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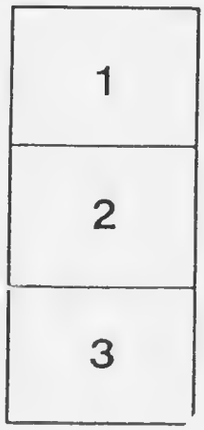

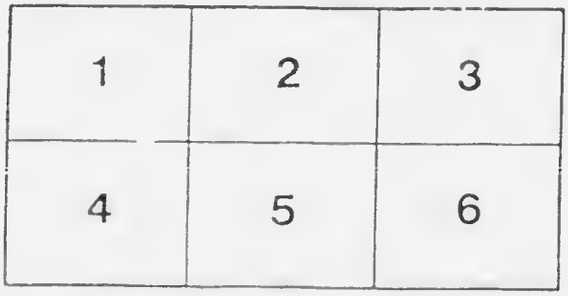

BRITISH COLUMBIA FISHERIES DEPARTMENT [illegible]

CONTRIBUTIONS TO THE LIFE-HISTORY OF THE SOCKEYE SALMON.

PAPER N[illegible]

BY

CHARLES H. GILBERT, Ph.D.,

Professor of [illegible], Stanford University.

(Reprinted [illegible] pages [illegible] from Report of the B.C. Commissioner of Fisheries, 1918.)

[REPRINTED WITHOUT CHANGE OF PAGING FROM THE REPORT OF THE BRITISH COLUMBIA COMMISSIONER OF FISHERIES, 1918.]

CONTRIBUTIONS TO THE LIFE HISTORY OF THE SOCKEYE SALMON. (No. 5.)

By CHARLES H. GILBERT, PH.D., Professor of Zoology, Stanford University

I. SPAWNING SOCKEYE COLONIES IN THE TRIBUTARIES OF THE FRASER RIVER DURING THE SEASON OF 1918

In our report for the season of 1916 we presented for the first time evidence derived from an investigation of the extent to which frequented separate spawning areas of the Fraser River. Those which were found spawning in Morris Creek were examined separately from those that spawned at the Harrison Rapids. And in like manner independent studies were made of the spawners at the Harrison Hatchery, in the Birkenhead River at Pemberton, in Pitt Lake, in Cultus Lake, and in the Chilliwack River. The object of the investigation was to throw light on the much mooted question as to the return of the mature spawning salmon to that particular part of the river basin in which they had been hatched and reared. In the answer to this question a number of possibilities must be considered.

(1.) There may be no tendency for a salmon to return to any definite spawning district, or to any geographically distinct group of spawning districts. In such case any sockeye entering the Fraser would be as likely to spawn above as below the canyon, and as likely to spawn in any one tributary as in any other. Every spawning bed in that event would contain individuals which had been hatched and reared in widely different portions of the basin.

Each spawning area would draw indifferently on the common stock of migrants, and the salmon frequenting it would necessarily agree in their characteristics with those frequenting each of the other spawning areas throughout the basin. There would be no basis for differences of any description. The salmon spawning in different parts of the basin would agree in their average size, as adults, and in their early history as fingerlings migrating seawards. They would agree in the relative numbers of four- and five-year fish, in the relative numbers of those which had spent one year or two years in fresh water after hatching or had proceeded to sea as soon as they were free swimming. All the groups and all the variations of characters which we find in the main run examined off the mouth of the river would be repeated in approximately equal proportions on every spawning ground. Such would inevitably be the case if the salmon passed indifferently to the various spawning areas without reference to their native habitat.

On the other hand, if differences are found to exist in the populations of distinct spawning districts, this must be considered direct evidence that segregation has occurred, based on some principle which has determined that certain individuals in the common run pass to one spawning area while other individuals go elsewhere to spawn. The only principle adequate to explain such segregation, if it generally occurs, would be the return of fish to spawn in their native tributaries.

This principle obtains, as we have abundantly demonstrated, as between different river-basins, even when these are of very limited size and have their outlets to the sea in close proximity to each other. In their passage to these minor streams along the salt-water channels the schools of fish are often very intimately mingled, and they separate only as the river mouths are approached. Thus, in the vicinity of Naam, on Fitzhugh Sound, gill nets operated along shore capture in about equal numbers at the same time sockeyes which are bound for Bella Coola and those which are bound for Kimsquit. These can be distinguished by characteristic scale-markings. The two schools are running intimately mingled along the same channels. Where they separate has not been determined. The greater part of them may pass up Burke Channel together, or it may be the Kimsquit fish may take the Dean Channel. But by the time Bella Coola and Kimsquit are reached complete separation has occurred.

The case would seem not greatly different from that of fish bound for different tributaries of the same river. Conceivably, the schools may be mingled along the main channels of the river and become separated as their respective tributaries are reached. If the populations of these tributaries show distinguishing characteristics, no other satisfactory explanation presents itself.

(2) We must consider also the possibility that a partial segregation of spawners occurs, but not a total one, that within certain limits a difference exists as to the precise spawning ground frequented. Thus the early run may predominately run early and proceed above the canyon, passing without selection into any stream that becomes available; while the late running fish may enter the Harrison, the Pitt, and Cultus Lakes again without discriminate distribution. That this supposition is without validity for the lower river becomes evident from the fact previously emphasized that the fish entering Pitt Lake are so widely different from those entering Cultus Lake, and that even the different spawning beds at the Harrison can usually be shown to possess individual characteristics of unquestioned significance.

With regard to the river above the canyon, the case is not so clear, partly, no doubt, from lack of adequate material. The runs of the upper river have of late years become extremely attenuated. No material at all adequate has been obtained from any upper river tributary except the Chilcotin, and because of its inaccessibility and depletion we may now find it too late to secure any. A small run which makes it possible for natives to secure a few fish for food from the main channel of the upper river may yet disappear for all practical purposes when it becomes widely distributed among the tributaries. And unless material can be so secured after final segregation has occurred it is useless for our purposes. The differences which distinguish fish spawning in contiguous areas are usually of such small amount and compass that they become wholly masked when two or more races are mingled.

This may be the case even at the mouths of the main tributaries. More than one spawning district, each with its special characteristics, may be found within a given tributary. The Harrison River, for example, has at least four spawning areas. Scales and other data collected solely at the mouth of the Harrison, or in its lower course, would be valueless. The different strains would be mingled and their characteristics obliterated. The nearer the material is obtained to the final spawning grounds, the greater its value for investigations of racial divergence.

(3) Where spawning populations show distinguishing characteristics the inference is clear and unavoidable. A physiological barrier has existed, the racial habit of return at maturity to spawn in the native stream, for so long a period that minor differentiations have developed and a strain or subrace has been formed. But what are we to conclude in cases where the colonies of two distinct spawning areas present no characteristics by which we can distinguish them? Obviously, we must infer either (a) that segregation in their case has not occurred, or (b) that it has occurred but has not been effective in producing divergence between the colonies. If the first of these were true, it would signify that the "homestream" instinct was in most cases rigidly operative, while in one or more instances within the same river-basin it was wholly in abeyance.

The second supposition would seem *a priori* far less improbable. Complete segregation of spawning fish may occur, so that each individual returns to the stream in which it was hatched and reared, and yet, in certain instances, separate colonies may have failed to develop distinct methods of growth or of habit by which they can be distinguished. Failure to discover distinguishing characteristics between populations of separate spawning areas need not indicate then that their progeny will fail to return at maturity each to its native stream.

This process may have been in operation for many thousand years. The two colonies may have been wholly distinct and self perpetuating for a very long period and yet no differences have developed. If we should adopt distinctive marks for the young from each of the two streams on their downward migration to the sea, it might be shown at maturity that each stream contained spawners with a single mark only, the one that had been applied to the young from that stream. Yet the adults from the two tributaries might be otherwise indistinguishable. Negative evidence in this case proves nothing. But if affirmative evidence is found, it is conclusive. If in fact, differences are found to exist, there is no alternative to our acceptance of the home-stream theory.

Different tributaries of the same river may be quite unlike in the sharpness of the characteristics by which their colonies may be recognized. Cultus Lake, a tributary of the Lower Fraser, possesses a strongly marked race of small salmon, pale in colour of flesh, poor in oil, scarce

worthy of the name of sockeye, while Pitt Lake, also tributary of the Lower Fraser, is frequented by a large race the opposite in all respects of the Cultus Lake colony. But we have been unable to distinguish the fish of Morris Creek, tributary to the Harrison River from those spawning in the lake gravels in front of the Harrison Hatchery and in the small stream that supplies it. In this latter case we have obtained no direct evidence of segregation; but it is rendered highly probable by the more numerous differences in which it can elsewhere be demonstrated.

The most important investigation during the season of 1918 consisted in an attempt to test the conclusions which we had based on the material of 1916 by a re-examination of the colonies frequenting the same spawning grounds previously reported on. It was hoped to secure, also, material from additional spawning grounds above the canyon, from which nothing heretofore had been obtained.

The season of 1918 was peculiarly unsuited to the purpose. In the recent history of the Fraser we have grown accustomed to noting that each successive year is the worst in the history of the industry, or is in any case distinctly worse than its representative in the last cycle, four years previously. But the extent of the disaster in 1918 was unexpected and overwhelming. A run of sockeyes to the Fraser can hardly be said to have occurred. Under such circumstances the numbers that escaped to the spawning grounds were most limited. Along the main river-channels were a few localities, like the canyon above Yale, the Bridge River fishing grounds above Lillooet, and those above the mouth of the Chilcotin at the Chimney Creek Bridge and at Soda Creek, where, as was by persistent dipping secured a few fish. Material was obtained at all these points, but for reasons already stated it was of less value for the purposes of the present investigation. In all these river channels it was apparent a number of local races were mingled. Because of this the range of variation in all the characters examined was excessive, far greater than when we have before us data obtained from a single spawning area.

In addition to these main river localities, we were successful in securing a limited amount of material from the Chilcotin River at Hanceville and at Fish Canyon near its mouth; from the Birkenhead at Pemberton; from the Skookumchuck above Harrison Lake; from the Harrison Hatchery, Morris Creek, and the Harrison Rapids; and from Pitt Lake. For much of this material we have to thank the very generous co-operation of Alex. Robertson, Superintendent of the Harrison Lake Hatchery, and T. W. Graham, Superintendent of the Pemberton Hatchery on the Birkenhead. To both of these gentlemen we extend our grateful acknowledgments.

