Passage, although west coast of Vancouver Island localities are possible alternatives and Nanoose Bay is a remote possibility. The remainder are considered to have come from Kwakshua Passage (A—16, B—11, C—7, D—6).

Clio Channel (6N): Thirty recoveries. One very probably came from Sydney Inlet, with Nanoose Bay and Quatsino Sound as less likely alternatives. It is certain that fourteen came from the vicinity of Clio Channel. Another very probably came from Clio Channel, but with east coast of Vancouver Island localities as a remote alternative. Four came from Kwakshua Passage (A—2, B—1, C—1). Of the remaining

ten, six were reported from Clio Channel vicinity, three from Clio Channel or Kwakshua Passage, and one from Kwakshua Passage. According to plant records all ten are equally likely to have come from either Clio Channel or Kwakshua Passage. In view of the small number of recoveries from plants which processed Kwakshua Passage but not Clio Channel fish, it is likely that most of the ten actually originated with fish from the latter locality, although this interpretation is not used in compiling the tables of data.

Kingcome Inlet (6O): Twenty-four recoveries. Twelve were recovered with fish from Clio Channel and two with Kwakshua Passage fish (A—2). Of the remaining ten, five were reported from Clio Channel vicinity and five from either Clio Channel or Kwakshua Passage. Although for the same reason given in the preceding paragraph, most of these tags are likely to have come from Clio Channel fish, the strictly unbiased interpretation that they came from either Clio Channel or Kwakshua Passage is adhered to in tabulating the results.

Cahnish Bay (6P): Six recoveries, one from Clio Channel vicinity and four from Kwakshua Passage (A—3, D—1). The sixth tag probably came from Deepwater Bay, but with localities along the south-east coast of Vancouver Island as less likely alternatives.

Ladysmith Harbour (7B): Three recoveries. It is certain that one came from the east coast of Vancouver Island, probably Satellite Channel, and it is probable that a second also came from the east coast of Vancouver Island, possibly Porlier Pass vicinity, although it was recorded from Tofino Inlet. The third tag probably came from Barkley Sound, with Sydney Inlet and east coast of Vancouver Island localities as less likely alternatives.

Skuttle Bay (7D): Four recoveries. One probably came from Deepwater Bay, but with east coast of Vancouver Island fishing-grounds as an alternative. One probably came from Nanoose Bay, but with Satellite Channel and Deepwater Bay as alternatives. One was recovered with Kwakshua Passage fish (B).

Deserted Bay (7G): Two recoveries, both from the same plant at about the same time and reported from Kwakshua Passage fish. They may have come from that locality, although it is considered unlikely in view of the fact that no 7G tags were recovered by other plants processing far larger quantities of Kwakshua Passage fish than the plant making the two recoveries. Localities along the south-east coast of Vancouver Island and Deepwater Bay are likely alternatives. No further interpretation is offered.

Union Bay (7I): One recovery from Kwakshua Passage (A), and one from either Clio Channel or Kwakshua Passage.

Deepwater Bay (7J): Twenty-eight recoveries. Four came from fishing-grounds in the vicinity of Clio Channel and twenty-one came from Kwakshua Passage (A—12, B—5, C—1, D—3). Two tags, one reported from Clio Channel vicinity and another reported from Clio Channel and Kwakshua Passage, could equally well have come from either of these two fishing-grounds. No interpretation is offered for one tag which was found in the drier of a plant processing fish and offal from many different places.

Clio Channel (7K): Twenty recoveries. Six came from Clio Channel and three from Kwakshua Passage (A—2, C—1). The remaining eleven tags, six of which were reported from the vicinity of Clio Channel and five from either Clio Channel or Kwakshua Passage, may have come from either of these two localities.

Retreat Passage (7L): Twenty-one recoveries, two from Clio Channel and thirteen from Kwakshua Passage (A—8, B—2, C—2, D—1). The remaining six, two of which were reported from Clio Channel vicinity and four from Clio Channel or Kwakshua Passage, may have come from either of these two places.

Gunboat Passage (7M): Two hundred and thirty-nine recoveries. Two were recovered from Clio Channel fishing-grounds. Two hundred and twenty-six were re-

covered from Kwakshua Passage (A—85, B—76, C—27, D—38). An additional two tags are interpreted as coming from Kwakshua Passage, but with localities along the south-east coast of Vancouver Island as less likely alternatives. The remaining nine are considered to have come from either Clio Channel or Kwakshua Passage—eight were reported from fishing-grounds in the vicinity of Clio Channel and one was reported from either Clio Channel or Kwakshua Passage.

Chatham Channel (7N): One hundred recoveries. Forty-three came from Clio Channel fishing-grounds. Twenty-eight came from Kwakshua Passage (A—10, B—12, C—4, D—2). Twenty-seven came from either Clio Channel or from Kwakshua Passage; of these sixteen were reported from Clio Channel fish and eleven from either Clio Channel or Kwakshua Passage fish. Of the remaining two tags, no interpretation is offered for one (found in the drier of a plant processing fish from many different places) and the other, reported from Deepwater Bay, probably came from that locality with south-east coast of Vancouver Island fishing-grounds as less likely alternatives.

Five tags with undecipherable code letters were received.

The above results are summarized in Table IV.

Table IV.—Summary of the Presumed Sources of Tags from each Tagging producing Returns, which were recovered on Magnets during the 1943–44 Season.

(For qualifications *see* text.)

Code.	Place and Time of Tagging.	Place of Capture.								Total.
		Barkley Sound.	Sydney Inlet.	South-east Coast of Vancouver Island.	Deepwater Bay.	Clio Channel vicinity.	Clio Channel or Kwakshua Passage.	Kwakshua Passage.	No Interpretation offered.	
4AA	Toquart Bay, March, 1940	2	1	----	----	----	----	------	----	3
5O	Lyall Point, March, 1941	1	----	----	----	----	----	------	----	1
5P	Toquart Bay, March, 1941	2	----	----	----	----	----	------	----	2
4Q	Refuge Cove, March, 1940	----	1	----	----	----	----	------	----	1
5Y	Refuge Cove, March, 1941	----	1	----	----	----	----	------	----	1
5X	Bunsby Islands, March, 1941	----	----	----	----	----	----	1	----	1
4U	Winter Harbour, March, 1940	----	----	----	----	----	----	2	----	2
5W	Browning Inlet, March, 1941	----	----	----	----	----	----	1	----	1
6A	Sooke, October, 1941	1	----	----	----	----	----	------	----	1
7B	Ladysmith Harbour, February, 1943	1	----	2	----	----	----	------	----	3
7I	Union Bay, April, 1943	----	----	----	----	----	1	1	----	2
7G	Deserted Bay, March, 1943	----	----	----	----	----	----	------	2	2
6I	Skuttle Bay, March, 1942	----	----	----	----	----	----	1	----	1
7D	Skuttle Bay, March, 1943	----	----	1	1	----	1	1	----	4
6K	Squirrel Cove, March, 1942	----	----	----	----	----	----	1	1	2
6P	Cahnish Bay, April, 1942	----	----	----	1	1	----	4	----	6
7J	Deepwater Bay, March, 1943	----	----	----	----	4	2	21	1	28
4L	Cutter Creek, March, 1940	----	----	----	----	2	3	1	----	6
4M	Shoal Harbour, March, 1940	----	----	----	----	----	----	2	----	2
6L	Retreat Passage, March, 1942	----	----	----	----	1	2	6	----	9
6N	Clio Channel, March, 1942	----	1	----	----	15	10	4	----	30
6O	Kingcome Inlet, March, 1942	----	----	----	----	12	10	2	----	24
7K	Clio Channel, March, 1943	----	----	----	----	6	11	3	----	20
7L	Retreat Passage, March, 1943	----	----	----	----	2	6	13	----	21
7N	Chatham Channel, April, 1943	----	----	----	1	43	27	28	1	100
4W	Campbell Island, March, 1940	----	----	----	----	----	----	4	----	4
5I	Campbell Island, March, 1941	----	----	----	----	----	1	21	----	22
5L	Laidlaw Islands, March, 1941	----	----	----	----	----	----	1	----	1
5M	Deer Passage, March, 1941	----	----	----	----	----	----	4	----	4
5N	Kwakshua Passage, March, 1941	----	----	----	----	----	1	14	----	15
6M	Campbell Island, March, 1942	----	----	----	----	----	1	41	----	42
7M	Gunboat Passage, March, 1943	----	----	----	----	2	9	228	----	239
?	Code undecipherable	----	----	----	----	----	----	------	5	5
	Totals	7	4	3	3	88	85	405	10	605

STABILITY OF POPULATIONS AND MOVEMENTS.

Major Areas.

Detector returns as listed in Table II. and magnet returns as listed in Table IV. are combined and further summarized according to major areas in Table V. The raw data show that in every case the number of tags used in and recovered from each major area is greater than the number used in one and recovered from another major area. However, in some cases, an apparently large number of tags used in one major area was recovered from another. For example, of the tags used in the Strait of Georgia and Discovery Passage, 87 were recovered from Strait of Georgia and Discovery Passage fish but 31 were recovered from the Central coast-line. Again, of the tags used in the Queen Charlotte Strait area, 84 were recovered from that area, but 61 were recovered from the Central coast-line. It is apparent from the data that intermingling between the fish of major areas has taken place. But it will also be apparent from the data and discussions to follow that this intermingling is not necessarily as extensive as might be judged from the raw data of Table V.

Table V.—Summary, according to Major Areas, of the Interpreted Sources of all Tags from Taggings producing Returns on both Magnets and Detectors during the 1943–44 Season.

Major Tagging Area.	Major Recovery Area.						Total.
	West Coast of Vancouver Island.	Strait of Georgia and Discovery Passage.	Queen Charlotte Strait.	Queen Charlotte Strait or Central Coast-line.	Central Coast-line.	No Interpretation offered.	
West Coast of Vancouver Island	9	----	----	----	4	----	13
Strait of Georgia and Discovery Passage	2	87	5	4	31	4	133
Queen Charlotte Strait	1	10	84	69	61	1	226
Central Coast-line	----	----	2	12	325	----	339
?	----	----	----	----	----	5	5
Totals	12	97	91	85	421	10	716

The number of tags recovered from a fishing-ground is influenced by many factors, among which of immediate concern are the following: (*a*) The tonnage caught, (*b*) the tonnage mechanically searched-for tags, (*c*) the efficiency of the recovery apparatus, and (*d*) the number of tags originally used. To obtain some idea of the extent of mixture between areas an attempt has been made to correct for (*a*) and (*b*) (Tester and Boughton, 1943, p. 62), but not (*c*). A correction for (*d*) will be discussed later.

In adjusting the results for (*a*) and (*b*) only part of the available data can be used: Imperial detector recoveries for catches from the west coast of Vancouver Island, the Strait of Georgia and Discovery Passage, Queen Charlotte Strait and the Central coast-line; magnet recoveries from Ucluelet and Nootka for catches from the west coast of Vancouver Island; magnet recoveries (in part) from Alert Bay for catches from Queen Charlotte Strait and the Central coast-line; and magnet recoveries from Namu, Butedale, and Port Edward for catches from the Central coast-line. Where necessary (Ucluelet, Nootka, and Port Edward) corrections for canning have been made by including half the tonnage canned along with the total tonnage reduced (a very arbitrary correction similar to that used in previous years, the accuracy of which will not appreciably affect the 1943–44 results because of the relatively small tonnages canned at canneries associated with these plants). Tags of doubtful origin are not

included in the calculations. The results, shown in Table VI., are expressed as the concentration of tags per 100 tons of fish caught.

Table VI.—Concentration of Tags per Hundred Tons of Fish according to Major Areas for Magnet (M) and Detector (D) Recoveries.

(Concentration, weighted to the number of tags originally used, is given in brackets. For explanation *see* text.)

Major Tagging Area.	Major Recovery Area.			
	West Coast of Vancouver Island.	Strait of Georgia and Discovery Passage.	Queen Charlotte Strait.	Central Coast-line.
	M.+D.	D.	M.+D.	M.+D.
West Coast of Vancouver Island	0.22	-----	-----	0.01
	(7.68)			(0.35)
Strait of Georgia and Discovery Passage	0.05	0.68	0.42	0.10
	(0.05)	(0.68)	(0.42)	(0.10)
Queen Charlotte Strait	0.02	0.09	7.12	0.20
	(0.08)	(0.36)	(28.32)	(0.80)
Central Coast-line	-----	-----	0.17	1.05
			(1.03)	(6.46)

Table VI. shows that the concentration of tags per 100 tons of fish is greatest in fish caught in the major area in which the tags were originally used. For example, in fish caught along the Central coast-line, the concentration of Central coast-line tags was 105 times that of west coast of Vancouver Island tags, 10 times that of Strait of Georgia and Discovery Passage tags, and 5 times that of Queen Charlotte Strait tags.

A rough correction for factor (*d*), differences in the numbers of tags originally used, has been attempted. In this, the above results are weighted to the total number of tags used in the Strait of Georgia and Discovery Passage during the past four spawning periods (51,144 between 1940 and 1943, inclusive), assuming an annual decrease in the availability of tags of 75 per cent. in all areas (a very rough approximation). In other words, the results, included in brackets in Table VI., give the probable concentration of tags per 100 tons of fish caught in 1943–44 if the same number of tags (51,144) had been used in all four major areas. It may be seen that in some cases the probable degree of mixing is less and in other cases greater than is indicated in the unbracketed figures of Table VI. For example, in fish caught along the Central coast-line, the concentration of Central coast-line tags would be about 18 times that of west coast of Vancouver Island tags, 65 times that of Strait of Georgia tags, and 8 times that of Queen Charlotte Strait tags.

If the concentrations (bracketed) of Table VI. are now reconverted to actual numbers by multiplying by the catch in each major area (west coast of Vancouver Island, 9,195; Strait of Georgia and Discovery Passage, 48,015; Queen Charlotte Strait, 2,670; Central coast-line, 37,661 tons) and they are divided by 100, the figures given in Table VII. result. These represent the number of tags, according to major area of insertion and recovery, which would probably have been taken by the 1943–44 fishery if the number of tags used over the period 1940 to 1943 had been equal to the number used in the Strait of Georgia and Discovery Passage. These figures give a better idea of the extent of mixing between major areas than those of Table V. They indicate that 84 per cent. ($^{4219}/_{4913}$) of the tagged fish returned to the same major area in which they were tagged and that 16 per cent. ($^{694}/_{4913}$) migrated to major areas other than those in which they were tagged. This conclusion is based on the assumption that in all four major areas the catch in each formed the same proportion of the population in each;

this is not necessarily true. It would seem that a more accurate idea of the extent of mixing would require information on the total population present in each major area. There is no way of procuring this information at the present time.

