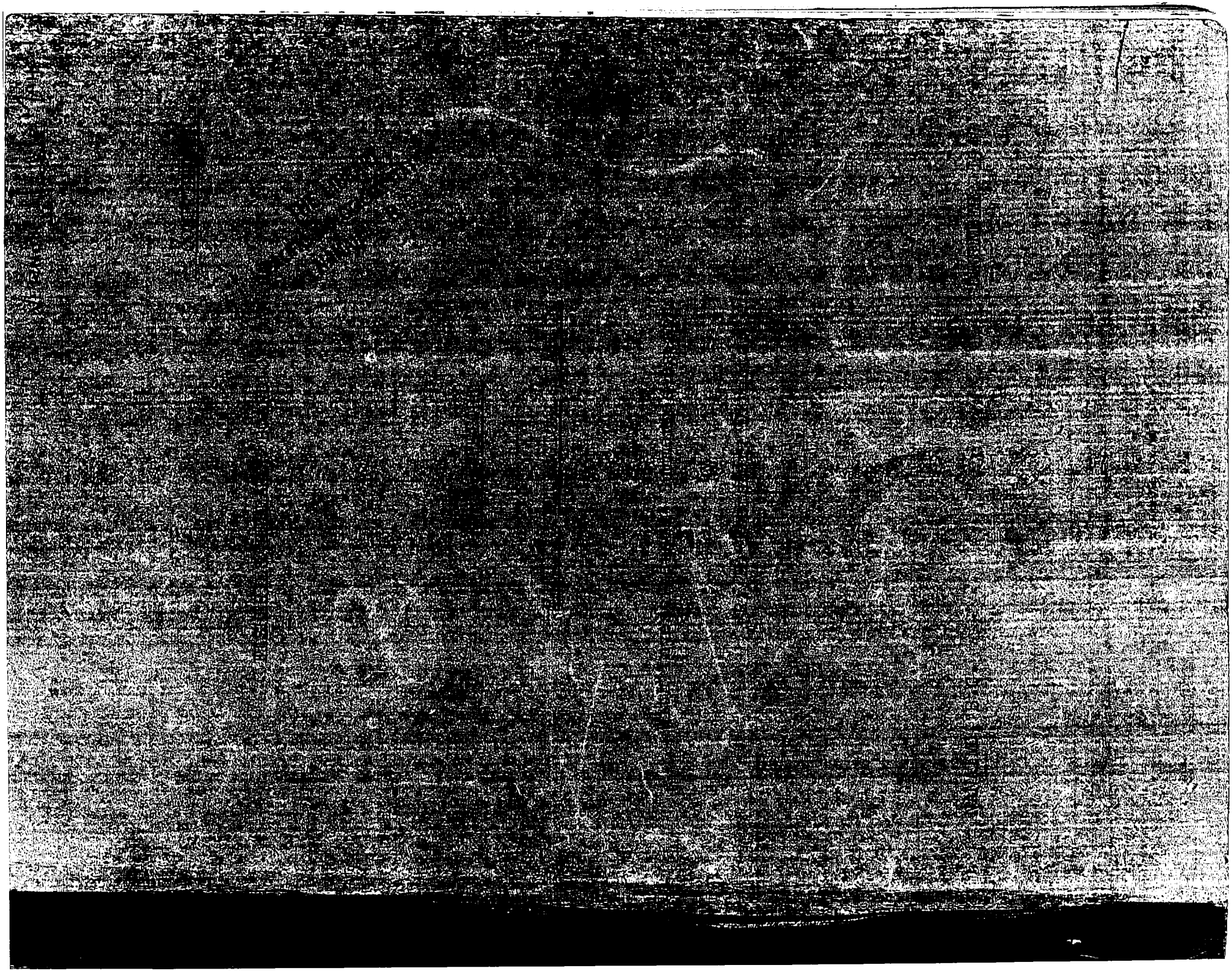

FISHERIES RESEARCH BOARD OF CANADA

REPORT OF THE

PACIFIC BIOLOGICAL STATION

NANAIMO, B.C.

for 1947

By R.E. Foerster, Director

The objective of biological fisheries research at this Station is to obtain those facts concerning our Canadian Pacific coast fisheries which will lead to an understanding of the condition in the fisheries and provide a basis for practical regulations that will permit optimum exploitation yet preserve an adequate spawning stock. The administration of the fisheries in order that an optimum sustained yield year after year can be obtained is the function of the Department of Fisheries; the collection of the basic biological information upon which appropriate regulations can be devised is the responsibility of the Station.

The gathering of facts, not in a heterogeneous fashion but according to a definitely designed plan of investigation, their organization, tabulation and analysis is a slow, rather tedious and quite unspectacular task. On casual inspection these laborious activities may appear to lack significance and essentiality. Progress may seem very slow and constructive action long delayed. Nevertheless it is very necessary "spade work" which must be done. Hasty action not based on adequate facts may prove ineffective, if not definitely harmful.

During the past year all of this Station's investigations, salmon, herring, otter trawl fishery, oyster, clam, crab, anchovy and pilchard made notable progress. As will be seen from the resumés which follow, some of the studies are beginning to bear fruit, while others are yet in relatively preliminary state. What is equally important is the fact (not revealed by the results reported but perhaps to be inferred) that the investigators have also increased in experience, are becoming better acquainted with the problems and their possible solution and can, where opinions are desired by Department or Industry, offer useful advice or timely recommendations.

One notable feature of the Station's biological work is the distinct variety of the studies, involving quite different design of experiment, methods and approach to solution. For example, the salmon investigations have to do with anadromous species in which the freshwater phases of the life history are the most critical. Success of propagation and survival of the young to the time when they reach the sea initially govern the size of the adult population returning from the sea. Anything that can be done to increase the number of young fish is of importance; all factors limiting survival are given careful study. It is not to be inferred that, mortality does not also occur in the ocean, but this is largely beyond effective control.

Therefore action to increase production must apply to the early freshwater stages. It should also be noted that in salmon there is very little, and in some cases no, overlap in age classes in each year's run or population. The failure in production of young in any year has, consequently, a very direct influence on the return of adults. It is vitally important, therefore, that for each year the fishery regulations be so designed as to ensure an adequate spawning escapement and that facilities for successful spawning be good. Prediction of runs can be based only on an estimation of the size of the seaward migration of young which it is extremely difficult to assess or upon the size of the spawning escapement and the general weather and water conditions prevailing during spawning and development of young which can be only a very crude and general guide.

For marine species, herring, pilchard, flatfish, etc., the losses during spawning and development of the young equally directly govern the size of the population but the conditions on the spawning grounds are presumably more stable and less influenced by weather, low water conditions, etc. Certainly they are largely beyond control. In these fisheries the commercial catch is normally composed of several age groups. Therefore if one year class fails the effect is not too severe - unless several successive year groups experience low production and the whole population drops, as seems to have occurred in the Pacific pilchard. For these fisheries, then, close regulation of the spawning escapement is less important than for salmon and greater consideration is given to the extent of capture of immature fish by fishing gear, effect of oceanographic conditions on the movements and well-being of the species, etc. Predictions of the probable sizes of the populations are made feasible since assessment of the relative percentage representation of age-groups in the commercial catches from year to year can be made. Consideration can also be given to the sizes or ages when it is most expedient to catch the fish. This is done by comparing the rates of growth of the fish with the rates of mortality. To catch the fish commercially when the rate of growth commences to slacken and the rate of mortality commences to increase is the desirable objective.

Even among the species of salmon and species of marine fish there are salient differences in approach to investigation and approach to effective management policies. Each investigation, therefore, represents a discrete study of its own, analagous in scientific scope and objectives to the studies of the great fisheries for which special investigations have been organized. It is only when one contemplates the subtle differences between the various projects of the Station that one realizes just how great are the departures in method and eventual management though the ultimate objective of optimum sustained yield is the same for all.

SKEENA RIVER SALMON. This investigation has for its objective a comprehensive biological examination of the whole salmon fishery with chief attention given to the sockeye. The Skeena is the second largest salmon river in British Columbia and supports an important sockeye fishery. Since 1930 the commercial catches of sockeye have not only fluctuated greatly from year to year but have been appreciably smaller. Concern on the part of the industry resulted in a study to determine whether the apparent decline is cyclic or due to overfishing and whether this fishery can be restored to a higher level of production. The investigation commenced in 1944 and at the end of five years a report is to be prepared of the general over-all findings.

During 1947 the several phases of the work were continued by Dr.A.L. Pritchard, assisted by Messrs. Brett, Milne, Withler, McMahon, McConnell, Foskett, fourteen research assistants from the University of British Columbia and two field technicians. (App. No. 1 and 46). These involved:
(a) the capture and marking, by removal of certain fins, of seaward migrating young sockeye in order to check the migratory routes when the adults return from the sea in 1949 (as four-year-olds) or 1950 (as five-year-olds), the time, place and degree of capture in the commercial and Indian fisheries and the percentage return to the parent spawning area. Markings were conducted at Lakelse lake where by means of a counting fence all the migrating smolts could be trapped and counted and where 100,019 yearling smolts were marked (App. No. 3) and at Babine lake, where by using a long "lead" and trap near the lake outlet 106,377 smolts were collected and marked. (App. No. 4).
(b) lake studies, (App. Nos. 8 - 17), particularly in Lakelse and Babine lakes, to determine conditions existing in the nursery areas. Limnological records of temperatures, dissolved oxygen content, pH, were taken regularly at designated stations and plankton collections were made. The abundance and general distribution of predator, competitor and other fishes were studied by setting standard gangs of gill nets of graduated mesh sizes periodically in specific locations. These regular "sets" were supplemented by other miscellaneous netting experiments as time and opportunity allowed. The trout and coarse fish thus taken provide material for study of food habits, rates of growth and the general likelihood of their having a detrimental influence on young sockeye survival. These lake studies involve a great amount of field work and of subsequent study in the laboratory. This latter is being aided very appreciably by some of the seasonal research assistants utilizing the material for their graduate thesis work at University.
(c) tagging of returning adult salmon, as they enter the river from the sea, in order to determine (1) the extent of the removal of fish by the commercial and Indian fisheries, (2) the rate of migration up-stream and (3) the time when each spawning "race" or population passes through the fishery areas en route to its final spawning ground. During the 1947 season one tagging vessel, a commercial salmon seiner, caught and tagged 2,329 sockeye, 152 springs, 106 coho, 613 pinks, 77 chums and 18 steelhead trout. (App. No. 7). Of the sockeye tagged, the recovery of 433 (18.6%) in the commercial fishery is the lowest of the four years of tagging. Previous recoveries were: 1944 - 40.1%; 1945 - 25.5%; 1946 - 30.1%. This may be due to less fishing effort in 1947 and to the fact that the commercial gill nets seldom took the small "jack" sockeye (under 19 inches in length) which formed a fair proportion (15.5%) of the individuals tagged. The Indian fishery (gill net, drift net and gaff) throughout the river system recovered 285 or 12.2% of the tags. At the Babine river counting fence 534 sockeye tags (23%) were retaken (App. No. 30). Much useful information on the characteristics of up-stream migration was obtained.

Again this year no tags used after the commercial fishing season commenced were recovered in certain lower-Skeena lakes thus signifying that the fish to these areas enter the river before the fishing season begins. In other areas the tag recoveries indicated that the fish proceeding to them moved through the commercial fishing areas throughout the whole fishing period.

(d) stream surveys(App. Nos. 18-28), primarily to obtain an estimate of the sockeye spawning escapement. These involved weekly visits to the streams tributary to Lakelse and Babine lakes, periodic trips to more remote areas, the flying-in of a party (Messrs. Foskett and Stokes) to Bear lake for a six-week inspection of that region and a quick trip by air (Messrs. Brett and Fisheries Inspector Giraud) to the Kispiox and Slamgeesh areas. A new district, the Gitnadoix (Alastair lake) (App. No. 19) was visited for the first time this year by Messrs. Brett, Alderdice and Fisheries Inspector Giraud, involving a gruelling four-mile boat-pushing and pulling ascent of continuous rapids and a hair-raising descent on a flash flood. A spawning of some 12,000 - 15,000 sockeye was estimated. The total spawning escapement for the season is estimated at 345,000 sockeye, but if the findings obtained at Babine lake, where the stream surveys indicated a spawning escapement of 245,000, while the records at the counting fence showed an escapement of 522,500 sockeye (App. No. 29), are applicable to the whole river system, the probable escapement could approximate 736,000 sockeye. With a commercial catch of 385,000 sockeye and an Indian catch of approximately 40,000, the total Skeena sockeye run would amount to 1,161,000, of which the probable escapement would represent 63.4%.

(e) statistics of the fishery. This work, in charge of Mr. Milne (App. No. 35-41), is a very necessary part of the investigation if a proper understanding of the apparent variations in the commercial packs from year to year is to be reached. To determine whether the catch is proportional in all years to the abundance of the fish is most essential. Difficulty has been experienced in accurately separating Skeena-bound from Nass-bound sockeye in areas between these two rivers but the problem is receiving further study. Records of the catches of fish for food by the Indians in up-river areas are important in revealing the drain on the spawning escapement after the fish have passed the commercial fishing areas. In seasons of large runs it may be of little consequence; in years of small runs it may be serious.

(f) a study of the efficiency of natural propagation. Ability to obtain counts of young seaward migrating sockeye from Lakelse lake and thus get a record of the production from known seedings (even though these be not particularly accurate, since they are based on estimates of spawning females rather than actual counts) has made it possible to arrive at a figure for percentage sockeye production to the seaward migrant stage. For the year 1946 - eggs deposited in the fall of 1944, migrants counted in the spring of 1946 - the percentage survival from egg to migrant was calculated at 1.06% whereas in 1947 the migrants represented 0.45% of estimated eggs deposited. (App. No. 2). With the anticipated construction of an adult salmon counting fence in Lakelse river in 1948, the numbers of adults in the Lakelse spawning escapement should be determined much more accurately and more precise determinations of efficiency of natural propagation under prevailing conditions should be obtainable. Such data over a number of years, particularly if correlated with changing environmental conditions - weather, water-flow, abundance of food, varied populations of predator and/or competitor fishes - are basic to any understanding of sockeye salmon production and fundamental to any scheme of prediction when based on extent of spawning escapement, etc.

GENERAL SALMON. The pink and chum salmon fisheries, with which this investigation is at present chiefly concerned, have become within recent years quite important. They have suffered serious fluctuation from year to year, however, both in abundance and availability of fish and, moreover, a severe decline in certain regions. In order to arrive at an understanding of the reasons for the fluctuations and to discover means of increasing the production, studies initiated in 1945 were carried forward during 1947 by Mr. Ferris Neave, assisted by Messrs. Wickett, Hunter, Robertson, Gibson (part-time), Dr. Hoar (seasonal), two research assistants and four field technicians.

One important phase of the work is an evaluation of the factors causing mortality during the early fresh-water period of the life-cycle. For this purpose two typical streams were selected for detailed study of spawning, incubation, hatch and migration of fry to salt water. One, at Nile creek on the lower east coast of Vancouver island, is primarily a chum salmon stream and last year showed a fry production, under natural propagation, of 3.0% of eggs deposited. For the 1946-47 season, a similar test produced only 0.44%. Since heavy mortality is believed due to uneven distribution of eggs over the spawning areas and scouring of the redds by freshets, a parallel experiment was undertaken wherein eggs taken to the hatchery and reared to the "eyed" stage were planted in a section of the creek and the resulting fry collected on the downstream migration. From the eggs taken for rearing (761,500) a percentage survival of 2.79 (21,235 fry) was obtained. (App. No. 53). This tends to demonstrate the possible value of utilizing some measure of artificial propagation for chum salmon production. Stream improvement and water-flow control measures may be also very effective.

The other experimental stream, Port John creek in the Central area of the coast and on Fisher Channel, north of Burke Channel, carried a mixed population of salmon, the counts at the newly-installed counting weir this fall including 374 sockeye, 677 coho, 5,631 pinks and 10,099 chums. (App. No. 54). It is expected that the effect of having several species of salmon spawning in the same stream, though not necessarily in the same sections, will be revealed, particularly if the various populations fluctuate appreciably with relation to each other.

Tagging of adult pink and chum salmon was also carried out this season in Fitzhugh Sound and adjacent areas in order to obtain data on fishing intensity, migration routes and time of migration through the fishing areas of the many stream populations. (App. No. 52). Of pinks, 914 were tagged and 227 (22.84%) were recovered in the fishery; of chums, 830 were tagged and 123 (14.82%) recaptured. Recoveries were made in the general tagging areas (75 pinks, 77 chums), to the northward (144 pinks, 32 chums) and to the southward (5 pinks, 3 chums). For pinks the time between tagging and recapture varied from a few hours to 45 days with the average time out being 7 days. Distance travelled per day was 5.56 miles. For chums, the average time-out between tagging and recapture was 10 days, average distance covered per day - 3.68 miles. It was of interest to find that very few of the salmon tagged in the Central area appeared to travel down to and enter the Johnstone Strait fishery to the south, though a few of the individuals did move down to Rivers Inlet.

Since pink and chum salmon spawn chiefly in the lower reaches of coastal streams which are subject to highly fluctuating water conditions the

stream water-flow conditions during the spawning period no doubt have a direct influence on success of spawning. This may be the main reason for the fluctuations in the runs from year to year. In order to determine the likelihood of such and the possibility, therefore, of predicting the general anticipated size of the runs each year from the available water-flow or stream velocity data for the various coastal areas during the year of spawning, studies of the correlation between stream discharge data during the months of spawning each year and the estimated sizes of the runs in the succeeding cycle year were made. (App. No. 51). Promising results were obtained and arrangements are now being made with the Dominion Water Power Bureau to increase the number of gauging stations along the coast so that records of stream discharge can be more complete and precise.