In general, it can be stated that the examination of this material completely supported and verified the conclusions reached in 1916. With regard to the spawning-beds below the canyon, we affirm without qualification that they are as distinctively populated as though they were located in separate streams independently entering the sea. Additional material only emphasizes this fact. Not only were the different colonies in 1918 marked by distinctive characters, but these characters were the same for each colony as those noted in 1916. We have then the picture of a number of self perpetuating sub-races, each of which has acquired certain minor habits of growth, of migration, of age at maturity, of length of life in fresh water, of colour and quality of flesh—the same characters, in short, which in various combinations characterize the races of the separate river-basins of the simpler sort.

A very conspicuous instance of racial differentiation is furnished by the Harrison watershed. We do not know how many distinct spawning areas it may have contained. Several minor colonies, like that frequenting Silver Creek, are now practically exterminated. There were spawning areas doubtless in Lillooet and in Texas Lakes, but no records of these have reached us. A very limited number of late spawners still frequent the slack water of the main river above Harrison Rapids, the vanishing remnant of a once fine run visits the lake at the head of Morris Creek, and a considerable run still goes up the Birkenhead. Both the Birkenhead and the Morris Creek fish pass over the very spawning beds at Harrison Rapids, but not one of them tarries there. An examination of 200 specimens, laboriously gathered at Harrison Rapids in 1918 by Mr. Robertson, failed to yield a single fish which had been spawned elsewhere than in the beds of the rapids. Not one could on even a cursory examination be confused with those constituting either the Morris Creek or the Birkenhead colony. Not one of the Harrison Rapids fish was found among over 400 specimens examined from Morris Creek, and over 200 from

Stockumchuck and the Pitt rivers. No Morris Creek [illegible] to the Pitt and [illegible] to Birkenhead lake were found. Morris Creek [illegible] of the fact that [illegible] passed the mouth of Morris Creek on their way [illegible] is most strictly in force; yet [illegible] of the spawning fish with resulting [illegible] fish pass over and [illegible] rules everywhere, though the evidence of it may [illegible]

Harrison Rapids.—The most interesting [illegible] in the season at Harrison Rapids. [illegible] report for 1916, page 70. The [illegible] spawning habits of sockeyes [illegible] other species of salmon. Unlike other species, they [illegible] any stream, otherwise suitable, which has no lake within [illegible] lake once attained, they spawn in the gravel [illegible] the lake in search of suitable spawning beds. The young develop mainly, if not exclusively, in the waters of the lake, frequenting the depths in the daytime, but rising to feed at the surface in the evening. Under such conditions the sockeye commonly [illegible] sometimes over two years, occasionally over three years, before seeking salt water. Of the varying number which [illegible] survive and return at maturity.

But the Harrison Rapids spawners [illegible] river, where they have no genuine lake [illegible] the young can drop back after hatching. They have, as [illegible] method of life for a sockeye, of dropping down to salt water as soon as they are free-swimming, and while we have no data as to their mortality or the percentage of survival, it is clear that before man disturbed the balance of nature, enough survived to keep the colony in a flourishing condition. More than this cannot be said for any of the other colonies. Clearly, then, under the spur of necessity, a sockeye colony can adapt itself to the habits of seal migration in the early free-swimming fry stage, a habit rare in species, and so far as known never occurring among coho-es; but almost exclusively characteristic of humpbacked and dog salmon, and frequent among chinooks.

The 200 specimens of Harrison Rapids spawners examined in 1918 had all had the history above outlined. Not one of them exhibited in the centre of its scale any trace of growth of the young in fresh water. All had passed down to sea as young fry before any portion of the scales had made their appearance.

It is very difficult to place satisfactorily on record the evidence for racial differentiation as observed on the spawning beds. As previously pointed out, the scales have suffered extensive erosion during the later weeks which precede the spawning. Not only are the margins of the scales broken down and absorbed to such an extent that they no longer serve for determination of age, but the surface of the remaining portion of the scales has become more or less defaced. Absorption has taken place not only at the margins but also on the surfaces of the scales, and the lines of growth are blurred or obliterated. Enough may be preserved to render possible a detailed examination under the microscope, where the course of the ridges can be traced from such fragments as remain, by the aid of focusing at different levels. But such scales produce very unsatisfactory photographs. Nevertheless, it has seemed advisable to have a number of these from each of several spawning areas of the Fraser reproduced as a permanent record. Only the centres of the scales are figured, the worn and jagged edges being omitted.

Figs. 1 to 5 are from the spawning race at Harrison Rapids. Each contains the extensive first year's growth which occurs wholly in salt water, together with a varying portion of the second year's growth. The boundary between the two years in these cases is not a sharp one, leading to the conclusion that fry which descend to the sea in their first year suffer less interruption to their growth during their first fall and winter in the sea than is the case with those which pass their first year or their first two years in fresh water. Rarely, however, a slackening of growth in the Harrison Rapids fish at the close of their first year is indicated by a definite line of demarcation at its outer edge. When this exists there are thirty-two to forty rings or lines of growth belonging to the first year.

As was observed in 1918 and during previous years, sockeyes belonging to the type which enters the Harrison Rapids spawning beds—the sea type—make their appearance during the latter part of the run only, at the mouth of the river and in the approaches to it. In 1916 the first to appear were taken on July 17th, and after that date they occurred constantly to the close of the season.

In 1918 the first to make their appearance at Esquimalt, from traps along the Vancouver Island shore, were found on July 14th. Not a single specimen had been found among the 250 which had been previously examined, distributed over June 17th, 20th, and 28th, July 2nd and 10th. They were present on July 18th, 18th, 21st, 25th, 29th, August 2nd, 4th, 8th, 11th, and 26th—five days on which examinations were made at Esquimalt after July 14th that included individuals of sea type were August 13th, 16th, and 23rd. The numbers of this type were evidently decreasing during the very last of the run.

The defective condition of the scales made it impossible to determine directly the age of the Harrison Rapids fish, but the lengths were secured, and a valuable clue can be obtained from the range in size found in three-year fish and in four-year fish of this type before they enter the river. The complete range may not be available because of the small number of individuals observed, which were obtained at Esquimalt during 1918. Only twenty-four in all were observed. Five were three-year males; one a three-year female; five were four-year males; thirteen were four-year females. The three-year males ranged from 20½ to 21 inches long; the four-year males from 26 to 28 inches. Comparing these figures with the Harrison Rapids column in Table I, it is seen that the majority of the Harrison Rapids males are from 25 to 29 inches long, and that the lengths of these, when tabulated, form a fairly regular curve, with the mode at 27. Lying below 25 inches, extending from 17½ to 21½, are sixteen thinly scattered records, which form no part of the curve referred to. As these two elements in the table agree closely with the observed lengths of three-year and four-year males obtained in salt water where age can be determined, we are justified in concluding that approximately all Harrison Rapids males between 17½ and 21½ inches long are in their third year, while those between 25 and 29 inches long are in their fourth year.

The single three-year female of this type secured from salt water in 1918 is 20½ inches long, while thirteen four-year females range from 24 to 26½ inches. Table II. gives the length distribution of Harrison Rapids females, all but three of which fall within the scope from 23 to 26 inches and form again a regular curve, while three individuals are 20, 22, and 22½ inches long respectively. It is highly probable that the three last mentioned are in their third year, while the others are in their fourth year. The earlier dates, on which sea-type individuals appeared in the run, produced only three-year males and four-year females, the other groups appearing subsequently.

In 1918, as in 1916, we failed to find any individuals of sea type spawning in any part of the Fraser River basin other than Harrison Rapids. Upwards of a thousand specimens were examined from other spawning districts, in which it might be thought an occasional sea-type individual might be found, if only as a stray. The fact that not one individual was discovered elsewhere, when coupled with the further fact that every Harrison Rapids sockeye belonged to this group, furnishes the strongest possible evidence of the return of spawning fish to their native districts.

Morris Creek.—This stream offered in the early days one of the most valuable spawning grounds in the Harrison watershed. In its report for 1902, pages 24 and 25, A. P. Babcock states: "Morris Creek and Lake are insufficient bodies of water, but as a spawning ground for the larger run of sockeye, and from the standpoint of artificial propagation, they constitute one of the most important and valuable points on the Fraser. The Dominion Government has operated a spawning station here since 1885, and with the exception of the year 1900 has never failed to take eggs. All the salmon eggs taken by the Dominion in this Province up to 1901 were secured at this station." Much later than 1901 Morris Creek still served as the principal source of eggs, first for the Port Accord hatchery near New Westminster, and later for the Harrison Lake hatchery. None of the fry in the early days were returned to Morris Creek, as it was not believed that such procedure was necessary to maintain the spawning run. Even

In 1902 (*loc. cit.*) Mr. Babcock wrote: "It is generally believed that fish bred in a given watershed, such as the Fraser, return to it upon reaching maturity, and there is considerable evidence to warrant it. It has not, however, been settled, and probably never will be, that the fish bred in a given tributary of a large river seek only that tributary to spawn." Believing, then, that any increase in the run to a large river would equally benefit all the tributaries, there seemed no reason for laboriously returning fry to Morris Lake in order that they should return there and help maintain the spawning run. Knowing, as we now do, that salmon will in general return to the district in which they are liberated, the fate of the Morris Creek run seems to have been inevitable. It has steadily dwindled with the years until it can no longer be depended on for any considerable take of eggs. Natural propagation was reduced to a minimum in order to obtain eggs for the hatcheries, while the hatchery reared fry did not at maturity return to Morris Creek. The same has been the history of Silver Creek, where the Dominion Government placed a weir in August, 1902, and took nearly two and a half million eggs, which were transferred to the hatchery near New Westminster." The run in Silver Creek is now practically extinct, and we cannot doubt that this process has been hastened by failure to replenish its run through the planting of fry. No better examples than these can be found of the necessity of working out completely the entire life-history of our commercial fishes before it is possible to propagate them with success or to legislate wisely for their protection. Failure to follow this principle has discredited hatchery-work from the beginning, and has led to the well founded suspicion that in many instances they have been more of a detriment than an advantage to the runs.

