PROVINCE OF BRITISH COLUMBIA

REPORT

OF THE

COMMISSIONER OF FISHERIES

FOR THE YEAR ENDED DECEMBER 31ST, 1932

WITH APPENDICES

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

MAY IT PLEASE YOUR HONOUR:

I beg to submit herewith the Report of the Provincial Fisheries Department for the year ended December 31st, 1932, with Appendices.

SAMUEL LYNESS HOWE,
Commissioner of Fisheries.

Provincial Fisheries Department,
Commissioner of Fisheries' Office,
Victoria, British Columbia, December 31st, 1932.

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FISHERIES COMMISSIONER'S REPORT FOR 1932.

VALUE OF CANADIAN FISHERIES AND THE STANDING OF PROVINCES, 1931.

The value of the fishery products of Canada for the year 1931 totalled $30,517,306. During that year British Columbia produced fishery products of a value of $11,108,873, or 36 per cent. of Canada's total.*

In 1931 British Columbia again led all the Provinces in the Dominion, as has been the case for over twenty years, in the value of her fishery products. Her output exceeded that of Nova Scotia, the second in rank, by $3,122,162.

The market value of the fishery products of British Columbia in 1931 was $11,994,429 less than in the previous year, 1930, due principally to a decrease in the value of the salmon-fishery in the amount of $9,415,614, and a decline in the value of halibut of $1,073,096 in comparison with 1930. Owing to the demoralized condition of the markets, fishing operations were greatly curtailed.

The capital invested in the fisheries of British Columbia in 1931 was $20,750,316, or 45¾ per cent. of the total capital employed in Canada. Of the $20,750,316 invested in the fisheries of British Columbia in 1931, $7,780,832 was employed in catching and handling the catches, and $12,969,484 invested in canneries, fish-packing establishments, and fish-reduction plants.

The number of persons engaged in British Columbia fisheries in 1931 was 13,940, or 18½ per cent. of Canada's total of 75,225. Of the 13,940 engaged in British Columbia, 9,495 were employed in catching and handling the catches and 4,445 in packing, curing, and fish-reduction. The total number engaged in the fisheries in 1931 was 5,407 less than in the preceding year.

The following statement gives in the order of their rank the value of the fishery products of the Provinces of Canada for the years 1927 to 1931, inclusive:—

Province.	1927.	1928.	1929.	1930.	1931.
British Columbia	$23,264,342	$26,562,727	$23,930,692	$23,103,302	$11,108,873
Nova Scotia	10,783,631	11,681,995	11,427,491	10,411,202	7,986,711
New Brunswick	4,406,673	5,001,641	5,935,635	4,853,575	4,169,811
Ontario	3,670,229	4,030,753	3,919,144	3,294,629	2,477,131
Quebec	2,736,450	2,996,614	2,933,339	2,502,998	1,952,894
Manitoba	2,039,738	2,240,314	2,745,205	1,811,962	1,241,575
Prince Edward Island	1,367,807	1,196,681	1,297,125	1,141,279	1,078,901
Alberta	712,469	725,050	732,214	421,258	153,897
Saskatchewan	503,609	563,533	572,871	234,501	317,963
Yukon Territory	12,090	51,665	24,805	29,510	29,550
Totals	$49,497,038	$55,050,973	$53,518,521	$47,804,216	$30,517,306

THE SPECIES AND VALUE OF FISH CAUGHT IN BRITISH COLUMBIA.

The total value of each of the principal species of fish taken in British Columbia for the year ended December 31st, 1931, is given in the following statement:—

Salmon	$7,195,220
Halibut	1,373,679
Herring, oil, meal, etc.	1,058,139
Pilchard, oil, meal, etc.	807,842
Ling cod, cod	242,911
Carried forward	$10,677,791

* As this report goes to press the Commissioner is in receipt of an advanced report of the value of the fisheries of the Province for the year 1932, issued by the Dominion Bureau of Statistics—R. H. Coats, Statistician—from which the following data are taken: The value of the fishery products of British Columbia for 1932 was $9,914,071; number of persons engaged, 14823; and the capital employed, $18,935,912.

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

Brought forward	$10,677,791
Clams, quahaugs	111,690
Black cod	39,521
Crabs	27,914
Soles	25,372
Shrimps	15,778
Oysters	61,247
Abalone	4,266
Flounders, brill	4,894
Rock cod, tomcod	10,937
Perch	3,893
Smelt	14,928
Sturgeon	3,774
Octopus	1,156
Skate	4,271
Oolachans	477
Whiting, shad	603
Fish-oils, grayfish, etc.	62,648
Fish-fertilizer	10,272
Fish-meals	13,256
Fur-seals	7,004
Miscellaneous	7,181
Total	$11,108,873

The above statement shows a sharp decline in the value of marketed products in the amount of $11,994,429. Of this amount, the salmon-fishery dropped $9,415,614.

Total halibut landings were marketed for $1,373,679, a decrease in production of 7,299,100 lb. and a decrease in value of $1,073,096 in comparison with 1930.

Herring-catches produced $1,058,139, an increase in value of $164,164.

Pilchard-catches produced $807,842, a decrease in production of 29,319 cwt. and in value of $781,767.

The foregoing data are derived from the "Fishery Statistics of Canada" for 1931.

THE SALMON-PACK OF THE PROVINCE IN 1932.

The catches of salmon in the Province in 1932 produced a pack of 1,081,031 cases. It consisted of 284,355 cases of sockeye, 223,758 cases of pinks, 306,761 cases of chums, 189,031 cases of cohoe, and 75,958 cases of springs. While the pack shows an increase of 395,927 cases in comparison with 1931, the years 1931 and 1932 were still the smallest since 1921. Owing to lack of demand little effort was made to pack pink and chum salmon. The anticipated large run of pinks to the Queen Charlotte Islands, which usually makes its appearance in the even years, did not materialize. No explanation can be offered at the present time for the failure of their return. The salmon runs to all districts, with the exception of the Queen Charlotte Islands, were of fair proportions.

THE SALMON-PACK BY DISTRICTS.

The Fraser River System.—The catches of salmon in the Provincial waters of the Fraser River system produced a pack of 126,641 cases. A total of 218,262 cases was packed in the Fraser District. Of this number, 96,621 were caught in other districts.

Salmon transported from other districts to the Fraser comprised 9,062 cases of sockeye from Rivers Inlet, 800 cases of sockeye from Smith Inlet, and 11,816 cases of sockeye, 28,530 cases of cohoe, 6,833 cases of springs, 9,428 cases of pinks, and 30,152 cases of chums from Vancouver Island District. They have been credited to their proper districts in the detailed pack report. Bluebacks have been classified as cohoe in this report.

The catch of sockeye in Provincial waters of the Fraser River system, including the catches of sockeye made by the traps at the southern end of Vancouver Island, produced a pack of

65,769 cases. The catch of sockeye in the State of Washington waters of the Fraser River system produced a pack of 81,188 cases. Combined they give a total pack for the entire Fraser River system of 146,957 cases, of which 55 per cent. were packed in the State of Washington waters. The combined sockeye-pack of 146,957 cases was 56,614 greater than that of the brood-year of 1928.

The following table shows the Fraser system sockeye-packs, by months, in Provincial and State of Washington waters for the season 1932:—

Month.	British Columbia.	State of Washington.	Total.
June	.....	130	130
July	7,289	15,632	22,921
August	39,147	63,119	102,266
September	17,394	1,869	19,263
October	1,939	438	2,377
Totals	65,769	81,188	146,957

The above table shows that the larger part of the pack was made in July and August. The September and October pack of 21,640 cases about equalled the pack of July. In this connection the principal catches were made in Provincial waters, while 78,751 cases of the State of Washington pack was made in July and August.

The Skeena River.—The catches of salmon made in the Skeena District produced a pack of 233,711 cases, of which 59,916 cases consisted of sockeye, 58,261 cases of pinks, 48,312 cases of cohoe, and 28,269 cases of springs.

Rivers Inlet.—The catches of salmon in the Rivers Inlet District produced a pack of 81,709 cases, consisting of 69,732 cases of sockeye, 3,483 cases of pinks, 7,062 cases of cohoe, and a few hundred cases of springs and chums. As already stated, 9,062 cases of sockeye packed on the Fraser were of fish caught in Rivers Inlet waters and are included in the total for that district.

Smith Inlet.—This district produced 25,488 cases of sockeye and 1,148 cases of pinks. Eight hundred cases of Smith Inlet sockeye were packed on the Fraser and have been credited to this district.

Nass River.—The catches on the Nass River produced a total pack of 85,671 cases, comprised of 14,154 cases of sockeye, 44,629 cases of pinks, 7,955 cases of cohoe, and 14,515 cases of chums.

Vancouver Island District.—Salmon caught in the Vancouver Island District, with the exception of sockeye taken in the traps at the southern end of the Island and credited to the Fraser, produced a pack of 205,930 cases. They comprised 27,611 cases of sockeye, 10,559 cases of springs, 63,637 cases of cohoe, 33,403 cases of pinks, and 70,629 cases of chums. As already stated, 96,621 cases of this catch were packed in canneries of the Fraser River.

Outlying Districts.—The catch of salmon in the outlying districts produced a total pack of 313,369 cases, of which 21,683 cases consisted of sockeye, 3,236 cases of springs, 41,172 cases of cohoe, 80,034 cases of pinks, and 166,653 cases of chums.

HALIBUT PRODUCTION.

Halibut landings in Provincial ports for the year 1932 totalled 16,884,700 lb., as against 18,200,500 lb. in 1931. The total landings on the North-west Pacific Coast totalled 44,503,925 lb., as against 43,879,322 lb. in 1931, showing an increase of 624,603 lb. over that year.

Of the total catches in 1932, the American fleet is credited with 86 per cent. and the Canadian fleet with 14 per cent. Seattle was again the most attractive halibut port in 1932; landings totalling nearly 22,000,000 lb. were made, an increase of about 7,000,000 lb. over 1931. The landings in Prince Rupert in 1932 totalled 14,861,500 lb., as against 16,775,700 lb. in 1931. Halibut prices to fishermen were at the lowest level for a number of years, the average price paid for the whole season being less than 5 cents per pound.

In 1932 halibut livers became an important product of Pacific halibut-fishing operations. For these the fishermen were paid at the rate of 12 cents per pound and the demand was maintained throughout the year. The extra income from this source was quite a welcome addition.

FISH OIL AND MEAL PRODUCTION.

The total production of fish-oil on the Pacific Coast totalled 10,000,000 gallons. The fish-oil production in the Province in 1932 totalled 1,547,554 gallons, as against 2,904,406 gallons in 1931. Of the 1,547,554 gallons of fish-oil produced in the Province in 1932, 1,315,864 gallons consisted of pilchard-oil. The balance consisted of oil extracted from herring and fish-offal. No whale-oil was produced. Fish-meal production in the Province in 1932 totalled 15,450 tons, as against 19,847 tons in 1931. Of the 15,450 tons produced, 8,842 tons consisted of pilchard-meal.

PILCHARD AND HERRING INVESTIGATION.

In the Appendix of this report will be found a bulletin on "The Pilchard Fishery of British Columbia," by Dr. John Lawson Hart.

The investigation of pilchard, along with that of herring, was undertaken in 1929 under a joint arrangement between the Biological Board of Canada and the Fisheries Department of the Province of British Columbia. The agreement was continued for three years. The work is now being continued under the Biological Board alone.

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

The eighteenth annual contribution to the series of papers on the life-history of the sockeye salmon, issued by this Department, and contained in the Appendix of this report, is again contributed by Drs. W. A. and Lucy S. Clemens. These detailed continuous records give the age-classes, sex, weight, and lengths of the sockeye in each of the runs to the principal salmon-producing waters of the Province for the last nineteen years. They constitute one of the longest detailed continuous records of any fishery and with each year's contribution the record becomes more valuable in providing a more comprehensive picture of the trends. A digest of the present report is given in the following paragraphs.

The Fraser River Sockeye Run of 1932.—The total pack of Fraser River sockeye in the season of 1932 amounted to 146,957 cases, of which 65,769 cases were packed in the Province of British Columbia and 81,188 cases in the State of Washington. The percentages for the two areas are 45 and 55 respectively. The reports from the spawning-beds made by officers of the Dominion Department of Fisheries indicate that the escapement to the upper section of the river was practically negligible, with the exception of that to the Chilco area, where there was a relatively large run estimated at over 70,000 fish. The failure of any substantial spawning run in Eagle River following the planting of 17,000,000 eyed eggs from Cultus Lake sockeye was disappointing as well as surprising. The Biological Board of Canada installed a substantial and efficient counting-fence below Malakwa and obtained only twenty sockeye. On the Lower Fraser the returns to the various areas were apparently smaller than those of 1928, except that to Pitt Lake. The authors point out that there was no expectancy of an increased run in 1932 and that the pack of 146,957 cases was undoubtedly too great for the cycle.

The run of 1933 will be derived from the spawning of 1929. In the latter year the pack amounted to slightly over 173,000 cases, representing approximately 2,000,000 fish. On many streams definite estimates were made of the numbers of spawning fish, and these, together with calculations in areas where hatcheries operate, make possible an estimate of the total escapement to the Fraser River, amounting to 116,000 fish. This is the first time that it has been possible to attempt an estimation of escapement and admittedly it is far from being exact. "Accurate determination of salmon in a stream is impossible by inspection and no reports are available for some of the smaller streams. The figure of 116,000 is undoubtedly too small, and probably one double it, 250,000, would approximately represent the extent of actual escapement.

"The calculation, though obviously a rough one, serves to emphasize four points: First, the value of accurate and extensive enumeration of escapements; second, the small escapement now supporting the Fraser River sockeye-fishery; third, the great disproportion between the catch in 1929, which was over 2,000,000 fish, and the escapement estimated as possibly 250,000 fish; fourth, that had the pack been limited to the amount of the previous two cycle-years—namely, about 143,000 cases—approximately 350,000 more fish would have passed to the spawning-beds and the escapement thereby more than doubled.

"The outlook for 1933 is therefore not bright, especially in view of the small escapement to the Birkenhead River, which has apparently been the mainstay of the Fraser River fishery since the elimination of the large up-river runs. There is every reason to expect a small return in 1933."

The Rivers Inlet Sockeye Run of 1932.—In dealing with the run of 1932 the authors state that it met expectation both in size of pack and general composition. The yield was mediocre, totalling 69,732 cases, and the five-year-old component of the run was fairly small (29 per cent.). Nevertheless, there is a bettering of the brood-years which produced the run. The pack is almost 10,000 cases more than that of the brood-year (1928) from which it was more largely derived, and the number of five-year-old fish is 10 per cent. greater. Flood conditions made inspection of the spawning-beds difficult. In so far as observations were possible, a "spotted" condition was reported.

The discussion of this river system falls in general into three categories: (1) The relation which exists between size of pack and relative abundance of the two dominant age-groups when the data are interpreted on the basis of a five-year cycle; (2) the changes that have occurred in the run; and (3) a review of the characteristics of these sockeyes.

As for the first point, tabulations of the packs and the relative percentages of the 4_2 and 5_2 groups in five-year series show in general that when the four-year-old fish are in the majority the packs are small, consisting of 50,000 to 65,000 cases; when the five-year-old fish slightly outnumber the fours, the packs amount to 85,000 to 95,000 cases; and when the five-year-olds are greatly in excess, then a pack of at least 120,000 cases is produced.

The authors are of the opinion that three major changes have occurred in the run in the nineteen years this run has been analysed—a general reduction in average size of the fish, a steady decrease in the numbers of the five-year-old fish, and a decrease in the number of males. The diminution of size has not been a gradual process, but a sudden occurrence which took place in 1917 and permanently lowered the size standard of the age-groups. Drs. Clemens bear out their assertion that the run is manifesting a steady decline in the relative numbers of five-year-old fish by the following figures: From 1913–17 their average was 63 per cent. of the run; from 1918–22, 52 per cent.; from 1923–27, 43 per cent.; and from 1929–32, 39 per cent. The suggestion is made that since this 5_2 age-group has a considerably greater average size than the 4_2 class, it may be that selective fishing is operating against the older fish. Unfortunate as it is that the more desirable component of the run should be decreasing, at the present time no practical remedy for the situation is apparent to Drs. Clemens.

In regard to the decrease in the number of males, they point out that a survey of the table which records the relative percentages of the sexes in the two dominant age-groups shows a definite decline in the numbers of the males in both year-classes and a corresponding increase in females. The authors suggest that, because of the smaller size of the younger age-groups, the gill-net is selecting only a limited proportion of the 4_2 fish, particularly of the males. Such a supposition would explain not only the percentage distribution of the sexes, but also the equality of the size of the sexes. They say that, should this trend continue or become well established, greater productivity may possibly be looked for in years to come, because the potentiality of future runs is augmented with the increase in the numbers of females.

Six traits are discussed by Drs. Clemens: (1.) Uniformity of type is evident both in the general external appearance of the fish and in the constant growth pattern of the scales. This characteristic is undoubtedly explained by the simplicity and uniformity of the external conditions of Rivers Inlet basin. (2.) These fish are the smallest of the sockeyes of all the major streams. The authors illustrate this point by tabulations of the average measurements over a period of years. (3.) Another character is found in practical identity in average size of the two sexes in the 4_2 age-group. In many years the two sexes have varied from one another by not more than 0.1 of an inch or 0.1 of a pound. Occasionally the measurements have been identical and in a very few instances the females have been even larger than the males. (4.) The average size of the fish tends to decrease as the season advances. Drs. Clemens present as evidence of this a table composed of average lengths of the year-classes plotted on the various dates on which material was gathered. (5.) The 4_2 males always exceed the females in number and the reverse condition obtains in the 5_2 age-group. (6.) There is a tendency for males to be more numerous than females at the onset of a run. This also is made evident in tabulations of data plotted on dates.

The run of 1933 falls in the cycle which is characterized by an excess of four-year-old fish and fair packs. There is very little reason for expecting a return greater than those of the brood-years 1928 and 1929, when the packs were 60,044 and 70,260 cases respectively.

The Skeena River Sockeye Run in 1932.—The sockeye-pack on the Skeena in 1932 totalled 59,916 cases, and the reports from the spawning areas indicated a fairly good escapement. In their report of 1931 Drs. Clemens pointed out that only a relatively small return was to be expected in 1932.

The run of 1933 will be derived from the brood-years of 1928 and 1929. In 1928 the pack was only 34,559 cases and the five-year-old fish constituted 53 per cent. of the run. In 1929 the pack was 78,017 cases and the four-year-old fish formed 67 per cent. of the run. While the escapements to the Babine area were reported as good in these years, those to Lakelse Lake have been recorded as very poor. Drs. Clemens state that the expectancy for 1933, therefore, is for another mediocre run. They further state that the Skeena River is now in a cycle of comparatively low production and that careful provision should be made to provide for large escapements, otherwise there can be no recovery. By means of a diagram they show the packs from 1902 to 1932 and that there has been a definite downward trend during this period. Reference is made to the escapements in these years and to the number of licences issued, and the situation summarized as follows:—

(1.) There has been a decided downward trend in the sockeye-salmon pack on the Skeena River.

(2.) While restrictive fishing regulations have been enforced, there is no clear-cut evidence that the escapements have been materially larger.

(3.) There has been an increase in the number of licences issued and a decrease in the catch per licence.

One point of interest is noted in the run of 1932—namely, the relatively high percentage of six-year-old fish (6_3), amounting to 12 per cent.

The Sockeye Salmon Run to the Nass in 1932.—The main points in Drs. Clemens's discussion of the Nass River run are depletion, lack of relation between size of packs in successive years of the same cycle, Nass River specializations in sockeye habits, and the racial characteristics of the Bowser and Meziadin colonies.

The authors state that, although depletion of run was not evident as early in this river system as it was in the others, nevertheless severe impairment has occurred. By combining the packs from 1907 through 1931 into five-year series the yearly averages have decreased as follows: 45,026 cases, 32,339, 19,673, 23,512, and 15,395. The pack for 1932 totalled 14,154 cases, a figure slightly lower than the average for the last five-year period.

In regard to the lack of relation between expectation and realization in the packs of successive years in the same cycle, the authors say that "the history of the later years abounds in contradictions. Brood-years with good packs have resulted in small packs, and vice versa. Neither have the spawning escapements been a guide in anticipating returns. The reason for these discrepancies is not clear, unless it be that our present knowledge of the Nass is incomplete both in regard to pack statistics and spawning areas. Like the Fraser River, the Nass is fished internationally, but as yet the American pack records are not available to supplement the Canadian ones. Likewise, the Meziadin watershed is the only spawning area concerning which there is adequate information, although there are undoubtedly others of importance in the river system."

Since the Nass is the most northerly of the four river systems, Drs. Clemens are of the opinion that it is to be expected that special modifications in sockeye habits will be different from those in the other streams. The specializations lie chiefly in prolonged fresh-water residence and late maturity. Over a period of twenty-one years an average of 73 per cent. of the fish have spent at least two years in fresh water and likewise an average of 86 per cent. have matured at five years of age or older. The interesting thing about this is that what is the rule in this respect in the Nass is the exception in the other streams.

These habits of a longer period in the lake and of late maturity have resulted in a well-ordered complexity of age-groups which is characteristic of the Nass River. The normal run consists of eight age-classes which appear year after year in nearly the same relative abundance.

Drs. Clemens point out that the size relationships exhibit two traits: First, The Nass fish have maintained their average size during the passage of years. Secondly, there is a very

close correspondence between size and age; that is, the largest fish are the oldest and the smallest fish are the youngest. In the other streams size is linked with the number of years spent in sea-feeding regardless of ultimate age.

The authors call attention to yet another characteristic, that of seasonal succession. That is to say, that year after year the various age-groups have definite times for entering the run, reaching their maximum number, and dwindling.

In summarizing the discussion of the Bowser and Meziadin colonies, Drs. Clemens say: "In brief, then, it appears that there are two races of Nass sockeyes, one associated with Meziadin Lake and the other presumably with Bowser Lake. The late-running fish of the former group are conspicuously large and their early history is characterized by two or three years' residence in the lake. The Bowser Lake group appears in very small numbers in September, the fish are smaller and younger than those of the other colony, and they spend only one or two years in fresh water. These conclusions are made with considerable reservation, since they are based on data too limited to preclude the possibility of error."

Since experience has taught that predictions are unwise in this river system, the authors simply state that the year 1928, from which the run of 1933 will be chiefly derived, is the gloomiest in the whole history of the Nass.

HALIBUT INVESTIGATION.

(Created by the Halibut Treaty between Canada and the United States.)

The International Fisheries Commission, under authority of the new halibut treaty signed May 9th, 1930, formulated regulations for the calendar year 1932. These were approved and became law in January, dividing the halibut banks into areas: No. 1, south of Willapa Harbor; No. 2, from there to Mount Fairweather, Alaska; No. 3, to the Aleutian Islands; and No. 4, Bering Sea. The catch in Area 2 was set at 22,500,000 lb.; in Area 3, at 23,500,000 lb., to be taken prior to November 1st. Halibut-vessels were licensed for the purpose of securing prompt and complete statistical returns. Two "nurseries" off Masset, B.C., and Timbered Islet, Alaska, were closed for the protection of small halibut. And the close season was defined as from November 1st to January 15th.

The provisions for licensing the vessels and obtaining statistical returns were put into force with the aid of Customs officers and have worked without hitch of any kind or inconvenience to vessels, a remarkable record. From these returns, complete for every halibut-vessel on the coast, and from records of previous years, the Commission forecast on September 9th the date of closure for Area 2 as October 22nd, which was thereupon set as the date of closure, and at that time the total was 22,800,000 lb., which must be regarded as close an estimate as is possible under the conditions of a deep-sea fishery. Area 3 closed with the beginning of the general closed season.

As the closed season drew to an end it became apparent that opening of the season January 15th was for economic reasons too early, and at the nearly unanimous request of the fleet and trade, opening was postponed to February 1st.

The investigations of the Commission have gone on as provided for by the treaty. The larger part of the year has been spent in analysis of the catches and preparation of reports, dealing with the statistics of the fishery and those phases of the life-history that are necessary to guide regulations.

