FISHERIES RESEARCH BOARD OF CANADA

ANNUAL REPORT

for

1949

of

PACIFIC BIOLOGICAL STATION

by

R. E. FOERSTER, Director

(With Investigators' Summaries as Appendices)

NANAIMO, B.C.

DECEMBER, 1949

FISHERIES RESEARCH BOARD OF CANADA

Report of the

Pacific Biological Station

Nanaimo, B. C.

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Fisheries research, like any similar basic investigative effort, makes progress relatively slowly. Seldom are outstanding discoveries made. Rarely are pertinent data readily assembled, significant findings quickly available. On the contrary, it is normally a case of designing a plan to obtain the necessary facts or observations, collecting them as and when procurable and in course of time analyzing them to ascertain the results. Particularly in biological problems so many factors can be involved -- some apparent and measurable and others not readily recognizable -- which can so appreciably influence results either favourable or unfavourably that a true evaluation of the average state or condition is by no means easy or readily obtainable.

Only by long-term studies and a proper appreciation of all the influencing factors involved can a proper understanding of a fisheries problem be realized. In many cases investigations appear to be collecting only a mass of scattered and not particularly relevant records. Yet when these are pieced together and properly interpreted, significant conclusions can be drawn.

Nevertheless, while investigations are in progress, much useful information is obtained and valuable experience is gained by the investigators. It transpires, consequently, that from time to time important contributions can be and have been made on various aspects of fisheries problems to industry and to the Department by way of stated opinions, suggestions or series of records. While, therefore, conducting major projects that require many years of data before final solution can be achieved, the Station makes use of its facilities, within safe limits, for the guidance of those calling on its services. In this way it provides a valuable service function the extent of which is not perhaps fully recognized.

The research activities of the Station are designed to obtain those facts concerning our commercial fish and fisheries which will lead to better management policies. These, in turn, will provide more adequately a maximum sustained catch of fish year after year, yet ensure sufficient seed each season to perpetuate the stocks.

Fishing intensity is steadily increasing. Investments in vessels and gear are greater. More and more fishermen are attracted into the industry. Nevertheless the supplies of fish are limited and unless present stocks are carefully husbanded and factors governing successful propagation studied and improved where possible, economic depletion may result. Our efforts are being directed to methods of increasing the stocks of fish despite increasing fishing effort rather than merely to attempt to curtail the catch to meet existing conservational requirements. As circumstances permit, attention is being given to some of our minor fisheries in order that these may be utilized to greater extent and the exploitation of our marine fishery resources thereby increased.

REVIEW OF INVESTIGATIONS

Salmon. Under the general direction of Mr. Ferris Neave studies of sockeye, coho, pink and chum salmon have been continued. Since the factors most closely limiting production are believed to be those involved in spawning and the development of the young, the freshwater phases of the life-history have been given principal attention at a number of field stations along the coast.

It will be recalled that since 1944 an intensive study of the Skeena river sockeye salmon fishery has been conducted. A five-year programme of general investigation had been drawn up which concluded last year. Certain recommendations were made concerning management of the fishery and concerning continuance of research. For the latter it was suggested that in order to acquire essential information on production of young fish from counted spawning escapements and on the relation of varying environmental or ecological conditions to the production percentages, specific studies should be made at Lakelse lake, a natural sockeye salmon area reasonably accessible throughout the year. In addition, observations on fry production in certain typical streams tributary to Babine lake should be made to determine the effect of weather and water conditions on egg and fry survival.

In conformity with the recommendations arrangements were made to continue at Lakelse lake the annual counts of spawning sockeye, to keep a record of stream conditions in the spawning areas and examine certain redds at specified intervals during the winter, to make a count of fry produced in one stream (Scully creek), where a fry counting weir had been built, and to maintain limnological records on Lakelse lake itself. Subsequent counts of yearling smolts leaving the lake will be made. Thus the percentage production of sockeye to the smolt stage can be determined over a period of years and the influence of limiting factors, i.e., weather and water conditions in the streams, predation in stream and lake, food supplies in the lake, etc., can be revealed. By studying these limiting factors as well as their significance and how they may be controlled, methods for improving conditions and increasing production can be devised.

During 1949 a very small run of sockeye (7785) returned to the Lakelse area. Variation in numbers of spawners from year to year may make more readily possible an evaluation of maximum spawning capacity of known areas and the factors limiting production. A total of 1230 sockeye entered Scully creek, giving an egg deposition of approximately 1,800,000 eggs.

At Babine lake, fry counting structures have not yet been installed in typical streams. This work is proposed for 1950. The adult fence in the Babine river was again operated, however, and a very satisfactory escapement of spawners through it was obtained. The final count was 509,132 sockeye, 13,663 pinks, 11,938 cohos and 7,433 spring salmon. The Babine lake area is considered to produce a very substantial proportion of the Skeena river sockeye run and therefore a quantitative record of the escapement at Babine may be an indispensable gauge of the condition and trend of the fishery as a whole.

In the study of pink and chum salmon spawning and production of fry -- the young of these species going to sea in the fry stage -- particular attention has been given to the success of propagation in small coastal streams of which there are a great number along the B. C. coast. These undoubtedly produce the bulk of the fish of these two species, particularly the chums. It is intended that test streams in several areas of the coast will eventually be operated, for it is firmly believed that the factors controlling production of these species can best be understood by quantitative studies over a period of years in a number of selected localities.

At present only two field stations are established, one at Nile creek on the east coast of Vancouver island and the other at Port John in the central area of the coast, north of Vancouver island. At the former, frequented largely by chum salmon, experiments are being continued not only on production from natural propagation, but also from eyed egg planting and from planting of "green" eggs in an area with controlled water supply. That experiments of this kind are extremely valuable and should be carried on over a number of years is indicated by the variability in results obtained over the past few seasons. For natural propagation the percentages of fry production have been as follows: 1945 - 3.0%, 1946 - 0.40%, 1947 - 0.38%, 1948 - 6.03%; for eyed egg planting: 1946 - 2.66%, 1947 - 10.62%, 1948 - 3.01%; for "green" eggs in controlled water area: 1947 - 3.40%, 1948 - 11.85%. Analysis of the factors causing the striking variations in percentage production is being made, but the data reveal that extensive differences can be obtained from year to year depending on prevailing conditions and that long-term studies are consequently essential.

At Port John, sizeable runs of four species of salmon occur, including sockeye. Not only, therefore, can the relative efficiencies of the four species be determined at one location, but the interaction of the species at spawning time and during the free-swimming fry period can be studied. Returns of pink salmon in 1949 revealed an exceedingly low percentage return of adults when based on the preceding cycle year's (1947) egg deposition, namely 0.0423%. This low return, associated with an extremely low percentage fry production in 1948 (0.866%) provides but another example of the failure of a parent escapement to reproduce itself. By contrast, as it were, counts of sockeye fry descending from a small tributary creek into Port John lake this spring, gave a percentage efficiency for natural propagation of 25.26%.

Ever since 1913 the Provincial Fisheries Department has arranged for the collection and analysis of sockeye records - length, weight, sex, age-classes -- pertaining to each season's fishery on the Fraser, Skeena and Nass rivers and at Rivers inlet. Up to 1924 the data were analyzed and reported on by Dr. C. H. Gilbert of Stanford University, but in 1925 the work was taken over by Dr. W. A. Clemens, then Director of this Station. The Fraser river sockeye studies were dropped in 1938 when the International Pacific Salmon Fisheries Commission took over its Fraser river investigations. The other series were continued by Dr. Clemens when he transferred to the University of British Columbia and have been maintained up until 1948. As of that year, however, the Provincial Department of Fisheries felt it should withdraw from the field since salmon research along the coast had been expanded by the Fisheries Research Board of Canada and the Board might now be prepared to take over these studies. Similar investigations were already being made on the Skeena and Smith inlet for sockeye and in several coastal areas for chum and spring salmon. It was therefore agreed that this Station would take over the sockeye scale studies, etc., for the Nass and Rivers inlet and collections were undertaken this year. It is proposed that they be continued each year. An increasingly valuable body of information has now been built up, which is extremely useful in framing predictions on the sizes of succeeding cycle years.

Ground Fish Investigation. The primary objectives of this investigation, directed by Dr. J. L. Hart, are to determine the changes in relative abundance of the various species of fish supplying the otter trawl fishery and to fill in the many gaps in our knowledge of the life-histories and habits of the species. With this information we can reach an understanding of the reaction of the stocks of fish to existing fishing intensity and suggest remedial measures for maintenance of the fishery at a high level of sustained yield.

For these purposes landing and fishing effort data are collected by "port contact" men at Vancouver, Victoria and Prince Rupert, entered on Trip Report forms and sent to the Station for tabulation and analysis. Many years' records

are required, however, before reliable statements can be made. For example, return-per-unit-of-effort compilations for the lemon sole fishery in Hecate strait and strait of Georgia over the past five years reveal a consistent and appreciable decline. Both areas are considered to be fairly heavily fished. Both are still important trawling areas. The likely causes of decline are not yet clear.

Biological data on the more important species are obtained by the port contact men, by special samplers and by the scientific staff. The most important records are of length, age (from otolith reading) and sex distributions in commercial landings, although other observations such as on food are also frequently made. Tagging programmes are in progress to indicate the effective range limits of the more important populations and to provide information on total and fishing mortalities.

In a major investigation of this kind much of the field work has to be done by a special research vessel. Unfortunately this year the field operations were badly curtailed owing to the long lay-up of the M/V "Investigator No. I" with dry rot and engine trouble. While important field programmes were disrupted, scientist time was not wasted since opportunity was offered to reduce the accumulation of material awaiting study and analysis. Methods of stratified sampling and allocation of work have been developed which are expected to accelerate laboratory work and thus allow it to be kept more up to date.

Herring Investigation. This investigation, under the supervision of Mr. J. C. Stevenson, has been designed to provide information on the most successful management policy which could be developed to provide a maximum sustained fishery. At the moment two procedures are being tested, one a quota system of regulation (enforced in the lower east coast area of the strait of Georgia), the other an unrestricted fishery, except for a closing date (on the west coast of Vancouver island). Both fisheries are being followed over a period of years. All pertinent information is being obtained, statistical as well as biological.

At the present time both fisheries are in a flourishing condition, and under these circumstances maintenance of quotas may result in a serious wastage of fish, particularly if it is established that the provision of a large spawning population is unnecessary to assure an adequate recruitment of young fish to the stock. However, the important thing is to determine what will occur when a cycle of poor or less highly productive years arrives. Which system of management will then be more effective in maintaining the stocks? It is thus necessary to continue the comparative studies until years of reduced productivity occur and a series of less abundant year classes result in less effective recruitment to the stock. Meanwhile the continuance of a quota system does have the advantage of stabilizing the fishery at a certain prescribed level.

With unrestricted fishing and, in all probability, a resulting highly variable fishery from year to year, great importance will attach to the possibility of predicting the sizes of populations. If this is practicable, it will be of value both to industry in estimating the extent of the commercial fishery and to the Department in determining the amount of protection required for conservation purposes. Studies are now being undertaken to refine as much as possible the available prediction procedures, particularly to get a measure of abundance of young in the feeding areas, rather than to have to rely on extent of egg deposition. At present the latter is the method used. It has been found to be highly unreliable since great fluctuations in mortality can take place in different years between the egg and larval stages due to varying weather and oceanographic conditions. Therefore the extent of egg deposition is not necessarily indicative of amount of recruitment of young fish to the stock.