Morris Creek would seem to have been an ideal hatching and rearing ground for the sockeye. The enormous run entering this very insignificant stream in early days furnishes evidence of extraordinarily favourable conditions. Examination of the scales of the fish now running shows a striking uniformity in their development. They form an impressively homogeneous lot. All have large sharply defined nuclear regions, testifying to a vigorous growth during their first year, which is uniformly passed in the lake. The number of nuclear rings varies from fifteen to twenty-eight, with the mode at twenty. The frequency curve is given in Table III. In all probability the fingerlings on migrating from the lake in the spring of their second year were 4 to 6 inches in length, and better fitted to cope with their enemies than the smaller weaker yearlings from less favourable localities.

Figs. 6 to 8 give typical centres of Morris Creek scales. No individuals from this district had lived two years in the lake before migrating, and none had proceeded to sea in their first year. The length distribution, given in Tables I. and II. in the columns for Morris Creek, seems to indicate that the majority of the fish were in their fifth year. The modal length for the males at 27 inches and for the females at 25 or 26 inches closely agrees with that usually characteristic of five-year Fraser River fish.

Birkenhead River.—This affluent of the Harrison has now the most reliable sockeye run, and is the only spawning district of value remaining in this watershed. Its present importance is due in part doubtless to the fact that it was not drawn on for hatchery purposes until a much later date than Morris Creek and the Harrison Lake region, and in perhaps larger part to the significant fact that the output of the hatchery is constantly planted in the Birkenhead and helps maintain the run.

The characteristics of the Birkenhead race in 1918 are in general the same as those described for the 1916 run. The growth of the fingerlings in fresh water must be much less than in the case of the Morris Creek and Harrison Lake fingerlings. The nuclear area of the scale averages small, with densely crowded rings. These were somewhat more numerous in 1918 than in either of the two years preceding and the extremes range far more widely. The lot in 1918 was far less homogeneous than in 1916 and 1917, even those taken at the Pemberton Hatchery presenting an unexpected amount of variation. While the nuclear regions average small and the number of rings in the great majority of individuals is less than sixteen (the mode lying somewhere between eight and eleven), occasional specimens have nuclear rings running as high as nineteen, twenty, and twenty-one. Furthermore, the frequency curve for nuclear rings in 1918 has none of the regularity so well defined in 1916 and 1917. The irregularities in 1918 are equally marked and

are similar, whether the specimens were procured at Skookumchuck or at the Pemberton Hatchery on the Birkenhead. As seen in Table III., there is at both localities a mode at eight rings, one at eleven, and a less regularly defined one at fifteen. Yet, so far as known, all come from the same spawning grounds. It is not clear what significance, if indeed any, attaches to this circumstance. In spite of the variation in nuclear rings, racial peculiarities are apparent. Especially marked is the small size of the first year's growth in the scale, a character that was also conspicuous in the two years preceding. Occasionally this is carried so far that the first year's growth in the scale resembles a second year in a lake, but only one undoubted two-years-in-lake individual was observed.

It was found possible to determine age from the scales in a larger percentage of individuals than was possible in other spawning localities. Both at Skookumchuck in the Lillooet River and at Pemberton on the Birkenhead between 60 and 70 per cent. of all specimens could be grouped by age. This does not, however, give a reliable estimate of the relative numbers of four- and of five-year fish present. With imperfect scales, the age of five-year fish is more readily determined than of four-year fish. Four-year scales cannot be determined unless some portion of the original margin of the scale is preserved, thus demonstrating that a fifth year's growth had not been present when the scale was intact. But five-year scales are unmistakably such in cases where not only the margin but the entire fifth summer's growth has been lost. If the last winter's band of crowded rings is present beyond the growth of the fourth summer, or any part of such band, the fish was evidently in its fifth year. The practical absence of six-year fish of the one-year-in-lake type in the Fraser River facilitates this determination.

In 108 specimens from Skookumchuck, the age was ascertained in fifty-four, or exactly one-half. Thirty-four of these were in their fourth year (twelve males and twenty-two females) and twenty were in their fifth year (twelve males and eight females). In 180 specimens from the Birkenhead, age could be determined in seventy-eight, or 43 per cent. Of these, forty-one were in their fourth year (three males and thirty-eight females) and thirty-seven in their fifth year (twenty-one males and sixteen females). If these proportions were reliable, we should have 37 per cent. of five-year fish at Skookumchuck and 47 per cent. at Pemberton, the percentage for both localities being 43. As stated above, this percentage is too high. The minimum percentage of five-year fish can be obtained by assuming that all the undetermined individuals were four-year fish, which reduces the proportion to 20 per cent. Obviously, this extreme assumption cannot be justified. If one-fifth of the undetermined individuals were five-year fish, there would be slightly over 30 per cent. of five-year fish in the Birkenhead-Lillooet section, and this must be considered a fairly satisfactory estimate. The percentage of five-year fish of the one-year-in-lake type in the total run, as determined by samples taken frequently throughout the season at Esquimalt, was 23, and these ran largely in the early part of the season. The percentage during June and the first half of July was higher than that indicated.

Pitt Lake.—Over 200 specimens were examined from Pitt Lake, and of these only twenty-five could have their age determined. These proved to be in their fifth year in every instance except one, the latter having spent two years in the lake as a fingerling and having returned from the sea in its sixth year. Reference to Table I. indicates that the sizes of the Pitt Lake spawners were similar to those from Morris Creek and Birkenhead, the majority ranging from 24½ to 29½ inches, with an average of 27.7 in the males, and from 23 to 27, with average at 25.1 in the females. These averages are in the case of the males much higher than for five-year males taken from the main run in salt water (26.3); while the average for females agrees exactly with that obtained from five-year females taken in the Vancouver Island traps. It is our belief that practically all of the Pitt Lake run was made up of fish in their fifth year.

The lot proved most homogeneous. The nuclear regions represented a fresh-water growth obviously under highly favourable conditions, though as fingerlings they had failed to attain as large a size as did the fingerlings in Morris Creek. The nuclear rings are bold, firm, well spaced, closely parallel, and regular. The number of rings, as seen in Table II., ranges from thirteen to twenty-one, with mode at seventeen, much lower than Morris Creek. One individual has as few as ten rings; another as many as twenty-three. It is a well marked race. Figs. 22, 23, and 24 illustrate the nuclear regions of characteristic scales from this region. Like the Morris Creek race, the first year's growth in the scale is large and vigorous.

Table I.—Fraser River Male Sockeyes, examined on their Spawning-beds, 1918, distributed by Lengths and by Locality.

Inches.	Morris Creek.	Harrison Hatchery.	Harrison Rapids.	Pitt Lake Hatchery.	Birkenhead.	Shookumchuck (Lillooet R.).	Hanceville (Chilcotin).	Fish Canyon (Chilcotin).
17½	..	..	1	..	..	..	..	..
18	..	..	..	..	..	..	..	..
18½	..	..	..	..	..	..	..	..
19	..	..	1	..	..	..	..	..
19½	..	..	..	..	1	..	..	..
20	..	..	..	..	..	..	..	..
20½	1	..	1	..	..	..	..	1
21	..	..	..	..	..	..	..	..
21½	..	..	..	..	1	..	..	..
22	1	..	1	1	..	..	..	..
22½	..	..	..	1	..	1	..	..
23	1	..	..	1	..	..	1	..
23½	..	1	..	1	3	1	1	..
24	1	1	3	4	1	..	1	1
24½	3	2	3	1	1	1	1	1
25	4	1	2	1	3	6	..	..
25½	5	..	3	3	3	4	..	1
26	11	..	2	1	2	6	..	..
26½	16	..	4	2	3	15	..	..
27	14	1	2	3	2	6	1	..
27½	18	..	1	1	1	4	..	..
28	19	..	3	3	1	3	1	..
28½	16	..	1	2	2	1	1	..
29	5	1	1	1	1	..	..	..
29½	3	..	..	1	1	..	..	..
30	1	..	..	..	..	..	..	..
30½	..	..	..	..	..	..	..	..
31	..	..	..	..	1	..	..	..

Table II.—Fraser River Female Sockeyes examined on their Spawning-beds, 1918, distributed by Lengths and by Locality.

Inches.	Morris Creek.	Harrison Hatchery.	Harrison Rapids.	Pitt Lake Hatchery.	Birkenhead.	Shookumchuck (Lillooet R.).	Hanceville (Chilcotin).	Fish Canyon (Chilcotin).
20	1	..	1	..	..	..	..	..
20½	..	..	..	..	..	..	..	..
21	..	..	..	..	1	1	..	..
21½	..	..	..	..	1	..	..	..
22	3	1	1	2	2	4	1	1
22½	3	..	1	..	4	..	1	1
23	10	1	..	1	6	1	1	..
23½	12	3	5	1	6	1	3	4
24	12	3	6	12	20	12	1	..
24½	10	1	5	9	14	3	1	..
25	11	3	6	14	14	4	1	..
25½	3	1	4	17	7	1	1	..
26	3	1	1	26	2	1	..	..
26½	2	..	..	17	2	1	..	..
27	0	1	..	6	2	2	..	..
27½	3	..	..	..	1	1	..	..
28	..	..	..	..	1	..	..	..
28½	..	..	..	..	..	..	..	..
29	1	..	..	..	1	..	..	..

Table III.—Fraser River Sockeyes examined on their Spawning-beds, 1918, distributed by Number of Nuclear Rings and by Locality.

No. of Rings.	Morris Creek	Harrison Hatchery.	Pitt Lake Hatchery.	Birkenhead.	Skookumchuck (Lillooet R.)	Fish Canyon (Chilcotin).	Hanceville (Chilcotin).
2	..	..	..	..	1	..	..
3	..	..	..	1	..	..	..
4	..	..	..	6	9	..	1
5	..	..	..	13	26	..	..
6	..	..	..	15	11	..	..
7	..	..	1	10	9	..	..
8	..	..	..	19	11	..	1
9	..	..	..	11	12	..	..
10	..	..	..	7	6	..	4
11	..	..	..	1	5	..	1
12	..	..	..	19	4	..	3
13	1	..	..	3	4	..	..
14	..	..	12	..	4	..	1
15	11	..	11	..	3	..	..
16	..	..	..	1	..	..	1
17	1	..	1	1	..	..	..
18	..	..	..	..	..	1	..
19	1	..	..	..	..	..	..
20	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
22	..	..	..	..	..	..	..
23	..	..	..	..	..	..	..
24	..	..	..	..	..	..	..