Table VII.—Calculated Number of Tags which probably would have been recovered in each Major Area if Tagging in all Areas had been as Extensive as in the Strait of Georgia.

(For explanation *see* text.)

Major Tagging Area.	Major Recovery Area.				Total.
	West Coast of Vancouver Island.	Strait of Georgia and Discovery Passage.	Queen Charlotte Strait.	Central Coast-line.	
West Coast of Vancouver Island	706	.....	.....	132	838
Strait of Georgia and Discovery Passage	5	327	11	38	381
Queen Charlotte Strait	7	173	753	301	1,234
Central Coast-line	.....	.....	27	2,433	2,460
Totals	718	500	791	2,904	4,913

A more thorough and refined treatment of the data will not be attempted in the present report. Details of mixing between and within major areas will be discussed in the following paragraphs.

West Coast of Vancouver Island.

In interpreting the west coast results the fact that there were no west coast taggings in 1941–42 and 1942–43 must be taken into consideration. The tagged fish, recaptured in 1943–44, had all been free to wander for a period of more than two and one-half years, whereas the majority of those recaptured in other areas had been at liberty for a shorter period.

The results show that a small run to Barkley Sound contained some fish originally spawning in Barkley Sound (4AA, 5O and 5P), with the addition of a few from the east coast of Vancouver Island (6A and 7B); and that a small run to Sydney Inlet contained some fish originally spawning in the Clayoquot Sound area (4Q and 5Y), with the addition of some from Barkley Sound (4AA) and a few from the Queen Charlotte Strait area (6N).

Some fish from the northern part of the west coast, Ououkinsh Inlet (5X) and Quatsino Sound (4U and 5W), joined the Kwakshua Passage run.

East Coast of Vancouver Island.

The results for the east coast of Vancouver Island, based on detector returns, have already been discussed in detail and will only be reviewed briefly. The few recoveries from magnets conform with the conclusions already drawn.

There is evidence similar to that of last year (Tester and Boughton, 1943, p. 66) of partial segregation of the east coast runs. The catches made at Satellite Channel and Porlier Pass vicinity contained tags most of which (90 per cent.) were originally used among the islands on the south-east coast of Vancouver Island. Tags from the Nanoose Bay fish were mostly (57 per cent.) from the south-east coast of Vancouver Island, but there was also a substantial number (35 per cent.) from spawning-grounds along the north-east shore of the Strait (including Jervis and Seechelt Inlets) and some (8 per cent.) from Discovery Passage. The Deepwater Bay fish contained mostly tags from Discovery Passage (33 per cent.) and the northern part of the Strait of Georgia (42 per cent.).

For the second year it has been shown that the fish caught at Deepwater Bay contained tags not only from the northern part of the Strait of Georgia and Discovery Passage, but also from Queen Charlotte Strait (25 per cent.). It seems likely that part, at least, of the fish which spawned in the northern part of the Strait of Georgia and the southern part of Discovery Passage left the area in the spring and returned again in the fall by way of Johnstone Strait, and that mixture with Queen Charlotte Strait fish took place during the period of migration or presumed ocean residence. During this period also, some of these fish mixed with Central coast-line fish which eventually were caught at Kwakshua Passage.

Calculations of the probable percentage recovery of tags used in the Strait of Georgia and Discovery Passage and recovered from fishing-grounds along the east coast of Vancouver Island (Satellite Channel to Deepwater Bay) indicate that fish from some spawning-grounds contributed to a much greater extent than others to the fishery in 1943–44. For the southern part of the Strait, a total annual mortality rate of 89 per cent. is indicated by calculations of the probable number of 6-series tags returned in 1942–43 and 1943–44.

Lack of recovery of 6-series tags used between Nanaimo and Comox during the 1942 spawning period corroborates evidence given last year that most of the fish tagged in that area during a period of unusual mortality (Tester, 1942) died, probably along with a fair percentage of the spawning population.

Queen Charlotte Strait.

The catches of Queen Charlotte Strait fish were all made in the vicinity of Clio Channel (Bones Bay, Minstrel Island, Serpentine Pass, and adjacent waters of lower Knight Inlet) during November and December, 1943. The actual number of tags recovered is shown in Table V. The results of calculations given in Table VII. give a fairer idea of the extent of mixing. Of the calculated probable number of recoveries of Queen Charlotte Strait tags (assuming that tagging in all areas was of similar intensity to that in the Strait of Georgia), 61.0 per cent. was taken from Clio Channel catches, 24.4 per cent. from Central coast-line (Kwakshua Passage) catches, 14.0 per cent. from Discovery Passage (Deepwater Bay) catches, and 0.6 per cent. from west coast of Vancouver Island (Sydney Inlet) catches. Of the calculated probable number of tags recovered from Clio Channel fish, 95.2 per cent. were from Queen Charlotte Strait, 1.4 per cent. from Discovery Passage, and 3.4 per cent. from Central coast-line spawning-grounds (all from one tagging, 7M). These results indicate a fairly substantial movement of Queen Charlotte Strait fish away from the area, chiefly to the north, and but a slight movement of fish from other major areas into the area. However, it must be remembered that the results are influenced to an unknown extent by the relative fishing intensity in Queen Charlotte Strait as compared with other areas.

The high concentration of Queen Charlotte Strait tags (7.12 per 100 tons), shown in Table VI., is worthy of note. This might be taken as indicating a relatively small population of fish in Queen Charlotte Strait, although there are other possible explanations.

There is evidence of a difference between taggings in the extent of mixing of Queen Charlotte Strait fish with those of the Central coast-line. To illustrate this, Table VIII. has been compiled from data included in Tables II. and IV. It may be seen from Table VIII. that there is a greater tendency (which may be shown to be statistically significant) for fish tagged in the vicinity of Retreat Passage (Shoal Harbour opens into Retreat Passage) to mix with Kwakshua Passage fish than is the case of those tagged elsewhere in the Queen Charlotte Strait area. This is interesting in view of the observation which has been made that there are frequently two kinds of herring in Retreat Passage, one consisting of small slow-growing fish and the other (Tester, 1941) of large fast-growing fish.

Table VIII.—Numbers of Tags originally used in Queen Charlotte Strait, recovered from Clio Channel and Kwakshua Passage Catches.

Code.	Place and Time of Tagging.	Area of Recovery.	
		Clio Channel.	Kwakshua Passage.
4L	Cutter Creek, March, 1940	2	1
6N	Clio Channel, March, 1942	17	4
7K	Clio Channel, March, 1943	6	4
7N	Chatham Channel, April, 1943	44	28
6O	Kingcome Inlet, March, 1942	12	3
	Sub-totals	81	40
4M	Shoal Harbour, March, 1940	----	2
6L	Retreat Passage, March, 1942	1	6
7L	Retreat Passage, March, 1943	2	13
	Sub-totals	3	21

It might be noted that the Chatham Channel tagging (7N) was very productive of returns. Calculations based on both magnet and detector recoveries indicate a total probable recovery from all fishing-grounds of 5.4 per cent. Similar calculations for the Clio Channel tagging (6N) indicate a total probable recovery of 2.1 per cent. These results are in contrast to those given in Table III. for detector recoveries alone, and show the danger of extrapolation from meagre data.

Central Coast-line.

The catches from which tags were obtained were all made at Kwakshua Passage during December and January. Catches were also made in February from the vicinity of Laredo Inlet but no recoveries resulted from these, the magnet having been removed for repairs from the plant which handled almost all of the fish.

The magnet recoveries from Kwakshua Passage fish are numerous and in most cases there is little or no doubt that the tags came from that fishing-ground. Consequently, together with the few detector recoveries, they give a fairly reliable and complete picture of the constitution of the Kwakshua run in so far as tagging and tag-recovery is concerned.

From Tables II., IV., and V. the following results are obtained. Of the tags recovered from Kwakshua Passage fish, 325 were originally used along the Central coast-line: Campbell Island (4W)—5; Kwakshua Passage (5N), Campbell Island (5I), Deer Passage (5M), and Laidlaw Islands (5L)—40; Campbell Island (6M)—42; and Gunboat Passage (7M)—238. Doubtless the number would have been greater if tagging had not been curtailed in 1942 (6-series) and 1943 (7-series). From Kwakshua Passage fish there were also recovered 61 tags originally used in the Queen Charlotte Strait area: Cutter Creek (4L) and Shoal Harbour (4M)—3; Retreat Passage (6L), Clio Channel (6N), and Kingcome Inlet (6O)—13; Retreat Passage (7L), Clio Channel (7K), and Chatham Channel (7N)—45. Neglecting a very small tagging (5H), there are represented eight of the nine taggings conducted in the Queen Charlotte Strait area over a four-year period (1940 to 1943). This shows that mixing of Queen Charlotte Strait fish with those caught at Kwakshua Passage, while limited in volume, was general in nature, although as already pointed out some fish (those tagged in the vicinity of Retreat Passage) joined the Kwakshua Passage run to a greater extent than others. Included among the tags from Kwakshua Passage fish were 31 from Discovery Passage and the northern part of the Strait of Georgia, mostly the former: Cahnish Bay (6P) and Deepwater Bay (7J)—27; Squirrel Cove (6K), Skuttle Bay (6I and

7D), and Union Bay (7I)—4. There were also four tags from the northern part of the west coast of Vancouver Island: Bunsby Islands (4X), Winter Harbour (4U), and Browning Inlet (5W).

Considering tags from the four major areas which were recovered from Kwakshua Passage fish the percentages are as follows: Central coast-line, 77.2; Queen Charlotte Strait, 14.5; Discovery Passage and Strait of Georgia, 7.4 (former, 6.4; latter, 1.0); and west coast of Vancouver Island, 1.0. If the figures given in Table VII. are used (corrected for differences in the number of tags originally used in each major area), the percentages become: Central coast-line, 83.8; Queen Charlotte Strait, 10.4; Discovery Passage and Strait of Georgia, 1.3; and west coast of Vancouver Island, 4.5. The latter figures probably give a better conception of the extent of movement of "outside" fish to Kwakshua Passage. However, it must be pointed out that the results would probably have been modified if there had been taggings on more than one of the many individual spawning-grounds within the Central coast-line area during the past two years.

Only two Central coast-line tags were recovered from other major areas, both from Clio Channel in Queen Charlotte Strait, forming but 1 per cent. of the recoveries (Table VII.). It is obvious therefore that the 1943–44 results show a much more extensive movement of fish into the Central coast-line area than away from it.

Some significance may perhaps be attached to the fact that there was only 1 recovery from Laidlaw Islands (5L) as compared with 21 from Campbell Island (5I) and 4 from Deer Passage (5M). This suggests that fish which spawned at the entrance to Laredo Inlet in 1941 did not join the 1943–44 Kwakshua run to the same extent as those which spawned in the Bardswell Group in that year. It may also be noted that there were no recoveries from taggings in the Northern coast-line area—Big Bay (4X), Butler Cove (4Y), Jap Inlet (5K), and Duncan Bay (5J).

Northern Coast-line.

No tags were recovered from a small tonnage, partly reduced and partly canned, taken from Khutzeymateen Inlet and Union Bay during February.

SUMMARY OF RESULTS.

The 1943–44 results agree with those of previous years in showing that mixing between the populations of major areas is limited in extent. To some extent they serve to clarify what is meant by the word "limited." While the conclusions are still based on several assumptions, which will influence them to an unknown extent, an interchange between major areas of about 16 per cent. in 1943–44 is indicated.

The movement of herring from "outside" areas (chiefly Queen Charlotte Strait) to the Central coast-line fishery (Kwakshua Passage) was apparently more extensive than the movement of Central coast-line fish to other major areas. In contrast, the movement of fish from "outside" areas to Queen Charlotte Strait fishing-grounds (Clio Channel vicinity) was apparently less extensive than the movement of Queen Charlotte Strait fish to other major areas.

Results of two successive years of intensive study of the Strait of Georgia and Queen Charlotte Strait populations are now at hand. The 1943–44 results for the Strait of Georgia are very similar to those for 1942–43. They reveal a complicated situation the explanation of which hinges on the fact that there are two migration routes which can be, and presumably are, followed by fish travelling to and from summer feeding-grounds outside the area—a southern route by way of the Strait of Juan de Fuca and a northern route by way of Johnstone Strait. It would appear that fish spawning along the south-east coast of Vancouver Island for the most part use the southern route and, on their return, contribute to the fisheries in the vicinity of Satellite Channel, Porlier Pass, and at Nanoose Bay; that fish spawning in Discovery

Passage and the north end of the Strait of Georgia mostly use the northern route and, on their return, contribute largely to the fishery at Deepwater Bay; and that fish which spawn along the north-east shore of the Strait (and possibly also the north-west shore of the Strait) use partly the southern route, contributing to the Nanoose Bay fishery on their return, and partly the northern route, contributing to the Deepwater Bay fishery on their return. Without doubt, the exact situation varies from year to year, depending on the proportions of spawning fish using each migration route and, on their return, the extent to which the southern group penetrates northward and the northern group penetrates southward along the east coast of Vancouver Island where the fishing-grounds are located. This interpretation of the results, as yet incomplete, must be regarded as a theory which appears to fit the observed facts (including recoveries made both inside and outside of the Strait of Georgia). It is subject to both modification and amplification by the addition of further data. For example, sufficient information is not yet available to include a comprehensive discussion of those fish which do not migrate from the area but which spend the summer on local feeding-grounds such as Point Grey, Active Pass, etc. These form an unknown percentage of the Strait of Georgia population.

Detailed information concerning the constitution of the Queen Charlotte Strait population or populations has not been obtained, chiefly because of the limited nature of the fishery in that area during the past two seasons. It is known, however, that fish from several different places within the area, including Chatham Channel, Clio Channel, Retreat Passage, and Kingcome Inlet, contributed to the fishery in the Clio Channel vicinity in 1943–44.