The condition of the spawning-grounds off British Columbia and South-eastern Alaska continues to hold the attention of the Commission. A vessel was chartered from March 16th to July 3rd and net-hauls for eggs and larvæ made. The earlier part of the operations, conducted on the west coast of the Queen Charlotte Islands, in Dixon Entrance, and Hecate Strait, corroborate the previous conclusions of the Commission, that very little spawn is being produced in the waters off British Columbia. The later operations, in the Gulf of Alaska and west of Kodiak Island, indicate that the development of the eggs, still produced in considerable numbers in the Gulf of Alaska, is completed there, and confirm the earlier conclusions of the Commission that the chances of any young being carried from the western grounds to those of British Columbia and South-eastern Alaska are fairly remote.

As a result of a reduction of the amount of fishing, the abundance or total weight of halibut on the banks has increased during the last two years. The increase is not due to a greater

production of spawn, but to the longer life and larger size of the fish already there. It will, however, result in the presence of a larger number of mature fish, and is a first step in the rehabilitation of the southern fishery. It is still not possible to say that the stocks on the southern grounds are in sound condition, as biological observations show they are not yet reproducing themselves.

The statistical work of the Commission during the past year has brought to light the existence of very important relations between the intensity of the fishery and the abundance or pounds of fish on the banks. The abundance of fish in each year seems to vary almost inversely to the intensity of the fishery in the two years preceding, if allowance is made for changes due to the amount of spawn produced in the years from which the stock are derived. The seeming exactness of the relation makes probable in the near future the prediction of the results to be obtained by any limitation of the total catch, and in consequence ensures the ultimate success of the Commission in conserving the fishery.

APPENDICES.

CONTRIBUTIONS TO THE LIFE-HISTORY OF THE SOCKEYE SALMON.
(No. 18.)

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

INTRODUCTION.

While not large, the runs of sockeye salmon to the four main river systems of the Province were all that could be expected, considering the brood-years from which they were derived. The escapements to the Nass and Skeena Rivers were reported as good and the packs were apparently not excessive. On the other hand, the escapements to Rivers Inlet were stated as being "spotty" and to the Fraser River as generally disappointing. There can be no doubt but that the catches in these two areas were too large.

Conditions with respect to the Nass and Fraser Rivers continue to be most unsatisfactory and rehabilitation of the runs to these rivers must await international co-operation.

In this report the discussions of the various river systems are not uniform. In the cases of Rivers Inlet and the Nass River the characteristics of the fish composing the runs are described in considerable detail, while for the Fraser and Skeena Rivers attention is given largely to the conditions of the fishery.

DESIGNATION OF AGE-GROUPS.

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

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

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

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

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

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

1. THE FRASER RIVER SOCKEYE RUN OF 1932.

(1.) General Characteristics.

The total pack of Fraser River sockeye in the season of 1932 amounted to 146,957 cases, of which 65,769 cases were packed in the Province of British Columbia and 81,188 cases in the State of Washington (Table I.). The percentages for the two areas are 45 and 55 respectively.

Because of financial conditions, the usual annual inspection of the spawning areas by Mr. J. P. Babcock was omitted after an unbroken record of twenty-nine years. Much as this is regretted, for many reasons, including the value of a continuous record by an observer with the experience possessed by Mr. Babcock, it is fortunate that reports have been made available through the courtesy of the Dominion Department of Fisheries. The reports indicate that the escapement to the upper section of the river was practically negligible, with the exception of that to the Chilco area, where there was a relatively large run estimated at over 70,000 fish. One of the outstanding and, at the same time, disappointing features was the failure of a substantial return to Eagle River following the planting in 1928 of 17,000,000 Cultus Lake eyed

sockeye-eggs, which would be the equivalent of the natural spawning of between 8,000 and 10,000 fish. The Biological Board of Canada installed a counting-fence below Malakwa to intercept any possible return and obtained twenty sockeye, of which one was a three-year-old and therefore a return from an experiment of 1929. In conjunction with this planting experiment, the Biological Board of Canada released, in the summer of 1929, in Eagle River at Taft, 123,550 marked fingerlings resulting from eggs taken at Cultus Lake and reared in ponds at Taft. None of the fish taken at Malakwa were marked fish, but twelve marked individuals were taken by commercial fishermen in the Lower Fraser River and one appeared at the counting-fence at Cultus Lake. Experiments have been continued at Eagle River by the Biological Board and the results will be awaited with interest.

On the Lower Fraser the returns to the various areas were apparently below those of 1928, with the exception of that to Pitt Lake.

In the report for 1931 it was pointed out that there was no indication of an increased run in 1932. While the pack put up was the largest since 1912, there is nothing in the record to indicate that such a take was justified, and the reports from the spawning-beds form substantial evidence of failure to provide for reasonable escapement. The situation is quite comparable with that of the year previous. Had a pack of 100,000 cases been taken, half a million more fish would have reached the spawning-beds and over 1,000,000,000 additional eggs would have been placed on the spawning-beds.

While the situation with respect to the lack of control of the fishery is quite well understood, the facts are repeated to emphasize again that, at the present time, no panacea is apparent for the cure of depleted runs. Increased escapements appear to be the logical remedy. Where depletion is not in evidence there must be constant vigilance. Fluctuations will always occur in the production of fish as in the production of wheat. Some years are particularly favourable for incubation and early growth, while others are extremely adverse. There is a definite need for research in this field, and undoubtedly the time will come when a system of continuous record of conditions will be set up analogous to the system of meteorological records. More reliable predictions may then be possible, but in the meantime a very conservative policy is imperative.

The year 1933 brings around once more the cycle of the once "big year" which was so tragically destroyed in 1913. The pack reached its lowest point in 1921, with 142,000 cases. There was a slightly larger pack in 1925 of 147,000 cases, followed in 1929 by a much increased catch of 173,000 cases. The reports from the spawning-beds in 1929 show that there was a much increased escapement to Stuart Lake, but that the Indians took approximately 9,000 fish, leaving the beds "but little, if any, better seeded than in recent years." The return to the Chilco area was estimated as in the neighbourhood of 70,000 fish. The escapements to the other upper areas are reported as approximately as follows: Quesnel, 1,000; Bowron, 1,000; Seton, 700; Shuswap, 10,000. A number entered the North Thompson River but were nearly all taken by the Indians. On the lower portion of the river the number of fish reaching the Birkenhead River was relatively very small and only 18,000,000 eggs were collected. This would represent about 9,000 fish. Since the hatchery take is stated as constituting 95 per cent. of the run, the total escapement could scarcely have been in excess of 12,000 fish. At Pitt Lake 5,315,000 eggs were taken, representing 2,650 fish. The number of fish spawning naturally is unknown, but may be considered as equal to the number handled in the hatchery operations. At Cultus Lake the number by actual count was 5,082. No estimate is available for Harrison Lake, but a figure of 2,000 fish may be taken as a liberal one. The total for the system is thus 116,000 fish.

This is the first time that an estimate of the total escapement has been attempted, and admittedly it is a very rough one. Accurate determination of salmon in a stream is impossible by inspection and no reports are available for some of the smaller streams. The figure of 116,000 is undoubtedly too small, and probably one double it, 250,000, would approximately represent the extent of the actual escapement.

The calculation, though obviously a rough one, serves to emphasize four points: First, the value of accurate and extensive enumeration of escapements; second, the small escapement now supporting the Fraser River sockeye-fishery; third, the great disproportion between the catch in 1929, which was over 2,000,000 fish, and the escapement estimated above as possibly 250,000 fish; fourth, that had the pack been limited to the amount of the previous two cycle-years—namely, about 143,000 cases—approximately 350,000 more fish would have passed to the spawning-beds and the escapement more than doubled.

The outlook for 1933 is therefore not bright, especially in view of the small escapement to the Birkenhead River, which has apparently been the mainstay of the Fraser River fishery since the elimination of the large up-river runs. There is every reason to expect a small return in 1933.

(2.) Age-groups.

The material for this year's study consists of data and scales from 1,313 fish selected at random from May 2nd to September 20th in thirty-six samplings. The 4_2 age-group is, as usual, the predominant one, being represented by 1,059 individuals, or 80.7 per cent. of the total sample. The 5_2 age-group contains 177 individuals, or 13.5 per cent. The remaining groups are represented as follows: 5_3, 37 fish, or 2.8 per cent.; 3_1, 11 fish, or 0.8 per cent.; 4_1, 10 fish, or 0.8 per cent.; 3_2 (grilse), 19 fish, or 1.4 per cent. Again this year, as in last, the 6_3 age-group is not represented (Tables II., III., and IV.).

It is interesting to record that the majority of the 5_3 fish are of Cultus Lake origin, in that they consist of fish which had been marked at Cultus Lake as seaward migrants by the removal of certain fins. The scales of these fish show that the first year of fresh-water life as represented by from three to six circuli and the second by twelve to twenty.

(3.) Lengths and Weights.

The average lengths of the males and females of the 4_2 age-group are 23.6 and 22.8 inches respectively, which are approximately equal to those of their progenitors and of the averages of the past twelve years. The average lengths of the two sexes of the 5_2 age-group are 25.3 and 24.2 inches respectively, which are somewhat below those of the year 1927 and slightly below the average of the past twelve years. In the 5_3 age-group the average lengths are 24.6 and 23.2 inches respectively, that of the males being considerably above the average (Table V.).

The average weights are as follows: 4_2, 6.1 and 5.4 lb.; 5_2, 7.3 and 6.7 lb.; 5_3, 6.6 and 5.4 lb. All these weights are practically identical with the average of the past nine years, with the exception of that of the males of the 5_3 group, which is somewhat higher (Table VI.).

(4.) Distribution of the Sexes.

The total number of males in the samplings is 601 and of females 712, percentages of 46 and 54 respectively. As usual, the females slightly exceed the males in number in the 4_2 age-group with a percentage of 56. On the other hand, the males outnumber the females in the 5_2 age-group with a percentage of 58.

Table I.—Fraser River Packs, 1895–1932, arranged in accordance with the Four-year Cycle.

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

Table II.—Fraser River Sockeyes, 1932, Vancouver Island Traps, grouped by Age, Sex, and Length, and by their Early History.

Length in Inches.	Number of Individuals.												Total.
	4_2		5_2		5_3		3_1		4_1		3_2		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	2
16½	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2
17	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	2
17½	2	1	.....	.....	.....	.....	.....	.....	.....	.....	1	1	5
18	6	3	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	12
18½	9	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24
19	21	21	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	44
19½	19	19	1	1	.....	.....	.....	.....	.....	.....	3	.....	43
20	10	18	2	.....	.....	1	.....	.....	1	.....	1	.....	33
20½	8	16	.....	.....	.....	.....	1	2	.....	1	.....	.....	28
21	9	10	4	5	.....	.....	1	1	.....	.....	1	.....	31
21½	6	17	4	6	.....	2	1	.....	.....	1	.....	2	39
22	9	27	5	3	.....	2	1	.....	.....	.....	1	.....	48
22½	11	44	3	2	1	3	.....	1	.....	.....	.....	.....	65
23	25	109	1	1	.....	5	1	1	.....	.....	.....	.....	143
23½	34	111	5	5	1	5	1	.....	.....	3	.....	.....	165
24	67	88	4	9	1	2	.....	.....	.....	.....	.....	.....	171
24½	77	60	4	8	2	3	.....	.....	.....	2	.....	.....	156
25	61	23	3	12	3	2	.....	.....	.....	.....	.....	.....	104
25½	47	7	9	10	2	1	.....	.....	.....	.....	.....	.....	76
26	24	3	16	8	1	.....	.....	.....	1	1	.....	.....	54
26½	15	.....	12	4	.....	.....	.....	.....	.....	.....	.....	.....	31
27	2	.....	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
27½	2	.....	9	1	.....	.....	.....	.....	.....	.....	.....	.....	12
28	1	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
28½	.....	.....	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
29	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Totals	465	594	102	75	11	26	6	5	2	8	15	4	1,313
Average lengths	23.6	22.8	25.3	24.2	24.6	23.2	21.9	21.5	23.0	23.4	18.7	17.0	.....

Table III.—Fraser River Sockeyes, 1932, Vancouver Island Traps, grouped by Age, Sex, and Weight, and by their Early History.

Weight in Pounds.	Number of Individuals.												Total.
	4_2		5_2		5_3		3_1		4_1		3_2		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
2	2	1	.....	.....	.....	.....	.....	.....	.....	.....	2	1	6
2½	9	15	.....	.....	.....	.....	.....	.....	.....	.....	5	1	30
3	38	47	1	1	.....	.....	.....	.....	1	.....	4	.....	92
3½	23	32	3	1	.....	2	.....	.....	.....	1	2	.....	64
4	17	20	7	4	1	2	1	3	.....	1	.....	.....	56
4½	14	34	6	8	.....	4	1	.....	.....	.....	2	2	71
5	19	67	8	5	1	3	2	2	.....	1	.....	.....	108
5½	40	119	5	2	.....	8	2	.....	.....	2	.....	.....	178
6	62	113	8	7	1	1	.....	.....	.....	.....	.....	.....	192
6½	62	65	10	7	2	3	.....	.....	.....	.....	.....	.....	149
7	47	46	8	7	1	.....	.....	.....	.....	.....	.....	.....	109
7½	49	15	3	10	4	2	.....	.....	.....	2	.....	.....	85
8	39	12	4	11	1	1	.....	.....	.....	.....	.....	.....	68
8½	25	7	6	1	.....	.....	.....	.....	1	1	.....	.....	41
9	11	1	7	7	.....	.....	.....	.....	.....	.....	.....	.....	26
9½	5	.....	6	4	.....	.....	.....	.....	.....	.....	.....	.....	15
10	2	.....	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
10½	.....	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
11	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
11½	1	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
12	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Totals	465	594	102	75	11	26	6	5	2	8	15	4	1,313
Average weights	6.1	5.4	7.3	6.7	6.6	5.4	4.9	4.4	5.7	5.9	3.0	3.4	.....

Table IV.—Fraser River Sockeyes, Percentages of the Year-classes from 1920 to 1932.

Year.	4_2	5_2	5_3	6_3	3_1	4_1	3_2	4_3
1920	69.6	21.2	6.2	0.2	1.9	0.9	.....	.....
1921	78.1	14.6	4.1	0.7	0.5	2.0	.....	.....
1922	70.5	9.3	4.5	2.0	6.3	5.6	0.9	0.9
1923	67.1	10.8	3.9	1.2	6.7	9.9	0.4	0.0
1924	68.2	18.7	9.2	0.5	0.5	2.0	0.8	0.1
1925	67.9	24.9	3.4	0.2	2.2	0.0	0.6	0.8
1926	66.1	20.3	5.2	1.6	2.0	2.5	2.1	0.2
1927	84.6	7.5	3.0	0.8	1.9	2.2	.....	.....
1928	71.4	18.8	5.3	0.5	2.0	0.7	1.0	0.3
1929	77.3	11.9	7.8	0.4	0.1	0.1	2.5	0.1
1930	75.7	19.6	2.8	0.5	0.2	0.7	0.5	.....
1931	79.0	13.1	1.3	.....	2.0	2.0	2.6	.....
1932	80.7	13.5	2.8	.....	0.8	0.8	1.4	.....

Table V.—Fraser River Sockeyes, Average Lengths of Principal Classes from 1920 to 1932.

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

Table VI.—Fraser River Sockeyes, Average Weights of Principal Classes from 1922 to 1932.

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

2. THE RIVERS INLET SOCKEYE RUN OF 1932.

(1.) General Characteristics.

In comparison with the Fraser River sockeyes, those of Rivers Inlet are characterized by uniformity of type. Here there is no succession of recognizable forms such as appear in the Fraser. The explanation undoubtedly lies in the fact that Rivers Inlet basin is the acme of simplicity, while the Fraser River system is one of great complexity. The former consists of a single lake (Owikeno) with numerous short tributary mountain streams and with a large, short outlet. The salmon spawn in the gravel beaches of the lake and along the lower courses of the tributary streams. In the early years of this study Dr. Gilbert linked the simplicity and uniformity of external conditions with the constancy of race. At the same time, he wondered if there might not be minute differences, not readily seen, which characterized sub-races for the various tributaries. After considerable investigation he concluded that there was no evidence of the existence of distinguishing characteristics of the salmon populations seeking the different streams tributary to Owikeno Lake.

It was not only the external appearance of these Rivers Inlet fish, but the character of the scales as well, which made Dr. Gilbert consider them a unified race. The most outstanding peculiarity of the scale is the very small growth area of the second year. Although the number of growth-rings is approximately equal to that found in other streams, the rings are much more

closely crowded. A second scale characteristic is the small central area. Limited growth at once suggests unfavourable feeding conditions. That Lake Owikeno is poor in food material is not impossible, for it is a cold, glacial, silt-laden body of water, and, such being the case, the dwarfing during the first season can readily be accounted for. But what about the phenomenally slow growth during the second year? Undoubtedly it, too, is associated with environmental conditions. There would appear to be two possibilities: (1) That the first year of sea-life is spent in regions of the coast where conditions are relatively poor because of scarcity or quality of food, or because of unfavourable temperature, salinity, or other physico-chemical factors; (2) that the stunting of the fresh-water period has a retarding effect upon the growth-rate of the first year in the sea. It would seem that this characteristic must be considered as impressed upon the individual year after year by the environment. In this connection it is interesting to note that occasionally, in the other river systems, individuals with small second-year growths are met with. Thus a peculiarity which appears as an exceptional variation elsewhere has become the common form of growth in the Rivers Inlet race.

Here it should also be mentioned that while the vast majority of scales studied, both from four- and five-year-old fish, conform to the pattern described above, each year a few scales with different growth-histories are found. One of these is a pattern common to all the river systems, that of the double nucleus, indicative of two full years of fresh-water life, but here again the scale is typically Rivers Inlet marked by stunted growth. The other type met with very infrequently in this river is the form common in the Skeena, Fraser, and Nass Rivers, that of a large nuclear area and extensive growth during the first year of ocean-life.

Just as the scales show retarded growth during the first two years, so also do the young fish. Dr. Gilbert found that the seaward migrants averaged 1.7 inches in length and the two-year-olds 7.6 inches, against 3.15 and 12.25 inches for Fraser River fish of the same ages. At the end of the second year the rate of development suddenly undergoes a change and the growth during the third year is so rapid that it largely compensates for the earlier retardation. Thus the average lengths of the three- and four-year-old fish of Rivers Inlet are 19 and 23.5 inches respectively in comparison with 20.7 and 24.25 inches for the Fraser River fish.

The Rivers Inlet run consists principally of four- and five-year-old fish which spend one year in the lake, and are designated as 4_2's and 5_2's. To these is added a small component of fish which have two years' residence in fresh water and mature at the ages of five and six, the 5_3's and 6_3's. Although there has been no orderly sequence in the relative proportions of the four- and five-year-old fish in successive years, the five-year cycle has been pre-eminent, as Dr. Gilbert suggested. On this basis the data can best be interpreted. In the following table (A) the packs are arranged horizontally across the page in series at five-year intervals:—

Table A.

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

Series 2, 3, and 4 show the greatest uniformity. In series 2, except for the year 1923, the packs have ranged between 50,000 and 65,000 cases. Again, series 3, with two exceptions, has produced packs in the neighbourhood of 90,000 cases.

The yield of the year 1923 is considerably above expectancy and that of 1919 is somewhat smaller than was anticipated. Inspector Stone's report of the spawning-bed conditions in 1919 throws considerable light upon these two exceptions. He tells us, and the data for the year corroborate his statement, that the fish were not of average standard size, and as a result an unusually large number of them must have passed through the nets because the spawning-beds were abundantly seeded. Thus, although the pack was small, the escapement was highly satisfactory, as was verified by the yield of 1924. Similarly, the unexpectedly large pack in 1923 is accounted for by the fact that 76 per cent. of the run was the progeny of this same enormous escapement.

The failure of the pack to reach normal expectancy in 1929 is more difficult to explain. Inspector Stone believed that the pack was not a true index of the run, because cold, wet weather interfered with the fishing in the early part of the season, but, at the same time, he did

not find all regions of the spawning-beds amply seeded. But the return in 1934 must be awaited for the final evidence of the degree of success which the run of 1929 attained.

Series 4 has maintained from the beginning a high average of approximately 120,000 cases. Series 1 and 5 show considerably less uniformity than do the other series. However, the last four packs in the first series are similar to the average range of pack in the second series, and it may be that, as the years pass, this series will also develop an orderly sequence.

By substituting the percentages of four- and five-year-old fish for the packs a second interesting relation is brought out.

Table B.

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

As in Table A, the series which show the greatest constancy are the second, third, and fourth. Series 2 is characterized by a preponderance of four-year-old fish, series 3 by a slightly larger proportion of fives than fours, and series 4 by a much larger percentage of five-year-olds.

These tabulations were arranged in 1928 and two of the years, 1929 and 1930, since added, have broken the uniformity of their respective series. Thus, at the end of the third series, a reversal of the relative proportions of the four- and five-year-old fish is found. This failure of the five-year-olds may be at least partly explained by the fact that in 1924 enormous freshets occurred at the close of the spawning season. At that time Inspector Stone expressed the fear that untold damage would be done to the eggs. Again, in 1930, the number of five-year-old fish was far below expectancy. Yet the spawning-bed conditions in 1925 were highly satisfactory. In the 1930 report it was pointed out that this Rivers Inlet run was manifesting a steady decrease in the numbers of five-year-old fish. A glance across each series in Table B, or at the following figures, gives abundant evidence of this fact. Grouping the relative percentages of the 5_2's in five-year periods, they are: 1913–1917, 63 per cent.; 1918–1922, 52 per cent.; 1923–1927, 43 per cent.; and 1928–1932, 39 per cent. It has been frequently pointed out that large packs on Rivers Inlet coincide with large numbers of five-year-old fish. That the component which is most desirable is steadily declining is a deplorable fact.

A feature which is discussed more fully in a later paragraph is the size of these four- and five-year-old fish. At this point it is sufficient to state that the 4_2's are appreciably smaller than those in the other river systems, so that the fishing in Rivers Inlet may be operating in a selective way against the 5_2's. If the four-year-olds are of smaller size, a relatively greater proportion of them are escaping the nets and reaching the spawning-beds. At the same time the five-year-old fish are undergoing relatively more intensive fishing and fewer of them are becoming the progenitors of the runs. Thus it would appear that the 5_2 fish, which are the chief asset of this river system, both because of their superior size and the superabundance of the females in the group, are likely suffering depletion through selective fishing. If such be the case, unfortunate as it is, at the present time no practical remedy for the situation is apparent.

Returning now to Tables A and B and considering them together, an interesting relation between the size of pack and the relative proportions of the four- and five-year-old fish is seen. In general it can be said: First, when the four-year-olds exceed the fives, the packs are small, in round numbers 50,000 to 65,000 cases (series 2); secondly, when the five-year-olds are slightly more numerous than the fours, the packs range from 85,000 to 95,000 cases (series 3); lastly, when the fives are decidedly more abundant, the commercial yields are at least 120,000 cases (series 4).

The year 1932 belongs to series 1, in which there is little relation lest it be the general relationship between size of pack and proportion of five-year-old fish. Expectations in regard to the pack of this year were realized both as to size and composition of run. The pack was fair, totalling 69,732 cases, and the percentage of 5_2's (29) was not large. However, there is some

improvement over the brood-years which produced the run. The pack is nearly 10,000 cases greater than that of the brood-year (1928) from which it was more largely derived and the number of five-year-old fish is 10 per cent. greater. While the inspection of the spawning-beds was not made as usual by Mr. Stone, the Provincial Overseer, Major Motherwell has made available such information as was gathered by his department. The observations were more limited and made under difficulty because of excessive rains and high water. The report states some areas to be well seeded and others not. While on the one hand it may be hoped that the seeding was more extensive than observed, on the other hand it must be kept in mind that there is a possibility of destruction of eggs because of flood conditions.

The year 1933 falls in series 2, which, as has been stated above, is characterized by (1) an excess of four-year-old fish, and (2) fair packs. The ancestors of the run are the fish of the years 1928 and 1929, and there is very little ground for anticipating a run and pack of greater magnitude than those of the mediocre brood-years. The only aspect of the situation upon which one might base hope for a more favourable return is Overseer Stone's opinion that the larger fish predominated on the spawning-beds in 1928. These larger fish, which are the 5_2's, formed 42 per cent. of the run and 70 per cent. of them were females. If this group spawned more successfully than the 4_2's, there is a possibility that they will outnumber the smaller fish in 1933. If such should be the case, the run should be greater than that of 1928, which produced a pack of 60,044 cases.