The Chilcotin River.—It was with difficulty that any material was obtained from this district. Mr. Babcock and the writer spent August 21st to 23rd at Hanceville and Alexis Creek. One specimen only was seen at Alexis Creek, while at Hanceville, although dipping was constantly in progress, only eighteen individuals were taken. At Fish Canyon, near the mouth of the Chilcotin, on August 24th and 25th, thirty freshly caught sockeyes were examined, and portions of the skin containing scales were dissected off from sixty-two fish found drying on the racks. In the case of the dried specimens we could obtain no reliable measurements and no record of sex. But the history of the individuals is, of course, found equally recorded on the scales. Such material, in default of better, may be availed of for the present purpose.

A cursory examination of the Chilcotin material would be sufficient to demonstrate that it is totally distinct from any of the spawning runs investigated in the part of the Fraser River basin which lies below the canyon. No single specimen from the Chilcotin agrees with the Harrison Rapids colony in having migrated to salt water in its first year. All had spent at least one year in the fresh-water lakes before descending to the sea. Furthermore, a considerable proportion of the Chilcotin fish (from 35 to 40 per cent. of the whole) had spent two full years as fingerlings in their lake. This is a very significant fact, in view of the almost total absence of representatives of this group from the Harrison watershed and the Pitt during the season of 1918. Obviously there is wide variation from year to year in the extent to which fingerlings in the same spawning area will tarry in the lake for a second year. Thus, as has been shown in our report for 1916 (page 51), the two-years-in-lake type was abundantly represented in the Birkenhead, where they constituted 10 per cent. of the run. But only one specimen was found in 1918 among 288 examples from Skookumchuck and Pemberton.

Only 6 per cent. two-years-in-lake fish were found in the Chilcotin in 1916. It seems evident that the occurrence of this type in some abundance is more probable within certain spawning areas than in others; but extensive fluctuations occur in successive years. From such evidence as is before us, it would seem that in 1918 the members of this group were exclusively bound for the Chilcotin, and perhaps other spawning-grounds above the Yale Canyon. Their distribution

in the main run becomes then a matter of special interest. Referring to our Esquimalt records, we find this class sparingly represented during the early part of June, but the number increasing during the month, until on June 28th it constituted 11 per cent. of the whole. Up to this point the history of 1918 exactly parallels that of 1916. On July 2nd they constituted 12 per cent.; July 10th, 3.5 per cent.; July 14th, 9 per cent.; July 18th, 9 per cent.; July 21st, 11 per cent.; July 25th, 11 per cent.; July 29th, 13 per cent.; August 2nd, 5.5 per cent.; August 4th, 5.5 per cent.; August 8th, 5.5 per cent.; August 11th, 2 per cent.; and subsequent dates occasionally with one specimen, but usually without any. The striking difference between 1918 and 1916, as regards the run of the two-years in-lake type, lies in the heavier early run in 1918 and the almost total disappearance of these forms in the latter part of August. On August 10th, 1916, 10 per cent. and on August 27th 10 per cent. of the run belonged to this class. It seems highly probable that the numerous late-running individuals in 1916 were bound to streams below the canyon.

The material obtained at Fish Canyon did not differ in any respect from that obtained higher up-stream at Hanceville. The nuclear areas of the scales are characteristically marked with slender rings, not greatly crowded, nor widely spaced. The rings are fairly regular and in general parallel, but the individual rings are frequently broken and interrupted. Figs. 11 to 20 present characteristic centres of Chilcotin scales, the majority of those from the two-years in-lake form.

The first year's growth in the sea usually averages small, with the scale-rings often crowded and irregularly spaced, indicating partial checks in the middle of the growing season. Variations are found in this regard, as is always the case, but the general picture is of a single spawning type, displaying not more than the usual amount of variation. Two forms can be roughly distinguished, one with large, the other with small nuclear regions, and these two exist among those individuals that spent two years in the lake as well as among those that migrated seawards in their second spring. No other differences have been detected between the two groups. Those with the larger type nucleus may have been the first to hatch. Intermediate individuals are found.

It was impossible to determine the age in the majority of the specimens. In thirty-three out of a total of 108 the scale was complete at some point on the margin, and made it possible to ascertain in each case that the fish when captured was in its third year since entering the sea. Those of the one-year-in-lake type were all in their fourth year; those of the two-years-in-lake type were in their fifth year. Both types had spent an equal period on the sea-feeding grounds and had reached essentially the same size. A comparison of length-frequencies of Chilcotin fish (Table I.) with those of Pitt Lake, Morris Creek, and the Birkenhead will show the much smaller range in size of the Chilcotin material. We failed to find evidence of five-year fish (one-year-in-lake type) in the Chilcotin, either in 1916 or in 1918; or of six-year fish (two-years-in-lake type), although numerous examples of these six-year fish are known to have entered the mouth of the river in June and July.

The Quesnel River.—No material was obtained from the Quesnel River. Mr. Babcock and the writer visited the dam and fishway at the outlet of Quesnel Lake on September 3rd and 4th. No salmon had been observed to enter the fishway, and only two or three which we did not secure were seen in the pool at the foot of the race. No run was reported at any later date.

Specimens were secured, mainly from drying-racks, at Chimney Creek Bridge and at Soda Creek, points on the main river between the mouths of the Chilcotin and the Quesnel. It might be assumed with some justice that the majority, if not all, of these fish were headed for the Quesnel. Along the river between Quesnel and Fort George no success appeared to attend fishing at any point. Here and there we could learn of the capture of a few strays, but that was all. Yet it is hazardous to adopt conclusions based on evidence of this nature. Some proportion of the Soda Creek and Chimney Creek fish were undoubtedly bound up-river beyond the Quesnel. What the relative numbers were it is impossible to estimate. The same kind of evidence that would convince us no fish were running in the upper river can also be adduced to demonstrate that none entered the Quesnel.

The material secured at Chimney Creek Bridge and at Soda Creek was clearly different from that obtained in the Chilcotin. For one point of distinction, there were few individuals of the two-years-in-lake type. Out of a total of seventy-one specimens, only five, or 7 per cent., were of this class, which constituted 35 per cent. of the Chilcotin fish. This abrupt change from

the mouth of the Chilcotin in the few miles to Soda Creek could have only one meaning. A distinct body of fish, developed from fry which had been hatched in the Chilcotin, had entered that river. Other minor differences marked the nuclear portions of the scales from fish taken above the mouth of the Chilcotin—differences which hardly lend themselves to description, as they appear in the ever-varying material, but nevertheless in a composite image are found to have a certain distinctness and an unquestioned significance. The nuclear rings are on the average more closely crowded, while the number of rings remains about the same, ranging widely from seven to twenty-one, with the mode at ten. The first year's growth in the sea is small, and the individuals are all of those sizes which characterize Fraser River sockeyes that have spent three years at sea. The condition of the scales permitted us to ascertain the age of but one specimen, a four-year fish, but we entertain no doubt that all the individuals observed had spent three years at sea, and were either in their fourth or fifth year, depending on whether as fingerlings they had remained one year or two years in fresh water. Fig. 21 presents for comparison the centre of the scale of a Soda Creek specimen.

Fraser River Canyon above Yale.—Fifty specimens were obtained from natives dipping in the canyon and above, as far as Lytton. Inasmuch as it is supposed no sockeyes entered the Thompson in 1918, and the Seton-Anderson section was wholly bare of spawning-fish, it would be natural to assume that sockeyes captured in the canyon above Yale were all bound for the Chilcotin and the Quesnel, and would wholly resemble the fish captured at Fish Canyon and Chimney Creek. Nothing could be farther from the truth. The Yale Canyon fish averaged much larger than the up-river fish, and contained a considerable proportion of five-year individuals, of which not one was detected above. Apparently some 20 per cent. of the fish dipped in the canyon were five years old, a much larger percentage than was at any part of the run entering the mouth of the river. The destination of these five-year sockeyes is a question of much importance. The only direct evidence we have is derived from two specimens, the only material obtained from the Thompson River—one taken two miles east of Lytton on the Thompson; the other at Thompson Siding, nine miles east of Lytton. Both of these are five years old, one 21 the other 26 inches long, and both females. Only four of the fifty are of the two-years-in-lake type, so we could not be dealing to any considerable extent with Chilcotin material. Furthermore, many of the nuclear regions of the scales are of the robust type, with strong, bold, parallel ridges, quite different from the delicate slender ringed nuclei of the upper river. Figs. 25 to 28 illustrate certain of the types of scales characterizing the sockeyes taken in Yale Canyon and above, while Fig. 20 is from the Thompson.

We can apparently not escape the conclusion that a large proportion of these canyon fish, taken during the month of August, were found up the Thompson River. Certainly they were *not* bound for the Chilcotin or the upper district. Although few in number, they were concentrated in the canyon, but when they reached the quiet waters above the canyon, and afterwards scattered over the immense Shuswap-Adams district, they were wholly lost to sight. If this inference is correct, it gives us the first glimpse of the Thompson race or races. The suggestion that these fish, like those spawning below the canyon, may in considerable numbers attain five years of age is an interesting one, and must be taken into account in all discussions of the four-year cycle and the striking variation in the proportion of the age-groups in the Fraser River.

Bridge River.—No material was obtained from the stretch of the Fraser between the mouth of the Thompson at Lytton and the outlet to Seton Lake at Lillooet. Above Lillooet, at Bridge River, fifty specimens were obtained from August 21st to September 8th, and proved on examination to contain a mixture of the type found in the Chilcotin at Fish Canyon, together with that secured above the Chilcotin in the main Fraser at Chimney Creek Bridge and at Soda Creek. The Chilcotin type predominated. Twenty-six per cent. were constituted of two-years-in-lake fish. The sizes ran low and the entire assemblage was markedly different from that taken at the same period and earlier in the month of August in the Yale Canyon. One specimen, a male 27 inches long, was in its fifth year, but all the others were of smaller size and apparently four-year fish. The nuclear rings of those of the one-year-in-lake form ranged from twelve to twenty-one, the smaller sizes predominating, and largely concentrated between thirteen and seventeen; the mode at sixteen. Those of the two-years-in-lake type have the rings of the first year ranging from six to eleven; those of the second year from twelve to twenty.