Grounds. There remain to be undertaken the construction of a sidewalk around the New Building, the hard-surfacing of the road, the installation of suitable retaining wall and gutter at the foot of the bank opposite the front entrance, proper rip-rapping of the fill on the seaward side of the new structure to prevent washing away of the fill material, addition of more earth or gravel to complete the present fill, spreading of top soil for gardens and lawns and planting of shrubs to give a pleasing appearance. Some of this work is now in hand and it is expected that it will all be completed by the end of the fiscal year.

VESSELS

Plans are now being prepared by Messrs. German and Milne, naval architects, for two new vessels for the Station, one to be an 80-90 foot all-purpose ocean-going research vessel, the other a 40 foot fast cruiser for the salmon investigation. Discussions have been held with Messrs. J. G. and H. H. German, our requirements have been generally outlined and sketches are now being made. Addition of these two vessels to the Station's equipment will very materially increase the scope and effectiveness of field operations.

At the present time the M/V "Investigator No. 1" is undergoing extensive repair and overhaul and when completed should be capable of almost continuous operation in the groundfish investigation. Meanwhile a chartered vessel and Departmental patrol craft are being utilized, when required, for urgent field studies.

PUBLICATIONS

During the year 26 papers have been published on work done at the Station. Of these one appeared in the Board's Journal, one in the Bulletin series and thirteen in outside publications. Eleven articles were contributed to Progress Reports of the Pacific Stations. Eleven papers have been written and the manuscripts submitted for publication, chiefly to the Board's Journal. In addition six were prepared and read at the Seventh Pacific Science Congress in New Zealand. Three volumes of mimeographed records of "Seawater temperatures, salinity and density on the Pacific coast of Canada" were prepared and distributed, thus bringing the data up to date (end of 1948). Four reports appeared in the mimeographed Circular Series.

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Stevenson, J. C. The extent of herring spawning in British Columbia in 1949. Prog. Rep. Pac. No. 80, pp. 57-59.

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INDEX TO SUMMARY REPORTS FOR 1949

Ferris Neave Appendix No. 1

The Salmon Investigation

The general object of the investigation -- an understanding of the conservational needs of the various species of Pacific salmon in British Columbia -- has been advanced through activities which can be classified as follows:

Operation of field stations

It is firmly believed that the factors limiting production of salmon can best be investigated by quantitative studies undertaken at selected localities and maintained over a period of years. With a sufficient number of field stations in operation, instructive comparisons can be made between different watersheds as well as between different years, and the establishment of general conservational principles can be advanced more rapidly. During 1949, field stations were operated as follows:

Lakelse lake. The work here has been principally concerned with the enumeration of the adult sockeye run, limnological studies on the lake and associated investigations of predatory or competitive fish. For the former purpose, fences were installed on the two chief spawning tributaries, namely Williams creek and Scully creek. At the latter, installations have been provided for the counting of fry next spring. This will permit comparison between the reproductive efficiency of sockeye at this locality and at Port John.

Babine lake. The major task has been the enumeration of the very large sockeye run, which accounts for an outstanding proportion of the whole Skeena escapement. This annual quantitative record is considered to be indispensable to a knowledge of the condition and trend of the Skeena fishery. Supplementary data on the composition of the run and the effect of the weir on migrating fish are recorded.

Nile creek. This station has continued to provide valuable information on the physical conditions influencing chum salmon production. Particular attention has been given to the application of remedial measures and definite ideas for the promotion of increased production are now taking shape.

Port John. Since this small stream system supports sizeable runs of four species of salmon, opportunity is given for investigating the relative efficiency of reproduction and evaluation of the requirements of each species. In 1949, the first quantitative estimates of sockeye fry production in a small stream were obtained.

Investigations of commercial and sport fisheries

The commercial sockeye catch of the Skeena river was sampled at six canneries for pertinent data on total production, size of fish, age-composition and incidence of fish marked in previous years at Lakelse and Babine lakes.

Scale collections and measurements of individual fish were undertaken with respect to the Nass river (sockeye); Rivers inlet (sockeye); Smith inlet (sockeye); Central area (chum and spring); Queen Charlotte islands (chum); Victoria and Sooke (chum and spring). In several instances officers of the Department of Fisheries have been responsible for collection of the samples.

Ferris Neave — Appendix No. 1

As outlined in later appendices, a statistical record was maintained for the Cowichan bay sport fishery (spring and coho) and a special investigation was made of the troll fishery of the west coast of Vancouver island.

Physiological and histological studies

In interpreting the results of field investigations and in considering conservational possibilities, the lack of fundamental biological information on salmon physiology is frequently felt. Studies of this kind can in many instances be more appropriately conducted at a university but it is thought that in other cases the facilities of the Biological Station or of a field station provide special opportunities for work which, while not in itself conservational, may lead to practical application.

In 1949, interesting experiments were conducted by Dr. W. S. Hoar on the effects of thyroxine on resistance of young salmon to salt water and on their behaviour in fresh water. A field experiment on the transference of sockeye fry to salt water is reported by Mr. J. G. Hunter in another appendix. Under this general heading may also be mentioned certain hybridization experiments initiated by Mr. A. Andrekson at Port John and studies on the recognition of sex in young salmon by Mr. J. G. Robertson.

Preparation of reports

The presentation of results and conclusions in published or other readily available form continues to be an important problem, since actual field work occupies a great deal of the time of most personnel. The accumulated data of five years' work on the Skeena is a special case but the condition also extends more widely through the Salmon Investigation. Good progress, however, has been made with the Skeena material, particularly through the full-time application of Mr. J. R. Brett to the problem during the summer months. In addition to various manuscripts prepared by permanent members of the staff, Dr. W. S. Hoar completed a bulletin on the pink and chum salmon fisheries of British Columbia.

Relations with other organizations

In view of the large number of agencies concerned with salmon conservation on the Pacific coast of North America, it is felt that exchange of ideas and information will contribute in an important degree to realization of the objects of the Salmon Investigation. Efforts have been made to keep in touch with the work of state, federal and international groups having similar objectives. In this connection the Investigation has acted as a clearing house for the registration and allocation of the numerous salmon marks used for experimental purposes by these organizations.

D. J. Milne and K. V. Aro — Appendix No. 2

Commercial Fishery 1949 Season

Following the recommendations in the Skeena interim report of 1948 the sockeye season was to start earlier, viz. June 19. However, a two day strike ensued so that fishing actually started June 22. The opening dates since 1940 average June 28.4 so that 6.4 days were actually gained. The closing date was set at August 12 which is 6.3 days earlier than the average

D. J. Milne and K. V. Aro — Appendix No. 2

since 1940. As the average daily catches during the first and last week of fishing were approximately equal the fishing season covered the run more uniformly than in past years. On the basis of the mark returns for Lakelse lake fish, this run was exploited about 50% and the heavy exploitation of the populations towards the end of the migration must have been curtailed to some extent.

Prior to the opening of the season a predicted catch for sockeye salmon of around the twenty year average of 68,000 cases was made. The fishing started off slowly in June with daily averages of 20 fish per boat which gradually rose to 45 during the third week of July followed by a drop to 30 during the fourth week. Thus up to the end of July with a catch of only 40,000 cases it looked as if the total for the season would be lower than expected and some concern was held regarding the adequacy of the escapement. However, the first week of August produced the largest daily catches of the season (55 fish per boat day) composed of exceptionally large fish (average 6.8 lb.). During the last week fishing fell off markedly to 20 fish per boat day. By the end of the season the total catch was 65,000 cases (700,000 fish).

Before the ages were determined it was difficult to account for the exceptionally large size of the fish so late in the season. On the basis of the large "jack" run in 1947 and the large run of 4_2 fish late in the 1948 season it was anticipated that there might be a large run of 5_2 fish early in the season. However, the age determinations (Appendix 8) indicate that the catch was composed of 75% 5_2 fish which accounts for the large average size of 6.35 lb. (10.8 fish per case). Since the spawning run passed Moricetown falls and Babine counting weir later than usual the poor weather conditions may be associated with the general lateness of the run.

The pink salmon catch, although curtailed by the complete closure of gill net fishing in the river from August 12 to August 21, was almost 2 1/2 times that of the cycle year 1947 and the escapement was also considerably larger. Thus the run for the odd year cycle has apparently reverted to a more normal condition following the drastic failure in 1947. The chum salmon catch was lower than the catches in the last six seasons. The catches of spring and coho salmon were fair but the size of the fish of the latter species was smaller than usual.

F. C. Withler — Appendix No. 3

Enumeration of the Run at the Babine Fence in 1949

Following the washout of the east end of the Babine fence on July 9, 1948, repair work was started last fall to put the fence in operating condition for 1949, (see app. no. 14, Annual Report for 1948). The work was continued from March 27 until May 15 of this year by Mr. O. A. Ragsdale, who in addition to repairing the washout damage rebuilt the cribbing on the west bank, resetting it flush with the shoreline and filling it with a large quantity of stone. That portion washed out under the floor of the fence has been refilled with stone and sheet-piled so that further trouble due to extreme water level conditions is not anticipated. The recording shed removed during the 1948 flood was replaced as part of the preparatory work during June of this year.

All of the panels were installed by June 29, and counting was carried out as in past years with Veeder Root Counters and Multiple Labcount Denominators as the fish passed out of the six pens over white chutes. The pens operated from 7 a.m. until 7 p.m. every day from June 29 until October 3, on which date the panels were removed.

Sockeye salmon. The first sockeye passed the Babine fence on July 3, but the daily run did not exceed 100 until July 25, which is 12 and 8 days later, respectively, than in 1946 and 1947. The peak daily run of 22,688 did not occur until September 2, as compared to August 21 and August 15 in 1946 and 1947, which fact places comparative segments of the run two weeks later than usual. After September 2 the run declined rapidly until October 3 when only 91 sockeye were counted.

The final count was 509,132, which compares favourably with 475,705 and 522,561 for 1946 and 1947. A daily breakdown of figures for the "jack" count places the percentage of "jacks" or precocious male sockeye at 9.4, determined from an observed sample of 5.9% of the run. Since the small "jacks" are of little importance on the spawning grounds, the effective population is closer to 461,164. This compares very favourably with 1947 when 47.7% of the run was comprised of "jacks", leaving a total of 273,100 large ("normal") fish.

In conjunction with the "jack" sampling, records of injured fish were kept. Net marks appeared on 5.6% of the fish observed and 0.3% bore evidence of gaffing. Other injuries appeared on 5.9% of the run, so that a total of 11.8% of the run bore injuries of some kind.

Pink salmon. The total of 13,663 pink salmon is phenomenally low when the cycle years of 1947 and 1945 are considered. Fifty-five thousand pinks passed the fence in 1947; the 1945 run was reported as medium to heavy, which would be greater than the 1947 run.

The first pink appeared on August 8 and the peak daily run occurred on August 31. The last pink passed the fence on September 26. The run arrived, reached a peak, and declined in the same manner as in 1947, which indicates that the run was not late as was that of sockeye.

Coho salmon. A total of 11,938 coho had passed the fence by October 3, when the daily count dropped to 93. This is 1,686 more than in 1947 and 551 less than 1946. The first coho appeared on August 13 and the peak run of 775 was recorded on September 11.

Spring salmon. The spring salmon total of 7,433 is the lowest in three years of fence operation. Although no "jack" count was undertaken for this species, a large proportion of the total number can be attributed to small "jack" springs which appeared to be more numerous than in other years. As in the case of the pinks, spring salmon spawn below the Babine fence as well, so that the fence count is not an absolute count to this tributary, but nevertheless should be a good indication of the concentration of spawners.

