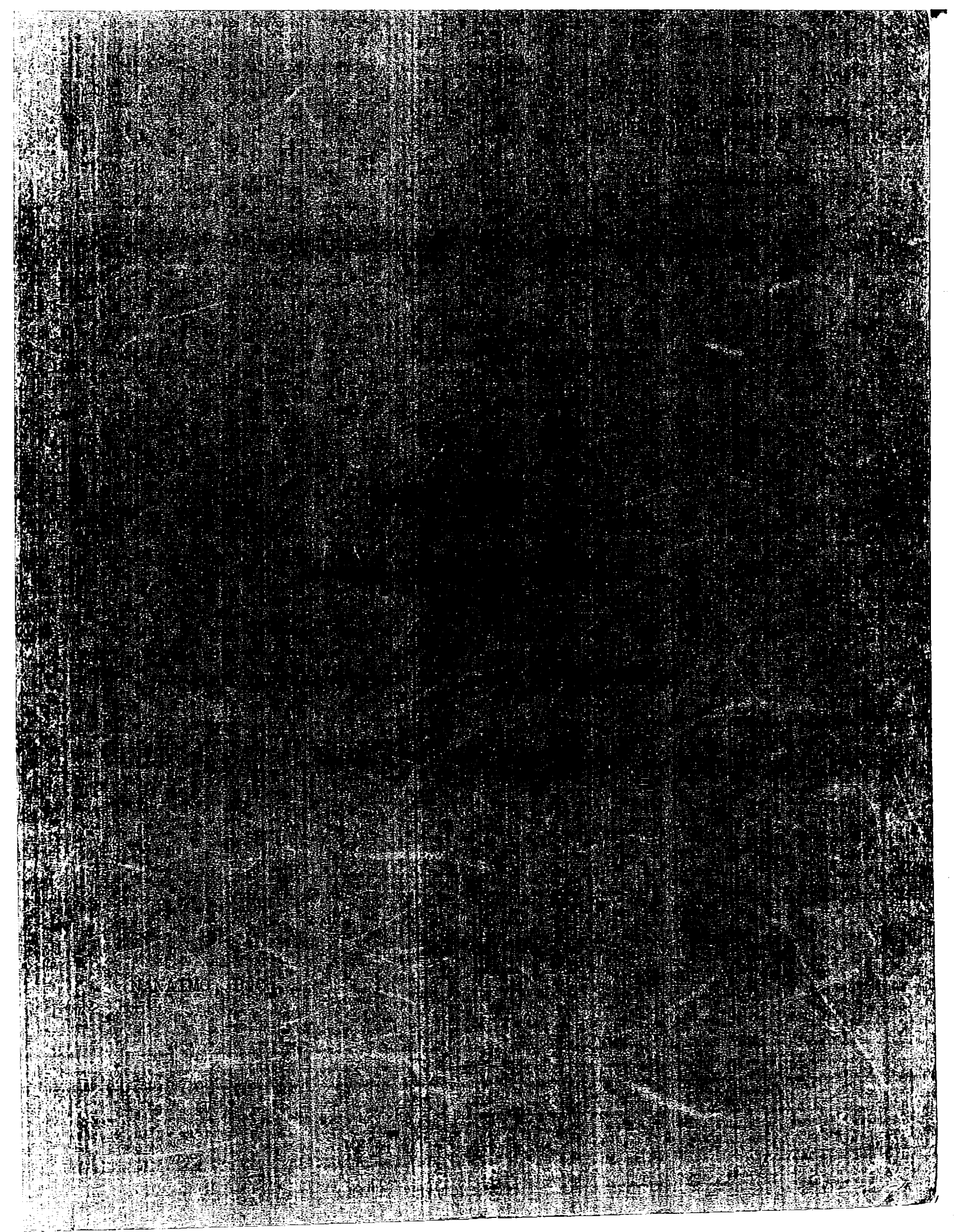

FISHERIES RESEARCH BOARD OF CANADA

REPORT OF THE

PACIFIC BIOLOGICAL STATION

NANAIMO, B.C.

for 1945

By R.E. Foerster, Director

During 1945 very satisfactory progress has been made in all departments of the Station's work, despite the handicaps of limited personnel and shortages of equipment and supplies.

The Skeena river salmon investigation, completing its second year of operation, successfully carried forward those studies initiated the preceding year such as marking and tagging experiments to reveal the details of migration routes, lake surveys to indicate conditions prevailing in nursery areas, and spawning ground inspections to estimate the extent of natural spawning occurring and the conditions prevailing. In addition, the field of action was notably increased by sending parties into five relatively remote salmon areas.

The general salmon studies conducted at Cowichan lake, particularly with reference to the coho and spring salmon runs, were continued and a pink salmon tagging in southern British Columbia waters was again undertaken in association with the Washington State Department of Fisheries.

The trawl fishery study, commenced as a Development Committee project, collected much useful data and as a result will be able to direct its operations more effectively during 1946 to achieve the ends desired.

The herring investigation, confining its efforts chiefly to the lower east coast of Vancouver island, has added appreciably to its collection of data on the reaction of the fishery to the fishing effort applied and on the characteristics of the stocks of fish in all areas.

A new investigation was undertaken during the year - a study of the salmon runs associated with the coastal streams lying between the Fraser and Skeena rivers. Particular attention was given to the pink and chum salmon. Besides a general reconnaissance of the whole area, largely of an exploratory and fact-finding nature, a chum tagging experiment in the waters off the east coast of Vancouver island was conducted. The observations during the present year form the basis for a more direct plan of attack in 1946.

The clam and oyster studies were continued during the year and certain experiments brought to completion.

Collection and analysis of surface sea water samples from the twelve lighthouse stations along the outer and inner coasts have been continued and are proving of much value as indices of coastal water conditions.

In previous annual reports emphasis has been laid upon the extent to which the fisheries research work of the Pacific Biological Station has been more and more directed toward investigations of fisheries of prime economic importance. Many pertinent facts related to the life history of the species, to their normal production or abundance and to the reaction of the stocks to existing fishing effort have been revealed. All these are extremely necessary to the proper regulation or management of the fisheries by the Department. They are also of benefit to industry since they lead to a clearer understanding of the fisheries and should result in greater stability of that industry.

It is gratifying now to be able to report that the objectives being sought are coming closer to attainment and that efficiency of research is increasing because of the addition to the staff of a number of soundly-trained and actively interested young scientists. This has permitted a more comprehensive attack on the problems and has speeded up the collection of required data. Its result is apparent in the accounts of investigations which follow and in the summary reports which are appended hereto.

Industry is noted for its demand for quick action, speedy results. The Department of Fisheries naturally desires information and advice as early as possible in order to base its regulations on sound foundations. In some investigations pertinent and usable results are readily obtainable but in many others there must still prevail the necessity of carrying on investigation over many years in order that the general natural variations occurring from year to year may be understood and to ensure that snap decisions formulated from abnormal and insufficient facts be avoided.

This requirement for long-term study before achieving significant and usable results is nowhere more apparent than in the salmon investigations. Here widely fluctuating environmental conditions prevailing from the time of spawning to the time when the young fish reach the sea have a very definite bearing on the results obtained and oceanographical conditions existing during the ocean period of residence exert an unknown but probably appreciable influence. Many of these fluctuating factors are measurable but the correlation between them and survival of salmon is difficult to obtain. Many of them are quite uncontrollable. Hence it is only by conducting studies for a long period of time under whatever natural conditions prevail, collecting all the information available and piecing the data together that we may arrive at a proper solution which may serve as a foundation for adequate regulation or management.

It does not follow, therefore, that because in certain fishery studies few results are reportable in any one year there has been no creditable progress made. Nor does it follow that because certain projects, such as tagging, have to be repeated a number of times the investigators are merely

duplicating their work or are in a "rut". Data are being accumulated which in time will be capable of proper interpretation and useful application.

For Pacific coast fishery investigations much progress is being made and, as mentioned above, the increase in personnel greatly increases the scope of the work. However there are still certain phases of the work, particularly projections of necessary field studies, which have yet to be tackled.

The first of these is a suitable system of collecting biological statistics of the various fisheries. This was referred to last year but no action has been taken. At the present time three of the investigations, i.e. the herring, pilchard and trawl fishery, are gathering certain records through issuance of pilot house log books and one, the clam, is collecting digging records but other fisheries have thus far not included statistics collection. What is required, in our estimation, is a system of buyers' reports, whereby each time fish are sold a record is obtained of (1) species caught, (2) amount caught and purchased, (3) locality of capture, (4) date caught or delivered, (5) name of boat, (6) name of buyer, (7) port of landing and (8) price paid. Similar systems have been in operation in California and Washington for many years and give an excellent record of the species of fish caught according to date and place of capture which for biological purposes is highly essential. It leads to the accumulation of pertinent facts concerning the various fisheries which, when available over a period of years, makes possible an analysis of trends and the reaction of the stocks of fish to existing fishing effort. Such data are bound to become more and more necessary for Pacific coast fish as time goes on. The earlier the beginning the more readily will a useful backlog of data become available.

The second problem concerns the proper collection of field data particularly pertaining to the salmon fisheries but having application to other fisheries as well. In a report to the Development Committee a scheme of having resident biologists stationed in certain areas of the coast was suggested. The duties of these officers would be to keep in close contact with conditions prevailing in the coastal waters and streams of their respective areas throughout the year and make special studies as required. Now that a coastwise salmon study under Mr. Neave has been launched the need for an adequate field staff becomes apparent and it is realized that much more must be known of the conditions prevailing in the important salmon areas throughout the year if much is to be actually accomplished in a practical way. With a long coast line and several climatically different areas involved a much more definite survey of each area than one or two general visits will permit will be required. Establishment of resident biologists in various strategic areas will make possible not only proper collection of data for salmon investigations but allow for observations on herring fishing and spawning, shellfish operations and the general accumulation of valuable data respecting the marine resources of the coast as a whole. As a profitable Post-war project such a scheme has definite merit.

STAFF

During 1945 several additions to the staff were made. In May and June, respectively, Mr. J.E. Moore, M.A., (Saskatchewan) and Mr. D.J. Milne, M.A. (Saskatchewan), released from the R.C.A.F., joined the staff as Scientific Assistants in Biology, the former to assist in the general salmon study under Mr. Neave, the latter to take up certain phases of the Skeena river salmon investigation, under Dr. Pritchard. In September Mr. P.E. Wickett, B.A. (British Columbia) released from the R.C.N.V.R. was engaged as Scientific Assistant in Biology in the General salmon study while in October Mr. F.H.C. Taylor, B.A. (British Columbia), released from the R.C.A.F., joined the trawl fishery investigation under Dr. Hart, as Scientific Assistant in Biology.

It is gratifying to record that Flt. Lieut. D.B. Quayle, M.A., and Capt. J.L. McHugh, M.A., have returned to Canada, received their discharges, have completed their leave of absence for military service and returned to the Station. Mr. Quayle, rejoining the staff in July, was forced to undergo subsequently a month's hospitalization and expects to leave again early in 1946 for the University of Glasgow where he will take further post-graduate work. Mr. McHugh is planning to take his post-graduate work at the University of California under Professor Hubbs.

No appointment of an engineer with civil and hydraulic engineering training has yet been made. Since there is a definite need for an engineer with previous experience who can readily undertake certain projects involved in the salmon investigations it is hoped that an appointment can be made early in 1946 when a suitable selection from among returning members of the R.C.E. may be possible.

A complete list of the Station staff and of the field personnel employed during the year is given at the end of this report. The success of the Board's work on the Pacific coast is due, in large measure, to the enthusiasm and conscientious service of the staff. For their splendid attitude and efficient work under somewhat trying conditions I should like to express my deep thanks and sincere appreciation.

BUILDINGS

With the prospect of a new administrative and laboratory building at Departure Bay to the fore, several sketch plans have already been prepared with a view to having a suitable design and plans ready whenever funds become available and construction can proceed. The desire is to have a modern, fire-proof building which will adequately meet the needs of the Station for the next few years and provide working conditions for scientific and clerical staff of a high order.

PUBLICATIONS

During 1945 pressure of work and initiation of new studies have seriously limited the production of publications. In the four issues of Pacific Progress Reports appearing during the year ten contributions appeared. One bulletin was issued and two scientific papers appeared in the Journal, with two other manuscripts submitted. Three papers were published in the Annual Report of the British Columbia Fisheries Department. A list of the Station's publications is appended hereto.

During the year six mimeographed Circulars were issued:--Herring Catch Statistics - Lower East Coast Sub-District; Memorandum to the British Columbia Fishing Industry re Commercial Utilization of the Slime Flounder; Recovery of Herring Scales; Common Names for Flatfish; Herring Catch Statistics - West Coast of Vancouver Island Sub-District; Prospects for the 1945-46 Herring Fishing Season. These were well received by the industry.

ACKNOWLEDGEMENTS

During 1945 the active co-operation and support of both Federal and Provincial Department of Fisheries were freely tendered and warmly appreciated. The Provincial Department continued to contribute financially to the herring, pilchard and shellfish researches. To Major J.A. Motherwell, Chief Supervisor of Fisheries for British Columbia and to Mr. Geo. J. Alexander, Assistant Commissioner of the Provincial Fisheries Department, grateful thanks are extended for advice, suggestions and help graciously given. We wish also to acknowledge the excellent assistance given in so many different ways by the field officers of the Federal Department in their respective districts.

During the herring spawning season the British Columbia Packers Limited and the Canadian Fishing Company again provided seine boats for tagging work and spawning ground surveys. The former firm also again allotted space in their Imperial Cannery, Steveston, and Alert bay cannery for installation of induction detectors. This co-operation is deeply appreciated and has helped materially in the progress of the herring work. All fishing companies readily assisted, through members of their staffs, in collection and submission of statistical data, tags and tag records and many fishermen aided the various investigations by sending in scars from marked fish, tags and pertinent particulars. To all who have helped we extend sincere thanks.

INVESTIGATIONS

Brief references only are here made to the various scientific investigations undertaken during the year. Further reports are contained in the investigators' summaries which follow as appendices.

Salmon. In addition to (1) the continued observations of the coho and spring salmon runs to the Cowichan river system, the checking of the efficiency of natural propagation of cohos at Oliver creek and the collection of data with reference to the recovery of marked coho and spring salmon in the commercial fishery and upon return to the Cowichan and (2.) the development of the Skeena river salmon investigation in its second year of operation, there was commenced during 1945 a study of the salmon runs related to the many rivers and streams situated on the east coast of Vancouver island and on the mainland between the Fraser and Skeena rivers. Particular attention was given to the important pink and chum salmon runs and, in addition to certain tagging experiments to trace the migration of the pinks and chums involved in the fishery along the east and south coasts of Vancouver island and in the American fishery in Puget sound, a general reconnaissance was made of the spawning escapements to many important coastal streams. The Cowichan river studies have been handled jointly by Dr. Pritchard and Mr. Neave; the Skeena river investigation is in charge of Dr. Pritchard, assisted by Messrs. Milne, Brett and Foskett; the general salmon tagging and survey has been directed by Mr. Neave, assisted by Messrs. Moore and Wickett.

Variation in size of the Cowichan river coho run from year to year. In studying the degree of variation occurring in coho runs to coastal streams observations have been made on the Cowichan since 1941. Estimates, based on tagging experiments, of the escapements above Skutz Falls where the principal spawning occurs, have been as follows: 1941 - 65,000; 1942 - 67,000; 1943 - 56,000; 1944 - 63,000. The 1944 run was therefore only slightly less than the previous cycle year, 1941 (App. 1). During 1945 the angling fishery effort in Cowichan bay was quite similar to that of the two previous seasons (App. 6) but the catches were lower, due largely to a reduction in the numbers of grilse caught.

Distribution in the sea of marked coho and spring salmon of Cowichan river origin. Recovery of marked salmon in the commercial fishery during 1945 has again demonstrated that fish from east coast of Vancouver island streams contribute to the fisheries of both west coast and strait of Georgia and that maintenance of these fisheries should include adequate protection to all coastal salmon spawning areas (App. 3-5).

Natural propagation of coho salmon. Continuing the studies in Oliver creek, tributary to the upper Cowichan river, a fry migration amounting to 22.3% of eggs presumed to have been deposited occurred in the spring of 1945. Previous tests had given the following results - 14.4, 11.8, 30.4, 26.0 and 25.6% of eggs presumably laid. (App. No. 2).

The Skeena river salmon investigation. In order to reach an understanding of the present state and trend of the salmon fisheries and their reaction to existing fishing effort, and to establish a suitable management policy which will maintain salmon production at a high level, the studies undertaken by Dr. Pritchard and Messrs. Milne, Brett and Foskett, assisted during the summer months by some twelve to fifteen field men (App. No. 7), cover researches into (1) the details of migration of the

fish from the offshore ocean areas into and through the fishery and on to the up-river spawning grounds, (2) the characteristics of each year's populations, including sizes, sex ratios, age classes, (3) the drain produced by the commercial and Indian food fisheries, and (4) the extent of the spawning escapements. Examinations are also being made of the various spawning streams and nursery lakes to reveal those factors affecting growth and survival of the young fish and to ascertain in what manner, if any, production of young fish can be increased. (App. Nos. 12-20).

During the spring of 1945 the marking of seaward migrating sockeye (by removal of certain fins) was again attempted at Lakelse and Babine lakes with only limited success due to high water conditions prevailing. (App. Nos. 8,9). These markings serve to reveal the migratory routes of the salmon coming in from the ocean and they may prove the only means of obtaining such data. Therefore more attention may have to be given to this phase of the work and more areas included. Tagging in the river estuary was again undertaken (App. Nos. 10,11) and the recoveries for sockeye in the various areas were as follows, (1944 records in brackets): total sockeye tagged - 2,212 (901); commercial fishery - 25.5% (41.0%); Indian fishery - 9.0% (6.9%); spawning grounds - 0.4% (not calculated for 1944). The returns from up-river spawning areas being so low and the information desired as to time of migration of each spawning "race" through the fishery and time taken to reach the spawning grounds so valuable, it is proposed to operate a trap in the river in 1946, located above the fishing areas so that greater quantities of fish can be tagged and allowed to proceed to the spawning areas.