II. THE FRASER RUN OF 1918.

In our report for 1916 we remarked: "The run of sockeye salmon to the Fraser River in 1916 was the poorest known." In 1917 we were obliged to record the disappearance of the big year of the cycle from Fraser River runs, with no prospect of its recovery. And in 1918 the run reaches still lower dimensions than in 1916, the total catch on Puget Sound being 50,617 cases and in Canadian waters 20,955 cases, a total of 71,572 cases. This is but sixtenths the catch of 1916, the poorest previous year.

The brood years for 1918 were 1903 for the five-year fish and 1914 for those in their fourth year, the four-year fish largely predominating, as is customary in the Fraser River. 1913 was the big year of that cycle, but big years are now known to owe their magnitude to four-year fish hatched in the upper waters of the Fraser, in tributaries which produce few or no five-year fish. The tributaries of the Fraser which are responsible for five-year fish lie below the Yale Canyon, with the possible exception of the Thompson River, and have never experienced large increases in the size of the run during the big years of the cycle. We would have no reason to expect, therefore, any unusual influx of five-year fish in 1918 because of its relation to 1913. On the other hand, the 1913 run to the Lillooet Lake section, which supports the Pemberton Hatchery on the Birkenhead, the most important spawning stream of the Harrison-Lillooet section of the river, was distinctly poorer than in any big year since the hatchery had been established there. The history of 1913 gave no grounds for hope of any large number of five-year fish in 1918.

The four-year fish were hatched from the 1914 brood stock, which would be considered of more than average size for an off-year if we relied on the figures for the commercial returns (1,555,337 cases). On inspecting the reports from the spawning-grounds presented by Mr. Babcock for 1914, we find, however, that serious obstructions in the canyon above Yale prevented the ascent of the salmon during the greater part of August, and hampered them greatly at other portions of the run. The result was what might have been anticipated. The numbers that reached the upriver spawning grounds were everywhere greatly reduced. Fewer sockeye reached the Chilcotin than during any other recorded year. The run at Quesnel Lake was one of the poorest since the fishway was built in 1903, the total number that entered the lake being too small to make any noticeable showing there. Only a few hundred reached the Seton-Anderson Lake section, and the run to the Shuswap-Adams District was distinctly light. There was a fair run to Lillooet Lake and a rather small run to the Harrison.

This review of the situation is given to show how hazardous it is to predict future runs solely on the basis of the number of cases packed during the brood years. This cannot be depended on to give reliable data on the number of fish that will succeed in spawning. A careful study of the conditions described on the spawning-beds of the Fraser in 1913 and 1914 by Mr. Babcock would have prepared us for a decidedly limited run in 1918, though perhaps it would not have foreshadowed the magnitude of the disaster.

Age-groups.—In spite of the phenomenally small size of the run, the number of five-year fish shows no marked increase above the normal, although in other years of reduced run it has frequently shown such increase. Taking into consideration those sockeyes only which remained one year in the lake before passing to sea, we find the average percentage of five-year fish in the run to have been 23 per cent., varying on different days of the run from 5 to 59 per cent. No orderly sequence was observed, although in general the heavier percentages were found in June and July. Striking changes in the relative proportions of age-groups in successive years accompanies violent alternations of good and bad years. In such cases we find the poor years in such a series are signalized on the Fraser by a high percentage of five-year fish. But when the runs have declined almost uniformly to a low level, as seems now to be the case, the age-groups regain their normal relations and remain about the same from year to year.

Succession of Types in the Run.—As in previous years, it was obvious in examining the takes of different dates in orderly sequence that changes were constantly occurring in the constitution of the run. On July 2nd and 10th, for example, two distinct types could be recognized, one with a small nuclear region, containing most frequently eight to fourteen rings, usually with a band of intermediate rings outside it, and a small first year in the sea. The nuclear rings were fine, crowded, and more or less broken, and numerous five-year fish were included in this series. The characteristics here given are so closely those of the Lillooet-Birkenhead race as to raise a presumption that the fish of this type were bound to that portion of the Fraser watershed

The second type was marked by the large size of the nucleus, containing sixteen to twenty-two rings, and without distinct band of intermediates surrounding it. The nuclear rings are boldly drawn and strong, well spaced, and not interrupted. The first year's growth in the sea is not reduced, with more or less crowded, irregularly spaced rings, as in the preceding type, and very few are in their fifth year. This second type apparently disappears abruptly about the middle of July and is replaced by several partially recognizable strains which, together with type number one, form a very mixed assemblage. Figs. 30 to 34 illustrate some of the different forms which appear in this run.

Tables IV. to XI. give the succession of sizes appearing on a series of dates, and indicate that the average size increases during the advance of the season, largely by the disappearance of the smaller individuals included in the early part of the run. Taking into consideration only the predominating classes in the Fraser, which after hatching spends one full year (fifteen months) in the lake, the average sizes for the 1918 run are as follows:—

	Length, Inches.	Weight, Lb.
Four-year males	24.9	6.5
Four-year females	23.8	5.7
Five-year males	26.3	7.5
Five-year females	25.1	6.7

From the above it appears the conditions on the feeding grounds at sea were normal and an average growth was effected. Compare with Table XI., page 35 of Paper No. 3 (1915), of this series.

Table IV. Fraser River Sockeyes, Four-year Males, Esquimalt, 1918, distributed by Lengths and Dates of Capture.

Inches.	June 16.	June 20.	June 24.	July 2.	July 10.	July 14.	July 18.	July 21.	July 25.	July 29.	Aug. 5.	Aug. 4.	Aug. 8.	Aug. 11.	Aug. 13.	Aug. 16.	Aug. 23.	Aug. 26.
19½	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20½	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21½	...	...	...	1	...	2	...	...	...	...	...	...	...	...	...	...	...	...
22	...	3	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
22½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
23	...	4	...	1	1	...	...	3	...	1	...	...	...	...	...	...	...	...
23½	...	5½	1	4	1	5½	2	1	4	3	1	1	...	2	...	1	...	...
24	1	5	1	2	3	5	4	3	4	...	...	1	1	3	...	...	...	2
24½	2	...	...	1	...	1	2	4	2	1	5	...	2	3	1	8	...	...
25	1	3	2	4	3	4	3	1	1	1	3	2	3	3	3	1	1	3
25½	...	2	2	7	1	3	1	4	3	4	6	10	7	...	12	1	...	12
26	...	...	3	6	2	...	1	...	1	1	1	5	3	3	3	1	...	...
26½	...	...	...	1	1	...	...	...	...	1	2	...	1	1	...	2	...	...
27	...	...	...	1	2	...	...	2	2	...	...	...	...	...	...	...	...	...
Totals	5	18	7	19	26	16	17	16	19	12	16	23	22	25	12	27	3	7

Table V.—Fraser River Sockeyes, Four-year Females, Esquimalt, 1918, distributed by Lengths and Dates of Capture.

Inches.	June 17.	June 20.	June 25.	July 2.	July 10.	July 14.	July 18.	July 21.	July 25.	July 29.	Aug. 2.	Aug. 4.	Aug. 8.	Aug. 11.	Aug. 13.	Aug. 16.	Aug. 23.	Aug. 26.	Sept. 3.
20	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21	...	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21½	1	...	...	...	...	2	...	...	1	...	...	...	...	...	1	...	...	...	...
22	...	3	2	1	1	...	1	2	...	...	...	...	...	2	...	...	...	...	...
22½	2	3	1	1	...	1	2	...	...	1	...	...	...	3	...	...	...	...	...
23	1	5	4	1	1	1	4	3	6	4	1	...	2	...	...	1	...	...	...
23½	1	4	2	4	1	1	4	3	3	8	2	4	3	...	...	...	...	2	...
24	...	1	1	1	2	4	2	3	4	2	...	2	1	4	1	5	...	...	1
24½	...	...	...	2	2	2	...	...	3	4	2	1	1	4	2	3	...	...	...
25	...	...	1	...	1	2	...	...	1	3	1	2	1	1	2	...	1	1	...
25½	...	...	...	...	1	...	1	1	...	1	...	1	3	1	...	...	...	...	...
26	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...
26½	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...
27½	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...
Totals	10	21	12	12	16	19	15	21	17	28	9	21	20	17	9	18	1	3	1

Table VI.—Fraser River Sockeyes, Five-year Males, Esquimalt, 1918, distributed by Lengths and Dates of Capture.

Inches.	June 17.	June 20.	June 25.	July 2.	July 10.	July 14.	July 18.	July 21.	July 25.	July 29.	Aug. 2.	Aug. 4.	Aug. 8.	Aug. 11.	Aug. 13.	Aug. 16.	Aug. 23.	Aug. 26.
20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
20½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21½	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...
22	1	...	...	...	...	1	1	1	...	...	...	1	...	...	...	...	...	...
22½	...	1	2	...	1	1	1	...	...	...	1	...	...	...	...	...	...	1
23	...	1	...	1	1	...	1	1	...	...	...	3	1	...	...	1	...	...
23½	1	1	3	1	...	3	...	1	...	...	...	...	...	...	...	...	...	...
24	1	...	3	...	1	1	3	...	1	...	...	1	...	1	...	...	...	1
24½	...	...	2	2	2	3	1	1	1	...	...	1	3	...	...	1	...	...
25	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
25½	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
26	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
Totals	4	11	13	8	4	11	9	4	6	...	1	7	4	2	1	2	...	2

Table VII.—Fraser River Sockeyes, Four-year Females, Esquimalt, 1918, distributed by Lengths and Dates of Capture

Inches	17	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	June	June	July	July	July	July	July	July	July	July	July	July	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.
33					1													
32½																		
32			1						1									
31½				1					2		1						1	
31				1	3	3					1		1				1	
30½					1								2		1			
30				1		2		1			1		2	1	2	1	1	1
29½			1		1		1		1									
29								2										
28½											1							
Totals	1	3	15	5	7	1	1	6	2	2	4	3	3	3	1	1	3	1

Table VIII.—Fraser River Sockeyes, Four-year Males, Esquimalt, 1918, distributed by Weights and Dates of Capture

Pounds	17	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	June	June	July	July	July	July	July	July	July	July	July	July	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.
8																		
7½																		
7																		
6½																		
6																		
5½																		
5																		
4½																		
4																		
3½																		
Totals	5	18	7	19	26	16	17	16	19	12	10	23	22	25	12	27	3	7

Table IV.—Fraser River Sockeyes, Four-year Females, Esquimalt, 1918, distributed by Weights and Dates of Capture.