Chum salmon. Five chum salmon appeared at the fence between August 21 and September 2. A few chum salmon have appeared every year of operation of the Babine fence.

The table following summarizes the runs of the five species for the three years of fence operation:

	1946	1947	1948	1949
Sockeye	475,705	522,561 (47.7% "jacks")	560,000*	509,132 (9.4% "jacks")
Spring	11,528	15,614		7,433
Pink	28,161	55,421		13,663
Coho	12,489	10,252		11,938
Chum	18	7		5
Total	526,901	603,855		542,171

*estimated from comparison of stream survey counts and fence counts of previous years.

F. C. Withler Appendix No. 4

Salmon Sampling at the Babine Fence

In previous years, length and sex data of the Babine sockeye run were obtained from the proportionate tagging programme, where 1 or 2% of the run was tagged morning and afternoon. In order to furnish these data for 1949, 1% of the previous half-day's run was examined for fork length and sex by dipping randomly from No. 2 trap throughout the sockeye run.

Average lengths of male sockeye other than "jacks" increased from 60.0 cm. during the first week of the run to 65.9 cm. during the last week in August, and thereafter remained above 64 cm. until the end of the run. Similarly female sockeye rose from 53.8 cm. during the first week to 61.2 cm. during the last week of August and did not fall below 59.8 cm. before the end of the run. The increase in average length of "normal" fish was coincident with the increase in daily run, so that the average length of these fish for the season was high, (61.2 cm.). "Jack" sockeye in general decreased in average length throughout the period from 47.2 cm. to 39.0 cm., making the average length of all sockeye for the season 58.6 cm.

"Jack" sockeye formed 12.8% of the length-sex sample of 5094 fish. This proportion compares favourably with the 9.6% figure obtained from the differential count described in the previous appendix. In the remaining fish of the sample the sex ratio was 39.1% males to 60.9% females.

Since "jacks" formed only a small portion of the run this year, and the sex balance was in favour of the females, the run favoured a large potential egg deposition in the Babine area. Using the 1946 and 1947 average egg count of 3,239 from 137 samples, an approximate estimation of the egg deposition for 1949 and consequent number of yearlings resulting in 1951 is possible. (The egg count from 60 samples from the Babine fence this year are not yet available).

Total adult count	509,132
Probable no. of females	310,061
Av. no. eggs per female	3,239
No. of eggs available for deposition	1,004,288,000
Possible no. of resulting yearlings (Basis: 2% survival)	20,085,760

F. C. Withler Appendix No. 5

Water Level Changes and Speed of Passage of Sockeye Through the Babine Fence

Water level and maximum-minimum temperature records were maintained at the Babine fence in 1949 as in past years. The maximum temperature recorded was 18°C. on August 30 which immediately preceded the days of heaviest run. The greatest daily difference between maximum and minimum readings was 3.6°C.

Water levels as recorded at the official gauging station at Fort Babine were the lowest since the fence has been operated. At the time of installation on June 29, the flow in the Babine river approximated 2450 c.f.s.; at the time of removal of panels the flow was 900 c.f.s. On the date of the washout in 1948 the estimated flow was over 3700 c.f.s., while previous to panel installation in that year over 9000 c.f.s. had been recorded. The decline in water flow in the Babine river throughout the summer is very gradual, small variations being attributable more to wind direction on the Babine lake than to local rainfall.

F. C. Withler Appendix No. 5

As in previous years, an experiment to evaluate the delay by the fence to the passage of sockeye was performed. Twenty fish were tagged every five days from July 25 until September 23, released below the fence and the time of their return recorded. In this way it was found that 56% of the fish thus handled returned in the first 24 hours, and 80% returned by the end of 72 hours. By the end of fourteen days 93% of the fish had returned. Only 7% of the fish were not accounted for -- they either had not returned by the time the fence panels were removed on October 3, or had spawned below the fence, as a few fish are inclined to do.

These figures indicate a speedier passage of salmon through the fence than in either 1946 or 1947. In these years 45% and 43% returned in the first 24 hours and 77% and 61% returned within 72 hours. It is safe to conclude that the runs pass through with little delay, and the ease of passage is increasing, probably due to the increased number of pens used in 1949 (six). One pen was closed throughout all but the heavier runs because its operation was deemed unnecessary at other times in order to handle the fish adequately.

K. V. Aro and J. A. McConnell Appendix No. 6

Williams Creek Counting Fences

In the absence of a workable adult counting fence on the Lakelse river the three old fences at Williams creek used in 1939 by Dr. Pritchard and Mr. Cameron were reconstructed to complete the adult sockeye count for Lakelse lake and to examine the spawning population for marked individuals. According to spawning estimates for the last five years Williams creek provides spawning grounds for approximately 94% of the Lakelse sockeye.

In the reconstruction of the fences the old bulkheads, platforms and pylons were utilized whenever possible. Traps and some other materials were used from the ineffective Lakelse river fence. The fences in the main (80 feet) and the west (55 feet) channels were of the conventional wooden picket-type with 1 5/8 inch gaps between the slats. Wire panels from the Lakelse river fence were used in the construction of the fence in the smaller east (25 feet) channel. Four traps were used, one in the east channel, two in the main channel and one in the west channel. The old cabin used by the previous investigators was repaired to provide shelter for the crew while operating the fences.

The channels were sealed off on August 3 and the fences were completely operational on August 12. From a stream survey conducted by Fisheries Inspector Giraud it was estimated that about 100 fish had entered the stream prior to August 3.

The traps were kept open continuously and the fish were dipped out each morning and evening and periodically during the day and night as the size of the run demanded. Daily numerical counts of the males, females and "jacks" were kept. Each fish was examined for marks as it was dipped out. In addition a random sample was taken each day by measuring 2% of the previous days run. In order to determine the average egg count, ovaries were taken from 25 females throughout the season. For a later winter study of survival 12 redds were staked. A daily record of the water level was kept.

The first fish to enter the traps were two males on August 3 followed the next day by 14 males and 3 females. Thereafter the numbers of both sexes increased until August 14 when a total of 1,132 entered the traps during a rise in water level. After this peak the run decreased, except for a second peak of 420 fish on August 21, until by September 10 no fish were counted. Later, on September 15, a minor run of 71 fish entered the fences.

K. V. Aro and J. A. McConnell — Appendix No. 6

As a result of heavy rains during the preceding night the main fence was rendered inoperative on September 21 by a flash flood which damaged much of the fence in the main channel. An estimated 50 to 75 sockeye were in the traps at the time. The count was discontinued on September 21.

In the following table the total count in 1949 is compared with that obtained in 1939 by Pritchard and Cameron.

	Males		"Jacks"*		Females		Total
	No.	% of total	No.	% of total	No.	% of total	
1939	12,350	51.3	--	--	11,735	48.7	24,085
1949	2,685	47.0	22	0.4	3,000	52.6	5,707

*The "jack" count cannot be considered absolute because some of the "jacks" may have passed through the gaps in the panels.

From 1944 to 1948 the population of adults at Lakelse lake was estimated from the ratio of tagged to untagged fish on the spawning grounds. On this basis the spawning estimates for Williams creek are: 1944 - 22,000, 1945 - 54,500, 1946 - 38,000, 1947 - 15,900 and 1948 - 13,800. Thus a comparatively large run of sockeye was anticipated in 1949 but it proved to be much below the five-year average of 28,840. This may be due in part to a greater exploitation of Lakelse fish in the commercial fishery this year because of the lateness of the Lakelse run and because of the earlier opening date of the fishery.

G. C. Broadhead and R. E. Lindsay — Appendix No. 7

Scully Creek Fence

Construction

Scully creek has been selected for a detailed study of the stream phase in the life of the sockeye salmon of Lakelse lake. The programme was initiated this year with the construction of a combined adult and fry counting fence and a 12 by 14 foot cabin. The site chosen for the fence was at an old beaver dam, 400 yards upstream from the creek mouth. There the stream was 22 feet wide and approximately two feet above the lake level. A swampy area prevented placing the structure nearer to the lake, and even at the site, there was soft mud below the fine gravel bottom.

The fence is patterned after the one at Port John, B. C. The adult part is a conventional picket-type fence 44 feet long consisting of eight sections with one section so modified as to lead into a trap. To this, a "Wolf" trap has been added, to capture the fry migrants. This consists of a dam 2 1/2 feet high, fine wire screens set almost horizontally to strain the water, and troughs leading to two central pens in which the fry are collected.

Clearing and excavation for the adult structure commenced on June 6 and the fence started operating on July 9. The fry portions were added at a later date, August 16 to September 3. Construction was carried out by Mr. O. Ragsdale and crew.

Operation of adult fence

All the fish were dipped from the trap, sexed, measured, examined for marks and released on the upstream side of the fence. During low water, it was necessary to block off a varying number of sections in order to maintain a sufficient flow of water through the trap.

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The sockeye run commenced on August 4 and built up steadily to a peak of 456 fish for the week of August 20 to 27. The run terminated on September 23, with the exception of one fish on October 12. This year the run was nearly two weeks late, as previous reports indicate that sockeye have been observed in the stream as early as July 23. The fence count consisted of 565 (52.4%) males, 485 (45.0%) females, and 28 (2.6%) "jacks", making a total of 1078. In addition 152 sockeye were observed to spawn below the fence, making a grand total of 1230 fish for the creek. This is lower than the average (1700), of the estimates for the last five years.

The egg content, determined by counting the eggs of every twenty-fifth female, averaged 3665.5 eggs per fish. Thus the potential egg deposition from the 485 females spawning above the fence is 1,777,767.

To determine the effect of coho salmon spawning later, either on or upstream from the sockeye redds, it was necessary to operate the adult fence until late fall. The first coho appeared on October 12 and by October 21, 42 were recorded. A heavy freshet on the night of October 21 rendered the fence temporarily inoperative so that a complete count could not be obtained.

D. R. Foskett — Appendix No. 8

Sockeye Salmon Age Determinations

Since it was evident that in the past too much time had been spent in mounting scales an investigation was made of the newer methods in order to find one suitable for our purposes. The elimination of one or more steps in the process was desired and the plastic impression method showed the best possibilities in this line. The method being tried at the University of British Columbia seemed to be suitable and through the courtesy of Dr. W. A. Clemens the apparatus was borrowed during the summer months for a trial. At first some difficulty was encountered due to the variability in the thickness of the acetate slides and the relatively poor impressions formed by the small circuli representing the freshwater growth of the salmon. Consequently a warming table was devised to soften the slides and also to eliminate picking the slide up to bring it in contact with the rollers. This apparatus, using different sized light globes for different degrees of heat, seemed to eliminate most of the difficulties and it was found that once the operator became familiar with the method what had formerly been a week's work could very easily be done in a day. This made it possible to have the rough analysis of the age composition of the Skeena sockeye salmon run available for the Skeena Advisory Committee meeting and for prediction purposes by the end of September this year whereas in other years it has not been available before the following spring.

The age composition of the sockeye tagged during the 1948 Skeena river tagging was as shown in the table below. The age composition of the samples of the commercial catch for the same year as determined by Dr. Clemens are also shown. Fish tagged in the Nass river area are included in the table under appropriate headings.