It is of course important that the relative sizes of the populations of fish returning from the sea each year be obtained as accurately as possible. For this purpose additions to and refinements of existing statistics on annual catches obtained by the Department are being made (App. No. 48) and more reliable data on spawning escapements to individual streams are being attempted. Records of these latter are being supplied by Departmental Inspectors and their interest and keen desire to make their observations as useful as possible are most helpful.

Differences in age-class representation from year to year play an important part in the fluctuations in abundance of salmon runs. It has generally been taken for granted that chum salmon are predominantly four-year-old fish. In 1946, however, from 2,000 scale samples read covering the whole coast, it was found that while for southern areas the four-year-olds constituted approximately 75% of the fish, with three-year fish amounting to 20 - 25%, in the central areas the three-year-olds formed from 35% to 50% of the runs with four-year individuals representing but 45 - 55%. (App. No. 49).

An important sockeye fishery occurs in Smith Inlet each year. The Federal Fisheries Inspector for the area, Mr. Charles Lord, has for some years desired information on the age classes involved in the fishery and their importance in relation to fluctuations in abundance of fish. During 1947 a study was made of the scale samples collected by the Department's Officers at Smith Inlet during 1945 and 1946 (App. No. 50) together with size measurements and sex ratios. In 1945, four-year fish constituted 44.6% of the samples, with five-year-olds amounting to 55.4%. In 1946 the four-year-olds made up only 12% of the samples with five-year-olds forming 88%. These differences are important because five-year-old fish are roughly $2\frac{1}{2}$ inches longer than four-year-olds and weigh some 2 pounds heavier. When the latter age class predominates, as in 1946, the size of the catch, in pounds or in cases of canned salmon, is appreciably larger and of greater value. In both 1945 and 1946 males represented from 70 - 75 percent of the four-year-olds, whereas for five-year-old fish the sexes were more evenly balanced, although in 1946 the females constituted 64.4% of the samples.

Cowichan River Salmon. This investigation, in charge of Mr. Neave, assisted by Mr. E.V. Epps, fish cultural officer resident at Cowichan Lake Hatchery, has carried forward over a period of years a study of (1) the fluctuations from year to year in a sizeable coho salmon run which is subjected to both

commercial fishing (trolling) in the sea and sport fishing in the vicinity of the river mouth and (2) the efficiency of natural propagation of cohos in a small spawning stream tributary to Cowichan river.

Since 1939, observations have been made on the sport fishery in Cowichan Bay during the height of the angling season for cohos, mid-September to early November. Analysis of "boat landings" for cohos other than grilse revealed that in 1946 the availability was the lowest on record - 6.3 line hours per fish - which undoubtedly reflected a light run of fish but was influenced also by late arrival of the run. (App. No. 56). After the commercial fishermen and the anglers had taken their toll, approximately 35,000 cohos were left to make up the spawning escapement to the Cowichan River. (App. No. 57). This represents the smallest spawning since 1940. The escapement in 1943, the previous cycle year, was estimated at 56,000.

At Oliver creek, a natural coho spawning stream where records have been collected since 1938-39, the spawning run was exceedingly low in 1946 - only 48 males and 33 females - with a presumed deposition of 60,000 eggs. (App. No. 58). In the spring of 1947 only 1,757 fry were obtained, representing a percentage efficiency of fry production of but 2.9. This is entirely out of line with results of previous experiments which have ranged from 12% to 30% efficiency and can be largely attributed to the fact that during the year expansion of the village of Lake Cowichan around and beyond Oliver creek resulted in appreciable land clearing, disturbance to the stream bed and considerable interferences during the spawning period. The 1946-47 results from Oliver creek may have some significant bearing upon the general effect of the "march of civilization" upon the future of our salmon resources.

OTTER-TRAWL FISHERY. During the latter stages of the Second World War and the subsequent early Post-war period a "boom" occurred in the Pacific coast otter-trawl fishery because of the great demand for flatfish and for those species of fish with high vitamin oils, chiefly lingcod and dog-fish (grayfish). Exploitation reached a high level and concern was felt for the effect of the fishing intensity upon the stocks of fish being caught. As a result this investigation was begun in 1944. Its aim was essentially to study the characteristics of the fish comprising the trawl landings, relate these to the stocks of fish on the grounds, determine the trends in the populations as affected by the increased fishing and endeavor to recommend sound conservation measures for the maintenance of the fishery at an optimal level. Within the last year or so the demand for flatfish has decreased appreciably resulting in less urgency for control measures. Nevertheless it is the opinion of many that there will always be a market for these species of fish, one which may increase as improvements in handling and presentation to the consuming public are effected. For that reason it is felt that adequate information should still be obtained on which to frame suitable management policies.

Up until this year the investigation had no trawl vessel of its own and consequently had to depend on commercial trawlers for studies at sea - tagging, sampling, etc. - and analysis of catches as and where landed. During the present season a research vessel, the "Investigator No. I", has been obtained, adequately equipped with essential gear, and has been very useful. During 1947, Dr. J.L. Hart, in charge of the investigation has been assisted at various times by Messrs. Barraclough, Manzer, Ketchen, Taylor, Miss Bethune,

two port contact men - R.M. Wilson at Vancouver, K.J. Jackson at Prince Rupert, subsequently replaced by G.A. Calderwood - and the crew of the "Investigator No. 1".

Adequate collection of statistics is essential in order to ascertain the amount of fish taken from individual areas in relation to the amount of gear used and to trace changes in abundance or availability over the years. Departmental records were at one time supplemented by pilot-house logbooks supplied to trawl vessels but in 1947 they were abandoned in favour of "contact" men stationed at the ports of Vancouver and Prince Rupert who obtained the desired information directly from the vessels when arriving in port. The "trip" reports sent in weekly by the contact men are not only most useful but the incidental information submitted is also very valuable.

Trawling is conducted principally in three areas of the coast, the strait of Georgia, the west coast of Vancouver island and Hecate strait. In the latter two regions American trawlers also operate. The important species of flatfish are the lemon sole, brill and rockfish. A fishery for butter sole occurs in Skidegate inlet, Queen Charlotte islands.

Studies of lemon sole (Parophrys vetulus) mortality rates indicate (App. No. 62) that while in the south where the grounds are near good markets and have been exploited over a number of years the total mortality rates are high (65% - 70% for males, 55% - 65% for females) whereas in more recently fished northern grounds the rates are much lower (40% for males; 30% for females). Probably these latter mortality rates represent a close approximation to natural mortality rates since the fishery is a new one. Age determinations (App. No. 60) indicate that in Hecate strait areas the fish display a greater range in age (2 to 13 years) than on southern grounds. The 1939 and 1942 year groups appear to be dominant, presumably either as a result of more successful spawning in those years or better survival of young. In all areas of the coast growth of female fish per year in the fourth and eighth year groups greatly exceeded that of males, almost double in most areas. (App. No. 61).

The migratory habits of the various species of flatfish and the extent of separation or intermingling of geographical populations have been studied by tagging experiments. (App. No. 74). During the year 1729 brill, 1200 rock sole, 1136 butter sole and 289 lemon sole were tagged. Recoveries to date indicate that lemon sole and brill on the west coast of Vancouver island migrate to waters off Washington and Oregon during the fall and winter, returning south in the spring. Using fish tagged off Barkley sound in 1945 as an index it was found that 64% of the lemon sole and 50% of the brill landed during June, 1945 and June, 1947, were caught by American vessels.

Damage to the grounds by otter trawls has been a controversial subject for some years. Preliminary tests (App. No. 78) reveal that on medium hard bottom the boards tend to scrape rather than plow the bottom but on turning, some digging-in does occur. No damage appeared to be caused by sole rope or net. Further tests on bottoms of different kinds are planned.

The trawl fishery investigation embraces also a study of those species of fish in the capture of which other gear compete. Dogfish and soupfin sharks are two of these, taken also by sunken gill net. Examination of dogfish catches

made in Hecate strait (around 30% of the total for B.C. waters in 1946, as compared with 3% in 1943) shows a decided decline in abundance (App. No. 83) in recent years. For soupfin shark, approximately 40% of all B.C. catches were made in Hecate strait since 1943 and analysis of catch data indicate an appreciable drop in availability in 1946. In fact this fishery was very poor. (App. No. 84).

HERRING. This study has been of long standing and yearly has increased in importance and usefulness. It is one investigation which has shown the necessity for and the value of long-term research and it has now reached a point where practical management of the fishery can be undertaken. Predictions of catch, valuable to both industry and Department, are being prepared and utilized (App. No. 105) though with some hesitancy and with due emphasis given to the probable incompleteness of essential facts. Predictions for the 1946-47 season were well substantiated in practically all areas. Those for the current year are shaping up well although experience has again demonstrated that their usefulness would be greatly increased by ability to forecast the time of appearance of the runs. The investigation is in charge of Dr. Tester, assisted by Messrs. Stevenson, Glover and Lanigan, four field technicians and seasonally - employed seine boat crews.

During the 1946-47 season catches in all southern districts were good, (App. No. 86) especially on the west coast of Vancouver island where removal of the quota resulted in the capture of 59,000 tons, almost half of the total for all areas - 123,500 tons. In the north the fish again entered the fishing areas only toward the close of the fishing season.

During the year two types of management procedure were instituted in order to establish their relative effectiveness. On the east coast of Vancouver island a 40,000 tons quota was agreed upon with the understanding that the reaction of the herring populations to this degree of fishing intensity would be carefully analyzed. On the west coast of Vancouver island, however, all restrictions were removed, except for a fixed closing date as the fish approach spawning condition, the purpose being to determine whether catch restrictions are required to provide adequate spawning stocks. In the past it has appeared that heavy spawning populations do not necessarily produce large numbers of recruits to the stocks while, on the other hand, small spawnings have sometimes been most productive. If large numbers of spawners are not necessary to provide adequate recruitment to the stock, then large quantities of catchable fish are annually being lost to the fishery. It may be found, further, that adequate supplies of fish come into the spawning areas from the open ocean after the season has closed, thus making unnecessary any restriction during the fishing season.

In the conduct of these two experiments extensive sampling will be continued to determine trends in size of fish, age classes involved, apparent dominance of certain year-groups and reasons therefore. Spawning ground surveys will be made as complete as possible and trends in oceanographic conditions will be watched. In short, all available factors affecting the well-being of the herring will be carefully analyzed.

During the 1946-47 season recovery of tags was again undertaken (App. No. 87) by means of induction tag detectors at certain strategic canneries and of magnets in the meal lines of all reduction plants. Of the recoveries

Mr. K.S. Ketchen, M.A., University of British Columbia. Mr. Ketchen was employed as a Senior Research Assistant (Seasonal) from May 21 to Sept. 30 in the Trawl Fishery Investigation and on Oct. 1st was engaged as Assistant Biilogist, continuing with the trawl fishery work as a replacement for Mr. F.H.C. Taylor.

Mr. J.S.T. Gibson, M.A., Oxford University. Engaged July 14th as Junior Biologist but attached to no particular study in order to get experience in all. Mr. Gibson is very proficient in photography and art work and has been most helpful in many respects.

Messrs. J.G. Robertson (May 8th), J.H. Glover (June 1), J.A. Lanigan (Nov. 8), all University of Manitoba, with B.A. degrees incomplete, and engaged as Junior Biologists. Mr. Robertson is attached to the General Salmon investigation, and Messrs. Glover and Lanigan to Herring. During the summer (June 24 - Oct. 2) Mr. Lanigan was associated with the Skeena river salmon investigation as Junior Research Assistant (Seasonal).

Miss Winona J. Bethune, B.A., Honours Zoology graduate of University of British Columbia. Miss Bethune was engaged Oct. 1st as Senior Research Assistant to the Trawl Fishery Investigation.

Granted leave of absence to commence or continue post graduate studies were the following:

Messrs. W.P. Wickett, B.A., and J.I. Manzer B. Sc., (the latter part-time only) at the University of British Columbia.

Mr. F.H.C. Taylor, B.A., at Scripps Institution of Oceanography, University of California.

Mr. J.P. Tully returned from leave of absence (on half pay) at the University of Washington Aug. 1st. Mr. W.M. Cameron continues on leave without pay at Scripps Institution of Oceanography.

GENERAL

During the spring a course for Fisheries Officers was conducted, in association with the Department of Veterans' Affairs. Lectures were given by Senior members of staff on the various fisheries and species of fish involved, on limnology and the theory of fishing. Outside scientists kindly consented to contribute as follows - Messrs. Dunlop and Bell of the International Fisheries Commission, halibut; Dr. I. McT. Cowan, of the University of B.C., aquatic birds and mammals; Mr. R.G. Scagel of the University of B.C., marine plants; Dr. R. Van Cleve, oceanography. Much time and effort went into the preparation of the lectures and in most cases mimeographed notes for the use of the Inspectors were prepared.

During the year many distinguished scientists visited the Station and conferred with staff members. Among these were: Sir Charles Wright, formerly with the British Admiralty; Mr. E.D. LeCren of the freshwater Biological Station, Wray Castle, England; Mr. Rao V. John, Deputy Minister of Fisheries, Madras, India; Mr. S. Mitra, Orissa, India; Mr. Ph. Wolf, Swedish Salmon and Trout Association, Sweden; Dr. Gunnar Alm, Dr. J. Hult, Mr. V. Furusbog, Department of Freshwater Fisheries, Sweden; Dr. William Rowan, University of Alberta; Mr. Francisco Lara, Brazil; Dr. W.E. Ricker, University of Indiana; Mr. Cemlyn-Jones, London University; Mr. R. Raghu Prasad, Hopkins Marine

Station, California, and others. Mr. Tom Reid, M.P. for New Westminster, paid a brief visit to the Station in June. Dr. Reid, Acting Chairman of the Board, and Major Sutherland made the customary annual inspection during October.

In September the Station was invited to display an exhibit at the Port Alberni and Nanaimo Fall Fairs. A very attractive and instructive exhibit, taking the theme "How old is a fish?" was designed by Dr. Tester and constructed by Messrs. Gibson and Ketchen. Large-scale illustrations of herring and salmon scales, a flatfish otolith and a dogfish spine were prepared by Mr. Gibson. These were supplemented by numerous samples of fish of various ages and sizes. Dr. Tester and Messrs. Gibson and Ketchen accompanied the exhibit to Port Alberni and made comments, answered questions, etc. At Nanaimo various members of staff were in attendance. The exhibit was most favourably received and the subject of many complimentary remarks. An illustration of the exhibit appears in Pacific Progress Reports, No. 73.

During the year the Director and Senior members of staff attended meetings with the industry when the progress of particular major investigations were reported and discussed. By such informal meetings the work of the Station is receiving greater attention and the results to date made known to those most actively interested.

In the field of newspaper publicity a staff editor of the Vancouver Sun is presently preparing a series of articles on the major work of the Station for the Magazine Section of the Sunday Sun. The articles will be illustrated. Short items in Vancouver, Victoria, Prince Rupert and Nanaimo papers have appeared from time to time. Officials of CBR have for several months promised to visit the Station and discuss the possibility of putting on some radio talks, interviews, etc., but no action has been forthcoming.

PUBLICATIONS DURING 1947

Barraclough, W.E. A new record of a species of agonid fish (Occa verucosa Lockington) from the west coast of Vancouver island, British Columbia. Can. Field Nat. 61 (2), p. 39.

Barraclough, W.E. and Lyle A. Swain. Vitamin A in Brill Livers. II. Prog. Rep. Pac., No. 71, pp. 12-14.

Brett, J.R. Lakes of the Skeena River Drainage. IV. Kitsumgallum lake. Prog. Rep. Pac., No. 69, pp. 70-73.

DeLacy, Allan C. and Ferris Neave. Migration of pink salmon in southern British Columbia and Washington in 1945. Bull. Fish. Res. Bd. Can. 74, 11 p.

Fisher, H.D. The Harbour Seals (Phoca vitulina richardii) on the Skeena river, B.C. Prog. Rep. Pac., No. 72, pp. 36-40.

Foerster, R.E. Experiment to develop sea-run from land-locked sockeye salmon (Oncorhynchus nerka kennerlyi). J. Fish. Res. Bd. Can. 7 (2), pp. 88-93.

Prospects for Fisheries Management. Bull. Bingham Ocean. Inst.

Foskett, D.R. Lakes of the Skeena River Drainage. V. Bear lake. Prog. Rep. Pac., No. 70, pp. 10-12.

Lakes of the Skeena River Drainage: VI. The lakes of the upper Sustut river. Prog. Rep. Pac., No. 72, pp. 28-32.

Hart, J.L. and H.J. Hollister. Notes on the Albacore fishery. Prog. Rep. Pac., No. 71, pp. 3-4.

Ketchen, K.S. Studies on lemon sole development and egg production. Prog. Rep. Pac., No. 73, pp.

An investigation into the destruction of grounds by otter trawling gear. Prog. Rep. Pac., No. 73, pp.

Manzer, J.I. and F.H.C. Taylor. The rate of growth in lemon sole in the strait of Georgia. Prog. Rep. Pac., No. 72, pp. 24-27.

Manzer, J.I. A July spawning population of sand soles in Sydney inlet, Prog. Rep. Pac., No. 73, pp.

Neave, Ferris. Development of the lateral line organs in salmonids. Trans. Roy. Soc. Can. I, 1946, pp. 113-118 (1 plate).

Natural propagation of chum salmon in a coastal stream. Prog. Rep. Pac., No. 70, pp. 20-21.

Neave, Ferris. Investigations of commercial shellfish. Report B.C. Fisheries Department for 1946. pp.

Neave, F. and A.L. Pritchard. Do small salmon tend to produce small salmon? Can. Fish Culturist, I (3), pp.