Estimation of spawning populations reaching the numerous up-river spawning areas is very important since it indicates the extent of probable seeding and the size of the run to be exploited in succeeding cycle years. (App. Nos. 21-29). The spawning ground surveys were extended in 1945 to include five new areas in remote parts of the drainage basin but the observations were rendered indefinite because either the fish had not actually appeared on the spawning grounds, the spawning seemed to be confined largely to the lake beaches or the streams were too difficult to patrol. In view of such conditions prevailing the advisability of erecting counting fences in the convenient locations in the outlet rivers to these areas should be considered. One such structure is being placed in the Babine river this season.

Calculation of the relation of the commercial catch to the extent of the spawning escapement again proves interesting, though at the same time somewhat disconcerting. With a commercial pack of around 100,000 cases or 1,100,000 sockeye, if the fishing drain amounted to but 25.5%, as suggested by tag recoveries, the escapement would have approximated 3,000,000 spawners. Spawning ground estimates obtained by observation amount to around 450,000 fish. This wide discrepancy must indicate either that the tag recoveries are decidedly too low and not a correct measure of fishing intensity or that very extensive bodies of spawning fish are not being found, or, if observed, are definitely under-estimated. To reconcile pack records with present spawning ground estimates it would be neces-

sary to concede that the fishery removed around 66.6% of the population (1,100,000 fish) allowing an escapement of 33.3% (550,000 fish). This would indicate a catch to escapement ratio of 2:1, as compared to 1:3 as suggested by the tag recovery data. Due to the great significance attaching to a proper ratio of spawning escapement to commercial catch, this phase of the work must be given more attention, probably by trying to establish the accuracy of the tag recoveries (establishing the extent of differential mortality of tagged individuals) and by increasing the extent and accuracy of actual spawning escapement observations (perhaps by construction of more counting weirs).

Certain observations were made on the pink salmon runs to the Skeena in 1945. Individuals were tagged in the river estuary but few recoveries were made. Spawning streams were observed and it is believed that a very good seeding took place.

General salmon investigation. In this the initial year of study field observations, conducted by Mr. Neave and Messrs. Moore, Wickett and several summer field assistants, were confined largely to a fact-finding general reconnaissance of the coastal streams lying between the Fraser and Skeena rivers, on the B.C. mainland and on Vancouver and other northern islands. Principal attention was devoted to pink and chum salmon. It was found (App. No. 40) that pink salmon seedings were generally adequate, despite the heavy fishery, but for chum salmon the spawning escapement was light.

Natural propagation of pink and chum salmon. It would be helpful if some attention could be given to the success of natural propagation in the many pink and chum streams and some prediction possible of the likely production of fish for the subsequent cycle year - 1947 for pinks and 1949 and 1950 for chums. The vastness of such an undertaking is obvious but certain observations in certain important and "strategic" streams may be attempted.

In any event definite arrangements were made in Morrison and Nile creeks, east coast of Vancouver island, respectively, by erection of counting fences to enumerate the numbers of pink and chum adult spawners ascending the creeks this fall (App. Nos. 38 and 39). Next spring counts of outgoing fry will reveal the degree of efficiency of propagation and the extent of production of young for the next cycle years. Data of this kind should be acquired from various sections of the coast for more local application. This may be undertaken next year.

Migration of pink and chum salmon along the east and south shores of Vancouver island. To provide information on the proportion of pink and chum salmon caught by the commercial fishery, the routes and destinations of the migrating fish and the possibility of identifying certain spawning runs of salmon when they pass through the commercial fishery, tagging operations were carried on in certain areas off the east coast of Vancouver island and at the Sooke traps. The pink salmon experiments were similar to those conducted in 1943 and were done in association with the Washington

State Fisheries Department who tagged at Swiftsure banks and in the approaches to Puget sound. For the pink salmon (App. No. 36) returns from Canadian sources constitute 27.7 per cent. of Canadian tags affixed but there are quantities of American recoveries yet to be reported which will raise the return to approximately the same level as in 1943, with essentially similar distribution. Unfortunately spawning stream recoveries have been substantially less than in 1943 due to prevailing high water conditions, etc.

For the chum (App. No. 37) tagging returns are still being received and spawning ground surveys are not yet completed. To date recovery from the fishery constitutes around 22 per cent. of tags released.

Development of pink and chum salmon eggs in waters of varying saline content. Since both pink and chum salmon are frequently observed spawning in stream estuaries where the tide must bring in salt water, experiments were undertaken by Mr. J.E. Moore to determine under what salinities pink and chum eggs will survive and develop. Early results suggest that in water mixtures where sea water made up two-tenths development of eggs does not occur. (App. No. 41).

HERRING. The herring investigation, conducted by Dr. Tester and Mr. J.C. Stevenson, continued to follow closely the characteristics of the populations of herring in the four major areas of British Columbia as developed under natural conditions and as influenced by the fishing effort.

The catch in 1944-45 (113,300 tons) was appreciably greater than in the previous year (98,000 tons) and resulted largely from a substantial increase in the west coast of Vancouver island area (20,400 tons as compared with 9,200 in 1943-44). In many areas, notably the east coast of Vancouver island, reduced availability figures (average catch per seine per day's active fishing) were found indicating a greater fishing effort to obtain the fish. No catches were made in the Queen Charlotte islands or northern sub-districts. (App. No. 42).

During the year tag recoveries (App. No. 43) again indicated that, as in previous years, the extent of mixing of populations between major areas was small, about 8 per cent. Among sub-districts, however, the intermingling was greater. Tagging operations were again conducted in the Strait of Georgia, Queen Charlotte strait and along the central coast-line. (App. No. 44). For the 1945-46 season a new type tag detector has been devised and is being operated at Alert bay. (App. No. 45). In order to use tag recovery data for calculating fishing mortality and population sizes, it is necessary to know the extent of differential mortality among tagged individuals. Experiments were undertaken and it was found that over a thirteen week period, the rate of mortality increased rapidly to the fourth week, reached a peak in the sixth and then declined to a low, presumably constant, rate for the ninth to thirteenth weeks. The rate for the whole period was high, approximately 60 per cent. Mortality seemed to be due to infection of the tagging wound and of the gonad when punctured by the tag. (App. No. 46).

Surveys of coastal herring spawning areas were again undertaken in the spring of 1945 (App. No. 47). They revealed light spawnings in most districts particularly so in the strait of Georgia. On the west coast of Vancouver island, however, a sudden large increase occurred, chiefly in Barkley sound, presumably due to the addition of new age classes to the population.

By sampling the major fishing and spawning runs during the 1944-45 season data pertaining to length, weight, sex and age were obtained (App. Nos. 48-53). These indicate what fluctuations occur in the age classes and determine the presence of local populations. For the strait of Georgia area fish of age II were well represented (21.8%) while those of age IV declined (from 29.4% in 1943-44 to 15.6% in 1944-45). Three-year fish constituted the dominant age group (57.8%). For the west coast of Vancouver island the average length decreased largely due to an influx of II year fish, constituting 29.3% of the samples in 1944-45 as compared with 13.1% in the previous year. Three-year fish constituted the dominant year group (37.0%). It is noteworthy that for Barkley sound, the dominant II year group (43.6%) together with the large III year class (36.6%) produced in the spring of 1945 the largest Barkley sound spawning to occur in many years. Other district and sub-district samples were similarly analyzed and gradually a very illuminating body of information is being built up, of much value in delineating the natural variations occurring in normal herring populations subject to varying degrees of exploitation.

During the 1942-43 herring season tests were made of the use of an "echo sounder" to detect the presence of herring and to determine the depth and density of the schools. (App. No. 54). The practical value of these instruments was not readily appreciated at the time nor in the following year but subsequently interest became keener, particularly during the 1944-45 season when herring were scattered and established methods of detection were not particularly effective. As a result many herring seine boats are now equipped with sounders. Trawlers, too, are finding them very helpful.

To arrive at a more effective method of management of the west coast of Vancouver island stocks which for several years have remained at a low level of abundance under conditions of high fishing effort, Dr. Tester is proposing (App. No. 56) a series of studies in which in every third year all fishing will be prohibited. This will tend to build up the populations of every third year into a large spawning stock which will support the fishery in the two intervening years of fishing and result in larger fish, higher availability and perhaps a greater catch in the two years of fishing than now is taken in three years. The proposal is being referred to the Department and the industry for consideration and comment.

OTTER TRAWL FISHERY INVESTIGATION. Covering a large number of species of marine fish that form the normal catch of the otter trawl this investigation under Dr. Hart, assisted by Messrs. Manzer and Taylor and (part time) Messrs. Ketchen and Barraclough and commenced last year, has as its objectives the development of a conservation policy which will provide a continual successful fishery, particularly for flat fish, and a study of the

competition between trawls and other fishing gear in areas where several types of fishing can be conducted.

Initially it was necessary to arrive at a standardization of the common names used along the coast for the various species of flatfish (App. No. 57). This was done and a list of the names agreed to by all agencies has already been publicized. A start was made on examining both trawl catches as taken aboard the boats on the fishing grounds and in port landings after the customary sorting over of catches and selection of commercially valuable individuals had been made. Over 20,000 specimens in 30 species were measured in fish-houses or at sea and otoliths for age determination were taken from 15,075. (App. No. 57).

In order to obtain data on migratory habits of the species concerned, tagging experiments were undertaken. (App. No. 58). To date in the coastal area from the Strait of Georgia to Hecate strait and along the west coast of Vancouver island, 5,530 specimens have been tagged and 274 or 5% recovered. Interesting data are being obtained.

It is necessary that adequate statistics be obtained of the catches made on the various trawling grounds and in relation to effort expended. These are being obtained by the distribution of pilot house log books to trawl skippers, many of whom readily co-operate. It is probable that these data will have to be supplemented in the future by more detailed records of landings which can be obtained only by having field assistants stationed at the larger ports. (App. No. 57).

To contribute to the knowledge of the inter-relationships between species, predation, competition for food, etc., food examinations were made for many species occurring in trawl catches. (App. No. 57). Those species examined and the numbers of each (in brackets) were: lingcod (341), greycod (329), blackcod (76), big skate (111), blue skate (124), prickly skate (19), dogfish (576), hake (58), whiting (112), ratfish (125), brill (112), long-jawed flounder (210), halibut (37), flathead sole (80), rock sole (151), curl-fin sole (21), lemon sole (483), butter sole (122), rex sole (178), dover sole (85), sand dab (32), slender sole (27), starry flounder (31). The food items embraced worms, clams, crabs, shrimps, schizopods, amphipods, gastropods, starfish, sand launce, hake, blackcod, greycod, tomcod, herring, whiting, flatfish, squid and octopus, fish remains.

Since the extent to which trawls take certain species of commercial fish is providing serious problems in fisheries administration, a memorandum has been prepared based on preliminary observations and upon information obtained from fishermen. It proposes control of trawling by closing certain areas in order to maintain the fisheries there for the gear traditionally used. This proposed action seems warranted in advance of exhaustive study and report. The proposals are tentative and will be altered as further study reveals their effect.

LEMON SOLES. Age and rate of growth studies (App. No. 59) of samples from the three main areas of fishing, strait of Georgia, west coast of Vancouver island and Hecate strait, reveal that though the females of all areas grow to a much larger size than the males they are about the same age. Apparently both sexes grow at much the same rate until they reach a length of 200 mm. or just over II years of age. By age III the females exhibit a marked increase over the males to age VI, when the male growth becomes considerably reduced. West coast and Hecate strait fish are much larger than those in the strait of Georgia partly because older age classes predominate.

Studies of racial differences in lemon soles, as revealed by dorsal fin-ray counts have been undertaken (App. No. 60). An increase in the number of fin-rays as the samples progress northward is suggested. It is planned to investigate also vertebral counts.

PILCHARD. The 1945 pilchard season was most erratic. During the normal summer fishing season only 15,550 tons were caught but early in October fish again appeared and, to November 15, another 16,174 tons were taken. For the whole year the catch is less than two-thirds of the previous year.

Size measurements of samples (App. Nos. 61-62) suggested that the 1939 year class again predominated. No substantial body of new recruits appeared to increase the stock. Until new recruitment to the population does take place, decline in pilchards must result.

Tagging experiments involved only the recovery of tags put out in previous years. Five were recovered, all in California waters and they had been out for more than four years, one for 7 1/2 seasons. (App. No. 64).

LINGCOD. Since November, 1944, 76 tags from previous taggings in the Strait of Georgia and adjacent waters have been recovered. Periods of freedom of from 0-5 to 72-77 months were involved. The recoveries substantiate previous findings regarding movement and growth rates of the fish. (App. No. 65).

THE SUNKEN GILL NET FISHERY. Because of the effectiveness of sunken gill nets for capturing certain species of fish and, in certain areas, competing ing severely with other types of gear, further studies of the catches were made on the West Coast of Vancouver island in the Barkley sound area. In 10 "sets" the following species and numbers (in brackets) were taken: hagfish (2), dogfish (1028), big skate (1), ratfish (175), spring salmon (2), greycod (1), bocaccio (3), yellow-tailed rockfish (3), sebastodes spp (3), lingcod (32), blackcod (4), long-jaw flounder (245), halibut (2), brill (52), crabs (1).

For the two most important species, dogfish and lingcod, length measurements and sex ratios were taken and it was found that most of the male dogfish (88%) were over 76 cm. (30 in.) in length and the majority of

the females (90%) over 91 cm. (36 in.) which lengths, respectively, are considered to represent the minimum sizes for dogfish of real commercial value. A large proportion of the lingcod are of good marketable size. The male population seems limited on the netting grounds in comparison with females. (App. No. 66).

EULACHON. During the year catch statistics of the eulachon fishing were collected by Dominion Fishery Inspectors on the Fraser river and submitted to Dr. Hart for analysis. Five year's records are now available. There is a suggestion that the fish have become less numerous in the last two years but the condition may be a natural fluctuation. (App. No. 67).

ALBACORE. The albacore fishing off the west coast appears to have certain possibilities and is attracting more interest each year. As samples of fish caught become available for analysis they are examined. Length determinations of three samples in 1945 showed well defined modes between 62 and 64 cm. and 80 and 82 cm., suggesting the absence of one group of fish in 1945 usually well represented in the populations in normal years.

Stomachs of 86 albacore were examined and the 45 which had food contained schizopods, squid and various species of small and large fish. (App. No. 68).

ANCHOVY. Four samples were examined by Mr. Barraclough and Dr. Hart. An August sample showed a rather diffuse mode at around 120 mm. standard length while the three November samples exhibited definite modes at around 127 mm. (App. No. 69).

PREPARATION OF OTOLITHS FOR AGE READING. Mr. Manzer has been testing out several methods of preparing otoliths in order that age determinations can be made. Grinding and staining have been investigated with promising results and the study is proceeding. (App. No. 70).

CLAMS. This investigation conducted by Mr. Neave, has had as its objective the analysis of the present condition of the various butter clam areas of the coast and the devising of suitable regulatory measures for continued steady yield. Since taking over the general salmon work in the summer of 1945 Mr. Neave has had to curtail the shellfish work to those features requiring long-term recording, such as sampling and catch statistics. It is hoped to engage a junior scientist to work under Mr. Neave's supervision in 1946-47.

The commercial production of butter clams during 1945 was substantially higher than during the previous year due to striking increases from Queen Charlotte and Johnstone straits and the south-east coast of Vancouver island. Statistics indicated that in these areas the average catch per man-tide also showed an increase, suggesting more favourable

A.L. Pritchard

Appendix No. 7

The Skeena River Investigation - General Introduction

The Skeena river investigation in 1945 was organized, expanded and prosecuted along the general lines discussed at the meetings of the Fisheries Research Board at Ottawa last year. For the purpose of summary, the work may be divided under the following headings: Migration Studies, Lake Surveys, Spawning Ground Surveys, Statistics, Study of Moricetown Falls, Age Determinations, and Hair Seal Studies. In the appendices which follow all these phases are treated in detail by the investigators immediately responsible for the separate parts. As a general guide, certain brief comments are made herein together with notes on other plans which, although much work was completed, did not actually reach fruition.

Migration Studies

These studies were designed, as noted in 1944, to produce information on the times and routes of migration of the various river populations and to indicate the extent to which each was exploited in the different localities along the routes of travel. The same methods of approach to the solution were applied, viz: Marking i.e. the removal of certain fins from young salmon moving downstream to the sea, and Tagging, i.e. the affixing of serially-numbered discs to the larger adult fish offshore and at the stream mouth. In the first instance, data should be forthcoming on the history of groups of fish throughout the life cycle, and in the second, information should be available on the individual from the time it enters the fishery until it reaches the spawning grounds.

Marking experiments were again conducted in two areas, - Lakelse and Babine lakes. As reported later, some success was attained in both places but weather conditions seriously interfered with the efforts.

Tagging programmes were to be greatly expanded by using two chartered seine boats instead of one and by building a trap above the fishing boundary in the Skeena from which as many fish as desired could be obtained. Through the co-operation of the B.C. Packers Ltd., it was possible to obtain a vessel to work offshore around Dundas, Banks, Stephens, and Porcher islands and in Hecate strait. In addition the "Lady V", as last year, operated mainly off the immediate river mouth. Details and comments are submitted in a later appendix.

The third alternative, the construction of the trap above the fishing boundary, was not applied. A site was located and examined in April by the writer and Mr. J. Martinson of J.H. Todd and Son. Mr. F. Gray of the same company designed a suitable structure and constructed the webbing which is now stored at Sooke. Piles were procured through the co-operation of Mr. E. MacMillan of Cassiar Packing Co. Unfortunately there was some difficulty in procuring long timbers for capping. When this was available early in June, no pile driver could be found although definite reservation had been made. Before this misunderstanding could be cleared up, freshets were of such a size as to make the work exceedingly doubtful if not impossible. This, added to the fact that the trap, being installed late, would only sample the latter part of the run, led to abandonment of the project. Arrangements for next year are now in progress to avoid a repetition of the disappointment.