(2.) Age-groups.

One thousand four hundred and fifty-three fish gathered in ten samples between June 27th and August 8th form the basis for the analysis of the run of 1932. As has been stated in the preceding paragraphs, the run is characterized by the dominance of the two groups which spend one year in the lake and return as mature spawners either in their fourth or fifth year; that is, the 4_2's and the 5_2's. To all practical purposes the run consists of these two age-groups and the only variation that occurs from year to year is in the relative abundance of these two classes (Table VII.). The age-groups which linger two years in the fresh water and mature at five and six years of age are always present in insignificant numbers. In 1932 the 5_3's and 6_3's together comprised only 5½ per cent. of the run. During the early years of this study, Dr. Gilbert found an occasional sea-type, but none of them have been noted by the present writers.

(3.) Lengths and Weights.

Among the various characteristics of the runs to the important sockeye-rivers, that of size is undoubtedly the most obvious and readily noticed. The results of this investigation show year by year that the Rivers Inlet sockeyes are the smallest of the sockeye of the four streams under consideration. This can be most simply illustrated by comparing the averages of the size measurements over the period of years (Tables C and D).

Table C.

	Four-year Males.	Four-year Females.	Five-year Males.	Five-year Females.
	Inches.	Inches.	Inches.	Inches.
Fraser—Average, 1920–31	23.8	23.0	25.6	24.5
Rivers Inlet—Average, 1912–31	22.6	22.5	25.3	24.7
Skeena—Average, 1912–31	23.6	23.2	25.7	24.8
Nass—Average, 1912–31	24.4	23.6	26.0	25.0

Table D.

	Four-year Males.	Four-year Females.	Five-year Males.	Five-year Females.
	Lb.	Lb.	Lb.	Lb.
Fraser—Average, 1920–31	6.1	5.5	7.3	6.5
Rivers Inlet—Average, 1912–31	5.1	5.0	7.0	6.5
Skeena—Average, 1912–31	5.5	5.1	6.7	6.1
Nass—Average, 1912–31	5.9	5.3	7.0	6.3

The average lengths for both sexes of the 4_2 age-group of Rivers Inlet are conspicuously less than the corresponding measurements for the fish from the other rivers. This length difference is especially emphasized in the males; they are shorter by 1.2 inches than those of the Fraser and Skeena and by 1.8 inches than those of the Nass. The peculiarity is less marked in the females, but here also there is an appreciable diminution, the range being from 0.5 to 1.1 inches less.

The five-year-old fish do not manifest this feature to the same extent. While the males are the smallest of all four rivers, the females are smaller than those of the Skeena and Nass, but 0.3 inch larger than those of the Fraser.

The comparative weight measurements show slighter differences. The 4_2 males are only a pound less in weight and the females half a pound than the heaviest of the other fish. As for the 5_2's, in spite of their smaller size their weight equals or exceeds that of the Skeena and Nass five-year-olds. Consequently the Rivers Inlet sockeyes are not only a shorter race, but also comparatively stouter-bodied.

Tables C and D, as well as Tables X. and XI., exhibit a size peculiarity to which attention has been frequently directed—namely, that there is less difference between the lengths and weights of the four-year-old Rivers Inlet males and females than there is in other streams. In twelve of the twenty years for which the average lengths are available, this difference between the sexes has not exceeded 0.1 inch, and in eight out of seventeen years the average weights have not varied by more than 0.1 lb. In three instances for length and two for weight, the measurements of the males and females have been identical. This close correspondence in size has brought about a secondary size trait not uncommon in this particular group of four-year-old fish —namely, that the females sometimes surpass the males in length or weight. As was stated above, these Rivers Inlet males are very noticeably small for 4_2 fish; hence this equality in size between the sexes is due not to relatively larger females, but to decidedly smaller males.

The complete size variations for the year 1932 are listed in Tables VIII. and IX. In 1931 the averages for both lengths and weights touched a new low level. This year (1932) the lengths have recovered and are practically equivalent to the general averages. Except for the 5_2 females, the weights do not show a corresponding improvement; they are the second lowest on record.

On previous occasions it has been pointed out in these reports that the present size standard of the Rivers Inlet sockeyes is lower than that of the earlier years of this investigation. The decrease was not a gradual development, but a sudden change which occurred in the year 1917 and has remained with little change since that date. This is illustrated in the following tabulations (E and F), which combine the length and weight data of Tables X. and XI. in four five-year periods.

Table E.

	Four-year Males.	Four-year Females.	Five-year Males.	Five-year Females.
	Inches.	Inches.	Inches.	Inches.
1912–16	23.0	22.8	25.9	25.0
1917–21	22.5	22.4	25.1	24.5
1922–26	22.4	22.4	24.9	24.5
1927–31	22.3	22.4	25.4	24.9

Table F.

	Four-year Males.	Four-year Females.	Five-year Males.	Five-year Females.
	Lb.	Lb.	Lb.	Lb.
1914–16	5.4	5.1	7.4	6.6
1917–21	5.0	4.9	6.7	6.3
1922–26	5.1	5.0	6.9	6.3
1927–31	4.9	5.0	7.1	6.9

The only major differences in these measurements are between those of the first two periods. Lengths suffered greater reduction than weights and males decreased to a greater degree than females. The only indication of improvement toward the older standard is in the 5_2 age-group during the last five-year period, 1927–31.

(4.) Distribution of Sexes.

In this river system the 4_2 males always outnumber the females and the reverse condition is true of the older group. This unequal distribution of sexes in the two dominant age-groups was one of the earliest characteristics to be observed. Dr. Gilbert was intensely interested in this sex ratio which was different from the usual equal proportion of males and females, and in order to get at the root of the matter he examined for several seasons the sex of the yearlings during their downward migration. He became convinced that each brood-year started out with approximately equivalent numbers of the two sexes; that their disparity at maturity was a characteristic which appeared during their later development. In seeking an explanation for it, he early suggested precocious maturity, and in 1917 accepted it unreservedly when he said, "the preponderance of males over females in four-year fish and the reverse condition in five-year fish are both due to the tendency of males somewhat to anticipate the females in age of maturing . . . in Rivers Inlet, the prevailing age for maturing is five, the precocious tendency of the males does not seem to extend far enough to bring any considerable number to maturity at three, but causes a much larger proportion of them to mature at four than in the case of the female."

This relationship of unequal sex-distribution has never failed to exist, although the relative excess, or deficiency, as the case may be, of the sexes within an age-group has shown some fluctuation. Within the last eight or ten years, however, there has been a decided change in the relative abundance of the sexes in each of the two year-classes. In the earlier years there were three males to every female in the four-year-old class and an average of something less than one male to each female in the older class. In the present run there is a nearly complete reversal of these proportions, with a ratio of three to one in favour of the females in the five-year-old group and a ratio of slightly more than one to one in the four-year-olds. These shifting proportions, then, have been brought about by a scarcity of males, or an abundance of females, in both year-classes (Table XII.).

As far as the 5_2 year-class is concerned, it might be possible to say that the tendency of the males to mature early has become more common and greater numbers of them mature at the age of four. But, if this is the case, why is there not a corresponding increase in the relative numbers of the 4_2 males? Instead of there being more of them there are fewer. Can it be that this trait of early maturity has developed among the males of the 4_2 year-group as well? If so, it is resulting in the production of three-year-old grilse which are too small to be netted and are therefore not included in our cross-section of the Rivers Inlet run. It is not unlikely that, because of the smaller size of the younger age-groups, the gill-net is selecting only a limited proportion of the 4_2 fish, particularly of the males. Such a supposition would explain not only the percentage distribution of the sexes, but also the equality of size of the sexes.

In this run of 1932 the sex ratios in both groups represent new records; the males touch new low levels, 54 per cent. for the 4_2's and 28 per cent. for the 5_2's. Furthermore, for the third consecutive year the total number of females has exceeded that of the males. Previous to 1931 such a relationship obtained only in the cycle of the large run, 1915–20–25–30, whose success is apparently directly dependent upon the predominance of five-year-old fish. Theoretically, runs in which the females outnumber the males are decidedly advantageous because they hold the possibilities of increased future runs. The returns of the next years will be awaited with much interest, for, should this present sex ratio become well established, future runs should be attended by greater productivity.

(5.) Seasonal Changes in the Run.

For a number of years after this investigation was initiated, Dr. Gilbert tabulated the Rivers Inlet data on series of dates in order to ascertain what seasonal changes occurred during the runs. His investigation followed three lines: First, which of the two dominant age-groups appeared in larger numbers at the beginning of the runs; second, which sex was more abundant at the onset of the runs; and, third, what relation, if any, existed between the fluctuating average size of the fish and progression of season.

The first point was settled negatively, for there proved to be no orderly sequence in the relative proportions of 4_2's and 5_2's at any given time during the season. In regard to the second point, although the evidence was not without exception, it showed that as a rule the males were more numerous than the females at the beginning of the run, but they became less abundant as the season advanced and were outnumbered by the females toward the end of the run. As for the last point, a comparison of the average sizes of the same year-class on different dates during the run showed that there was no increase in size, but, on the contrary, a slight decrease. Dr. Gilbert considered this habit as well marked in the Rivers Inlet fish as the reverse habit was with the fish of the Fraser River basin.

This year, which is just ten years later than Dr. Gilbert's last tabulations on a series of dates, similar tables have been made and are here presented in comparison with those of 1922. The comparison seems a valid one, because the composition of the two runs differs by only 10 per cent. both in the relative numbers of the two age-groups present and also in the relative percentages of the sexes in each age-class.

In order to place the entire data for the year 1932 on record, dates prior to July are included in the tables, but these are disregarded in the comparison between the two years 1922 and 1932. Table XIII., which gives the relative percentage of the sexes on dates, shows that in 1932 only one age-group, the 5_2's, had an excess of males at the commencement of the run. In comparing the figures of 1932 with those of 1922, a steadier decrease as the run progresses is noted. The 4_2 age-group does not exhibit the same characteristic; the females are more abundant throughout the season. In connection with another problem, the data for 1929 were plotted on dates and the results are exactly opposite to these of 1932, in that the 4_2's show the expected excess of males early in July, but the females predominate throughout the run in the 5_2 group. Thus the data of these more recent years do not completely uphold the theory that the males predominate during earlier weeks of the runs.

Tables XIV. and XV. give the size variations during the course of the run. In this characteristic the findings of 1932 (and also 1929) are in closer accord with those of 1922. While the average size in August may be greater than that early in July, there is no instance for either length or weight in which the final measurement is the greatest during the season.

(6.) Summary of Characters.

This discussion of the Rivers Inlet sockeyes is brought to a conclusion by an enumeration of the traits which characterize these fish. They are: (1) Uniformity of type characterized by slow growth in the lake and the first year in salt water as evidenced by the structure of the scales; (2) size generally smaller than that of the sockeyes of the other major streams; (3) practical equality in size of the two sexes in the 4_2 age-group; (4) a tendency toward slight reduction in the average size of the fish at the end of the season; (5) unequal sex-distribution with more males in the 4_2 age-group and an excess of females in the 5_2 age-class; and (6) a tendency for males to be more numerous than females in the early part of the run.

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

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

Table VIII.—Rivers Inlet Sockeyes, Run of 1932, 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.	
19	1	....	....	....	....	....	....	....	1
19½	4	....	....	....	....	....	....	....	4
20	13	3	....	....	....	....	....	....	16
20½	25	6	....	....	1	....	....	....	32
21	73	54	....	....	3	2	....	....	132
21½	67	52	3	....	2	4	....	....	128
22	79	96	....	6	5	3	....	....	189
22½	70	99	3	14	3	4	....	1	194
23	59	66	3	15	3	3	....	1	150
23½	57	43	11	38	5	6	....	....	160
24	39	24	11	41	8	2	1	....	126
24½	18	8	16	51	3	3	....	2	101
25	13	2	15	40	1	1	....	1	73
25½	7	....	9	36	3	1	....	....	56
26	2	....	6	23	....	1	....	1	33
26½	1	....	14	12	....	....	....	2	29
27	....	....	5	2	....	....	2	2	11
27½	....	....	5	3	....	....	....	....	8
28	....	....	3	3	....	....	....	....	6
28½	....	....	4	....	....	....	....	....	4
Totals	528	453	108	284	37	30	3	10	1,453
Ave. lengths	22.4	22.4	25.2	24.6	23.2	23.1	26.0	25.2	.....

Table IX.—Rivers Inlet Sockeyes, Run of 1932, 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	1	....	....	....	....	....	....	....	1
3	2	....	....	....	....	....	....	....	2
3½	55	27	1	....	1	1	....	....	85
4	136	122	4	5	9	7	....	1	284
4½	119	120	2	14	6	6	....	....	267
5	78	84	14	49	3	4	1	1	234
5½	60	60	13	47	7	4	....	....	191
6	31	31	14	46	4	4	....	1	131
6½	28	7	18	46	6	4	....	1	110
7	13	2	10	37	1	....	1	2	66
7½	4	....	13	19	....	....	....	1	37
8	....	....	8	11	....	....	....	3	22
8½	1	....	4	6	....	....	1	....	12
9	....	....	2	2	....	....	....	....	4
9½	....	....	2	2	....	....	....	....	4
10	....	....	1	....	....	....	....	....	1
10½	....	....	1	....	....	....	....	....	1
11	....	....	....	....	....	....	....	....	.....
11½	....	....	1	....	....	....	....	....	1
Totals	528	453	108	284	37	30	3	10	1,453
Ave. weights	4.7	4.7	6.5	6.5	5.2	5.0	6.8	6.7	.....

Table X.—Average Length in Inches of Rivers Inlet Sockeyes for Twenty-one Years.

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

Table XI.—Average Weight in Pounds of Rivers Inlet Sockeyes for Eighteen Years.

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

Table XII.—Relative Numbers of Males and Females, Rivers Inlet Sockeyes, of the 4_2 and 5_2 Groups, 1915 to 1932.

Year.	Average Percentages.				Per Cent. Total Males.	Per Cent. Total Females.
	Four-year Males.	Four-year Females.	Five-year Males.	Five-year Females.		
1915	....	....	....	....	45	55
1916	74	26	40	60	52	48
1917	75	25	42	58	53	47
1918	74	26	49	51	66	34
1919	79	21	45	55	58	42
1920	74	26	48	52	49	51
1921	65	35	38	62	51	49
1922	66	34	38	62	61	39
1923	71	29	33	67	62	38
1924	74	26	31	69	50	50
1925	66	34	34	66	41	59
1926	63	37	32	68	51	49
1927	68	32	36	64	62	38
1928	63	37	30	70	51	49
1929	57	43	36	64	53	47
1930	56	44	37	63	47	53
1931	59	41	33	67	47	53
1932	54	46	28	72	46	54

Table XIII.—Percentages of Males and Females in Rivers Inlet Sockeyes occurring on Different Dates, Seasons of 1922 and 1932.

Date.	Four-year Males.		Four-year Females.		Five-year Males.		Five-year Females.	
	1922.	1932.	1922.	1932.	1922.	1932.	1922.	1932.
June 27	....	32	....	68	....	77	....	23
June 30	....	57	....	43	....	64	....	36
July 6–10	90	32	10	68	57	71	43	29
July 12–18	78	21	22	79	38	50	62	50
July 20	64	24	36	76	27	48	73	52
July 22	76	13	24	87	33	44	67	56
July 24–25	59	25	41	75	42	37	58	63
Aug. 5–8	45	29	55	71	10	37	90	63

Table XIV.—Average Lengths in Inches of Rivers Inlet Sockeyes, Runs of 1922 and 1932, on a Series of Dates.

Date.	Four-year Males.		Four-year Females.		Five-year Males.		Five-year Females.	
	1922.	1932.	1922.	1932.	1922.	1932.	1922.	1932.
June 27	.....	21.8	.....	22.2	.....	24.3	.....	24.2
June 30	.....	22.1	.....	22.2	.....	23.9	.....	24.2
July 6–10	22.2	22.2	22.7	22.3	24.7	24.9	23.9	24.7
July 12–18	22.7	23.2	22.6	22.4	25.2	26.0	24.3	24.6
July 20	22.7	22.6	22.5	22.4	24.3	25.0	23.9	24.4
July 22	22.8	22.7	22.7	22.9	24.2	25.7	24.9	24.4
July 24–25	22.3	22.6	22.2	22.4	24.0	25.7	24.6	24.6
Aug. 5–8	22.2	22.8	22.4	22.3	21.0	25.6	23.5	24.6

Table XV.—Average Weights in Pounds of Rivers Inlet Sockeyes, Runs of 1922 and 1932, on a Series of Dates.

Date.	Four-year Males.		Four-year Females.		Five-year Males.		Five-year Females.	
	1922.	1932.	1922.	1932.	1922.	1932.	1922.	1932.
June 27	....	4.1	....	4.2	....	5.3	....	5.2
June 30	....	4.3	....	4.2	....	5.2	....	5.3
July 6–10	5.7	4.6	5.8	4.6	7.4	6.3	6.9	6.0
July 12–18	6.1	5.5	5.9	4.7	7.6	7.4	7.1	6.4
July 20	6.1	5.0	5.9	4.8	7.3	6.2	6.6	6.0
July 22	6.2	5.1	6.1	5.0	6.8	7.2	7.1	6.2
July 24–25	6.0	4.9	5.8	4.7	6.8	6.7	7.3	6.1
Aug. 5–8	5.7	5.3	5.8	4.8	5.5	7.1	6.7	6.4

3. THE SKEENA RIVER SOCKEYE RUN OF 1932.

(1.) General Characteristics.

The pack on the Skeena River amounted to 59,916 cases. No inspection of the spawning-beds was made by a departmental officer, but reports by Dominion officers indicate that the escapement was fairly good. While the run to the Babine area was reported as being only fair in extent, those to the Lakelse and Bulkley areas were stated to have been large. The postponement of commencement of fishing operations for twelve days no doubt had effects on the size of the pack and on the extent of the escapement, although nullified to some extent by the curtailment of the weekly closed season after July 23rd, equivalent to five fishing-days. As pointed out in the report of 1931, only a relatively small return was to be expected in 1932 and it is probably fortunate that no larger catch was made.

The run of 1933 will be derived from the brood-years 1928 and 1929. In 1928 the pack was only 34,559 cases and the five-year-old fish constituted 53 per cent. of the run (Table XVI.). In 1929 the pack was 78,017 cases and the four-year-old fish formed 67 per cent. of the run. While the escapements to the Babine area were reported as good in these years, those to the Lakelse Lake have been recorded as very poor. The expectancy for 1933, therefore, is for another mediocre run. It would appear that the Skeena River is now in a cycle of comparatively low production and careful provision should be made to provide for large escapements, otherwise there can be no recovery.

The packs in cases from 1902 to 1932 are shown in Fig. 1 in heavy line. Two points may be noted: (1) That there has been an extreme fluctuation in size of packs from 187,000 cases in 1910 to 34,000 cases in 1928; (2) that since 1924 there has been a succession of relatively small packs with the exception of that of 1930. In order to "smooth out" the fluctuations and indicate the trend in the pack record, the packs have been subjected to a running average by fives and the resulting averages again smoothed by a running average by fives. The result is shown by the broken line in Fig. 1. To obtain a still smoother line the packs were subjected to running averages of fives and elevens. The result is shown in Fig. 1 by the dotted line. There would seem to be no doubt as to the downward trend of the Skeena River packs. In the calculations the pack for 1933 has been estimated at 60,000 cases.

The escapement should be considered along with the pack, for increased escapements might be associated with low packs. However, there is no indication in the reports from the spawning-beds that such has been the case. The reports for the period 1926 to 1932 do not indicate larger escapements than in the period 1919 to 1924. In fact, in the years 1927, 1928, and 1929 the runs to the Lakelse area were very poor and in 1931 and 1932 the runs to the Babine area were only "fair."

One other point may be noted—namely, that the number of gill-net licences issued for the Skeena River has shown a decided increase. In the years 1911 to 1914, inclusive, 850 licences were issued annually, while during the years 1925 to 1931 the average yearly number has been 1,146. It is evident, then, that the fishing effort has increased. The number of fishing licences in the

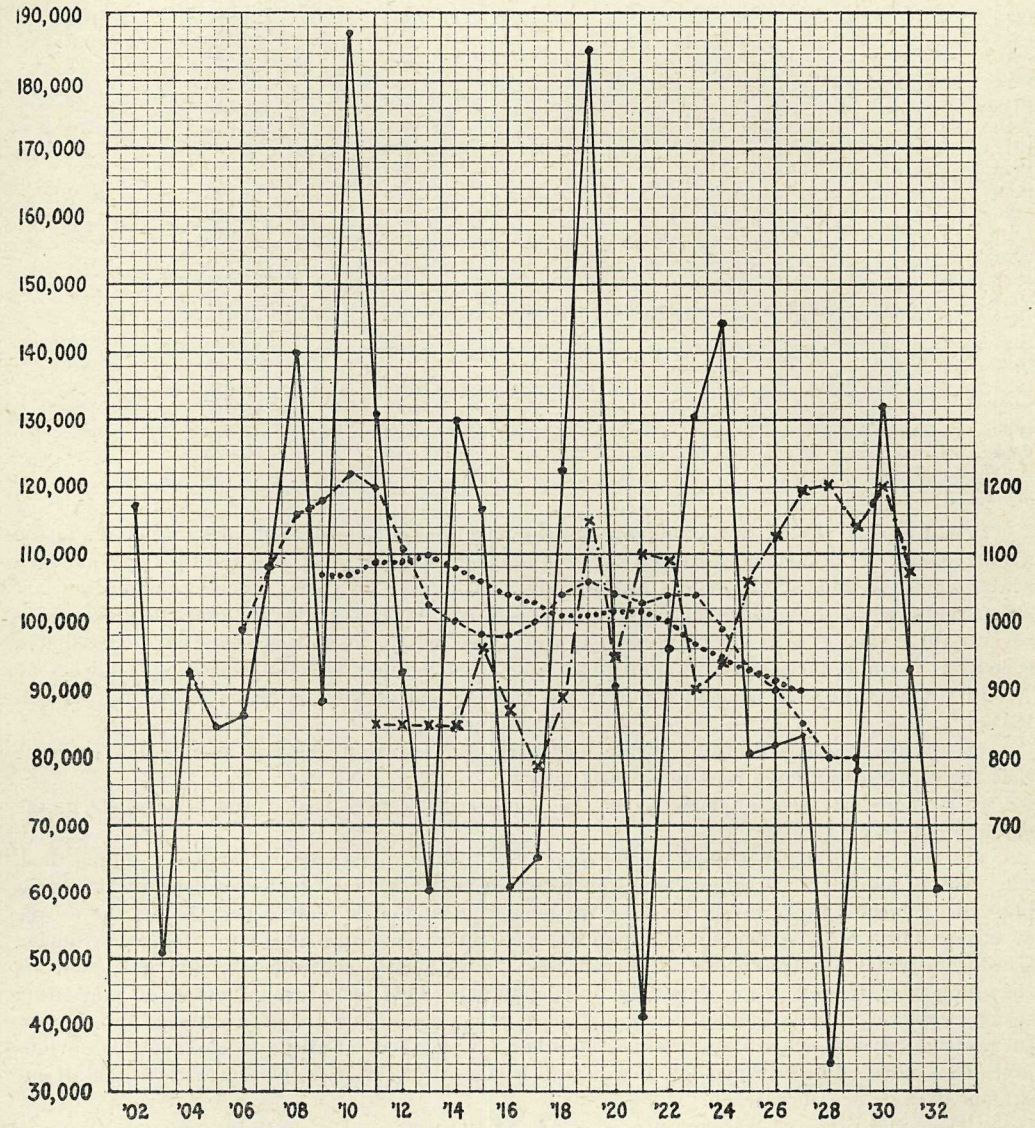

Fig. 1. Showing packs in cases on Skeena River for the years 1902 to 1932 and number of gill-net licences, 1911 to 1931. The continuous line ———— represents the actual packs in cases; the dash line – – – – – represents the packs as smoothed by running averages of five followed by five; the dotted line . . . . . represents the packs as smoothed by running averages of five followed by eleven; the x—dash—dot line x—x—.—x represents the number of gill-net licences issued.

various years is shown in Fig. 1 by the dash—dot line. The catch per licence or boat has decreased, as is shown by the following data:—

Year.	Number of Licences issued.	Packs in Cases.	Average Pack per Licence.
1911	850	131,066	154
1912	850	92,498	109
1913	850	59,927	71
1914	850	130,166	153
1915	962	116,553	121
1916	868	60,923	70
1917	788	65,760	83
1918	899	123,322	139
1919	1,153	184,945	160
1920	954	90,869	95
1921	1,109	41,018	37
1922	1,091	96,277	88
1923	900	131,731	146
1924	941	144,747	154
1925	1,068	81,146	76
1926	1,129	82,360	73
1927	1,198	83,996	70
1928	1,208	34,559	29
1929	1,143	78,017	68
1930	1,202	132,372	110
1931	1,076	93,023	86

It will be seen that with the increase in the number of licences there has been a decline in the average catch per licence as expressed above in number of cases. The average for the first seven years, when the number of licences was less than 1,000, was 109 cases, whereas during the last seven years, when the number of licences has been over 1,000, the average catch has been only seventy-three cases. It is not unlikely that restrictive fishing regulations may have contributed somewhat to the reduction in average catch. The situation may be summarized as follows:—

(1.) There has been a decided downward trend in the sockeye-salmon pack on the Skeena River.