Age composition of the 1948 sockeye run in the Skeena area

Age class	Skeena river				Nass river	
	Tagged fish		Commercial catch			
	Number	%	Number	%	Number	%
2_1						
3_1					1	.85
4_1	7	.30			2	1.69
3_2	14	.60			3	2.54
4_2	1641	70.68	2182	79.93	22	18.64
5_2	339	14.59	361	13.22	23	19.49
6_2	1	.04				
4_3	3	.13				
5_3	271	11.68	162	5.93	56	47.47
6_3	46	1.98	25	.92	10	8.47
7_3					1	.85
Total	2322	100.00	2730	100.00	118	100.00

The age composition of the 1949 commercial catch for the Skeena and Nass river areas was:

Age class	Skeena sockeye		Nass sockeye	
	Number	%	Number	%
3_1	1	.07		
4_1	1	.07	1	.64
3_2	1	.07		
4_2	224	16.41	61	38.85
5_2	1024	75.02	9	5.73
5_3	57	4.18	72	45.86
6_3	43	3.15	11	7.01
Indeterminate	14	1.03	3	1.91
Totals	1365	100.00	157	100.00

In addition to the above samples, marked fish from Lakelse and Babine markings were recovered in the commercial fishery in 1949. These showed that the age composition of the sockeye run to these two areas was in the main similar. The age composition of those fish having marks of doubtful origin is also included in the following table.

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Age class	Babine marks		Lakelse marks		Doubtful		Totals	
	Number	%	Number	%	Number	%	Number	%
4_2	67	19.42	25	17.86	10	8.77	102	17.03
5_2	263	76.23	107	76.43	85	74.56	455	75.96
5_3	7	2.03	1	0.71	5	4.39	13	2.17
6_3	1	0.29	4	2.86	8	7.02	13	2.17
Indeterminate	7	2.03	3	2.14	6	5.26	16	2.67
Totals	345	100.00	140	100.00	114	100.00	599	100.00

It is evident from a study of the last two tables that the 1949 sockeye run was largely composed of 5_2 sockeye and that the 1948 run, as shown by the first table, was largely 4_2 sockeye. That is, the sockeye run on the Skeena river during 1948 and 1949 was largely composed of the progeny of the 1944 run of sockeye.

D. J. Milne and K. V. Aro — Appendix No. 9

Return of Marked Sockeye Salmon in 1949

As in 1948 an observer was stationed at each of the six operating canneries at the mouth of the Skeena river to examine all the sockeye caught in the Skeena gill net area and as many from other areas as possible. In addition all the fish counted through the three weirs upriver, viz., on Williams and Scully creeks at Lakelse lake and on Babine river at Babine lake, were examined for marks. Many five and four year old fish were expected from the 100,967 and 100,119 young salmon marked at Lakelse lake in 1946 and 1947, respectively and from the 88,972 and 107,650 marked at Babine lake in the same years. A few six year old fish from the small number marked in 1945 (ca. 11,000) and a small number of three year olds from the 1948 experiments involving approximately 110,000 were also expected.

Each year the yearling sockeye at Lakelse lake had been marked by the removal of both ventral fins while those at Babine lake had the adipose and both ventral fins removed. As the recovered marks exhibited much variation each fin was graded into four groups depending on its size. An authentic Babine mark was taken as one in which the adipose and one or both of the ventral fins were damaged. Actually there were only three specimens which did not have both fins damaged. An authentic Lakelse mark was taken as one in which both ventral fins were damaged. This left numerous doubtful marks with either one ventral fin damaged or both ventral fins missing due to abnormal development or accidental causes. How many of the doubtful marks should be considered as authentic marks is difficult to say but no doubt some are due to natural causes.

Ocean Returns. From approximately 670,000 sockeye examined from the Skeena gill net area 345 Babine, 140 Lakelse and 114 doubtful marks were obtained. Marked fish from both lakes were widely distributed throughout the area. The Lakelse marks were spread more uniformly throughout the season in 1949 than in 1948 with 45% of the returns being made by the middle of July in

1949 as compared to 70% in 1948. Thus the mark returns of both years indicate that more Lakelse sockeye are taken in the commercial fishery than was previously inferred from either tag returns or from the time of the arrival of the adults at the lake. The recapture of Babine marks in general followed the size of the commercial catch. Among the doubtful marks there were nine fish which lacked a pelvic girdle.

From 70,800 sockeye examined from other areas outside the Skeena gill net area the following marks were obtained; Nass river (62,000 fish) 7 Babine, 5 Lakelse and one doubtful mark, Banks island (6,400 fish) one Babine mark and in Wright sound (2,400 fish) no marks were found.

River Returns. At Babine fence the examination of 509,132 sockeye produced 298 Babine, 21 Lakelse and 3 doubtful marks. The occurrence of so many Lakelse marks is confusing especially when nine had both ventrals off clean. Whether the adipose fin was not adequately removed in the initial marking and regenerated completely or whether these specimens were truly Lakelse fish is a contentious point. Only two of the authentic Babine marks had one ventral fin complete. The low number of doubtful marks compared to the high number found at the coast can probably be attributed to the difficulty in obtaining as complete a count from the live fish at Babine. Most of the marks (97%) were found in the first half of the run. As only the first part of the yearling run was marked it appears that those yearlings which migrated to the sea early also returned from the sea early.

At Lakelse lake 31 Lakelse and 1 doubtful mark were recovered from 1,077 sockeye examined at Scully creek fence and 109 Lakelse and 8 doubtful marks were found at Williams creek fence in the 5,707 fish examined. The marked fish occurred uniformly throughout the run which was in keeping with the way in which they were originally marked.

Discussion. On the basis of the count of yearlings at Lakelse in 1946 and 1947 and the age determinations of Lakelse ocean mark returns the 7,000 spawning adults represent the survival from approximately 500,000 seaward migrants. This ocean survival for Lakelse fish of less than 1.5% is lower than expected. At Babine where almost the same number of fish were marked the return of more than twice as many marked adults indicates that the ocean survival for Babine fish may have been twice as great. At Lakelse the mortality of marked fish compared to unmarked fish was also high. We might expect about one marked fish in five but as we recovered about one marked fish in 50 a marking mortality of 90% is indicated. Since the number of mark returns both at Lakelse and Babine was approximately the same as those caught in the commercial fishery it would appear that both runs received approximately 50% exploitation. If this exploitation rate is applied to the whole fishery then the spawning adults counted at Babine and at Lakelse would represent about 75% and 1% respectively of the escapement.

When compared to experiments elsewhere the total mark returns are low but despite the difficulty of alloting authentic marks the returns have been valuable in demonstrating that in 1949 the Lakelse run did not escape the fishery and that both the ocean and marking mortalities were high.

V. H. McMahon and T. H. Bilton Appendix No. 10

Physical-chemical Studies at Lakelse Lake

The Lakelse field programme for this year was so designed that detailed studies might be made of some of the natural environmental conditions encountered by the young sockeye salmon in the lake. The physical-chemical phase of the programme included the regular collection of meteorological and thermal data as well as a determination of the dissolved oxygen concentrations and the analysis of the lake water for phosphate and nitrate content.

Meteorology and lake levels

Records of the rainfall, maximum and minimum air temperatures, cloud coverage, wind velocity and direction, and lake level changes were kept for the entire period.

Three peaks appeared in the rainfall and lake level. The first came near the beginning of June at which time the lake level rose sharply. A small rise appeared in late July and early August when approximately 3 1/2 inches of rain fell. The last and greatest rise in the lake level did not appear until late September and October during which period a rainfall of 10.50 inches was recorded. The lake level for the period April to November fluctuated between a low of three inches on September 13 and 38 inches on October 15, as recorded on the gauge.

The mean monthly maximum air temperatures from June to October were 67.9, 64.3, 67.4, 62.2 and 48.4°F., respectively, while the mean minimum temperatures were 48.5, 47.6, 47.5, 44.6 and 44.2°F. The maximum temperature was recorded on August 29 at 83.5°F., the minimum on October 18 at 28.5°F.

The wind blew on approximately 75% of the days and over 90% of the winds originated in the south-west. In general a heavy cloud coverage and often rain accompanied these winds.

Thermal conditions of the lake

Water temperatures were taken weekly at six stations with a reversing thermometer.

On May 5, the first recorded series, a uniform temperature distribution was revealed. At this time the temperature at the bottom (30.0 m.) was 5.5°C. with a gradual increase to 6.3°C. at the surface. A similar situation developed in late October when the bottom water was 8.2°C. while the surface was 8.9°C. Throughout the season the temperature of the surface water ranged between 6.3°C. on May 5 and 19.2°C. on August 30 while the bottom water was between 5.5°C. on May 5 and 10.8°C. on September 13. Below the 10 metre level the water warmed up gradually as the summer progressed but the upper layers fluctuated considerably throughout the season. The period of greatest thermal stratification occurred in the middle of July when there was a difference of 5.7°C. between the water at 10 metres and that at the surface.

Thermal studies were also made with a shallow bathythermograph. The temperatures were recorded at the central deep-hole once a week, at seven stations down the middle of the lake twice a month, and once a month an overall thermal picture was obtained by taking readings at 17 different positions. This latter series included the previous stations as well as the mouths of Williams creek and Lakelse river. The records have yet to be examined.

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Chemical conditions of the lake

During the 1949 season the lake water was analysed for dissolved oxygen, nitrates and phosphates, the latter two analyses being attempted for the first time. The methods employed were the Winkler method for dissolved oxygen concentration, the reduced strychnine method of Harvey (1926) with certain modifications by Riddell (1936) for nitrates, and the ceruleomolybdic method of Deniges (1920) with modifications for phosphates. The Miller method of oxygen determination was also checked against that of Winkler. The values obtained by the former method were slightly lower in each case.

The bottom, middle and surface waters of the deep central station and the surface water of the shallow southern station were analysed bi-monthly for oxygen, nitrate and phosphate. In addition, the inflowing water of Williams creek and the water leaving by Lakelse river were analysed once each month.

It is difficult at this time to interpret the results of the phosphate and nitrate analyses. The concentration of the phosphates was extremely low at all times and difficult to measure accurately as the colours produced were often masked or indefinite. The nitrate determinations were more clear-cut, but unfortunately two different lots of strychnine sulphate reagent were used during the summer and the switch over on August 22 is strongly reflected in the resulting high values. Subsequent to this date the higher concentrations of nitrates were in the deeper waters. The salts increased in concentration from August 22 to October 3 at which time the concentration from surface to bottom was more uniform. The nitrate and phosphate salts were always more concentrated in Williams creek water than in Lakelse river.

Although the results of this year's chemical analyses leave much to be desired they have served the purpose of a preliminary chemical study. With the experience gained this year a more comprehensive undertaking can be attempted in the future.

V. H. McMahon and T. H. Bilton — Appendix No. 11

Biological Studies at Lakelse Lake

The biological phase of the work at Lakelse lake consisted mainly of the routine sampling of plankton organisms and the netting of the fish populations. In addition, various methods for capturing the young sockeye in the lake were tested, with a view to making a study of the distribution, feeding habits and growth rates of the fish, during the various stages of lake residence.

Plankton collection

Six plankton stations were set up throughout the lake at depths of from 5 to 30 metres. The samples which consisted of total verticals, partial verticals and stage hauls were taken with a Wisconsin type plankton net of No. 10 mesh. The plankton populations were sampled weekly at each station throughout the period May to November.

From preliminary observation of the samples the plankton appears to be extremely scarce in the shallow waters of the south end, especially during and immediately following a period of windy weather. As the prevailing winds originate in the south-west it seems likely that the plankton, which is most concentrated in the upper water, is almost continuously carried into the deeper central and northern portions of the lake.

Netting

From our experience in past years it seems that gill netting is still the most practical method of sampling fish populations and the catch per net-night the best index of relative population density. Netting in Lakelse lake has therefore been carried on this season as in past years.