ACKNOWLEDGMENTS.

Again it is a pleasure to record the support of the herring-fishing industry in connection with the present investigation. British Columbia Packers, Limited, and Canadian Fishing Company, Limited, again permitted the operation of tag detectors at their respective plants, the Imperial Cannery and the Gulf of Georgia Cannery, Steveston, B.C. The management of these plants gave every assistance to the tag detector operators, Mr. A. G. Paul and Mr. R. S. Isaacson. Crews of most of the reduction plants operated by various companies assisted the investigation by searching for tags on magnets and in the plant machinery. Technical advice and assistance of Mr. F. J. Bartholomew, of the Electric Power and Equipment Company, Vancouver, is also gratefully acknowledged.

The seine-boats "Arctic Queen" and "B.C. Pride" were loaned for spring tagging-work by the Nootka-Banfield Company, Limited, and by Nelson Brothers Fisheries, Limited. The crews, Captains O. Brune and A. Godson, and Messrs. R. Lund, E. Kevis, P. Reite, and F. Orange, co-operated fully in every respect. The seine-boats, modern vessels equipped with radio-telephone, were ideally suited for the purpose. The assistance of Mr. J. C. Stevenson, M.A., Mr. A. G. Paul, and Mr. R. S. Isaacson, of the Pacific Biological Station, made the extensive tagging programme possible. Particular mention is made of courtesies extended by Mr. M. Warnock, of Bargain Harbour, during tagging operations in that locality.

The investigation has been carried on under joint agreement by the Fisheries Research Board of Canada and the Fisheries Department of the Province of British Columbia. Thanks are extended to Dr. R. E. Foerster and to Mr. G. J. Alexander, of the respective organizations, for their support and assistance.

Table IX.—Detailed List of Tags inserted during 1943–44.

Identification Marks.	Date released.	Tagging Code.	Where released.	No. of Tags used.
H79901–H80000	Mar. 3, 1944	8D	Skuttle Bay	100
H89201–H90000	Mar. 3, 1944	8D	Skuttle Bay	791
H99601–H99701	Mar. 3, 1944	8D	Skuttle Bay	99
LLJJ	Mar. 31, 1944	8I	Deepwater Bay	500
LLKK	Mar. 31, 1944	8I	Deepwater Bay	499
LLLL	Mar. 3, 1944	8D	Skuttle Bay	500
LLMM	Mar. 31, 1944	8I	Deepwater Bay	502
LLNN	Mar. 31, 1944	8I	Deepwater Bay	498
LLOO	Mar. 31, 1944	8I	Deepwater Bay	500
LLPP	Mar. 31, 1944	8I	Deepwater Bay	500
LLTT	Mar. 31, 1944	8I	Deepwater Bay	500
LLUU	Mar. 31, 1944	8I	Deepwater Bay	500
MMBB	Feb. 29, 1944	8C	Comox Harbour	498
MMTT	Mar. 3, 1944	8D	Skuttle Bay	495
MMZZ	Feb. 29, 1944	8C	Comox Harbour	499
OOAA	Mar. 2, 1944	8D	Skuttle Bay	924
OOBB	Feb. 21, 1944	8A	Nanaimo Harbour	1,150
OOJJ	Feb. 21, 1944	8A	Nanaimo Harbour	988
OOKK	Mar. 6, 1944	8J	Retreat Passage	952
OOLL	Mar. 6, 1944	8J	Retreat Passage	1,077
OOMM	Mar. 18, 1944	8L	Rivers Inlet	977
OOOO	Feb. 25, 1944	8B	Departure Bay	1,015
OOPP	Mar. 18, 1944	8L	Rivers Inlet	1,047
OORR	Feb. 24, 1944	8B	Departure Bay	1,049
OOSS	Feb. 29, 1944	8C	Comox Harbour	1,250
OOTT	Feb. 25, 1944	8B	Departure Bay	953
OOUU	Mar. 6, 1944	8J	Retreat Passage	968
OOXX	Feb. 29, 1944	8C	Comox Harbour	943
OOYY	Mar. 18, 1944	8L	Rivers Inlet	1,097
OOZZ	Mar. 2, 1944	8D	Skuttle Bay	921
OO44	Mar. 7, 1944	8E	Horswell Point	1,178
OO66	Mar. 26, 1944	8N	Matilda Inlet	1,105
PPAA	Mar. 10, 1944	8F	Gabriola Island	1,094
PPBB	Mar. 10, 1944	8F	Gabriola Island	1,078
PPJJ	Mar. 26, 1944	8N	Matilda Inlet	1,084
PPKK*	Mar. 11, 1944	8F	Gabriola Island	1,002
PPLL*	Mar. 15, 1944	8G	Kuper Island	1,002
PPMM*	Mar. 13, 1944	8G	Kuper Island	1,004
PPNN*	Mar. 12, 1944	8G	Kuper Island	1,007
PPOO*	Mar. 26, 1944	8N	Matilda Inlet	1,006
PPPP*	Mar. 15, 1944	8G	Kuper Island	994
PPRR*	Apr. 2, 1944	8H	Bargain Harbour	510
PPSS*	Apr. 3, 1944	8H	Bargain Harbour	506
PPTT*	Mar. 27, 1944	8K	Shoal Harbour	506
PPUU*	Apr. 2, 1944	8H	Bargain Harbour	500
PPXX*	Apr. 4, 1944	8H	Bargain Harbour	405
PPYY*	Apr. 3, 1944	8H	Bargain Harbour	601
PPZZ*	Mar. 14, 1944	8G	Kuper Island	509
PP44*	Mar. 27, 1944	8K	Shoal Harbour	515
PP66*	Mar. 27, 1944	8K	Shoal Harbour	491
RRAA*	Mar. 27, 1944	8N	Matilda Inlet	508
RRBB*	Mar. 27, 1944	8N	Matilda Inlet	517
RRHH*	Mar. 20, 1944	8M	Gunboat Passage	508
RRII*	Apr. 3, 1944	8H	Bargain Harbour	502
RRJJ*	Mar. 14, 1944	8G	Kuper Island	505
RRKK*	Apr. 3, 1944	8H	Bargain Harbour	511
RRLL*	Mar. 27, 1944	8K	Shoal Harbour	502
RRMM*	Apr. 3, 1944	8H	Bargain Harbour	508
RRNN*	Mar. 20, 1944	8M	Gunboat Passage	501
RROO*	Mar. 27, 1944	8K	Shoal Harbour	504
RRPP*	Mar. 20, 1944	8M	Gunboat Passage	500
RRRR*	Mar. 20, 1944	8M	Gunboat Passage	489
RRSS*	Mar. 20, 1944	8M	Gunboat Passage	506
RRUU*	Mar. 27, 1944	8K	Shoal Harbour	508
RRXX*	Mar. 20, 1944	8M	Gunboat Passage	507
IILL†	Mar. 28, 1941	5L	Laidlaw Islands	100

* Silver-plated tags.

† Omitted from previous lists.

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POSTSCRIPT.

Since the preparation of the foregoing report two tags have been received from Kildonan as follows: Porlier Pass (7E)—one; Deserted Bay (7G)—one. Both tags were reported from Barkley Sound fish. Both may have come from this locality, from Sydney Inlet, from Nanoose Bay, or from Deepwater Bay. No further interpretation is offered.

BIOLOGICAL INVESTIGATIONS OF COMMERCIAL SHELL-FISH.

By Ferris Neave, Pacific Biological Station, Nanaimo, B.C.

During the past year shell-fish investigations have continued to deal mainly with problems affecting the production of butter-clams and oysters. In the case of the former species the problems at the present time concern the utilization and conservation of the existing stocks. With oysters, on the other hand, the issues at stake are to a large extent concerned with methods of cultivation, improvements in which might result in an increase of stock and an expansion of the industry.

As in previous years, the investigation has received the support and encouragement of both the Fisheries Research Board and the Provincial Fisheries Department, while officers of the Dominion Department of Fisheries have continued to obtain the statistical data desired.

COMMERCIAL CLAM-CATCH.

Efforts have again been made to express the season's commercial clam-catches in terms of the average quantity taken by one man during one low-tide period. While the figures arrived at may vary because of weather conditions, the number and efficiency of diggers, and other factors, it is felt that they should reveal long-term trends in the productivity of the areas regularly exploited. As in previous reports, the year is taken as beginning on October 1st.

Records submitted during 1942–43 comprise the following quantities of clams:—

Species.	Lb.
Butter-clams	2,893,222
Razor-clams	389,825
Little-neck clams	248,920

Butter-clams.—The catches reported were distributed geographically as follows:—

Area and Centre.	Lb.
Northern British Columbia (Prince Rupert)	741,421
Central British Columbia (Bella Bella, Namu)	417,934
Queen Charlotte Strait and Johnstone Strait (Alert Bay)	1,066,200
Seal Island, near Comox	236,825
South-east coast of Vancouver Island (Porlier Pass)	430,742

These figures, while not necessarily complete, show a greater production than in the previous season in Central British Columbia and in the southern part of the Strait of Georgia while a decrease is evident in Northern British Columbia.

Average catches per man-tide, during the seasons for which data are available, are given in the following table:—

Area.	Average Catch per Man-tide.			
	1939–40.	1940–41.	1941–42.	1942–43.
	Lb.	Lb.	Lb.	Lb.
Northern British Columbia	.....	.....	558.1	352.2
Central British Columbia	.....	182.7	272.3	287.4
Queen Charlotte Strait, etc.	200.7	198.2	186.7	248.2
Seal Island	.....	.....	599.9	601.1
South-east Vancouver Island—				
(*a.*) Chemainus district	120.0	124.7	153.8	175.2
(*b.*) Sidney district	138.0	149.9	159.1	202.4

With respect to the 1942–43 figures, the reduced average (and total production) for the northern area is considered to be due mainly to bad weather conditions preventing full exploitation of the most productive beaches. The Queen Charlotte Strait

area shows a higher average for the first time in the annual series. Whether this should be attributed, in part, to a smaller number of men engaged in digging is uncertain. All the clams reported from the south-east region of Vancouver Island were delivered to the same buyer and could logically be considered as belonging to one area. During the earlier years covered by the present system of statistics, however, the locations of buyers facilitated a division into "Sidney" and "Chemainus" districts. It has been thought interesting to continue the two series of averages. Hence, catches of the past season have been segregated into two groups representing as closely as possible these two topographical units. The continued rise since 1939–40 in the average catch per man-tide in these districts is the most striking feature of the table given above.

Little-neck Clams.—The total reported production of 248,920 lb. was about 25 per cent. greater than that shown by the records for the previous year, the increase being due to the greater quantities produced in the area of south-east Vancouver Island. On the other hand, no catches were reported from Burrard Inlet and Jervis Inlet, which have previously contributed small amounts. Catches amounting to 10,840 lb. were reported from the Milbanke Sound area of Central British Columbia, the rest coming from the southern part of the Strait of Georgia.

The significance of man-tide averages is doubtful in the case of winter catches of little-necks, since in 1942–43 these were obtained in the course of operations which were mainly directed towards the taking of butter-clams. These operations have been included in the figures given for the latter species. Comparisons are possible, however, in the case of the spring and summer clam-fishery of the south-east Vancouver Island area. This fishery has supplied from 60 to 80 per cent. of the total reported little-neck catch for British Columbia during the last three seasons. Average catches per man-tide based on this portion of the annual production are as follows: 1941, 129.8 lb.; 1942, 127.8 lb.; 1943, 152.7 lb. The large increase in productivity which is indicated for the 1943 season is encouraging, but it is possible that human factors are involved.

Razor-clams.—At the desire and through the co-operation of the Massett Co-operative Association, a system of catch records was instituted on the razor-clam grounds of Graham Island, Queen Charlotte Islands. This is the only area in which this species is being exploited commercially at the present time. For statistical purposes the productive portion of the northern coast-line of the island was divided into three sections. The production is shown in the following table. Digging operations took place between March 2nd and June 23rd.

Beach.	No. of Man-tides.	Lb.	Average Catch per Man-tide (Lb.).
North	1,518	118,400	78.0
Middle	806	82,350	102.2
South	1,631	189,075	115.9
All	3,955	389,825	98.6

The catch was regarded as poor, the season's total being one of the lowest recorded from these beaches. Bad weather conditions and a relative scarcity of diggers are considered to have been at least partly responsible. No previous figures for the catch per unit of effort at Masset are available, but the general average of 98.6 lb. per man-tide can be contrasted favourably with conditions on the main razor-clam beaches of Washington, where, during the years 1928 to 1938, the annual average varied from about 18 to 68 lb. per man-tide.

INVESTIGATIONS AT SEAL ISLAND.

For the third consecutive year controlled digging of the butter-clam beach at Seal Island, near Comox, was carried out during two sets of low tides in the winter (January 23rd to February 7th, 1944).

During previous operations digging had been confined to four areas marked out on the beach, the intensity of the digging being varied for each area and records being kept of the catch obtained and the man-hours expended. In the present season, after testing the productivity of each marked area, digging was permitted on the whole beach up to a total production of just over 100 tons, in accordance with the view expressed previously (Rept. Prov. Fish. Dept., 1942) that such a quota could be sustained for several years.

As in 1942 and 1943, these operations were conducted in co-operation with British Columbia Packers, who recruited diggers and took delivery of the clams.

Statistics for 1944 were as follows:—

Area.	Man-tides.	Man-hours.	Catch (Lb.).	Average Catch.		Amount removed previously (Lb.).
				Per Man-tide.	Per Man-hour.	
A	18	82.44	8,002	444.55	97.06	198,781
B	18	99.00	20,030	1,112.77	202.32	62,035
C	21	108.57	10,390	494.76	95.70	110,023
D	22	117.26	19,428	883.09	165.68	101,725
General*	185	752.58	151,361	818.17	201.12	.....
All	264	1,159.85	209,211	792.57	180.38	472,582
All (1943)	394	1,588.47	236,825	601.08	149.09	235,757

* The statistics for "general" include some clams dug from areas B and D subsequent to the figures given for those areas.