Pritchard, A.L. Fish cultural problems involved in the conservation of anadromous fish, with particular reference to Skeena river salmon. Can. Fish Culturist, 1 (2), pp. 8-13.

Efficiency of natural propagation of Pacific salmon. Can. Fish. Culturist, 1 (2), pp. 22-26.

Sockeye salmon tagging off the Skeena river in 1946. Prog. Rep. Pac. No. 70, pp. 13-16.

Quayle, D.B. How frequently should butter clam beds be dug? Prog. Rep. Pac. No. 69, pp. 63-65.

Stevenson, J.C. Preliminary survey of larval herring on the west coast of Vancouver island: 1947. Prog. Rep. Pac., No. 73, pp.

Swain, Lyle A. and W.E. Barraclough. Vitamin A in brill livers. Prog. Rep. Pac., No. 69, pp. 74-76.

Vitamin A in long-jaw flounder livers. Prog. Rep. Pac., No. 72, pp. 41-42.

Tester, A.L. and J.C. Stevenson. Results of the west coast of Vancouver island herring investigation: 1946-47. Report B.C. Fisheries Department for 1946, pp.

Wilby, G.V. Fishes collected by the Wm. J. Stewart in British Columbia waters during 1934 and 1935. Can. Journ. Res., D, 24, pp. 134-155.

CIRCULAR SERIES. (Mimeographed)

Tester, A.L. and J.C. Stevenson. Prospects for the 1947-48 herring fishing season. No. 8, 2 pp.

Record herring catch does not greatly decrease west coast of Vancouver island spawning. No. 9, 6 pp.

MANUSCRIPTS SUBMITTED FOR PUBLICATION

Black, E.C. and C.R. Elsey. The incidence of marine wood-borers in the coastal waters of British Columbia, Bull. Fish. Res. Bd. Can.

Brett, J.R. The design and operation of a trap for the capture of migrating young sockeye salmon. Trans. Amer. Fish. Soc.

Pritchard, A.L. Efficiency of natural propagation of the pink salmon (Oncorhynchus gorbuscha) in McClinton creek, Masset inlet, B.C.

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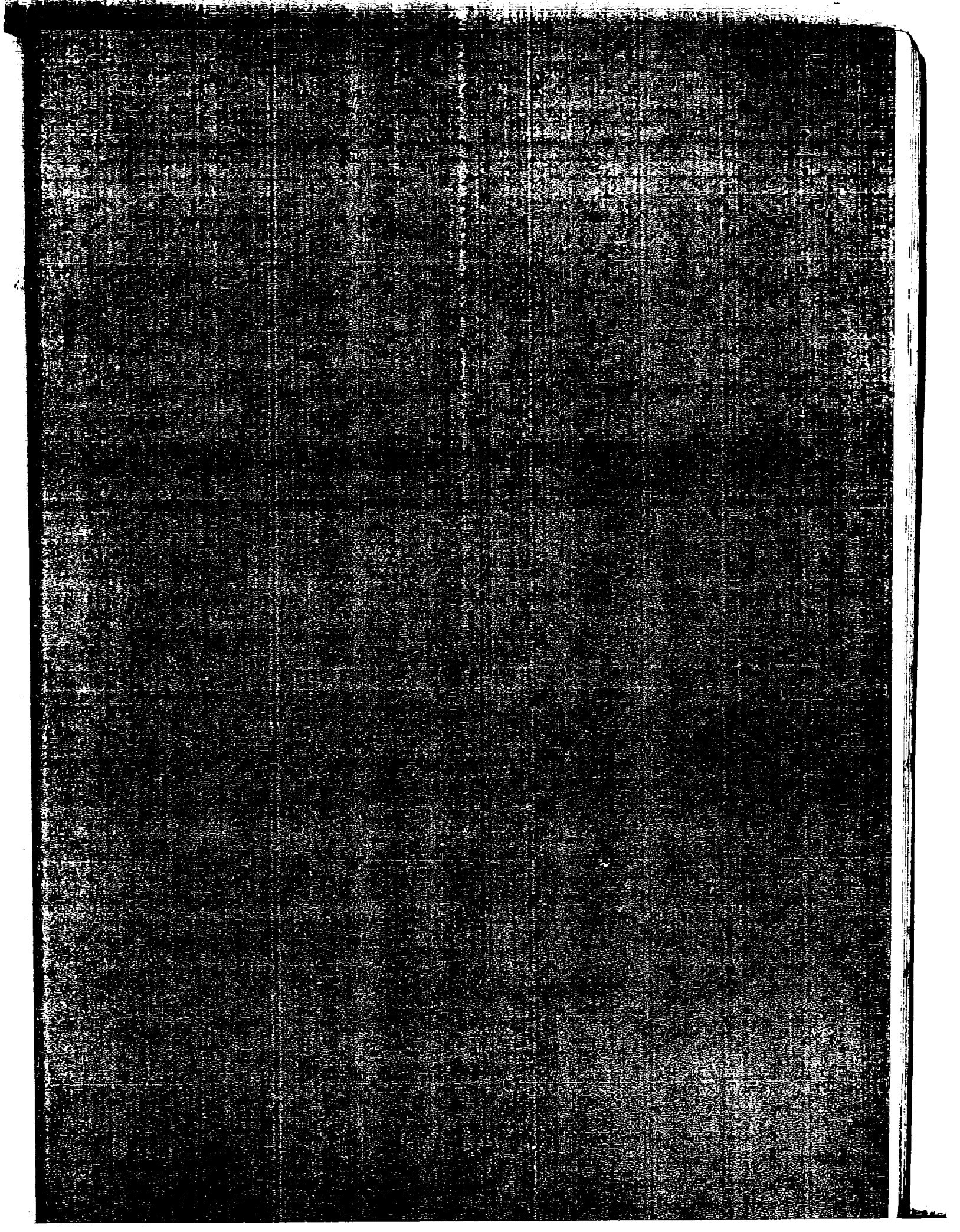


SKEENA RIVER INVESTIGATION

1. GENERAL INTRODUCTION

A. L. Pritchard Appendix No. 1

The further and more detailed analyses during the winter of 1946-47 of the data already collected in the Skeena river investigation led to a revision of the programme for the summer of 1947. The main object of the change was to ensure that all essential information would be available for the summary of the first phase at the end of 1948 and that time would not be wasted in gathering facts which were not pertinent to the problems outlined by the terms of reference.

It was decided that the statistical work should be arranged with a view to collecting information missing from previous records examined and to keeping a close check on current operations. If possible a method of prediction was to be outlined as a guide to the operators and fishermen. Tagging was to be limited to one boat off the mouth of the Skeena to provide sufficient fish to indicate exploitation, time of migration and distribution of the runs throughout the season. Marking of yearlings at Lakelse and Babine was to be continued in a further effort to obtain some data on the movements and exploitation of these populations. The lake survey or nursery area investigations were to be concentrated mainly in Lakelse and Babine lakes, with only incidental trips to other areas for supplementary information considered essential to complete the general picture. At Lakelse, the effort was to be of a more experimental nature designed to permit fuller interpretation of the findings throughout the system. At Babine lake most stress was to be laid upon the final assessment of the coarse fish populations. Stream surveys and spawning population estimates were to be stressed to every possible extent after greatly restricting the programmes for areas such as Morice, Kitsumgallum etc. where experience had shown that the effort and time expended were not repaid in information because of conditions of poor visibility brought about by glacial silt in suspension. To aid in estimating escapement, a counting fence of a modified type was to be inserted in the Lakelse river, the Babine fence was to be operated, and a temporary structure was to be erected in the Bear river if necessary. A final close check of conditions was to be maintained at Moricetown falls and a contour survey thereof was to be completed.

With the revision of the programme, rearrangement of the duties of the permanent staff became necessary. Mr. D. J. Milne, with a central office in Prince Rupert, was responsible for the statistical investigation - commercial and Indian - and the Moricetown inspection. In addition he assumed the direction of the tagging and of the collection of returns. Mr. J. R. Brett, with headquarters at Lakelse lake, supervised all the lake and stream survey programmes. At Lakelse, he had the help of two experienced graduate students, Mr. M. P. Shepard who took charge of the limnology and netting, and Mr. D. F. Alderdice who ran the counting fences. Mr. F. C. Withler was in general charge of the Babine lake operations with Mr. V. McMahon looking after the limnological endeavours and Mr. J. A. McConnell the counting fence. Mr. W. R. Hourston, another experienced graduate student, headed a party at Donald's Landing on this lake. Mr. D. R. Foskett carried through the work at Bear lake.

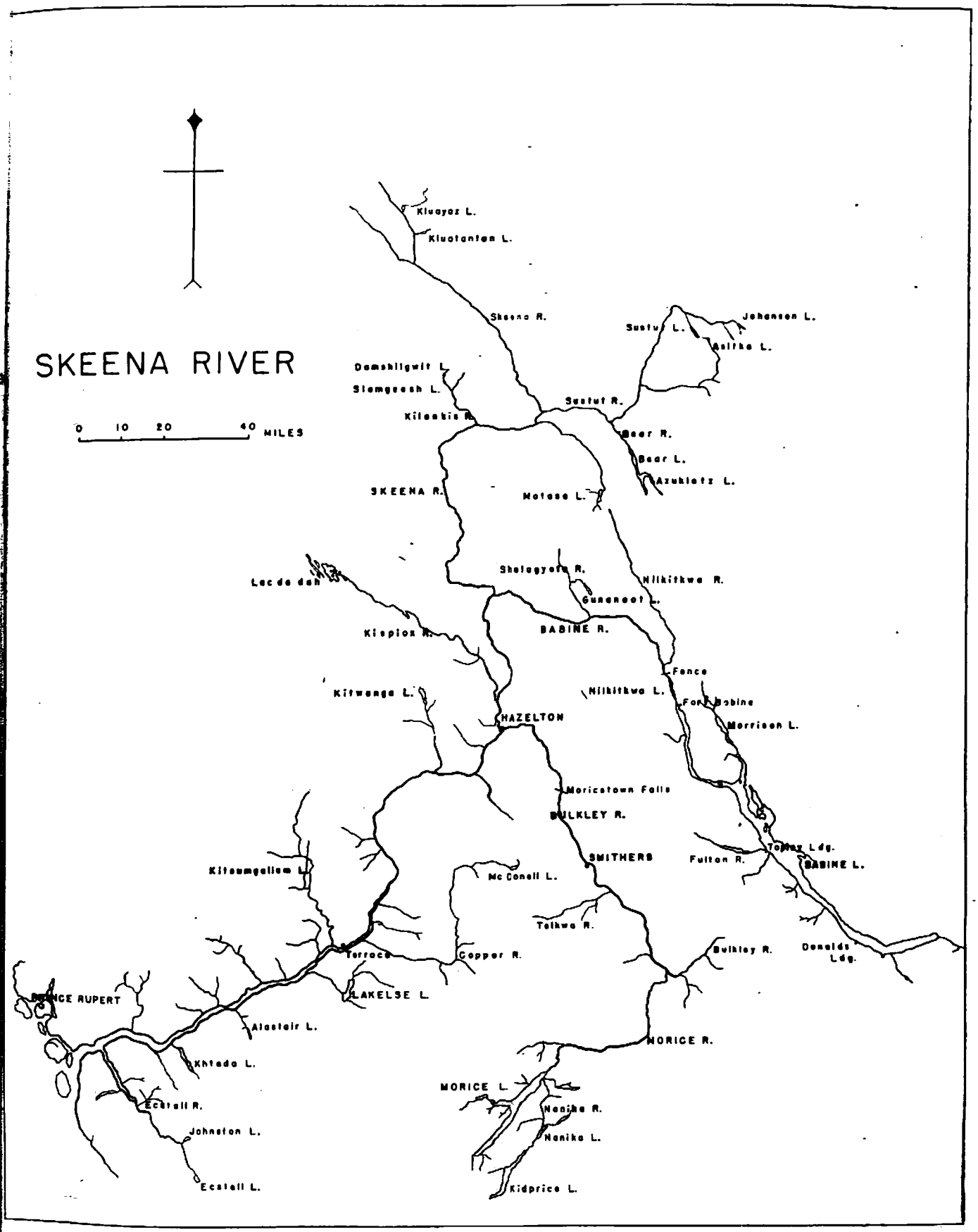
The standard procedures outlined and adopted in 1946 were again followed in 1947 for all operations including gill netting and sampling of fish, survey of spawning streams, and limnological determinations such as

plankton collections, temperature readings, oxygen determinations, transparency readings and other minor efforts. In addition the investigators were requested to carry through in Lakelse and Babine lakes experimental netting of any type with a view to exploring thoroughly the distribution of the fish. In one or two areas plankton series were taken to supplement the standards and to indicate the dispersal of the planktonts in the hope of proving or disproving the reliability of checking at centrally located stations. Much more effort was applied on standardizing net catches against those taken with a plankton trap.

In the appendices which follow, the work for the year has been summarized in as much detail as the limited time for analysis has allowed. The contributions are grouped under the following major headings: Propagation Studies, Migration Studies (marking and tagging), Lake Surveys, Stream Surveys, Salmon Counting Fences, Statistics, Influence of Environmental Conditions on Skeena River Runs, Study of Obstructions, Age Determinations, and Hair Seal Studies. In each section the areas are arranged in order of their location from the coast toward the interior. A map is inserted as a guide to location of areas. The following is a list of the fish encountered with the scientific names. Common names only are used in the discussions.

(1)	Pink Salmon	- Oncorhynchus gorbuscha
(2)	Chum "	- Oncorhynchus keta
(3)	Coho "	- Oncorhynchus kisutch
(4)	Sockeye "	- Oncorhynchus nerka
(5)	Kokanee "	- Oncorhynchus nerka kennerlyi
(6)	Spring "	- Oncorhynchus tshawytscha
(7)	Cutthroat trout	- Salmo clarkii
(8)	Rainbow or Steelhead trout	- Salmo gairdnerii
(9)	Lake trout	- Cristivomer namaycush
(10)	Dolly varden char	- Salvelinus malma
(11)	Eastern whitefish	- Coregonus clupeaformis
(12)	Rocky mountain whitefish	- Prosopium williamsoni
(13)	Common sucker	- Catostomus commersonii
(14)	Columbia river sucker	- Catostomus machrocheilus
(15)	Long-nosed sucker	- Catostomus catostomus
(16)	Squawfish	- Ptyocheilus oregonensis
(17)	Peamouth	- Mylocheilus caurinus
(18)	Shiner	- Richardsonius balteatus
(19)	Chub	- Couesius greeni
(20)	Burbot (ling)	- Lota maculosa
(21)	Sculpin	- Cottus asper

Again in 1947 many persons not employed in the investigation have contributed greatly to such success as has been achieved. Mr. I. Urseth, the Supervisor of Fisheries at Prince Rupert, has shown keen and active interest. Grateful thanks are due many of his officers including Mr. G. E. Moore and Inspectors Strachan, McDonell, Hutchinson, Skipper and Fielden. Inspector Giraud at Terrace was very intimately connected with the detailed programme at Lakelse lake and was of great assistance in accompanying and helping the parties which went to Alastair lake and the northern Skeena districts. The members of the Skeena River Advisory Committee, Messrs. I. Urseth, T. Wallace, C. E. Salter, W. Johnson and B. Kristmanson have always been ready with constructive suggestions and active aid. The managers and


SKEENA RIVER
0 10 20 40 MILES
Kwayaz L.
Kwatanten L.
Skeena R.
Sustut L.
Johanson L.
Asitka L.
Damshilgwit L.
Slamgeesh L.
Kilsumis R.
Sustut R.
Bear R.
Bear L.
Azukiatz L.
SKEENA R.
Motase L.
Shelagyote R.
Nilkitkwa R.
Gunanoot L.
Lac de dah
Kispiox R.
BABINE R.
Fence
Kitwanga L.
Nilkitkwa L.
Fort Babine
HAZELTON
Morrison L.
Moricetown Falls
BULKLEY R.
SMITHERS
Fulton R.
Topley Ldg.
BABINE L.
Kitsumgallum L.
Mc Connell L.
Telkwa R.
Terrace
Copper R.
Bulkley R.
Donalds Ldg.
PRINCE RUPERT
LAKELSE L.
Alastair L.
MORICE R.
Khtada L.
MORICE L.
Ecstall R.
Nanika R.
Johnston L.
Nanika L.
Ecstall L.
Kidprice L.

A. L. Pritchard Appendix No. 1

personnel of the Skeena river canneries and of the fresh fish plants in the area have extended all possible cooperation.

Thanks should also be expressed to the Director and the staff of the station for their advice and help toward solving many of the problems. Our gratitude is due not only to ther permanent members of the investigation and others mentioned later in the reports but also to the remainder of the temporary assistants, viz.- Messrs. R. Ferguson, J. W. Stokes, J. A. Lanigan, E. C. McDonnell, B. M. Chatwin, E. W. Burridge, H. Godfrey, A. C. Johnston, P. T. Abear, E. Rice and D. W. Outram for their keen interest and conscientious service.

2. PROPAGATION STUDIES

J. R. Brett Appendix No. 2

Propagation Studies at Lakelse Lake

In view of the success obtained in 1946 through the use of a netting fence spanning the Lakelse river for the capture of migrating young sockeye, the same structure was reinstalled during the last two weeks of April, 1947.

The stages in migration were traced throughout the complete run which commenced with a few stragglers on May 1, reached a peak of 45,440 on May 23 and fell to minor proportions by the second week of June. Between the dates of May 16 and 25, sixty per cent. of the total enumerated passed through the trap. The final aggregate equalled 372,000 as compared with 557,400 for 1946.