A total of 23 net sets were made during the sampling period -- 5 in June, 3 in July, 8 in August, 6 in September and 1 in October. The nets were set in rotation at 6 representative positions selected in previous years.

During the first part of the season the conventional gang of 5 nets (1 1/2, 2 1/2, 3 1/2, 4 1/2 and 5 1/2 inch meshes) was employed. After July 13, however, the 4 1/2 and 5 1/2 inch meshes were removed since too many salmon were being taken. Past results proved these meshes to be of little netting value. Of 326 fish taken in all nets by July 13 only 2 fish other than sockeye were caught in the 4 1/2 or 5 1/2 inch meshes. These were 2 cutthroat small enough to have been taken in the smaller meshes.

The following table includes the catch per net-night values for 1945, 1946, 1947 and 1949 to show the trends in the successive years. All figures are based on a net series of 5 meshes.

Species	Catch per net-night			
	1945	1946	1947	1949
Peamouth	6.41	5.95	4.42	6.24
Squawfish	1.63	1.30	1.04	1.27
Cutthroat	.72	1.07	.94	1.12
Rocky Mountain whitefish	.40	.32	.25	.27
Sculpin	.44	.26	.11	.16
Columbia river sucker	.40	.19	.08	.23
Dolly Varden	.05	.03	.06	.09

It is noted that the catch per net-night value for each species is greater in 1949 than in 1947 and in some cases greater than for 1946 also. The explanation for this situation may stem from the extremely few nets set (5) in the 1948 season, when the fish populations were given an opportunity to build up.

The high value for Dolly Varden in 1949 may be due to the fact that the netting was carried on later in the season than in previous years. The first fish of this species was taken on September 27, following which the numbers increased.

As in past years the stomachs of all predator fish were preserved for later analysis as well as a portion of those from non-predator species.

Young sockeye collection

Numerous attempts were made to capture the young sockeye in the lake by various means. Towing hoop nets of different sizes and dropping flash-light boxes yielded negative results. A cylindrical trap consisting of 2 steel hoops of approximately 4 feet diameter and separated by 5 feet of fine seine netting was lowered into the water to various depths at the central deep-hole plankton station. The trap had a funnel opening at one end and was closed off at the other. At 7 and 15 metres depth five small 3-spined sticklebacks were captured while a small sculpin was taken from a depth of 5 metres. Although no sockeye were recovered, the results looked

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promising and so a stronger trap was built with a wooden frame 4 feet square and 5 feet in length. Instead of the rather coarse seine netting fine wire mesh was used on the new trap. Unfortunately this trap was lost in a storm in late August before it could be determined whether or not it was successful in trapping small fish.

G. C. Broadhead — Appendix No. 12

Survival Studies in Scully Creek

Scully creek was selected as a small sockeye stream where the problems of survival, predation and stream improvement could be readily studied because of its availability, stream flow and the size of run. The creek drains a low wooded area in the south-east corner of Lakelse lake. Observations from the past five years indicated an annual spawning of from 1,000 to 2,500 sockeye and a smaller but undetermined number of coho salmon. The stream flow during the sockeye spawning period is below 20 cubic feet per second but during the spring and fall rains the creek may freshen severely. The spawning redds range from extremely fine gravel near the lake to very coarse gravel at the upper spawning levels.

Preliminary studies are designed to record the efficiency of stream survival under natural conditions. An attempt is being made to assign egg and fry losses to various factors such as water conditions, silting, gravel used, superimposition and predation. Later various stream improvements will be effected and their effects noted. The work undertaken this summer included the construction of an adult-fry fence and cabin, mapping of the creek and available spawning gravel, the distribution of the spawning sockeye and coho and the examination of certain sockeye redds during the pre-eyed and eyed stages. From June to November stream water levels and temperatures were also recorded.

The sockeye spawned during August and September from the stream mouth to 7,300 feet upstream. Here a log block occurred during the summer low water and above this point considerable spawning gravel was not available to the sockeye. At the mouth of Scully creek no lake spawning was observed or thought to occur due to the muddy bottom of the lake in this region. Stream spawning was greatest in the areas above riffles formed by sunken logs. Tightly packed gravel was ignored. No areas appeared to be crowded and each pair had at least two square yards of gravel on which to spawn. No redds were uncovered by receding water as the levels were at a minimum during the spawning period. With respect to the early and late spawners no superimposition was noted.

The examination of 51 spawned out female sockeye showed that less than 2% of the eggs had been retained. Samples of the developing eggs during the pre-eyed and eyed stages were obtained in conjunction with the type of gravel in the redd, the amount of silting and the water flow over the redd. Although these have not been thoroughly analysed yet six pre-eyed samples gave a preliminary indication of about 90% survival. Sampling will be continued at intervals throughout the winter.

The coho migration occurs during October and November in the upper reaches of the stream and is under observation at the time of writing.

Appendix No. 13

D. J. Milne

Moricetown Falls and the Indian Fishery

The Indian fishing sites along the Skeena were not visited this year except for a short trip to Moricetown falls to evaluate the escapement to the Bulkley river and to discuss the problem of the fishways which had been recommended in the Skeena Interim report of 1948.

The Indian catch of 7,673 sockeye, 2,350 coho and 1,481 spring salmon was average. The number and large size of the sockeye were in keeping with the commercial catch and indicated an average escapement.

Both the sockeye and spring runs were at least a week later than usual for by August 23 few of the sockeye had turned red. As the water levels were average the salmon no doubt ascended the falls under conditions which were similar to those which existed in 1946 and 1947.

The engineers of the Fish Culture Branch of the Department of Fisheries were surveying the banks of the canyon in preparation for designing fishways this winter along the lines of those installed at Farwell canyon on the Fraser river system. Actual construction is to take place during the winter of 1950-51 at an estimated cost of $80,000.

Concerning the replacement of the Indian gaffs by dipnets, Inspector Giraud had experimented with Indian dipnets from the Fraser river with success. In one trial he caught 65 fish in 15 minutes which is about four times as many fish as the Indians usually take by gaff.

Thus it would appear that, with the installation of suitable fishways at Moricetown falls, some less damaging method of taking salmon for Indian food purposes will be evolved, so that the salmon runs to the Bulkley river will be spared the hardships which have confronted them in the past. If it can be arranged to count the fish through the fishways a better estimate of the size of these runs will be achieved.

Appendix No. 14

W. P. Wickett

Natural and Artificial Propagation of Chum Salmon at Nile Creek 1948-49

Procedures for the season were the same as for 1947-48. A very small run of 247 males and 211 females spawned in the lower section, depositing 400,000 eggs. Equivalent numbers of eggs were placed (1) in the "eyeing room" and (2) planted "green" in the controlled water section of the stream.

1. Stream flow during the spawning season was moderate - greater than that of 1947 and less than that of 1945. No heavy floods were experienced during the winter. Fry production amounted to 6.03% of eggs potentially deposited.

2. Hatchery survival was nearly identical with last year's 56.1%. Eggs were picked before eyeing. Saprolegnia losses were light but excessive rust was present in the water supply and on the trays. Eyed eggs were planted from January 13 - March 2. Redd sampling in May indicated that losses were occurring shortly before emergence from the gravel as well as at the eyed stage. Fry production amounted to 3.01% of eggs available for collection.

3. The controlled water section flow was maintained at about 3 cubic feet per second for the season. Green eggs were planted by shovel and planting cylinder - 1,500 eggs per planting. Only the upper portion (riffle) was planted. Sampling indicated a survival to the eyed stage of 51%. Numerous coho and trout yearlings were present above the counting fence. Fry production amounted to 11.85% of eggs available for collection.

Predation tests were made each week, by releasing marked fry. Weighted mean survival percentages for the three sections were (1) 34.75%

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(2) 26.82% (3) 46.12%. Allowing for these varying rates of predation the survival in each section to time of emergence from the gravel would be (1) 17.40% (2) 11.30% (3) 25.70% of potentially-available eggs.

						Fry			
	*Section	Females	Egg count	No. of eggs	No. of eggs planted	Count	% survival from predation	% to emergence	% production
1945-46	1	1564	2922	4,570,000		109,047	62.00	3.85	3.0
1946-47	1	827	2558	2,115,466		8,319	45.00	0.87	.40
	2			761,500	254,341	20,275	(13.89)	(19.17)	2.66
1947-48	1	473	2697	1,275,681		4,808	55.86	0.67	.38
	2			490,774	275,044	52,109	61.00	17.40	10.62
	3			421,531		14,331	66.47	5.11	3.40
1948-49	1	170	2263	384,710		23,188	34.75	17.40	6.03
	2			461,471	259,032	13,882	26.82	11.30	3.01
	3			401,862		47,635	46.12	25.70	11.85

*Type of propagation - Section 1 natural
" 2 eyed egg planting
" 3 green eggs, controlled water

W. P. Wickett Appendix No. 15

Some Factors Affecting Survival of Chum Salmon in the Gravel at Nile Creek

Natural. Stream gauge weekly average during the run was .74 feet as opposed to .48 for the previous year. Maximum readings of 5 feet in December and 4.5 in February occurred in 1947-48. Maxima were 2.2 in November, 2.6 in December, 2.6 in February 1948-49. Water flow for 1948-49 is considered to have been conducive to high survival. With few adults, interference with one another's redds was negligible.

Eyed eggs from hatchery. Rusting trays and water pipes not only caused loss of eggs in the hatchery but necessitated movement of the eggs before eyeing. Three small samples from the gravel, containing 46+ disintegrated eggs, 27 dead sac fry and 6 live fry, were taken at the peak of the fry run. The inference is that damage to the eggs caused heavy hatching and post-hatching losses.

Green eggs in controlled water. The upper portion of the planting bed, which was the only part used last year has been noted to contain much humus and sand and in portions to be consolidated. These conditions are more severe where the surface flow is least. Egg sampling indicated greatest mortalities occurred at these points. By means of pipes set in the stream bed, water samples and temperatures were taken. Two thermographs are set up to record temperatures of the surface and 12 inches in the gravel.

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Washing out of sand and silt increased the oxygen content from zero to 5 p.p.m. where the hydraulic gradient is least and silting greatest (#8 pipe). Subsequent silting due to renewed washing upstream again reduced the oxygen to 1.3 p.p.m. Near the bottom of the riffle where consolidation was greatest (#6) oxygen p.p.m. increased from 0.3 to 8.4. A comparison of thermograph records shows that the temperature lag in the gravel has been reduced from 9-12 hours to 3-6 hours (#3).

By use of dye in the pipes the dilution rate is obtained. Oxygen content and rate of dilution are not necessarily associated, due to the presence of unaerated ground water.

W. P. Wickett Appendix No. 16

Operation of Nile Creek Field Station, 1949

To improve propagation procedures, basket trays free from rust have been procured from the old Kennedy Lake hatchery through the courtesy of officials of the Department of Fisheries. Cabinets have been built to hold them and reduce temperature fluctuations about the eggs. To further protect the eggs, an inner partition and door have been installed in the hatchery. To eliminate rust in the water system, a separate plastic pipe now carries water from the storage tank to the head trough.

On the controlled water section, the gravel has been dug and hosed. A channel has been dug below the fence to minimize backing up of the water during high stream discharge. Planting is being done by placing the eggs in trenches dug and hosed out across the stream. The high predator loss in the spring appears due to the large numbers of coho and trout yearlings that accumulated in a pool above the counting fence. It is proposed to eliminate predators next spring as this is one of the obvious advantages of having the stream under control. The rate of flow over the planting bed will be increased this year.