Pounds.	June 17	June 21	June 25	July 1	July 10	July 14	July 18	July 21	July 25	July 29	Aug. 2	Aug. 4	Aug. 8	Aug. 11	Aug. 13	Aug. 16	Aug. 23	Aug. 26	Sept. 7
3	1																		
3½	1	1		1															
4		6		1															
4½	2	1	1	1	1						1	1	2			1			
5	2	1		3	1	2	1	2	2	1	1		1						
5½		2	6	1	1	3	3	3	3	1	1	10	1	7	1				1
6			1	3	2	1	2	3	3	1	3	6	1	1	2	1	2		
6½	1			2	1	2		1		2		1		1	2			1	
7					3	1			1		1								
7½						2								1					
8																			
8½										1									
9																			
9½																			
Totals	10	21	12	12	16	19	15	21	17	28	9	21	20	17	9	18	1	3	6

Table V.—Fraser River Sockeyes, Five-year Males, Esquimalt, 1918, distributed by Weights and Dates of Capture.

Pounds.	June 17	June 20	June 25	July 2	July 10	July 14	July 18	July 21	July 25	July 29	Aug. 2	Aug. 4	Aug. 8	Aug. 11	Aug. 13	Aug. 16	Aug. 23	Aug. 26
4½						2												
5	1													1				
5½		2					2					2						1
6	1	1	6	3		1	1	1				1						
6½	1	3	1	2		1	1	1		1		1	1		1			
7	3	3	1	2		1	2	1	1		1		1	1		1		1
7½			1	2		1	2		1									
8			1			1	1											
8½						1	1			3				1	2		1	
9							1											
9½						1												
10																		
10½						1												
11																		
11½						1												
Totals	1	11	13	8	1	11	9	1	6	...	1	7	4	2	1	2	...	2

Table VI.—Fraser River Sockeyes, Live-year Females, Esquimalt, 1918, distributed by Weights and Dates of Capture.

Pounds	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4½					1														
5		1																	
5½	1	1	1				1	1										2	
6			1															1	
6½		2	6	1	3		2	2	2		2	2		1	1				
7		1	1		1		1		1			1		1					
7½	1		3		2			2			1		2	2					1
8						1						1			1				
8½					1					1									
9										1									
9½																			
10								1											
10½																			
11																			
11½																			
Totals	2	5	15	5	7	1	4	6	2	2	4	3	3	3	1	1	3	1	1

III. THE RIVERS INLET SOCKEYE RUN OF 1918.

The Rivers Inlet sockeye run of 1918 was the third very poor run in succession. Were it not for the exceptionally favourable showing in 1915 (130,350 cases), giving evidence of extensive destructions for which we cannot account, the present situation would take on a grave aspect. With the spawning-beds in Owikeno Lake in unsatisfactory condition, close attention should be paid this fishing district in the following years.

The run of 1918 had a smaller percentage of five-year fish than in any previous year since the very unsatisfactory season of 1913. Rivers Inlet is predominately a five-year stream, and in general exceptions can be noted it has shown the largest proportions of five-year fish during the most successful seasons. The five-year fish of 1918 were derived from 1913, when the fish, in addition to small numbers, were small in size for the various age-groups. But in 1918 they were far smaller, well below the average for this river both in length and in weight for all groups. The season must be considered a highly exceptional one. The males were much more numerous than the females compared with previous years, and the five-year fish pursued the very opposite course to that which they followed in 1916 and 1917. In these two years they appeared most abundantly in the early days of the run and gradually decreased as the season advanced. This is the customary method with five-year fish, not only in Rivers Inlet, but in other streams as well. But in 1918 the Rivers Inlet five-year-olds were almost wholly lacking at the beginning of the run, when on June 27th they constituted only 7 per cent. of the catch. From this date they increased regularly until July 19th, when they made 60 per cent. of the day's capture, and then maintained approximately that percentage for the remainder of the season. The reasons for such complete reversals of habit in a highly exceptional year cannot be conjectured at present.

Table VII.—Percentages of Four- and Five-year Rivers Inlet Sockeyes in Runs from 1912 to 1918, with the Broods from which they were derived.

Run of the Year	Percentage Four and Five Years old	Brood year from which derived
1912 (112,884 cases)	5 yrs. 79% 4 yrs. 21%	1907 (87,874 cases). 1908 (34,052 cases).
1913 (61,745 cases)	5 yrs. 20% 4 yrs. 80%	1909 (80,027 cases).
1914 (89,890 cases)	5 yrs. 65% 4 yrs. 35%	1910 (126,924 cases).
1915 (130,350 cases)	5 yrs. 87% 4 yrs. 13%	1911 (88,763 cases).
1916 (44,939 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 (53,101 cases)	5 yrs. 57% 4 yrs. 43%	1914 (89,890 cases).

Table VIII.—Percentages of Five-year Rivers Inlet Sockeyes occurring at Different Dates in the 1918 Run.

Dates, 1918.	Percentages of Five-year Fish.	Number of Specimens examined.
June 27	7	15
" 29	19	35
July 2	25	35
" 4	32	35
" 10	62	35
" 12	51	35
" 16	59	35
" 19	69	35
" 23	44	70
" 26	59	35
" 30	54	70

Table VII.—Percentages of Males and Females in Rivers Inlet Sockeyes occurring on Different Dates, Season of 1918.

	June 27	June 29	July 2	July 4	July 10	July 12	July 16	July 19	July 23	July 26	July 30
Four-year males	93	85	91	98	81	59	77	78	51	51	48
Four-year females	7	15	9	2	19	41	23	22	49	29	42
Five-year males	60	57	63	92	43	50	39	48	58	34	43
Five-year females	40	43	37	8	57	50	61	52	42	66	57

Average percentages—	
Four-year males	74
Four-year females	26
Five-year males	53
Five-year females	47
Average total males throughout season	66 per cent.
Average total females throughout season	34 "

Table VI. Rivers Inlet Sockeye, Run of 1918, grouped by Length, Age, and Sex.

Length in Inches.	Number of Individuals.			
	Four Years old.		Five Years old.	
	Males.	Females.	Males.	Females.
19	1	..	..	..
19½	1	..	..	..
20	6	..	..	..
20½	10	1	..	..
21	50	1	..	..
21½	55	11	1	..
22	69	23	1	1
22½	49	25	4	3
23	37	9	8	17
23½	26	11	23	13
24	31	7	20	39
24½	15	1	14	35
25	7	2	21	25
25½	..	..	17	20
26	..	1	28	16
26½	..	..	15	4
27	..	..	11	2
27½	..	..	4	..
28	..	..	1	..
Totals	355	96	171	175
Average length in inches	22.3	22.5	24.9	24.5

Table VII. Rivers Inlet Sockeye, Run of 1918, grouped by Weight, Age, and Sex.

Weight in Pounds.	Number of Individuals.			
	Four Years old.		Five Years old.	
	Males.	Females.	Males.	Females.
3	2	..	..	..
3½	17	..	..	..
4	42	3	..	..
4½	117	24	2	2
5	77	34	11	20
5½	51	20	26	32
6	30	9	21	46
6½	20	3	22	29
7	7	..	29	26
7½	1	..	21	20
8	..	1	15	6
8½	..	..	12	2
9	..	..	3	1
9½	..	..	3	1
10	..	..	1	..
Totals	355	96	171	175
Average weight in pounds	4.9	5.1	6.7	6.3

IV. SKEENA RIVER SOCKEYE RUN OF 1918.

(1.) GENERAL CHARACTERISTICS AND THE AGE-GROUPS.

The Skeena River sockeye-pack for 1918 consisted of 123,722 cases, and ranks among the best half dozen years in the history of the industry. Coming as it does after two phenomenally poor years, it gives grounds for hope that the Skeena may not as yet be suffering the results of overfishing. Evidences of the decline of a run, with standardized fishing methods, are, however, generally of slow and irregular approach. The returns from this river should be most carefully scrutinized.

The necessity for this is all the more evident for the reason that some important factor which must be largely concerned in determining the success or failure of the runs remains unknown to us. Attention has been repeatedly drawn to the total lack of relation between the run of any year and the apparent size of the runs four and five years before. The year 1918 presents a striking example of this lack of correlation. Its brood-years were 1913 and 1911, and as its five-year fish constituted 53 per cent. of the total run of 1918, the year 1913 was relatively the most important. But 1913 was apparently the very poorest year the Skeena has ever experienced. The four-year fish derived from the 1913 run constituted only 38 per cent. of the run of 1917, which was but little better than 1913. There seemed no reason to anticipate that 1913 would deliver five-year fish in 1918 far in excess of its entire yield of both four- and five-year fish.

The nature of the unknown factor must be at present wholly a matter for conjecture. We have called attention previously to the effect of boisterous weather on the commercial success of a season. A stormy summer is popularly supposed largely to diminish the proportion of salmon captured. The number of cases packed during such a season might indicate a poor run, whereas the run may have been above the average, and the escape to the spawning-beds unusually large. An attempt to correlate size of pack with weather conditions has not been made. It is possible that weather may exert a directly favourable or unfavourable influence on the size of the run in any year, in addition to its effect on fishing operations. This also is a matter inviting careful investigation.

During previous years we have observed an extensive variation in the relative abundance of the two-years-in-lake groups. It has varied from 7 per cent. in 1911 to 27 per cent. in 1916 but in two of the four years in which this proportion has been determined it has been 14 and 15 per cent. We have observed in other rivers a wide disparity in this regard between successive years. Evidently, at times, a much larger percentage of the yearlings fail to migrate in their second spring than is usually the case. We have no clue to the significance of this change of habit. It is perhaps to be sought in the fluctuating conditions which in certain seasons are less favourable to vigorous growth of the fingerlings than in other seasons. We have previously called attention to the fact that the larger sizes of yearlings migrate at the end of their first year, while the smaller sizes more frequently remain behind for additional growth. If a racial habit has been formed in a given river favouring migration seawards when a certain average stature has been attained, a much larger proportion of individuals may fail to reach it in one year than in another.