In the parent year 1945, the number of adult sockeye entering Lakelse lake was estimated by use of a tagging ratio to be 56,700. Applying to this a sex ratio of 50% females and an average number of eggs per female of 3,900, approximated from egg counts made in 1939 on Williams creek by Dr. A. L. Pritchard and Mr. W. M. Cameron, the survival from egg deposition to migrant can be calculated as approximately 0.34%. This particularly low survival brings Lakelse lake more in line with the low returns of 0.45% for two year old migrants arrived at in Karluk lake, Alaska, by Mr. J. T. Barnaby and considerably below those for Cultus lake which were calculated at 1.13%, 1.05% and 3.23% for one year old migrants by Dr. R. E. Foerster.

On the basis of the survival from estimated egg deposition derived from the migration counts of last year (1.06%), some one million odd yearlings might have been expected. The comparatively low returns which were obtained in the 1947 operations might well be accounted for through the extreme flood conditions which occurred in November of 1945 and consdquent disruption to spawning grounds just subsequent to the deposition of eggs in the parent year.

The desirability of continuing this propagation study for a considerable period of time is felt to be as essential as any other feature of the investigation. The design of the fence has proven adequate although the construction of the trap was not such as to permit repeated use. A new trap of heavier material incorporating wire screening rather than netting and of a more permanent type is therefore contemplated for installation in 1948.

3. MIGRATION STUDIES

J. R. Brett — Appendix No. 3

Marking of Sockeye Salmon Yearlings at Lakelse Lake

During the period May 9 to May 28, while carrying out the operations involved in counting the number of yearling sockeye migrating down the Lakelse river, 100,019 were marked by the removal of both pelvic fins. This has been the distinguishing mark used throughout this programme at Lakelse lake as opposed to the additional removal of the adipose fin at Babine lake.

Although the operation of marking only occupies a matter of a few seconds per fish, it entails sufficient handling which, along with the actual loss of two fins, results in a differential mortality between marked and unmarked yearlings. This difference was investigated in part by transferring to a small floating pound two groups of two hundred young sockeye, one group being marked, the other unmarked. It was not possible to continue the experiment beyond two weeks, but this was sufficient to indicate that the initial mortality was greater in marked fish and that following this first stage, the general resistance to adversity appeared to be fairly similar in the two groups. A small number of marked yearlings were held for over a month. No indication of regeneration of the clipped fins was apparent.

By far the largest number of adult sockeye entering Lakelse lake are in their fourth and fifth years. The majority of the returns from this year's marking cannot therefore be expected until the years 1949 and 1950, and, along with those from the 1946 effort, should provide the greatest number in 1949.

V. H. McMahon and F. C. Withler — Appendix No. 4

Marking of Sockeye Salmon Yearlings at Babine Lake in 1947

As a result of the experience gained during 1946, the collection apparatus for yearling sockeye at Babine lake was redesigned. Immediately upon arrival of the party at Fort Babine on May 18, the new lead and trap were erected at the same location as in 1946, viz.- about 100 yards above the Babine river and at an angle of 30° to the flow of water.

The lead consisted of a row of piles driven 10 feet apart and extending about 200 feet out into the lake. Chicken wire was strung between the piles to support the 1/2 inch mesh cotton seine netting which was hung along the upstream surface of the wire. The water current was sufficient to hold the netting against the wire but the wire in turn prevented bulging in which the young salmon could be accidentally trapped and killed. The trap took the form of a large box at the shoreward end of the lead having seine netting on the sides and bottom and an open top. A wide door was installed in the upstream side through which the yearling salmon entered. A small door was inserted in the downstream end to be used during trapping operations to allow the young fish to swim into the large holding pen which was attached, and also as an outlet through which to remove the debris from the trap during the daytime. The holding pen was of similar construction and size to the main trap but was moveable. Two smaller pens were also used for retention when needed.

V. H. McMahon and F. C. Withler Appendix No. 4

The entire system was ready for operation on the night of May 21 but no yearling sockeye were observed until May 23 when approximately 500 were caught. By May 25, the total had risen to about 4,000 and from that date the run increased in intensity until the night of May 28 when over 30,000 were captured. Thereafter the run subsided gradually. On June 3, however, at which time over 10,000 fish were still being taken each night, the objective of 100,000 had been reached and the lead was dismantled.

The adipose and both ventral fins were removed by clipping from a total of 106,377 individuals. Eight hundred and ninety-seven fish were taken as samples. The mortality due to manipulation during the marking process was estimated as being slightly greater than 1 per cent.

Many predator fish were observed in the vicinity during trapping operations. These included rainbow trout, burbot and squawfish. From those which entered the lead and trap, stomachs were removed and preserved for later examinations.

Data pertinent to factors which might affect the yearling migration were regularly recorded. These included records of climate, water level and temperature, time of migration, size and numbers in the various schools, rate of movement, etc.

F. C. Withler Appendix No. 5

Skeena River Observations for Young Sockeye

Following the completion of yearling marking at Fort Babine, Messrs. Withler and Godfrey left Babine in an attempt to trace the movement of the young sockeye down the Skeena river. If any number of yearlings could be obtained in the system below the Babine and Lakelse marking stations, some idea might be available of the proportion of marked to unmarked individuals and from that could be calculated a rough general estimate of the production of young above the point of capture.

The swollen and muddy condition of the stream made observations difficult. Two gill nets set near Hazelton were torn out by debris and current, brought on by an over-night rise of one foot of water level. Seine hauls were impossible in the strong current. Line fishing for possible yearling predators brought no results, since the river under flood conditions is poor for bait fishing.

However, general deductions might be possible. If the yearlings migrate down the Skeena under similar water conditions each year, it appears probable that predation would be small because of the extremely poor visibility in the water. Presence of a "dark streak of yearlings moving down the centre of the river" as has been described as seen on the Fraser, seems unlikely in face of the heavy turbulence and muddiness. For the same reasons, the congregation of yearlings in eddies at some time of the day is doubtful. Light conditions a few inches below the surface of the river must be little affected by the time of day, so that migration behaviour would be little affected by this factor unless the yearlings were quite close to the surface.

A considerable expenditure of men and money would be necessary for a comprehensive study of yearling migration in the Skeena. Some method of trapping involving leads or fences operative under flood conditions would be demanded.

J. A. McConnell Appendix No. 6.

Returns of Sockeye Salmon Marked at Babine Lake

At the outlet of Babine lake during the spring of the past three years sockeye salmon yearlings have been marked by removal of the adipose and both ventral fins as follows:

Brood Year	Year of Marking	Total Marked
1942	1944	24,890
1943	1945	5,283
1944	1946	68,972

Also, in 1945, some 8,805 sockeye fry from the spawning of 1944 were given the same mark.

The first returns from these markings came when 19 "unquestionable" marked sockeye were recorded at the Babine fence in 1946. No other reclaims were made last year.

A. Returns at Babine lake in 1947

In enumerating the sockeye salmon at the Babine fence, the fish pass from the pens through the outlet doors and over white chutes which are enclosed in a wire "basket" having an upstream door which can be rapidly closed. As a general rule the sockeye moving slowly upstream over the chutes displayed their ventral fins and were allowed to pass through. If however, no ventral fins were seen, the observer closed the upstream door of the wire "basket" and also the outlet door of the pen, thus trapping the individual for further study. In cases where the fish appeared to be marked, it was removed from the "basket" trap in a dip net and examined more closely for missing fins. If deemed to be a marked fish, another investigator was summoned to verify the return and if both considered it to be doubtful (i.e. if one or more of the fins was only partly missing) the area around the fin insertions was preserved for later examination together with the other data.

During the season's operations, 145 "unquestionable" marked sockeye were taken at the Babine fence. As yet, there has been no opportunity to read the scales of these fish and thus assign them to a definite brood year. On the basis of length, however, it was almost certain that the 36 which were "jacks" (under 19" in length) were progeny of the brood year of 1944 and that the remaining 109 belonged mostly to the brood of 1942 with some from 1943. In addition to these "unquestionables" there were 21 returns which have been recorded as "doubtful" and three as "probably abnormal." These will be examined later and either discarded or accepted as genuine returns. Also seven fish which appeared to have missing fins were recorded as having escaped before they could be examined closely.

The marked fish appeared at the fence early in the run, 119 or 82% of the total "unquestionables" being recovered before August 15 during which time 225,000 or only 43% of the total sockeye had been enumerated. The ratio of marked to unmarked for this period was 1 to 1,900 whereas for the run as a whole it was only 1 to 3,600. Assuming that the observers did not miss more marked fish toward the latter part of the season than in the early part, it is indicated that the original marking did not give a random sample for the whole lake but selected from one portion of the run.

J. A. McConnell Appendix No. 6

B. Returns from Ocean

Only one return was obtained from the mouth of the Skeena. This fish, lacking both ventrals and adipose fins, was seined near Smith island on July 20 during tagging operations by the "Lady V." It was recovered 11 days after tagging by a commercial gill net at Carlisle Bar farther inshore in the mouth of the Skeena.

The low return from the commercial fishery is not surprising, however, since on the basis of the recoveries at the Babine fence there might only have been 160 in the total catch of just less than 400,000, or about one in 2,500. It does nevertheless emphasize the need for full coverage of the commercial catch next year when returns from larger markings are expected.

A. L. Pritchard Appendix No. 7

Salmon Tagging off the Skeena River in 1947

As in the three earlier years, it was possible to obtain the "Lady V" with its experienced crew under Captain Wm. Leask. During previous operations some trouble had been experienced in small salmon "gilling" in the seine which varied from 4 to 4½ inches stretched mesh. For that reason a new net was fabricated of 3½ inch mesh. This largely eliminated the difficulty but added a large number of "jack" salmon or small fish to the tagged population.

After a two day trip to Mink Trap bay on the west coast of Pitt island on June 12 and 13, operations were concentrated at the mouth of the Skeena off Inverness passage, Kitson, Smith and Kennedy islands until July 27 with the exception of two trips of short duration to the Nass area, the first on July 1 and the second on July 17 and 18.

Offshore Tagging

Principe Channel district. As mentioned above, only one trip was made to Mink Trap bay in this area on June 12 and 13 on which days 400 sockeye were tagged. Recoveries to date have been 37 (9.3%). Twelve fish were taken by the commercial fishermen - 9 in Mink Trap bay and contiguous districts and 3 from the mouth of the Skeena off Oceanic cannery. Twenty-five tags were collected from the spawning streams tributary to Mink Trap and adjacent Mikado Bay by Fishery Inspectors Skipper and Fielden. The collections confirm previous conclusions that the Principe channel sockeye (Mink Trap) are chiefly local although some individuals may find their way to the Skeena.

Nass area including Steamer passage, and Finlayson island. There follows a summary of the numbers tagged and recovered (in brackets) from the two expeditions to the area on July 1 and July 17 to 18: Sockeye - 25 (10), Spring - 4 (1), Coho - 4 (1), Pink - 15 (0), and Chum - 11 (2). The sockeye returns - Nass area - 4, Skeena river commercial fishery - 3, Skeena Indian fishery - 2, and Babine fence - 1 - did not differ from those of other years in point of general distribution, but, though small in numbers, they indicate a greater tendency to move toward and up the Skeena. The one spring was recaptured by an Indian fishing on the Bear river in the Skeena headwaters. The coho was retaken at the Babine river counting fence. The chums were recovered close to the locality of tagging.

A. L. Pritchard Appendix No. 7

Inshore Tagging

The "inshore" tagging immediately off the mouth of the Skeena was very successful and produced the following numbers for the period between June 15 and July 27: Sockeye - 2,329, Spring - 152, Coho - 106, Pink - 613, Chum - 77, and Steelhead trout - 18.

Sockeye Salmon Recoveries. Of the 2,329 tags affixed to sockeye salmon, there have been reported to date: Commercial fishery - 433 (18.6%), Indian fishery - 285 (12.2%) and spawning grounds - 106 (4.6%).

The percentage recovery from the commercial fishery (18.6%) - an indication of minimum exploitation - is the lowest of any year since the inception of the investigation, cf. 1944 - 40.1%, 1945 - 25.5%, and 1946 - 30.1%. This drop is due to two main causes. In the first place, the fishing effort in 1947 whether reckoned on the basis of licences issued or days fished, was the lowest of the four seasons. In the second place, there was a large number of "jack" salmon - fish under 19 inches in length - in the 1947 run. These were captured in the small meshed seine ($3\frac{1}{2}$ inches stretched) but escaped the larger meshed commercial gill nets ($5\frac{7}{8}$ inches stretched). In the total tagged population of 2,329 were 360 "jacks" (15.5%) not available to the fishermen. If the percentage is recalculated on the normal sized salmon only (1,969), it becomes 22.0% which although low is not too greatly out of line with the others.

The percentage recovery from the Indian fishery (12.2%) may be compared with 10.2 in 1946, 9.0 in 1945 and 6.9 in 1944. This would indicate that the Indian food fishery was normally heavy and that the methods consisting of gaffing, anchored gill nets and a few drift nets, are not as selective of large salmon as are the commercial drift nets.

The percentage recoveries by the commercial fishery from each day's tagging varied greatly (2.5% to 33.8%) for reasons as yet not entirely clear. As has been usual, they were low for those fish which were off the Skeena river mouth until June 28. For those present on June 29, when sockeye fishing began, the figure rose to 29.9. It dropped for the fish of the first week in July, rose for those of July 5 and 6, and dropped for salmon up to July 11. From that time on the percentage increased to a high of 33.8 for July 20 and dropped thereafter.

As in other years, the Indian fishery exploited most heavily the early run - those present up to June 21. This tendency has been attributed to a desire to procure fresh fish as soon as possible after the winter. In contrast to other seasons, however, a moderate pressure was maintained throughout the summer with heavy exploitation on the fish of July 23 to 26. Of the total recoveries the Indian fishery took 34.6% in 1947 as compared with 27% in 1946, 26% in 1945 and 14.4% in 1944. As noted above some of this difference is due to the relatively heavier effort and greater ability to get "jack" salmon.

The times taken for the sockeye to move upriver from the point of tagging, as calculated from dates of tagging and return, although only roughly accurate, do show a general progression as in 1946 (figures in brackets): to the eastern end of deHorsey island - 5.6 (5.7) days, Point Lambert - 5.9 (7.4), Terrace and Kitselas - 14.3 (14.6), Cedarvale, Kitwanga and Skeena Crossing - 19.0 (19.0), Hazelton, Hagwilget and Kispiox - 16.7 (20.2), Babine fence - 23.2 (27.4), Babine lake streams - 46.7 (55.0), and Moricetown - 19.7 (25.4). Once again the fact that the fish remained in the lower river up to Point Lambert for an average of over 5 days reduced

A. L. Pritchard Appendix No. 7

the value of the closed week end. Exploitation is high for fish tagged on Saturday, Sunday, Monday and Tuesday with only a slight drop for those at the mouth on Wednesday, Thursday and Friday. The speed of migration was slightly greater in 1947 than in 1946 probably because of the fact that the average water level was higher throughout this season.

The thorough stream surveys, the partial operation of the Lakelse river fence, the close inspection of the Indian catches, and the complete examination of the Babine run at the Babine fence, have again produced very reliable information on the time of migration of the various populations through the fishery. No ocean tags were discovered in the Gitnadoix area, west of Lakelse, which were affixed after June 25, nor in the Lakelse area itself from fish after June 29, clearly demonstrating that both these runs are early and have passed upstream before the fishery can exploit them. The 39 recaptures in the Bulkley river above Hazelton show that fish from the runs to this area are moving through the lower river from June 17 until the end of July but they constitute their greatest proportion in the first two weeks in July. The 584 recoveries from Babine again show that Babine fish are moving in at all times but in greatest relative numbers after the middle of July. Thus in the 1947 season as in that of 1946, with the exception of Lakelse and Gitnadoix, the runs are thoroughly mixed but each may be relatively more numerous at certain periods.

Recoveries for Other Species. Of the 152 spring salmon tagged, 36 (23.7%) have been returned as follows: commercial fishery at the mouth of the Skeena river - 18, Indian fishery exclusive of Bear river - 5, and Bear river - 13. The large number captured in the Bear river emphasizes the fact that this is one of the most, if not the most, outstanding spawning area for the species in the Skeena system.

Twenty-four out of the 106 cohoes (22.6%) have been returned from the commercial fishery in the Skeena (16), from Edye pass (1), from the Indian fishery (2), from Babine fence (4) and from Bear river (1). The distribution is not so widespread as in previous years.

Seventy-nine of the 613 pinks tagged (12.9%) have been recaptured, 64 from the Skeena river commercial fishery, 1 from Edye pass, 1 from Whale channel, 7 from the Indian fishery in the lower Skeena around Kitwanga and Hazelton, 5 from the Babine fence and 1 from Bear river. Of particular interest is the low exploitation by the commercial fishery - 64 out of 613 or 10.4% - which by comparison with 18.6% for sockeye, bears out the contention that the commercial nets operated as at present are not particularly efficient in catching pink salmon.

Not tagged chum salmon have as yet been reported but four steelhead trout have been retaken - 3 from the commercial fishery and 1 at Cedarvale.

4. LAKE SURVEYS

J. R. Brett Appendix No. 8

Alastair Lake

During the period August 21 to 29, a first survey of Alastair lake and its connecting link to the Skeena, the Gitnadoix river, was undertaken. Despite its proximity to the coast as well as to the Skeena river,

this lake had never been investigated except through a very brief and superficial study made by plane on August 10, 1946. This was sufficient to confirm certain reports of the conditions to be expected if any endeavour were made to reach the lake by boat. The chief stumbling block in this respect was the presence of a long series of rapids in the Gitnadoix river commencing close to its confluence with the Skeena. These rapids, although not impassable, were of sufficient force and gradient to act as a real deterrent. Lacking a trail, however, and not lending itself to such in a steep walled valley characterized in its upper reaches by flat swamp land, the earlier decision to enter the lake by boat was maintained.