A marked increase over 1943 is shown in the average catch per man-tide and per man-hour. The former unit was influenced by the somewhat more favourable tides utilized in 1944. The increased production per man-hour was due to the exploitation of previously undug territory outside the staked areas. Of the latter, A, C, and D, which had been subject to more or less heavy previous digging, showed a decrease in production per unit of effort. Area B, which had been dug more lightly, showed a marked increase in productivity.

At the end of the 1944 season a large number of random square-yard plots were dug and the clams obtained were counted and weighed. Based on these samples, rough estimates of the quantities of legal-sized clams remaining in the staked areas were as follows: A, 40 tons; B, 55 tons; C, 20 tons; D, 50 tons.

With exploitation now extended to the whole beach and limited quantities of young clams reaching commercial size each year, it is not to be expected that the present very high average catches per man-hour can be maintained in future years. It is believed, however, that an annual production about equal to this year's (104.6 tons) can be sustained for a time without serious depletion of the beds.

It is proposed to review the three years' operations at Seal Island and to discuss the problems more fully in the near future.

SIZE AND AGE IN RELATION TO MATURITY OF THE BUTTER-CLAM.

In view of the regulation prohibiting the taking of butter-clams less than 2½ inches in length, it is of interest to know the size at which the species becomes capable

of spawning. In addition, growth is known to be much more rapid in some beaches and areas than in others. The effect of this factor on the degree of protection afforded by the size-limit has not been clear. Samples of small clams from several localities were collected during the past year in order to throw light on these points. Smears from the freshly cut gonads were examined microscopically, the criterion for maturity being the presence of fully developed oocytes or spermatozoa.

Locality.	Smallest Mature Clam.		Probable Age.	Largest Immature Clam.		Probable Age.
	In.	Mm.	Years.	In.	Mm.	Years.
Knapp Island, near Sidney	1.53	38.8	3	1.53	38.8	3
False Narrows	1.32	33.6	4	1.39	35.4	4
Departure Bay	1.47	37.3	4	1.70	43.4	5
Seal Island	1.28	32.4	3	1.61	40.8	3
Burdwood Island (Queen Charlotte Strait)	1.56	39.5	5	1.64	41.6	5

The figures given under "age" indicate the age at the next spawning season following the examination.

While further data from more localities are desirable, these samples indicate a considerable degree of uniformity in the size at which butter-clams mature. The mature condition appears to be reached at an average length of about 1½ inches both in fast-growing and slow-growing populations; that is, it is associated with size rather than age. In the localities shown in the table it appears that clams become capable of spawning at least two or three years before attaining legal size.

TANK-REARING OF OYSTER LARVÆ.

In view of a developing shortage of seed-oysters and the unreliability of natural spatfalls as a source of new stock, experiments were begun in 1943 on the rearing of oyster larvæ in confinement.

A specially built tank, situated on the foreshore at Departure Bay, facing south, was used. This tank has concrete walls and a sloping floor of natural rock. It can be filled through a valve at high tides and at the usual working-level contains about 20,000 gallons of water having a maximum depth of about 7 feet.

Native Oysters.—A small stock of native oysters was held over winter in the tank. Larvæ from these appeared in the water on May 27th and continued to be fairly numerous until August 6th, on which date the tank was drained. Development appeared to take place in a normal manner and setting of the larvæ occurred from about the end of June onward. During the period from July 10th to August 3rd an average set of about three spat per square inch of surface was obtained on the under-side of glass plates immersed in the tank. This was considered to be very satisfactory, especially in view of the small number of mature oysters used and the lack of previous knowledge of this species under tank conditions.

Pacific Oysters.—Experiments on the tank-rearing of Pacific oyster larvæ were unavoidably postponed until too late in the season to give good chances of success. A spawning which was made on August 11th produced a heavy population of larvæ which developed well until August 20th, when a reduction in numbers was apparent, coincident with a drop in water temperature to about 18.9° C. Temperatures continued low during the next three days, at the end of which time few living larvæ could be found. Following a rise in temperature to 20.5° a further spawning was made on August 25th. Very numerous larvæ again resulted, but after three days the temperature again fell to 18.5° and heavy mortality again occurred.

Although the majority of the larvæ succumbed in these two experiments, some were successful in completing their development, since a number of living well-grown spat were discovered in the tank when the latter was drained several months later.

Neither of these two species of oyster has been previously reared from the egg under tank conditions and the degree of success attained in these initial experiments warrants further investigation of this method of culture.

SUMMARY.

The distribution of the 1942–43 clam-catch is discussed and comparisons are made between the annual production of different areas in relation to the fishing effort expended. In most areas, increased availability of butter-clams and little-neck clams is noted. Similar statistical information is now being obtained for razor-clams on the Graham Island beaches.

In the third season of controlled digging at Seal Island, production was extended to the whole beach, with a limit of about 100 tons for the season. Availability of clams was very high and although the more heavily dug portions of the beach showed a reduced productivity, it is believed that an annual production of 100 tons could be sustained for several years.

Examination of small butter-clams from several localities indicates that sexual maturity is attained at an average length of about 1½ inches, both in slower and faster growing populations. In the localities in question, clams become capable of spawning at from three to five years of age and at least two or three years before reaching the minimum legal length of 2½ inches.

Preliminary experiments on the production of seed-oysters in an open-air tank gave favourable results in the case of the native oyster. While only a few Pacific oyster larvæ were reared to the setting stage, there remains a possibility of future success.

REPORT ON INVESTIGATIONS OF THE INTERNATIONAL PACIFIC SALMON FISHERIES COMMISSION FOR THE YEAR 1943.

By B. M. Brennan, Director.

The International Pacific Salmon Fisheries Commission was established primarily for the purpose of rehabilitating the seriously depleted sockeye-salmon fishery of the Fraser River system. Scientific investigation of the various factors that vitally affect the present state of the fishery must precede regulation and such other measures as may be necessary in order to increase the stock. In many instances new and radically different methods of study have had to be devised, tested, and used for the solution of unusual problems. An example is the Hell's Gate study, which soon after the commencement of investigations in 1938 was recognized as a cause of mortality. Not until 1940 and 1941, however, were methods perfected which showed the full seriousness of the obstruction. This work has made it possible to recognize the extensive harm to salmon migration caused by numerous other blocks. The installation of permanent remedial measures for all serious obstructions is one of the first objectives of the Commission.

Barriers to salmon migration constitute but one of the major problems awaiting solution by the Commission's staff. Other projects have been continued and will be dealt with briefly in this report. Results from the various projects during 1943 have given us data even more satisfactory than during previous years. The improvement is traceable to the recognition and gradual elimination of errors and to improvements in technique resulting from greater experience.

SALT-WATER TAGGING.

The tagging of sockeye at Sooke was continued with the excellent co-operation of the Canadian Department of Fisheries and the trap operators. A total of 1,953 sockeye were tagged, 502 or 48 per cent. of which were later recovered. Results to date of the tagging at Sooke are as follows:—

Year.	Number tagged.	Number recovered.	Per Cent. recovered.
1938	980	439	44
1939	1,042	558	54
1940	930	437	47
1941	849	503	59
1942	1,803	793	44
1943	1,053	502*	48

* Number recovered as of March 31st, 1944.

During 1943 few tagged fish were recovered in streams or areas other than the Fraser. Fish tagged early in the season are frequently recovered from the Nitinat and Barkley Sound; this year tagging did not commence until July 8th. Shortage of personnel made further salt-water tagging impracticable.

THE COMMERCIAL FISHERY.

During the 1943 sockeye-fishing season the Commission again made observations of the commercial fishing operations. Landing and pack statistics were gathered currently from Puget Sound and Fraser River canneries. Such statistics were checked against other sources, such as the Washington State Department of Fisheries and the Dominion Fisheries Department. The system of fishing-vessel log-book records was continued in order to provide details of the fishery with respect to location and intensity of fishing and the composition of the fleet. The system of log-book records has been

in operation for several seasons and promises to yield valuable results. The co-operation of the fishermen has been excellent.

All these data are being used to formulate a policy for the ultimate regulation of the fishery as provided for in the treaty establishing the Commission.

INDIAN FISHERIES.

Careful observations and records of the Indian fisheries in the Fraser River watershed have been made by both the Dominion fisheries guardians and the Commission's field observers. The combined efforts of these men provide reasonably accurate estimates of the numbers of salmon caught by Indians each season. Special emphasis has been placed on the spawning-ground fisheries, where strict control must be exercised for the protection of some of the smaller and more valuable seed-stocks. Close co-operation between the guardians and the field observers has eliminated considerable overlapping and repetition and has provided useful data for use in connection with a programme of rehabilitation.

THE HELL'S GATE PROJECT.

Scientific investigations carried out since 1938 prove that serious obstructions to up-stream migration of salmon exist at Hell's Gate, Bridge River Rapids, and at numerous other points. Remedial measures at Hell's Gate constitute the greatest single need, since this is the first obstruction to be encountered during up-stream migration. Realizing that the removal of obstructions must precede other phases of the rehabilitation programme for the river, the International Pacific Salmon Fisheries Commission has asked the Governments of Canada and the United States for $2,000,000 with which to remove all important obstructions. Meantime, temporary emergency measures have been taken in order to reduce losses until the permanent programme can be completed. The emergency measures include a temporary fish-ladder and a flume, the latter largely financed by the canning industry. In consequence of these measures there is reason to believe that up-stream migration has been considerably aided and that injuries to migrating salmon have been reduced. What has been accomplished thus far in a small way may be achieved in much larger measure when the projected plans have been carried out.

A scale model of the Hell's Gate canyon, built on the grounds of the Hydraulics Laboratory of the University of Washington, has been studied thoroughly by the Commission's engineers. With the aid of the model actual conditions at the Gate can be reproduced readily and the effects of any proposed alterations determined quickly. By this means various remedial measures have been tested and the best solution determined.

An important part of the Hell's Gate investigation has been the tagging programme carried out in the river with the object of confirming the water-levels at which fish can pass the Gate. With this purpose in view, 8,684 fish were tagged at Hell's Gate during the 1943 season. Total recoveries above or below the Gate (but not including those recovered at the Gate) to March 16th, 1944, were 2,850 or 32.8 per cent. of the number tagged. The results confirmed the earlier assumption that a block exists between the approximate levels of 25 and 40 feet. Above or below this range salmon have a relatively free passage. The period of blockade as determined from these data was found to be short during 1943 with consequent advantage to the migrating sockeye. With the completion of this phase of the investigation the basic facts have been obtained for the projected permanent project which, it is hoped, will go far to restore the Fraser River runs to their former magnitude.

SPAWNING-GROUNDS.

Determination of the escapement to the various spawning-grounds and the evaluation of the relative success of spawning are important phases of the Commission's scientific investigations. During 1943 all known sockeye-streams were patrolled regularly and the necessary information obtained. A weir was placed in the Bowron River and the entire run counted. The Raft River was fenced for the bulk of the run and an approximate population figure obtained. In the Stellako River an extensive tagging programme was undertaken for the purpose of population determination. Other regions such as the Harrison, Birkenhead, and Chilko areas were enumerated by calibrated indices based on recoveries of dead sockeye, live counts, or other features of a spawning population. A preliminary study of the Pitt River system was made in an attempt to devise a successful method for enumeration of this race of fish. The escapement studies are tedious and expensive, but the accuracy of the observations improves each year as the dynamics of a spawning population becomes better understood.

The 1943 escapement above Hell's Gate was particularly favourable with increases of 100 to 300 per cent. of the brood-year. In addition, it is reported that the sockeye arrived and spawned in better physical condition than has been the case for the past several years, a reflection of the more favourable water conditions encountered during migration. The success of spawning appears to be based on sex ratio, completeness of spawning, and other indices favourable for this portion of the escapement.

OTHER PROJECTS.

During the year a number of other investigations have been pursued by the staff of the Commission. These include a continuation of the research on the history of the fishery, additional limnological surveys, and a study of the races of Fraser River sockeye. The racial investigations embraced the study of scales, the counting of pyloric cæca, and the study of such other morphological characters as may possibly serve in the recognition of particular races.

THE PACIFIC SALMON IN BRITISH COLUMBIA WATERS.

By W. A. Clemens, Ph.D., Department of Zoology, University of British Columbia, Vancouver.

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 plyoric 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.

By R. E. Foerster, Ph.D., and A. L. Pritchard, Ph.D., Pacific Biological Station, Nanaimo, B.C.

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.

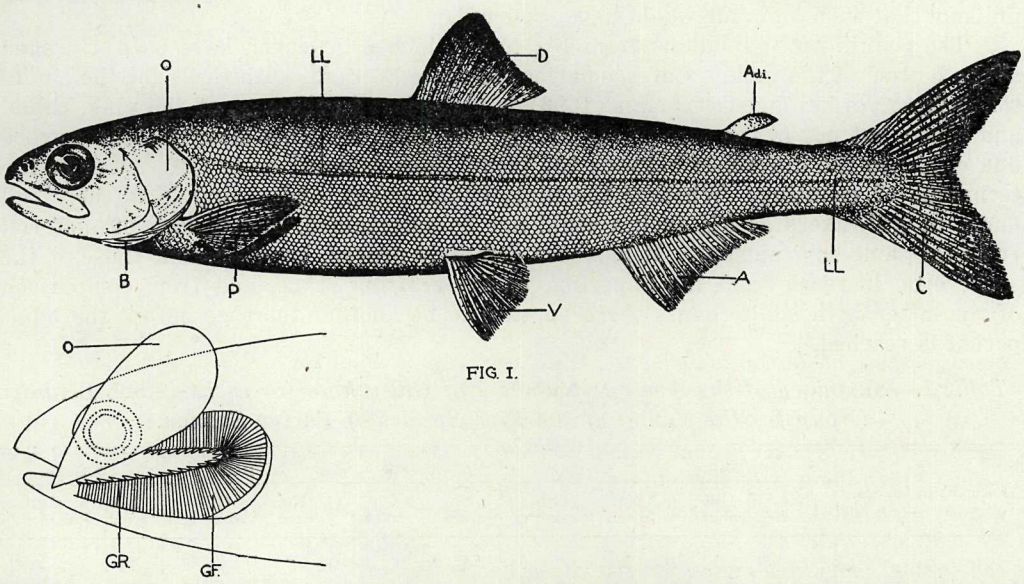

FIG. I.