Various improvements to the building have been made, the most important being the provision of a laboratory above the hatchery and wiring of the building preparatory to the advent of electric power in the district.

100,000 pink eggs have been planted in the controlled water section for comparison with chum survival. The chum run this year though small is larger than last, the October run amounting to 800 fish. 19 marked fish have returned so far. It is planned to put 500,000 eggs in both hatchery and controlled water section this year.

In addition to studies being carried out on water conditions in the gravel, tests on the consumption of oxygen by pink, chum and coho eggs are being carried out.

Technical operations have been carried out ably by Messrs. Eaton, Caulfield and Neate. Members of the Pacific Oceanographic Group have been very helpful with advice and assistance.

J. G. Hunter Appendix No. 17

Production of Seaward Migrants at Port John

The fry fence on Hooknose creek was installed and ready for operation on March 20th. A short time after this date the pink fry started to move downstream. They were followed at a slightly later date by the other three species present.

The course of the run is indicated in the following table.

Week Ending	Pinks	Chums	Sockeye	Coho
March 25	2	0	0	1
April 1	101	20	0	1
8	325	167	0	8
15	1,964	1,218	3	10
22	11,715	3,461	8	60
29	24,825	10,723	13	78
May 6	17,551	15,255	1,749	250
13	6,263	11,425	9,443	792
20	1,081	15,198	5,817	1,662
27	379	16,223	2,386	547
June 3	25	3,203	392	110
10	1	604	17	21
Total	64,232	77,497	19,828	3,540

The general course of the run was very similar to that of 1948 inasmuch as the same general pattern of overlapping of species occurred, yet all species, with the exception of the coho, were approximately two weeks later in their migration time this year. A very cold winter was experienced, causing the lake feeding Hooknose creek to freeze. This ice cover did not leave the lake completely until the middle of April.

The following table records the total numbers counted and the percentage survival of migrants in relation to the potential egg deposition as estimated in the autumn of 1947 and 1948.

Species	No. of Adults ♂	♀	Average No. of Eggs	Potential Deposition	Downstream Migrants	Percentage Survival
Pinks	563	597	1341.5	800,875	64,232	8.020
Chums	512	502	2101.5	1,054,953	77,497	7.346
Sockeye *	158	216	2511	542,376	19,828	3.655 (?)
Coho *	449	216	2313	499,608	3,540	0.708 (?)

*1947 parent year and count probably incomplete

The incubation period for the eggs was carefully noted. Extremely cold weather in January and February caused a zero percent survival in all the redds situated near the bank of the stream where freezing occurred. An overall survival of 50.77% for the combined samples of pinks and chums was estimated up to this mid winter period. Fungus which was so prevalent on the eggs in 1948 was completely lacking this year.

The redd sampling was carried out in the first week of February. The first fry appeared in the third week of March after which time a series of stream predation studies was made. It was found in these instances that mortality of fry during their descent of the stream ranged from 60 to 75% depending upon the absolute numbers migrating at the time.

All the sockeye yearlings migrating from Port John this spring were marked by the removal of the adipose and the two pelvic fins. A total of 19,651 marked sockeye were released.

Detailed records of precipitation and stream levels have been maintained throughout the year.

J. G. Hunter Appendix No. 18

Adult Salmon Migration at Port John, 1949

In order to ensure a complete count of the sockeye run of 1949, the adult weir on Hooknose creek was installed immediately upon removal of the fry fence and was in operation by June 13th.

The first sockeye appeared June 29th. In the following table are given the numbers of the several species and the time at which they entered the stream.

Week ending	Pinks	Chums	Sockeye	Coho	Precipitation
July 1	0	0	12	0	3.98
8	0	0	36	0	.02
15	0	0	1	0	.07
22	0	0	8	0	1.03
29	2	0	100	0	2.05
Aug. 5	4	0	111	0	1.11
12	5	0	102	4	2.50
19	0	0	226	17	2.29
26	11	0	10	0	.69
Sept. 2	5	0	0	0	.00
9	5	0	0	0	.00
16	250	2	11	25	2.58
23	522	64	1,541	325	5.37
30	119	86	16	19	1.13
Oct. 7	162	182	30	25	2.00
14	81	207	36	226	7.05
21	3	64	3	13	1.30
28	3	85	2	27	2.75
Total (to date)	1,172	690	2,245	681	

In general, the adult runs (like the preceding seaward migration of young fish) were about two weeks later than the corresponding movements in 1947 and 1948. The delay in arrival of adults is thought to be due to low stream levels caused by lack of precipitation. Fry runs were probably postponed on account of unusually severe winter conditions in 1948-49.

The adult runs of both pink and chum salmon were very light, a condition which was also true of all other small coastal streams which were visited in the district. Although no quantitative data are available regarding the parent run of chums, a low return of pinks had been anticipated in view of the very small output of seaward migrants recorded at Port John in the spring of 1948, despite a large parent escapement. Since the fry migrants responsible for the present adult run were counted, and about a third of them were also marked, the following data can be presented concerning the survival of marked and unmarked fish, on the assumption that "straying" of adults to other streams did not occur. In this connection it may be added that examination of dead fish in other streams did not reveal any marked individuals. The mortality due to fishing is unknown.

J. G. Hunter — Appendix No. 18

Pink Salmon, Port John, 1947-49 cycle

Number of adults, 1947	5,576
Potential egg deposition	3,850,616
Percentage survival to migrant stage	0.866%
Number of fry migrating to sea, 1948	31,303
Number of fry marked	10,787
Number of returning adults (unmarked), 1949	1,069
Number of returning adults (marked), 1949	103
Percentage of return of unmarked fish	5.210%
Percentage return of marked fish	0.955%
Mortality due to marking	81.673%
Percentage survival of adults (unmarked) from egg deposition	0.0423%

Points of particular interest in this tabulation are: (1) Failure of a large parent escapement to reproduce itself (2) Correspondence between a low output of fry migrants and a low adult return (3) An apparent heavy mortality associated with the marking of fry.

Poor spawning runs in 1949 appear to have been quite general in the district, in small streams of the Hooknose creek type. The comparatively good catches obtained by the fishery this year appear to have been due to heavy runs in a few of the larger mainland streams, such as the Koeye and Bella Coola rivers.

Quantitative data are not yet complete for the chum run at Hooknose creek or for the small spawning streams tributary to Port John lake.

J. G. Robertson — Appendix No. 19

Sockeye Fry Production at Port John Lake

The fall of 1948 provided the first opportunity to enumerate the adult sockeye runs utilizing spawning grounds on the small streams dropping into Port John lake, -- a body of water 1.6 miles long, situated in a small mountainous watershed on King island. To assess the efficiency of natural propagation from the known egg deposition, counting weirs were installed on the three pertinent streams this spring. Various physical factors such as temperature, precipitation and stream levels were recorded throughout the season.

The work necessary to obtain these data for creek sockeye both in the fall and spring was severe. As an example one may point out the 1,400 miles of hiking necessary to pack lumber and equipment to the lake site. This took over 200 round trips through snowdrifts, mud, creeks and windfalls. By April 24, three fry fences were in operation.

In 1948 the adult sockeye began to enter Hooknose creek (the outlet stream from the lake) in early July. Movement into the spawning streams tributary to the lake began on September 25, reached a peak the week ending October 9, and was completed by November 5. Of the 647 fish passed upstream at the fence on the main creek, 162 were females, whose average egg count of 1,830 showed a potential deposition of 296,500 eggs.

Stream observations on the other two creeks used by the sockeye indicated only small runs, there being only 60 sockeye seen in the more important of the two, located on the west side of the lake. The potential egg deposition for these streams is not accurately known but it was certainly

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very small in relation to the total spawning population.

In the spring of 1949 the fry began to migrate to the lake about May 13 at all fences. The actual count obtained at the three streams is shown in the following table:

Week ending	Number of fry		
	Creek 1	Creek 2	Creek 3
April 30	1	-	-
May 7	0	-	-
14	94	1	1
21	4,752	29	87
28	15,772	451	417
June 4	13,673	86	231
11	28,616	419	158
18	6,948	55	55
25	3,841	8	5
July 2	1,061	1	0
Total	74,758	1,050	954

Freshets interfered with the count at fence III on several occasions.

The calculated percentage efficiency of natural propagation from figures based on the work at Creek I is 25.26, a higher survival rate than is known for pinks and chums in a similar period of their life history.

The water temperatures at Creeks I and II were closely alike at an early date, the streams being of similar origin, while those at Creek III were higher, this creek originating in a watershed from which snow had disappeared. Despite differences in temperature a general movement of fry began simultaneously.

Increases in the water volume increased the daily migration downstream. Observations showed this movement began with the arrival of darkness and reached a peak about midnight. Sockeye fry could never be observed in daylight but by overturning stones they could be seen escaping to new shelter.

Stomach analyses of stream predators indicated that sculpins exacted the greatest toll on the fry, followed by trout and coho yearlings (in order of importance). One sculpin 4 1/2 inches long had consumed 38 fry, but the general average was about 13. The trout yearlings averaged 7 fry and coho yearlings 6. Sixteen adult trout caught off the creek mouth had only 2 fry in all, so were not considered serious predators at this time. They were eating young coho, trout, and insects.

Of the fry run in the main creek, 10,014 were marked by removal of their ventral fins, in order to establish the mortality caused by marking. Marked and unmarked yearlings will be counted in the spring of 1950, as they pass out of Hooknose creek.

J. G. Robertson Appendix No. 20

Limnological Studies, Port John Lake, 1949

In conjunction with studies on sockeye fry production in the streams of Port John lake an investigation of the limnological features of the lake was undertaken this year.

The lake was sounded and two rafts were built to serve as collecting stations. They were anchored at depths of 72 feet (Station I) and 135 (Station II) in waters that might be considered typical of the lake under varying physical conditions. From here data as to temperature, oxygen content, transparency, disposition and abundance of plankton were collected. Other studies involved bottom fauna and fishes present.

Physical Conditions. This lake on King island lies on a north-south direction approximately 150 feet above sea level and is 1.6 miles long and averages .27 miles in width. It is fed by 10 streams and has but one outlet, Hooknose creek. There is generally a sudden drop-off from the shore-line into 20 feet of water. The maximum depth is 147 feet as indicated by 77 soundings. Lake levels varied by 2.55 feet during the course of the summer. Temperatures taken at the surface varied from 5.0° to 21.0°.

At Station I, 8 temperature series were taken commencing April 28. A maximum-minimum thermometer was used until arrival of a suitable reversing thermometer in July. Bottom temperatures varied from 3.9° to 5.7° while surface temperatures over the same period were 5.2° to 19.5°. The series vertically revealed no definite thermocline until the July 31 readings. From Station II work was begun July 6, a time when the bottom temperature was 4.8°; this reading went up to 5.0° in August. Surface temperatures over these weeks varied from 15.4° to 18.2°. As at Station I no thermocline was shown to be present until July 31.

When apparatus became available in July for oxygen determinations, sampling was done in series (2 to 5 per series) at Station I and/or Station II. Six series showed a minimum percentage saturation of 61.507% and a maximum saturation of 108.945%. These values may be a little high due to the interval between sampling and titrating (1 1/2 hours) although the manganese sulphate and hydroxide were added immediately.

Transparency data were taken using a standard Secchi disc. The readings varied from 12.4 feet up to 16.6 feet. Increasing transparency occurred with the advance of summer.