By use of long ropes and poles, an eighteen foot boat heavily loaded with equipment was pulled, pushed, dragged and guided over the gravel bars and up the swift current for the first four miles. Above this point it was possible to operate an outboard motor for much of the remaining sixteen miles of water course. This latter portion varied greatly in depth from relatively deep holes to wide shallow bars as the river twisted and turned through the narrow valley eventually ending in a large flat swamp and beaver meadow just below the lake proper.

Despite the steeply inclined mountains which border the very edge of the lake and usually characterize deep bodies of water, soundings revealed a flat and relatively shallow bottom at the northern or outlet end which gradually dropped off toward the maximum depth of 236 feet one-half mile from the southern shore. The overall average was slightly less than 100 feet in depth. Its area is approximately 1,700 acres being $5\frac{1}{4}$ miles long and averaging one-half mile in width. This is also the average width of the valley for its complete length from the Skeena to where it terminates in moderately heavy snow and ice fields in the fringe of mountains encircling the southern end of the lake. Very few rooted, aquatic plants were present other than at the northern end. The remaining restricted very shallow portions of the lake are the product of active erosion caused by small creeks which cascade down into the lake depositing gravel, sand and silt and are not suited to plant growth.

The temperature conditions within the lake on August 26 showed a high thermocline extending from 16.3° C. at 10 feet to 6.0° C. at 40 feet followed by a steady drop to 4.4° C. at 200 feet in the deepest section. The protection afforded by the surrounding mountains results in comparatively little wind and undoubtedly accounts for a high and very shallow epilimnion which did not even reach the proportion of that for such a small lake as Kitwanga. A second station set up for purposes of comparison in 80 feet of water, more centrally in the lake, showed essentially the same thermal gradient. At both of these a series of stage hauls for plankton analysis was performed. From macroscopic examination of the samples, the majority have been identified as copepods of the genus Cyclops, the commonest form throughout the Skeena drainage. Their abundance appears to be about average.

For a lake with its water source essentially of a glacial origin, the clarity of the water was surprising. The average of disappearance and reappearance of a Secchi disc was 25.7 feet which is among the deepest points of disappearance on record for lakes of the Skeena river. Considering the fair abundance of plankton, the amount of glacial silt in suspension must be exceedingly low.

A standard gang of gill nets incorporating mesh sizes of $1\frac{1}{2}$, 2, 3, 4 and 5 inches was operated three times in a corresponding number of different

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positions, mainly set parallel to shore in depths up to but not exceeding 22 feet. The different species obtained and their relative abundance have been tabulated below. Certain observations and conjectures as to the disposition of the general fish population were provided with corroborative evidence from the netting returns. There was a concentration of dolly varden char around those creek outlets which carried spawning salmon but this was not true of cutthroat which were found in more abundance elsewhere in the lake. Whitefish, peamouth and suckers were also more concentrated off the deltas formed by tributary creeks but only the latter two were prevalent in the shallows of the southern end probably because whitefish show a preference for colder waters. From the index of catch per net-night, the over-all abundance is low with cutthroat the most common but still not in any way plentiful.

Species	Total Catch	Catch per net-night
Cutthroat	16	1.2
Peamouth	17	1.1
Long-nosed sucker	13	0.9
Rocky mountain whitefish	9	0.6
Dolly varden	5	0.3
Sculpin	3	0.2
Total	65	4.3

On the basis of this short investigation it might also be concluded that conditions for survival of young sockeye are quite favourable and that the chief limitation is the relatively small area available for spawning (refer to spawning stream surveys, Appendix No. 19).

Particular mention must be added here of the efforts expended by Mr. D. F. Alderdice of the Lakelse lake party and Mr. V. H. B. Giraud, Fisheries Inspector, to guarantee that the expedition was successful.

J. R. Brett and M. P. Shepard Appendix No. 9

Lakelse Lake Area

The work at Lakelse lake while including both the construction and operation of yearling and adult sockeye fences, has gradually developed along lines of study designed to provide a better understanding of the biological interrelations within the lake and the limitations of the gear in use. The main endeavour to arrive at some working conception of the population density of each species, has progressed through an expanded program of gill netting but the results thus far have indicated more the limitations of the technique rather than providing answers to the problems.

In the field of standard netting which involves repeated sets using gangs of gill nets including one 50 yard section from each of the 1", 2", 3", 4" and 5" mesh size, and placed in previously assigned positions, some indication of the yearly variation in catch has been traced. The positions for these sets were established in 1945 at 10 and increased to 13

in 1946 being maintained at that number for 1947. A system of random rotation through these has been observed. The total of such standard sets was 36 in the past field season (i.e. 180 net-nights).

The catch per net-night for the past three years is included in the table below as well as the total number of each species caught in 1947 and the sum total for 1945-47.

	Catch per net-night				Total Catch		
Species	1945	1946	1947	1945-7	1947	1945-7	%
Peamouth	6.41	5.95	4.42	5.62	794	3,238	65
Squawfish	1.63	1.30	1.04	1.33	187	768	15
Cutthroat	0.72	1.07	0.94	0.91	170	523	10
Rocky Mountain whitefish	0.40	0.32	0.25	0.32	45	186	3
Sculpin	0.44	0.26	0.11	0.27	20	158	3
Columbia river sucker	0.40	0.19	0.08	0.23	15	133	2
Dolly varden	0.05	0.03	0.06	0.04	10	26	
Rainbow	0.00	0.00	0.01	0.00	2	2	

There is an obvious and continuous drop in the catches for the most abundant species, the peamouth, and a similar falling off in the catches of squawfish, The cutthroat catches have remained fairly constant despite increased angling effort in 1946 and 1947. The other species have not been caught in sufficient numbers to permit close comparison but the whitefish, sculpin and sucker all show a drop in returns. Until it is possible to assess the significance and value of the unit "catch per net-night" it is impossible to draw any more precise quantitative conclusions from the data.

To investigate the action of gill nets from the point of view of selection, area affected and efficiency in reducing a population of fish, as well as to obtain samples of fish from the open waters, a second phase of the netting programme was initiated. This experimental netting as opposed to standard netting was not intended for quantitative interpretation and imposed no limitations on any ideas which might be suggested by the investigators in charge. Forty-four sets were made and from the total catches of 1,657 fish of all species the following observations or conclusions were derived:

(1) Fish enter a gill net mainly between the hours of 12.00 p.m. to 3.00 a.m. with some species difference, e.g., cutthroat are caught earlier. This applies only to lakes where the water is not heavily glaciated.

(2) Continuous operation of a small number of gill nets shows only a temporary depletion with moderately constant catches.

(3) The area affected by a gill net when set inshore is approximately 50 yards on either side of the net, indicating relatively little movement in periods of one to five days with the exception of spawning migrations.

(4) Considerable netting is necessary to result in any permanent depletion of a given area, e.g. 3 to 4 gangs in a small area covering 150 yards of shore.

(5) There is a low abundance in returns in surface sets by comparison with bottom sets with the exception of cutthroat which show an even distribution throughout the lake.

(6) Very few fish are obtained by vertical gangs in the open waters.

In general it can be said that to deplete the population perceptibly in a lake the size of Lakelse for purposes of eliminating either predators and/or competitors, it would be necessary to operate some 15 to 20 standard gill net gangs particularly from April through to June which includes the spawning periods of cutthroat and squawfish.

To further the experimental phase in netting operations, considerable effort was expended in the construction of a large impounded zone. The intention was to introduce a known population of fish (all entries measured and marked) and then to set individual nets within this enclosure. Although over 1,000 fish were inserted, none was caught in the series of 10 single net sets made during the course of the experiment. The reasons for this stem in part from:

(1) The high mortality and abnormality amongst marked fish particularly those obtained from gill nets.

(2) The fact that despite the size of the impounded zone, 480 feet by 250 feet (2.76 acres), the fish appeared to act as "trapped", schooling along the retaining netting and consequently avoiding the centrally placed gill netting.

(3) Gill nets sample a very small percentage of a fish population.

Over 2,500 fish have been marked and released in the past three years. The returns from these number 45. To calculate a possible population on the basis of these recaptures without the knowledge of the differential mortality and natural mortality is without doubt unwarranted. If an assumption were made that these mortalities accounted for 50% of the marked fish then the population of catchable fish (using gill nets of $1\frac{1}{2}$" to $5\frac{3}{4}$" stretched mesh) would be in the region of 1,400,000 for all species. From the catch per net-night for the past three years, the predator fish, (squawfish, cutthroat and dolly varden) constitute 26% of the total catches which places them at about 360,000. The heavy losses encountered by sockeye fry from an average seeding in this lake could be accounted for by such a population of predators if the average consumption was only 100 per year, a figure which is quite conceivable.

To arrive at sufficient accuracy in this interrelation will require a very extensive and intensive piece of research. Its possibilities and limitations by the methods at present in use have become increasingly apparent. The conclusions to be drawn are that the population of fish in this comparatively small lake are large and that the possibility of predation being the main source of mortality in young sockeye is quite probable.

All physical, chemical and meteorological recordings introduced over the past years have been continued. The thermal recordings place Lakelse lake in the "temperate" class with an average "summer heat-income" of 10,500 gm. cal/cm^2. Despite the fact that this lake is amongst the high temperature lakes of the Skeena, the heat-income is low. This would appear to indicate that the whole area may well be limited by being of basically low productivity purely through lack of heat units.

The meteorological recordings have been compared with those taken at Terrace, and have proven to be very similar, with a slightly more moderate temperature during the summer months and a rainfall but little in excess of that for the town. This close similarity permits use of the Terrace observations for past years when no station was in operation for the lake and for

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those months when no observations are taken during the winter.

The plankton collections were increased toward the latter part of the summer to the extent of making hauls at a variety of stations distributed throughout the lake to test the degree of representation which is obtained by operating in the single deep hole of the lake. The accuracy of the net itself has also been tested by making hauls with different nets at the same time while using a plankton trap.

J. A. McConnell and J. R. Brett Appendix No. 10

Kitwanga Lake

A single visit was made to Kitwanga lake early in September to gather more data on the physical conditions, plankton supplies and fish population to permit comparison from year to year and to explain certain phases of the earlier work.

The temperature records, taken on September 4, indicated what are apparently the conditions just preceding the fall overturn. In the shallow northern section of the lake, the usual thermal conditions were present, the surface being only 1.2° C. warmer than the bottom. The thermocline in the southern section was 6 feet lower than in the middle of August in previous years with the surface temperature 15.7° C. (60.3° F.) and the bottom 7.0° C. (44.6° F.).

The plankton samples have as yet not been analysed, but superficial observation verifies earlier reports as to the abundance of food for young sockeye. A "bloom" of blue green algae was observed throughout both parts of the lake.

In sampling the fish population two standard gangs of linen gill nets were used, each being set twice. The gangs consisted of five nets each, the mesh sizes of one being 1½", 2½", 3½", 4½", 5½" and of the other 1½", 2", 3", 4" and 5". Tabulated below is the total catch and catch per net-night for 1947 together with the average catch per net-night for 1945, 1946 and 1947.

Species	Total Catch	Catch per net-night	Average catch per net-night for 1945, 1946, 1947
Peamouth	58	2.90	3.29
Squawfish	39	1.95	2.16
Cutthroat	37	1.85	.99
Rocky mountain whitefish	6	.30	.71
Long-nosed sucker	2	.10	.31
Kokanee	3	.15	.15
Dolly varden	2	.10	.08

Now that 75 net-nights have been set in the lake, the average catches probably offer a more reliable index of relative abundance. The peamouth certainly appears to be the most abundant fish followed by the two main predators, squawfish and cutthroat trout.

The most interesting feature of the study this year was the presence of spawned-out or partially spawned-out sockeye salmon in the nets. From 10

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to 15% of the sockeye taken were in this condition, giving positive evidence of lake spawning previously suspected but not verified.

In general, sufficient data have now been collected on Kitwanga lake to permit an understanding of conditions at least during the summer months. The scarcity of good spawning facilities rather than any biological situation appears to be the main limiting factor. Analysis of this condition should precede corrective measures in the lake itself.

J. R. Brett and F. C. Withler — Appendix No. 11

Babine Lake - General Introduction

In planning the 1947 lake work for Babine, the objectives were to maintain the rather extensive program begun in 1946 for at least a second year, and to complete or expand any of the operations involved where it was felt that more information was required. This would permit comparison and a more critical analysis of the complete data for both years.

Since predation is considered a major factor in the striking losses which occur in the lacustrine stages of the life of young sockeye, and has yet to be proven important by the catches to date in Babine, a program of "experimental" netting, involving the use of floating or suspended gill nets, was initiated. It was hoped to obtain information concerning the distribution and range of predators and competitors in the limnetic areas inhabited by the fry and to procure stomach samples from this zone. Thus the standard netting was replaced to some extent in 1947 by the experimental sets.

Nilkitkwa lake was more thoroughly netted because it was felt that this area would be potentially high in predation on sockeye yearlings. Its position is such that the total migration of yearlings from Babine must pass through it, and a fair proportion of the fry from the Upper and Lower Babine river spend one year within its depths.

Limnological procedures paralleled those of 1946, i.e. physico-chemical and plankton series were carried out at the five stations on Babine and Nilkitkwa at fortnightly intervals. In order to determine whether plankton samples at a single station were indicative of the horizontal distribution in that area, an investigation of this dispersion was initiated in Area II.

Meteorological records were kept both at Fort Babine and Topley Landing. In addition to cloud coverage and wind data taken in 1946, rainfall measurements were also recorded at Topley Landing from June until September.

Sounding in the Babine area was very nearly completed with the measuring of Nilkitkwa lake. Some additional determinations remain to be made in 1948 to complete Hagan's Arm and the area around the islands at its mouth.

By virtue of its difference in fish populations and food relations from that of Babine which is in such close proximity, Morrison lake was again subjected to investigation for one week of every month to complete a comprehensive comparative study. At these times the regular limnology, netting and dredging series were made for further data on food relationships.

V. H. McMahon Appendix No. 12

Babine Lake - Division I

Physico-chemical conditions - Starting on June 13 and continuing at fortnightly intervals throughout the summer, water temperatures, pH values and oxygen saturation samples were taken and checked against those of 1946. Plankton samples were collected and the transparency of the water was tested.

An early series of recordings of water conditions was taken on May 17 during the spring turnover. Temperatures ranged from 4.4° C. to 4.6° C. throughout the whole 55 metre column of water. An oxygen saturation of 40%, the lowest for the season, was discovered in the bottom waters at this time.

The upper 5-metre layer of water was found to be colder this summer by an average of 2.4° C. whereas that between 10 and 20 metres was warmer than in 1946 by .98° C. No evidence of a thermocline was detected.

Meteorology - Meteorology recordings were extended slightly over those of 1946. In addition to wind, cloud coverage and general weather conditions, air temperatures and precipitation were also noted in 1947. A maximum summer rainfall came in the week of July 14-20, inclusive, when a total of 6.84 inches were recorded, a daily average of .974 inches. This, however, made no appreciable difference in the level of either the lake or Fulton river.

Netting

Standard Netting - In order to obtain data which might be comparable to those collected in 1946, a portion of the time in the field was devoted to making standard gill net sets. A total of 20 such sets was made at seven of the eight standard netting positions established in 1946. At least one set was carried out at each position with both cotton and linen series. The former was made up of 5 fifty-yard sections of mesh sizes 2", 3", 4" 5" and $5\frac{3}{4}$" and the latter of 5 fifty-yard nets of mesh size $1\frac{1}{2}$", $2\frac{3}{4}$", 4", 5" and 6".

The species obtained in the two years and their respective catch per net-night values are listed below.

	Catch per net-night	
Species	1947	1946
Peamouth	1.38	.54
Kokanee	.53	.49
Rocky mountain whitefish	.30	.30
Eastern whitefish	.12	.31
Lake trout	.11	.12
Common sucker	.11	.04
Squawfish	.09	.07
Sockeye	.07	.30
Rainbow trout	.05	.03
Long-nosed sucker	.03	--
Burbot (ling)	.01	.02
Average catch per set	2.80	2.22

In both seasons over 75% of the fish caught were of the first

V. H. McMahon Appendix No. 12

four species listed. The peamouth chub was taken in relatively greater abundance in 1947, but this may be accounted for by one large catch of 80 individuals which was probably due to a spawning or other type of migration. Fewer eastern whitefish were caught this year but the difference is not significant. On the whole the fish populations appear to be very similar in the two years of sampling.

Stomachs of all fish caught were taken and preserved for later analysis.

Experimental Netting - In Division I three types of experimental gill-net sets were employed as follows:

1. Hanging set - Two 50-yard nets were suspended, one directly below the other, between two anchored buoys 50 yards apart. The ends of the nets were fitted with rings so that they could be lowered down the anchor ropes to any desired depth. Sets were made offshore in positions of 25 and 20 metre depths, and the nets were lowered on successive nights from the surface to the bottom.
2. Vertical set - A standard series of nets (1,2,3,4 and 5" mesh groups) was lowered to a depth of 250 yards. The ends were anchored on the bottom and floated at the surface so that the series stood vertically in the water.
3. Rolling set - A buoyant float of 15 feet length and 1.5 feet diameter was built, around which two net meshes were rolled and tied to each other at short intervals. The float was then anchored in any desired depth, up to 50 yards, and the nets rolled down. Sets were made starting at the shoreline and progressively moving out into deeper water, with the nets hanging in a line perpendicular to the shore.

A total of 12 fish (5 kokanee, 5 sockeye, 1 lake trout and 1 rainbow trout) were taken from the ten hanging sets made, and 2 fish (1 sucker and 1 squawfish) were caught in the six trials with the rolling set. No fish were caught in the single vertical set.

In addition to the above, abother type of fishing was tried. A main line with baited hooks suspended at depths of 1,2,4,6,8,10,12,15,20, 40,60 and 80 metres was stretched between two anchored buoys approximately 250 feet apart. No fish were caught by this means after several nightly trials.