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.

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.

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 7/8 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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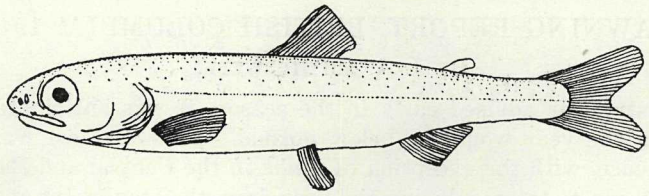
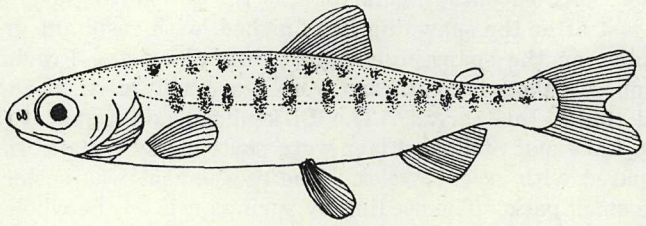
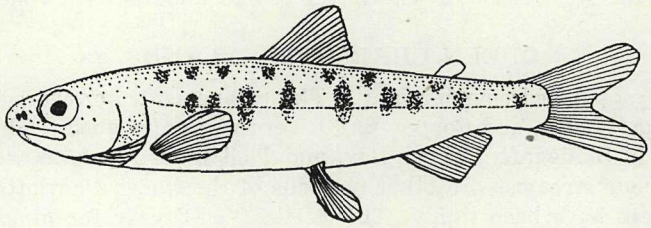


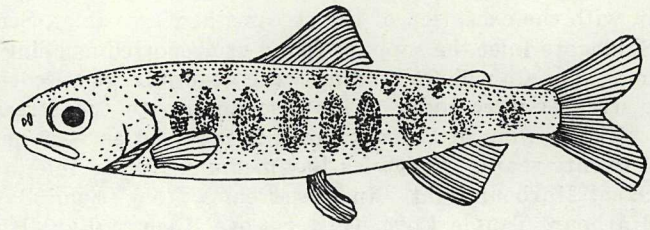
PINK SALMON



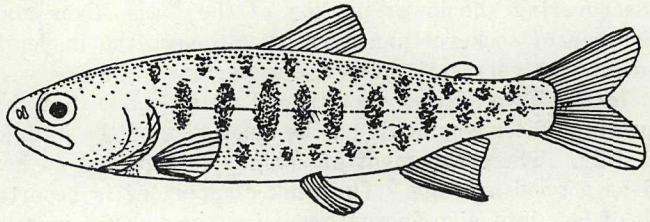
SOCKEYE SALMON



CHUM SALMON



SPRING SALMON



COHOE SALMON

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

SPAWNING REPORT, BRITISH COLUMBIA, 1943.

By J. A. Motherwell.

As the industry was advised early in the season, it was anticipated that the run of salmon during the year would be below normal. This forecast was borne out by the year's experience, with the exception of pinks in the Central and Bella Coola areas.

Conditions in most streams during the year from the standpoint of sufficient water to permit of the easy access of salmon to the spawning-grounds were unusually good, with the exception of some of the streams in the lower part of the Province, and conditions generally in spawning-streams were such as to justify the expectation of a good season's hatch. An encouraging factor was the absence of severe freshets which sometimes occur just after the spawning has finished, with resultant great damage.

Sockeye-supplies on the spawning-grounds throughout the Province were not as satisfactory as hoped, although conditions were reasonably good at the Nass, Skeena, Rivers Inlet, and Smith Inlet areas. The Birkenhead and Upper Fraser spawning-grounds at Chilko Lake and Stellako River were particularly satisfactorily seeded with this variety compared with recent cycles. The escapement was better than might be inferred from the small pack. The seeding by springs was on the whole unsatisfactory. The cohoe-supplies were found to be fair, with some areas quite good. The seeding by pinks was generally fair, but in the Central and Bella Coola areas the escapement was very heavy. The supplies of chums were reasonably good, with the exception of the areas along the west coast of Vancouver Island and the east coast of the Queen Charlotte Islands.

QUEEN CHARLOTTE ISLANDS.

Sockeye are not fished commercially. The escapement, however, to such streams as the Ain, Awun, Naden, and Copper Bay Rivers was quite good. The cohoe seeding was fairly good in Skidegate, Copper Bay, and Tlell River areas, as well as in Masset and Naden Harbour streams. In other portions of the Queen Charlottes, however, the seeding appears to have been light. This is the "off" year for pinks and none was found on the spawning-grounds.

The chum-supplies were not up to expectations. In the Naden, Ain, and Awun Rivers the run was practically a failure. The seeding in the west coast streams is reported as light, with the exception of the streams at Nesto Inlet, Security Cove, and Peel Inlet. At Skidegate Inlet the supplies found are reported as being from a medium to a heavy seeding. The Cumshewa streams were generally well seeded. The supplies in Selwyn Inlet streams were light. This also applies to the streams in Atli and Crescent Inlets. The seeding at Salmon Creek is reported as very heavy, the best in probably the last twenty years. Sedgwick Bay medium, Hutton Inlet a failure, Werner Bay a failure, Skaat Harbour light. In the streams from Island Bay to Ikeda Bay, including Bag Harbour, Tangle Cove, Oyster Cove, George Bay, Huston Inlet, and Harriet Bay, the seeding ran from good, medium, to heavy.

LOWER NASS AREA.

Observations covering the lower portion of the Nass River and its tributaries suggest a smaller run of sockeye than average, although the inspecting officer states that the escapement was very satisfactory, due partly to the bad weather conditions. The escapement to the Tseax River was a good average one, but that to Bear Lake poor. The inspecting officer comments on the small size of the individual fish passing up-stream after July. The escapement of springs is reported as heavy. The cohoe run is reported as a good average. The pink escapement is reported as very good, partly the result of less intensive fishing operations by purse-seines. The chum seeding was above average, especially to the stream at the head of Work Channel. The escapement to Toon River is stated by the inspecting officer as the heaviest he has seen in the Nass area.

UPPER NASS AREA.

The main sockeye-spawning areas of this system were not inspected by an officer of the Department, but by a man who has had many years' experience in this work, having accompanied both the officers of the Federal and the Provincial Fisheries Departments over the areas for many years. He has had more experience in this area than any officer of the Fisheries Department. The seeding by the early run of sockeye is reported as being rather light and disappointing. The seeding by the late run, however, was found to be heavy and similar to that reported in 1938, and better than in the years 1939 and 1942. The inspecting officer suggests that, taking the seeding as a whole, it could be considered as fairly good, although a little under average. The seeding by springs is reported as the best in the twenty-one years' experience of the inspecting officer. The cohoe-supply is better than average, the fish being individually large. The fishway at Meziadin Lake was cleaned out and left in good condition. Another portion of the old cribbing had given way, but the fishway itself is functioning quite satisfactorily.

SKEENA AREA.

In the Babine Lake area, the principal sockeye-spawning ground of this watershed, the seeding by this variety, although in general being satisfactory, was below that of 1939. Some of the principal spawning-streams, such as Fulton and Morrison Rivers, received a heavy seeding, although in the former there appears to have been some waste of eggs. The seeding at Fifteen-mile Creek was definitely poor. The supplies in Babine River generally were quite good. The inspecting officer called attention to the considerable percentage of small individual sockeye on the spawning-grounds in the year under review. The seeding by springs in the Babine River was light to medium, and the cohoe seeding average. The pink seeding, however, was very heavy, the fish being individually large.

In the Morice River and Lake system, which is tributary to the Skeena River, conditions for observation were poor. The sockeye seeding, however, appeared to be light. The spring seeding also was fairly light but the cohoe-supply was good.

In the Kalu Lake system, also tributary to the Skeena River, a very good seeding of sockeye was found at the head of Kalum Lake. The supplies were greater than in the year 1939 when the seeding was good. There was also a good escapement to Cedar River and Clear Creek. The individual fish in the Kalu Lake system were large.

Lakelse Lake, an important part of the Skeena system, is primarily a sockeye and pink area. The seeding in Williams Creek, which is the principal spawning-ground for the former variety, was found to be good. The seeding at Schulbuckhand Creek was good, being an improvement over the brood-year. The supplies in Salmon and Granite Creeks were not up to expectations, although these streams are small and not as suitable as the first two mentioned. The pink-supply is reported as being very heavy and an improvement over the brood-year, when a heavy escapement took place.

In the Ocstahl River system the sockeye seeding was only fair, being less than in 1939. There was a heavy seeding of spring salmon in Johnson Creek. The cohoe supplies appear to have been satisfactory. There was a very good seeding of pinks in the main Ocstahl River and its tributaries, which was an improvement over the cycle-year of 1941. The supply of chums in the Ocstahl River and tributaries is reported as fair; not as good as in the brood-year.

LOWE INLET AREA.

The sockeye seeding is reported as being good, due to less intensive fishing and favourable water conditions. The cohoe-supplies were average. Pinks showed a decided improvement over the brood-year. The same remarks apply to the chums.

BUTEDALE AREA.

Weather conditions were very favourable for the ascent of salmon to the spawning-grounds, streams being at all times well supplied with water. High water, of course, made the inspection very difficult. The sockeye-supply in the southern portion of the area was below average. The Kitlope River, at the head of Gardner Canal, however, received a satisfactory seeding. The cohoe escapement to the southern part of the area was lighter than that of the brood-year, but conditions were just the reverse in the northern part of the area. The seeding generally of this variety was satisfactory. The pink-supply is reported as being exceptionally large and is described by the inspecting officer as " unheard of in an off-year, having only been exceeded in the past eleven seasons by the seeding of 1936." The seeding at Quaal River, Bish Creek, and Kainet River is reported as very heavy. While the chum seeding was better than that of the brood-year, it could only be classified as light to medium. Kainet River was the only stream which received a heavy supply.

BELLA BELLA AREA.

The early sockeye seeding was reported as light to medium, with some improvement in the later runs. The total, however, was poorer than that of the brood-year. The same condition applies to the cohoe-supply. A very heavy seeding of pinks occurred and all major streams are reported as being filled to spawning capacity, the seeding showing improvement generally over the brood-year. The chum seeding was abundant, with all large streams receiving plentiful supplies. Spawning conditions from the standpoint of water were good.

BELLA COOLA AREA.

The sockeye seeding was not heavy, but is reported by the inspecting officer as quite satisfactory, in view of the run. One outstanding feature this season is the large percentage of small fish, the so-called " runts." It is estimated that approximately 60 per cent. of the total run was made up of these small individuals, not over 12 inches in length. A disturbing factor of the Bella Coola spawning-ground situation is the report that the big flood of 1936 altered the course of one of the glacial streams which up to that time had drained into Knight Inlet. It now carries deposits of silt into the Atnarko River and this settles over a portion of the salmon-spawning grounds frequented by the larger sized fish. Conditions in the Kimsquit River were reasonably good.

The seeding by springs was satisfactory in the Bella Coola system, but rather light in the Dean River area. The cohoe-supplies are considered adequate.

The outstanding feature of the spawning inspection was the very large quantities of pinks found over the whole district supervised by the Bella Coola Inspector. The inspecting officer observes that: " It is a remarkable return from the cycle-year's heavy seeding. Practically all streams tributary to the Bella Coola and Atnarko were literally loaded with spawning pinks, this species reaching points 80 miles distant from salt water in appreciable numbers."

Spawning conditions throughout the season were favourable and, to the date of inspection, no freshets had occurred. The chum seeding was also heavy throughout the district.

RIVERS INLET AREA.

The usual two inspections of the sockeye-spawning grounds were made in this area; the first between September 6th and 10th and the second between October 12th and 20th. The seeding generally was found to be poorer than in the brood-years of 1938 and 1939. In some rivers, however, the conditions were on a par or even better, while the spawning in two streams was found to be very disappointing.

At Waukwash River the supply was not as good as in 1938, but equal to that of 1939. The Inspector observes that the stream was generally well seeded and one of the best seen in 1943. The seeding at Indian River was equal to that of the two brood-years. Conditions at Asklum River were satisfactory; in fact, it received the best seeding of any stream in the area, and was better than in the brood-years. The situation at Genesee River was most disappointing. At Owikeno River, which is one of the main spawning areas, the seeding was definitely poor.

A later report has been received from a one-time employee at the Department's hatchery at Rivers Inlet, with regard to conditions at Whonnock River, which shows that there was an average seeding of sockeye in that important stream, although the fish were individually small.

With regard to the streams tributary to Rivers Inlet proper, and those streams tributary to Owikeno Lake, to which fall salmon proceed, the information is that the cohoe-supplies were light, the pinks very good, but the chum-supplies only medium.

SMITH INLET AREA.

The sockeye seeding is reported as being equal to that of 1938, when the supplies were found to be satisfactory. There was a good escapement to the Geluck River and a satisfactory one to the Delabah, two important sockeye-streams of the system.

The remarks with regard to the fall varieties, in the Rivers Inlet area, apply to this district also.

FRASER RIVER WATERSHED.

Prince George Area.—Encouraging supplies of sockeye were found in the Fraser-Francois Lake watershed, the quantities being estimated at 13,000 compared with 2,000 in the brood-year. Most of this seeding was in the Stellako River. In the Stuart Lake system the seeding is estimated at five times greater than that of the brood-year, although the quantities are still not great compared with early runs of this variety. The supplies of springs in the Nechako and Stuart Lake system were disappointing.

Quesnel Area.—In the Chilko system, which is the main sockeye-spawning ground of this area, the supply of sockeye was found to be approximately 300 per cent. greater than that of the brood-year. In the Quesnel Lake system no sockeye were observed. In the Bowron Lake system there was an increase of approximately 100 per cent. over the spawning of the brood-year. The supply of springs at Chilcotin was an average one. The seeding in the Quesnel Lake system was fair. This also applies to the Bowron, Cottonwood, and Blackwood Rivers systems.

Kamloops Area.—At Raft River the sockeye seeding showed considerable improvement over that of the brood-year. The supplies in the Shuswap area, including Little River and Adams River, were disappointing, the inspecting officer estimating only 5,000 individuals in the former and 12,000 in the latter stream. The supply of springs was about an average one, the fish arriving on the spawning-beds in excellent condition. The quantities of cohoes on the spawning-grounds were estimated to be normal.