Plankton. To estimate the abundance and distribution of plankton in the lake 11 vertical series (numbering 5-7 samples per series) were taken at Station I starting April 28 and 4 series from July 6 at Station II. These vertical hauls were taken under recorded physical conditions such as cloud coverage, winds, temperature, etc. Similarly, horizontal tows in both littoral and limnetic zones were made in defined areas of the lake. Casual observations over the period of sampling seemed to indicate an abundance of plankton at all depths despite the absence of life in the higher waters early in the year. As summer approached, the copepods appeared to dominate the lake while latterly there was a preponderance of cladocerans.

Bottom Fauna. Some 70 samples were taken using an Ekman dredge. The bottom is generally covered with detritus, but there are regions of sand, gravel and rock. Thirty-two samples representative of the muddy and sandy areas of the lake were sifted, using a tray with metal screening of 20 meshes to the linear inch. The 504 1/4 pounds so analysed revealed a paucity of animal life (approximately 40 chironomid larvae, 15 oligochaetes, and a possible population of ostracods off the mouth of the largest creek). There was an abundance of diatoms and diatom shells. Samples of the mud, sand, and animal life have been collected.

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Fish Life. Apart from the salmon utilizing the lake there appeared no evidence of fish other than the observed dolly varden, rainbow and cutthroat trout, cottids, sticklebacks and lampreys. On three occasions when nets of 1 1/2, 3 and 4 1/2 inch mesh were set overnight, no fish were taken. Line fishing as an indication of the abundance of trout showed a substantial number lying off the stream mouths. Only occasional fish were taken by trolling, one of which had been tagged at the fence at the mouth of Hooknose creek. Since only 5 cutthroats were tagged at the fence this might indicate a paucity of cutthroat in the lake. Only 2 dolly varden were taken and no rainbow trout were captured. The predatory effect of these large trout on sockeye fry was considered to be unimportant.

Thirteen sockeye yearlings were trapped as they left the lake in order to determine the nature of their food. Sockeye fry were never seen, although coho fry were observed in both limnetic and littoral zones.

H. W. Spencer and Ferris Neave Appendix No. 21

Salmon Troll Fishery Investigation

In view of widespread demands for the application of additional conservation measures to the troll fishery off the west coast of Vancouver island, together with a desire for more uniform fishing regulations throughout the Pacific coast, statistical data were obtained and tagging operations were undertaken, through charter of the trolling vessel "Wandelaine", owned and operated by Mr. P. W. Martin. Since a revision of minimum size limits has been an important feature of proposals for changes in present regulations, information was sought on the size- and weight-composition of catches made by an experienced fisherman, using commercial gear. A large proportion of the fish caught were tagged and released in order to provide information on the migration routes and destinations of the stocks of salmon presently being exploited on the west coast.

Fishing operations were conducted in the Ucluelet area from May 10 to July 2 and August 3-4, and in the Quatsino area from July 5 to August 1. A few additional small spring salmon were tagged near Ucluelet between August 13 and August 26, subsequent to the expiration of the charter.

Total numbers of fish caught and tagged were:

Species	No. caught	No. tagged
Spring	1,143	840
Coho	671	511
Sockeye	23	19
Pink	59	17
Chum	1	0
Total	1,897	1,387

Spring Salmon. The relation between total length (to tip of tail) and dressed weight is indicated in the following table, which also gives the cumulative percentage of the fish caught which were smaller than the stated lengths.

Total length	Approx. dr. wt.	% of individuals smaller than stated size	Total length	Approx. dr. wt.	% of individuals smaller than stated size
20"	3.2#	2.3	27"	6.3#	37.4
21	3.5	3.6	28	7.2	47.3
22	3.6	4.8	29	8.2	56.7
23	3.7	5.7	30	9.7	61.0
24	4.0	8.9	31	11.0	68.6
25	4.5	16.1	32	12.0	74.7
26	5.5	27.1			

Changes in size composition of the catches during the 12-week period of operations are shown below:

Date	% below 5#	% between 5# and 10#	% between 10# and 14#	% 14# and above	Number of individuals
May 14 - May 20	34.2	49.8	8.7	7.3	231
May 21 - May 27	17.3	60.0	16.0	6.7	75
May 28 - June 3	23.6	47.1	15.9	13.4	157
June 4 - June 10	20.0	38.0	22.0	20.0	50
June 11 - June 17	29.6	46.5	8.9	15.0	179
June 18 - June 24	15.4	46.1	21.9	16.6	187
June 25 - July 1	5.7	54.6	17.0	22.7	106
July 2 - July 8	2.1	16.6	35.4	45.9	48
July 9 - July 15	0.0	9.5	19.0	71.5	21
July 16 - July 22	7.7	7.7	23.1	61.5	13
July 23 - July 29	6.9	10.3	31.0	51.8	29
July 30 - August 5	8.8	32.3	19.0	39.9	68

A study of the age-composition of catches made throughout the period of operations showed that about 77% of the fish were in their fourth year, with third-year and fifth-year fish each accounting for approximately 11%.

Coho Salmon. Total lengths, corresponding dressed weights, and changes in the size-composition of catches during the season have been summarized as follows:

Total length	Approx. dressed weight	% of individuals below stated sizes May	June	July
20"	2.7#	28.0	--	--
21	3.0	40.0	5.3	0.2
22	3.2	72.0	15.8	1.3
23	3.4	84.0	31.6	2.3
24	3.9	92.0	52.6	5.2
25	4.3	100.	84.2	10.5
26	4.8	--	84.2	18.7
27	5.5	--	95.0	43.6
28	6.2	--	95.0	68.6

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Recovery of tagged fish. Up to November 5, tags have been returned to the Pacific Biological Station as follows:

Species	No. tagged	No. of returns	%
Spring	840	36	4.3
Coho	511	34	6.7
Sockeye	19	5	26.3
Pink	17	3	17.6

A majority of spring salmon recoveries have been made in localities close to the tagging areas or (more frequently) to the south of these. Thirteen fish had entered the strait of Juan de Fuca as against only 4 reported from the Columbia river, -- a result which is at variance with findings recorded some 20 years ago.

Recoveries of cohos show a different pattern, with none reported from the Columbia but wide distribution from Puget sound to as far north as Milbanke sound.

The five sockeye recoveries resulting from incidental taggings of this species are of interest, since they show that fish bound for such widely distant and important areas as the Fraser river (3 tags) and Rivers inlet (2 tags) may feed or migrate together for a time in the ocean. All sockeyes were tagged in the Quatsino sound area in July. One Rivers inlet and one Fraser fish had been tagged at the same place and on the same day.

The three pink salmon recoveries (from fish tagged in the Quatsino area) came from Puget sound, Fraser river and northern end of Georgia strait respectively.

The data obtained from this project will be correlated with similar work conducted in Washington, Oregon and California, to provide a general picture of Pacific coast salmon migrations and to serve as a possible basis for legislative action.

Ferris Neave — Appendix No. 22

The Salmon Angling Fishery at Cowichan Bay

The concentrated sport fishery which takes place each year at Cowichan bay and which depends on salmon migrating to the Cowichan and Koksilah rivers, provides opportunity for obtaining statistical data on the annual fluctuations in size and availability of a well-defined salmon run. Observations on this run have now been extended over a period of ten years (although in a few instances records have been confined largely to the coho-fishing period, which occurs during the latter part of the season). In view of the scarcity of long-term statistics of this kind, continuation of the record is felt to be very desirable.

In 1948 an observer (Miss Gertrude Paul) maintained records of landings and fishing intensity from July 25 to November 13. The number of fish reported and the estimated fishing effort involved during this period can be summarized as follows:

Boats	Line-hours	Springs		Cohos		Total fish
		Large	Jacks	Large	Grilse	
5,612	50,256	1,202	216	2,395	986	4,799

In view of the predominance of spring salmon in the earlier catches, followed by a later period of intensive coho fishing, with a varying intensity of fishing effort applied to the two species, annual comparisons have been made on the basis of periods selected to cover the major fishing activity in each case.

For spring salmon the following comparison relates to a four-week period beginning about August 18th and ending about September 15th.

Year	Boats	Line-hours	Springs			Line-hours per spring
			Large	Jack	Total	
1939	1,095	6,574	429	234	663	9.9
1940	1,227	7,476	1,088	200	1,288	5.8
1941	1,382	7,313	765	137	902	8.1
1942	1,652	9,843	562	227	789	12.4
1943	1,839	11,707	636	324	960	12.1
1944	1,873	11,676	769	169	938	12.4
1945	2,216	11,557	644	73	717	16.1
1948	1,715	13,400	805	149	954	14.0

"Jack-springs" (i.e. fish under 5 lb. in weight, mainly 2 years old) constituted an unusually small proportion of the catch in 1948, -- only about 15%, taking the season as a whole. In previous years the percentage has varied from 17 to 62.

Coho records, for a six-week period beginning about September 22, are as follows:

Year	Boats	Line-hours	Cohos		Line-hours per large coho
			Large	Grilse	
1939	1,708	12,432	3,362	585	3.6
1940	1,470	10,694	1,813	61	5.8
1941	2,435	16,287	3,435	417	4.7
1942	2,671	18,796	3,867	566	4.8
1943	2,849	19,875	3,903	116	4.9
1944	2,967	19,931	3,575	225	5.2
1945	2,895	18,798	3,660	55	5.1
1946	1,517	12,271	1,936	486	6.3
1947	2,295	18,508	3,751	56	4.9
1948	2,897	30,329	2,020	462	15.1

Features of the 1948 season were the heavy intensity of fishing, as measured by "line-hours" and the poor returns, especially in cohos. It is believed that the very low catch of this species does not entirely reflect the size of the run, although this was undoubtedly not large. High water levels encouraged fish to ascend the rivers without lingering for a prolonged period in the bay. Furthermore, the periods of maximum availability of fish did not coincide with the period of maximum effort.

A. Andrekson Appendix No. 23

Age, Size, and Sex Ratio Composition of Rivers Inlet Sockeye, 1949.

In order to obtain information on the relative success of different brood years and possible indication of the magnitude of future runs, scale sampling was carried on from June 27 to August 5 at Goose Bay Cannery, Rivers inlet.

It was decided to obtain samples in the ratio of 1:200 fish landed by the commercial fishery. This ratio yielded 686 from Rivers inlet sockeye, taken during the above-mentioned period.

From an examination of the collected data the following results were obtained:

Average weight 4.64 lb.
Average length 21.42 in.

	♂	♀
Sex ratio	62.4%	37.6%
Weight	4.55 lb.	4.78 lb.
Length	21.17 in.	21.84 in.

Age determinations are not as yet completed, but of the 334 scales read, the percentage age groups are as follows:

4_1	4_2	5_2	5_3	6_3
5.7%	77.8%	15.9%	0.3%	0.3%

No definite conclusions may be drawn until the sex-age analysis is complete.

W. S. Hoar Appendix No. 24

A Study of the Effects of Thyroxine on the Resistance of Under-yearling Coho Salmon to Sea Water

The thyroids of several different species of salmonoid fishes have been shown to exhibit a marked activity at the time of seaward migration. This activity is sometimes evident in the coho. A number of investigators have shown that the thyroid gland of fish is stimulated by transfer from water of one salinity to another and that feeding thyroid gland alters the chloride metabolism of fishes. With these facts as background an attempt was made to demonstrate possible effects of thyroid materials on tolerance of young coho salmon for sea water.

Fish were immersed in solutions of pure synthetic thyroxine (1:2,500,000) for varying periods and their resistance, when suddenly transferred to sea water, determined or thyroxine was added to sea water into which fish were placed and the lethal times determined.