Lake Surveys

In view of the importance of the many lakes in the Skeena system as nursery areas for young sockeye salmon, every effort was made to expand field surveys to the limit of the personnel, equipment and funds available. The results reported later, though gratifying, certainly did not cover all possible

areas. Parties operated in the following lakes: Lakelse, Kitsumgallum, Kitwanga, Lac-da-dah system on the Kispiox, Morice, Babine, Morrison, Bear and Sustut. In each district surveys were designed to include mapping of the general features, e.g. depth, drainage, etc., examination of chemical and physical conditions, and netting to discover the presence and abundance of other fish in the body of water.

To accomplish even as much as is recorded required the complete co-operation of many agencies and the assumption of heavy additional responsibility by the senior members on the staff of investigation. In the first place, fully trained men could not be obtained for all areas. It was thus necessary to place a number of students for the early part of the season under Mr. Brett at Lakelse and Mr. Foskett at Babine for instruction in the fundamental procedures. The way in which the men later organized their respective parties, carried out the manipulations and made their reports, appeared to justify the intensive drilling.

Transportation at times was exceedingly difficult. The trucks, now available, were not ready and roadworthy in sufficient time to be used extensively. The lack of large outboard motors which could not be procured, handicapped the Babine party to some extent but rendered impossible one phase of the Morice lake work. In the middle of the summer, a series of unfortunate mechanical mishaps almost removed the charterable planes from operation. At this time Mr. D.J. Milne, who was stationed at Hazelton, made remarkable use of the truck assigned to him, in servicing and transferring the Kitwanga party. Sane judgement on the part of the men in the parties prevented any unforeseen trouble until it was possible to reach them with additional supplies. Too much emphasis cannot be given to the accomplishments of the personnel - in many cases comparatively inexperienced - under such trying and adverse conditions. It is to be hoped that trouble will be alleviated to some extent next year since the three trucks are now available, four small motors are at hand, and boats are stationed at Lakelse Kitwanga, Lac-da-dah, Babine, Morrison and Bear lakes.

Spawning Ground Surveys

As would be expected, with the expansion of the lake survey program, the number and variety of spawning ground examinations have increased. More detail is available for many areas particularly concerning conditions in several parts of the season. A much more complete idea of escapement has resulted.

In connection with the estimation of escapement, it was planned to install a counting fence on the Babine river to obtain an absolute count of the salmon running to this, the largest single spawning district. In February the writer visited Burns lake and there made arrangements with Mr. O.A. Ragsdale to assume the responsibility for construction which was to start immediately. Unfortunately ice conditions were poor and the equipment could not be moved over the lake. In late May work was commenced but by that time, as was predicted, the water was too high to allow completion of the structure to handle this year's run. Mr. Ragsdale has worked steadily during the summer. He has overcome many obstacles even to the extent of moving a mill in over the lake about 100 miles to cut the required lumber. In late October with the cabins all constructed, and all but one-quarter of the fence built, weather conditions became so bad that it was dangerous to work in and around the pile driver. A temporary halt was called. This project remains to be completed preferably in the winter or early spring before high water again interferes.

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A.L. Pritchard

Statistics

With the appointment of Mr. D.J. Milne, it has been possible to start examining the statistics available for the commercial and Indian fisheries. A thorough study has been made of the type of figures now available and the machinery used in their collection with the idea of estimating their use in so far as biological work is concerned. The study is proceeding and will depend in accomplishment mainly on application, available help, and the amount of co-operation received from the companies departments and individuals involved.

Study of Moricetown Falls

Moricetown falls has been recognized as a possible hazard to salmon migrating to the spawning grounds in the upper Bulkley system. Accordingly, during the past summer, close observation of conditions was maintained and a tagging programme was conducted. Certain findings are submitted in a summary report which follows.

Age Determinations

At the present time, Mr. J.D. Campbell is working over the scale collection for 1944 and to date has discovered a definite indication of differences in age composition between different river branches. Since such information is the very basis of statistical calculation and prediction in assigning weight to the conditions of the proper year, the work will be continued as rapidly as possible.

Hair Seal Studies

This study of one of the major predators of salmon was initiated at the request of the fishermen and canners who apparently suffer much financially through net damage and fish loss. General information has been gathered for the area on abundance, damage to fish and nets, behaviour, and the feasibility of the known methods of reduction and extermination.

During the past season many persons entirely outside of the immediate personnel of the investigation have contributed to such success as has been achieved Too much cannot be said of the help afforded by Supervisor F. Warne and the officers of the Dominion Fisheries Department in District No. 2. Inspector Strachan of the lower Skeena area aided in every way possible by extending the use of his boats, a and accommodation. Inspector McDonell of the upper Skeena, showed deep interest and many times saved the situation at crucial periods by providing engines, boats and help as well as sound advice resulting from long experience. Particular thanks are due to Messrs. T. Wallace, of Sunnyside Cannery, C.E. Salter of Carlisle, D. McLachlan of Inverness and E. MacMillan of Cassiar, since they never refused a reasonable request for aid. Many fishermen were extremely co-operative particularly Mr. W. Johnson, a member of the Advisory Committee. To the men employed in the investigation should go praise for their conscientious efforts and to Dr. R.E. Foerster, gratitude for untiring efforts to keep the investigation's requirements supplied as quickly as possible, thus avoiding delay and consequent difficulty.

2. MIGRATION STUDIES

J.R. Brett

Appendix No. 8

Marking of Sockeye Yearling from Lake Lakelse

On April 11th the first attempts were commenced to block off the Lakelse river with netting for the purpose of obtaining yearling sockeye as they migrated from the lake to the ocean. Although it was not until April 29th that the first indication of the start of the migration was obtained, the early effort and consequent intervening period proved of immense value in the process of understanding and in attempting to overcome the difficulties of operating fine meshed seine nets under such conditions as were presented. The initial idea was to incorporate two, 100-foot small meshed seine nets as extended arms of a fyke net placed centrally in the river with the arms reaching from shore to shore. Having accomplished this, it was discovered that the force of the current of water passing through the fyke net, increased by the resistance of the seine nets on either side and causing an increased current centrally in the river, was sufficient to kill the smaller fish not long after their entry into the fyke net. At the point of operation the river was approximately 120 feet wide, 3 1/2 feet deep in the centre and with a surface flow of 3 to 4 m.p.h. Throughout the whole process of realining, resetting and readjusting the netting system, the one factor which proved insurmountable was that of the strong current killing, or injuring, the small fish by forcing them against the netting. The fyke net was abandoned.

The seine nets were then joined and strung across the river in a down-current, sweeping, "s" curve and secondary ropes prevented bagging. A constant increase in the volume of flow with rising water levels in April and May and a 20% mortality of the yearling sockeye with an additional factor of many with scales rubbed off, terminated the use of this system against such a flow. It seems highly probable, however, under conditions of slow current that this technique would prove most successful. It is proposed in the spring of 1946 with similar type netting to spawn the upper section of the river which, in that portion, is nearly 700 feet wide with a uniform depth of about 3 to 4 feet and a current flow of less than 1 m.p.h. at all times.

Having discovered that it was not practical to maintain the netting as a block across the river, efforts were then directed toward obtaining the migrants by seining a cleared area of the river. From May 9th to June 3rd, seining operations were carried out usually from 7:30 p.m. to 12:30 a.m. the peak of the daily run occurring at about 9:30 p.m. Whenever possible the nets were hauled in from an anchored position in the centre of the river when a school of young fish was seen to be passing, but these occasions were relatively few. On the average one seine haul was made every 15 to 20 minutes throughout the evening.

The run commenced to build up by May 2nd and dropped off sharply within three weeks, ceasing to give worthwhile returns after May 25th, although seining was maintained until June 3rd. The total of migrants obtained was 7018 while the total of those marked by the removal of both ventral fins was 5788 (82.5%). As previously stated the majority of the mortality was caused by current pressure against stationary netting. The mortality when seining was less than 1%.

Although it was a very late spring, the lake being covered with ice until April 4th, the season was accelerated greatly by exceptionally hot weather in May causing the temperature of the surface water to rise above 20°C. by May 26th

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at which time the run ceased for all practical purposes. In general the fluctuations in numbers of yearlings migrating each day followed the changes in lake surface temperature and also, although not as closely, the variations in water level of the river. These latter two phenomena are themselves closely related for at that time of year the water levels depend mainly upon the melting of snow and glaciers in the surrounding watershed.

D.R. Foskett — Appendix No. 9

Marking Experiments at Babine Lake

Marking of migrating sockeye was again undertaken at Fort Babine on Babine lake. Due to the late ice break-up this experiment could not be commenced as soon as anticipated. It was also seriously hampered by high water. The lack of sufficiently high waders due to wartime shortages also had a marked effect on the catch of yearlings.

The behaviour of the migrating fish was similar to that observed in 1944. The most notable exception was a greater tendency to turn out of the migration route either for feeding or other purposes. This made it harder to predict their behaviour when they contacted the seine. The use of auxiliary seines as leads was found helpful.

Seining was commenced on May 24 and continued until July 8. During the period from May 24 to June 27 yearling sockeye were marked. The latter part of the time was devoted to catching and marking sockeye fry which were at that time migrating along the shore in large numbers. Five thousand two hundred and eighty-three yearling sockeye and 8,865 fry were marked. The mark used was the same as in 1944 - the adipose and both ventral fins. Forty-five yearlings and 81 fry were retained as samples. Thirty-five yearlings were killed by the seining operations.

As had been feared, high water cut the yearling catch to a minimum this season. It seems reasonable, however, that some form of trap could be designed to catch the yearlings. Perhaps a small meshed purse seine would suffice. The practicability of a lead was proven during the seining this year. Although this involves considerable capital outlay, it would be well worth a trial in view of the importance of marking large numbers of yearlings as a part of the larger general program.

A.L. Pritchard — Appendix No. 10

Salmon Tagging off the Skeena River in 1945

During the season of 1945 the salmon tagging was expanded by including all five species yet maintaining special emphasis on the sockeye, and by using two chartered boats instead of one. The first of these vessels the "Estep" under Captain N. Lovrich worked offshore in the neighbourhood of Dundas, Banks, Stephens and Porcher islands and in Hecate straits from June 2nd to June 25. The second, the "Lady V" under Captain Wm. Leask, restricted its operations mainly

to the mouth of the Skeena off Inverness passage, Smith and Kitson islands with one side trip to the Nass area and one to Principe channel.

Offshore Tagging.

In spite of the most conscientious effort and industry on the part of the crew of the "Estep" and the tagger, offshore tagging was a virtaul failure. Only 26 fish were tagged as follows: sockeye - 13, spring - 9, and coho - 4. Only two recoveries have been made, viz.- one sockeye tagged in Ogden channel moved into the mouth of the Skeena river in six days, and one coho tagged in Beaver pass was recaptured four days later in the Ecstall, a tributary of the lower Skeena. These returns, though limited, are important in that they prove for the first time that sockeye going to the Skeena may enter through Ogden channel, a channel farther south than the Edye pass boundary set last year.

Inshore Tagging.

The inshore tagging with the "Lady V" continued from June 13 to July 30 and was much more successful than in 1944 when 1384 sockeye were handled. The totals reached were: sockeye - 2,796, pink - 1,609, chum - 61, spring - 85, and coho - 83 or 4,634 in all. When considered from the purely financial viewpoint, this increased catch more than compensated for the failure of the "Estep". If the charter and operation of the boats and travelling expenses and wages of the taggers are considered as total costs, the price per fish in 1944 was about $3.10 and in 1945 - $1.85.

Sockeye salmon recoveries

In discussing the recoveries from the inshore tagging experiments, the areas have been grouped as last year into more or less limited geographical districts. The following numbers were tagged and returned in each: Nass area - 71 tagged, 20 returned (28.2%); Principe channel - 513 and 11 (2.0%) and Skeena mouth area - 2212 and 773 (34.9%).

All the returns from the Nass area tagging were from the commercial and Indian fishing. Particularly interesting in their implications are three fish which found their way to the Skeena - one to Carlisle bar, one to point Lambert and one to the fishery at Moricetown. Such recoveries of necessity make more complicated any attempt to divide the catches of the areas into Nass river and Skeena river fish. The returns from the Principe channel tagging were even more local in their distribution than last year. Five were recovered in the Mink Trap bay fishery and seven on the spawning grounds above Mink trap lake. The recoveries from the Skeena mouth area may be divided as follows: Commercial fishery - 563 (25.5%), Indian fishery - 198 (9.0%), spawning grounds - 12 (.4%).

The daily percentage recoveries from the commercial fishery throughout the summer indicate that exploitation was relatively low for fish tagged up to July 1 when the season opened (5.1 to 30.8%). After this time the figure gradually rose to a peak of 41.6 on July 7 and dropped to 29.0 on July 29. The average for the season was 25.5%. The history of the Indian fishery was slightly different since the percentages were higher early in the season (5.1 to 15.5%) dropping to 3.3% on July 29 with an average of 9.0 for the season. On the basis of tag recoveries, the Indians in 1945 took 26.0 per cent. of the catch as opposed to 14.4 in 1944.

The time taken for the sockeye to move from the point of tagging to the locality of recapture, as calculated from the dates of recapture submitted,

is only roughly accurate. The averages which follow do show a general progression: mouth of Skeena to the eastern end of DeHorsey island - 6.6 days, Point Lambert - 5.3, Terrace - 10.7, Kitselas - 12.1, Kitwanga and Skeena crossing - 16.0, Hazelton and Kispiox - 18.4, Babine lake - 38.1, and Moricetown - 22.2. By comparison with the figures for 1944, it is immediately evident that the fish remained for a longer time in the lower Skeena taking about 5 days as opposed to 3 to get above the fishing boundary at point Lambert. The migration upriver was also slower. It is possible that this delay in migration constitutes the main reason why the fish tagged on Wednesday and Thursday appear to be less exploited than those on other days of the week. The Friday night to Sunday night closed season would benefit them to a greater extent.

The location of the tagged fish in the Indian fishery and on the spawning grounds indicates that the runs to the various rivers are mixed throughout the season. The one known exception is Lakelse lake where all tagged fish recovered (5) were from the early part of the run up to June 20, thus indicating that the Lakelse sockeye were little affected by the commercial fishery.

Pink Salmon Recoveries

The pink salmon tagging may be grouped under two general districts, namely,- Nass area (Steamer passage) where 327 were handled from July 4 to 19, and the Skeena Mouth Area where a total of 1282 were tagged from July 7 to 30. Recoveries have been 38 (11.9%) and 91 (7.1%) respectively. The low percentages as compared with those for the sockeye, viz.- 28.2 and 34.9, certainly confirms the conclusion drawn from the large escapement, that the exploitation by the fishery was light. In the case of the Nass area, bad weather conditions might have affected seining. In the Skeena, the gill netting does not appear very effective.

Most of the recoveries from Steamer pass were made in the same general vicinity as that of the tagging. One fish, however, migrated to Humpback bay off the Skeena, two found their way into the lower reaches of that river, and one was taken at Nakat, Alaska, just over the boundary. Almost all the recaptures from the Skeena river mouth experiment were made in the lower river up to point Lambert. Four had found their way north to Finlayson island and the Nass river. Thus as in the case of the sockeye, a slight interningling of Skeena and Nass populations has been demonstrated.

Recoveries for Other Species

Although 61 chums were tagged, only two recoveries have yet been made. An individual from Steamer passage moved into the Nass river and another from Smith island moved up the Skeena.

Of the 85 tagged springs, 16 have been returned. None of these were at all striking but merely showed that those taken off the mouth of the Skeena moved into that stream while those caught in the Nass area were mainly recaught in the Nass river.

Twenty of the 83 cohoes have now been returned and merely indicate similar behaviour to that shown for the springs.

Summary

One fact which has been proven to the satisfaction of the investigators by this year's tagging program, is that it is not feasible to purse seine sockeye in areas offshore from the Skeena river. Although such a situation has been sus-

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pected, the proof is definitely submitted here. No further attempts of this type should be contemplated.

Inshore seining produces much information of value on the amount and course of the exploitation. For instance, detailed analysis indicates the effect of the strike during the week of June 24 to July 1, on the catch and escapement. Tagging of this type is essential to keep a check on the fishery each year.

Even though the recoveries from upriver are more numerous than in 1944, they are still not sufficient to accurately delineate the time at which the runs to the various areas move upriver. At the present it is planned to put a trap in above the boundary where as many fish as desired can be tagged. With the exploitation of the commercial fishery removed, a greater concentration should appear both in the Indian fishery and on the spawning grounds.

A.L. Pritchard — Appendix No. 11

An Indication Through Tagging of the Effect of a Delay of One Week in the Commencement of Fishing on the Skeena Sockeye Run of 1945.

In 1945 the sockeye salmon gill net fishing was scheduled to start as usual on the night of the last Sunday in June (June 24). Due, however, to difficulties which arose in the negotiation of the general price agreement for all salmon in British Columbia, the sockeye fishermen remained idle until one week later (Sunday night, July 1). As a result during what would normally have been the first seven days of the sockeye season, only spring salmon fishermen operated, using nets over six and one-half inches stretched mesh. The tagging experiment, then in progress off the mouth of the river, has given some indication as to what effect this lessening of fishing intensity for a short period had on the size of the commercial catch and of the escapement to the spawning rivers.

The following summary gives the numbers tagged each week throughout the summer together with the numbers and percentages recovered later from these groups in the commercial and Indian-food fisheries.

Summary of sockeye salmon tagging experiment at the mouth of the Skeena river in 1945 showing the recoveries from the commercial and Indian-food fisheries

Week	No. Tagged	Number Recovered: Commercial Fishery	Number Recovered: Indian Fishery	Percentage Recovered: Commercial Fishery	Percentage Recovered: Indian Fishery
June 19 to 23	381	45	43	11.8	11.3
" 24 " 30	614	108	67	17.6	10.9
July 1 " 7	208	82	16	39.4	7.7
" 8 " 14	390	143	39	36.7	10.0
" 15 " 21	409	126	23	30.8	5.6
" 22 " 28	111	32	7	28.9	6.3
" 29 & 30	99	27	3	27.3	3.0
	2212	563	198	25.5	9.0

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The percentage recoveries listed in the table for the commercial fishery from fish tagged in the period up to June 30 (11.8 and 17.6) definitely prove that all the sockeye salmon did not escape above the fishing boundary. Since they are smaller than those for fish tagged after July 1 (27.3 to 39.4), it is also apparent that much lower percentages were removed in the early part of the season. If allowance is made in the calculations for the five days which is the average known time of migration to point Lambert at the boundary, the comparison is even more striking.