Pemberton Area.—The inspecting officer reports a remarkably heavy seeding of sockeye in the Birkenhead River system. In Seton Creek some 800 spawning sockeye were observed. It has been noted in previous seasons that the conditions at the falls in the Fraser River at the mouth of Bridge River appear to affect the quantities of sockeye entering the Seton Lake system. The seeding by springs in the Squamish area was light, but there was a fair average in the Pemberton system. Satisfactory supplies were observed in the Seton Creek area. The cohoe-supplies were disappointing on the whole, although the run of this variety extends into January and February and the inspection in the fall does not cover the whole seeding. The pink-supplies were disappointing. The seeding by chums in the Squamish River system was good. This also applies to the streams tributary to the west side of Howe Sound.

Chilliwack Area.—In the Chilliwack-Cultus Lake section the only important sockeye-spawning beds are at Vedder River and Cultus Lake. The supplies of sockeye were disappointing, the return to Cultus Lake being estimated at approximately 12,000 fish compared with 73,000 in the brood-year of 1939. The spring seeding was light, as was also that of the cohoe, although the upper waters of the Chilliwack River were fairly well stocked. Fair supplies of cohoes were observed in the main streams, including the Coquihalla River. The seeding of pinks was fairly heavy, although not quite equalling that of 1941. The supplies were found particularly abundant in the Chilliwack River and Jones and Popkum Creeks. There was a satisfactory seeding of pinks in the Coquihalla River. The chum seeding was an improvement over the brood-year and fresh fish were still entering the stream at the time of inspection. A heavy seeding occurred in the Vedder and Chilliwack Rivers and Sweltzer Creek. Steelhead trout were unusually plentiful.

Harrison Area.—The sockeye seeding in this area, including the Mission portion of the district, has been light. This applies also to the springs and cohoes. The pink and chum supplies, however, are reported as being quite heavy, particularly in the principal streams such as the Harrison and Chehalis Rivers.

Pitt Lake Area.—A satisfactory supply of sockeye was observed in this system, estimated to be an improvement over the brood-year. Only fair supplies of cohoes were found.

Lower Fraser Area.—Fair supplies of cohoes were found in the Serpentine and Nicomekl Rivers, tributary to Mud Bay. In the smaller streams tributary to the Fraser, west of Chilliwack, excellent supplies of pinks were found at Whonnock Creek and a remarkably good showing in the North and South Alouette Rivers and Beaver River. Chums were found to be exceptionally plentiful in Whonnock Creek and there was a fair seeding at Stave and Coquitlam Rivers.

North Vancouver Area.—In the streams tributary to Burrard Inlet the seeding by springs was disappointing. The cohoe seeding was fair and the pinks not up to expectations. The chum-supplies were also light.

ALERT BAY AREA.

The sockeye-supplies in the main spawning-grounds such as the Nimpkish River, Keough River, Glendale Cove, Shushartie, Port Neville, Quatsi River, and MacKenzie River were fair, and compared favourably with those of the brood-year of 1939. Water conditions in the streams were favourable. Average supplies of spring salmon were observed at all streams, except Quatsi River and Adams River. A medium seeding occurred in the case of cohoes at nearly all streams, with heavy supplies at Wakeman, Viner, and Salmon Rivers. The pink seeding in mainland streams was the heaviest in the past ten years, practically all streams receiving large supplies. On the other hand, the seeding in the streams in the Vancouver Island section of the area was disappointing, being below that of the brood-year. Heavy supplies of chums were found at Kingcome, Seymour, Salmon, and Viner Rivers, those in the Viner River area being particularly heavy. The remaining streams received from light to medium supplies. All streams were well supplied with water.

QUATHIASKI AREA.

The streams tributary to Hayden Bay and Phillips Arm are the only ones frequented by sockeye. The seeding at Hayden Bay was equal to that of the cycle-year, but an improvement was observed in Phillips River. The seeding by spring salmon is considered a fair average, Campbell, Phillips, and Salmon Rivers being at least equal to that of the cycle-year. The cohoe escapement is reported as considerably better than that of the previous cycle, to all spawning-grounds, particularly those of the

Campbell and Homathko Rivers and Cumsack Creek, where the escapement was heavy. Even for an "off" year, the supply of pinks was found to be very disappointing, the only exception being the streams tributary to Bute Inlet, where a good escapement was observed, being a considerable improvement over that of the brood-year. The chum-supply was found to be disappointing and this is suggested as being possibly the result of flood conditions in 1939.

COMOX AREA.

The seeding by springs in the Puntledge River was found to be satisfactory, being an increase over that of 1940, 1941, and 1942, although not equalling the average runs of 1936 to 1939. The cohoe seeding was light. The inspecting officer attributes this condition to the effect of the numerous freshets in 1940. An extremely heavy supply of pinks was reported in the Courtenay River system. The seeding was even better than that of 1939. There were few to be found in other streams in the area, as this is the "off" cycle for the pink variety. In the brood-year the seeding was poor, even for this particular cycle. Generally speaking, only medium supplies of chum salmon were found, although they compared favourably with the seeding of the brood-year. The best conditions were found in the Courtenay River system, although the seeding at Little Qualicum River is reported as excellent. That at Big Qualicum River, however, was not as good as that of the brood-year.

PENDER HARBOUR AREA.

The sockeye seeding in the Saginaw Lake system was light, but compared well with that of the brood-year. The same conditions apply in the case of cohoes. There was a heavy seeding of pinks in the important Jervis Inlet area, particularly to Squaka River. At Deserted Bay River the supply was only fair, and in other streams in the district there was the usual light seeding. Chums were found in fair quantities in most of the larger streams, comparing well with the quantities showing in the brood-year.

NANAIMO AREA.

Cohoes were found in satisfactory quantities and the chum seeding was adequate. Other varieties of salmon do not frequent this area in commercial quantities.

LADYSMITH AREA.

The cohoe seeding was equal to that of the brood-year in the Nanaimo River system. In the Chemainus River and other creeks in the vicinity the supplies are reported as being excellent and an improvement over those of 1940. The seeding by springs in the Nanaimo River is reported as very satisfactory. Average quantities were also found in the Chemainus River. The usual few pinks appeared in both the Nanaimo and Chemainus River systems. The chum seeding in the Nanaimo River was heavier than that of the brood-year. The supplies in the Chemainus River were also excellent. This also applies to the smaller adjacent streams which are frequented by chums.

COWICHAN AREA.

The seeding by springs is reported as being satisfactory and the cohoe-supply was good. The chum seeding was also quite satisfactory. Spawning conditions in the Cowichan River were very good. Salmon had no difficulty in passing over Skutz Falls via the fish-ladder installed by the Department. In fact, salmon were observed passing through the ladder at the rate of 1,500 per hour at times.

VICTORIA AREA.

The cohoe-supply to the various streams compared favourably with that of the brood-year. This also applies to the chums in the Sooke and Demanuel Rivers. In the smaller streams in the Sooke area the supply was found to be below average. At Goldstream, however, the chum seeding was better than for many years, and the run was still continuing at the time of the last inspection.

ALBERNI AREA.

The sockeye seeding in the Somass River system, which includes the Sproat and Great Central Lakes and tributaries, has apparently not been as good as hoped. Due to high-water conditions at Sproat Falls and Stamp River Falls the ascent of the salmon was made much easier. Only 5,400 sockeye were counted through the fishway during the fall, which is approximately 30 per cent. of the runs counted in the same weir during each of the two preceding seasons. However, undoubtedly a much smaller percentage of the run used the fishway, in view of the favourable natural water conditions. Unfortunately, no inspection was made of the spawning-grounds at the head of Anderson Lake, although a fair escapement of sockeye was observed passing up-stream during the fishing season. The escapement at Hobarton River, tributary to Nitinat Arm, is reported as satisfactory. The seeding of the spring-salmon beds in the principal streams, such as the Somass, Nahmint, Sarita, Toquart, and Nitinat Rivers, is considered good, and spawning conditions favourable. A fair seeding of cohoes was observed in the Somass River system, as well as in the Nahmint, Toquart, Sarita, San Juan, and Nitinat Rivers. The supply of chums was found to be most disappointing, but early closing of fishing provided a fair seeding in some of the streams. Generally speaking, however, the chum seeding was poor. Water conditions in the several streams were satisfactory.

CLAYOQUOT AREA.

The sockeye-supplies are reported as being medium in the Kennedy Lake and Clayoquot River systems. The supplies observed were below those of the brood-year. The seeding in the Megin River and Lake system was not up to expectations. The seeding by springs is reported as the heaviest in the past four years, in all streams. The cohoe-supplies were less than those of the brood-year. A few pinks were observed, although this is not a pink area. The chum-supplies, generally speaking, were found to be light, although varying greatly in the several streams.

NOOTKA AREA.

The usual small seeding of sockeye was again observed, although this variety never appears in any material quantities. The spring-supplies were found to be normal. This also applies to the cohoe variety. The chum escapement was much the same as that found in the years 1939 and 1940. The individual fish, however, averaged only about 7 lb. in weight.

KYUQUOT AREA.

The seeding by springs is reported as only fair. The cohoe-supply is reported as being below that of the brood-year. For an " off " year the seeding by chums was good, showing considerable improvement over that of the brood-year.

QUATSINO AREA.

This is not an important sockeye area, but the seeding of this variety was found below normal. A good average supply of springs was observed at Marble Creek, which is the most important stream for this variety. Average seedings also occurred at Main

River and Klaskish River. Medium supplies of cohoe were seen in all the streams in Winter Harbour and Quatsino Sound, with the exception of Main River and Koprino River. The seeding in the outside streams, between the entrance to Quatsino Sound and Cape Scott, such as the Macjack, San Josef, and Fisherman Rivers, is reported as being below average. This being an " off " year for pinks, very few were observed. The chum-supply was found to be medium. It is reported to be equal to that of an average year, except to most of the streams in the West Arm of Quatsino Sound and to Jim's Creek and Klashkino Inlet. The seeding was, however, an improvement over that of 1939.

STATISTICAL TABLES.

PACK OF BRITISH COLUMBIA SALMON, SEASON 1943.

Showing the Origin of Salmon caught in each District.

District.	Sockeye.	Springs.	Steel-heads.	Cohoe.	Pinks.	Chums.	Total.
Fraser River	31,973½	3,505½	244	8,809	29,860½	52,149	126,541½
Queen Charlotte Islands	53	.....	.....	14,488	313	35,370	50,224
Nass River	13,412½	1,002½	335	9,768	17,669	10,146½	52,333½
Skeena River	28,268½	1,783	1,952	40,479½	54,509	6,597	133,589
Rivers Inlet	47,602½	765	69	11,466	8,347	11,448	79,697½
Smith Inlet	15,010	118	24	541	556	5,693	21,942
Central Area	21,101	547	397	26,645	288,109½	109,101	445,900½
Vancouver Island*	7,185	2,937	74	73,846½	130,825	132,843	347,710½
Alaska	283	.....	.....	.....	.....	.....	283
Totals	164,889	10,658	3,095	186,043	530,189	363,347½	1,258,221½

* 14,059½ cases of bluebacks are included with the cohoe pack for Vancouver Island.

STATEMENT SHOWING THE TOTAL SALMON-PACK BY SPECIES FROM 1935 TO 1943.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.	1935.
Sockeye	164,889	666,570	455,298	366,402	269,887	447,450	325,836	414,809	350,444
Spring	10,658	24,744½	51,593	17,740	16,098	15,356	16,174	29,853	21,920
Chum	363,347½	633,834	926,801	643,441	386,590	541,819	447,760	597,488	409,604
Pink	530,189	270,622½	427,774	213,904	620,595	400,876	585,574	591,535½	514,966
Cohoe	186,043	211,138	430,513	224,522	245,097	301,081	133,489	229,750	231,492
Steelhead	3,095	4,649	3,454	1,207	796	1,036	844	1,068	596
Totals	1,258,221½	1,811,558	2,295,433	1,467,216	1,539,063	1,707,798	1,509,677	1,864,503½	1,529,022

STATEMENT SHOWING THE TOTAL SALMON-PACK OF BRITISH COLUMBIA BY DISTRICTS.

Total packed by Districts in 1935 to 1943, inclusive.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.	1935.
Fraser	126,541½	549,617	431,299	152,363	199,241	277,084	231,848	260,261	216,728
Skeena	133,589	152,418½	200,497	195,355	205,604	223,413	133,165	218,634	170,420
Rivers Inlet	79,697½	105,539	138,650	88,665	83,502	122,363	108,782	72,011½	155,571
Smith Inlet	21,942	23,777	32,109	33,998	28,727	44,921	35,502	14,888	49,928
Nass River	52,333½	100,142½	71,330	60,441	55,946	113,970	49,042	139,575½	78,214
Vancouver Island	347,710½	536,803½	985,835	419,579	590,736	458,554	608,798	559,746½	469,427
Other Districts	496,407	343,260½	398,152	516,815	375,307	467,493	342,350	599,387	388,734
Cold storage	.....	.....	46,561	.....	.....	.....	.....	.....	.....
Grand totals	1,258,221½	1,811,558	2,295,433	1,467,216	1,539,063	1,707,798†	1,509,677*	1,864,503½	1,529,022

* Including 527 cases of Alaska cohoe packed at Skeena River.

† Including 5,779 cases of Alaska sockeye and 26,828 cases of Alaska cohoe packed at Skeena River.

TABLE SHOWING THE TOTAL SOCKEYE-PACK OF THE FRASER RIVER, ARRANGED IN ACCORDANCE WITH THE FOUR-YEAR CYCLE, 1895–1943.