Evidence will be presented as follows:

(a) the thyroid glands of coho immersed in synthetic thyroxine solutions (1:2,500,000) show that this drug has entered the fish and accumulated in the thyroid by 72 hours.

(b) if the sea water is not strong enough to kill the fish in the first 48 hours then fish in thyroxine solutions are slightly more resistant than those in straight sea water.

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(c) immersion of coho in thyroxine solutions for from 72 to 96 hours enables them to withstand sudden transfer to sea water better but does not afford complete protection.

(d) a mortality curve is presented for the death of coho salmon in sea water solutions ranging from 20°/oo to 30°/oo salinity at temperatures 14°C. to 16°C.

(e) larger fry, on the whole, survive longer than smaller ones but no relation, such as that postulated by Huntsman and Hoar (1939), for Atlantic salmon can be demonstrated.

(f) coho salmon are more resistant than trout to sea water.

It is concluded that thyroid hormone stimulates metabolism of the coho somewhat and enables the fish to deal with chlorides somewhat more efficiently than the untreated controls. Thyroxine, however, does not provide protection from even dilute sea water solutions and the transformation which occurs prior to seaward migration involves more than increased activity of the thyroid gland.

W. S. Hoar Appendix No. 25

Some Behaviour Patterns of Under-yearling Chum and Coho Salmon and a Study of the Possible Effects of Thyroxine on Them

An understanding of migratory behaviour is of fundamental importance to the applied fishery biologist who may wish to alter the time relations of the life cycle of a fish or predict the animal's movements. In addition, the subject of migration has a great interest from the purely academic standpoint. Several workers have recently suggested that the thyroid and pituitary glands undergo basic changes in relation to the migration of salmon.

In the present study an attempt has been made to develop a quantitative description of some of the behaviour patterns of migratory and non-migratory Pacific salmon. Such descriptions are necessary if the effects of hormones or other factors on migration are to be measured. In particular, three aspects were investigated:

(1) schooling behaviour of migrating chums
(2) tendency of coho salmon to select and defend territory
(3) rheotactic responses of chum and coho salmon.

Two pieces of apparatus were used. The first consisted of a trough 72" long and 7" wide with a slow stream of water, to a depth of 4 inches, running through it. A definite number of fish were placed in the trough and their tendency to depart from random distribution measured by the chi-square test. The second apparatus was a galvanized iron wash-tub, diameter 36", with an inlet at one side directing a stream of water around the periphery. The water flowed out a central overflow pipe. The rheotactic response was measured in relation to currents of different speed.

The findings for untreated fish under these experimental conditions may be summarized as follows:

1. under-yearling chum migrants form schools and individuals never show any tendency to select and defend territory.
2. Under-yearling chum migrants are always positively rheotactic during the day and swim vigorously into the strongest currents. In darkness they swim actively with the current.
3. Under-yearling coho never form schools but select and defend territory. A group organization develops within 24 hours after the fish are brought into the laboratory.

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4. Under-yearling coho are positively rheotactic both day and night but do not swim as vigorously into the current as do the chums.
5. Yearling coho migrants do not select and defend territory vigorously. They are often grouped but do not form schools as do migrating chums. The variations in behaviour shown by this group may be due to a difference in physiology or to the apparatus being relatively smaller in relation to the fish size.

The work on hormones in connection with behaviour was carried out by Miss G. Mary Bell working at the Pacific Biological Station, on a National Research Council summer graduate scholarship. Under-yearling coho fry were treated with synthetic thyroxine for varying periods up to one week. The behaviour was somewhat modified with the tendency to select and defend territory less strongly marked than in untreated fish. However, at the present stage of investigations, it would not be safe to say that thyroid treatment changed the behaviour of the fresh water coho to that of a migrating yearling. Further work is necessary.

J. G. Hunter — Appendix No. 26

Experimental transference of sockeye fry to salt water

A preliminary experiment of acclimation of sockeye fry to salt water was started in June of this year.

A floating cage, 3 feet by 2 feet by 1 foot, of brass screen was anchored in the bay at Port John where it would experience the full effect of salt water. Into this cage were placed two hundred sockeye fry which had been carried down from the lake, approximately three miles away. These fish were placed directly into salt water from the fresh water in which they had been transported. The only precaution taken was to ascertain that the temperature of fresh and salt water was similar at the time.

A similar group which had been transported from the lake in the same manner was kept in troughs through which a steady stream of creek water was flowing.

The fry placed in the bay all lived and grew quickly while the fry kept in fresh water all died before showing any appreciable amount of growth.

Unfortunately a storm caused the salt water cage to break from its moorings, terminating the experiment prematurely. It was indicated, however, that the sockeye fry at this stage were able to make the necessary adjustment without any apparent harm.

J. G. Robertson — Appendix No. 27

Sex Ratios of Pacific Salmon

A histo-morphological examination of the sex organs of alevin, alevin fry, fry, fingerling, and yearling salmon indicated that the sex could be shown on any species after the absorption of the yolk sac.

Accordingly, the spring migrations at Port John of four species of salmon (chum, pink, coho and sockeye) were sampled as to their sex distribution (see table). The coho fry samples from the lake stream and Hooknose creek have not been fully analysed.

J. G. Robertson

Appendix No. 27

Sex Determination, Port John Migrants, 1949

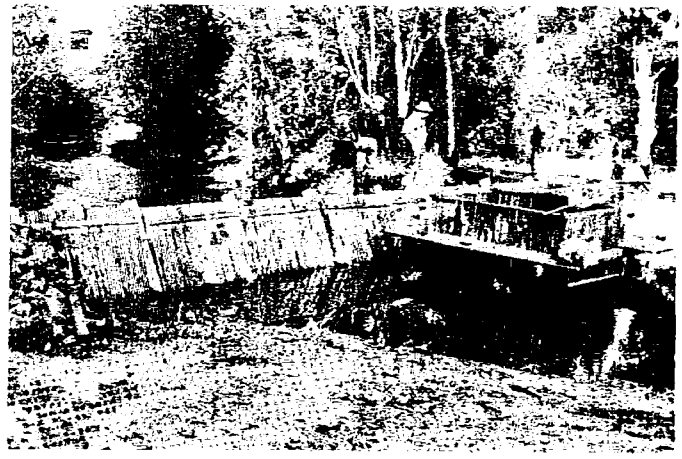
Species		Sockeye Yearlings	Sockeye Fry	Chum Fry	Pink Fry
Number		277	41	352	365
Percentage of sexes	♂	51.6	60.9	79.5	52.9
	♀	48.4	39.1	20.5	47.1

It is observed that the ratios depart from a natural 1:1 distribution in some cases. This may be due to a statistically unsound sample of sockeye fry, and to a possible deferment of recognizable female characteristics in the case of the chum.

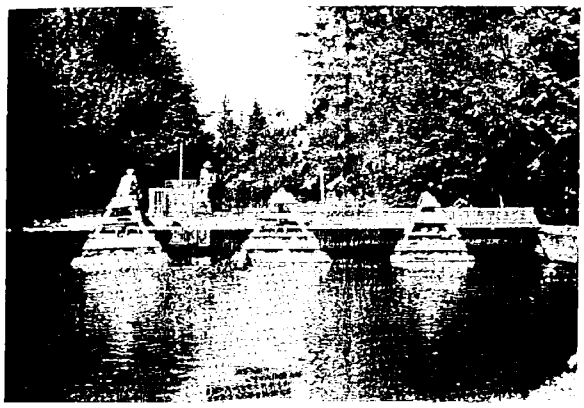
These apparent disproportions are being studied in relation to the influence of the environment on the developing embryo.

It is hoped that studies of the sex ratios of seaward migrants will contribute to an understanding of the effects of commercial fishing methods, which are frequently selective in respect to the sexes of fish caught.

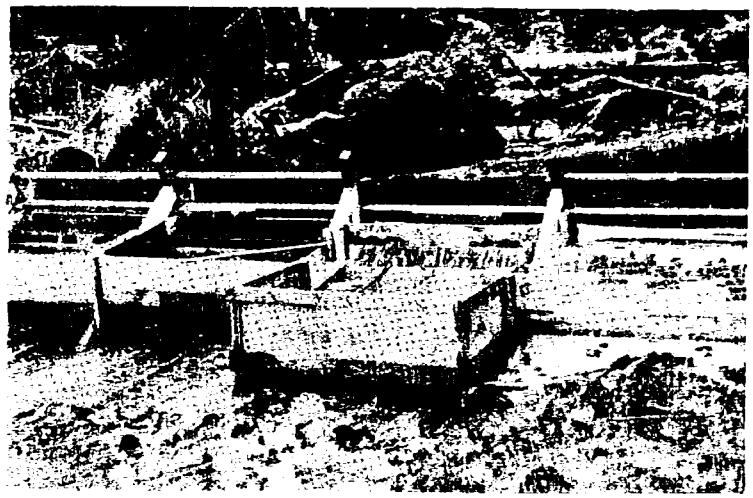
Scully Creek, Lakelse Lake



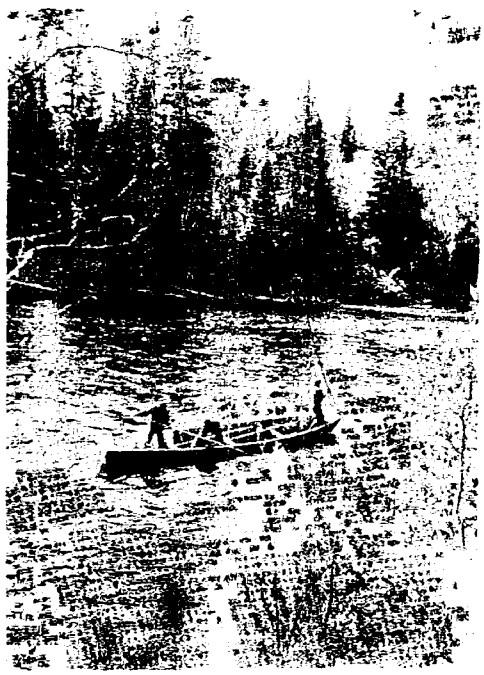
Adult Fence and Trap, Scully Creek



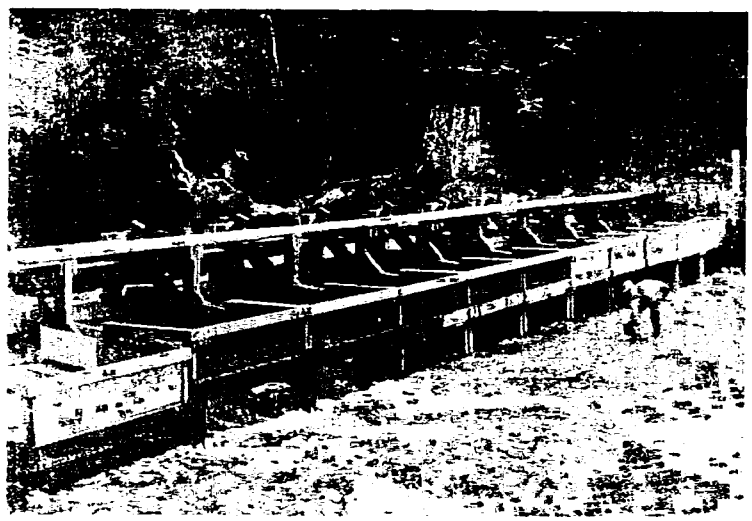
One of the three fenced outlets of Williams Creek, Lakelse Lake.



Sockeye Fry Trap, Port John



Indians gaffing spring salmon, Babine River.



Main Fry Fence, Port John