The percentages taken by the Indian fishery from fish tagged before June 30 were 11.3 and 10.9. For those after July 1 they ranged from 3.0 to 10.0. This heavy exploitation by the Indians for food from the runs at the first of the summer followed by a gradual drop to the end of the season may be the usual condition because of a desire on their part to get their food supplies as soon as possible. Until further data are available, however, the possibility must not be ruled out that the high exploitation on the early runs could have been caused in part by the presence of relatively more sockeye salmon at the capture stations.

It would be well nigh impossible to set a definite accurate figure for the numbers which escaped the commercial fishery and proceeded to spawn as a result of the lowered fishing intensity between June 24 and June 30. That the salmon were already in the lower river in an abundance not greatly different from later in the season is proven by the numbers which were seined for tagging by the boat which operated similarly on the tides throughout. If this is the case, it is not unreasonable to assume that the 700 odd boats could have caught at an absolute minimum between June 24 and June 30, 200,000 sockeye salmon. This would presumably be best represented as an exploitation of 33.6 per cent, (the average exploitation for the season after July 1). Actually, however, only 16.4 per cent was taken. Thus 17.2/33.6 of 200,000 or about 102,000 over and above the normal escapement went upriver. If it is considered that the Indian fishery was proportionately heavier because of this increased migration, the figure of 102,000 should be reduced to compensate. Actually it seems that this reduction should be, at a maximum, the difference between the percentage recoveries for the period from June 19 to 30 and those for the period between July 1 and 14. This amounts to roughly about 2.5 in 10.0 or 25%. The minimum extra escapement to the spawning beds would thus be about 75,000 fish assuming the loss to the catch as 102,000 or 9 to 10,000 cases.

That the extra escapement was not limited to one particular spawning area, is amply demonstrated by the recoveries from the Indian-food fishery and the rivers. These were distributed as usual to all districts such as Moricetown, Kispiox, and Babine.

3. LAKE SURVEYS

J.R. Brett Appendix No. 12

Lakelse Lake Area

In general the lake survey followed the plan of investigation set up during the previous year extending the program and including such modifications as were seen fit after working over the 1944 records.

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The readings of water level, transparency, temperature, oxygen and pH from April to mid-September of 1945 when compared with the 1944 findings showed that considerable variation occurred in the physical and chemical features.

Following the ice "break-up" on April 4th the water level rose from an extreme low to an extreme high by the end of May, dropping again to a comparatively low level in early August and, by the last week, to an extremely low state with a continued low during September. The early rapid rise necessitated the removal of the seine nets strung across the Lakelse river for catching yearling sockeye, while the low levels of August and September affected the distribution of the adult salmon to the spawning creeks, restricted their upstream movements and reduced the size of the spawning areas.

Very high surface temperatures occurred during the month of May, accelerating the whole turn over of many biological events from a late start to an early completion. The migration of yearling sockeye began in this month and virtually terminated after about three weeks on May 25th during which time the surface temperature had risen from 8°C. to 19°C.

Below the thermocline the oxygen concentrations exhibited a distinct falling off with time although not to a level which could be called limiting for fish. In addition, at the end of the summer the hypolimnion was found only in the deep hole and constituted but a small percentage of the total water volume of the lake.

Plankton collections were made with the same nets and in the same manner as in 1944 at two week intervals. At the same time the physical and chemical determinations were made. To date four species of Cladocera (Bosmina longispina, Diaphanosoma leuchtenbergianum, Daphnia longispina, Sida crystallina) and two species of Copepoda (Cyclops sp., Epischura nevadensis) have been identified. Of these six species, the two copepods constitute numerically at least seventy-five per cent. of the total catch.

The investigation of the bottom fauna which was only sampled by five dredgings in 1944, was extended considerably to provide data for different depths, types of bottom and varied positions within the lake. By the middle of September, 76 dredgings had been made from which it can be stated without further analysis that there is an abundance of life especially in depths up to fifteen feet.

The program of collecting fish by setting gill nets of various mesh sizes (1 1/2" to 5 3/4") was expanded. The gangs of nets assembled in 1944 were reassembled and additional gangs made up. These were set in the same positions as in 1944 as well as in new areas, thus increasing the variety and number of sets by nearly three times that for the previous year. Exactly 200 night-net sets were made from which just over 2000 fish were obtained. The total for each of the eight species caught in the nets and the catch per night-net in order of abundance were as follows:

Species	Total catch	Catch per night-net	Percent. change from 1944
Peamouth	1,282	6.41	270% increase
Squawfish	326	1.63	33% decrease
Cutthroat	143	0.72	21% "
Sockeye	137	0.69	18% "
Sculpin	87	0.44	25% "
Sucker	80	0.40	37% "
Whitefish	79	0.40	Increase
Dolly Varden	9	0.05	Increase

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The marked increase in the number of peamouth may be accounted for by the earlier net sets which intercepted certain spawning migrations of this species, while the general decrease in the others is at least in part due to an increase in the number of deep sets. It has been proven that although the general distribution of species is fairly uniform throughout the lake, their abundance decreases markedly with increased depth.

From stomach analyses of the two main predator fish within the lake, cutthroat trout and squawfish, for the mid-summer period of 1944, 90 per cent. of the contents were discovered to be fish of various species. In the case of the cutthroat, 25 per cent. were found to be salmonidae, mostly sockeye yearling, and in the case of the squawfish, 2 per cent. Over 50 per cent. of the contents for both these predators consisted of 3-spined sticklebacks. Dolly Varden were obtained in 1945 only in the early months and in small numbers, while rainbow and steelhead trout have only been caught in the spring of the year by fyke nets set in the Lakelse river. Thus the predation within the lake does not appear to be too serious on the basis of the present data. Ricker (1940), however, reports that during the summer period (May to September) at Cultus lake, very few sockeye were found in squawfish stomachs, but that during the other months of the year young sockeye constitute their most important food. From observations of the number of cut-throat, dolly varden and steelhead caught either by fishermen or by fyke nets in the Lakelse river, it would seem desirable that more information should be obtained concerning the fish population and relations within the outlet rivers through which the young salmon must migrate.

J.R. Brett and D.F. Alderdice Appendix No. 13

Kitsumgallum lake

A return visit was made to Kitsumgallum lake to obtain records of water conditions and fish samples in the same manner as in 1944. Only five days were spent on the trip, July 4th to 9th. During this time two plankton series were taken, oxygen, pH, temperature and transparency readings were made, and six sets were completed with two gangs of three nets each.

In general the physical and chemical findings bear out those of 1944. The netting returns, although illustrating marked variations, also confirm and add to the data already obtained. The total number of each species of netted fish, the catch per night-net and the percent. change from 1944 are recorded herein for general comparison with other lakes:

Species	Total catch	Catch per night-net	Percent. change from 1944
Peamouth	637	35.4	225% increase
Cutthroat	62	3.44	92% "
Dolly varden	23	1.28	15% decrease
Spring salmon	11	0.61	11% increase
Whitefish	10	0.56	70% decrease
Sculpin	0	0.0	decrease

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Although the numbers are too small to carry too definite significance, it can be said that the predation on younger fish and small salmonidae must be more serious in Kalum than in Lakelse lake. Although there are no squawfish, the cutthroat are more numerous and the Dolly varden fairly abundant. Both of these last two species, from stomach analyses, prove themselves to be voracious fish eaters.

The plankton is not prolific, consisting almost completely of copepods. At present one species of Cladocera (Bosmina obtusirostris) and two species of Copepoda (Cyclops sp., Epischura nevadensis) have been identified. A more thorough investigation of the plankton, both qualitatively and quantitatively, is in progress for all the lakes of the Skeena river.

J.A. McConnell and J.R. Brett — Appendix No. 14

Kitwanga lake

Kitwanga lake is located about 20 miles north of Kitwanga, a village on the Skeena river 40 miles west of Hazelton, B.C. The lake lies in a broad valley between mountain ridges which extend roughly in a northerly and southerly direction from the Skeena up into the Cranberry river valley. The Cranberry, a branch of the Nass, is only 3 1/2 miles from the northern end of Kitwanga lake. Thus the drainage area is bounded on the north by the height of land dividing it from the Cranberry river, and on the east and west by the mountain ridges.

The lake is quite small, 4 1/2 miles long and 1 mile wide. A narrow channel divides it into a large northern part and a smaller southern part. It is fed chiefly by one creek that enters at the northeast corner. A series of 12 small clear streamlets empty into the lake from the slopes on either side. A small stream, fairly shallow but quite rapid drains the lake into the Skeena river. This stream, the Kitwanga river, is slightly over 20 miles in length and enters the Skeena about one mile west of the village of Kitwanga.

Kitwanga lake was found to be quite shallow, the greatest depth, 44 feet, being in the smaller south section. Each section maintains a fairly uniform depth, the northern about 30 feet, the southern 40, with a relatively steep incline for most of the shore. Shallow shelves are present at the north and south ends where there are extensive areas of reeds and horsetails. The typical shoreline, however, is steep and stony.

Transparency readings, temperature readings, oxygen concentrations and plankton hauls were taken at two stations, the first being in the southern section at a depth of 42 feet and the second in the centre of the northern part at a depth of 28 feet.

The water of the lake is very clear. For readings taken when the lake was fairly calm and the sun brilliant, the mean depth of disappearance and reappearance of a standard Secchi disk in the northern end was 20.5 feet and in the south 26.7 feet.

Temperature readings taken during the month of August showed a fairly high surface temperature of 18°C. (64.4°F.). Definite indications of thermal stratification were found in the southern portion where the bottom temperature remained quite low, 5.6°C. (42.1°F.). Wind action in the northern section evidently maintains a fairly uniform heat circulation, the bottom waters having a temperature of 15.4°C. (59.7°F.), only about 3 degrees lower than the surface.

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As might be expected with the thermal stratification in the southern section, the oxygen saturation of the bottom waters was low. A sample of the bottom water of the northern part showed about 35% saturation.

A gang of six gill nets, each 50 yards in length (mesh sizes 1 3/4", 2 1/2", 3", 3 1/2", 4", 5") was used to sample the fish population. The gang was set in 6 recorded localities, 3 in each lake, and usually parallel to the shore line. Each fish caught therein was measured and sexed, a scale sample was taken and the stomach preserved for later analysis.

From the six sets made, the catch per net-night for 50 yards of netting was calculated giving an approximate index of the abundance of each species as follows:

Species		Catch per net-night
Squawfish -	Ptychocheilus oregonensis	3.21
Whitefish -	Prosopium williamsoni	1.51
Peamouth -	Mylocheilus caurinus	1.10
Cutthroat -	Salmo clarkii	.96
Sucker -	Catostomus catostomus	.60
Kokanee -	Oncorhynchus nerka	.26
Dolly varden -	Salvelinus malma	.10
Sculpin -	Cottus sp.	.06

F.C. Withler

Appendix No. 15

Lac-da-dah Basin - Kispiox System

General

The Lac-da-dah basin, which contains a chain of three lakes, lies approximately 35 miles directly NNE of Hazelton, B.C. The basin is cut off from the Cranberry River drainage to the west and the Brown Bear lake drainage to the north by a range of high hills. To the east, a few low hills separate the lakes from the Kispiox river. The drainage flows into the Kispiox river, which empties into the Skeena at Kispiox Village, 10 miles north of Hazelton.

Of the lakes, Swan is the largest and most westerly. It is, by rough estimation, 7 miles long and 3 miles wide. The lake has a greatly indented shoreline at the western and eastern ends, and contains nearly fifty islands varying in size from small pinnacles of the underlying bedrock to islands over a mile long.

Swan lake drains through a short channel into Club lake, which is approximately 1 mile long and from 50 to 300 yards wide. The shoreline is quite irregular.

Club lake is joined to Stephen's lake by Club creek, a stream about 1 mile long.

Stephen's lake is 3 1/2 miles long, and has a moderately regular shoreline. The eastern half is divided into two deep bays by a long peninsula, the longer northern bay draining through Stephen's creek into the Kispiox river. Stephen's creek is 3 to 4 miles long, the greater part of its length being made up of extensive windings before flowing into the Kispiox.

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Bottom Configuration

Swan lake was found to have highly irregular bottom contours. The greatest depth sounded was 66.5 m. in the western part of the lake. In the eastern half, where the islands are more numerous, the bottom tends to be shallower. In general, the shore line is steep and rocky, except at the entrances of small streams, where the bottom is silty and given largely to the growth of water lilies.

Club lake proved to be extremely shallow throughout its length, the greatest depth being 7 metres, sounded at the northern end of the lake. The bottom appeared muddy, without much plant growth.

Stephen's lake was found to have a fairly regular bottom. The greatest depth sounded was 26.5 metres at the mouth of the southern bay. The bottom of the rest of the lake varied between 10 and 20 metres. The shore line, which is fairly gradual and rocky, is given over largely to the growth of water lilies and other water weeds.

Physical and Chemical Conditions

From the temperature readings taken on Swan lake on August 19, a definite thermal stratification was apparent. At 64 metres the temperature was 4.3°C., at the surface 16.8°C. The thermocline appeared between 10 metres (8.2°C.) and 5 metres (16.7°C.). The oxygen saturation, however, was constantly high at all depths, being approximately 90% at the bottom and around 100% at the thermocline.

Temperature and oxygen readings were taken twice on Stephen's lake, on August 9 and August 24. Thermal stratification was again evident. On August 24, the bottom temperature was 5°C., the surface temperature 19.2°C. The thermocline appeared between 10 metres (6.3°C.) and 5 metres (16.7°C.). Here again, oxygen saturation was high, with 70% at the bottom, and about 100% at the thermocline.

Because of the shallowness of Club lake, no temperature-oxygen station was set up.

Fishes

To sample the fish populations of the lakes, a gang of five gill nets was used. This consisted of 50 yards each of 1 1/2", 3", 4" and 5" mesh, and 40 yards of 2" mesh. In most cases, the net was set perpendicular to the shore line, with the smaller meshes inshore. Of the eight sets made, four were made in Stephen's lake and four in Swan lake. Lengths, sexes, scale samples and stomach contents were recorded for most of the fish.

The long-nosed sucker appeared to be the most abundant fish in Stephen's lake. Adult sockeye were also caught in the lake. The catch per night-net for each species in order of abundance in Stephen's lake was as follows:

Species		Catch per net-night
Suckers	- Catostomus catostomus	13.5
Whitefish	- Prosopium williamsoni	2.2
Sockeye	- Oncorhynchus nerka	1.7
Dolly varden	- Salvelinus malma	0.6
Rainbow trout	- Salmo gairdneri	0.2
Sculpins	- Cottus sp.	0.1

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In Swan lake, the suckers were proportionately less abundant than in Stephen's lake, but were still the most numerous group in the catches. The same species were found to be present in Swan lake as were present in Stephen's. The catch per night-net in Swan lake was:

Species	Catch per net-night
Suckers	2.4
Whitefish	1.6
Sockeye	1.4
Dolly varden	0.2
Rainbow trout	0.2

(Although no sculpins were netted in Swan lake, they could be seen in the shallower waters).

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Morice Lake

Considering the effort that was expended in the survey of Morice lake, the returns have been disappointing from the point of view of salmon observation and investigation. The rather short survey that was initiated in 1944 proved in part the impracticability of attempting to observe salmon in an area so distinctly a glacier-fed and glacier-characterized water-shed in which the visibility in all the water courses is very restricted. Certain of the accomplishments must be considered as proving a negative for, despite worthwhile suggestions of approach to the problem, comparatively few salmon were observed, considering the number which from observations at Moricetown falls must disperse throughout the area. In other respects the investigation was successful in laying the foundation for an understanding of the physical and chemical characteristics of the area, the different species of fish inhabiting the lake and their abundance, and the variety and abundance of plankton.

The sounding of the lake was completed revealing that the lake was even deeper on the average than first suspected. In the narrow southern end, less than one mile wide, much of the bottom is over 600 feet deep, reflecting the sharply inclined shores and precipitous mountain sides drained by rivers which are more in the nature of cascading waterfalls tumbling down from large snow fields and immense ice beds.

By use of a bathythermograph, temperature recordings were made to depths of 400 feet. It is apparent that by far the largest volume of the lake water (below 200 feet) probably never varies more than 1°C.

The water transparency within the lake, determined by a Secchi disc, dropped from just over 9 feet in August to about 7 1/2 feet in September. This factor is of particular importance since it determines the visibility in the Morice river. It is probable that somewhat later in the year when the ice fields remain frozen and are not melted by warm suns, the water transparency increases quite perceptibly.

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During the course of the investigation ten gill net sets were made using a single gang of five nets which, because of the steep incline of the shores, were usually set parallel and close to shore. Excluding salmon, seven species of fish were obtained. These are listed in the table which follows in the order of abundance indicated by the catch per night-net.

Species	Catch per night-net
Long nosed sucker, Catostomus catostomus	3.12
Rocky mountain whitefish, Prosopium williamsoni	1.02
Lake trout, Cristivomer namaycush	0.72
Dolly varden char, Salvelinus malma	0.18
Rainbow trout, Salmo gairdnerii	0.16
Common sucker, Catostomus commersonnii	0.02
Prickly bullhead, Cottus asper	+

Considering the returns from the seven different localities in which nets were set, including the extreme ends of the lake, it appeared that the northern sector was the most prolific area, particularly in certain more shallow bays. With the exception of one large specimen, all the lake trout were of a fairly uniform seventeen inch size and presented a starved appearance with large heads and long thin bodies. In contrast to this the whitefish were round and fat, and excellent as a food fish.