British Columbia	1895— 395,984	1896— 356,984	1897— 860,459	1898— 256,101
Washington	65,143	72,979	312,048	252,000
Total	461,127	429,963	1,172,507	508,101
British Columbia	1899— 480,485	1900— 229,800	1901— 928,669	1902— 293,477
Washington	499,646	228,704	1,105,096	339,556
Total	980,131	458,504	2,033,765	633,033
British Columbia	1903— 204,809	1904— 72,688	1905— 837,489	1906— 183,007
Washington	167,211	123,419	837,122	182,241
Total	372,020	196,107	1,674,611	365,248
British Columbia	1907— 59,815	1908— 74,574	1909— 585,435	1910— 150,432
Washington	96,974	170,951	1,097,904	248,014
Total	156,789	245,525	1,683,339	398,446
British Columbia	1911— 58,487	1912— 123,879	1913— 719,796	1914— 198,183
Washington	127,761	184,680	1,673,099	335,230
Total	186,248	308,559	2,392,895	533,413
British Columbia	1915— 91,130	1916— 32,146	1917— 148,164	1918— 19,697
Washington	64,584	84,637	411,538	50,723
Total	155,714	116,783	559,702	70,420
British Columbia	1919— 38,854	1920— 48,399	1921— 39,631	1922— 51,832
Washington	64,346	62,654	102,967	48,566
Total	103,200	111,053	142,598	100,398
British Columbia	1923— 31,655	1924— 39,743	1925— 35,385	1926— 85,689
Washington	47,402	69,369	112,023	44,673
Total	79,057	109,112	147,408	130,362
British Columbia	1927— 61,393	1928— 29,299	1929— 61,569	1930— 103,692
Washington	97,594	61,044	111,898	352,194
Total	158,987	90,343	173,467	455,886
British Columbia	1931— 40,947	1932— 65,769	1933— 52,465	1934— 139,238
Washington	87,211	81,188	126,604	352,579
Total	128,158	146,957	179,069	491,817
British Columbia	1935— 62,822	1936— 184,854	1937— 100,272	1938— 186,794
Washington	54,677	59,505	60,259	134,641
Total	117,499	244,359	160,531	321,435
British Columbia	1939— 54,296	1940— 99,009	1941— 171,290	1942— 446,371
Washington	43,511	59,354	110,605	263,458
Total	97,807	158,363	281,895	709,829
British Columbia	1943— 31,973½			
Washington	19,116½			
Total	51,090			

STATEMENT SHOWING THE SALMON-PACK OF BRITISH COLUMBIA, BY DISTRICTS AND SPECIES.

FRASER RIVER, 1928–43, INCLUSIVE.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.
Sockeyes	31,973½	446,371	171,290	99,009	54,296	186,794	100,272	184,854
Springs	3,505½	9,688	34,038	4,504	5,993	4,308	5,444	15,126
Chums	52,149	82,573	95,070	35,665	30,150	58,778	20,878	31,565
Pinks	29,860½	134	102,388	12	95,176	63	94,010	.....
Cohoes	8,809	10,542	28,265	13,028	13,557	27,127	11,244	28,716
Steelheads	244	309	248	145	69	14	.....	.....
Totals	126,541½	549,617	431,299	152,363	199,241	277,084	231,848	260,261

	1935.	1934.	1933.	1932.	1931.	1930.	1929.	1928.
Sockeyes	62,822	139,238	52,465	65,769	40,947	103,692	61,569	29,299
Springs	9,401	16,218	5,579	28,701	9,740	21,127	10,004	5,082
Chums	8,227	104,092	34,391	14,948	251	68,946	144,159	193,106
Pinks	111,328	2,199	92,746	385	13,307	30,754	158,208	2,881
Cohoes	24,950	11,392	13,901	16,815	8,165	25,585	40,520	27,061
Steelheads	.....	.....	.....	23	657	27,879	12,013	795
Totals	216,728	273,139	199,082	126,641	73,067	277,983	426,473	258,224

SKEENA RIVER, 1928–43, INCLUSIVE.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.
Sockeyes	28,268½	34,544	81,767	116,507	68,485	47,257	42,491	81,973
Springs	1,783	6,374	4,985	6,118	4,857	4,318	4,401	4,551½
Chums	6,597	11,421	10,707	4,682	7,773	16,758	10,811	15,297½
Pinks	54,509	52,767	50,537	47,301	95,236	69,610	59,400	91,389
Cohoes	40,479½	44,081½	50,605	20,614	29,198	52,821	15,514	25,390
Steelheads	1,952	3,231	1,896	133	55	42	21	33
Totals	133,589	152,418½	200,497	195,355	205,604	190,806	132,638	218,634

	1935.	1934.	1933.	1932.	1931.	1930.	1929.	1928.
Sockeyes	52,879	70,655	30,506	59,916	93,023	132,372	78,017	34,559
Springs	4,039	8,300	3,297	28,269	9,857	7,501	4,324	6,420
Chums	8,122	24,388	15,714	38,549	3,893	5,187	4,908	17,716
Pinks	81,868	126,163	95,783	58,261	44,807	275,642	95,305	209,579
Cohoes	23,498	54,456	39,896	48,312	10,637	29,617	37,678	30,194
Steelheads	14	114	267	404	768	58	13	241
Totals	170,420	284,096	185,463	233,711	162,986	450,377	220,245	298,709

STATEMENT SHOWING THE SALMON-PACK OF BRITISH COLUMBIA, BY DISTRICTS AND SPECIES—*Continued.*

RIVERS INLET, 1928–43, INCLUSIVE.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.
Sockeyes	47,602½	79,199	93,378	63,469	54,143	87,942	84,832	46,351
Springs	765	985	1,692	1,226	745	1,209	917	581½
Chums	11,448	15,874	15,442	9,025	5,462	7,759	9,415	11,505
Pinks	8,347	954	4,807	3,329	12,095	9,063	7,536	6,432½
Cohoes	11,466	8,467	23,202	11,561	10,974	16,285	6,012	7,122½
Steelheads	69	60	129	55	83	105	70	19
Totals	79,697½	105,539	138,650	88,665	83,502	122,363	108,782	72,011½

	1935.	1934.	1933.	1932.	1931.	1930.	1929.	1928.
Sockeyes	135,038	76,923	83,507	69,732	76,428	119,170	70,260	60,044
Springs	429	436	449	459	325	434	342	468
Chums	7,136	895	677	944	429	492	989	3,594
Pinks	4,554	2,815	5,059	3,483	5,089	18,023	2,386	16,546
Cohoes	8,375	4,852	3,446	7,062	6,571	756	1,120	868
Steelheads	39	79	82	29	32	105	29	7
Totals	155,571	86,000	93,220	81,709	88,874	138,980	75,126	81,527

SMITH INLET, 1928–43, INCLUSIVE.*

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.
Sockeyes	15,010	15,939	21,495	25,947	17,833	33,894	25,258	12,788
Springs	118	8	124	142	215	68	21	30
Cohoes	541	1,813	1,955	1,102	3,880	1,058	241	310
Pinks	556	527	749	755	3,978	1,761	483	65
Chums	5,693	5,490	7,741	6,015	2,771	8,076	9,494	1,653
Steelheads	24	.....	45	37	50	64	5	42
Totals	21,942	23,777	32,109	33,998	28,727	44,921	35,502	14,888

	1935.	1934.	1933.	1932.	1931.	1930.	1929.	1928.
Sockeyes	31,648	14,607	37,369	25,488	12,867	32,057	9,683	33,442
Springs	216	164	354	48	122	290	78	286
Cohoes	1,201	3,941	5,068	273	112	1,460	275	230
Pinks	4,412	6,953	19,995	1,148	824	16,615	853	167
Chums	12,427	15,548	8,841	165	133	1,660	113	19
Steelheads	24	43	87	20	36	103	12	6
Totals	49,928	41,256	71,714	27,142	14,094	52,185	11,014	34,150

* Previously reported in Queen Charlotte and other districts.

STATEMENT SHOWING THE SALMON-PACK OF BRITISH COLUMBIA, BY DISTRICTS AND SPECIES—*Continued.*

NASS RIVER, 1928–43, INCLUSIVE.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.
Sockeyes	13,412½	21,085	24,876	13,809	24,357	21,462	17,567	28,562½
Springs	1,002½	1,515	519	1,716	708	773	1,251	2,167
Chums	10,146½	12,518	6,246	5,461	2,500	15,911	10,080	20,620½
Pinks	17,669	49,003½	22,667	29,278	26,370	61,477	8,031	75,887½
Cohoes	9,768	15,487	16,648	10,060	1,996	14,159	12,067	11,842
Steelheads	335	534	374	117	15	188	46	496
Totals	52,333½	100,142½	71,330	60,441	55,946	113,970	49,042	139,575½

	1935.	1934.	1933.	1932.	1931.	1930.	1929.	1928.
Sockeyes	12,712	28,701	9,757	14,154	16,929	26,405	16,077	5,540
Springs	560	654	1,296	4,408	1,439	1,891	352	1,846
Chums	17,481	2,648	1,775	14,515	392	3,978	1,212	3,538
Pinks	25,508	32,964	44,306	44,629	5,178	79,976	10,342	83,183
Cohoes	21,810	9,935	3,251	7,955	8,943	1,126	1,202	10,734
Steelheads	143	311	49	10	.....	84	.....	36
Totals	78,214	75,213	60,434	85,671	32,881	113,460	29,185	104,877

VANCOUVER ISLAND DISTRICT, 1928–43, INCLUSIVE.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.
Sockeyes	7,185	51,961	40,273	15,177	16,259	27,965	25,427	32,696½
Springs	2,937	5,407	8,038	2,454	2,889	4,254	2,359	6,340
Chums	132,843	383,005	593,016	279,064	212,949	266,566	203,900	347,951
Pinks	130,825	14,474	177,292	33,785	235,119	70,108	318,780	82,028½
Cohoes	73,846½	81,837½	166,908	88,885*	123,388	62,054	52,244	90,625
Steelheads	74	119	308	214	132	27,607	88	105
Totals	347,710½	536,803½	985,835	419,579	590,736	458,554	608,798	559,746

	1935.	1934.	1933.	1932.	1931.	1930.	1929.	1928.
Sockeyes	22,928	27,282	18,397	27,611	22,199	24,784	10,340	14,248
Springs	6,525	1,630	4,875	10,559	4,055	3,431	1,645	2,269
Chums	143,960	210,239	96,642	70,629	16,329	177,856	162,246	303,474
Pinks	191,627	54,526	172,945	33,403	81,965	89,941	74,001	41,885
Cohoes	104,366	78,670	60,019	35,132	26,310	30,206	35,504	23,345
Steelheads and Bluebacks	21	.....	147	28,596	24,638	14,177	11,118	5,249
Totals	469,427	372,347	353,025	205,930	175,541	340,395	294,854	390,470

* 23,277 cases of bluebacks are included with the cohoe-pack for Vancouver Island.

STATEMENT SHOWING THE SALMON-PACK OF BRITISH COLUMBIA, BY DISTRICTS AND SPECIES—*Continued.*

QUEEN CHARLOTTE ISLANDS, 1934–43, INCLUSIVE.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.	1935.	1934.
Sockeyes	53	1	149	16	1	179	2	85	.....	.....
Springs	.....	38	236	62	36	66	140	227	63	258
Chums	35,370	43,801	76,745	164,911	45,519	40,882	72,689	69,304	86,298	38,062
Pinks	313	83,329	524	44,966	2,123	57,952	13	89,355	1,479	53,398
Cohoes	14,488	16,935	27,421	8,897	3,020	16,616	4,631	19,920	5,461	8,315
Steelheads	.....	41	11	.....	.....	.....	.....	.....	.....	.....
Totals	50,224	144,145	105,086	218,852	50,699	115,695	77,475	178,891	93,301	100,033

CENTRAL AREA, 1934–43, INCLUSIVE.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.	1935.	1934.
Sockeyes	21,101	17,470	20,854	32,042	26,158	36,178	29,987	27,499	32,417	20,438
Springs	547	723½	460	1,518	655	540	1,641	830	687	2,116
Chums	109,101	79,152	111,587	135,802	79,384	127,089	110,493	99,592	125,953	117,309
Pinks	288,109½	69,434	66,130	54,478	150,498	130,842	97,321	246,378	94,190	157,336
Cohoes	26,645	31,274	45,218	49,886	44,426	56,716	25,009	45,824	41,831	53,850
Steelheads	397	355	330	506	392	433	614	373	355	733
Totals	445,900½	198,408½	244,579	274,232	301,513	351,798	265,065	420,496	295,433	351,782

STATEMENT SHOWING THE SOCKEYE-PACK OF BRITISH COLUMBIA, BY DISTRICTS, 1928 TO 1943, INCLUSIVE.

	1943.	1942.	1941.	1940.	1939.	1938.	1937.	1936.
Fraser River	31,973½	446,371	171,290	99,009	54,296	186,794	100,272	183,120
Skeena River	28,268½	34,544	81,767	116,507	68,485	47,257	42,491	81,973
Rivers Inlet	47,602½	79,199	93,378	63,469	54,143	87,942	84,832	46,351
Smith Inlet	15,010	15,939	21,495	25,947	17,833	33,894	25,258	12,788
Nass River	13,412½	21,085	24,876	13,809	24,357	21,462	17,567	28,562½
Vancouver Island	7,185	51,961	40,273	15,177	16,259	27,965	25,427	34,430½
Other Districts	21,437	17,471	22,219	32,484	34,514	36,357	29,989	27,584
Totals	164,889	666,570	455,298	366,402	269,887	441,671*	325,836	414,809

	1935.	1934.	1933.	1932.	1931.	1930.	1929.	1928.
Fraser River	62,822	139,238	52,465	65,769	40,947	103,692	61,569	29,299
Skeena River	52,879	70,655	30,506	59,916	93,023	132,372	78,017	34,559
Rivers Inlet	135,038	76,923	83,507	69,732	76,428	119,170	70,260	60,044
Smith Inlet	31,648	14,607	37,369	25,488	12,867	32,057	9,683	33,442
Nass River	12,712	28,701	9,757	14,154	16,929	26,405	16,077	5,540
Vancouver Island	22,928	27,282	18,397	27,611	22,199	24,784	10,340	14,248
Other Districts	32,417	20,438	26,106	21,685	29,071	39,198	35,331	26,410
Totals	350,444	377,844	258,107	284,355	291,464	477,678	281,277	203,542

216 cases of Alaska sockeye packed in British Columbia canneries are not shown in the above table for the year 1936.

* 5,779 cases of Alaska sockeye packed at Skeena River are not shown in the above table for the year 1938.