(2.) While restrictive fishing regulations have been enforced, there is no clear-cut evidence that the escapements have been materially larger.

(3.) There has been an increase in the number of licences issued and a decrease in the catch per licence.

The statements of Dr. Gilbert in his report for 1920 are particularly pertinent at this time. They are as follows: "It cannot too often be urged that a rational policy of conservation must prescribe a large annual safety factor. We must continue each year to provide for the escape of larger numbers of spawning fish than are necessary to ensure adequate production during seasons in which the conditions are favourable. A rationally controlled stream will show its spawning-grounds each year seemingly overpopulated. This is nature's method of preventing serious depletion during the not infrequent years when conditions are unfavourable for successful propagation and growth and there is no other safe method. Failure to observe this obvious precaution must be held responsible in no small measure for certain depletion with which all our salmon-streams are threatened.

"The appearance of occasional good years in the course of a declining run is customary and to be expected. They should not serve in any degree to allay our apprehensions. Poor years also, it is true, have occurred during the most prosperous periods of productivity in our streams. But in a declining salmon run the poor years become ever more numerous, they infallibly in the long run produce their kind, and they fall to lower and lower levels. The average production for a series of years can always be depended on to tell the tale."

(2.) Age-groups.

Scales and length, weight and sex data were obtained from 2,229 fish from June 23rd to August 13th in seventeen random samplings. The 4_2 age-group is the most abundant, being represented by 992 individuals, or 44 per cent. They only slightly exceed in numbers the five-

year-olds, which total 972 individuals, of which 822 constitute the 5_2 age-group, 37 per cent., and 150 the 5_3 age-group, 7 per cent. The outstanding feature of the run this year is the large number of six-year-old fish (6_3), of which there are 265, or 12 per cent. This is the largest number since the year 1918, when a percentage of 18 was recorded. With the exception of these two years, the average representation has been approximately 3 per cent. It will be recalled that in 1931 there was an exceptionally high percentage of fish in the 5_3 age-group, and it may be that the six-year-old fish of 1932 were individuals of the same group which remained an additional year in the sea (Table XVII.).

(3.) Lengths and Weights.

In general, the average lengths and weights of the two sexes of the various age-groups in 1932 are slightly below the general averages, but the males of the 5_3 age-group are somewhat above the average in length and weight and the males of the 6_3 age-group in weight (Tables XVIII. to XXIII.).

The data for the year are as follows:—

4_2 males, 23.4 inches, 5.4 lb.; females, 22.7 inches, 4.9 lb.
5_2 males, 25.2 inches, 6.9 lb.; females, 24.4 inches, 6.1 lb.
5_3 males, 24.1 inches, 6.0 lb.; females, 22.8 inches, 5.0 lb.
6_3 males, 25.4 inches, 6.8 lb.; females, 24.4 inches, 5.9 lb.

As has been pointed out in previous reports, the additional year in the lake adds but little to the ultimate size, for the 4_2 and 5_3 age-groups have approximately equal lengths and weights, as do also the 5_2 and 6_3 age-groups. On the other hand, an additional year in the sea contributes from 1 to 2 inches in length and approximately 1 lb. in weight. The following averages of the past sixteen to twenty years illustrate these points:—

4_2 males, 23.6 inches, 5.5 lb.; females, 23.2 inches, 5.1 lb.
5_3 males, 24.0 inches, 5.7 lb.; females, 23.3 inches, 5.1 lb.
5_2 males, 25.7 inches, 6.7 lb.; females, 24.8 inches, 6.1 lb.
6_3 males, 25.5 inches, 6.6 lb.; females, 24.6 inches, 5.9 lb.

(4.) Proportions of the Sexes.

The total number of males in the samplings is 1,194, 54 per cent., and of females 1,035, 46 per cent. In the 4_2 age-group the females slightly exceed the males in number. An excess of females has characterized this group during the past seven years, except in 1929, when the numbers of the two sexes were equal. In the early years—that is, from 1912 to 1919, inclusive—the males consistently outnumbered the females. In the 5_2 age-group the males are greatly in excess of the females, the percentages being 63 and 37 respectively. Only in one other year has a similar condition existed—namely, in 1930. In the remaining nineteen years of record the females have exceeded the males by percentages from 4 to 16. The percentage of males in the 5_3 age-group is 41, while that of the females is 59. In the 6_3 age-group the percentage of males is 57 and of females 43 (Table XXIV.).

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

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

Table XVII.—Percentages of the Principal Year-classes, Skeena River Sockeyes, from 1916 to 1932.

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

Table XVIII.—Skeena River Sockeyes, 1932, 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.	
18	1	1	.....	.....	.....	.....	.....	.....	2
19	1	.....	.....	.....	.....	.....	.....	.....	1
19½	.....	.....	.....	.....	.....	1	.....	.....	1
20	10	7	1	1	.....	.....	.....	.....	19
20½	3	3	.....	.....	.....	.....	.....	.....	6
21	22	44	4	4	1	7	.....	.....	82
21½	8	20	1	3	.....	2	.....	.....	34
22	53	126	8	10	1	19	3	2	222
22½	27	64	8	6	3	12	.....	4	124
23	101	133	35	33	9	27	5	10	353
23½	34	40	13	17	6	6	1	10	127
24	99	66	64	58	20	8	16	29	360
24½	34	11	24	29	3	2	11	12	126
25	44	8	103	78	9	3	41	28	314
25½	15	3	34	20	3	1	16	8	100
26	9	2	116	29	3	1	29	10	199
26½	1	.....	33	5	1	.....	6	.....	46
27	1	.....	56	11	1	.....	16	1	86
27½	.....	.....	5	.....	.....	.....	5	.....	10
28	1	.....	9	.....	1	.....	1	.....	12
28½	.....	.....	1	.....	.....	.....	1	.....	2
29	.....	.....	3	.....	.....	.....	.....	.....	3
Totals	464	528	518	304	61	89	151	114	2,229
Ave. lengths	23.4	22.7	25.2	24.4	24.1	22.8	25.4	24.4	.....

Table XIX.—Skeena River Sockeyes, 1932, grouped by Age, Sex, and Weight, and by their Early History.

Weight in Pounds.	Number of Individuals.								Total.
	4_2		5_2		5_3		6_3		
	M.	F.	M.	F.	M.	F.	M.	F.	
3	1	2	.....	.....	.....	.....	.....	.....	3
3½	6	9	.....	2	.....	2	.....	.....	19
4	29	65	5	5	1	12	2	1	120
4½	70	167	13	23	3	21	2	7	306
5	98	150	37	32	9	22	6	15	369
5½	98	82	41	55	11	20	12	30	349
6	81	34	56	61	18	7	24	24	305
6½	40	10	86	43	9	2	22	20	232
7	30	6	85	43	5	2	34	14	219
7½	6	.....	72	24	1	1	26	3	133
8	4	3	52	10	4	.....	13	.....	86
8½	.....	.....	29	1	.....	.....	8	.....	38
9	1	.....	32	4	.....	.....	2	.....	39
9½	.....	.....	9	.....	.....	.....	.....	.....	9
10	.....	.....	1	1	.....	.....	.....	.....	2
Totals	464	528	518	304	61	89	151	114	2,229
Ave. weights	5.4	4.9	6.9	6.1	6.0	5.0	6.8	5.9	.....

Table XX.—Average Lengths of Skeena River Sockeyes, 4_2 and 5_2 Age-groups, for Twenty-one Successive Years.

Year.	Four-year Males.	Four-year Females.	Five-year Males.	Five-year Females.
1912	24.6	23.5	26.4	25.2
1913	23.5	22.9	25.5	24.7
1914	24.2	23.4	26.2	25.1
1915	24.2	23.5	25.9	25.0
1916	23.9	23.6	26.2	25.0
1917	23.6	23.2	25.5	24.7
1918	24.1	23.3	25.9	25.0
1919	24.3	23.4	25.7	24.8
1920	23.8	23.2	26.2	25.3
1921	23.8	23.1	25.2	24.2
1922	23.6	23.2	25.3	24.4
1923	23.7	23.1	25.5	24.5
1924	24.1	23.3	26.2	25.2
1925	23.6	22.8	25.6	24.7
1926	23.8	23.4	25.6	24.8
1927	23.9	23.3	25.7	24.8
1928	23.3	22.8	25.3	24.7
1929	22.9	22.7	25.5	24.7
1930	23.1	22.7	24.7	23.9
1931	23.5	23.1	25.7	24.8
Average lengths	23.6	23.2	25.7	24.8
1932	23.4	22.7	25.2	24.4

Table XXI.—Average Lengths of Skeena River Sockeyes, 5_3 and 6_3 Age-groups, for Seventeen Successive Years.

Year.	Five-year Males.	Five-year Females.	Six-year Males.	Six-year Females.
1916	24.1	23.8	26.2	24.8
1917	23.9	23.8	25.4	25.0
1918	23.9	23.4	25.2	24.7
1919	24.3	23.4	25.8	24.7
1920	24.1	23.4	26.2	25.1
1921	24.2	23.4	24.9	24.2
1922	23.8	23.3	24.6	24.1
1923	23.9	23.2	25.6	24.4
1924	24.7	23.6	25.8	24.8
1925	24.1	23.3	25.8	24.8
1926	24.6	23.8	26.0	25.0
1927	24.1	23.5	25.2	24.9
1928	23.5	22.8	25.6	24.7
1929	23.8	22.8	25.5	24.3
1930	23.5	22.4	24.6	23.2
1931	23.8	23.1	25.8	24.7
Average lengths	24.0	23.3	25.5	24.6
1932	24.1	22.8	25.4	24.4

Table XXII.—Average Weights of Skeena River Sockeyes, 4_2 and 5_2 Age-groups, for Nineteen Successive Years.

Year.	Four-year Males.	Four-year Females.	Five-year Males.	Five-year Females.
1914	5.9	5.3	7.2	6.3
1915	5.7	5.2	6.8	6.2
1916	5.4	5.1	7.1	6.3
1917	5.3	5.0	6.4	6.0
1918	5.8	5.3	6.9	6.4
1919	6.1	5.5	7.0	6.2
1920	5.6	5.1	7.2	6.4
1921	5.7	5.1	6.4	5.7
1922	5.4	5.1	6.5	5.7
1923	5.3	4.9	6.3	5.7
1924	5.6	5.0	7.0	6.3
1925	5.1	4.7	6.5	5.8
1926	5.3	5.1	6.5	5.8
1927	5.4	5.1	6.5	5.9
1928	5.0	4.6	6.4	5.8
1929	4.9	4.7	6.8	6.2
1930	5.4	5.1	6.7	6.0
1931	5.4	5.1	6.8	6.3
Average weights	5.5	5.1	6.7	6.1
1932	5.4	4.9	6.9	6.1

Table XXIII.—Average Weights of Skeena River Sockeyes, 5_3 and 6_3 Age-groups, for Eighteen Successive Years.

Year.	Five-year Males.	Five-year Females.	Six-year Males.	Six-year Females.
1915	5.9	5.2	6.6	6.0
1916	5.8	5.4	7.1	5.9
1917	5.5	5.2	6.3	5.8
1918	5.7	5.3	6.6	6.1
1919	6.1	5.4	6.9	6.3
1920	6.3	5.1	7.3	6.3
1921	5.8	5.1	6.0	5.6
1922	5.5	5.1	6.2	5.7
1923	5.3	4.8	6.3	5.4
1924	5.9	5.1	6.6	5.8
1925	5.5	4.9	6.9	5.4
1926	5.9	5.2	6.9	6.2
1927	5.4	5.0	6.0	5.8
1928	5.0	4.6	6.5	5.8
1929	5.6	4.9	6.8	5.7
1930	5.6	5.0	6.8	5.8
1931	5.5	5.0	6.9	6.0
Average weights	5.7	5.1	6.6	5.9
1932	6.0	5.0	6.8	5.9

Table XXIV.—Percentages of Males and Females in each of the Different Year-groups, Skeena River Sockeyes, in a Series of Years.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1912	54	46	42	58	....	....	....	....
1913	69	31	47	53	....	....	....	....
1914	60	40	47	53	....	....	....	....
1915	55	45	45	55	....	....	....	....
1916	70	30	43	57	56	44	54	46
1917	65	35	48	52	65	35	58	42
1918	63	37	46	54	61	39	56	44
1919	53	47	46	54	52	48	45	55
1920	41	59	37	63	43	57	41	59
1921	44	56	44	56	50	50	43	57
1922	52	48	41	59	52	48	53	47
1923	60	40	37	63	56	44	40	60
1924	50	50	43	57	46	54	46	54
1925	57	43	42	58	45	55	47	53
1926	40	60	43	57	48	52	49	51
1927	45	55	41	59	47	53	56	44
1928	48	52	45	55	43	57	50	50
1929	50	50	46	54	65	35	57	43
1930	47	53	56	44	55	45	63	37
1931	43	57	39	61	51	49	53	47
1932	47	53	63	37	41	59	57	43

4. THE NASS RIVER SOCKEYE RUN OF 1932.

(1.) General Characteristics.

The Nass River has never been as valuable to the sockeye-fishery as the other three rivers, and now, like the other streams, its present productivity is considerably less than it was in the earlier years. It is interesting to note what Dr. Gilbert wrote of the Nass run of 1916. He said: "While there is reason to fear that the other principal streams in the Province are beginning to experience the effects of overfishing, the lower levels of the fluctuations in the runs becoming lower, and the higher levels less high, there seems to be no indication so far that the Nass River has suffered." After the season of 1919 he remarked that the statement was still valid, though conditions gave cause for uneasiness. The following year he said that his forebodings had been justified; there was now conclusive evidence that the Nass River run had suffered depletion.

Since that year the river has undergone greater impairment, as the following figures signify:—

Total pack, 1907–11—225,134 cases; yearly average, 45,026.
Total pack, 1912–16—161,698 cases; yearly average, 32,339.
Total pack, 1917–21— 98,367 cases; yearly average, 19,673.
Total pack, 1922–26—117,562 cases; yearly average, 23,512.
Total pack, 1927–31— 76,977 cases; yearly average, 15,395.

The pack for 1932 is 14,154 cases, a figure slightly less than the average of the last five-year period. However, it is all that could be expected in view of the facts that the pack of the brood-year was even smaller and that the spawning escapement was poor in 1927.

As was the case in the other river systems, the inspection of the Nass spawning-beds in the fall of 1932 was not made by the usual Provincial Overseer, but by an officer of the Dominion Department of Fisheries. However, Mr. Young, who made the inspection, had accompanied Inspector Hickman for a number of years on his annual trips to the Meziadin watershed and was thus able to compare the conditions with those of previous years. He states that this run of 1932 compares favourably with those of other good years. It is quite possible that the spawning escapement was larger than the pack would indicate, because the gill-net fishing was delayed for a considerable period owing to a strike by the fishermen. This additional closed season should have augmented the escapement.

The run of 1933 will be derived chiefly from the year 1928, the gloomiest year in the whole history of the Nass. Its pack stands at the paltry figure of 5,540 cases, which has the distinction of being the lowest yet recorded. In addition, Inspector Hickman found very few sockeyes on the spawning-beds of Meziadin Lake and they were so scarce at the falls that he could not make the usual collection of scales. In the other river systems such conditions would signify an extraordinarily poor return in 1933. However, former experiences have taught that there is very little relation between expectation and realization in the Nass. In fact, the history of the later years abounds in contradictions. Brood-years with good packs have resulted in small packs, and vice versa. Neither have the spawning escapements been a guide in anticipating returns. One feature in the run of 1932 illustrates this peculiarity of the Nass. Although the year 1928 stands for practical failure, 28 per cent. of the run of 1932 is derived from it. This is all the more surprising when one realizes that in only three other years has the percentage of four-year-old fish equalled or exceeded this figure. The reason for these discrepancies is not clear, unless it be that our present knowledge of the Nass is incomplete both in regard to pack statistics and spawning areas. Like the Fraser River, the Nass is fished internationally, but as yet the American pack records are not available to supplement the Canadian ones. Likewise, the Meziadin watershed is the only spawning area concerning which there is adequate information, although there are undoubtedly others of importance in the river system.

Whatever the cause may be for the lack of correlation in the size of the packs in successive years of the same cycle, there is undeniable evidence that the productivity of the river is decreasing. Dr. Gilbert's warning of 1921 can well be repeated: "All of those interested in the perpetuation of the salmon industry on the Nass should co-operate to lessen the intensity of fishing operations in this district before hopeless depletion has become a fact."

The Nass River has always been of especial interest because of the well-defined racial characteristics of its sockeye. Since it is the most northerly of the four river systems, it is to

be expected that the special modifications in sockeye habits will be different from those of the other river-basins. As has been seen, the races of sockeye along the coast differ from one another according to the portion of the field of variable factors in which their specializations have occurred. In the Nass the specializations lie chiefly in prolonged fresh-water residence and late maturity. From 54 to 93 per cent., with an average of 73 for a period of twenty-one years, of the Nass sockeyes linger at least two years in fresh water. In the Fraser, Skeena, and Rivers Inlet as a rule this component of the run is so small that it can be almost disregarded. In addition, the Nass is the only one of the four streams in which fish remain three years in the lake before starting the downward migration. The habit of late maturity is also much more marked in the Nass than elsewhere. Over the twenty-one years for which there are records the percentage of fish maturing at five years of age or older has varied between the extremes of 70 and 96 per cent., with the average falling at 86 per cent. In the history of Rivers Inlet and the Skeena there are individual years in which the percentage of older fish has equalled or exceeded 86, but the average over the period of years lies just above 50 per cent. The number of Fraser River fish maturing at five and six years of age is too small to be considered. These habits of longer lake residence and late maturity have combined to bring about a well-ordered complexity of age-groups.

(2.) Age-groups.

Normally the following eight age-groups are met with in the Nass River run: 3_1 and 4_1 (the sea-types), classes which go to sea as fry and return at the end of either the third or fourth year; 4_2 and 5_2, groups which spend one year in the lake before migrating and return after three or four years in the ocean at the ages of four or five; 5_3 and 6_3, classes which extend their lake residence to two years and remain three or four years at sea, reaching maturity at the ages of five or six; 6_4 and 7_4, assemblages which delay migration for three years and after three or four years in salt water return in their sixth or seventh year. The most unusual feature is that the 5_3 group, which is almost negligible in the other streams, should be the dominant class. In addition to these usual age-classes, occasionally single individuals of other groups, such as 4_3, 6_2, and 8_5, have been found. The material which is used for the study of the 1932 run comprises 1,624 individuals and was gathered in fourteen samples between July 6th and August 20th. As has happened in some of the previous years, it was impossible to start the collection of data early enough to include the three-year-old sea-types which run in June. The other seven classes are present in the run of 1932. It is interesting to find individuals belonging to the 7_4 group which has not been represented since 1926 and to find a larger number of 6_4's than has been found for several years. These two older groups and the sea-types form such a small part of the entire run that their relative abundance has not been recorded year by year. The other four classes, the 4_2's, 5_2's, 5_3's, and 6_3's, are the principal groups and their percentages during the last twenty-one years, together with the respective packs, are listed in Table XXV. The data concerning the relative abundance of the age-groups have been condensed by combining them into four periods of five years each. This forms Table XXVI., which is especially interesting because it reveals the general stability or weakness of the various age-groups. The figures show a definite decrease in the 5_2's, and during the more recent years a noticeable increase among the 4_2's. The dominant age-group, 5_3, shows what appears to be an excess of its normal numbers in the 1922–26 period. Comparing the 1932 percentages (28 per cent. of 4_2's, 4 per cent. of 5_2's, 61 per cent. of 5_3's, and 7 per cent. of 6_3's) with those in Table XXVI., the same trend in the composition of the run is noticed—namely, stability of the 5_3's at 60 to 65 per cent., further decrease in the 5_2's, and greater abundance of 4_2's.

(3.) Lengths and Weights.

Tables XXVII. and XXVIII. are a record of the size variations of the several age-groups in the run of 1932 and Tables XXIX. and XXX. contain the average measurements of the principal classes during the last twenty years. A scrutiny of these tabulations shows that the average size of all the age-classes for both sexes and for both length and weight is somewhat greater in 1932 than the general averages.

The size relationships of the Nass sockeyes exhibit two characteristics. One is that, unlike the other river systems, these fish have not undergone a reduction in size as the years have passed. The following figures, showing the average lengths in inches of the Nass sockeyes combined in five-year periods, bear this out:—

Table A.

Year.	4_2		5_2		5_3		6_3	
	M.	F.	M.	F.	M.	F.	M.	F.
1912–16	24.36	23.26	26.12	25.04	26.30	25.52	26.88	25.76
1917–21	24.32	23.50	25.84	24.78	26.12	25.40	27.38	25.90
1922–26	24.50	23.76	25.94	24.96	26.04	25.24	27.60	26.04
1927–31	24.46	23.74	26.08	25.32	26.04	25.20	27.80	26.56

As a matter of fact, the 4_2 and 6_3 age-classes show a slight increase in size.

The second trait allied to length and weight is the close correspondence between age and size; that is, the smallest fish are the youngest and, conversely, the largest fish are the oldest. Tables XXXI. and XXXII. have been arranged in ascending series according to age, and in reading the data of the sexes separately it will be seen that the size increases with age. This correspondence between size and age does not hold in the other three river systems, where the factor determining size seems to be the number of years spent in sea-feeding. Table XXXIII. makes this point clear. The data are arranged on the basis of the number of years spent at sea and ultimate age. The Fraser, Skeena, and Rivers Inlet fish which have lived three years in the ocean are approximately the same size regardless of ultimate age, whereas the Nass fish show steady progression in size. The same is true of the fish which have had four years in the ocean. It is interesting to note that the number of years at sea plays a secondary part in the Nass River. There are three couplets of year-classes with the same ultimate age, but differing from one another by an additional year at sea; that is, the 4_1's and 4_2's, the 5_2's and 5_3's, and the 6_3's and 6_4's. In each pair there is a tendency for the group which had the extra year of ocean-life to have the greater length and weight.

(4.) Seasonal Changes during the Run.

By plotting the Nass River data on the series of dates on which the material was gathered, it is possible to discover the internal changes which occur during the course of the run. One group, the sea-types, is confined to the early weeks, and another, the 6_4's, is restricted to the latter portion of the run. Although the 6_3's appear toward the beginning of the run, their numbers increase very materially in August. The dominant group, the 5_3, is present throughout, but with varying proportions. The four- and five-year-old fish which have spent one year in the lake (4_2's and 5_2's) are also found during the entire run. Their greatest intensity is usually reached the middle or end of July. Year by year these general movements follow each other closely. The phenomenon is known as seasonal succession. Table XXXIV. gives the seasonal changes for 1932. Since the first collection of material was not made until July 6th, the sea-types are very poorly represented. The 5_2 group deviates from the normal standard in not becoming more noticeably abundant in mid-July. This is undoubtedly due to the greatly reduced numbers of this class in the run of 1932.

(5.) The Meziadin and Bowser Sockeye Colonies.