Although the numbers of fish caught by experimental netting would seem to indicate a small fish population in the offshore waters, too much emphasis on this should be avoided since the number of sets was very limited for a lake of this size. However it does seem apparent, from the results, that in general the forage fish such as peamouth, squawfish and suckers are to be found only in close proximity to the shore.

W. R. Hourston and V. H. McMahon Appendix No. 13

Babine Lake - Division II

Physico-Chemical Conditions - As a check for last year's results, water temperatures, pH, and oxygen samples were taken fortnightly at Station

II, commencing June 13. In general the whole body of water was found to be cooler this summer, the contrast being most evident in the upper 20 feet where an average difference of 1.5° C. occurred. No evidence of the presence of a thermocline appeared.

In the past the plankton populations in the lake have been sampled in such a manner as to indicate distribution of a vertical nature only, since all sampling was done at a single station in the area. In 1947 this phase was extended to include sampling at six other positions of equal depth with the hope of learning something of the horizontal distribution.

Netting

Standard Netting - Of the 45 standard gill net sets made in Division II this year, 43 were set at the 10 standard positions established on the main part of the lake in 1946 and 2 sets were made at such positions in Wright's Bay. Cotton and linen series were used and were constituted as follows: Cotton - 5 sections 1½" mesh - 50 yd., 2" - 30 yd., 3" - 50 yd., 4" - 30 yd., and 5" - 30 yd; Linen - 5 sections each 50 yd. of 1½", 2½", 3½", 4½" and 5½" mesh.

The species taken in the two years with their respective catch per net-night values are listed below:

	Catch per Net-Night			
	Babine Lake Proper		Wright's Bay	
Species	1947	1946	1947	1946
Kokanee	1.33	.58	1.4	.8
Rocky mountain whitefish	.40	.53	1.2	1.6
Suckers (common and long-nosed)	.29	.42	.1	.7
Sockeye	.218	.83	.2	---
Eastern whitefish	.126	.13	---	.5
Lake trout	.126	.12	.3	---
Rainbow trout	.05	.14	.1	.2
Burbot (ling)	.046	.04	---	.1
Peamouth	.02	.02	9.7	4.7
Squawfish	.018	---	4.1	---
Average catch per set	2.62	2.61	17.1	8.6

Apart from the prevalence of kokanee this season, the catches made in Babine lake proper in 1946 and 1947 are not significantly different. On the other hand there is great diversity in the characteristics of catches made in Wright's Bay in the two years. However since 2 sets only were made in this area each year, their catch per net-night values cannot be considered on a comparative basis. Certain indications, however, are evident. The presence of a large population of peamouth in this area, as indicated in the 1946 catches is further substantiated by this year's results. It is also evident, from the figures above, that Wright's Bay is a comparatively prolific zone for most species.

Experimental Netting - A variety of types of experimental sets were made in Division II, the descriptions and results of which are listed below:

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1. Vertical set as described for Division I - No fish were caught by 3 trials with this type of set.
2. Net set across the mouth of a creek - Three sets of this type yielded 50 fish (27 kokanee, 9 suckers, 4 lake trout, 4 eastern whitefish, and 6 Rocky Mountain whitefish).
3. Floating set - Three sets were made by floating a standard series at the surface. No fish were caught by this method.
4. Hanging set - One trial was made with this type, as described for Division I but no fish were caught.
5. Suspended set - One series of nets was laid along the bottom and another series suspended over this. No fish were caught in suspended nets.
6. Oblique set - Six kokanee and 1 lake trout were taken by this type which is similar to the vertical set but has the nets hanging in a line diagonal with the bottom and surface.
7. Bottom set - shallow. A standard series of nets were laid along the bottom in water less than 50 feet deep. From the 4 sets made a total of 73 fish were taken (42 kokanee, 12 Rocky mountain whitefish, 8 suckers, 7 rainbow trout, 1 burbot, 1 eastern whitefish, 1 squawfish and 1 peamouth.

. . - deep. A standard series was set in water deeper than 80 feet. One lake trout was caught.

In general it may be said that apart from those made across the mouths of creeks, all sets were one of three types or a combination of these. The floating sets were designed to sample fish which frequented the upper waters. The bottom sets were made in order to capture those fish having a bottom habitat, while the suspended and hanging nets were intended to catch fish living in the intermediate zones. It was hoped that the vertical and oblique sets would combine and supplement the results of the others, thereby giving an indication as to the vertical distribution of fish in the lake.

From analysis of the catches it is evident that a large proportion of the fish populations are to be found in the inshore waters since 93% of the 132 fish caught in experimental sets were taken from depths of less than 30 feet. As in the case of Division I, however, the number of experimental sets were very limited.

F. C. Withler — Appendix No. 14

Babine Lake - Division III

Operations at Fort Babine camp were carried out at frequent intervals from May 19 until October 11 whenever pressure of work at the Babine Fence was such that two men could be spared.

Physico-chemical records - Station III, in Babine lake, and Station III-N in Nilkitkwa lake were operated as in 1946 at approximately fortnightly intervals, when temperature and transparency records, and plankton samples were taken. In addition Station III-A, set up during 1947 in a water depth of 18 metres off Fort Babine to take records of winter conditions was operated at the same times.

The average surface temperature at Station III was 13.9° C. the highest being 17.5° C. recorded on August 22. The average bottom temperature was 5.5° C., the lowest being 4.2° C. on May 23. Compared to 1946,

when the average surface and bottom temperatures were 16.1° C. and 5.1° C. (both of which are higher and lower respectively than in 1947), there appears to have been more circulation of the lake water in Division III in 1947. This coincides with the observation of a greater incidence of high winds.

In Nilkitkwa lake, the average surface temperature was 14.0° C. and the average bottom temperature 6.3° C. Again, the comparable temperatures w were more extreme in 1946 (14.6° C. and 8.0° C.), indicating greater circulation during the summer of 1947.

The average transparency reading from the Secchi disc at Station III was 5.5 metres, and at Station III-N, 4.6 metres. Readings of 2.2 metres and 1.6 metres occurred on June 3, when, from observation of plankton samples, a heavy bloom of copepods was evident. Since Babine lake seldom becomes heavily sedimented, except near the outlets of streams in freshet condition, and since the abundance of plankton is more readily observed from plankton hauls, there seems to be little advantage in taking further Secchi disc records there.

As in the past, water levels were recorded at the Hazelton Trail bridge. The lake level during the summer of 1947, including the period of the sockeye run, was consistently lower than in 1946. Ice coverage during the winter of 1946-47 lasted from November 21 until May 7 in Division III, with a maximum layer of solid ice recorded on January 15. Slush ice above the solid increased steadily throughout the winter until March 30, when it reached a depth of 24 inches. Since ice coverage in the winters 1945-46 and 1946-47 lasted approximately 19 days longer than in 1944-45, these two winters were probably relatively colder.

Plankton - Total vertical plankton hauls were made with a #10 mesh Wisconsin-B. C. type net at all stations at the same time as the physico-chemical records were taken. In addition, stage hauls were made at these times at Station III.

Meteorological Records - Year-round meteorology records which included wind direction and velocity, cloud coverage, rainfall and snowfall, and daily maximum-minimum temperatures were maintained at Fort Babine.

Soundings - Sounding of Nilkitkwa lake was completed in 1947 with eleven sounding lines and three spot soundings. The greatest depth noted was 17.2 metres. Since 70% of the soundings made were less than 10 metres, Nilkitkwa must be considered a relatively shallow, high productivity lake similar to Lakelse, Kitwanga and Morrison.

Netting - Netting was reduced in 1947 to eight standard and one experimental set in Nilkitkwa lake, and two sets in Division III, Babine lake. Both sets in Babine lake contained no fish, although they were set close to the yearling marking operation where predators (burbot and rainbow trout) could be observed. Two gangs of nets, one cotton and one linen, were used, containing $1\frac{1}{2}$", $2\frac{1}{2}$", $3\frac{1}{2}$", $4\frac{1}{2}$" and $5\frac{1}{2}$" meshes.

Using these nets in Nilkitkwa for the eight standard sets gave the following catches per net-night:

F. C. Withler — Appendix No. 14

Species	Catch per Net-Night 1946	1947
Peamouth	2.60	0.95
Common sucker	0.10	0.25
Squawfish	0.15	0.15
Rainbow trout	0.10	0.12
Lake trout	--	0.05
Burbot (ling)	0.20	--
	3.15	1.52

Figures for 1946, based on only four net sets, are included for comparison. The higher incidence of peamouth in 1946 was due to a large catch of spawners in one net set.

Since all yearling migrants from Babine and Morrison lakes must pass through the Upper Babine river and Nilkitkwa lake, these areas must have a high predation potential. Netting in Nilkitkwa indicates slightly higher populations of squawfish, rainbow trout and possibly burbot than the other areas in Babine lake, but lake trout appear to be few in number. Observations from the yearling marking operations and sport fishing near Fort Babine suggest that higher concentrations of predators than is indicated from net records are actually present.

V. H. McMahon — Appendix No. 15

Morrison Lake

Physico-Chemical Conditions - Certain gaps which became apparent from the analysis of last summer's data for Morrison lake were filled in and supplemented this year by three visits each of about one week's duration. Complete physico-chemical conditions were recorded for the deep central station on each visit while temperature series and plankton samples only were collected from the shallow stations to the north and south.

The whole body of water was found to be slightly warmer in the summer of 1947 with the greatest average temperature difference for the two years (1.4° C.) appearing between the 5 and 10-metre levels. During the months of July and August of both years, this same layer formed a definite thermocline.

Analysis of water samples showed that the oxygen concentration varied between 62 and 105% saturation and thus could not be considered a limiting factor in the economy of the lake.

Netting - Time did not permit the setting of experimental nets in Morrison lake, but it was found possible to extend the period of standard netting. Thirteen such sets were made at the 3 standard positions established in 1946. Both cotton and linen series were used at each of these positions and were constituted as follows: Cotton: five 50 yd. nets of $1\frac{1}{2}$, $2\frac{1}{2}$, $3\frac{1}{2}$, $4\frac{1}{2}$ and $5\frac{3}{4}$ inch meshes; Linen: five 50 yd. nets consisting of $1\frac{1}{2}$, 2, 3, 4 and 5 inch meshes.

The following species were taken and their catch per net-night values calculated.

V. H. McMahon Appendix No. 15

Species	Catch per Net-Night 1947	1946 (corrected)
Eastern whitefish	1.90	2.60
Squawfish	.95	.49
Peamouth	.75	.11
Kokanee	.64	.40
Lake trout	.44	.42
Rocky mountain whitefish	.17	--
Rainbow trout	.09	.08
Burbot (ling)	.06	.08
Long-nosed sucker	.06	--
Cutthroat trout	.04	--
Common sucker	.01	.06
Sockeye	--	.02
Coho	--	.02
Average catch per set:	5.11	4.28

From the above figures it is evident that most species were taken in greater abundance in 1947. One exception to this is the eastern whitefish. However, the difference in the figures for this species is not as significant as it may appear. Although 61% of the total catch in 1946 consisted of these fish and only 37% in 1947, if only those sets which are strictly comparable in the two years are considered, these percentages are reduced to 45% for the first and 35% for the second.

A much larger catch of peamouth chub was made in 1947 but with this exception the various fish populations, in general, appeared in the same relative abundance in the two years of fishing.

Although no Rocky mountain whitefish were caught in 1946 their presence had been recorded in 1945 as was also that of the cutthroat trout.

Stomachs were removed from all captured fish and were preserved for later analysis.

Bottom Fauna - A few bottom samples were collected again this summer in order to supplement the findings of 1946 in this phase of the investigation.

V. H. McMahon and F. C. Withler Appendix No. 16

Babine Lake Area - General Summary and Discussion

Babine lake proper is made up of at least three ecologically different areas. Division III to the north is a relatively shallow portion with many shallow bays and otherwise gradually sloping sides. It is fed only by two or three small creeks near its northern end. The central area of the lake (Division I) is moderately deep throughout its length and is in other ways intermediate between the northern and southern areas. This division is fed by the large Fulton river and at least one other smaller stream. By comparison, the southern Division II is very deep, with steep sides and few shallow bays. At least 8 smaller creeks as well as the large 15-Mile creek and the Sutherland river flow into this section. Nilkitkwa

lake to the north of Division III and Wright's Bay in the northeast corner of Division II provide examples of further differentiation in ecology, but since these areas have received relatively little investigation, the data therefrom are not considered in detail herein.

A study of water temperatures taken at the three stations on Babine lake show that a definite thermocline exists in Division III (Fort Babine) during the summer months, whereas such a thermal stratification may or may not occur in the central division at Topley Landing depending on weather conditions. A thermocline never becomes apparent in Division II (Donald's Landing) because of this area's greater depth and its exposure to the wind.

An oxygen saturation of 40% was discovered in the bottom water at Station I in May of 1947. However the oxygen saturations throughout the three divisions for the remainder of the spring and summer were greater than this. The amount of dissolved oxygen present should therefore not be a factor limiting production.

It is also evident that no limitation to animal or plant growth is provided by the hydrogen ion concentration of the water. From regular recordings at Station I and sporadic tests made at the other stations, the greatest range found to occur over the entire summer was 6.8 - 7.5 with a maximum spread of .3 for any one set of recordings.

The plankton populations of the lake have been regularly sampled at each of the three stations. Time has not yet permitted detailed analysis of these samples and thus any definite statements regarding distribution of plankton forms must be postponed. However a very general indication as to plankton intensity may be found in the transparency tests in the three divisions. The summer averages for disappearance and reappearance of a Secchi disc were 5.8, 5.2 and 5.8 metres for Stations I, II and III respectively, thus indicating a greater abundance of plankton in Division II than elsewhere.

From the limited numbers of fish caught and sampled, certain indications as to distribution seem apparent. The analysis of fish stomachs taken in 1946 catches indicate that the fish in the lake may be roughly divided into 3 categories, namely those which depend upon the flesh of other fish for over 50% of their food, those in which the diet is made up chiefly of plankton, and a third much broader group which feeds mostly on insects, bottom forms, etc.

Of all samples taken from the lake by netting, approximately 8% were of predacious species, 30% were competitors and fish other than these made up the remaining 62% of the catches. By comparison, and on this same basis, 11% of the fish in Morrison lake are predacious, 61% are competitors and only 28% belong to the third group.

On the same basis and according to the catches per net-night for the years 1946 and 1947, Division II, the southern end, accounts for approximately 49% of all predator fish in the lake (first category), 63% of the competitors (second group) and 32% of the third group. Division I (centre) contains 28% of the predators, 33% of the competitors and 48% of all other fish. The relatively sparsely populated Division III is responsible for 23% of the first group, 4% of the second and 20% of all others.

The analyses given above are the result of standard gill net setting, a procedure which samples only those fish frequenting inshore waters and the

V. H. McMahon and F. C. Withler Appendix No. 16

bottom. Another method of sampling the fish populations was adopted in 1947 in the form of experimental net sets. This however met with indifferent success as it was found that too few fish could be caught to give significant information in any respect.

Observations of fish feeding near the surface, and of the size of catches made by trolling by sport fishermen tend to indicate that the limnetic populations are greater than would appear from the net records. In view of this, some type of angling approach to the evaluation of the populations should be instituted in 1948. One of the large lake boats rigged with "poles" similar to a sea-going troller might be effective.

The elimination of predators in Babine lake by netting would appear a difficult task in view of the numbers caught either by standard sets or by the floating type of net.

Observations of trout predation on yearlings and fry in the Babine river, particularly where the yearlings pass through the Babine fence, suggest that the area including the Upper and Lower Babine rivers and Nilkitkwa lake may be as detrimental to the migrants as previously thought. Line fishing for the predators to obtain data on their feeding habits would be in order, since netting in these regions has proved singularly ineffective.

D. R. Foskett Appendix No. 17

Bear Lake and Azuklotz Lake

During 1947 work was carried out in the Bear-Azuklotz area for a longer period than in any previous year. For approximately nine and one-half weeks commencing on August 4 limnological work involving temperature readings, plankton collections, and netting was completed for comparison with the results of 1945 and 1946. The extension of the time made possible the examination of the lakes when they were losing their summer heat preparatory to freeze-up.

In Bear lake temperatures during August corresponded fairly closely with those of other years especially in waters below 20 feet. Maximum temperatures at the surface were 15° C. at Station I in the northern end and 16° C. at Station II in the southern portion. One peculiar deviation for which there is at present no reasonable explanation, was noted in the temperature series taken on August 8. At this time there apparently was a layer of water approximately 10 feet in thickness between the 60 and 70 foot depths which was much warmer than the waters above and below it. As a matter of fact this layer was almost as warm as the surface. It was apparently present at both stations at opposite ends of the lake although the waters at this depth are entirely separated by the narrows which is less than 15 feet in depth. No trace of the phenomenon could be found when subsequent series were taken. Cooling of the lake was taking place gradually during August, September and October. It is possible that this was partly a reflection of the action of the continuous storms which mixed the waters cooling the surface layer and warming the deeper portions.

Temperatures in Azuklotz lake during August were similar in range to those of previous years.

Plankton catches in both lakes appeared quite normal for the area.

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In Bear lake the algal bloom which was noted in the first part of September 1945 and 1946, was again present. The longer stay this year enabled the recording of the fact that the bloom gradually extended and became general over at least the northern portion of the lake during the first week of October.

The netting in Bear lake during 1947 produced four species which had not previously been taken in that manner, namely rainbow trout, dolly varden char, coho salmon and sculpins. Rainbow trout had not previously been recorded from the lake by the investigation.