As might be expected from the nature of the lake, the plankton was not particularly abundant although considerably more so than in Kitsumgallum lake, a smaller but somewhat similar type. Two species of Cladocera (Bosmina longispina, Daphnia longispina) and two species of Copepoda (Cyclops sp., Epischura sp.) have been identified.

To describe simply the facts recorded by the expedition does not seem to do real justice to the effort expended in obtaining such information. It is not only a difficult place to reach (excluding air travel) but the investigator is faced by many natural hazards and obstacles. The prevailing winds from the south churn up the surface waters for days necessitating a sturdy boat of 26 feet or more to bridge the wave lengths. To take such a boat into the lake means travelling up the Morice river, a task which takes skill and quick action. Numerous rapids, sharp turns, fast white water, hidden rocks and stumps, log jams and canyons require a powerful motor and experience in handling river boats and motors. In the lake itself numerous submerged dead heads, stumps and logs rolled into the lake over many years by land and snow slides, add unsuspected difficulties to gill netting. The spawning areas of the Nanika river and the head waters of certain other rivers of interest are far from being easily accessible.

D.R. Foskett Appendix No. 17

Babine Lake

During the 1945 field season work on Babine lake was reduced in favour of surveys in previously unexplored regions. Temperature series were taken only once at the Babine lake stations. Dissolved oxygen determinations were made and plankton samples were taken at the same times. Gill netting was, however, emphasized and the results were gratifying.

D.R. Foskett

Appendix No. 17

Temperatures taken on July 16 at Station II, 1 1/2 miles north of Donalds landing, were lower in the upper 18 metres than those taken at this station during July and August of 1944. Below this depth they were similar to those of 1944. At Station I, 1/2 mile northeast of Topley landing, temperatures on July 27 closely approximated those of 1944 though the surface temperature was higher on July 25 of last year. At Station III, 3 1/2 miles south of Fort Babine, the temperature series showed a thermocline in the top 5 metres on August 14 whereas during July and August, 1944, the thermocline was between 5 and 10 metres depth.

Oxygen was sufficient to support fish life at all depths where it was determined. When corrected for altitude no values below 50% saturation were obtained. It is doubtful if under ordinary conditions a lake of this size and depth ever becomes stagnant enough to be detrimental to fish.

Plankton samples were taken at Station I, II and III on the same dates as the temperatures and oxygen determinations. A total vertical haul was made in each case and then repeated in sections according to depth and temperature. Though these samples have not yet been analysed, they appear similar to the 1944 samples.

Though a start was made towards sounding the southern portion of the lake, motor trouble forced its postponement. Further support for the belief that this is the deepest part of the lake was obtained when a sounding of 200 metres (656 feet) was made.

Analysis of the 1944 gill net catches showed that, with gang settings perpendicular to the shore, most of the meshes in the nets were not fishing. This year the meshes were made into nets one-half the length of those used last year. Netting was commenced earlier in the season so that it was possible to net off the mouths of the Fulton and Beaver rivers without interfering with the salmon runs. Thus, though less net nights were fished, the larger number of sets with the shorter nets resulted in an increased catch per fifty yard net-night from 1.963 fish in 1944 to 7.27 fish in 1945. The total catch was 276 fish in 1944 and 705 fish in 1945. Sockeye and kokanee have been placed in one group due to difficulties in separating them in the field. Actually it is known that the sockeye catch was down and the kokanee catch up in comparison with 1944.

Species	Catch per 50 yard net-night	
	1944	1945
Sockeye and kokanee - Oncorhynchus nerka	0.55	2.825
Rocky Mountain whitefish - Prosopium williamsoni	0.371	1.41
Chub (pearmouth)- Mylocheilus caurinus	0.107	1.39
Rainbow trout - (steelhead) Salmo gairdnerii	0.021	0.51
Lake trout - Cristivomer namaycush	0.121	0.33
Squawfish - Ptychocheilus oregonensis	0.043	0.32
Common sucker - Catostomus commersonni	0.007	0.21
Eastern whitefish - Coregonus clupeaformis	0.193	0.165
Northern sucker - Catostomus catostomus	0.514	0.04
Coho salmon - Oncorhynchus kisutch	-	0.04
Ling - Lota maculosa	0.036	0.03

Stomach contents and scales were obtained from a representative sample of each species. These were supplemented in some instances by sampling fish taken by anglers.

D.R. Foskett — Appendix No. 17

A trip was made last February to Topley landing in order to check winter conditions on the spawning grounds of that area. Eggs and alevins were collected from the gravel of the Fulton river and Tachek creek. Conditions appeared favourable for the survival of the young salmon. Winter kill was exceedingly light. Development of the eggs was well advanced, many of the alevins having developed to the stage at which emergence from the gravel normally takes place.

During the winter months analyses were made of the samples and data collected during the summer of 1944. Reference has already been made to the analysis of gill net catches and the results obtained from it. An analysis was made of the food taken by the migrating yearling sockeye during May and June. This consisted of 70% plankton organisms and 30% insect life. The plankton organisms taken most abundantly were those which would be most readily observed though individual preference was marked. Bosmina, Heterocope and Dephnia formed the bulk of the food in the stomachs examined. The analysis of the plankton taken in the plankton nets did not show that these organisms were the most abundant. Also one plankter of the same size order as the above seems to escape utilisation due to its transparency.

The analysis of the stomach contents of the various coarse fish in the lake showed that three species are competitors with the sockeye and five species are probably predators. It is unlikely that food competition would be of any great importance to plankton feeders in Babine lake which include eastern and Rocky mountain whitefishes and the northern sucker. The lake trout, rainbow trout and ling probably prey to some extent on the young sockeye throughout its freshwater life. The squawfish and bullhead (Cottus asper) probably are predators during the spring when the sockeye fry are found in the shallow waters inhabited by these fish. At present little can be said of the role played by the kokanee and the coho salmon in Babine lake.

V. McMahon and D.R. Foskett — Appendix No. 18

Morrison Lake

Morrison lake lies parallel to the northern arm of Babine lake in a north-westerly, south-easterly direction and is separated from it by a range of high hills. It flows into Babine lake by way of the Morrison river (Hatchery creek) at its southern extremity. Due to its location, the body of water is open to winds from the north and north-west. The lake is approximately 10 miles long and from one mile to 200 yards wide. Its narrowest point is approximately two miles from the southern end.

The lake was found to be divided roughly into three regions, in so far as water depths are concerned. The narrow northern portion comprising approximately one-fifth the length of the lake, has depths ranging from 8 to 20 metres, the depths in the wider central region, constituting about two-fifths of the total length, range from 30 to 63 metres, and the narrow southern portion, making up the other two-fifths of the lake length, has depths of 9 to 30 metres.

Stations were set up at the two ends of the lake for the purpose of taking oxygen samples, pH values, temperature readings, and plankton hauls at the various water levels. Temperatures and a total vertical plankton haul were taken, also, in the deepest portion of the lake.

V. McMahon and D.R. Foskett

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Since the time spent on this lake was limited to about ten days (August 1-10), only small fluctuations in the oxygen concentrations of the water were found from samples taken on the first and last days. However, at both times, the concentration of oxygen was found to be greater at the northern station, at which end Salmon creek enters the lake. From results of temperature measurements taken at both ends and in the middle of the lake, it is apparent that there was a thermocline present between the five and ten metre levels.

It would appear from the number of fish taken by gill netting that Morrison lake is not very plentifully stocked. Five sets were made with a gang of six nets each 50 yards in length (meshes 1 5/8", 2 1/8", 2 3/4", 3 15/16", 5 1/16", 5 3/4") and a total of 59 individuals were caught. However, two of these sets were made parallel to the shore line and one was a deep-water set, where the oxygen concentration was probably moderately low.

All fish taken in gill nets with the exception of the live sockeye and those kept for samples, were measured, most of them were sexed and had scale samples taken. The stomach contents of all predators and of some of the non-predators were taken and preserved. Also preserved were all fish taken in the five seine hauls. Gill net catches are recorded below by species.

Species	Catch per net-night
Eastern whitefish - Coregonus clupeaformis	.46
Northern sucker - Catostomus catostomus	.26
Kokanee - Oncorhynchus nerka kennerlyi	.23
Sockeye - Oncorhynchus nerka	.20
Rocky Mountain whitefish - Prosopium williamsoni	.16
Lake trout - Cristivomer namaycush	.16
Squawfish - Ptychocheilus oregonensis	.13
Chub - Mylocheilus caurinus	.13
Rainbow trout - Salmo gairdneri	.13
Cutthroat trout - Salmo clarkii	.06

D.R. Foskett

Appendix No. 19

Bear Lake

Bear lake is a narrow lake about 12 miles long by 3 miles wide at its widest point. It lies about 50 miles north of Fort Babine in a narrow mountain valley at an altitude of 2,640 feet. The main trough in the lake lies in a general south-easterly north-westerly direction. In the northern part it is in general over 100 feet deep and in the southern part reaches a depth of 228 feet. The lake, and hence the trough, is divided by shallows in the narrow central portion. Just to the south of this narrows on the east side lies the large shallow Tsaytut bay. While in general the lake is deep, in two areas hidden rocks necessitate care when using motor boats. The shoreline is fairly regular though the type of material forming it shows all gradations. There are three main tributaries and several smaller ones, the latter in most cases finally reaching the lake as seepage rather than as open streams. The largest tributary carries a great deal of glacial silt which appears to be precipitated very rapidly once the stream

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enters the lake. Drainage is through the Bear river at the northern end.

The maximum surface temperature recorded was 60°F. at Station 1 at the north end of the lake on August 6 and the minimum at Station 2 in the deepest part near the south end on September 4. At Station 1 on August 6 the thermocline was between 15 and 40 feet and on September 3rd there was one between 30 and 40 feet and another between 90 and 100 feet. At Station 2 on September 4 the thermocline was between 25 and 40 feet with an area of less rapid change down to 90 feet. As was to be expected with such a cold lake, the plankton was not abundant. Surface tows in shallow areas showed a much heavier plankton population. Gill netting in the shallows showed that the greatest fish concentrations were also in these areas.

The catch per species in order of abundance per fifty yard net-night was:

Species	Catch per net-night
Rocky mountain whitefish - Prosopium williamsoni	4.36
Eastern whitefish - Coregonus clupeaformis	1.18
Northern sucker - Catostomus catostomus	1.14
Sockeye - Oncorhynchus nerka	.82
Lake trout - Cristivomer namaycush	.25
Ling - Lota maculosa	.25
Common sucker - Catostomus commersonnii	.07
All species	8.07

The salmon noted in the lake were the sockeye and coho. Kokanee were seen in the spawning streams but none were netted in the lake.

Weather conditions at Bear lake are apparently much more severe than at Babine lake. It was reported that the lake freezes in November and does not open until late May or June. In 1945 the ice was reported to have broken up on June 27 as compared with May 17 at Babine.

D.R. Foskett Appendix No. 20

Sustut Lake

Sustut lake is a moderately shallow lake 3 1/2 miles long and about 1/2 mile wide lying about 30 miles north and 15 miles east of Bear lake. It is situated at an altitude of 4,250 feet and surrounded by high peaks. Although fed by glacial streams, it is moderately clear though not entirely free of glacial silt. There is a large shallow area at the north end of the lake with numerous bars. Apart from this the bottom is fairly regular though the slope of the sides is steeper than that of the ends. For the most part the shores are regular and bordered by marsh. Only three streams actually enter the lake as such, - the others are either broken into a number of small streamlets by the marsh or enter as seepage.

Due to the short stay at Sustut lake a temperature record was only taken once. At this time the surface temperature was 58°F. and the bottom 48°F. There was no thermocline. The plankton did not appear to be at all abundant.

D.R. Foskett

Appendix No. 20

While no gill netting was done at Sustut lake, a number of fish were taken by beach seining and trolling. Other records were added by observation. The following species are found in the lake - steelhead trout (Salmo gairdneri), dolly varden char (Salvelinus malma), ling (Lota maculosa), rocky mountain whitefish (Prosopium williamsoni) and a minnow (Richardsonius balteatus) as well as sockeye and coho salmon.

4. SPAWNING GROUND SURVEYS

J.R. Brett

Appendix No. 21

Lakelse Lake Area

A decided increase in the number of sockeye entering Lakelse lake by comparison with the previous year's observations was very apparent, even at the start of the season during the first early runs up the Lakelse river. By June 9th, the first sockeye were in the lake and during the middle of June, Large schools were observed making their way up the river, thus confirming the belief that the majority of the Lakelse lake run enters the lake before the start and during the early phases of the commercial season. Of the total number of sockeye (2212) tagged off the mouth of the Skeena river during the period June 13th to July 30th, five were discovered among the Lakelse lake fish. These had been tagged between June 21st and 29th by which time less than one third of the total tagging had been completed. Since the sockeye fishing season did not commence until July 1st, being delayed one week as a result of a strike, it would appear that the Lakelse lake run was affected very little by commercial fishing.

The program of tagging sockeye within the lake in order to provide an aid in estimating the total run was repeated. Between July 24th and August 5th, 807 were netted and tagged with white discs and baffles. Of the 807, 233 were later observed in the streams on living fish and 24 were picked up from dead fish. By use of the tagging ratios and by comparison with the figures for 1944, the calculated total number of sockeye entering the lake was set at approximately 57,000, an increase over the 1944 run of more than 100%.

The following estimates have been made of the distribution of sockeye to the different spawning creeks:

Williams creek	50,000
Eliza creek (tributary to Williams)	4,500
Scully creek	1,800
Granite "	200
Others	200
Total	56,700

The rather exceptionally low water conditions during August which reached a minimum for the year by the first week of September, certainly constituted a major factor affecting the distribution of salmon to the different tributary rivers. The flow in Granite creek was so reduced that despite the

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clearing of a passage by the Dominion Fisheries officer around a log jam known to block upstream migration, the creek only carried a few hundred fish. This contrasts sharply with the estimation in 1939 by Dr. Pritchard of 5,000 to 10,000, or with estimates for previous years by the Fisheries officer of from 1,000 to 2,000.

The duration of the run from start to finish exceeded that for 1944 by nearly two weeks, the salmon apparently being held up at the creek mouths. At first Scully creek was running far behind 1944 in total spawning population, but on the final count it came up to slightly better than 75% of the previous year's escapement. Its general history shows that it has maintained itself with fair constancy through the years from 1926.

Williams creek, being much larger than any of the other creeks took the main load of salmon and, despite the low water level, showed an increase of more than 100% over last year's estimate and rose to 85% of the total run for the lake.

J.R. Brett

Appendix No. 22

Kitsumgallum Lake Area

At the time of the expected peak of the sockeye salmon run in Kitsumgallum lake, an inspection was made of the spawning streams. Once again the task of determining with any degree of accuracy the number of salmon in the different areas was made virtually impossible by the heavy glacial silt which pours down the Cedar river into the lake. There appeared to be an increase in the number of lake spawners with a decrease in the total for creek spawning, a condition which might well be accounted for from the low level of water in the rivers. The one creek with sufficiently clear water to permit an accurate count, Clear creek, had about two thirds of the number for 1944. Cedar creek, to judge from the numbers observed in the side sloughs, had less spawners.

The following rough estimates are set forth of the number of sockeye spawning in the Kalum lake area:

River	Estimated Run
Cedar creek	3,000
Clear "	1,000
Dry "	200
Kalum lake	5,000
Total	9,200

Any comment on the spawning grounds would have to lay most emphasis on the low water conditions. Other than that, there appears to be no particular change in the general spawning beds. The log jam on one of the Beaver river outlets has continued to build up, but as yet cannot be said to be blocking the upstream movement of salmon.

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Appendix No. 23

Kitwanga Lake Area

The largest tributary to Kitwanga lake enters at the north-east corner and drains an extensive muskeg area north of the lake near the source of the Cranberry river. At its point of entrance into the lake and for a considerable distance upstream, the creek is murky, slow-flowing and entirely dissimilar from what is considered a good salmon spawning stream. At the mouth, the width is about 30 feet and the depth 5 feet while out in the lake a shallow bar has been formed from the deposition of silt. A survey was made of the lower two miles, but it was not possible to reach the headwaters where redds may be present although this appears unlikely. Despite the fact that fairly large numbers of sockeye were observed in schools off the mouth during the month of August, none were seen moving up the creek. It is most probable that sockeye salmon spawn in the lake itself and in the Kitwanga river below.

From observations on sockeye in the Kitwanga river during the period July 24 to August 24, there appeared to be an average movement past a given point of about 200 per day from which it can be estimated that the run was probably greater than 6000 fish.

Kitwanga lake is drained by a fairly rapid-flowing stream, the Kitwanga river. This was surveyed completely on August 25th to 28th in order to examine the spawning beds, the tributary creeks and the pink salmon which were spawning at this time on localized gravel beds up the whole course of the river. Several places were noted where logs had fallen across the stream which, although not forming absolute barriers, caused sufficient difficulty for migration to warrant being removed.

The volume of water entering this river from the lake is fairly small but it is increased several fold as it flows south towards its entrance into the Skeena by the entrance of three large creeks. Moon creek which enters the Kitwanga about two miles below the lake is a cold, glacial stream which arises, according to the natives, north-east of Kitwanga lake. A brief survey of the lower two miles of its course showed little in the nature of good spawning beds. Evidently the spring and pink salmon observed in it spawn at a considerable distance farther up. Kitwancool creek enters the Kitwanga five miles below the lake. It arises in the hills to the west and flows in a southerly and easterly direction into the main river. Although a large pink run was spawning in the Kitwanga river, only eight were observed in the lower two miles of the Kitwancool.

The other fairly large creek, Deuce creek, is a clear stream which drops swiftly into the Kitwanga river about one mile below Kitwancool creek. No fish were observed.

In addition to the good sockeye and pink runs observed in the Kitwanga proper, reports from the natives indicated that a run of cohoes usually enters in September.