In the year 1915 Dr. Gilbert first called attention to the probable existence of two races of Nass sockeyes. His opinion was based on observations which seemed to show that: (1) The run was sharply divided into early and late periods; (2) the late-running fish were decidedly larger; and (3) there were different rates of fresh-water growth as shown in the nuclei of the scales. Since the Meziadin and Bowser were the only two known lakes of any size in this river system, it was assumed that they were the spawning regions of these two distinct races. The difficulty and costliness of exploration in country as inaccessible as that surrounding the Nass has made thorough investigation impossible. Nevertheless, there is abundant evidence that the Meziadin watershed is one of the important spawning-grounds, but the assumption that Bowser Lake is the other still awaits absolute confirmation. For many years Inspector Hickman has made an annual September inspection of Meziadin Lake and River, and since 1922 he has been

gathering data concerning the two races of Nass sockeyes. He takes a sampling of the Meziadin fish in Meziadin River, and by setting a net in the Nass above its junction with the Meziadin he obtains a sample of the other race, presumably on its way to Bowser Lake. As Table XXXV. indicates, the attempt to net the latter race has not met with much success in spite of annual continuous fishing for eight days. In some years not a single specimen has been taken and in other years the sample has been too small for reliable analysis. If there is any considerable run to Bowser or some other lake, it must occur earlier in the season. Nevertheless, the analysis of these data, meagre as they are, which Inspector Hickman has been collecting, substantiates the theory of two races among the Nass sockeyes. The size character—that there was a large late-running fish—which was originally suggested has been confirmed year by year, as is shown in Table XXXVI. The larger fish belong to the Meziadin colony. Table XXXVII. is typical of the size-distribution in any given year. The sample consists of a majority of large-sized fish interspersed with a scattering of smaller ones. The Bowser samplings have always consisted of a great majority of fish of small size.

As has been shown in the preceding paragraphs, in this river system the larger fish are the older fish, and vice versa. The margins of the scales of spawning fish are so badly absorbed that it is impossible to read the ultimate age, but by comparing the size variations of these Bowser and Meziadin fish with the general averages of the year-groups of the Nass proper (Table XXVII.) it is possible to estimate the ages. The majority of the Meziadin fish appear to be six years old and the Bowser group four and five years of age. It must be borne in mind that this analysis of the constitution of these two colonies is true of September only. Earlier in the season undoubtedly there is an entirely different age-group distribution.

The second original character used in separating the two colonies was an apparent difference in rates of fresh-water growth, but after several years of study of the scales from fish of the actual colonies it was discarded. Another phase of fresh-water life—namely, the difference in the number of years spent in the lake—was adopted. Although, as has been said, the scales of spawning fish are useless as complete records of ocean-life, the nuclei which give the account of the lake residence are intact and furnish the information concerning the earlier years. A summary of the study of such material as has been available is given in Table XXXV. In general, it appears that the fish of Bowser Lake seek the ocean earlier than those of Meziadin Lake. In other words, a considerable number of the former colony migrate at the end of the first year, while a very large proportion of the latter group postpone the journey for two or three years.

The year 1932 is one for which there is no Bowser Lake material. Extremely high water prevented operation of a net. The length frequencies of this year's Meziadin sockeyes are enumerated in Table XXXVII. The average for the males lies toward the upper extreme, and for the females toward the lower, of the size variations of their respective groups. The results of the study of the nuclei of these fish tally only in part with those of previous years. The unusual feature is the high percentage (16) of fish which left the lake after one year's residence. In brief, then, it appears that there are two races of Nass sockeyes, one associated with Meziadin Lake and the other presumably with Bowser Lake. The late-running fish of the former group are conspicuously large and their early history is characterized by two or three years' residence in the lake. The Bowser Lake group appears in very small numbers in September, the fish are smaller and younger than those of the other colony, and they spend only one or two years in fresh water. These conclusions are made with considerable reservation, since they are based on *data too limited to preclude the possibility of error.*

Table XXV.—Percentages of Principal Age-groups present in the Nass River Sockeye Run from 1912 to 1932.

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

Table XXVI.—Percentage of Principal Age-groups in Nass River Sockeye Run from 1912 to 1931 combined in Five-year Periods.

Year.	One Year in Lake.		Two Years in Lake.	
	Four Years old.	Five Years old.	Five Years old.	Six Years old.
1912–16	11	22	62	5
1917–21	13	15	65	7
1922–26	11	7	77	5
1927–31	20	11	65	4

Table XXVII.—Nass River Sockeyes, 1932, grouped by Age, Sex, and Length, and by their Early History.

Length in Inches.	Number of Individuals.														Total
	4_1		4_2		5_2		5_3		6_3		6_4		7_4		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
21			1												1
21½			1												1
22				6				1							7
22½			1	9				1							11
23	1		5	37		3	3	8							57
23½			8	38			2	6							54
24		2	37	58	3	3	5	34	1	1					144
24½			27	35		4	7	27			1				101
25		1	76	30	2	10	29	122		2		2			274
25½	1		17	8	2	3	35	71	2	2		2			143
26	1		32	2	8	7	85	160	6	2	2	2			307
26½			4	1	1	1	57	50	4	2	2	1			123
27			5	1	8	5	126	46	11	10	2	2	1		217
27½			1		6		34	5	5	2					53
28							39	7	11	4					61
28½					1		8		7	4					20
29							7		12	1			1		21
29½									6						6
30							1		14	2		1			18
30½									2						2
31									3						3
Totals	3	3	215	225	31	36	438	538	84	32	7	10	2		1,624
Ave. lengths	24.8	24.3	24.9	23.9	26.4	25.2	26.6	25.6	28.3	27.1	26.2	26.3	28.0		

Table XXVIII.—Nass River Sockeyes, 1932, grouped by Age, Sex, and Weight, and by their Early History.

Weight in Pounds.	Number of Individuals.														Total.
	4_1		4_2		5_2		5_3		6_3		6_4		7_4		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
4			3					1		1	1				6
4½			2	16		1	2	5							26
5			9	53		2	6	23							93
5½	1	1	27	64	2	2	8	49							154
6			55	58	3	5	35	128	2	2		2			290
6½		2	61	28	2	5	57	141	4	3	3	5			311
7			36	4	6	11	92	113	7	9	3	2	1		284
7½	2		16	1	5	7	87	54	8	3					183
8			5	1	5	2	79	15	10	7			1		125
8½			1		3	1	48	7	10	2					72
9					3		15	2	15	2					37
9½					1		5		10			1			17
10					1		2		9	3					15
10½							2		7						9
11									2						2
Totals	3	3	215	225	31	36	438	538	84	32	7	10	2		1,624
Ave. weights	6.6	6.2	6.3	5.6	7.5	6.6	7.3	6.3	8.7	7.5	6.4	6.8	7.5		

Table XXIX.—Nass River Sockeyes, Average Lengths of Principal Classes from 1912 to 1932.

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

Table XXX.—Nass River Sockeyes, Average Weights of Principal Classes from 1914 to 1932.

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

Table XXXI.—Nass River Sockeyes, 1919–32, grouped by Age, Sex, and Average Lengths of Principal Age-groups.

Year.	Average Lengths in Inches of Groups.															
	Three Years old.		Four Years old.				Five Years old.				Six Years old.				Seven Years old.	
	3_1		4_2		4_1		5_3		5_2		6_4		6_3		7_4	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1919	.....	.....	24.9	24.1	26.1	25.1	26.5	25.8	26.2	25.2	28.2	26.5	27.9	26.7	27.2	28.0
1920	.....	.....	24.0	23.4	.....	.....	26.7	25.9	26.3	25.0	26.6	26.7	27.4	25.9	.....	.....
1921	23.1	22.4	24.3	23.5	24.2	23.6	26.2	25.6	25.5	24.3	26.9	26.5	27.9	26.2	.....	.....
1922	.....	.....	24.2	23.4	24.5	23.5	25.7	25.0	25.6	24.6	26.2	25.4	28.0	25.9	.....	.....
1923	.....	.....	24.3	23.7	25.5	24.3	26.2	25.5	25.9	25.3	26.1	25.5	27.2	26.5	.....	.....
1924	.....	.....	24.7	23.8	.....	.....	26.3	25.4	26.2	24.9	27.1	26.4	28.0	25.4	.....	.....
1925	.....	.....	24.4	23.8	.....	.....	25.9	25.0	25.9	24.7	26.3	25.3	26.9	25.4	.....	.....
1926	23.7	22.3	24.9	24.1	24.5	24.0	26.1	25.3	26.1	25.3	26.7	25.8	27.9	27.0	28.2	27.0
1927	23.4	23.5	24.9	24.2	25.6	24.1	26.3	25.9	26.3	25.2	26.8	27.0	27.6	26.5	29.0	.....
1928	23.7	22.4	24.3	23.5	25.1	23.6	25.5	24.6	26.0	25.1	25.5	24.6	28.1	26.2	.....	.....
1929	.....	.....	24.1	23.5	.....	.....	25.9	24.9	26.1	25.2	.....	.....	27.2	26.2	.....	.....
1930	.....	.....	24.5	23.7	25.8	24.3	26.4	25.3	26.5	25.4	.....	.....	27.9	26.8	.....	.....
1931	23.7	22.5	24.5	23.8	25.4	23.9	26.1	25.3	26.5	25.7	27.2	25.5	28.2	27.1	.....	.....
Ave. lengths	.....	.....	24.5	23.7	25.2	24.1	26.1	25.4	26.1	25.1	26.7	25.9	27.7	26.3	.....	.....
1932	.....	.....	24.9	23.9	24.8	24.3	26.6	25.6	26.4	25.2	26.2	26.3	28.3	27.1	28.0	.....

Table XXXII.—Nass River Sockeyes, 1919–32, grouped by Age, Sex, and Average Weights of Principal Age-groups.

Year.	Average Weights in Pounds of Groups.															
	Three Years old.		Four Years old.				Five Years old.				Six Years old.				Seven Years old.	
	3_1		4_2		4_1		5_3		5_2		6_4		6_3		7_4	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1919	.....	.....	6.0	5.5	6.4	5.7	6.7	6.1	6.6	5.9	7.7	7.0	7.8	6.7	7.1	7.5
1920	.....	.....	5.6	5.2	.....	.....	7.4	6.7	7.4	6.3	7.6	6.9	7.9	7.0	.....	.....
1921	5.0	4.6	6.0	5.4	5.9	5.5	6.9	6.3	6.9	6.1	7.0	6.5	7.7	6.6	.....	.....
1922	.....	.....	5.9	5.4	6.1	5.5	6.8	6.3	6.8	6.2	7.5	6.3	8.1	6.6	.....	.....
1923	.....	.....	5.8	5.2	7.0	5.5	6.6	6.0	6.7	6.1	6.7	6.3	7.2	6.8	.....	.....
1924	.....	.....	5.9	5.4	.....	.....	6.8	6.1	7.2	6.1	7.3	6.5	8.0	6.5	.....	.....
1925	.....	.....	5.9	5.4	.....	.....	6.7	6.0	6.8	6.1	6.8	6.0	7.4	6.3	.....	.....
1926	5.5	4.5	6.0	5.4	5.9	5.7	6.7	6.0	6.9	6.2	6.8	6.2	7.8	7.1	7.7	7.3
1927	5.3	.....	6.2	5.8	6.8	5.6	6.9	6.2	7.1	6.3	7.0	7.2	7.8	7.0	9.0	.....
1928	5.4	4.7	5.6	5.0	6.9	5.5	6.2	5.5	7.0	6.2	6.3	5.4	8.1	6.6	.....	.....
1929	.....	.....	5.7	5.2	.....	.....	6.7	5.9	7.1	6.6	.....	.....	7.6	6.8	.....	.....
1930	.....	.....	5.9	5.2	6.8	5.8	7.1	6.1	7.3	6.5	.....	.....	8.2	7.2	.....	.....
1931	5.5	5.0	6.0	5.5	6.7	5.7	6.8	6.2	7.4	6.8	7.8	5.7	8.3	7.4	.....	.....
Ave. weights	.....	.....	5.9	5.3	6.5	5.6	6.8	6.1	7.0	6.3	7.1	6.4	7.8	6.8	.....	.....
1932	.....	.....	6.3	5.6	6.6	6.2	7.3	6.3	7.5	6.6	6.4	6.8	8.7	7.5	7.5	.....

Table XXXIII.—Nass, Fraser, and Skeena Rivers and Rivers Inlet Sockeyes, 1922 and 1926, grouped by Number of Years spent on the Sea-feeding Grounds.

Age.		Nass.		Fraser.		Skeena.		Rivers Inlet.	
		M.	F.	M.	F.	M.	F.	M.	F.
	Year 1922.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
	Three years at sea—								
3	Sea-type	.....	.....	23.0	22.6	.....	.....	.....	.....
4	One-year-in-lake type	24.2	23.4	24.0	23.0	23.6	23.2	22.5	22.4
5	Two-years-in-lake type	25.7	25.0	23.5	22.7	23.8	23.3	22.4	23.2
	Four years at sea—								
4	Sea-type	24.5	23.5	25.5	24.2	.....	.....	.....	.....
5	One-year-in-lake type	25.6	24.6	25.8	24.1	25.3	24.4	24.6	24.2
6	Two-years-in-lake type	28.0	25.9	25.4	24.3	24.9	24.1	25.5	.....
	Year 1926.								
	Three years at sea—								
3	Sea-type	23.7	22.3	23.4	22.5	.....	.....	.....	.....
4	One-year-in-lake type	24.9	24.1	22.6	22.3	23.8	23.4	22.8	22.9
5	Two-years-in-lake type	26.1	25.3	23.2	22.4	24.6	23.8	22.9	23.1
	Four years at sea—								
4	Sea-type	24.5	24.0	25.4	24.6	.....	.....	.....	.....
5	One-year-in-lake type	26.1	25.3	24.6	24.0	25.6	24.8	25.1	24.6
6	Two-years-in-lake type	27.9	27.0	25.5	23.7	26.0	25.0	25.6	26.8

Table XXXIV.—Number of Individuals of each Class of Nass River Sockeyes running at Different Dates in 1932.

Date.	4_2	5_2	5_3	6_3	3_1	4_1	6_4	7_4	Number of Individuals examined.
July 6	46	4	64	.....	.....	5	.....	.....	119
„ 9	42	3	76	2	.....	1	1	.....	125
„ 11	43	12	66	2	.....	.....	.....	.....	123
„ 15	60	3	54	7	.....	.....	.....	.....	124
„ 18	58	6	50	5	.....	.....	.....	.....	119
„ 22	55	8	54	7	.....	.....	1	.....	125
„ 26	40	5	69	8	.....	.....	.....	.....	122
„ 29	29	3	78	11	.....	.....	1	.....	122
Aug. 1	24	10	76	15	.....	.....	.....	.....	125
„ 4	19	7	81	18	.....	.....	.....	.....	125
„ 9	7	3	102	9	.....	.....	1	.....	122
„ 15	9	.....	93	12	.....	.....	6	.....	120
„ 19	7	3	88	17	.....	.....	6	2	123
„ 20	1	.....	25	3	.....	.....	1	.....	30
Individuals	440	67	976	116	.....	6	17	2	1,624

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

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

Table XXXVI.—Average Lengths of the Meziadin and Bowser Lake Sockeyes for the Years 1924–32.

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

Table XXXVII.—The Lengths of Individuals comprising the Meziadin Run in 1932.

Length in Inches.	Number of Individuals.	
	M.	F.
23	....	1
24	1	1
24½	....	3
25	3	4
25½	2	9
26	2	7
26½	5	5
27	13	3
27½	9	3
28	7	1
28½	6	2
29	7	....
29½	4	....
30	4	....
30½	1	....
31	1	....
Totals	65	39
Average lengths	27.7	25.5

THE SALMON-SPAWNING AREAS.

Owing to financial necessity the Department made no personal inspection of the spawning areas of the Fraser, Skeena, Rivers Inlet, Smith Inlet, and Nass River systems.

We were, however, furnished with copies of spawning-bed reports made to Major J. A. Motherwell, Chief Supervisor of Dominion Fisheries, who conducted investigations of those spawning areas. His courtesy in supplying us with these reports is gratefully acknowledged.

The following gives a brief summary taken from these reports:—

FRASER RIVER.

Upper Fraser System.—Sockeye in Stuart, Fraser, Francois, Bowron, and Quesnel areas showed a great scarcity of spawners, the escapement being most disappointing. Springs in this area were better than usual.

Chilco.—A large escapement of sockeye, estimated at 70,000 in comparison with 20,000 in 1928, the brood-year.

Shuswap.—Sockeye were most disappointing; not more than 2,000 spawners in Little and Adams Rivers, the main spawning-streams of this system.

Eagle River.—From the planting of 16,000,000 eyed sockeye-eggs in the Eagle River, taken from Cultus Lake, the return did not materialize, neither was there any evidence to justify a conclusion that they returned to their home waters at Cultus Lake.

Seton-Anderson.—In late years attempts have been made to seed this area with eyed sockeye-eggs from the Pemberton Lake Hatchery. The results have not been satisfactory. Two thousand spawners were seen in Gates Creek this fall, the place where most of the plantings were made. There was a good run of cohoe to Gates Creek.

Harrison Lake.—Two thousand sockeye were estimated at Morris Creek, the same number as reported for 1928. The quantity of springs, cohoe, and chums in this area were the greatest seen in years.

Birkenhead.—There was only a fair return of sockeye, estimated at about 75 per cent. of the brood-year of 1928. A large run of cohoe returned to the tributaries of the Birkenhead.

Pitt Lake.—This area is keeping up well since the establishment of a hatchery. A good natural spawning occurred quite apart from 4,000,000 sockeye-eggs taken for the hatchery.

Cultus Lake.—The count of sockeye was far below that of 1928. Heavy freshets were experienced in the Lower Fraser system.

SKEENA RIVER.

Babine.—Sockeye made their first appearance at Babine Lake July 12th. The run consisted of 50 per cent. runts. The sockeye return to this watershed was only fair; the return of springs good.

Bulkley River.—Large numbers of sockeye passed up the Bulkley River, no doubt heading for the Morice River and Lake system.

Lakelse.—The run of sockeye to Lakelse was good, showing an increase of 50 per cent. over 1928. It is considered that a large amount of spawn deposited will have been destroyed by freshets.

RIVERS INLET.

Sockeye reports to this district show spotty conditions; some streams with a fair average, others poor. Observations were made most difficult owing to excessive rains and flood conditions in all streams. It is anticipated that a large percentage of eggs deposited have been destroyed. The spring-salmon run was good.

SMITH INLET.

Sockeye seeding in this area was unusually good. The pink run was poor and chums were heavy.

NASS RIVER.

The sockeye escapement to the Meziadin Lake watershed was considered satisfactory and compared favourably with the runs of 1924, 1925, 1929, and 1930. The run of pinks and springs to the Nass were of fair proportions. Heavy fall rains were experienced in the whole of the district.

SALMON-EGG COLLECTIONS, BRITISH COLUMBIA HATCHERIES, 1932.

Hatchery.	Sockeye.	Springs.	Cohoe.	Total.
Anderson Lake, V.I.	7,532,000	540,000	.....	8,072,000
Babine Lake, Skeena River	6,217,500	.....	.....	6,217,500
Lakelse Lake, Skeena River	5,815,500	.....	.....	5,815,500
Cowichan Lake, V.I.	.....	946,100	714,800	1,666,900
Cultus Lake	4,436,375	.....	.....	4,436,375
Kennedy Lake, V.I.	7,460,715	.....	.....	7,460,715
Pemberton	22,710,000	.....	.....	22,710,000
Pitt Lake	4,004,500	.....	.....	4,004,500
Rivers Inlet	16,618,868	1,039,240	.....	17,658,108
Totals	74,795,458	2,525,340	714,800	78,035,598

THE PILCHARD-FISHERY OF BRITISH COLUMBIA.

By John Lawson Hart.*

RELATIVE IMPORTANCE AND VALUE OF PILCHARD-FISHERY.

In recent years the catches of pilchard (*Sardinops cærulea*) in British Columbia has been exceeded in Canada only by those of three other kinds of fish—the salmons, the herring, and the cod. Since the salmon-catch includes six species, and as the herring-catch is divided about equally between the Atlantic and Pacific Coasts, the tonnage of fish captured in the pilchard-fishery in British Columbia exceeds that of any other Pacific fishery and is second in the Dominion only to the catch of cod on the Atlantic Coast. However, in value of products as marketed, the pilchard-fishery ranks only eighth in Canada, and third in British Columbia, owing to the comparatively low value of the saleable products.

In 1930, the last year for which complete figures are available, the capital invested in plants and equipment used in the pilchard industry amounted to over $3,000,000, and the amount paid to some 700 pilchard-fishermen and reduction-plant employees was in the neighbourhood of $450,000. In the same year some 75,000 tons of pilchards were delivered to the fifteen reduction plants and three canneries in operation. From these 75,000 tons of pilchards, 3,200,000 gallons (imperial) of oil, 14,000 tons of meal, and 55,000 cases of canned fish were obtained. Respectively, these were valued at $678,000, $688,000, and $220,000. The above figures are for 1930, a year in which falling prices had resulted in the curtailment of the catch and diminished returns for the marketed products, and must be regarded as under- rather than over-representing the magnitude of the pilchard industry.

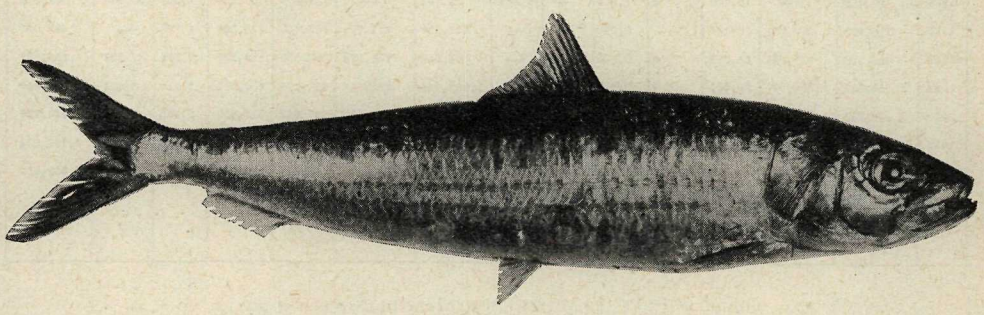

Fig. 1. Pilchard.

THE DEVELOPMENT AND PRESENT CONDITION OF THE PILCHARD INDUSTRY.

The earliest records of pilchards off the coast of British Columbia are naturally somewhat vague. Some of the older Indians maintain that pilchards were at one time common on the coast, and later disappeared for some years. If this report is true, it means only that the pilchards failed to enter or show in the inlets, rather than that they were not off the British Columbia Coast at all. It is probable that the occurrence of pilchards in estuary waters has always been uncertain.

In 1917 the canning of pilchards for commercial purposes was first begun, and since then the catch has always been more than sufficient to meet the requirements of the canners. As a result of its potential economic possibilities the species was an object of interest after 1917 and its occurrence on the coast was more thoroughly observed.

In the early years of the fishery some plichards remained in the inlets throughout the winter and were even fished as late as December. More recently pilchards have been seen only during the summer, and the greater part of the fishing has been concentrated in the three months from July to September, with occasional catches in June and October. The shortening of the season is, no doubt, due in part to the increased intensity of the fishing during the last few years.

* Reprint of Bulletin No. XXXVI., published by the Biological Board of Canada.

Until recent years all the fishing was done in the inlets. Since 1928, however, the tendency has been for the fishery to develop into one of the open sea. This has resulted from a combination of two factors, the increased demand for fish which followed the installation of reduction machinery in 1925 and the decreasing tendency of the pilchards to enter the estuaries. The change has been made possible by improvements in fishing equipment and increased experience of the fishermen.

TABLE I. STATISTICS OF THE PILCHARD FISHERY 1917 - 1931.