STATEMENT SHOWING THE SPRING-SALMON PACK OF BRITISH COLUMBIA, BY DISTRICTS, 1932 TO 1943, INCLUSIVE.

	1943.	1942.	1941.*	1940.	1939.	1938.
Fraser River	3,505½	9,688	34,038	4,504	5,993	4,308
Queen Charlotte Islands	----------	38	236	62	36	66
Nass River	1,002½	1,515	519	1,716	708	773
Skeena River	1,783	6,374	4,985	6,118	4,857	4,318
Rivers Inlet	765	985	1,692	1,226	745	1,209
Smith Inlet	118	8	124	142	215	68
Central Area	547	723½	460	1,518	655	540
Vancouver Island	2,937	5,407	8,038	2,454	2,889	4,254
Alaska	----------	6	383	----------	----------	----------
Totals	10,658	24,744½	50,475	17,740	16,098	15,536

	1937.	1936.	1935.	1934.	1933.	1932.
Fraser River	5,444	15,126	9,401	16,218	5,579	28,701
Queen Charlotte Islands	140	227	63	258	3,575	278
Nass River	1,251	2,167	560	654	1,296	4,408
Skeena River	4,401	4,551½	4,039	8,300	3,297	28,269
Rivers Inlet	917	581½	429	436	449	459
Smith Inlet	21	30	216	164	354	48
Central Area	1,641	830	687	2,116	841	3,236
Vancouver Island	2,359	6,340	6,525	1,630	4,875	10,559
Totals	16,174	29,853	21,920	29,776	20,266	75,958

* In addition to the above there were packed 1,118 cases of springs out of cold-storage stocks, catch of 1940.

STATEMENT SHOWING THE COHOE-SALMON PACK OF BRITISH COLUMBIA, BY DISTRICTS, 1932 TO 1943, INCLUSIVE.

	1943.	1942.	1941.*	1940.	1939.	1938.
Fraser River	8,809	10,542	28,265	13,028	13,557	27,127
Queen Charlotte Islands	14,488	16,935	27,421	8,897	3,020	16,616
Nass River	9,768	15,487	16,648	10,060	1,996	14,159
Skeena River	40,479½	44,081½	50,605	20,614	29,198	52,821
Rivers Inlet	11,466	8,467	23,202	11,561	10,974	16,285
Smith Inlet	541	1,813	1,955	1,102	3,880	1,058
Central Area	26,645	31,274	45,218	49,886	44,426	56,716
Vancouver Island	73,846½	81,837½	166,908	88,885	123,388	89,471
Alaska	----------	701	31,187	20,489	14,658	26,828
Totals	186,043	211,138	391,409	224,522	245,097	301,081

	1937.	1936.	1935.	1934.	1933.	1932.
Fraser River	11,244	28,716	24,950	11,392	13,901	16,815
Queen Charlotte Islands	4,631	19,920	5,461	8,315	----------	3,805
Nass River	12,067	11,842	21,810	9,935	3,251	7,955
Skeena River	15,514	25,390	23,498	54,476	39,896	48,312
Rivers Inlet	6,012	7,122½	8,375	4,852	3,446	7,062
Smith Inlet	241	310	1,201	3,941	5,068	273
Central Area	25,009	45,824	41,831	53,850	33,471	41,172
Vancouver Island	58,244	90,625½	104,366	78,670	60,019	63,637
Alaska	527	----------	----------	----------	----------	----------
Totals	133,489	229,750	231,492	225,431	159,052	189,031

* In addition to the above there were packed 39,104 cases of cohoe out of cold-storage stocks, catch of 1940.

STATEMENT SHOWING THE PINK-SALMON PACK OF BRITISH COLUMBIA, BY DISTRICTS, 1932 TO 1943, INCLUSIVE.

	1943.	1942.	1941.	1940.	1939.	1938.
Fraser River	29,860½	134	102,388	12	95,176	63
Queen Charlotte Islands	313	83,329	524	44,966	2,123	57,952
Nass River	17,669	49,003½	22,667	29,278	26,370	61,477
Skeena River	54,509	52,767	50,537	47,301	95,236	69,610
Rivers Inlet	8,347	954	4,807	3,329	12,095	9,063
Smith Inlet	556	527	749	755	3,978	1,761
Central Area	288,109½	69,434	66,130	54,478	150,498	130,842
Vancouver Island	130,825	14,474	177,292	33,785	235,119	70,108
Alaska	----------	----------	2,680	----------	----------	----------
Totals	530,189	270,622½	427,774	213,904	620,595	400,876

	1937.	1936.	1935.	1934.	1933.	1932.
Fraser River	94,010	----------	111,328	2,199	92,746	385
Queen Charlotte Islands	13	89,355	1,479	53,398	----------	2,415
Nass River	8,031	75,887½	25,508	32,964	44,306	44,629
Skeena River	59,400	91,389	81,868	126,163	95,783	58,261
Rivers Inlet	7,536	6,432½	4,554	2,815	5,059	3,483
Smith Inlet	483	65	4,412	6,953	19,995	1,148
Central Area	97,321	246,378	94,190	157,336	101,701	80,034
Vancouver Island	318,780	82,028½	191,627	54,526	172,945	33,403
Totals	585,574	591,535½	514,966	436,354	532,535	223,758

STATEMENT SHOWING THE CHUM-SALMON PACK OF BRITISH COLUMBIA, BY DISTRICTS, 1932 TO 1943, INCLUSIVE.

	1943.	1942.	1941.*	1940.	1939.	1938.
Fraser River	52,149	82,573	95,070	35,665	30,150	58,778
Queen Charlotte Islands	35,370	43,801	76,745	164,911	45,519	40,882
Nass River	10,146½	12,518	6,246	5,461	2,500	15,911
Skeena River	6,597	11,421	10,707	4,682	7,773	16,758
Rivers Inlet	11,448	15,874	15,442	9,025	5,462	7,759
Smith Inlet	5,693	5,490	7,741	6,015	2,771	8,076
Central Area	109,101	79,152	111,587	135,802	79,384	127,089
Vancouver Island	132,843	383,005	593,016	279,064	212,949	266,566
Alaska	----	----------	3,908	2,816	82	----------
Totals	363,347½	633,834	920,462	643,441	386,590	541,819

	1937.	1936.	1935.	1934.	1933.	1932.
Fraser River	20,878	31,565	8,227	104,092	34,391	14,948
Queen Charlotte Islands	72,689	69,304	86,298	38,062	6,988	358
Nass River	10,080	20,620½	17,481	2,648	1,775	14,515
Skeena River	10,811	15,297½	8,122	24,388	15,714	38,549
Rivers Inlet	9,415	11,505	7,136	895	677	944
Smith Inlet	9,494	1,653	12,427	15,548	8,841	165
Central Area	110,493	99,592	125,953	117,309	128,602	166,653
Vancouver Island	203,900	347,951	143,960	210,239	96,642	70,629
Totals	447,760	597,488	409,604	513,181	293,630	306,761

* In addition to the above there were packed 6,339 cases of chums out of cold-storage stocks, catch of 1940.

STATEMENT SHOWING THE QUANTITY OF PILCHARD PRODUCTS PRODUCED IN BRITISH COLUMBIA, 1930 TO 1943.

Season.	Canned.	Meal.	Oil.
	Cases.	Tons.	Gals.
1930–31	55,166	13,934	3,204,058
1931–32	17,336	14,200	2,551,914
1932–33	4,622	8,842	1,315,864
1933–34	2,946	1,108	275,879
1934–35	35,437	7,628	1,635,123
1935–36	27,184	8,666	1,634,592
1936–37	35,007	8,715	1,217,087
1937–38	40,975	8,483	1,707,276
1938–39	69,473	8,891	2,195,850
1939–40	7,300	906	178,305
1940–41	59,166	4,853	890,296
1941–42	72,498	11,437	1,916,191
1942–43	42,008	11,003	1,560,269
1943–44	94,512	15,209	2,238,987

STATEMENT SHOWING THE QUANTITY OF HERRING PRODUCTS PRODUCED IN BRITISH COLUMBIA, 1935 TO 1943.

Season.	Canned.	Dry-salted.	Pickled.	Meal.	Oil.
	Cases.	Tons.	Tons.	Tons.	Gals.
1935–36	26,143	14,983	.....	5,313	328,639
1936–37	20,914	16,454	.....	10,340	786,742
1937–38	27,365	10,230	.....	14,643	1,333,245
1938–39	23,353	7,600	.....	18,028	1,526,117
1939–40	418,021	7,596	.....	22,870	1,677,736
1940–41	640,252	5,039	892	10,886	923,137
1941–42	1,527,350	.....	779	8,780	594,684
1942–43	1,253,978	.....	502	4,633	323,379
1943–44	1,198,632	.....	591	7,662	512,516

The above figures are for the season, October to March 31st, annually.

STATEMENT SHOWING THE QUANTITY OF MEAL, OIL, AND FERTILIZER, PRODUCED FROM SOURCES OTHER THAN HERRING AND PILCHARD, 1935 TO 1943.

Season.	From Whales.			From other Sources.	
	Whalebone and Meal.	Fertilizer.	Oil.	Meal and Fertilizer.	Oil.
	Tons.	Tons.	Gals.	Tons.	Gals.
1935–36	211	354	426,772	2,226	260,387
1936–37	332	687	763,740	2,857	356,464
1937–38	268	527	662,355	2,445	266,009
1938–39	273	512	543,378	2,059	186,261
1939–40	.....	.....	.....	3,559	331,725
1940–41	181	434	361,820	4,998	415,856
1941–42	270	561	619,025	5,410	405,340
1942–43	130	205	255,555	4,768	1,255,225*
1943–44	62	90	134,553	4,332	882,250†

* Includes 916,723 gallons fish-liver oil.
† Includes 822,250 gallons fish-liver oil.

CATCH OF FISH TAKEN FROM THE FOLLOWING NON-TIDAL WATERS DURING THE 1943–44 SEASON.

Lakes and Rivers.	Kind of Licence.			Trout.		Kokanee.		Lake Trout.		White Fish.		Carp.		Ling.		Squaw Fish.		Suckers.		Other Fish.		No. of Fish taken.	Approximate Weight.
	Fur-farm.	Ordinary.	Sturgeon.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.		
Burns Lake	2					100	25			75	75			30	240	383	725	945	1,445			1,533	2,510
Clucluz Lake	2			17	18			7	87	1,230	3,600			818	3,077	6,134	4,350	8,415	21,965	1,975	1,775	18,596	34,872
Columbia River and Sloughs	3																	121	67			121	67
Chief Lake	2									725	705			11	21	171	177	1,175	1,275			2,082	2,178
Charlie Lake		1																					
Christina Lake		11				13,412	3,671							43	151			12	40	1	5	13,458	3,867
Chain Lake	1																	190	500			190	500
Decker Lake	1									75	75			30	240	312	625	875	1,350			1,292	2,290
Dahl Lake	1									325	230					300	300	300	300			925	830
Eaglet Lake	2					1,296	344	7	6					240	1,136	493	557	669	745			2,705	2,788
Eagen Lake	1																						
Francois Lake	1	6				200	25	1,252	6,905	454	1,573			329	1,648	3	9	46	71			2,284	10,231
Finger Lake	2			6	7	820	408			2,187	771							2,116	2,624			5,129	3,810
Gwillim Lake	1																						
Kiskatinaw River	1																	260	890	200	990	460	1,880
Little Bull River		1																					
Moberly Lake	1	2								700	1,400											700	1,400
Margaret Lake	1																						
Mitchette Creek	1																						
Murch Lake	1															157	194	181	155			338	349
McLeod Lake	1									150	75											150	75
McLeese Lake	1															2	2					2	2
Nadsilnich Lake	1					1,050	175			300	220			35	81	145	170	190	230			1,720	876
Nulki Lake	3			34	45					968	751	3,815	2,775	154	406	1,440	1,405	584	656			6,995	6,038
Naltesby Lake	1					400	350			1,150	575					800	935	220	235	150	50	2,720	2,145
Norman Lake	1									325	230					300	300	300	300			925	830
Nechako River			1																				
Okanagan Lake		46				48,568	16,365											7	23			48,575	16,388
Okanagan River and Sloughs	1											475	1,900	15	55	61	245	840	2,100			1,391	4,300
Ootsa Lake	1			28	40									56	115	223	221	298	298			605	674
Osprey Lake	1																	190	500			190	500
Pinchi Lake	1																						
Pinkut Lake		1						2	16	496	590											498	606
Sinclair Lake	1			29	41									56	116	222	221	297	298			604	676
Stuart Lake	2									1,094	1,037	225	450	31	158	239	474	536	975			2,125	3,094
Stuart River	1															58	58	46	49			104	107
Sinkut Lake	1											6,012	1,649	30	153	2,531	3,457	331	996			8,904	6,255

CATCH OF FISH TAKEN FROM THE FOLLOWING NON-TIDAL WATERS DURING THE 1943–44 SEASON—*Continued.*

Lakes and Rivers.	Kind of Licence.			Trout.		Kokanee.		Lake Trout.		White Fish.		Carp.		Ling.		Squaw Fish.		Suckers.		Other Fish.		No. of Fish taken.	Approximate Weight.
	Fur-farm.	Ordinary.	Sturgeon.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.		
Swan Lake	----	1	----	----	----	----	----	----	----	330	1,129	----	----	----	----	----	----	90	226	----	----	420	1,355
Sheridan Creek	1	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Tchesinkut Lake	1	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	880	2,400	----	----	880	2,400
Tatuk Lake	2	----	----	7	7	820	409	----	----	2,188	774	----	----	----	----	----	----	2,116	2,626	----	----	5,131	3,816
Tachick Lake	1	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Windermere Lake and Sloughs	1	----	----	----	----	----	----	----	----	----	----	----	----	90	150	601	885	390	840	----	----	1,081	1,875
Totals	----	----	----	121	158	66,666	21,772	1,268	7,014	12,772	13,810	10,527	6,774	1,968	7,747	14,575	15,310	22,620	44,179	2,326	2,870	132,843	119,584

Number of Non-tidal Fishing Licences issued—

Fur-farm fishing licences	36
Ordinary fishing licences	69
Sturgeon fishing licences	1
	106

No sturgeon were taken by licence-holder.

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