In 1918 the Skeena River run contained what appears to be a fair average number of adults that had when fingerlings spent two years in fresh water. Fifteen per cent. of the run belonged to this class. As shown in Table XVIII., 69 per cent. of these returned at the age of five and 30 per cent. at the age of six. A tendency appears for the members of this group to run into the river in larger numbers during the early part of the season, although this tendency is not so strongly marked as in the case of the five-year fish that as fingerlings spent only one year in the lake. As shown in the table, the individuals belonging to the latter group become proportionally less abundant during the latter half of July, while the four-year fish that have spent only one year in fresh water become more abundant.

(2.) RELATIVE NUMBERS OF MALES AND FEMALES.

A well-marked tendency for the males to precede the females was shown in 1918 in the Skeena, and is evidenced by Table XX., giving the proportions of the sexes in both four-year and five-year fish, taken at intervals of three or four days throughout the run. During the dates in June males were in excess of females generally in both groups, largely in excess in

the younger group, less so in the five-year contingent. In both groups, as the season progresses, there is an obvious increase in the number of females at the expense of the males. During the latter half of July the five-year females are greatly predominating, and the four-year females are nearly as abundant as the males of their class. Taking into consideration all the groups present in the run, the one-year-in-lake and the two-years-in-lake groups, of all ages, we find the males notably exceeding the females a constituting 57 per cent. of the entire run.

Considering the run as a unit and ignoring the fluctuations in its constitution from its origin to its close, we find the proportions of the sexes in the different groups, brought into comparison with previous years, presented in Table XXI. The close correspondence in a series of years is most striking, as is also the fact that the proportions of the sexes in 1918 represents in each of the groups the average for all the years of which we have a record. We note again that males predominate in both groups of the two-years-in-lake series. The five-year members have a slightly higher percentage of males than the six-year class, but in both classes the males are constantly in excess. It is not clear why the two years spent in fresh water in their early history should have influenced them in this manner. We should have expected males to predominate in the five-year class, while females would be equally in excess with the six-year-olds.

(3.) Lengths and Weights.

The following tables indicate that the size of Skeena River sockeyes in 1918 was fully up to the average observed over a series of years. The conditions at sea then had been favourable, and no adverse weather conditions had stunted growth during the late winter and early spring months of the spawning year. We again call attention to the comparatively unreliable averages for fish of the t years-in-lake group, due to the small size of these groups. The weigh for the year agree as closely as do the lengths. Comparing 1918 with 1915, we find the greatest difference in the average weights for the various classes is two-tenths of a pound; while the greatest difference in the average lengths equals two-tenths of an inch.

Table XVII.—Percentages of Four- and Five-year Skeena River Sockeyes that spent One Year in Lake, 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 (52,927 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 (116,573 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).

Table XVIII.—Percentages of Different Age-groups Skeena River Sockeyes, found to constitute the Run on a Succession of Dates, Season of 1918.

Dates, 1918.	One Year in Lake.		Two Years in Lake.	
	Four Years old.	Five Years old.	Five Years old.	Six Years old.
June 22	87	13	13	27
" 25	94	6	6	6
" 28	89	11	11	11
July 1	84	16	16	32
" 4	97	3	3	8
" 8	88	12	12	32
" 12	86	14	14	32
" 15	95	5	5	12
" 19	89	11	11	..
" 24	96	4	4	..
" 30	87	13	13	..
" 30	82	16	16	..

Table XIX.—Relative Numbers in One-year-in-lake and Two-years-in-lake Groups, Skeena River Sockeyes, 1918, on a Succession of Dates.

Dates.	One Year in Lake.	Two Years in Lake.
June 22	60	40
" 25	88	12
" 28	83	17
July 1	82	18
" 4	94	6
" 8	80	20
" 12	83	17
" 15	93	7
" 19	89	11
" 24	96	4
" 30	98	2

Table XX.—Percentages of Males and Females, One-year-in-lake Group, Skeena River Sockeyes, 1918, on a Succession of Dates.

Dates.	Four Years.		Five Years.	
	Males.	Females.	Males.	Females.
June 22	61	39	61	39
" 25	74	26	59	41
" 28	94	6	46	54
July 1	82	18	60	40
" 4	59	41	53	47
" 8	85	15	46	54
" 12	67	33	46	54
" 15	62	37	30	70
" 19	63	37	12	88
" 24	56	44	17	83
" 30	44	56	33	67
" 30	52	48	33	67

Table XVI.—Relative Numbers of Males and Females in Different Year-groups, Skeena River Sockeyes, in a Series of Years.

Years.	One Year in Lake.				Two Years in Lake.			
	Four Years old.		Five Years old.		Five Years old.		Six Years old.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
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	51	16
1917	65	35	48	52	65	35	58	12
1918	63	37	46	54	61	39	56	44

Table XVII.—Skeena River Sockeyes, Run of 1918, One Year in Lake, grouped by Length, Age, and Sex.

Length in Inches.	Number of Individuals.			
	Four Years old.		Five Years old.	
	Males.	Females.	Males.	Females.
21	..	..	..	..
21½	1	..	..	..
22	2	7	..	..
22½	8	21	..	..
23	25	39	1	4
23½	35	23	1	3
24	13	21	6	19
24½	39	9	2	22
25	41	6	13	41
25½	9	2	20	20
26	12	1	31	16
26½	1	..	17	6
27	..	..	11	2
27½	1	..	5	..
28	..	..	1	..
Totals	226	133	111	133
Average length in inches	24.1	23.3	25.8	24.9

Table XXIII. Skeena River Sockeyes, Run of 1918, One Year in Lake, grouped by Weight, Age, and Sex.

Weight in Pounds	Number of Individuals.			
	Four Years old.		Five Years old.	
	Males	Females.	Males.	Females.
3½	..	1	..	..
4	2	1	..	..
4½	16	12	2	..
5	11	18	1	5
5½	51	39	3	20
6	53	21	12	37
6½	43	9	24	31
7	20	1	31	20
7½	6	1	16	10
8	..	..	13	5
8½	1	..	3	2
9	..	..	5	..
9½	..	..	..	..
10	..	..	1	..
Totals	226	133	113	130
Average weight in pounds	5.7	5.3	6.8	6.3

Table XXIV. Average Lengths of Skeena River Sockeyes, One Year in Lake, for Seven Successive Years.

	1912.	1913.	1914.	1915.	1916.	1917.	1918.
Four-year males	24.6	23.5	24.2	24.2	23.9	23.6	24.1
Four-year females	23.5	22.9	23.1	23.5	23.6	23.2	23.3
Five-year males	26.1	25.5	26.2	25.9	26.2	25.5	25.9
Five-year females	25.2	24.7	25.1	25.0	25.0	24.7	25.0

Table XXV. Average Lengths of Skeena River Sockeyes, Two Years in Lake, for Three Successive Years.

	1916.	1917.	1918.
Five-year males	24.1	23.9	23.9
Five-year females	23.8	23.8	23.1
Six-year males	26.2	25.1	25.2
Six-year females	24.8	25.0	24.7

Table XVII.—Average Weights, Skeena River Sockeyes, for Five Successive Years.

	1914	1915.	1916.	1917.	1918.
One year in lake—					
Four year males	5.9	5.7	5.4	5.3	5.8
Four year females	5.3	5.2	5.1	5.0	5.3
Five year males	7.2	6.8	7.1	6.1	6.9
Five year females	6.3	6.2	6.3	6.0	6.4
Two years in lake—					
Five year males	..	5.9	5.8	5.5	5.7
Five year females	..	5.2	5.4	5.2	5.3
Six year males	.	6.6	7.08	6.3	6.6
Six year females	.	6.0	5.9	5.8	6.1

V. THE SOCKEYE RUN IN THE NASS RIVER, 1918

The 1918 run of sockeyes in the Nass River agreed with 1917 as being far below the average take for the last ten years, which is a little over 30,000 cases. The pack in 1917 was only 22,188 cases and was the worst up to that date for the past decade. But the 1918 pack was only 21,316 cases.

The size of the fish in the different classes was not less than the average in good years. In the four year fish of the one year in lake type, both males and females were distinctly larger than in the two previous years, as is shown by both average lengths and average weights in Table XXVII., the averages used being for the July fish only. The sizes would have been even larger had the August run been included.

The July and the August portions of the run were as sharply marked as had previously been noted. The one-year in lake type, both four- and five-year classes, had practically disappeared from the August run, which was composed of individuals that had spent two years in fresh water in the fingerling stage, and others that had spent three years in fresh water. Representatives of both of these groups had been present also in July, but the July individuals, in all the groups that spent two years in the lake, averaged distinctly smaller than the August fish of the same classes. It would be interesting to follow the August fish to their spawning-grounds, which are probably distinct from those of the early run.

Table XXVII. Nass River Sockeyes, Average Lengths and Weights of Different Classes, Runs of 1916, 1917, and 1918.

	Average Sizes of Individuals that spent							
	One Year in Lake.				Two Years in Lake.			
	Four Years old.		Five Years old.		Five Years old.		Six Years old.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
1916 (inches) ...	24.5	23.3	26.4	25.0	26.5	25.7	27.9	25.8
1917 (inches)	23.4	23.2	25.5	24.7	25.3	24.7	26.5	25.5
1918 (inches)	24.9	24.1	25.6	24.7	25.7	24.8	27.1	25.0
1916 (pounds)	6.0	5.3	7.2	6.3	7.2	6.2	8.1	6.4
1917 (pounds)	5.3	5.3	6.8	6.2	6.3	5.8	7.3	6.4
1918 (pounds)	6.2	5.7	7.1	6.2	7.1	6.2	8.2	6.6

Table XXVIII.—Nass River Sockeyes which ran in July, 1918, grouped by Age, Sex, Length, and by their Early History.