	TOTAL CATCH cwt.	REDUCED cwt.	CANNED cwt.	USED FRESH cwt.	BAIT cwt.	SMOKED cwt.	DRY SALTED cwt.	VALUE FISH AS CAUGHT $	VALUE OIL $	VALUE MEAL $	VALUE CANNED $	VALUE BAIT $	VALUE MISCEL-LANEOUS $	TOTAL VALUE PRODUCTS $
1917	1,363	---	963	---	400	---	---	2,726	---	---	9,810	2,000	---	11,810
1918	72,723	---	50,405	17,359	---	15	4,944	146,727	---	---	336,225	---	77,628	413,853
1919	65,624	---	65,392	76	---	---	156	81,321	---	---	370,841	---	1,030	371,871
1920	88,050	---	65,315	553	19,874	---	2,308	77,097	---	---	503,937	28,191	8,137	540,265
1921	19,737	---	11,264	9	8,464	---	---	12,019	---	---	91,328	10,580	37	101,945
1922	20,342	---	13,975	---	6,250	117	---	15,255	---	---	98,082	7,154	819	106,055
1923	19,492	---	12,089	5	7,250	20	128	31,939	---	---	82,518	9,129	389	92,036
1924	27,485	---	15,790	3	1,846	---	9,846	21,794	---	---	60,180	2,307	20,358	82,845
1925	318,973	273,701	37,182	---	8,090	---	---	221,557	211,774	103,400	178,121	4,790	---	498,085
1926	969,958	937,291	26,731	36	5,900	---	---	848,062	734,078	395,386	119,526	7,375	357	1,256,721
1927	1,368,582	1,304,590	58,501	2,017	3,474	---	---	1,027,746	982,786	617,298	230,582	4,719	3,482	1,838,867
1928	1,610,252	1,540,613	65,097	118	4,298	126	---	1,075,407	1,474,512	767,049	314,457	5,175	1,944	2,563,137
1929	1,726,851	1,624,928	98,821	6	3,076	20	---	966,999	1,128,164	656,867	411,011	3,634	158	2,199,834
1930	1,501,404	1,444,361	55,166	25	1,852	---	---	613,947	678,115	688,457	220,468	2,415	154	1,589,609
1931	1,472,085	1,447,552	17,336	4,091	3,106	---	---							

Development of Methods of Handling the Catch.

Since the inception of the pilchard-canning industry in 1917, those engaged in it have been seeking methods of placing pilchards on the markets of the world in large quantities and of improving the quality of the finished product. The first endeavours to dispose of a large pilchard-catch consisted of experiments with different methods of canning and curing. (*See* Table I.) These experiments have, on the whole, been only moderately successful, although they had for their result the establishment of a satisfactory method of canning.

In 1925 reduction machinery was installed on the coast for the reduction of pilchards to oil and meal. An examination of Table I. illustrates the impetus given to the pilchard industry by that innovation. Even yet, the improvement in marketing methods is probably far from complete. The reduction machinery in use is not perfect, with the result that much oil and meal is lost with the waste liquors to contaminate the shores. Some of these defects have been eliminated by the use of more efficient machinery and further improvements appear imminent. These should lead to more profitable operation of reduction plants and improved products.

Moreover, it seems reasonable to expect that still further improvements may take place in methods of marketing the products of the pilchard-fishery. Even with the present and imminent improvements, the reduction and canning processes are not perfect and it is possible that entirely new outlets may be developed.

Early Fishing Equipment.

The first pilchard-catches in British Columbia were made with equipment designed for use in other fisheries. The seine-boats used were small herring or salmon seiners of lengths between 45 and 55 feet and of 20 or 30 tons displacement. Boats such as those used could not be con-

sidered seaworthy under the conditions of the present fishery. Power-brailing and turntables were part of the equipment, but live rollers were not used.

With the small nets used under the favourable weather conditions of the inlets, it was not usually considered essential that the seine-boat be "towed off" by the tender in order to prevent the seine-boat drifting over the net. Accordingly, the tenders were quite small boats which were employed chiefly to handle scows. In those early years when pilchards were used entirely for canning by canneries of small capacity, the requirements of the operators were best met by a few tons of fish in a small deck-scow.

The nets used were small herring purse-seines. Those used by one operator were in the neighbourhood of 75 fathoms long by 14 fathoms deep, which is small in comparison with those employed at present.

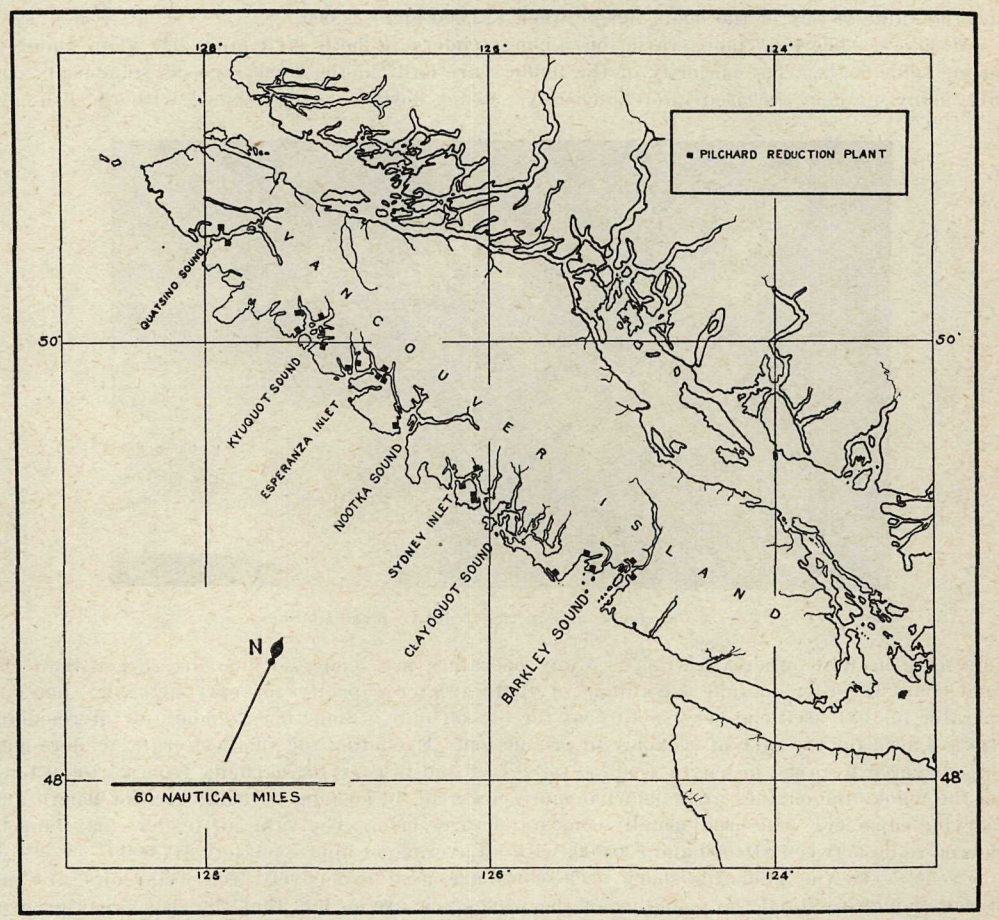

Fig. 2. Map of Vancouver Island, showing the position of pilchard-reduction plants.

Modern Equipment of the Pilchard-fishery.

Seine-boats.—A seine-boat of the style now in common use in the pilchard-fishery is laid out with pilot-house and galley amidships above the engine-room, the sleeping-quarters of the six or seven members of the crew, other than the skipper, forward, and the fish-hold aft. A 30-foot mast is placed immediately abaft the house and the boom is adjusted to reach to within 2 or 3 feet of its top. A wheel on the lookout bridge on top of the pilot-house enables the skipper to direct the boat from a place of vantage while scouting for fish or making a set. A large hatch leading to the fish-hold, an independent power-gurdy with two nigger-heads situated about 3 feet aft of the mast, and a turntable with a power-driven live roller, constitute the rest of the

essential deck equipment. There are in use on the coast a number of pilchard seine-boats which depart from this description, but they are few in number and the differences are not radical.

The pilchard seine-boats at present in use range in length from 55 to 75 feet, with lengths in the neighbourhood of 65 feet being most common. The specifications for seine-boats which follow do not necessarily apply to the largest or smallest craft. Beams are from 16 to 18 feet. Tonnages are registered at from 30 to 45 tons and hold capacities run from 30 to 60 tons. Most of the boats are powered by full Diesel engines, although both gasoline and semi-Diesel engines are used. These units range in power from 40 to 140 horse-power, with the majority between 65 and 90 horse-power.

A skiff is a necessary part of fishing equipment, as will be shown later. It is a heavily built, sturdy, flat-bottomed boat of a size up to 25 feet long, 7 feet wide, and 2 feet deep.

An average value for the seine-boats in use at present is in the neighbourhood of $15,000 and the value of any of the boats lies between $12,000 and $22,000.

Tenders.—There is more variation among tenders in both style and size than there is among seine-boats. The majority of the tenders are built in the same style as seine-boats; in fact, many of them are used interchangeably. Some, however, are designed with the fish-hold

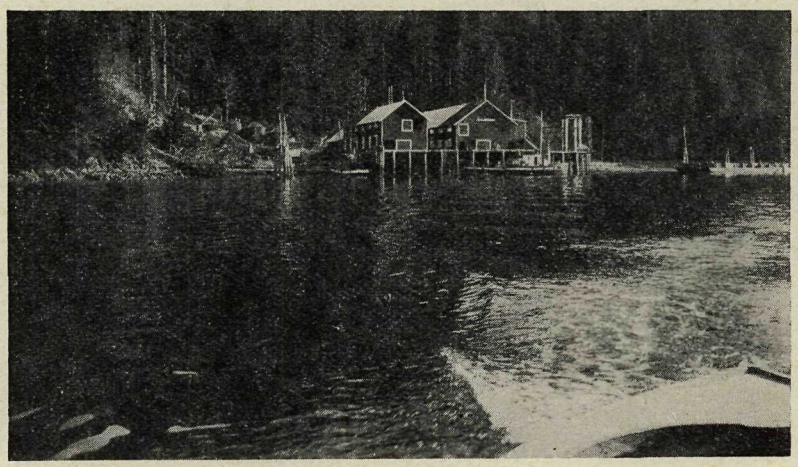

Fig. 3. Caledonia, a reduction plant in Kyuquot Sound.

amidships or with other variations. Many operators use tenders which are larger than the seine-boats in order to take advantage of their greater capacity for carrying fish; but one operator in 1931 used one very small boat for tow-off only. Sometimes tenders of intermediate size are used for the sake of economy in production. Excluding the smallest craft, tenders may be considered to range in length from 50 to 80 feet and in carrying capacity from 25 to 90 tons. On the whole, the engines are somewhat more powerful, in keeping with the greater length and carrying capacity. The crew usually consists of three men. The value of tenders may be considered to lie between $10,000 and $30,000, with an average of approximately $17,000.

Scows.—In the pilchard-fishery deck-scows are used exclusively, for well-scows are not strong enough to stand the pounding of the waves and are so low that the seas breaking over them would wash out the contents. In load capacity scows range from 30 to 80 tons and in value from $1,200 to $1,600.

Nets.—The commercial fishery for pilchards is carried on entirely with purse-seines. The seines are fitted with a purse-line or draw-string, so that when the net has been set around a school of fish the bottom of the net may be closed and the fish entirely surrounded by the net and the surface of the water.

The purse-seines in common use in the present fishery are 200 to 225 fathoms long and 20 to 22 fathoms deep. The cork-line is made of 33-thread (2½-inch circumference) pure manila rope, although one end or both may be heavier. The floats are disks of cork 2 inches thick and 5 inches in diameter; their number is such that they average one to every 4 or 5 inches, but they are usually placed two or four together so that the gaps between them are longer, in order to provide hand-holds for the crew. In fishing, the cork-line is also held up by six to twenty

"Scotch buoys." These inflated 12-inch canvas bags are tied or snapped on the cork-line in such a way that they may be readily moved from one part of the cork-line to any part which appears to be getting carried down by the movement of the fish. The lead-line is manila rope 1¼ to 1½ inches in circumference. On it are strung a large number of leads which run in weight from four to six to the pound. Their number is sufficient to bring the total weight of lead up to 1,000 or 1,500 lb.; their arrangement depends on the preferences of the man in charge of making the net. The ends of the net are laced to a 15-thread rope to which are lashed at intervals of about a fathom the 2½-inch brass breast-rings. Through these rings runs the heavy breast-line. Along the lead-line are placed the purse-rings. These rings are made of ⅜-inch brass and have an inside diameter of 4 or 4½ inches. Each is made fast to the middle of a 2-fathom piece of rope, the ends of which are tied to the lead-line, so as to meet it at points 2 fathoms apart. The rings are thus 4 fathoms apart. Through the rings runs the 3-inch to 4½-inch (circumference) purse-line of best manila 4-strand rope. One operator, however, uses a 1⅛-inch wire cable for a purse-line.

As is the case with the specifications for the nets already described, the detail of the arrangement of the web is dependent largely on the judgment of the individual concerned, so that the following figures must be taken as indicating the general conditions, rather than the specifications for a definite net or applying to all nets used on the coast. For the main part of

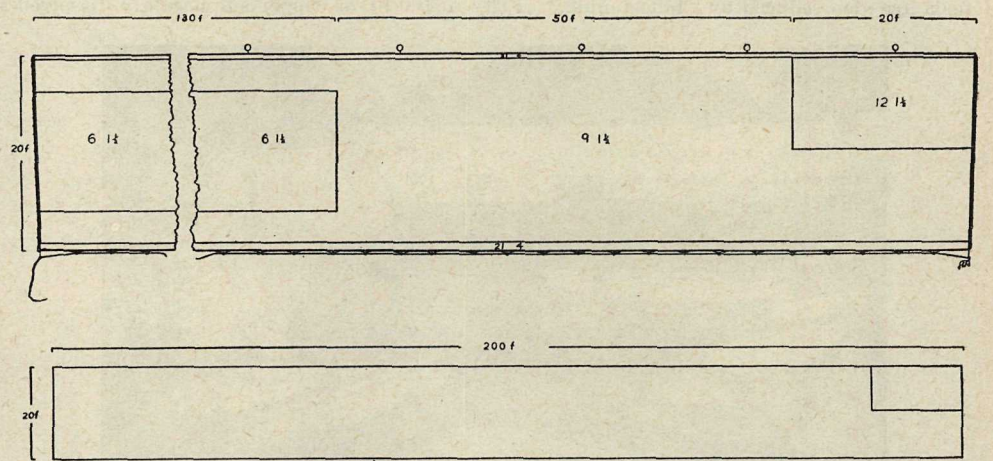

Fig. 4. Diagrammatic representation of the arrangement of a pilchard-seine. The diagram is not intended to illustrate any particular net, but is intended to show the principles involved in assembling a purse-seine. Twine weight and mesh are indicated on the various sections of the net. The lower diagram is intended to illustrate the proportions of the complete seine and the relative size of the bunt. The various sections of the net are drawn to scale, but the rings, buoys, and lines are drawn to a larger scale.

the net some operators prefer to use 1½-inch stretched mesh with No. 6-thread twine, while others prefer 1¾-inch mesh with No. 9-thread twine. The parts of the net next to the cork and lead lines, and the bunt, the section in which the fish are closely confined before being brailed into the boat, are made out of heavier material to withstand the heavy strain put upon them by the pull of corks and leads or the weight of the fish. A strip of 20 or 25 meshes along the lead-line is made of 4-inch mesh net woven of No. 15- or even No. 21-thread twine, and some operators prefer a similar, though narrower, strip along the cork-line. A bunt of 20 to 30 fathoms is usually made of No. 9- or No. 12-thread 1¾-inch mesh, but the top of the bunt in which the final stages of "drying-up" are carried out is usually constructed of even heavier material (12- to 18-thread). The nets are usually, although not always, hung a little more fully in the lead-line than in the cork-line in order to make the net bag and, consequently, purse more effectively and readily. Twenty-five to 35 per cent. slack is usually allowed on the cork-line. The way in which nets may be assembled is shown in Fig. 4.

The value of a pilchard purse-seine is between $2,700 and $3,500.

Other Equipment.—Two other pieces of equipment are essential to pilchard-fishing—the turntable and the brailer. The turntable is approximately 15 feet square and is placed at the stern of the seine-boat, of which it is really a part. Its chief use is to allow the net to be

pulled in over the side of the boat and later set over the stern with a minimum of difficulty. In addition to this, the outer edge of the turntable is fitted with a power-driven "live roller" which by its rolling action assists the fishermen in hauling the net aboard after a set.

The brailer is a large dip-net with a long handle and an open bottom whose head is connected by a triple or quadruple bridle to the block on the boom, and from it to a special independent brailing-winch. While the head is lowered by the winch its direction is guided by the long handle, so that the net is plunged among the fish. While this is being done the bottom of the net is kept closed by a patent brailing-block which is tripped after the net has been lifted over the scow or hold, allowing the fish to fall through the bottom of the net. The bottom of the net is then closed by gently pulling on the trip-line and the operation repeated. Both winches and the live roller are driven by the main engine.

Care of Pilchard-seines.—Large tears in the net necessitate the return of the seine-boat to the cannery or reduction plant so that the net may be pulled out on the dock for repairs. Small holes are disregarded until they are observed in "bluestoning" the net or in making major repairs.

In order to avoid rotting of the web all twine for use in purse-seines is tarred. When nets are not in use, as during closed seasons or in bad weather, a couple of bags of salt are scattered over the net and washed through it with a few pails of water to avoid heating. Decay-producing bacteria are also reduced by "bluestoning." Fifty to 100 lb. of copper sulphate are dissolved in

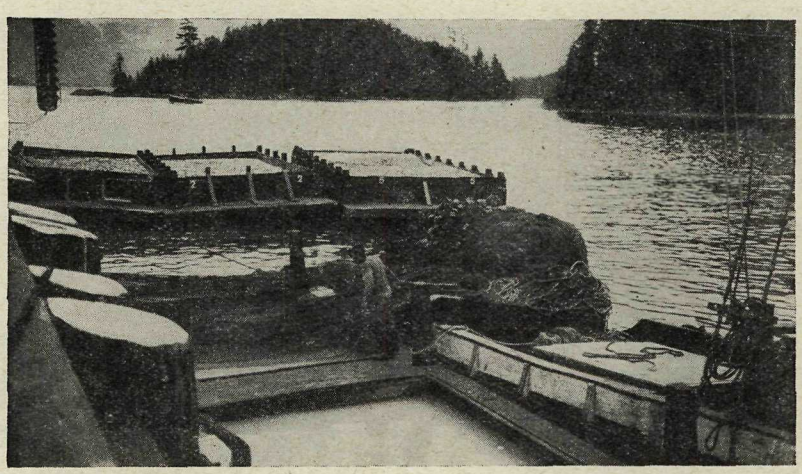

Fig. 5. Pulling a seine from the turntable into a bluestone tank. In the background are shown three scows waiting to be unloaded, and the position of the marine leg when not in use.

water in a small well-scow large enough to allow the net to be covered with the solution while in it. The net is piled into the scow and left for a short time before being washed and replaced on the turntable (Fig. 5).

Economic Considerations.—Practically all the boats and nets are owned or chartered by the pilchard-plant operators and are turned over to captains selected for the season by them. In recent years a few independent outfits have been engaged in the fishery, but have met with indifferent success, probably due to lack of capital and consequent inferior equipment.

The costs to the operator have been subjected to considerable fluctuation. In the early days, when all the pilchards were used by two or three canneries, there was not sufficient competition for either fish or boats to materially reduce the availability of either. However, with the rapid growth of the industry which followed the introduction of reduction machinery, the most accessible fish were soon captured, necessitating going farther afield and using better boats. As first-class seiners and tenders were scarce, the competition for these became very keen, with the result that charters were expensive. This stimulated the building of suitable craft, so that now the supply almost meets the demand. In consequence it is unlikely that charter prices will ever again run so high as they did before the deflation in 1929.

The price paid the fishermen for fish varies from year to year and is fixed at the beginning of the season. Three dollars a ton, divided equally among the crew, with a 25-cent bonus for the

skipper, is a fair average figure for crews using company equipment. This brings the price of fish to the operators to something between $8 and $10 a ton. Eight dollars to $10 a ton is the price paid to independent crews.

Tender crews are paid either by the month or by the ton.

The catch of one boat during the fishing season is between 1,000 and 3,000 tons, exclusive of extremes. The size of the catch made by a boat depends on a number of factors, prominent among which are the abundance and availability of fish, the weather, the skill of the fishermen, the size and efficiency of equipment available, and luck.

Fishing Methods.

General.—The British Columbia pilchard-fishery is carried on entirely during the daylight and dusk hours, with the best results usually obtained at daybreak and dusk. Night-fishing is precluded by the damage which is done to nets after dark by dogfish. As the fishermen must be on the fishing-grounds by daybreak, and may be working after dark in brailing from the net fish that were caught at dusk, the working-hours during the fishing season are very long. The location of the fishing-grounds varies from day to day. As a rule, fish are sought in the neighbourhood of recent catches, but, if such an indication of the location of the schools is lacking, the search is directed to localities in which the discoloration of the water indicates an abundance of food-organisms.

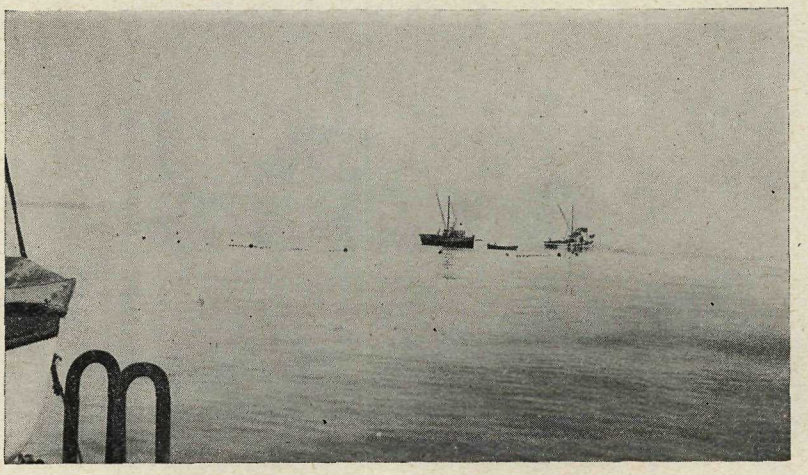

Fig. 6. Pursing. The size of the circle made by the net is shown by the positions of the Scotch buoys. The corks may be seen in some places. The farther boat is giving tow-off.

Scouting.—When a boat is scouting for fish the skipper directs its course from the lookout bridge in order to have an increased range of vision. More often than not, he is assisted in keeping a lookout by some member of the crew there or in a crow's-nest on the mast. The skiff is dragged behind by the skiff-line, which is made fast to the seine-boat by being passed into a loop in a fixed rope and wedged there with a stick. The long free end of the skiff-line is fixed to the loop in the end of the cork-line, to which the breast and purse lines are fastened. At the other end of the net purse-line and breast-line are made fast to the loop in the end of the cork-line, as well as the tow-line, the other end of which is made fast to the seine-boat. The turntable faces aft.

Setting.—The seine-boat is usually followed at a considerable distance by the tender, which tows a scow on a long tow-rope and bridle when weather conditions are favourable.

When a school of fish is detected by a black "spot" on the water, or by individuals flipping from the water, the boat circles about them at slow speed in order to give the skipper an opportunity of studying their direction and speed of movement and of estimating wind and tide conditions. At this stage one member of the crew gets into the skiff. The net is then set by drawing the stick which releases the skiff-line and allows the skiff to pull the net off the turntable by the cork-line and purse-line, which are made fast to the skiff-line. The man in the skiff

assists in this operation by using the oars to oppose the pull of the net. The set is made in a circle to starboard at full speed in such a direction that the net is completely paid off the turn-table as the skiff is reached. If the circle is too large the tow-line is paid out until the skiff is reached. The tow-line is then pulled in by the winch until the net is brought up to the boat. The ropes are adjusted so that the strain in towing comes on the cork-line.

Pursing.—As soon as the circle has been completed, the purse-line is picked up from the skiff, the two ends are brought over rollers at the centre of the boat, and pursing is begun by hauling both ends of the purse-line with the winch. At this stage the fish are surrounded on only three sides and partly below, so that it is considered necessary to use some kind of a "scare" to keep the fish from escaping through the gap in the net under the boat. For this purpose a long pole is used, or a white, weighted board on a light rope, which is supposed to simulate a large fish. These scares are used until pursing is almost complete.