D.J. Milne

Appendix No. 24

Lower Skeena and Tributaries (from Hazelton West)

From September 10th to September 20th, a brief survey was made of the salmon spawning in the lower Skeena river and in about thirty tributaries which enter between Hazelton and the ocean - a distance of approximately 175 miles. The three lake systems, Kitwanga, Kitsumgallum and Lakelse were examined by lake

survey parties and are described elsewhere. Some more inaccessible localities such as the Gitnadoix, Khtada and Ecstall were omitted due to lack of time. Particular emphasis was placed on observing the pink spawning run which was in progress at the time. All the miscellaneous data collected on the size and type of streams have been recorded for future reference.

For convenience the streams visited have been classified on the basis of size and number of spawning pink salmon observed. Examples of each are given in the following table in which the headings, heavy (more than 25 fish per 100 square yards), medium (5 to 25 fish), light (less than 5), and none, are used to describe the number of spawning fish observed.

Spawning Intensity	Short streams less than fifty feet wide at mouth	Long streams more than fifty feet wide at mouth
Heavy	Stoney, Price and Deep Creeks	Gold cr., Lakelse and Exchamsiks river
Medium	Mission creek and Shames river	Kitsumgallum and Simacord river
Light	Little Oliver, Chemdimash cr.	Copper and Kasiks rivers
None	Sealey, Whiskey, Coyote Creeks	Exstew, Kwinitsa and Khyex rivers

Individually the short streams are not as important as the large ones but in the aggregate they contain a good proportion of the total spawning areas used by such species as the pink, chum and coho. The small degree of spawning in many streams of both groups is probably due to various conditions such as the level of the water in the Skeena river being too low for fish to enter the mouth (Sealey creek), a bed with a steep gradient and small falls (Whiskey and Little Oliver creeks), silt, fine sand (Exstew) and muddy (Kasiks) bottoms associated with slow current or the influence of tide conditions and brown acid bog water (Khyex and Kwinitsa rivers). Most of the streams in which pink spawning was observed were clear with soft gravel bottoms and in the opinion of the local residents, the run was the heaviest in years. In the case of Gold creek, 12 miles east of Terrace, about 5,000 pinks were spawning in the mile of stream stretching from its mouth to an impassable falls. On September 10th, only about ten per cent. of the fish had died and by September 20th the peak of the run was past. There is some evidence that the best spawning area freezes below the gravel and heaves up during the winter to expose many of the eggs. The pinks in Lakelse river, about 25 miles lower down the Skeena, appear to be later. On September 19, many thousands in a very fresh condition were milling around at the entrance from Lakelse lake as if there was no room in the river left for spawning. On inspection it was found that the complete 12 miles of river was full of spawning pinks. The Copper and the Simacord rivers were both silty with hard coarse gravel bottoms and from an examination of the dead, 5 to 25 per cent. of the fish were unspawned.

In the Skeena river proper the pinks probably spawned on most of the gravel bars throughout its course. This was particularly noticeable at such places as Hagwilget canyon pool, at Cedarvale ferry (peak of dead September 13), Kitselas canyon, Remo ferry (about twice as many dead as in Simacord river) and the mouth of Exstew and Exchamsiks rivers. Down the river below Kwinitsa, where the tidal influence is noticeable, where the shores smelled of dead fish and where the gravel was covered with algae, no spawning pinks were observed.

Although many of these streams probably carry an earlier run of springs as well as later runs of chum, coho and steelhead, there was practically none in evidence during September. On September 13, six spawned-out springs were found in Kitsumgallum river. On September 12, in a clear side channel of the Copper river, twelve chums were spawning among the pinks and a few coho fingerlings were busy eating the loose eggs.

F.C. Withler

Appendix No. 25

Kispiox System

A. Lac-da-dah district

Since very few of the sockeye present in Swan, Club and Stephen's lakes had moved into the streams, it was difficult to estimate the run into this district. From observations of the sockeye lying off the mouths of the creeks, however, a fair run was indicated.

Falls creek is the only stream draining into Swan lake large enough to support a sockeye run. It flows into the lake from the north, running through a steep canyon from a small lake two miles from Swan lake. Sockeye were observed congregated at the mouth on August 13, but no fish had moved into the creek until September 17, when 520 live and 19 bear-killed sockeye were counted. From the length of the spawning area (150 yards) there seems small likelihood that this creek supports the number of sockeye observed in Swan lake. It is quite possible that lake spawning supports the surplus.

Club creek, joining Club Lake and Stephen's lake, contains approximately 500 yards of sockeye spawning beds. Although during August the stream was extremely low, it is obviously the main spawning area of the district. On September 7, several thousand sockeye were schooled at the mouth of Club creek in Stephen's lake. No fish were spawning in the creek at this time.

Stephen's creek, which drains Stephen's lake into the Kispiox River contains about 1 1/2 miles of spawning gravel, near the upper end. The lower part (approximately 2 miles) is extremely muddy and meanders through thick willows. A count made on September 6 revealed 30 live spring and one dead sockeye.

B. Streams draining into the Kispiox below Stephen's creek.

Ammoanook creek (September 8). No fish, live or dead were observed in this stream. Ammoanook creek flows out of a small lake 1 1/2 miles N.E. of the Kispiox river and contains a short stretch of spawning gravel near the mouth.

Mongeese creek (September 9). Approximately a mile of the lower part of Mongeese creek revealed an estimated 200 live pinks and 30 springs. The great number of dead pinks indicated a large run already past. The water was high and too muddy for accurate counting.

Sweetin creek (September 10). Recent rain made Sweetin creek too high and dirty to make observations of the stream. No fish were seen at the horse trail.

Scounsnosit creek (September 10). No fish were observed in this stream.

Grouse creek (September 11). This stream was covered for about one mile up from the mouth. Seven hundred and fifty live pink and 60 live chum salmon were estimated. The dead count revealed 107 pinks and 3 chums.

A.L. Pritchard

Appendix No. 26

Upper Bulkley River

The Upper Bulkley which drains Bulkley lake and a number of other smaller bodies of water, offers at least 10 miles of possible spawning area for

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salmon from its source to where it joins the Morice river just below the village of Huston. In 1944 an examination revealed that even in the first ten miles where there was no real obstruction, fish did not appear. This was attributed mainly to the small flow at low water in comparison with the larger Morice.

In 1945 during late July and early August, when the water was at a comparatively high level, a run of salmon did occur although it was relatively small. From moving pictures, luckily discovered in the possession of a local amateur, these were identified as sockeye. It was also revealed from the "shots" that the fish were having difficulty ascending Topley falls about 30 miles up-river due to lack of water, in spite of the fact that they had passed on their way all dams and beaver dams then only partially constructed. A further visit was made on September 9 and 10. At that time water conditions were extremely unfavourable since many of the bars were hardly covered. No fish were visible. Only a trickle ran over Topley falls and the many jams and beaver dams, now almost completed, were almost impassable obstructions. With the autumn rains conditions might have improved but at a time too late to benefit the main sockeye run.

A very thorough investigation of this area should be prosecuted. In this not only biological but engineering advice will be needed to determine whether more use could not be made of the potential spawning area.

J.R. Brett Appendix No. 27

Morice Lake Area

In the Morice lake district there seems little doubt that, for sockeye which pass into the lake, the Nanika river constitutes the main spawning area. In an effort to ascertain this fact, gill nets were set in the very outlets of the two other most probable rivers, one at the extreme southern end and the other at the extreme western bay, the Atna river. One injured sockeye was obtained off the Atna river but none was observed either finning at the mouth or ascending the falls about one mile up. Three sockeye with head injuries of a similar nature, apparently produced by fighting their way past river obstructions, were caught at the southern end while none was observed in any part of the lower section of the stream there. The sets which did catch normal sockeye were all within a radius of two miles of the Nanika river. At the outlet of this river, and only this river, fair schools of sockeye were seen throughout August and in decreasing numbers in September. Attempts to gill net these with floating 4 1/2" mesh nets for tag reclaiming and inspection proved futile. The main spawning in the Nanika appears to occur in minor side sloughs and over the last two miles of stream bed just below the falls at Kidprice lake. Observation is made exceedingly difficult by the rapidity of flow and very heavy glacial silt which is poured into Morice lake. There does not appear to be any lake spawning.

The Morice river has, over its complete length of about fifty miles, excellent mixed fine to fairly coarse gravel beds. Spawning, however, by sockeye and spring salmon, only occurs in various areas over that section of the river extending from the lake to the North Fork, about 15 miles, and mainly in the few miles between the lake and the upper canyon. All the creeks flowing into the Morice river were inspected in the middle of September for salmon and, al-

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though it is reported that later in the year coho travel up a good many of them, only one, Gosnell creek, was discovered to carry sockeye and only a small number at that. None showed indications of spring salmon. Thus the sockeye spawning appears to be mainly in the last few miles of the Nanika river and the upper section of the Morice river above the upper canyon with intermittent beds below this to the North Fork. The spring salmon, of which a good many move up into the lake dropping back later, concentrate the majority of their spawning over this last section of about two miles above the upper canyon with scattered groups below this to the North Fork. No indication of spawning or signs of spawning beds were observed from the North Fork to the Bulkley river. The peak of the spring salmon spawning came near the end of the second week of September. That for the sockeye must come somewhat earlier, probably the end of August, or earlier in September.

In the second week of September coho began to appear in schools off the outlets of a few of the rivers tributary to the Morice river. Fingerlings of the species were discovered in every main stream tributary to the Morice river except Owen creek. At this date low water conditions were holding back the coho at Moricetown falls so no further observations were made. At no time were pink or chum salmon observed in this area.

If it were not for observations at Moricetown falls no understanding or true conception of the number of salmon moving into the Morice river and lake area would be forthcoming from direct observation on the Morice lake, river, and respective tributaries.

The importance of the Morice lake area is reflected in the Indian fishery and in the experimental tagging carried on at Moricetown falls, and any estimates on the run of the different species of salmon to Morice lake must find basis mainly in the figures available from the above sources. Sockeye were observed in the height of the season to be moving up the falls at the rate of about 400 per hour. From this observation and other data from the Indian catches, it has been estimated that in the neighbourhood of 80,000 sockeye migrated into the Morice lake area with a probable round figure of about 10,000 for spring salmon.

D.R. Foskett

Appendix No. 28

Babine Area

The salmon run to the Babine area was marked by an increased population, longer time on redds and low stream levels. The last is said to be the normal tendency in this area.

The first sockeye was caught at Fort Babine on June 30, four days ahead of last years mark. Within three weeks they were scattered throughout the lake, some being caught in almost every net setting after July 15. Five streams had sockeye in them by July 25. These were Sockeye, Tachek, Twin, Pierre and Fifteen Mile creeks. It is likely that Nine Mile creek also had salmon in it by this time. The Fulton, Babine and Morrison rivers had spawning sockeye populations well into October.

The low water conditions in the streams may or may not have a serious effect on the salmon. There is a belief that when the streams are low more sockeye spawn in the lake. Such may be the case as spawning took place in the lake

at Nine Mile point this year. Last year when the creek was high no lake spawning was noticed. It was reported that most of the sockeye in Twin creek died without spawning because of low water this year. Unfortunately the creek could not be examined at the time the mortality took place. Other than temperatures slightly higher than usual in spawning streams, nothing seemed out of the ordinary in the creek. Conditions may have been more severe at the time of the mortality.

One of the factors contributing to the extreme low water on some creeks is the fact that the watershed area has been burned off at some time. Even though the second growth has a good start the soil has not recovered sufficiently to prevent excessive run offs with subsequent low water. In one case, Sockeye creek, this has resulted in several mouths to the stream. Only one of these is used by sockeye. This year the sockeye could not ascend to the best spawning grounds due to the stream being dry at some points.

With the low water predators had greater opportunities to catch the salmon. This was particularly noticeable on Tahlo (Salmon) creek, a tributary of Morrison lake. Here hundreds of salmon had been taken from the stream by bears. It is probable that most of these fish were wholly or partly spawned out. However in view of the situation in certain streams in other districts such as Bear lake where grizzlies attack the salmon, an investigation should be made of the damage here. This would permit methods to be worked out which could be used to assess damage done by the more dangerous grizzlies without exposing the personnel to more hazards than necessary.

While runs were present in all the main streams where they were found last year, they were absent in some of the smaller streams and lake spawning areas. This does not necessarily mean that salmon spawn in these places only when the streams are high but probably means that there are not runs to these areas in every year of the cycle.

The runs to the various streams are listed below and compared with those of 1944. The escapement to the Babine area was probably about 240,000 sockeye. There were more coho than in 1944 but a lighter run of spring salmon.

Sockeye Runs, Babine Area

	1944	1945
Babine river, lower	10,000	15,000
" " , upper	10,000	15,000
Trail creek	169	--
Unnamed creek	75	--
Five Mile creek	571	750
Nine Mile "	5,045	10,000
Bear Island creeks	32	--
Fulton river	35,000	70,000
Tachek creek	14,021	12,000
Sockeye creek	2,255	350
Pierre "	13,246	17,000
Twin "	13,500	15,500
Pendleton "	350	2,100
Fifteen Mile creek	5,200	25,000
Four Mile creek	6,107	6,000
Six Mile creek	4,110	800
Grizzly creek	5,100	5,000
Morrison river	12,785	24,100
Salmon creek	5,000	10,000

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In 1946 it is hoped that the fence in the Babine river will be working. This will allow experiments to be conducted on the enumeration and distribution of the salmon. It is felt that fences for both fry and adults should be established on one or two smaller creeks in order to gain specific information to tie in with the general information obtained from the Babine fence. Tachek creek has been suggested since it is close to Topley landing. However it might be better to fence Twin creek since it would give information on the effect of low water and mortality. It has the additional advantage of being close to Pierre creek which apparently does not suffer from these conditions. Thus a control could be had for Twin creek by fencing Pierre creek. Also the conditions regarding early and late runs to the same stream could be studied at Pierre creek.

Experiments in regard to controlling the run-off and improving the streams should be started in the Babine area. Sockeye creek would be very good for this purpose as it is close enough to Topley Landing to be kept under observation. Since the salmon are blocked from the headwaters of all the spawning streams around Babine lake, consideration could be given to beaver planting in these headwaters to control the run-off. Some protection would have to be provided for these animals in any area stocked with them.

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Bear-Sustut Area

In the Bear lake area there are three main spawning areas. These are (1) the creeks of the Bear lake drainage basin (2) the beaches around Bear lake and (3) the Bear river.

There are two creeks in the Bear lake area known to have sockeye runs. Willow creek tributary to the east side of Bear lake at Willow point had a run of 600 sockeye. It could have accommodated three or four times this number. Mink creek tributary to Azuklotz lake which flows almost directly into the point of Tsaytut bay on Bear lake, had a run estimated at 3000 sockeye. On neither of the above creeks could accurate counts be made. This was due to the heavy growth of willows which completely covered the creek in parts in the former case. Due to the commotion caused by the fish, counting was impossible in parts of Mink creek. This was undoubtedly due to frequent attacks by grizzly bears whose sign was everywhere around the creek. Fully ten per cent. of the live spawning fish had gashes and cuts from attacks by these bears. The trails along the creek had the remains of many salmon left on them by bears.

Two creeks were not explored due to lack of and the uncertainty of obtaining any results. The Indians reported coho used these streams but were doubtful as to whether any sockeye spawned in them. In the case of one, Patcha creek, there was so much glacial silt that unless a salmon was within two inches of the surface, it could not be seen.

Many of the streams entering Bear lake are so blocked with windfalls, debris and gravel banks that the water from them enters the lake either as seepage or spreads over such an area that no salmon can ascend. In such areas sockeye spawn in the gravel beaches or sweep away the mud until gravel is reached.

In some localities up to thirty salmon were seen in a single large excavation. One, by no means the largest, was measured approximately with the boat and was 10 feet by 16 feet by 5 feet deep. In addition there were areas where the salmon spawned in pairs as in the streams. Seven hundred salmon were counted spawning around Bear lake and 800 were congregated in certain areas but were not spawning at that time. In places the constant accumulation of dead fish along shore seemed to indicate populations spawning at depths where they could not be seen.

Three days were necessary to examine the spawning beds of the Bear river. The two most striking discoveries were a hitherto unrecorded run of pink salmon and an unreported falls on the river. The latter is a definite obstacle to the larger salmon at low water though generally the sockeye, medium size coho and jack springs could make it with only one or two tries. The pink salmon for the most part were blocked by the falls, very few having been seen above them. Though it was reported last year that the main sockeye spawning of this area was in the river, such was not the case this year at the time the river was examined. Most of the hundred sockeye seen were migrating upstream. Three thousand pink salmon were seen in the river. Probably due to the excess of males, the ratio being about 4 to 1, in many redds there were from 3 to 5 males and one female. Nine thousand spring salmon were in the river. Most of these were already on the spawning beds.

The spawning ground survey in the Sustut lake area was confined to Sustut lake and its tributaries, the Sustut river to its junction with Johanson creek, Johanson creek up to the Ingenika trail and Asitka lake and its tributaries. The latter lake is situated two miles east of the southern end of Sustut lake and empties via the Asitka river into the Sustut river about fifteen miles above the Bear river. No spawning was observed in any of the creeks or rivers of the area, possibly because it was too early. The Indian guide said Johanson creek is the only place in the area where sockeye spawn other than in the lakes in the district. At the time of our visit, August 25, no sockeye were on the redds in that stream. Lake spawning commenced in one area of Sustut lake on August 26. At the time of return to Bear lake, September 1st, less than 100 sockeye had commenced spawning in that area.

In addition to the above, certain information was obtained from our Indian guide. Four areas along the shore of Sustut lake are used for spawning. Many sockeye spawn in Asitka lake though sometimes they are blocked by beaver dams down the river. This was apparently the case this year as no sockeye were seen in the lake and fresh beaver cuttings were seen in the river below the lake.

The Indian fishery in the Bear-Sustut area this year was confined to Bear river and lake though this is not always the case. The Indian catch of spring salmon was approximately 2100. Well over 100 large spring salmon had been caught and killed and then just left on the bank to rot. These are not included in the above figure. This abandonment was not due to any defects in the salmon which in any case are used almost exclusively as dog food in this area. About 1500 sockeye were caught at Bear lake. Pink salmon are not utilised at all in this area.