For comparison the species taken and the catch per net-night for the three years of operation are recorded in the following table. Nets used in 1947 consisted of fifty yard lengths of five meshes - $1\frac{1}{2}$", $2\frac{1}{2}$", $3\frac{1}{2}$", $4\frac{1}{2}$" and $5\frac{1}{2}$", and in one setting fifty yard lengths of $1\frac{1}{2}$", 2", 3", 4" and 5" meshes.

Species	Catch per Net-Night 1945	1946	1947
Sockeye salmon	.82	1.90	1.87
Rocky mountain whitefish	4.36	1.67	1.70
Eastern whitefish	1.18	1.13	1.50
Lake trout	.25	.10	.43
Long-nosed sucker	1.14	.43	.37
Burbot (ling)	.25	.23	.17
Common sucker	.07	.10	.07
Kokanee	--	.03	.03
Rainbow trout	--	--	.03
Dolly varden char	--	--	.03
Coho salmon	--	--	.03
Sculpin	--	--	.03
Total	8.07	5.59	6.26

A few dolly varden char and suckers taken incidental to salmon tagging operations were also tagged but none was later recovered.

5. STREAM SURVEYS

D. J. Milne — Appendix No. 18

Lower Skeena and Tributaries (from Hazelton west)

As in the previous two years, a brief survey was made of the salmon spawning in the lower Skeena river between Hazelton and the coast, and in the thirty-odd tributaries which enter it. The portion below Terrace was inspected on August 26 and September 9, and that above Terrace on August 27 and September 6. These times are comparable with some of the inspection periods in 1945 and 1946. Only pinks and chums are considered as other species are not observed in these places at this time.

The pink run should compare with the 1945 escapement rather than with that of 1946. However the conditions, as observed, are more similar to those found in 1946. This is also true of the commercial catch. In fact

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when the streams are listed according to the number of spawners seen and compared with the other years, the escapement this year appears to be the same or even lower than last year. For example, Gold, Kitwanga and Lakelse rivers dropped from a heavy to a medium seeding while Price creek went from light to none. Khyex and Exchamsiks remained the same. Except for a few found in the Copper river, no pinks were observed either in the remaining streams visited or in the Skeena itself. Thus it appears that this year's escapement of pinks is very low in this area although at both Moricetown and Babine there were more fish than last year. This condition may have been the result of the extreme freshets which occurred in the fall of 1945 as evidenced by the washout of at least six bridges and the flooding of many parts of the highway within a radius of 25 miles of Terrace.

In chums, this year's escapement is also more like 1946 than 1945. There were very few seen in 1945 while this year they were observed in Khyex, Gold and Kitwanga rivers as in 1946 and also in Kasiks and Copper rivers. Thus the heaviest escapement for chums in the last three years occurred this season. This is also true for the size of the ocean catch.

This fall Mr. Giraud, fishery inspector at Terrace, made an inspection trip along the full length of the Copper river and found that, although there were no obvious blockages, the fast water must make this migration a very rigorous ordeal.

J. R. Brett Appendix No. 19

Alastair Lake Area

Records for a new spawning area were added to those for the Skeena river drainage this year by an expedition up the Gitnadoix river and into Alastair lake (Appendix No. 8). The only reports on file credited this territory with having all species of salmon present in its streams but no information of abundance or distribution was available. That all species are present was clearly established, including the fact that a considerable percentage of the sockeye entering the lower lakes district distribute themselves to a main stream and side branch entering the extreme south end of Alastair lake.

Gitnadoix River - The Gitnadoix river enters the Skeena from the south some 40 miles due east of the coast and not far from the small station of Salvus. It is characterized by continuous rapids for the first four miles of its lower stream bed, above which the gradient changes, transforming the river into a slower, more meandering stream as it leads a winding course to the lake. Fairly coarse gravel, often strewn with numerous small boulders, provides scattered spawning beds in the lower reaches, mainly utilized by a limited number of pink and chum salmon (observations made August 21 to 28).

One stream which enters the main river about two and one-half miles from the Skeena, was supporting a few hundred chum salmon while the pink salmon, although far from numerous, were concentrated at the very upper end of the rapids. In the large pool immediately above this point the only spring salmon observed were holding over, probably to be found at a later date spawning in the gravel beds just below this point. With the exception of a school of approximately 30 sockeye located in the main water

course a few hundred yards from the lake proper, only a small number of pink salmon were observed along the remaining sixteen miles of the Gitnadoix river. The total salmon recorded for the river during the journey to the lake is tabulated below:

	Live	Dead
Chum salmon	555	6
Pink "	500	0
Spring "	20	0
Sockeye "	30	0
Coho "	Observed as fry	

Sockeye creeks - The main sockeye creek drains into the extreme southern end of the lake and stems from snow fields and glaciers which blanket the ridge of mountains encircling this upper end. A high falls with a sheer drop of 200 feet located about one and one-quarter miles from its outlet limits the area of spawning grounds to the lower portion. In this section spawning conditions are extremely good. Fine to medium coarse gravel is distributed very evenly, particularly for the upper three-quarters of a mile along the stream bed which is from 30 to 60 feet wide and follows what appears to be a very constant course. On August 23, 1,426 live and 289 dead sockeye were counted with an estimated school of from 500 to 1,000 off the outlet. The sex ratio, where enumerations for this purpose were made, was 48% males to 52% females.

Entering this southern creek from the east and approximately one-third of a mile upstream from the lake, was a second stream carrying exceptionally high numbers of sockeye for the area of spawning grounds presented. This side stream was relatively narrow (10 to 25 feet) and more diverse in nature with a flow of 3 to 4 miles per hour through alder, willow and high grass land. It is distinguished by medium to fine gravel in the lower reaches becoming coarser further upstream and ending in a long and continuous falls about three-quarters of a mile from its junction with the main stream. Live and dead sockeye counts totalled 1,212 and 610 respectively.

The remaining creeks draining into the lake although numerous were more in the nature of waterfalls than actual creeks and, with the exception of two small areas, were not found to carry any sockeye. These two were hardly worthy of note since the total count was only 71 live and 21 dead.

During the course of creek inspection seven tagged sockeye were picked up. The dates of tagging were all within the period of June 15 (first day of ocean tagging) and June 25 which indicates, as in the case of Lakelse lake, that the run to Alastair lake occurs before the commercial fishery commences.

By comparing these observations with those at Lakelse and elsewhere, the total run to this lake is estimated at between 12,000 and 15,000. One of the chief limitations in sockeye production would appear to be from the restricted area available for spawning. With the run at Lakelse and probably Kalum below average, it might be inferred that such would be the case at Alastair lake. Nevertheless some superimposition of eggs was observed on the crowded spawning beds.

The importance of this newly recorded area is reflected in the fact that it accounted for possibly 25 per cent. of the estimated run to

J. R. Brett Appendix No. 19

the lower Skeena lakes. In future years stream inspection of this area could be performed by flying into the lake at the same time of year. Three to four hours would be sufficient to cover the whole spawning grounds adequately for a single visit.

J. R. Brett Appendix No. 20

Lakelse Lake Area

The degree of accuracy of the propagation studies as well as the assigning of the actual escapement at Lakelse in relation to the other lakes is proportional to the accuracy obtained in the stream surveys there and elsewhere. Without some additional means of improving the estimations made from direct observation of spawning grounds, it has been well recognized that such records have wide limits of error. With particular attention focussed on Lakelse lake in this respect, efforts to improve the assessment have been attempted by tagging a random sample of the adults while schooled in Blackwater bay, in close proximity to the main spawning stream, Williams creek. The limitations of this tagging system for calculating total spawning populations have been also recognized. With a view to testing their accuracy and to provide an actual count it was decided to build a counting fence across the Lakelse river. A design of what appeared to be a feasible and particularly inexpensive type of fence was prepared and put into effect by its construction during the month of May and part of June.

At a point in the river just upstream from the yearling fence and where the river is equally wide (780 feet), screened panels (8' x 10') were inserted between special grooved piles driven ten feet apart. These were angled upstream 200 feet from shore to direct the fish into two centrally located pens, thirty feet apart. Driven pickets and similar screened panels completed the arms to either bank. The current strength was no more than one-quarter mile per hour at high water. To increase the rate of flow passing through the pens a short funnel entrance was added to the upstream side. On June 12 the last panel was set in place and pushed down into the mud bottom.

Many shortcomings of the operational efficiency of the fence became strikingly apparent during the following two weeks. The sockeye would neither enter the pens nor pass out of them readily and tended to accumulate at various points along the screening, fighting to pass the barrier. It appeared that the main problem was a direct result of the very sluggish current. The addition of a funnel entrance had not been effective enough in increasing the rate of flow through the central pens. The structure of the funnel entrance was therefore increased considerably in a hurried effort to circumvent the necessity to permit the accumulating run to pass the fence. This was not successful, nor any of the other emergency measures put into practice to make the operation satisfactory. During the course of these efforts a hole was made under two of the screens where rock had interfered with the usual depth to which the screens had been driven, and the majority of the run escaped upstream before remedial measures could be brought to bear. Having lost the possibility of a complete count, the remainder passing through the pens were tagged to increase the total

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for the original technique of releasing tagged fish for later recovery and calculation of the total run.

To the 866 sockeye tagged at the fence were added 1,046 from Blackwater bay and an additional 334 from tagging operations off Scully creek, bringing the total to 2,246 for the whole lake. By regular stream surveys carried out at weekly intervals for each of the spawning creeks the calculated total run from tag returns was 17,000. The distribution of these has been estimated to be as follows:

Williams creek	15,000
Eliza creek	900
Scully creek	1,050
Granite creek	50
Others	20
Total	17,020

During the examination of the sockeye from the fence and seining operations 14 ocean tags were reclaimed. These had been affixed between the dates June 17 to 29 off Smith island. This adds very distinct proof to the well founded belief that the majority of the Lakelse lake run has entered the Skeena prior to the commencement of the commercial fishery.

D. F. Alderdice Appendix No. 21

Kitsumgallum Lake Area

Marked difficulty has been experienced during the past three years in assessing the spawning population in the Kitsumgallum lake area by reason of its extreme glaciation. The heavy silt in suspension is sufficiently effective in limiting observation of spawning in the lake and main stream that in places it is necessary for a salmon to break water before it is located. By past reputation the peak of the sockeye run has occurred during the first and second weeks of September and labelled it as a late run. In consequence a first effort to cover this territory was made between the dates of September 11 and 14, This unfortunately coincided with one of the heaviest downpours on record and resulted in terrific flooding of the creeks bringing the lake up at the rate of 18 inches in 18 hours. It was found impossible to observe anything in the way of sockeye either dead or alive and the effort was curtailed.

A second visit was made on September 19 and counts were possible for Clear creek and Dry creek but still impossible for the Cedar river. In all, a total of 1,100 sockeye were counted and estimated as present at that time. By comparison with other years and considering the unavoidable shortcomings of the observations this year, it might be estimated that the total run was between 6,000 and 8,000.

During the course of the inspection three ocean tags were reclaimed. These had been inserted on the dates of July 5, 13 and 20. This places the Kitsumgallum run toward the middle and end of the general Skeena river migration and confirms the belief that the Kitsumgallum lake sockeye are subject to the reductions imposed by the commercial fishery, whereas the

D. F. Alderdice — Appendix No. 21

Alastair and Lakelse lake runs are not.

Without the aid of a tagging programme within the lake itself or some mechanical means of enumeration (e.g. fence, trap etc.), no greater accuracy or truer picture of the run can be expected in future years.

J. A. McConnell and J. R. Brett — Appendix No. 22

Kitwanga Lake Area

The exact nature of the spawning facilities for sockeye salmon in the Kitwanga lake area still remains an enigma. A survey on September 5 of the lower two miles of the unnamed creek which enters at the north-eastern corner of the lake indicates that few if any sockeye use it for spawning purposes. Sockeye were again observed in schools off the mouth of the creek and in its lower reaches but only two were discovered in the remaining $1\frac{3}{4}$ miles covered. There is still a possibility that some of the sockeye do move into the creek later in the season to spawn in the upper portion. On September 6 and 7, however, spawned-out sockeye were taken in gill nets in both sections of the lake offering positive evidence of lake spawning. The nature and extent of this behaviour has yet to be studied but it is evident that it may take place in fairly deep water on the steeply inclined shores. In the brief survey no dead salmon or other signs of spawning activities were apparent in the lake.

An examination of the Kitwanga river on September 7 and 8 revealed a run of pink salmon very much smaller than that of the parent year, 1945; even lower, perhaps by 3 or 4 times than that of 1946, the low year of the cycle. Because of its light nature, it was possible to count the fish in sections of the stream and estimate the total run at between 10,000 and 12,000. The fish were mostly concentrated in the upper 5 miles where actual spawning had just started. Farther downstream, spawning was near its peak and few "fresh run" fish were in evidence. A small number of chum and spring salmon were noted in this stream.

Only two pink salmon could be discovered in the lower one-half mile of Moon creek and none was present in the lower section of the other tributary, Kitwancool creek.

J. R. Brett — Appendix No. 23

Kispiox System or Lac-da-dah District

In any one year the total Skeena escapement can be ascertained with most accuracy by bringing together all the available data from tagging returns, counting fences and stream surveys. The more observations that can be added from the spawning grounds, the higher the observed total becomes and the closer the calculated figures approach one another. In order that the spawning ground observations could be as complete as possible and equal to those of any previous year, some of the more remote districts were visited by plane, hired to fly into first the Kispiox system and slightly later into the Slamgeesh area.

J. R. Brett Appendix No. 23

On September 19, Lower Club creek and Stephens creek in the Kispiox system were visited by landing on Stephens lake. In the former a count of 1,338 live and 438 dead sockeye was made with an estimated 200 to 500 off the mouth. A fair number had been dragged up the banks and into the bushes by the usual number of bears that inevitably collect during this season. It does not appear that this can be considered a serious source of mortality for the average bear-killed salmon was found to be spawned out. Stephens creek which drains the network of lakes is definitely not a sockeye creek being below the lake and lacking adequate spawning grounds. Only 26 live sockeye were observed on the few gravel beds inspected.

Swan lake which is the upper lake in the chain of three (Swan, Club and Stephens), has but one creek of any importance. This was found to carry 575 live and 339 dead sockeye. It is comparatively shallow and quite dispersed through willow and alder growths and permits a greater source of possible destruction through the feeding activities of bears. Again the extent of actual loss is difficult to ascertain for although many parts of carcasses can be found the question of how many were unspawned goes unanswered.

One other creek, Upper Club creek, was found to have 202 sockeye constructing redds in the few hundred feet which constitute its length. Undoubtedly more might be found at a slightly later date on this spawning area but there was little indication of this above or below the creek (it links Club and Swan lakes).

In round figures the Kispiox system must account for approximately 12,000 sockeye in the total escapement for 1947.

A. L. Pritchard and D. J. Milne Appendix No. 24

The Morice System and the Upper Bulkley

As in 1946, no specific survey was arranged for the Morice river and lake area in view of the fact that no real conception of the escapement is possible by direct observation in the heavily silted waters. The estimate was reached through close observation of the run and Indian fishery at Moricetown falls. The authors, however, examined portions of the Bulkley on numerous journeys through the district and kept a check on reports of the game and the little Indian fishery which took place.

That the salmon as usual reached the spawning grounds in Morice river and lake without serious hindrance is evident from the reports of the officers of the Dominion Department of Fisheries. Very few were recorded for the Upper Bulkley. The log jams and the resulting diverted flow are still in evidence. In the autumn they were almost impassable to fish. At the same time the beaver were again constructing their dams as an additional obstacle.

The run of sockeye at Moricetown falls was definitely smaller than 1945 and was characterized this year by the presence of a large proportion of jacks (fish less than 19 inches). On the basis of the Indian catch (3.200 sockeye) and the percentage of tags returned (14%), the sockeye population this year is calculated to be about 30,000 fish after corrections have been made for the amount of selective fishing by the Indians

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for both larger fish and white tags. This compares with 80,000 and 40,000 in 1945 and 1946 respectively. In contrast the spring salmon run this year was the largest in the last three years judging from the Indian fishery at the falls. The coho run appeared earlier than last year and was similar to 1945 in both time and size. The steelhead run was comparable with last year while the pink run appeared to be greater than last year but much smaller than 1945.

F. C. Withler — Appendix No. 25

Babine Lake Area

Enumeration of the sockeye on Babine spawning grounds was carried out by making stream surveys in each of the three divisions, at 8 to 10 day intervals when possible. A "survey" of a stream consisted of counting and estimating the live fish, counting and sexing the dead, picking up tags on dead fish and recording any information pertinent to the run, e.g. water levels, obstructions, predation and Indian fishing. In this way, all stream work was comparable to that done in 1946.

Comparison of the two year's estimates is given in the following table:

Sockeye Runs - Babine Area

	1946	1947
Lower Babine river	9,000	10,000
Upper Babine river	9,000	10,000
Trail creek	100	75
Unnamed creek	0	0
Five Mile creek	50	200
Nine Mile creek	1,000	600
Fulton river	100,000	115,000
Tachek creek	6,500	12,000
Sockeye creek	320	1,400
Pierre creek	16,000	19,000
Twin creek	9,500	9,700
Pendleton creek	2,000	1,800
Fifteen Mile creek	28,000	25,000
Four Mile creek	1,100	1,800
Six Mile creek	340	800
Grizzly creek	3,500	4,900
Morrison river	20,000	28,000
Salmon creek	5,000	5,000
Total	211,410	245,275

The runs to each stream are of the same order of magnitude for both years, with a tendency toward larger runs in 1947. This is shown in the totals for both years, which also reflects the increase of sockeye counted at the fence, (475,705 in 1946; 522,561 in 1947).

Large numbers of "jacks" were noted on the streams, particularly Twin, Pierre, Tachek and Morrison in which on October 11 they comprised 95%

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of the run. This observation coincides with the high proportion of these noted at the fence. The significance of the phenomenon is discussed in a later summary report.