When pursing is under way the ends of the lead-line are pulled toward the surface by the pull of the purse-line. This tends to make the ends of the net belly out and give the fish an enlarged avenue of escape. In order to prevent this by keeping the end lines straight, the breast-lines are also hauled at both ends of the net.

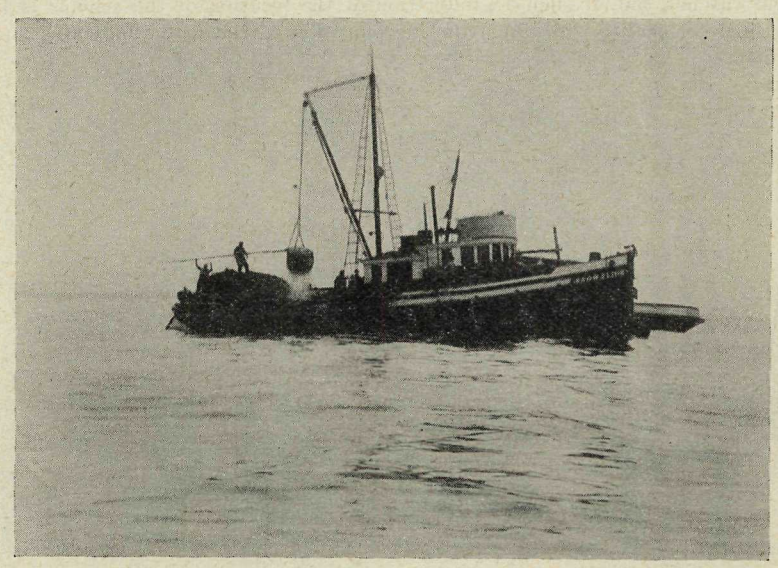

Fig. 7. Brailing. The stern of the tender may be seen beyond the bow of the seine-boat. The scow is shown only over the deck of the seine-boat and, to a slight extent, in front of it.

As soon as pursing is begun the tender drops the scow, if it has one, and gives the seine-boat "tow-off." To do this a line is attached amidships on the port side of the seiner, which is pulled by it steadily away from the net while pursing and hauling the net is under way (Fig. 6). In the meanwhile the scow is allowed to drift.

When pursing is complete the rings are drawn inboard by the last bight of the purse-line, a sling is put underneath the lines joining the purse-rings to the lead-line, the whole lead-line is pulled aboard by the winch and the boom and is made fast to the boat. By this time the two breast-lines are completely hauled and the breast-rings are on deck, so that the fish are completely surrounded below and on all sides by the net.

As a rule, when fish are missed, they are lost at a stage previous to the completion of pursing. Frequently, especially when the fish are "wild," the speed or direction of their travel is miscalculated and they are missed altogether. At other times they are surrounded by the seine, but escape by "sounding" under the lead-line before pursing is complete. In some cases, in spite of the scares, fish escape under the boat while pursing is in progress. After pursing is complete losses are more uncommon. When they do occur it is most often due to the weight of fish bursting the net or sinking the cork-line and skiff, although considerable losses often occur through holes torn in the net by sharks or dogfish trying to get at the catch.

"*Drying-up*" *and Brailing.*—The net is now pulled aboard from the seine-boat end and piled on the turntable, which has now been turned to face the starboard side of the boat. This is done either by making use of the live roller and having the crew pull the net over it, or by "fleeting" in the net, making use of the boom and winch. In the latter method a rope sling is put around the net and lifts it as high as possible before dropping it on the turntable. This operation is repeated until most of the net is brought aboard. While the net is being pulled aboard several members of the crew arrange it on the turntable so that it will run off smoothly on the next set. The purse-rings are slipped along the purse-line in the right order to keep the lead and cork lines even. The corks and floats are piled on the right-hand side of the turntable, the lead-line and purse-line on the left. Some crews draw the purse-line and run it through the rings again after all the net has been brought aboard.

While this is going on the man in the skiff works around the cork-line adjusting the Scotch buoys to the position where the weight of the fish seems to be greatest. Finally, the corks for a considerable section of the bunt are taken aboard the skiff in order to help support the weight of the fish, and the skiffman goes aboard to assist the rest of the crew.

When about 90 per cent. of the net has been pulled aboard the fish are all closely confined in the upper part of the heavy bunt at the skiff end of the net. At this stage the danger of the seine-boat overriding the net is largely obviated, so the tender is free to recover the scow and

Fig. 8. Tender, with scow alongside.

bring it alongside the seine-boat. When this done the scow is held in position between the seine-boat and tender on the port side of the seine-boat, while the catch is brailed into it as shown in Fig. 7. As the fish are removed from the net it is necessary, from time to time, to "dry up," by pulling in more of the net. This must be done cautiously, as there is danger lest the fish become overcrowded and die, resulting in the dead-weight breaking the net. If weather conditions are too unfavourable to permit the use of scows, the tender is made fast on the port side of the seiner and the fish are brailed into its hold. Scows are usually filled in preference to tenders, and tenders to seine-boats. This is to assure as small a loss of time as possible in unloading at the cannery or reduction plants, by having the boat take one of the empty scows which are usually available. Single catches of up to 100 tons of pilchards are made, but the average haul is in the neighbourhood of 35 tons. Catches in excess of 100 tons are infrequent, owing to the difficulty of holding in the net larger quantities of this active species.

When all the fish have been removed from the net the rest of the net is pulled aboard, the turntable turned to face the stern, and the search for fish continued, provided there is room in the carriers for them.

Packing and Unloading.--When the holds of all the carriers are filled, or if the boats are fishing close to their home plant at the end of the day, they return to be unloaded. Under favourable weather conditions several tons of fish may be carried on deck. Scows are towed in with a tow-line and bridle as usual until close to their destination, when they are taken alongside by the tender for better manœuvring (Fig. 8). On reaching the plant, seine-boats are usually unloaded first, in order to assure their ability to start out the next morning.

The method of unloading depends upon whether the fish are intended for canning or reducing. In the former case they are pushed and washed off scows, and are either shovelled by hand from the hold of a boat or the hold is filled with water and the fish brailed from it. This is to avoid unnecessary injury to the fish. Fish intended for reduction are usually unloaded directly from holds or scows by an adjustable bucket-conveyor or marine leg, as it has been established that the use of water in unloading results in the loss of oil (Fig. 9). Scows used in the pilchard-fishery are fitted with three small wells to accommodate the marine leg when unloading. The fish are pushed into the wells and then carried up into the fish-storage tanks by the bucket-conveyor.

At most reduction plants the amount of pilchards is measured while unloading, by making use of a specially constructed pair of identical boxes, each having a known capacity in the neighbourhood of a quarter of a ton. The boxes are constructed so that one may be filled while the fish run out of the other from below. At some plants the amount of fish is calculated from measurements of their depth on scows or in holds.

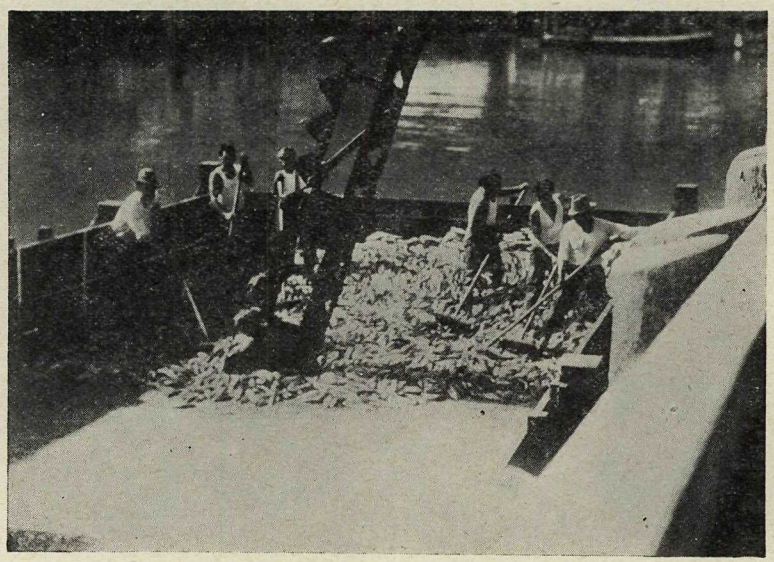

Fig. 9. Unloading a scow.

Reduction of Pilchards to Oil and Meal.

Ninety-five per cent. of the pilchards caught in British Columbia are reduced to oil and meal. On being unloaded at a reduction plant, pilchards are stored in large containers until they are processed, in order to free the floating equipment for further use and to assure a continuous supply of raw material for the plant. The fish are first passed through a continuous steam cooker, from which they go to a continuous press (Fig. 10), where the oil and water are separated from the moist cooked bone and muscle. The liquid portion is then pumped to a series of settling-tanks (Fig. 11), in which the oil and water separate. The oil so separated flows into other tanks where foreign material is allowed to settle from it for a few hours, after which the clear fluid is pumped into large tanks for storage. The water, with the suspended and dissolved material in it, runs into the sea. The solid portion from the press is carried by a screw-conveyor to the drier. This is a large horizontal revolving drum (Fig. 12), with longitudinal or spiral blades on the inside. Through this drum the solid material passes, being repeatedly

raised by the blades and dropped either through the heat of the flame from an oil-burner or against a hot metal drum, through which the heat passes. The dried flesh and bone is finally ground and sacked as fish-meal.

Reduction-plant crews are usually paid by the hour or the month, although those who assist in unloading are usually paid by the ton. Pilchard-reduction-plant crews are composed entirely of whites and native Indians.

Uses of Pilchard Oil and Meal.

Pilchard-oil is used for a variety of purposes. After being subjected to the process of hydrogenation it is largely used in the manufacture of shortenings, oleomargarine, and soap. It has been proven valuable as an oil for smoke-stack paints, and recent scientific work has shown that when used with suitable drying agents it is an excellent oil for general-purpose paints. It is rich in Vitamin D and has been used successfully as a base for poultry-oils, proving a competitor for cod-liver oil for this purpose. Other possible uses for pilchard-oil are in the manufacture of linoleum and water-proof coats and as oils for tanning and tin-plating. Scientific research is rapidly increasing the knowledge of possible uses of pilchard-oil and may be depended upon to indicate the way to make use of it in still further high-grade products.

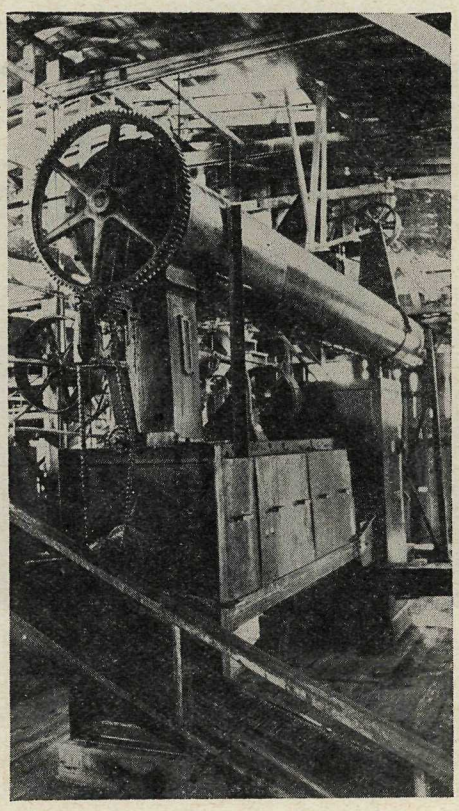

Fig. 10. Cooker and press unit. The cooker is above.

Since the commercial use of pilchard-oil in the raw state is practically negligible, and since no factories in Western Canada are equipped to bring about the changes in chemical composition of the oil which are necessary to prepare it for industrial purposes, relatively little pilchard-oil in the raw state is used in Canada, and the great proportion of the yield is exported for refining. In consequence the Canadian producers have the prices of their product controlled by foreign buyers—a condition which is far from satisfactory. The erection of one or more hydrogenation plants on the Pacific Coast of Canada would relieve this situation and greatly strengthen the position of the pilchard-fishing industry. This is a project which will, no doubt, go ahead as soon as capital is available.

Pilchard-meal is used largely as feed for domestic live stock, particularly poultry, although part of the lowest-quality product is used in fertilizers. Some of the better-quality pilchard-meal is used for human consumption.

Canning.

Pilchards are used for canning only when they reach the plant shortly after capture. Fish intended for canning are pushed off scows into an inclined slat-conveyor with the assistance of a strong stream of water; from boats they are unloaded either by filling the hold with water and brailing the fish into the conveyor or by shovelling them out of the hold with wire scoops. Fish are handled in this way to avoid injuring them and in order to remove some of the scales before the fish enter the cannery. Fish brought to the cannery on scows are preferred for canning, as they have not been subjected to as great a weight of fish above them as those packed in the holds of boats.

On leaving the conveyor the fish are weighed and then passed through the scaler, which consists of a revolving cylinder of coarse heavy wire netting about 2 feet in diameter and about 10 feet long, set at a slight angle to the horizontal. While operating it is freely sprayed with water. The fish, in passing through it, are tumbled against the netting and against one another, removing the loosely attached scales, which are washed away by the water. From the scalers the fish are carried to a large hopper, from which they are supplied to the cutters.

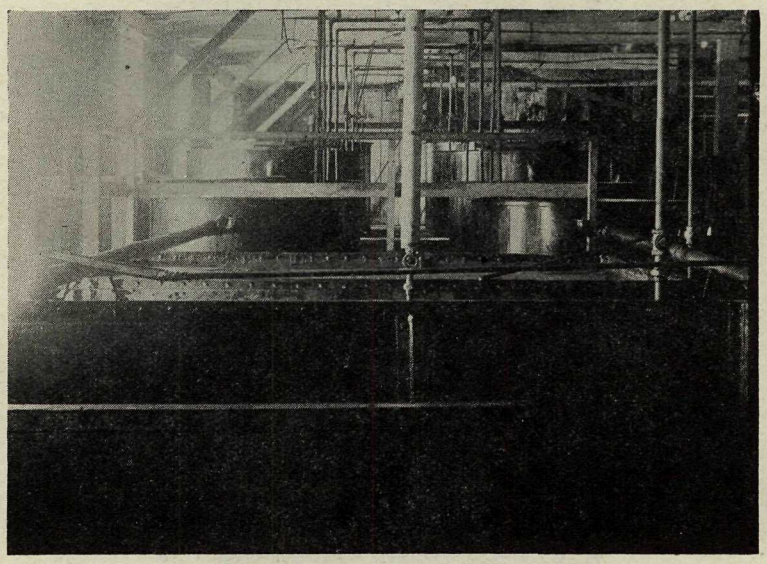

Fig. 11. Oil-separation tanks.

A cutter (Fig. 13) consists of an endless belt on which are fixed a large number of elongated wooden buckets of a size and shape suitable to hold a pilchard. In the buckets the fish are carried past a series of knives and paddles which carry out the operations preliminary to canning. The operator takes the pilchards as they come from the hopper and places them belly down in the buckets, with the snout against a plate to assure uniformity in their position on the conveyor. The fish are carried past the first knife, which makes a cut through the backbone from above. Then the head and viscera are removed by a pliable rotating paddle working at right angles to the direction of the conveyor. The paddle is adjusted so that one of the four blades strikes the head of the passing pilchard, pulling the head off and, attached to it, almost all of the internal organs. Another knife (or two in the case of half-pound flats) removes the tail and cuts the cleaned fish into appropriate lengths for "pound talls" or "half-pound flats" before these "body-cuts" fall off the end of the conveyor. The machine is arranged so that the heads and viscera and tails fall into one conveyor and the body-cuts of the fish reach another. The waste offal is carried by conveyors to the reduction plant for reduction to oil and meal. At this stage the body-cuts of the fish may be stored for a few hours, or they may be carried immediately to the filling-table, after being passed through a second scaler to remove any

remaining scales, and for thorough washing. When necessary body-cuts are picked over and cleaned by hand.

All cans are filled by hand, after which they are salted, capped, exhausted to exclude the air, and seamed by the usual cannery methods. Some pilchards are canned with tomato sauce. Finally, the cans are cooked in a retort at 15 lb. steam-pressure for an hour and a quarter. After cooling the cans are put in cases for shipment. Labelling may be done at the plant or by the wholesaler.

Three to five experienced cannery employees in charge of various phases of the work are paid salaries, but most of the work is done by contract labour as piece-work.

The British Columbia pilchard is very closely related to the Cornish pilchard, which is the adult of the species of which the young are packed as the true French sardine. Its relationship would therefore arouse expectations of a high-grade canned product. These expectations are not deceived, for canned pilchard, either plain or with tomato sauce, is an excellent product which is, however, not as popular as its quality would warrant. Its lack of favour is probably due to the low cost, suggestive of inferior goods, and the prejudice incurred during the early

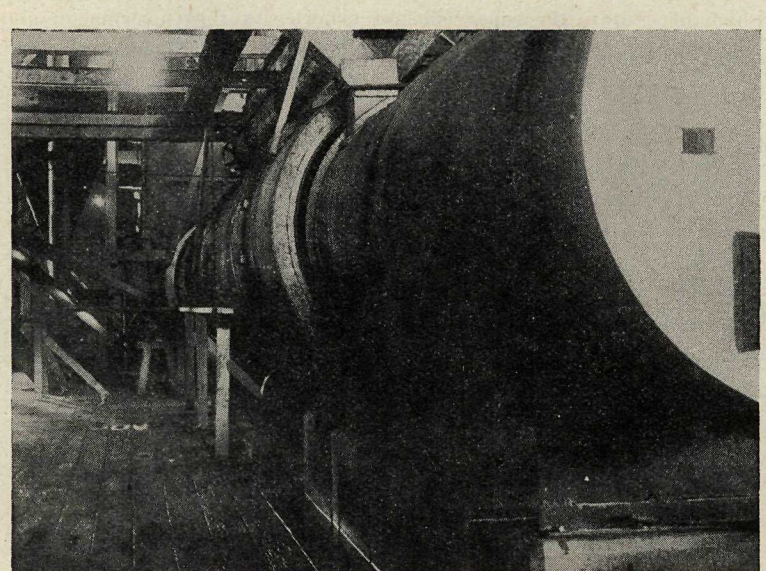

Fig. 12. Drier and firebox. The firebox is in the foreground.

days of the industry by the marketing of second-rate products produced in experiments with machine-filling and other methods of packing cheaply. There is no foundation now for any suspicion as to the quality of the canned pilchard-pack, for it is entirely put up from the freshest fish, handled with modern machinery, and treated with all necesssary care. The half-flat particularly is a choice product. At present approximately half a dozen brands are now produced by two operators. Familiarity of the public with the high quality of canned pilchards would no doubt greatly increase the demand for this product. A programme of educating the public by advertisement is in order and has, indeed, been begun by one company.

THE NEED FOR AND SCOPE OF A SCIENTIFIC INVESTIGATION.

The Need for an Investigation.

In the preceding sections it is pointed out, concerning the pilchard industry, that it is of recent development, that it is responsible for the capture of a very great quantity of pilchards, and that much capital has been invested in it. It is suggested, moreover, that for advantageous expansion of pilchard-canning it is necessary to educate the public concerning the excellence of the canned product, and that to continue profitable operation there is necessary the investment of considerable sums of money in the erection of hydrogenation plants and in research leading to the use of pilchard products in the manufacture of high-grade commodities, in order that the oil and meal may command higher prices on the market.

The levy which is being made upon the fishable stock of pilchards by the fishery, and the absence of a long-continued history of successful operation under existing conditions, has led to some doubt concerning the ability of the stock to withstand the demands upon it without becoming so materially reduced in numbers as to interfere with the profitableness and continuance of the industry. If these doubts prove correct it will be a matter of considerable gravity, in view of the amount of capital which has been already invested in the pilchard industry and the additional expenditures which are necessary to assist in assuring the profitable continuance of the industry. There is, then, an urgent need for information as to the extent of the pilchard stock, and the effect which the fishery is likely to have upon it in order that further investment may not be made unadvisedly. The continuance is indicated, therefore, of the investigation examining the life-history of the pilchard along those lines which deal with its numbers, its fecundity, and its reaction to the strain of a fishery.

The Role of the State in administering a Fishery.

Before examining the conditions peculiar to the pilchard industry, it may be well to consider the factors which necessitate the supervision of fisheries by the Government, and the nature and scope of the duties of its administration.

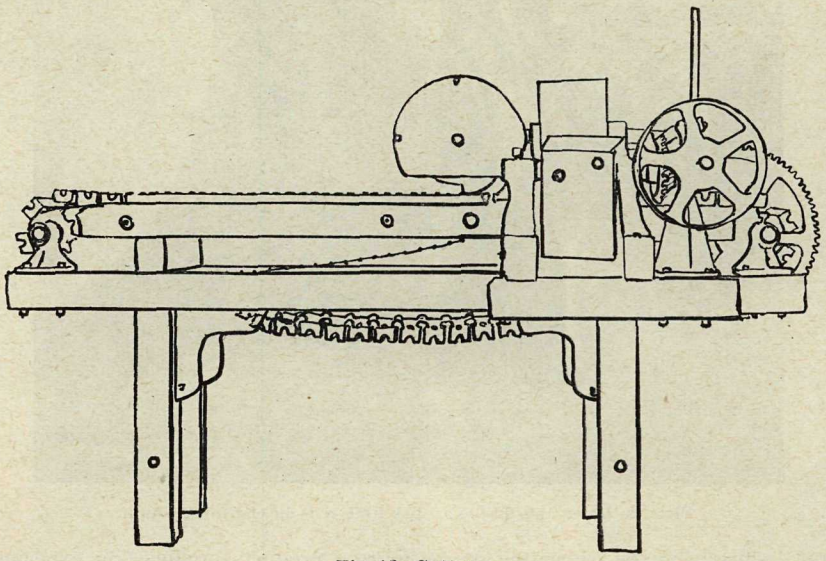

Fig. 13. Cutter.

Possibility of Depletion.—In the first place, it must be recognized that marine fisheries may become depleted. There are all too many illustrations to show that this is the case. In some districts of British Columbia the sockeye salmon is now reduced to a small fraction of its former abundance, as is clear from the catch records, and Thompson and others (Rep. Internat. Fish. Comm., No. 6, 1931) conclusively demonstrate that the abundance of halibut on the banks of the North Pacific has decreased by 50 to 80 per cent. Leim (Contr. Canad. Biol., Vol. 2, 1924) shows that the Canadian catch of the Atlantic shad has been greatly reduced in recent years, and Huntsman (Bull. Biol. Bd. Can., No. 21, 1931) points out that in a number of regions the Atlantic salmon is exterminated or nearly so. Rounsefell (Bull. U.S. Bur. Fish., Vol. 47, 1931) demonstrates the depletion of the herring in several districts in Alaska. Garstang (J. Mar. Biol. Ass., Vol. 6, 1900) shows definite depletion to exist in the bottom fisheries about the British Isles as early as 1900.

Responsibility of the State.—The fisheries are a public resource; they belong to the country, and they should be so administered that they may continue to be of service and yield profit in the future as at present. The prime duty of the Government in its administration is to assure to this end a continued supply of raw material for the fisheries. This task of necessity falls

upon the State, since private bodies have neither sufficient permanence nor disinterestedness to assure successful supervision.

In recent years the Governments of countries having extensive fisheries have sought to assist their fishing industries by helping them to market their products in their most profitable form, by inspecting and certifying products, by assisting in locating fish, and providing various aids to navigation. Useful as these forms of assistance most certainly are, they should always remain secondary to the main responsibility of the Government in regard to fisheries, which is to decide what regulations are necessary to protect the future of the fisheries and, having so decided, to promulgate the required laws and undertake their enforcement.

Determining the Most Advantageous System of Exploitation.—If the State is to accept as its duty the protection of a fishery and the assurance of its survival, some decision must be reached as to the form which protection should take. Unreasoned and unreasonable limitation of a fishery may not result in assuring its permanence, and is almost certain to result in less profitable operation for the industry. On the other hand, exploitation must not be allowed to proceed unrestrained and unheeded lest irreparable damage be sustained by the fishery. As there is no means of ascertaining what strain a species may withstand without actually submitting it to the strain, the policy of the Government with respect to a new fishery should be to allow free exploitation, but at the same time to maintain a very close inspection of the condition of the fishery and the way in which the stock of fish is reacting to the fishing strain. At the first sign that more fish are being captured by the fishery than may be supplied by the natural increase—i.e., that depletion is occurring—restrictive legislation should be enacted and enforced, and the fishery should still be kept under observation to determine (1) its reaction to the new strain, and (2) whether it is possible for fish stock and fishery to reach equilibrium under the new conditions. It is only by such a series of full scale, carefully observed experiments that the most satisfactory policy of exploitation may be determined.