5. STATISTICS

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Appendix No. 30

Commercial Fishery

The history of the Skeena salmon fishery together with the catch and biological statistics should present a complete picture of the commercial exploitation with the result that an indix might be derived to indicate the true fluctuations in the fish population. If accurate data were available, some light might also be thrown on the causes of the fluctuations so that more logical recommendations can be made to remedy any serious decline if such is found to occur.

With this in mind a visit was made to the Prince Rupert area during the first two weeks of July to become acquainted with the whole industry. Five of the six canneries were visited and one of the nine fresh fish establishments examined. A more detailed study was made of the operations of Cassiar Cannery. The method of collecting the Government catch statistics was inspected.

History

From 1925 to 1945 there has been a decrease from 15 to 6 in the number of canneries operating in this area. These six canneries are quite efficient and most of them are modern but improvements in some cases have been recent. For example, Inverness was built in 1887 but was only remodelled and electrified in the last two years. During the past fifteen years the fresh fish establishments have increased in importance.

The fishing effort as indicated by the number of gill net licenses has dropped, since there were 1138 in 1930 and 749 in 1944. However the intensity of exploitation has probably remained about the same due to the increase in efficiency of the gear caused by such things as the replacement of the sailboats by gasoline launches between 1930 and 1940 and the introduction of the motor driven net drum in 1942. The effort directed to catching coho and spring salmon has probably increased since trolling licenses in this area have increased from 308 in 1930 to 462 in 1944. In 1941 the removal of about 300 Japanese fishermen must have lowered the intensity of the fishing effort. From the records of Claxton cannery (1930-1936), the Japanese composed about one third of the fishermen yet they caught one half of the fish while the Indians were the reverse.

The fishing regulations have changed over the years. The ocean fishing area has enlarged many times in all directions, the river fishing boundary was finally brought down to Point Lambert and the seasonal and weekly closed periods have varied. The enforcement of restrictive regulations is always difficult but at present on the Skeena it seems to demand a good type of patrol officer in uniform with a fast boat as well as close co-operation from the cannery managers if the measures are to achieve their purpose of conservation.

Catch Statistics

Prior to 1938 the Dominion Fishery Inspectors collected all the catch data. Since then each cannery has reported the pack on weekly, monthly and annual forms. The results are published in the annual report of the Dominion Fisheries Department. The Provincial Fisheries Department also reports a compilation of the pack collected at the end of the season. If one compares these tables in an effort to arrive at an accurate figure of the catch, much discord results because prior to 1933 the pack of fish caught in the Skeena area regardless where canned

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is often confused with the pack in the Skeena area regardless where caught. In fact until the present tagging experiments are completed it is impossible to decide the exact area in which Skeena fish might be caught. In addition there is much disparity in the actual figures. For example, in 1942 the Provincial lists a pack of 34,544 cases and the Dominion a pack of 29,976 cases. In checking the basic Government figures at Prince Rupert, there is often disagreement with the annual pack figures taken from the individual cannery ledgers. The number of fresh fish taken is collected only for the district and is not presented in either of these reports. Thus there are many difficulties to overcome if accurate figures are to be obtained on the total commercial exploitation of all species of salmon.

If the provincial figures are accepted then in the case of the sockeye it is apparent that there has been a gradual decline in the catch from an estimated 132,000 cases in 1907 to 45,000 cases in 1943. There is no evidence of a marked levelling off under the existing conditions and great annual fluctuations have occurred at irregular intervals in the past. For the other species it is necessary to accept the figures obtained at the Prince Rupert office which include the fresh fish. They are recorded for the last fifteen years but are given in hundredweights. When due allowance is made for the lag in the lowering of the index (84 to 75) used in converting canned fish to green weight, the spring catch has decreased faster than the sockeye, the pinks and chums have dropped slightly and the coho catches have increased.

Biological Statistics

To elucidate the seasonal fluctuations in the fish population for each species, the wall charts recording the daily catch per boat maintained by some of the cannery managers should be useful as well as the packer tally books and the individual books of the fishermen. These data are being collected to obtain the catch per unit of effort, the relative efficiency of gear and men and the seasonal variation in the runs. It is evident from the records of the Cassiar cannery that the fishing season varies greatly. Over the past thirty years the season has started from June 22 to July 3rd and ended from Aug. 11 to Sept. 4 with the peak from July 17 to August 2. In general there is no apparent correlation between the time of run and the size of catch but the season has shortened from about 70 to 50 days by terminating earlier.

If statistical data are to be of value for biological work, then more efficient methods to collect specific details must be evolved and maintained for a number of years before accurate information will be available to derive a suitable index of abundance for the whole fishery.

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Indian Fishery on Skeena River in 1945

During the summer of 1945 a visit was made to most of the Indian fishing sites on the Skeena river. The Indian fishery at Moricetown was observed in detail in conjunction with a tagging programme conducted below the falls.

The records of the Dominion Department of Fisheries in Prince Rupert show that incomplete estimates were made on the number of fish taken by the

Indians for the years 1930 to 1934. Since 1935 a more comprehensive system has been followed and fishery guardians located at Terrace, Hazelton, Moricetown and Fort Babine and Donalds Landing in Babine lake, have made estimates for these territories. No record has been maintained in other areas.

The average of these annual estimates from 1935 to 1944 is sockeye - 73,300, coho 15,200, pink 11,000, spring 6,600, chum 140 and steelhead trout 1,700 or a total of 108,000 fish. These figures are certainly minimal figures for the whole Skeena drainage. The annual Indian catch has fluctuated greatly and as might be expected, varies in the case of the sockeye (68% of average catch) with the commercial catch which is approximately twelve times as large. In general the catches have been lower in the last few years, especially for pinks in 1942, 1943 and 1944.

There have been over 2000 Indians living on the upper Skeena in the past decade, 43% of which are under 17 years of age. The number of Indians recorded in 1944 together with the estimates of the fish caught in the four main regions are given below:

Area	Number of Indians	Number of Fish						
		Sockeye	Coho	Spring	Pink	Chum	Steelhead	Total Fish
Babine	398	38,200	--	550	--	--	---	38,750
Moricetown	278	9,200	2,000	1,000	--	--	500	12,700
Hazelton	1,122	8,400	2,000	400	850	15	200	11,865
Kitwanga	313	2,000	500	40	400	--	40	2,980
Totals	2,111	57,800	4,500	1,990	1,250	15	740	66,295

From these data the average number of fish caught per person for each area is Babine 97, Moricetown 45, Hazelton 11 and Kitwanga 10. The Babine Indians use the most because of the remoteness of the area in which they live and the Indians at Moricetown Falls take a relatively large number probably because they are so easy to obtain. The Indians at Hazelton and Kitwanga work in the canneries at the coast during the summer and when they return in the fall they have financial means of support and do not fish so much. From the ratio of ocean tag returns on sockeye, it would appear that the Moricetown Indians caught one-half as many fish as those at Babine. The above figures would indicate that they catch only about one-quarter as many.

For the past decade the average number of fish taken in the Babine area is sockeye 37,900, spring 2,000, coho 1,100 and pinks 1,700. The majority have been obtained by the use of about twenty-five gill nets set in Nilkitwa lake, a six mile enlargement at the mouth of the Babine river. As most of the fish are sockeye (90%) they are usually smoked in the 28 smokehouses which have been built to handle from one to four thousand fish apiece.

At Moricetown Falls the Indians gaff under permit below the falls. The average number taken over the past fifteen years is sockeye 6,200, coho 4,900, spring 1,900, pink 400 and steelhead 400. The large number of coho (35%) and spring (14%) are usually salted or eaten fresh and the sockeye are dried in seven smokehouses.

This year the sockeye catch (17,000) at the falls was very large com-

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prising 85% of the total catch. Four of the sixty permit holders took over 1,000 fish each as the fish could be caught at an average of one fish per minute. The practice of gaffing is quite destructive since 35% of the fish in a total of 648 tries were lost in a damaged condition. Most of these fish will probably have difficulty both ascending the falls and in spawning. In addition the waste is considerable in filleting a badly gaffed fish as the flesh is often bloody and torn. These damages may amount to 10,000 fish. On the basis of the returns from tagging 814 fish, the Indians this year took about 25% of the spawning run and from the daily count of the fish caught, an estimate for the sockeye run is approximately 80,000 fish and for coho is 10,000. A similar estimate could not be made for the spring, pink, or steelhead runs. Thus it is possible that the Indians are catching or damaging about one-third of the estimated runs.

In the Hazelton and Kitwanga areas both set and drift nets are used to catch the fish in the Skeena river. They fish particularly for coho in the fall.

It is most important that more accurate data be obtained on the Indian catches in the future, by increasing the number of fishery guardians and providing them with better transportation facilities, if a reliable estimate of the exploitation of the spawning runs is to be made. It is suggested that the use of gaffs at Moricetown Falls be replaced by some type of dip net.

6. STUDY OF MORICETOWN FALLS

D.J. Milne

Appendix No. 32

The Effect of Moricetown Falls on the Salmon Spawning Migration in the Bulkley River.

The Moricetown Falls are situated on the Bulkley River about thirty miles south-east of Hazelton. The falls present a twenty foot drop of fast cascades at the entrance to the deep canyon which constricts the river to less than one half of its usual width. In the autumn and winter the water drops very low and the side channels become dry forcing the fish to ascend the main falls. The Indians from the surrounding reservation have taken advantage of the conditions set up by the falls to procure fish for food easily. In 1929 the Dominion Department of Fisheries blasted a modified fishway in the main eastern channel.

During the past summer a study was started to determine just how much of a hazard, if any, still existed for the migrating salmon. Daily observations of the water level and temperatures were taken. Data as to the number of fish caught per day by the Indians was obtained from the Fishery Guardian. From July 19 to August 26, a total of 814 fish were caught by means of a dip net, examined and tagged with the ordinary button type attached through the body below the dorsal fin with a nickel pin. At the favorite Indian fishing site in the west channel the fish could be handled at the rate of one every two minutes. To assure a good return, a reward of fifty cents was offered for any recovery with data as to time and location of capture.

During August the water temperature reflected the fluctuations in weather conditions by varying about 1.5°C. daily and increasing from 12.5°C. to 17.5°C. As the water was white and murky with silt most of the time only a few

visual counts of migrating salmon were made. From spot counts on August 3rd and 19th an estimated run of at least 4000 and 300 fish respectively were observed to ascend the falls.

The water level measured at a point in the river directly above the falls, dropped four feet from July 20th to September 27th. From Indian catch data the duration of the runs at Moricetown was as follows - sockeye, July 1 - August 24, spring, July 1 - August 10, coho, August 5 - September 20, pink, August 5 - September 15 and steelhead trout, August 22 - September 31. By August 20th the water had reached such a low level that the fish could no longer ascend the west channel. By this time the runs of sockeye and spring were almost over, the run of coho and pinks had been in progress for about two weeks and the steelhead were just arriving. Thus the latter three species were the most seriously affected by the low water.

The above observations of delay are confirmed by the tagging results but unfortunately since only one return was obtained from above the falls, no estimate as to the number of fish which successfully passed the falls can be given. Of the 650 sockeye tagged, 75 per cent. (125) of the returned fish (167) were recaught within six days as they were again going up the falls, while only 6.5 per cent. (10) were retaken fifteen to fifty-seven days later. In the case of the 81 coho tagged only 20 per cent. (2) of the ten returned fish were retaken within six days while 70 per cent. (7) were taken fifteen to forty-one days later. Such a small number of spring, pink and steelhead were tagged that nothing could be obtained from the few returns.

There was no evidence of any fish dying below the falls without spawning but seven sockeye (4.2% of the returns) were retaken thirty to seventy miles below and one had even ascended the main branch of the Skeena to be caught ten miles north of Hazelton. As far as could be observed there was no great increase in the number of fish concentrated in the pool below the canyon throughout the season, and, as the percentage of tagged to untagged fish caught per day did not increase, it is probable that most of the sockeye and spring passed through with some success despite the heavy Indian fishery located there. In the latter part of September, pinks and a number of sockeye were spawning in the gravel of the pool. In addition there were many more coho and steelhead as well as a few large springs. The springs bore scars badly infected with fungus which presumably resulted from numerous futile attempts to get up the falls.

Thus it is evident that many of the coho and steelhead were being held up indefinitely and that many of the pinks probably dropped back to spawn further down. Further studies are necessary to provide more complete data but it is evident that to assure an easier passage to all species, it will be necessary to make some provision to eliminate the conditions which exist particularly at low water. According to the Chief Supervisor of Fisheries, such action has been contemplated and will be carried out as soon as an engineer is available.

7. AGE DETERMINATIONS

J.D. Campbell

Appendix No. 33

Age of Skeena River Sockeye Salmon of the 1944 Run

During the 1944 sockeye salmon tagging operations in northern British Columbia, scales were removed from each individual for age determination. Further collections were made from fish taken in the Indian fishery at Glen Vowell on the Skeena river just north of Hazelton and at Moricetown on the Bulkley river, 22 miles east of Hazelton. These samples have now been examined and the findings are reported herein.

The recoveries of tagged salmon in 1944 indicated that several more or less distinct groups of fish were handled during the salt water operations. This is particularly true of those from Mink Trap bay on the west coast of Banks island (Principe channel area) and those from immediately off the mouth of the Skeena river (Skeena river mouth area). The difference indicated is further confirmed by the age compositions shown in the table below:

	Skeena River Mouth		Mink Trap Bay	
Age Group	Number	Percentage	Number	Percentage
3_2	3	.4	-	-
4_2	412	48.1	9	2.3
5_2	348	40.6	317	80.0
5_3	47	5.5	3	.8
6_2	29	3.2	49	12.4
6_3	19	2.2	18	4.5
	858	100.0	396	100.0

It is evident that the Skeena river-mouth sockeye, which tag returns showed to be bound mainly for the Skeena and its tributaries, are constituted mainly (88.7%) of individuals in their fourth and fifth years which left fresh water after one year's residence (4_2 and 5_2). The Mink Trap bay sockeye which are bound for Mink Trap lake spawning grounds and other rivers on the west coast of Banks island, are chiefly fish in their fifth year (80.0%) which also left fresh water as yearlings.

A more detailed analysis of the Skeena mouth group, the larger of the collections, indicates as would be expected, an increase in average length with age and suggests a difference in the time of migration of fish of distinct age-groups. For instance, the percentage of 4_2's tends to increase from about 35 on July 8 to about 60 on July 21, whereas the 5_2's drop from 50 to 30 during the same period. In other words, it appears that the 4_2's are more prevalent late in the run.

Comparison of the fish at Glen Vowell and at Moricetown is of interest since it is known from tagging that the populations in these districts are simply parts of that which was originally at the mouth of the river.

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	Glen Vowell		Moricetown	
Age Group	Number	Percentage	Number	Percentage
4_2	43	58.1	13	5.8
5_2	27	36.5	74	32.6
5_3	3	4.1	88	38.7
6_2	-	-	7	3.1
6_3	1	1.3	45	19.8
	74	100.0	227	100.0

That the two samples above are differently constituted with respect to age is evident. The great variation does not lie in the number of age groups represented so much as in the fact that at Glen Vowell, where fish are migrating to the upper Skeena, there are relatively fewer individuals which remained two years in fresh water (5.4% as opposed to 38.5%). The predominance of two-year downstream migrants at Moricetown in the Bulkley river may be due to the fact that the main "nursery" area is Morice lake which, on the basis of present knowledge, appears as the coldest, deepest body of water on the system. Much further work will have to be done to check such a premise, but the age composition difference is certainly striking.

In the age-length tabulation for the Moricetown sample, it appears that the 4_2 and 5_3 groups have a similar range and approximately the same average. The same phenomenon applies roughly to the 5_2 and 6_3 categories. Growth in length, therefore, seems to be dependent chiefly on the time spent in salt water.

The 1944 sockeye scale samples which have not yet been examined are from the lakes of the system and the spawning rivers. It is not expected that these will add much to the information on total age since the scales are badly absorbed as a result of sexual maturity. They should give valuable information on the extent of fresh water residence.

Age determination thus far has been valuable in demonstrating differences between populations and suggesting problems for investigation. Because of this and the fact that analysis of age is necessary as a basis for assigning the effect of different factors to the proper year, the work will be continued as assiduously as possible.

8. HAIR SEAL STUDIES

H.D. Fisher

Appendix No. 34

Hair Seal Studies

The study of the hair seal was commenced in 1945 as part of the Skeena river salmon investigation in response to many requests from the fishermen who complained of the damage wrought by these mammals to gill nets and of the loss of prime fish due to their depradations. The investigation had three main objects,- (a) to evaluate the loss to Skeena river gill net fishermen caused by hair seals and thus make available actual figures for discussion, (b) to determine by stomach

analyses the food of the hair seal, its variation with the season, and the relative position of salmon in the food relationship, and (c) to study the life history and enumerate roughly the numbers present in the fishing areas of the Skeena.

During June, using Cassiar cannery as a base, numerous trips were made to the fishing grounds with operating fishermen. No exhaustive figures of damage could be obtained since the main spring salmon season, when depredations were heaviest, was past. It is evident, however, that seals are a genuine nuisance and that damage to nets and in fish degraded as a result of bites might be considerable.

To procure stomachs for analysis, kits containing bags, formalin, tags, etc. were distributed at Bones bay and on the Fraser river, after receiving an assurance of full co-operation from the fishermen and their unions. Further receptacles were maintained on the Skeena. A reward of one dollar was offered for each stomach supplied. This, added to the five dollar bounty offered by the Department, was considered attractive. Results have been disappointing since only a small number of stomachs have been collected. This failure was deemed to be due to the fact that fishermen were too busy to take time off to shoot seals, especially since the number of seals obtained by rifle is usually small and doubtful.