Length in Inches	Number of Individuals that spent									
	One Year in Lake.				Two Years in Lake.				Three Years in Lake.	
	Four Years old.		Five Years old.		Five Years old.		Six Years old.		Six Years old.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
22	..	3	..	..	..	1	..	1	..	..
22½	..	2	..	..	2	1	..	1	..	..
23	..	4	1	3	1	6	..	..	..	..
23½	5	1	..	3	2	6	..	..	..	..
24	6	13	..	3	6	3	..	..	..	..
24½	5	9	2	5	6	9	..	3	..	2
25	11	16	2	11	6	9	1	1	..	2
25½	17	12	6	11	9	19	1	1	..	3
26	19	3	7	10	11	11	1	1	..	3
26½	6	1	4	3	19	10	3	1	1	1
27	6	1	6	..	12	5	3	1	1	..
27½	..	..	1	..	9	2	2	..	..	..
28	..	..	..	..	1	..	1	2	2	..
28½	..	..	..	..	..	..	3	..	1	..
29	..	..	1	..	..	..	1	..	..	..
29½	..	..	..	..	..	..	2	..	..	..
30	..	..	..	..	..	..	1	..	..	..
Total No...	75	70	33	39	91	79	27	13	4	11
Ave. length	24.0	24.1	25.6	24.7	25.7	24.8	27.1	25.0	27.3	25.4
Ave. weight	6.2	5.7	7.1	6.2	7.1	6.2	8.2	6.6	8.1	6.8

Table XXIX.—Nass River Sockeyes which ran in August, 1918, grouped by Age, Sex, Length, and by their Early History.

Length in Inches.	Number of Individuals that spent									
	One Year in Lake.				Two Years in Lake.				Three Years in Lake.	
	Four Years old.		Five Years old.		Five Years old.		Six Years old.		Six Years old.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
22	..	..	..	..	..	..	..	..	..	..
22½	..	..	..	..	..	..	..	..	..	..
23	..	..	..	..	..	..	..	..	..	..
23½	..	..	..	..	..	1	..	..	..	..
24	..	..	..	..	..	..	..	..	..	..
24½	..	1	..	..	1	5	..	..	..	2
25	1	..	..	..	..	13	..	..	..	..
25½	1	1	..	..	2	6	..	..	4	1
26	1	..	..	..	5	6	..	..	4	4
26½	..	..	..	..	6	..	1	1	2	1
27	..	..	..	..	5	..	1	..	..	..
27½	..	..	..	..	2	1	1	..	1	..
28	..	..	..	..	1	..	1	..	..	..
28½	..	..	..	..	..	..	2	..	..	..
Total No...	3	2	..	..	22	32	6	1	11	8
Ave. length	25.3	25	..	..	25.1	25.2	27.6	26.5	26.5	26.1
Ave. weight	7	6	..	..	7.2	6.5	8.5	7.5	7.8	6.8

Table XXV. Percentages in each Class of Nass River Sockeyes running at Different Dates in 1918.

1918.	One Year in Lake		Two Years in Lake		Three Years in Lake	
	Four Years	Five Years	Five Years	Six Years	Six Years	Seven Years
June 26	..	35	25	40	..	..	..
July 2	..	35	11	50	..	..	..
" 6	..	34	13	51	..	..	..
" 7	..	43	37	12	6	2	..
" 11	..	40	32	22	6	..	..
" 16	..	47	33	14	..	..	..
" 19	..	42	33	25	16	4	..
" 23	..	42	29	29	7	2	..
" 26	..	40	21	33	6	19	..
" 30	..	30	9	61	18	2	..
Aug. 3	..	40	..	60	9	23	..
" 6	..	32	..	68	9	21	..

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Fig. 1. Fraser River sockeye, taken at Harrison Rapids, November 15th, 1918. Male, 26½ inches long.

Fig. 2. Fraser River sockeye. Taken at Harrison Rapids, November 15th, 1918. Female, 24 inches long.

Fig. — Fraser River sockeye, taken at Harrison Rapids, November 14th 1918. Female, 23 inches long.

Fig. — Fraser River sockeye, taken at Harrison Rapids, November 14th 1918. Female, 23 inches long.

Fig. 5. Fraser River sockeye, taken at Harrison Rapids, November 15th, 1918. Male. 27 inches long.

Fig. 6. Fraser River sockeye, taken at Mission Creek, October 11th, 1918. Male. 29 inches long.

Fig. 7. Fraser River sockeye from Morris Creek, taken October 12th, 1918. Female, 25 inches long.

Fig. 8. Fraser River sockeye from Morris Creek, taken October 22nd, 1918. Male, 28 inches long.

Fig. 9. Fraser River sockeye from the Birkenhead River, taken September 22nd, 1918. Female, 24 inches long.

Fig. 1c. Trout River sockeye from the Birkenhead River taken September 7th, 1918. Female. 24 inches long.

Fig. 11. Fraser River sockeye from the Birkenhead River, taken September 10th, 1918. Female, 25 inches long.

Fig. 12. Fraser River sockeye from the Harrison River, taken September 7th, 1918. Female, 24 inches long.

Fig. 13. Fraser River landlocked sockeye from the Lillooet River, taken at Skookumchuck, August 20th, 1918. Male, 12½ inches long, in its fourth year.

Fig. 13a. Fraser River landlocked sockeye or little redfish, taken at Harrison Lake, Hatchery, August 17th, 1918. Male, 9 inches long, in its third year.

Fig. 14. Fraser River sockeye from Hanceville, Chilcotin River, taken August 21st, 1918. Male, 27 inches long.

Fig. 15. Fraser River sockeye from Fort Garry on Quesnel Lake, taken August 24th, 1918.

Fig. 16. Fraser River sockeye from Fish Canyon, Chilcotin River, taken August 24th, 1918. Female, 23½ inches long.

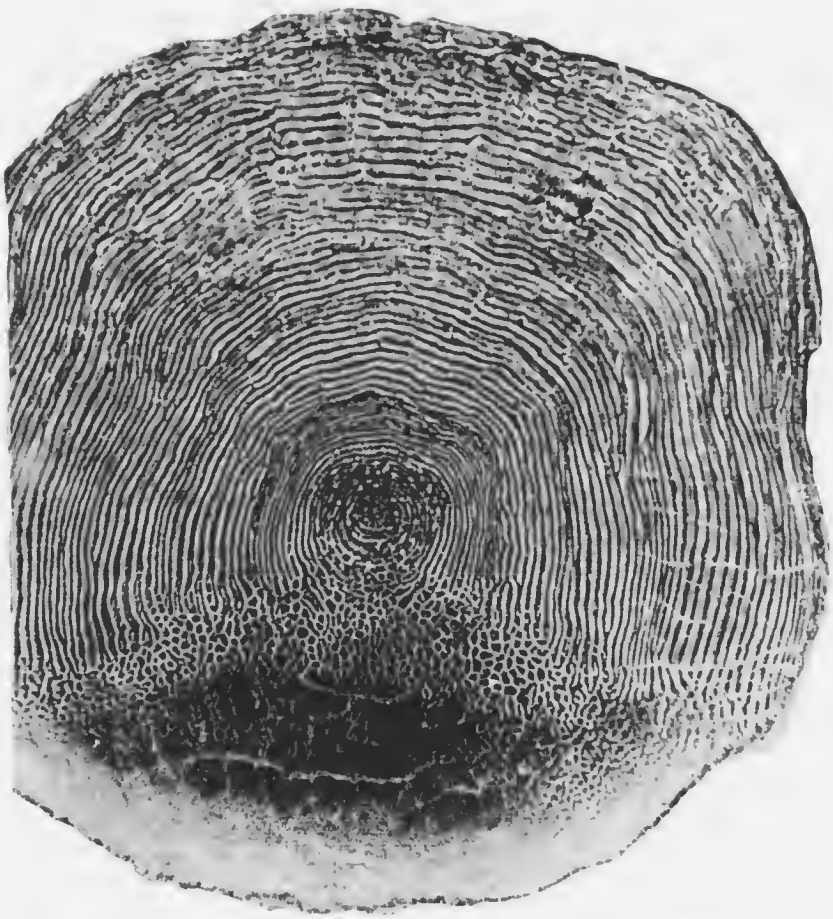

Fig. 17. Fraser River sockeye from Fish Canyon, C. Scotin Rl[illegible] Taken [illegible] 25th, 1918. Male, 2[illegible] inches long.

Fig. 18. Fraser River sockeye from Fish Canyon, Chilcotin River, taken August 24th, 1918.

Fig. 19. Fraser River sockeye from Fish Canyon, Chilcotin River, taken August 24th, 1918.

Fig. 20. Fraser River Sockeye from Hat[illegible] Canyon, Chilcotin River, taken August 2nd, 1918.

Fig. 21. Fraser River sockeye from the main river at Soda Creek, above the mouth of the Chilcotin; taken August 25th

Fig. 22. Fraser River sockeye from [illegible] Lake; taken October 27th, 1918. Mag. 2.8 inches long.

Fig. 24. Fraser River, Sockeye from Pitt Lake, October 27th, 1915. Female, 26½ inches long.

Fig. 25. Fraser River sockeye from the Canyon above Yale, taken August 9th, 1918. Female, 25 inches long, in fifth year.

Fig. 26. Fraser River sockeye from the Canyon above Yale, taken August 14th, 1918. Female, 25 inches long, in fourth year.

Fig. 27. Fraser River Sockeye from the Canyon above Yale, taken August 8th, 1918. Male, 27 inches long.

Fig. 28. Fraser River sockey from the Fraser River at Lytton, taken August 29th, 1918. Male, 27 inches long.

Fig. 29. Fraser River sockeye from the Thompson River at Thompson Sliding, taken August 29th, 1918. Female, 24 inches long, in fifth year.

Fig. 30. Fraser River sockeye from Vancouver Island traps, taken July 16th, 1918. Female, 21 inches long, two years in lake, in fifth year. Fingerling reached the sea 5 1/4 to inches long.

Fig. 41. Fraser River sockeye from Vancouver Island traps, taken July 25th, 1918. Female, 25½ inches long, in fourth year. Reached the sea as fingerling 5½ inches long.

PL. 2. Fraser River sockeye from Vancouver Island traps, taken July 25th, 1918. Male, 26 inches long, two years in lake, in fifth year. Fingerling reached the sea about 5½ inches long.

Fig. 33. Fraser River sockeye from Vancouver Island traps, taken July 29th, 1918. Male, 23½ inches long, in fifth year. Observe small nuclear region, indicating descent to sea as yearling less than 11½ inches long.

Fig. 31. Lesser Rye smelt from Vänern, Island Hov, taken June 20th, 1918. Male, 27 inches long, two years in lake, in fifth year. Note extremely large nuclear region, indicating these fish to be as two year old, which was 9 inches long.