Necessity for Accurate Statistics.—How, then, is the Government to keep a fishery under observation? The simplest and most obvious criterion of the condition of a fishery is the amount of fish caught. It is evident, accordingly, that the keeping of full and accurate statistics is one of the chief responsibilities of the State. It will be pointed out later that plain catch statistics cannot be sufficient in themselves to give positive indication of the condition of the fishery, but in most cases they are the foundation upon which more critical analyses are based, and to it they are most essential. These data are most valuable when kept along with those on the price paid for fish and the number of boats and men engaged in the fishery in question.

Factors tending to disguise Depletion.—Although economic conditions or other factors may occasionally tend to reduce the catch of any species of fish, it may be regarded as generally true that a falling-off in the catch of fish over a considerable period of time indicates a reduction in the abundance of the stock. However, a number of factors prevent the assumption that when the catch increases or remains stationary the abundance of fish in the stock is increasing or remaining unchanged.

The price paid for fish of a species may exert an influence toward disguising depletion. As a species becomes reduced in numbers the market for it becomes stronger, thus encouraging the fishermen to make greater efforts to secure that species, and even enabling them to pursue a profitable fishery at a level of abundance of the exploited species which would have compelled the cessation of the fishery for economic reasons at former prices. Since the price paid for fish is only a small proportion of the retail price paid by the consumer for the marketed commodity, the existence of depletion is not brought home to the public at large until the numbers of the species have been reduced to the point where it is in danger of economic, if not actual, extinction.

Another factor which is likely to lead to carrying on a fishery for a species beyond the minimum abundance for safety, and beyond the point where profitable exploitation could not otherwise have been carried on, is the broadening of the fishery to include other species. By expansion of this kind the profits for each fishing period are augmented, and the capture of the principal species on which the fishery was based originally may continue far past the point beyond which economic considerations would otherwise have led to the closing of the fishery.

A relationship which might result in a condition of this kind exists between the pilchard and herring fisheries of British Columbia. The same floating equipment is used in both fisheries, and to some extent the same nets, docks, and business offices. In consequence, given one abundant fishery, the other may be carried on profitably at a very low level of abundance of

the secondary species, or both fisheries may be carried on together under conditions which neither could withstand alone.

The inevitable development of the fishery is still another factor which is likely to disguise depletion until it has reached serious proportions. Development may take place in the continued adaptation of fishing equipment to the conditions of the particular fishery and consequent increase in fishing efficiency, or it may take the form of extensions to include new fishing-grounds, made economically possible by increased prices which recompense the fishermen for longer runs to and from less accessible regions. The introduction of steam-trawlers and otter-trawls prevented the detection of depletion in the North Sea ground fisheries for some time, and the north-westerly movement of the centre of the halibut-fishery to untouched and more populous banks for many years disguised the depletion which was occurring in the Pacific fishery for that species. The influence of developments of these kinds is to be discerned only with great difficulty, if at all, from an examination of fishery statistics as usually prepared.

One other type of growth is likely to mask the effects of overfishing and depletion. That is the increase in the number of boats or amounts of equipment used in fishing for the species in question. In many species the catch has been kept up by dint of increased numbers of fishing-boats and nets until depletion has become excessive. From the information contained in ordinary fishery statistics, some allowance may be made for the development of a fishery in this respect by considering the amount of the species caught for a unit of fishing equipment, but such allowances are not adequate in all cases.

In the case of schooling fish, such as pilchards, herring, or even salmon, it cannot with safety be assumed that the amount of fish caught by any selected fishing unit is proportional to the abundance of the fish until such an assumption is shown to be justified by a careful examination of the fishery. In the case of such species the time consumed in catching and landing fish may not increase materially as the fish become more scarce. This is true when comparatively small time is consumed, under all conditions of abundance, in locating the schools of fish, as compared with the time taken in setting, loading, running, and unloading. This will be particularly the case when a reduction in the numbers of the stock of fish is accompanied by the existence of a smaller number of schools of undiminished size.

The influence of catch limits imposed from time to time in periods of abundance by the buyers, and changes in the regulations in regard to periods closed to fishing, are difficult to allow for in estimating the abundance of a species from the catch.

Inadequacies of Fisheries Statistics and the Remedy.—From the foregoing it is evident that, although fisheries statistics are useful as indices of the condition of a fishery, they cannot be depended upon to reveal the existence of depletion as soon as it occurs. Furthermore, fisheries statistics have the disadvantage that at best they indicate only the changes in abundance of fish of a species, rather than why or how the abundance has altered. Ordinary fishery statistics have in them no means of distinguishing between changes in abundance of fish brought about by the action of the fishery and those caused by natural fluctuations in abundance, such as are known to occur in many species, and which have from time to time made themselves apparent in the great fisheries of the world.

It follows, then, that the responsibility of the State is not fully discharged by the collection of fishery statistics of abundance alone, but that it must also maintain careful supervision of the fishery to ascertain what may be the source of such variations in the abundance as may be observed. If variations appear which are evidently caused by depletion of the fishery, restrictive legislation must be adopted and enforced and the reaction of the fishery to the new conditions observed and analysed. The supervision of the fisheries should be undertaken by suitably trained investigators who would be competent to adjust each investigation to the species of fish in question, and who would be qualified by biological training to recommend the system of exploitation which would lead to the most profitable use of each species, compatible with the assurance of the permanence of the industry dependent upon it.

PACK OF BRITISH COLUMBIA SALMON, SEASON 1932.

SHOWING THE ORIGIN OF SALMON CAUGHT IN EACH DISTRICT.

District.	Sockeye.	Springs.	Steel-heads.	Cohoes.*	Pinks.	Chums.	Grand Total (Cases).
Fraser River†	65,769	28,701	23	16,815	385	14,948	126,641
Skeena River	59,916	28,269	404	48,312	58,261	38,549	233,711
Rivers Inlet‡	69,732	459	29	7,062	3,483	944	81,709
Smith Inlet§	25,488	48	20	273	1,148	165	27,142
Nass River	14,154	4,408	10	7,955	44,629	14,515	85,671
Queen Charlotte Islands	2	278	.....	3,805	2,415	358	6,858
Vancouver Island‖	27,611	10,559	91	63,637	33,403	70,629	205,930
Outlying Districts	27,683	3,236	591	41,172	80,034	166,653	313,369
Totals	284,355	75,958	1,168	189,031	223,758	306,761	1,081,031

* Bluebacks are combined with cohoe in this table.

† 4,000 cases of sockeye packed at Esquimalt are credited to the Fraser.

‡ 9,062 cases of sockeye packed on the Fraser are credited to Rivers Inlet.

§ 800 cases of sockeye packed on the Fraser are credited to Smith Inlet.

‖ 11,816 cases of sockeye packed on the Fraser are credited to Vancouver Island; 69,943 cases of other than sockeye packed on the Fraser are credited to Vancouver Island.

STATEMENT SHOWING THE SALMON-PACK OF THE PROVINCE, BY DISTRICTS AND SPECIES, FROM 1917 TO 1932, INCLUSIVE.

FRASER RIVER.

	1932.	1931.	1930.	1929.	1928.	1927.	1926.	1925.
Sockeyes	65,769	40,947	103,692	61,569	29,299	61,393	85,689	35,385
Springs, Red	18,298	9,740	11,366	3,305	1,173	7,925	12,783	7,989
Springs, White	10,403	.....	9,761	6,699	3,909	10,528	20,169	25,701
Chums	14,948	251	68,946	144,159	193,106	67,259	88,495	66,111
Pinks	385	13,307	30,754	158,208	2,881	102,536	32,256	99,800
Cohoes	16,815	8,165	25,585	40,520	27,061	24,079	21,783	36,717
Bluebacks and Steelheads	23	657	27,879	12,013	795	10,658	13,776	5,152
Totals	126,641	73,067	277,983	426,473	258,224	284,378	274,951	276,855

	1924.	1923.	1922.	1921.	1920.	1919.	1918.	1917.
Sockeyes	39,743	31,655	51,832	39,631	48,399	38,854	19,697	148,164
Springs, Red	2,982	3,854	10,561	11,360	10,691	14,519	15,192	10,197
Springs, White	4,648	4,279	6,300	5,949	4,432	4,296	24,853	18,916
Chums	109,495	103,248	17,895	11,233	23,884	15,718	86,215	59,973
Pinks	31,968	63,645	29,578	8,178	12,839	39,363	18,388	134,442
Cohoes	21,401	20,173	23,587	29,978	22,934	39,253	40,111	25,895
Bluebacks and Steelheads	1,822	15	817	1,331	4,522	15,941	4,395	4,951
Totals	212,059	226,869	140,570	107,650	136,661	167,944	208,857	402,538

STATEMENT SHOWING THE SALMON-PACK OF THE PROVINCE, BY DISTRICTS AND SPECIES, FROM 1917 TO 1932, INCLUSIVE—*Continued.*

Skeena River.

	1932.	1931.	1930.	1929.	1928.	1927.	1926.	1925.
Sockeyes	59,916	93,023	132,372	78,017	34,559	83,996	82,360	81,146
Springs	28,269	9,857	7,501	4,324	6,420	19,038	30,594	23,445
Chums	38,549	3,893	5,187	4,908	17,716	19,006	63,527	74,308
Pinks	58,261	44,807	275,642	95,305	209,579	38,768	210,081	130,079
Cohoes	48,312	10,637	29,617	37,678	30,194	26,326	30,208	39,168
Steelhead Trout	404	768	58	13	241	582	754	713
Totals	233,711	162,986	450,377	220,245	298,709	187,716	407,524	348,859

	1924.	1923.	1922.	1921.	1920.	1919.	1918.	1917.
Sockeyes	144,747	131,731	96,277	41,018	89,364	184,945	123,322	65,760
Springs	12,028	12,247	14,176	21,766	37,403	25,941	22,931	16,285
Chums	25,588	16,527	39,758	1,993	3,834	31,457	22,573	21,516
Pinks	181,313	145,973	301,655	124,457	177,679	117,303	161,727	148,319
Cohoes	26,968	31,967	24,699	45,033	18,068	36,559	38,759	38,456
Steelhead Trout	214	418	1,050	498	1,218	2,672	4,994	1,883
Totals	390,858	338,863	477,915	234,765	332,887	398,877	374,306	292,219

Rivers Inlet.

	1932.	1931.	1930.	1929.	1928.	1927.	1926.	1925.
Sockeyes	69,732	76,428	119,170	70,260	60,044	65,269	65,581	192,323*
Springs	459	325	434	342	468	608	685	496
Chums	944	429	492	989	3,594	1,122	11,727	11,510
Pinks	3,483	5,089	18,023	2,386	16,546	671	12,815	8,625
Cohoes	7,062	6,571	756	1,120	868	2,094	7,286	4,946
Steelhead Trout	29	32	105	29	7	9	11	.....
Totals	81,709	88,874	138,980	75,126	81,527	69,773	98,105	217,900

	1924.	1923.	1922.	1921.	1920.	1919.	1918.	1917.
Sockeyes	94,891	116,850	53,584	48,615	125,742	56,258	53,401	61,195
Springs	545	599	323	364	1,793	1,442	1,409	817
Chums	4,924	3,242	311	173	1,226	7,089	6,729	16,101
Pinks	15,105	10,057	24,292	5,303	25,647	6,538	29,542	8,065
Cohoes	1,980	1,526	1,120	4,718	2,908	9,038	12,074	9,124
Steelhead Trout	.....	.....	82	97	.....	.....	.....	.....
Totals	117,445	132,274	79,712	59,272	133,248	80,367	103,155	95,302

Smith Inlet.†

	1932.	1931.	1930.	1929.	1928.	1927.	1926.	1925.
Sockeyes	25,488	12,867	32,057	9,683	33,442	22,682	17,921	33,764
Springs, Red	46	122	268	18	108	270	73	33
Springs, White	2	.....	22	60	178	79	39	22
Cohoes	273	112	1,460	275	230	2,990	164	44
Pinks	1,148	824	16,615	853	167	732	689	134
Chums	165	133	1,660	113	19	2,605	31	1
Bluebacks and Steelheads	20	36	103	12	6	8	.....	.....
Totals	27,142	14,094	52,185	11,014	34,150	29,366	18,917	33,998

* Including 40,000 cases caught in Smith Inlet and 20,813 cases packed at Namu.

† Previously reported in Queen Charlotte and other Districts.

STATEMENT SHOWING THE SALMON-PACK OF THE PROVINCE, BY DISTRICTS AND SPECIES, FROM 1917 TO 1932, INCLUSIVE—*Continued.*

Nass River.

	1932.	1931.	1930.	1929.	1928.	1927.	1926.	1925.
Sockeyes	14.154	16,929	26,405	16,077	5,540	12,026	15,929	18,945
Springs	4,408	1,439	1,891	352	1,846	3,824	5,964	3,757
Chums	14,515	392	3,978	1,212	3,538	3,307	15,392	22,504
Pinks	44,629	5,178	79,976	10,342	83,183	16,609	50,815	35,530
Cohoes	7,955	8,943	1,126	1,202	10,734	3,966	4,274	8,027
Steelhead Trout	10	.....	84	.....	36	96	375	245
Totals	85,671	32,881	113,460	29,185	104,877	39,828	92,749	89,008

	1924.	1923.	1922.	1921.	1920.	1919.	1918.	1917.
Sockeyes	33,590	17,821	31,277	9,364	16,740	28,259	21,816	22,188
Springs	2,725	3,314	2,062	2,088	4,857	3,574	4,152	4,496
Chums	26,612	25,791	11,277	2,176	12,145	24,041	40,368	24,938
Pinks	72,496	44,165	75,687	29,488	43,151	29,949	59,206	44,568
Cohoes	6,481	7,894	3,533	8,236	3,700	10,900	17,061	22,180
Steelhead Trout	1,035	595	235	413	560	789	1,305	1,125
Totals	142,939	99,580	124,071	51,765	81,153	97,512	143,908	119,495

Vancouver Island District.

	1932.	1931.	1930.	1929.	1928.	1927.	1926.	1925.
Sockeyes	27,611	22,199	24,784	10,340	14,248	24,835	25,070	10,895
Springs	10,559	4,055	3,431	1,645	2,269	6,769	5,222	5,664
Chums	70,629	16,329	177,856	162,246	303,474	220,270	174,383	127,520
Pinks	33,403	81,965	89,941	74,001	41,885	52,561	86,113	51,384
Cohoes	35,132	26,310	30,206	35,504	23,345	58,834	51,551	59,747
Steelheads and Bluebacks	28,596	24,638	14,177	11,118	5,249	10,194	5,383	4,832
Totals	205,930	175,541	340,395	294,854	390,470	373,463	347,722	260,042

Queen Charlotte and other Districts.

	1932.	1931.	1930.	1929.	1928.	1927.	1926.	1925.
Sockeyes	21,685	29,071	39,198	35,331	59,852	60,533	62,383*	49,962
Springs	3,514	1,608	1,852	1,020	2,806	7,826	3,650	5,002
Chums	167,011	34,570	143,781	111,263	341,802	252,230	348,682	305,256
Pinks	82,449	55,825	600,986	136,758	438,298	36,481	380,243	120,747
Cohoes	44,977	16,141	61,418	56,938	58,455	47,433	47,183	40,269
Steelheads and Bluebacks	591	446	1,204	575	609	973	973	1,520
Totals	320,227	137,661	848,439	341,873	901,822	405,476	844,114	522,756

	1924.	1923.	1922.	1921.	1920.	1919.	1918.	1917.
Sockeyes	40,926	24,584	47,107	18,350	64,473	54,677	51,980	32,902
Springs	4,245	2,711	4,988	4,995	15,633	14,766	8,582	6,056
Chums	195,357	148,727	80,485	21,412	30,946	165,717	90,464	112,364
Pinks	141,878	146,943	113,824	14,818	247,149	110,300	201,847	112,209
Cohoes	26,031	29,142	31,331	18,203	33,807	35,011	42,331	30,201
Steelheads and Bluebacks	497	732	409	2,790	3,721	702	1,009	865
Totals	408,934	352,839	278,144	80,568	395,728	381,163	404,793	294,597

* Including 17,921 cases of sockeye packed at Smith Inlet.

STATEMENT SHOWING THE SALMON-PACK OF THE PROVINCE, BY DISTRICTS AND SPECIES, FROM 1917 TO 1932, INCLUSIVE—*Continued.*

TOTAL PACKED BY DISTRICTS IN 1917 TO 1932, INCLUSIVE.

	1932.	1931.	1930.	1929.	1928.	1927.	1926.	1925.
Fraser	126,641	73,067	277,983	426,473	258,224	284,378	274,951	276,855
Skeena	233,711	162,986	450,377	220,245	298,709	187,716	407,524	348,859
Rivers Inlet	81,709	88,874	138,980	75,126	81,527	69,773	98,105	217,900
Smith Inlet	27,142	14,094	52,185	11,014	34,150	29,366	18,917	33,998
Nass River	85,671	32,881	113,460	29,185	104,877	39,828	92,749	89,008
Vancouver Island	205,930	175,541	340,395	294,854	390,470	373,463	347,722	263,904
Other Districts	320,227	137,661	848,439	341,873	901,822	405,476	844,139*	522,756
Grand totals	1,081,031	685,104	2,221,819	1,398,770	2,035,629	1,360,634	2,065,190	1,719,282

	1924.	1923.	1922.	1921.	1920.	1919.	1918.	1917.
Fraser	212,059	226,869	140,570	107,650	136,661	167,944	210,851	402,538
Skeena	390,858	338,863	477,915	234,765	332,787	398,877	374,216	292,219
Rivers Inlet*	117,445	132,274	79,712	59,272	157,522	80,367	103,155	95,302
Smith Inlet	11,776	11,979	5,862	.....	.....	.....	.....	.....
Nass River	142,939	99,580	124,071	51,765	81,153	97,512	143,908	119,495
Vancouver Island	277,267	191,252	185,524	69,528	84,170	267,293	389,815	325,723
Other Districts	604,745	352,839	278,144	80,568	395,223	381,163	404,793	294,597
Grand totals	1,745,213	1,341,677	1,285,946	603,548	1,187,616	1,393,156	1,626,738	1,557,485

* Including 17,921 cases of sockeye packed at Smith Inlet.

STATEMENT SHOWING THE SOCKEYE-PACK OF THE ENTIRE FRASER RIVER SYSTEM FROM 1894 TO 1932, INCLUSIVE.

	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
Fraser River, B.C.	363,967	395,984	356,984	860,459	240,000	486,409	170,889	974,911
State of Washington	41,781	65,143	72,979	312,048	252,000	499,646	228,704	1,105,096
Totals	405,748	461,127	429,963	1,172,507	492,000	986,055	399,593	2,080,007

	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.
Fraser River, B.C.	293,477	204,809	72,688	837,489	183,007	59,815	74,574	585,435
State of Washington	339,556	167,211	123,419	837,122	182,241	96,974	170,951	1,097,904
Totals	633,033	372,020	196,107	1,674,611	365,248	156,789	245,525	1,683,339

	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.
Fraser River, B.C.	150,432	58,487	123,879	719,796	198,183	91,130	32,146	148,164
State of Washington	248,014	127,761	184,680	1,673,099	335,230	64,584	84,637	411,538
Totals	398,446	186,248	308,559	2,392,895	533,413	155,714	116,783	559,702

	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.
Fraser River, B.C.	19,697	38,854	48,399	39,631	51,832	31,655	39,743	35,385
State of Washington	50,723	64,364	62,654	102,967	48,566	47,402	69,369	112,023
Totals	70,420	103,200	111,053	142,598	100,398	79,057	109,112	147,408

	1926.	1927.	1928.	1929.	1930.	1931.	1932.	
Fraser River, B.C.	85,689	61,393	29,299	61,569	103,692	40,947	65,769	.....
State of Washington	44,673	97,594	61,044	111,898	352,194	87,211	81,188	.....
Totals	130,362	158,987	90,343	173,464	455,886	128,158	146,957	.....

STATEMENT SHOWING THE SOCKEYE-PACK OF THE PROVINCE, BY DISTRICTS, 1917 TO 1932, INCLUSIVE.

	1932.	1931.	1930.	1929.	1928.	1927.	1926.	1925.
Fraser River	65,769	40,947	103,692	61,569	29,299	61,393	85,689	35,385
Skeena River	59,916	93,023	132,372	78,017	34,559	83,996	82,360	81,146
Rivers Inlet	69,732	76,428	119,170	70,260	60,044	65,269	65,581	192,323
Smith Inlet	25,488	12,867	32,057	9,683	33,442	22,682	17,921	33,764
Nass River	14,154	16,929	26,405	16,077	5,540	12,026	15,929	18,945
Vancouver Island	27,611	22,199	24,784	10,340	14,248	24,835	25,070	14,757
Other Districts	21,685	29,071	39,198	35,331	26,410	37,851	44,462	16,198
Totals	284,355	291,464	477,678	281,277	203,542	308,052	337,012	392,518

	1924.	1923.	1922.	1921.	1920.	1919.	1918.	1917.
Fraser River	39,743	31,655	51,832	39,631	48,399	38,854	19,697	148,164
Skeena River	144,747	131,731	96,277	41,018	89,064	184,945	123,322	65,760
Rivers Inlet	94,891	116,850	53,584	48,615	125,742	56,258	53,401	61,195
Smith Inlet	11,435	11,864	.....	.....	.....	.....	.....	.....
Nass River	33,590	17,821	31,277	9,364	16,740	28,259	21,816	22,188
Vancouver Island	15,618	12,006	15,147	6,936	6,987	6,452	6,243	9,639
Other Districts	20,579	12,720	47,107	18,350	64,473	54,677	51,980	32,902
Totals	369,603	334,647	295,224	163,914	351,405	369,445	276,459	339,848

STATEMENT SHOWING THE PILCHARD INDUSTRY OF THE PROVINCE, 1920 TO 1932, INCLUSIVE.

Year.	Total Catch.	Canned.	Used in Reduction.	Oil.	Meal.	Bait.
	Cwt.	Cases.	Cwt.	Gals.	Tons.	Bbls.
1920	88,050	91,929	.....	.....	.....	9,937
1921	19,737	16,091	.....	.....	.....	4,232
1922	20,342	19,186	.....	.....	.....	3,125
1923	19,492	17,195	.....	.....	.....	3,625
1924	27,485	14,898	.....	.....	.....	923
1925	318,973	37,182	220,000	495,653	2,083	4,045
1926	969,958	26,731	940,000	1,898,721	8,481	2,950
1927	1,368,582	58,501	1,310,000	2,610,120	12,145	1,737
1928	1,610,252	65,097	1,560,000	3,997,656	14,502	2,149
1929	1,726,851	98,821	1,654,575	2,856,579	15,826	1,538
1930	1,501,404	55,166	1,468,840	3,204,058	13,934	926
1931	1,472,085	17,336	1,456,846	2,551,914	14,200	1,552
1932	886,964	4,622	876,700	1,315,864	8,842	1,603

PRODUCTION OF FISH OIL AND MEAL, 1920 TO 1932 (OTHER THAN FROM PILCHARD).

Year.	From Whales.			From other Sources.	
	Whalebone and Meal.	Fertilizer.	Oil.	Meal and Fertilizer.	Oil.
	Tons.	Tons.	Gals.	Tons.	Gals.
1920	503	1,035	604,070	466	55,669
1921	.....	.....	.....	489	44,700
1922	326	230	283,314	911	75,461
1923	485	910	706,514	823	180,318
1924	292	926	645,657	1,709	241,376
1925	347	835	556,939	2,468	354,853
1926	340	666	468,206	1,752	217,150
1927	345	651	437,967	1,948	250,811
1928	376	754	571,914	3,205	387,276
1929	417	780	712,597	3,626	459,575
1930	273	581	525,533	3,335	243,009
1931	.....	.....	.....	5,647	352,492
1932	.....	.....	.....	6,608	231,690

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