Personal observations of breeding and "hauling" habits and of pupping grounds in the Skeena were made over a period of a month or more. Several large hauling out areas were discovered on the lower Skeena. One, situated about six miles above the Hot springs, consists of a low sand bar, uncovered at low tide, on which 100 to 200 seals were observed at one time. The second is situated about twenty miles up the Ecstahl river. Many animals were present. During the sockeye salmon season the seals are very scarce around the fishing areas but numerous at these hauling grounds.

While the concrete information gained during the present summer has been limited because the large amount of organization and of arrangement of detail, though essential, occupied much valuable time, a reasonable start has been made. It is now planned to make available to many fishermen who have signified their desire to help, forms on which to record the catch per net set, the number of fish attacked by seals in each set, the loss in weight suffered in each fish attacked, the credit granted by the buyer, the total loss in dollars and cents to the fisherman both in fish and net damage. At the suggestion of Mr. George Miller, president of the U.F.A.W.U., stomach kits will in future be distributed in care of Union Locals and certain union officials will be asked to be responsible for the collection. Notices of the dollar reward will be widely distributed. An effort will be made by using a special crew to obtain seals in the Skeena during pupping season in the spring. More data will be obtained on numbers and habits.

The investigation should proceed to better advantage with the established co-operation of the fishermen and with the experience gained during the present year.

9. DISCUSSION

A.L. Pritchard — Appendix No. 35

Skeena River Investigations - General Summary and Suggestions

Since the reports on the Skeena river investigation for the year 1945 have treated with such a large geographical area and have covered such a wide range of subjects, it would appear of benefit to draw the more important findings into a summary and to indicate how the plans for the future may develop therefrom.

Migration Studies

Marking of young sockeye salmon migrants has not been extremely successful up to the present. In 1944, none were obtained at Lakelse but 24,890 were handled at Babine. In 1945, the totals were 5,788 and 14,148 respectively. The failure to procure large quantities has been chiefly due to ignorance of the behaviour of the young under the conditions in the district and the lack of material and personnel. There is no doubt that much has now been learned of the habits and many of the necessary procedures have been worked out. It would appear wise to continue the trials for at least another year since the returns will still be available before the end of the investigation which is now set as 1948. Plans will have to be laid to check the catches in 1946 for the returns from the first Babine experiment.

Tagging of adult salmon has not been too profitable in delineating the routes of travel of the fish in getting to the Skeena river or in indicating the location and amount of exploitation outside the river mouth. Purse seining for sockeye salmon far off the mouth of the Skeena is definitely not feasible so that some other method will have to be used to get information in these outside areas. The efforts have not been entirely unprofitable, however, since the general northern and southern boundaries of the Skeena run in northern British Columbia waters have been indicated, and it has been clearly demonstrated that complete and final separation of the Nass and Skeena populations in the fishing areas does not exist.

"River mouth" tagging has given a picture of the minimum exploitation and the variation therein. Such endeavours appear essential if a close check is to be maintained on the variations from the usual and their effect. This contention is amply supported by the fact that it was only through the tagging in the present season that there could be obtained any indication of the effect of the fishermen's strike from June 24 to 30.

If any comprehensive data are to be forthcoming on the times of migration of the runs to the various upriver areas, some method of tagging much larger numbers of fish must be initiated to increase the proportion of tagged individuals on the spawning grounds. A trap above the fishing boundaries has been suggested and is to be tried out in 1946 if possible.

Lake Surveys

Lake surveys up to the present have been of a very general nature designed to reveal only the most obvious factors which might affect the young salmon during their fresh-water residence. With the expansion of the programme in 1945 to include 9 bodies of water, much information on conditions is now available. At

least it is now known that in the areas thus far investigated, there is no evident deterrent to salmon production. The lakes vary in size, temperature, and depth, but all seem to have reasonably good chemical conditions and a sufficient supply of food.

The populations of fish vary from lake to lake both in species and numbers. Particularly striking in this connection is the prevalence of squawfish in Kitwanga and of the northern sucker in Stephens lake on the Kispiox. While some benefit could be gained by eliminating some of the more predatory forms in some areas, there is as yet no indication that this could be done by establishing a commercial fishery which would be profitable.

In order to be sure that extreme conditions do not exist in other areas not already visited, the surveys should be expanded to cover them. These include such lakes in the lower Skeena as Alastair and Johnson, and in the upper Skeena, as Slangese and Kluyaz.

The future of the work on the lakes already inspected may follow two courses. Since it is now recognized that the Babine area is the largest sockeye producing locality in the Skeena drainage, effort might be concentrated there with only incidental visits to other places. On the other hand, it appears that the Lakelse area supports a sockeye run which is apparently in natural equilibrium since, under present regulations, it is not greatly affected by the fishery. It might therefore be profitable to maintain a sizeable investigation here to determine whether the balance could be changed to raise the sockeye production.

Spawning Ground Surveys

With the expansion of the lake survey programme, there has followed a great increase in the number and variety of spawning areas examined. Certain conditions have been discovered which might be improved to the benefit of spawning salmon. As examples the upper Bulkley river might be made easier of access by the removal of log jams and beaver dams, something might be done to further improve Granite creek in the Lakelse area, and more information might be obtained on the beaver dams in the Sustut area and the falls in the Bear river. In general, however, access to the major spawning grounds is moderately easy and clear.

Estimation of the escapement, even though a great many or most of the spawning areas are closely inspected, will of necessity be still far from complete. In areas such as the Morice and Kitsumgallum, accuracy under the present conditions is impossible due to the glacial, silty water. The only hope for improvement is to insert counting weirs where possible even if special types have to be devised, and to work on other methods of estimation which are more accurate than the present system.

If, as was done in last year's reports, the percentage return of tagged fish in the commercial and Indian fisheries (34.5%) is taken as minimum exploitation and the escapement is calculated using this figure and a round number for the catch, it is possible that 1,900,000 sockeye reached the spawning grounds in 1945. Although many localities were inspected, the maximum estimate of the observers is about 450,000. A closer approach to this figure would have been obtained if the fisheries' exploitation had been 66.6% to give a total run of about 1,650,000 and an escapement of 550,000. There is no doubt that the calculated percentage exploitation for 1945 (34.5%) could be low and there is certainly no denying the fact that all the spawning fish were not examined, yet

until the discrepancy in the figures is eliminated by checking closely the accuracy of the tagging and the method of spawning estimation, only very general statements on seeding can be made. It is safe to say that in all areas examined, the escapement of sockeye was good and heavier than in 1944. An extremely heavy run of pink salmon reached the rivers tributary to the lower Skeena. The springs in some areas appeared fewer than in 1944 and in others in about the same quantities. The coho escapement apparently was of about the same size.

Statistics

The study of the statistics of the commercial fishery is just beginning but it has gone far enough to show inaccuracies in those at present collected by the various agencies. There is little doubt that, if a clear and even moderately accurate picture of the past history of the fishery is to be obtained, recourse will have to be had to the original and more detailed records of the canneries rather than to the summaries now available in the records of the various governments. These government records were never designed for biological analysis. For the future a system should be set up to provide the desired data currently.

Such records as are available for the Indian fishery show that it may have more than a slight effect on the perpetuation of the run. There is no doubt that it should be closely checked and watched.

Moricetown Falls as a Hazard to Fish Migration.

The inspection of the conditions at Moricetown falls and the tagging experiment conducted there during 1945, though preliminary in nature, were sufficient to indicate that the fish were being held up for short periods at all stages of the water but perhaps to a serious extent at low water stages. The effect on the runs will of course depend on the relation between the times of adverse conditions and the stage of migration. There is no doubt that beneficial changes could be made but they will require the consideration not only of the biologist who should indicate their effect on the fish, and the engineer who will predict what changes will do to the current, etc. in the river, but also of an official of the Indian department who will make the necessary arrangements to compensate for any serious changes which might result in the economy of the Indian population.

Ferris Neave, J.E. Moore and W.P. Wickett

Appendix No. 36

Pink Salmon Tagging and Recoveries in 1945

An extensive pink salmon tagging programme was undertaken in the summer and autumn of 1945. This was conducted on similar lines to the experiment of 1943 and, as in that year, was carried out in conjunction with taggings undertaken by the Washington State Department of Fisheries on the American side of the International boundary. Information on the progress of the work was exchanged between investigators of the two organizations and both parties made efforts to facilitate the collection of tags recovered by the fishery and in fresh water.

The experiment was designed to provide information on the percentage of fish caught by the industry, the routes and destinations of the migrating fish and the possibility of identifying fish present at a given time on the fishing grounds with subsequent spawning runs to particular rivers or areas.

Since returns are still being received, no complete analysis of results can be made at the present time. The following data relate to operations carried out by the Pacific Biological Station in British Columbia waters.

Tagging was performed in three main areas, namely (a) Upper Johnstone strait and adjacent waters (b) Lower Johnstone strait and adjacent waters (c) Juan de Fuca strait (Sooke). In the two first-named areas the tagging was carried out by parties working on Station boats. These contacted seiners on the fishing grounds and obtained live fish from the seine-hauls. At Sooke, fish were obtained from the traps of the Sooke Harbour Fishing and Packing Company. Tagging was obligingly performed by Mr. Max Weare, through the courtesy of the International Pacific Salmon Fisheries Commission, and also by local trap-tenders.

The following table shows the number of tags applied and the number of returns already received by the Biological Station from the fishery.

Tagging Area	Period of tagging	Number Tagged	Returns from the fishery	Percentage return
Upper Johnstone str.	July 26 - Oct. 17	3,089	1,245	40.3
Lower Johnstone str.	Aug. 6 - Oct. 3	2,025	436	21.5
Sooke	July 23 - Sept. 17	1,583	173	10.9
		6,697	1,854	27.7

In addition to the returns reported above, some hundreds of Canadian tags have been submitted to the Washington State Department of Fisheries, the greater number of these being from the Sooke taggings. The total number of tags returned from the fishery is believed to approximate 35% of the number applied. Both the percentage and distribution of the recoveries show a marked similarity to the results obtained in 1943.

A further 18 tags have been recovered from spawning grounds. Efforts to increase this small total were hampered in some instances by flood conditions prevailing at or prior to the time of examination of the streams.

In the collection of tags many private individuals, companies, fishery officers and members of the Biological Station staff have co-operated. Particular mention should be made of the services rendered by Mr. William Tomkinson of the International Pacific Salmon Fisheries Commission.

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Chum Salmon Tagging and Recoveries in 1945

A chum salmon tagging programme, with objectives similar to the pink salmon experiment described in the previous appendix, was carried out in 1945. The same boats, operating in the Johnstone strait area, tagged and released a total of 3,954 chums between August 3 and November 1. Lengths and weights of a large proportion of the tagged fish were also recorded and scale samples were obtained in order to determine the age-composition of the catch. This material has not yet been analysed.

Tags were recovered and submitted to the Station through the same channels as the pink salmon tags, but since the main chum fishery takes place later in the season the returns to date are probably less complete than those relating to the pink salmon experiment. So far, 875 chum tags have been recovered from the fishery, or about 22% of the number applied. Four tags have been recovered from spawning streams.

The examination of spawning populations is proceeding at the present time.

Ferris Neave and J.E. Moore Appendix No. 38

Investigation of the Salmon Run of Nile Creek, V.I.

In conjunction with more general surveys and observations on B.C. salmon streams, a special study of Nile creek near Bowser, V.I. has been undertaken. This stream was selected as being typical of many in this part of the province. It supports a sizeable though fluctuating run of chum salmon and some cohoes and pink salmon. It is subject to large changes in volume of flow. Extensive logging operations have taken place in the watershed.

It is hoped that by an intensive investigation of this stream information capable of wider application can be obtained on such points as: (a) extent to which available spawning grounds are utilized by the fish (b) effects of fluctuations in water volume and velocity on survival of eggs and fry (c) mortality and survival of eggs deposited in areas affected by tide (d) effects of inter- and intra-specific competition and predation.

Prior to the 1945 run, two counting fences were installed, one near the mouth of the creek within the limits of tidal influence, and one at a point 0.7 miles further upstream. The provision of the upper fence is to facilitate observations on the distribution of the spawning fish and to permit estimates of the mortality occurring in fry migrating downstream.

Actual investigations to date have included the surveying and mapping of the stream, counting of upstream migrants, estimation of egg content of female fish, experiments on the effects of salinity on developing eggs and experiments designed to assess the accuracy of estimates of fish populations made by unaided observation.

Difficulties encountered during a period of exceptional flood rendered the fences ineffective for a brief time but fairly satisfactory counts of ascending fish have been made. The numbers recorded to date (Nov. 23) are as follows:

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(1) lower fence - 2,933 chums (approximately one-half males and one-half females), 317 cohoes and 3 pinks, (2) upper fence - 175 chums and 17 cohoes. So far the spawning fish have shown a strong tendency to concentrate in the lowest half-mile section of the stream although the latter is accessible for a distance of about five miles.

Ferris Neave

Appendix No. 39

Natural Propagation of Pink Salmon at Morrison Creek, Vancouver Island.

The study of pink salmon at Morrison creek, begun by Dr. A.L. Pritchard in 1943, was continued in the autumn of 1945, the cycle year for the run previously investigated. The adult salmon were counted at a weir established near the mouth of the stream. The average number of eggs per female fish and the potential egg deposition were determined as on the previous occasion.

The run this year took place during the period from September 8 to November 1. The counting operations were handled by Mr. W.F. Baxter.

A comparison between the figures obtained in 1943-44 and those so far available for the present season is presented herewith.

Year	Males	Females	Total	Average no. of eggs	Potential deposition	Fry migrants	Efficiency of hatch
1943-44	7,654	8,101	15,755	1,779	14,400,000	670,341	4.7%
1945	6,980	6,431	13,411	1,862	11,928,000	--	--

If the 1945 adult migration can be regarded as expressing the survival of the fry hatched in this stream, then it appears that the 4.7% "efficiency of hatch" did not quite suffice to maintain the size of the run. In both years, however, the run must be regarded as very heavy for such a comparatively small stream as Morrison creek.

The fry migrants resulting from the present season's egg deposition will be counted in the spring of 1946.

Ferris Neave

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Survey of Salmon Streams

In order to provide a general background of information for future investigation of salmon problems, a large number of rivers and streams were visited between April and November 1945. Observations were made on stream flow, state of forestation, length of stream accessible to fish and extent of suitable spawning ground. Probable limitations on productivity imposed by variations in water volume, shifting of bottom, natural barriers, glacial silt and tidal cycles were noted. During the later trips observations on the distribution and numbers of adult salmon were made. While in many instances the examination of streams was necessarily brief and incomplete it nevertheless contributed to a more comprehensive understanding of the conditions of freshwater existence in various coastal areas. Two or more visits were paid to a number of streams.

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In all, about fifty streams and rivers were visited, these being distributed as follows: South-east Vancouver island - 18; West coast Vancouver island - 1; North Vancouver island - 6; Fraser river to Toba inlet - 4; Bute inlet to Knight inlet - 5; Fitzhugh sound and adjacent inlets - 10; Graham reach, Douglas channel and Gardner canal - 7.

Heavy runs of pink salmon were observed in streams in the Butedale, Bella Bella and Knight inlet areas, in some instances large numbers of chum salmon being also present at the same time. In several of the streams at the time of examination the migration of large numbers of fish was impeded by a combination of low water conditions and natural falls. In some other instances it was not possible to visit streams until the peak spawning period was passed. In spite of large spawning escapements seen or reported, the investigators do not consider it probable that there was any general overloading of streams and river systems beyond their carrying capacity, although overseeding may have occurred on local spawning beds or in short stretches of certain watercourses.

Escapement of chum salmon, unless supplemented by later runs, appeared light in most of the areas north of the strait of Georgia.

Considerable information was accumulated on the variation in different streams and areas in the time of arrival of the fish and the sequence of the species.

It is evident that in any widespread attempt to evaluate adequately the spawning runs, full-time observers must be stationed in designated localities for periods of at least some weeks. Attention would have to be paid to methods of estimating fish populations in order to obtain reliable results.

Examination of chum salmon streams is proceeding at the present time.

Messrs. J.E. Moore and W.P. Wickett were associated with the present writer in the surveys indicated above.

J.E. Moore Appendix No. 41

The Effect of Salinity on the Development of Pink and Chum Salmon Eggs.

In the course of stream examinations it has become evident that pink and chum salmon frequently construct redds in areas which for parts of each day are affected by salt water which comes in with the tides. The tidal influence is very slight in some streams while in others it extends a distance of a mile or more. The effect of the resulting saline conditions on eggs deposited in areas of this nature may be a factor of considerable importance in assessing survival and mortality in streams.

Pink Salmon

A preliminary experiment with pink salmon eggs was carried out at the Morrison creek counting fence on October 17. The eggs were fertilized in pint jars containing a salinity series ranging from fresh water to sea water in one-tenth gradations. One-half hour after fertilization eggs from fresh water, one-tenth and two-tenths sea water solutions were transferred to a series of solutions of greater salt concentration.

It was found that in the original series only the eggs fertilized in fresh water and in one-tenth sea water were normal with respect to hardness - general appearance. The experiment definitely indicates that eggs fertili-

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two-tenths sea water or higher salinities will not develop. Fertilization apparently took place in all solutions but hardening occurred only in fresh water and one-tenth sea water.

No positive results can be stated for the eggs in the second series which were transferred to solutions of higher salinities but from the observations made it is considered that eggs fertilized in fresh water and in one-tenth sea water will develop in salinities somewhat higher than one-tenth sea water.

Chum Salmon

A series of experiments involving this time the use of chum salmon eggs was done at the Nile creek counting fence on November 20. The general outline was the same as in the case of pink eggs except that the salinity gradations were reduced to one-twentieth. These tests are still in progress but already it is apparent that normal development of chum eggs does not take place in two-tenths sea water and it is very doubtful whether it can occur in three-twentieths sea water.

Eggs have been planted at low tide and half tide in parts of Nile creek that are definitely within the influence of salt water brought in with the tides as shown by the salt content of water samples taken there. Observations on the development of these eggs as well as examination of those deposited naturally in the creek bottom will provide further information with regard to the effect of salt water on chum salmon eggs.

In the future more extensive experiments and examinations of natural conditions will be made to help throw additional light on this problem.

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