Although the stream counts are far from the actual number recorded at the fence, since they appear to vary roughly in proportion to the fence counts, it should be possible to calculate the approximate total runs to Babine in past years from the stream records. That the estimates for the number of fish entering the lake before the fence was constructed have been too low is apparent. Since some of the discrepancy between fence and stream counts may be accounted for in lake spawning, an investigation of this possibility, deemed questionable in the past, is indicated as part of future programs.

With recommendations on stream improvement in view, rough mapping of all creeks in the Babine area was completed this year. Enough information has been collected at this time to suggest experimental investigations into the control of run-off (definitely indicated in Babine), the effect of log jams, the deleterious effect of stream dispersion into several channels, and the possibility of improving the gravel in the stream beds themselves.

J. R. Brett Appendix No. 26

Slamgeesh Area

Two small lakes, Damshilgwit and Slamgeesh, lie just north of the Skeena river in the northern sector of its drainage. They are linked together by the upper Slamgeesh river and drained by the lower Slamgeesh into the Kilankis river, and thence to the Skeena. One small stream, Damshilgwit or Fifth Cabin creek, drains the low flats north of these two.

A first visit to these streams during the spawning period was made in late September and observations at this time have proved that this zone is not one of the better spawning areas of the Skeena drainage. The total counts of sockeye for each of the spawning streams was:

	Live	Dead
Damshilgwit	309	41
Upper Slamgeesh	161	357
Lower Slamgeesh	0	0
Kilankis river	0	0

The Kilankis river is exceptionally opaque from glacial silt and upstream migration for such salmon as may frequent it is limited by a falls about one-half mile above its confluence with the lower Slamgeesh river. No sockeye were observed dead along its banks and although it was impossible to see if any live were present, it is difficult to conceive that it would ever be a spawning stream for sockeye.

Since the balance of live to dead sockeye in the upper Slamgeesh was in favour of the dead, it is probable that a week to ten days earlier would be more appropriate for catching the peak of the run. The 1947 total escapement might be guessed as between two and three thousand.

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Bear Lake Area

Although it was suspected that a large percentage of the sockeye spawning in the Bear lake area took place along the shores in water too deep for observation, this fact had never been definitely proven. For this reason a tagging program was outlined in the hope of assessing the distribution of the salmon which entered the lake.

Since dipping salmon from the pools in the Bear river proved to be impractical, a fence was constructed across the head of the stream to trap sufficient individuals. This fence, which was 290 feet long and stretched across a channel with a maximum depth of 7 feet 6 inches, had a log framework, small tree trunks for pickets, and stone cribbing at each end. In the one trap a total of 783 sockeye, 147 coho, 3 dolly varden char, 5 long-nosed suchers and 3 common suckers were tagged.

In order that the experiment should be of the greatest value, the Indians were persuaded to discontinue their fishing for salmon above the fence. Thirty-six tags were subsequently recovered from the various spawning grounds or in gill nets set in the lake.

Counts of the spawning fish made as in other years indicated a population of 3,046 sockeye. In addition the ratio of tagged to untagged salmon was noted when making counts. The period of tagging was too late to give a true estimate by this method since the stream population, the only one which can be adequately seen in the area, was largely past the river by the time the fence was completed. Thus it was felt that the population of over 100,000 indicated by the ratio of 1 tag to 140 sockeye was too high. The recovery of 23 tags from 1,244 salmon found dead on the shores of the lake indicates a population of 41,742 sockeye. Various factors, among them the inability to extend the investigation until all the sockeye were dead and the inherent error in the method itself, make it inadvisable to place too much reliance on either figure. It is certain, however, that methods used in estimating the population in this area in the past have led to figures far too low, perhpas of less than 10% of the actual population.

The tagging of salmon at the upper end of the Bear river gave pertinent information as to the length of time the sockeye spends in the lake before it dies after having spawned out. Amongst the freshly spawned out fish examined, the shortest time recorded between when a fish left the fence and was recovered was 27 days and the longest 46 days with the average at 36 days. Recoveries of tags in Azuklotz creek indicate that the stream spawning sockeye also enter the lake approximately a month before their deaths.

Only two coho tags were recovered before leaving Bear lake. It is expected that recoveries on the spawning beds by Indians will give some idea of the distribution of the coho spawning in this area, though the information is not likely to be received before March or April due to poor communications.

Although more counts than usual were made of salmon spawning in the Bear river, weather conditions were such that visibility was very poor. On the basis of past experience the run is estimated at 15,000 spring salmon. However, there is some evidence from tag returns that the run was of greater proportions.

The pink salmon in the Bear river this year were much fewer than those present in the cycle year, 1945. Approximately one-half the area occupied by redds of this species in 1945 was occupied this year. However,

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though the numbers were reduced from 3,000 in 1945 to 1,000 in 1947, the more even sex ratio, 3 males to 1 female instead of 6 males to 1 female as in 1945, probably resulted in a comparatively greater egg deposition than the numbers indicate.

Stream conditions in the area were good, the continuous stormy weather maintaining the water at a level higher than usual. In one case a creek which normally enters the lake as seepage was able to establish a definite channel to the lake. Should the stream consolidate this channel in subsequent years it will reduce the amount of seepage which at present supports sockeye spawning on the nearby shores. A small log jam was removed in each of Azuklotz and Salix creeks in order to facilitate stream examination and to prevent them developing into salmon migration hazards. Windfall creek, a relatively new stream, some years empties into and forms part of Azuklotz creek as in 1946, and other years, as in 1945 and 1947 follows a channel down to Azuklotz lake. Landslides account for the shifting channel. The value of the stream from the salmon production angle is problematical though both sockeye and coho use it when it occupies the channel emptying into Azuklotz lake.

The counts of spawning sockeye in the Bear lake area were:

Azuklotz (Mink)# creek	2,731
Salix (Willow) creek	40
Windfall creek	30
Bear lake	275

- Names in brackets are those used before streams were officially named.

The run in Azuklotz creek was about 60% jacks and though this stream usually has a large percentage of jacks it was higher than usual.

Coho commenced to spawn in the creeks toward the end of the third week in September though spawning was not general at the time of the close of the investigation in this area.

The Indian catch at Bear lake this year amounted to 500 sockeye and 3,000 spring salmon. As in 1945, however, some Indian youths killed a large number of salmon for sport and left them to rot on the river banks. In addition about 100 partially dried salmon rotted during wet weather and were discarded. Thus the total number of spring salmon killed in the area amounted to about 3,600.

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Probable Sockeye Salmon Escapement in the Skeena River

One of the most important objectives of any investigation of Pacific salmon should be to obtain the relationship between catch and escapement so that a basis for setting the proper balance between these two can be set forth and optimum exploitation result, yet the run be guaranteed for perpetuity. The catch - commercial and Indian - while not at present set down with absolute accuracy, can be so recorded merely by making such a condition mandatory. The absolute estimation of escapement to large river

systems such as the Fraser and the Skeena has always been a difficult task which so far has baffled investigators although the ultimate goal is gradually being approached.

Each year on the Skeena, the spawning grounds have been closely inspected and counts made of the fish thereon in accordance with definite procedures. Difficulty has always been experienced in larger streams where there are big numbers of moving fish and in both large and small rivers when schools of salmon are resting in the deep pools. The construction and operation of a counting fence on the Babine river, however, have made possible a count of all the fish entering this, the most important sockeye spawning area on the system, and has enabled comparison between the observational estimates and the actual counts. The returns from tagging at the mouth of the Skeena have provided a means of estimating roughly the total escapement and its distribution to the various districts.

Even prior to the time when the Babine fence was first operated, after taking into consideration all available information, the investigators had drawn up for each year "a most probable escapement" for the Skeena. It was felt at the time for various reasons that the observational method resulted in a figure as much as 50% too low. This has been amply confirmed by the counts at Babine in 1946 and 1947. The fact, however, that the error in the observed escapement could be recognized even before proof was available, gave the estimate greater value and has led to recording the following figures with the full recognition of the fact that although they are not absolutely correct, they are probably the closest which have yet been presented.

Year	Most Probable Escapement	Commercial Catch	Most Probable Indian Catch
1944	620,000	807,000	90,000
1945	1,360,000	1,227,000	150,000
1946	680,000	621,000	75,000
1947	690,000 #	ca. 385,000	ca. 70,000

- In considering this item, it must be remembered that the escapement in 1947 was constituted of just over 45% jacks - precocious three-year-old males under 19 inches in length. Since the sexes in the remaining normal-sized sockeye were about equal, these jacks were unnecessary for efficient fertilization and the effective escapement must be considered as about one-half this figure.

For the year 1946, the first in which the Babine fence was operated, the observational estimates for the spawning grounds of the whole Skeena system gave a total of 340,000 sockeye while the "most probable escapement" was assessed at 680,000, i.e. the observed was about 50% of the most probable. Of this difference (340,000), 261,000 or 77% were "found" in Babine as a result of the total enumeration at the fence where the actual count was 261,000 above the observed. There remained the problem of assigning the balance of 23% or 79,000 fish to the other areas in the system.

In 1947 further information on spawning grounds has been provided with the discovery of a sizeable run to Alastair lake and with the discovery that the estimates for the Bear lake area have undoubtedly been too low in previous years. The distribution figures for this year are

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therefore the most accurate and are presented in the table below. There is no doubt that further developments may change the figures slightly but we are convinced that they will not affect the general impression as to the importance of the various spawning areas which are listed as they occur from the coast toward the interior.

Area	Most probable Escapement	% of total Escapement
Ecstall system	1,000	.2
Khatada lake	nil	nil
Alastair lake	14,000	2.0
Lakelse lake	20,000	2.9
Kitsumgallum lake	8,000	1.2
McDonell lake	3,000	.4
Kitwanga lake	4,000	.6
Kispiox system	15,000	2.2
Babine lake	523,000	76.1
Morice lake	50,000	7.3
Upper Bulkley system	500	.1
Slamgeesh area	3,000	.4
Bear lake area	40,000	5.8
Motase lake	nil	nil
Sustut system	2,500	.4
Northern Skeena system	3,000	.4
Total	687,000	100.0

It is certainly safe to conclude from the above table that the Babine area received by far the largest sockeye salmon spawning population. Next in order was the Morice and upper Bulkley system followed closely by the Bear lake area. Of the same order of magnitude, but smaller than those already mentioned, were the escapements to Lakelse, Kispiox and Alastair systems.

6. SALMON COUNTING FENCES

J. A. McConnell Appendix No. 29

Enumeration of the Salmon at the Babine Fence in 1947

The salmon counting fence in the lower Babine river was inserted on June 26 for its second season of operation. The daily routine throughout the year followed that of 1946, the inlet doors to the traps being opened at 6.00 a.m. and the salmon counted out as often as was deemed necessary until 7.00 p.m. when the inlet doors were closed for the night. Multiple Denominator Labcounts having a counter for each species were used for enumeration in preference to the single Veeder Root tallies.

A fifth trap was constructed during the spring of this year which proved very successful in removing any crowding on the remaining four. Since the next two years will probably bring even larger salmon runs to the

Babine fence, plans have been made to add another pen to spread the pressure still further.

Sockeye Salmon - Although one sockeye was passed through the fence on June 30, the run did not start to build up until July 17 when 245 were recorded. During the next six days, a small "peak" occurred when 22,270 were counted. This was followed by a drop to below 1,000 a day until the main run entered during the month of August, the daily average for that period being 12,610. The daily total declined throughout September dropping below 1,000 on September 26 by which time 99% of the total run had passed. The fence panels were removed on October 7 when the daily count was down to 87.

The final sockeye count was 522,561. However, since this is actually 45,000 greater than 1946 and the commercial pack is approximately two-fifths smaller this year, an examination of the sizes of fish in the run seemed necessary to intelligently assess the situation. Throughout the season a differential count was made on a proportion of the run, the sockeye being separated into two categories: "jack" or precocious male sockeye (19.0" or less in length) and "normal" sockeye (over 19.0" in length). In the table below the results of this sampling are given for the five stated periods:

	"Jacks"	% of Total	"Normals"	% of Total
July 1 - July 31	529	10.5	4,512	89.5
Aug. 1 - Aug. 15	4,621	40.5	6,794	59.5
Aug. 16 - Aug. 31	6,951	59.8	4,663	40.2
Sep. 1 - Sep. 15	2,774	67.2	1,356	32.8
Sep. 16 - Oct. 1	1,352	75.4	440	24.6
Total	16,227	47.7	17,765	52.3

It will be noted that the precocious male sockeye increase in proportion throughout the run but an average is reached in using the totals for the whole period. The number of fish sampled was 33,992, this being 6.5% of the total count. Of these, 16,227 (47.7%) were "jacks" and 17,765 (52.3%) "normals". It is possible to expand the above data and estimate that the 522,561 sockeye enumerated at the fence were made up of approximately 249,500 "jacks" and 273,100 "normals". Since the small "jacks" are all males and since in the "normal" population the sex ratio was 45.8% males and 54.2% females, the extra "jacks" are probably surplus and not necessary for spawning. Thus, the effective population is possibly 200,000 lower than the 1946 total of 475,000; a conclusion more in agreement with the low commercial catch.

Together with the above count, records were kept of other irregularities which indicated that 5.5% of the run bore marks of having been partly caught in gill nets, that 0.35% had been gaffed by Indians and escaped, and that 1.9% had received some other injury.

Pink Salmon. The total of 55,421 pink salmon counted through the Babine fence this year is much lower than would be expected from the medium to heavy spawning reported in the parent year, 1945. The run was, however, almost twice that of 1946 but still only about one-fifth what might be

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expected in a "high" year. The first of these fish appeared on August 9, earlier than last year by 11 days. A peak of 4,772 was reached on August 29 and the run was complete on September 25.

Coho Salmon. The count of coho salmon was 2,237 less than last year, the total for 1947 being 10,252. The greatest daily total, 426, occurred on September 25. A few coho were noted passing over the apron of the fence after removal of the panels on October 7, but it was believed that the run was nearly over since the daily total had dropped to below 100 two days previously.

Spring Salmon. The early run of spring salmon in the Babine river did not materialize this year and thus the count of 15,614 must include virtually the total run. Only 37 fish were counted during July. The daily average in August was 153 and in September 348, the peak occurring between September 16 and 20. Although no actual counts were made, probably 10 to 15 per cent. of the total were small "jack" springs. The total count represents an increase of 5,000 over last year.

Chum Salmon. Seven chum salmon appeared at the Babine fence between August 19 and September 8 providing further evidence that some members of this species do spawn at considerable distances from the ocean.

Steelhead Trout. During the months of April and May, a heavy run of steelheads was observed in the lower Babine river, fair catches being made at that time by the local natives. Only three were counted through while the fence was in actual operation.

In the following table are the total counts of the five species of Pacific salmon passed through the Babine fence in 1946 and 1947. In consideration of the 1947 count, the prevalence of "jack" sockeye, mentioned above, must be remembered.

	1946	1947
Sockeye	475,705	522,561
Spring	10,528	15,614
Pink	28,161	55,421
Coho	12,489	10,252
Chum	18	7
Total	526,901	603,855

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"Ocean Tag" Recoveries at the Babine Fence in 1947

In order to reclaim and examine all salmon bearing ocean tags - white serially numbered disc and cerise baffle - at the Babine fence, the wire "baskets" and glass viewers in the outlet chute from the pens were again employed. A full description of this apparatus has already been submitted in Appendix 31B of the Summary Reports for this station in 1946. This year, however, the tags were merely examined, the numbers recorded and the fish counted and released above the fence. The change in procedure was designed to allow direct determination of the exploitation of the "ocean tagged" fish by the Indian fishery in Babine lake and thus avoid the

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necessity of indirect calculation of the type used last season.

The total number recovered and inspected was 543, distributed as follows: sockeye - 534, coho - 4 and pinks - 5. In addition, 50 sockeye passed through so quickly that they could not be retained and examined while 4 definitely showed scars resulting from carrying tags at one time.

In the case of the sockeye salmon, the recorded tags clearly indicate that Babine fish were present off the mouth of the Skeena river on every day on which tagging was conducted (June 15 to July 27). They were in greatest concentration off Smith island after the middle of July (July 19 to July 27), reaching a peak of 48.5% of the total tagged on July 24 and 25. The time occupied in covering the distance of about 300 miles from the point of tagging to the fence ranged from 14 to 35 days with an average of 23.2 as compared with a range of 20 to 39 days and an average of 27.4 in 1946. The slightly faster rate of travel is considered to be due to the fact that the water in the connecting rivers was generally higher this season than at the same period last year. It was again very apparent that the late fish made the trip more quickly.

If the running daily averages of recoveries are plotted against the running daily averages for the complete escapement, there is a fair correlation. Thus the tagging at the river mouth has again attained a certain degree of proportionality insofar as the Babine salmon are concerned.

It is interesting to calculate from the general tag returns, the percentage which the Babine lake escapement constitutes of that for the whole system. If from the total tagged (2,329), are subtracted those removed by the commercial fishery (433) and those taken by the Indian fishery outside of Babine (165), there remain 1,731 of which the 585 recaptured at Babine make up 33.3%. It is thus not illogical to assume that a minimum of one-third of the total sockeye in the Skeena spawned this year in the Babine area.

A. L. Pritchard Appendix No. 31

Tagging at the Babine Fence - Distribution of Runs in 1946

One of the main reasons for tagging a definite proportion (2% in 1946 and 1% in 1947) of the sockeye salmon passing the Babine fence was to procure information on the migration upriver and through the lake to the spawning tributaries. Particularly was it desirable to know whether there was any segregation in time of arrival and movement of the populations to the separate rivers.

During the winter of 1946-47, the results of the experiment in the summer of 1946 were analysed. In this from each day's escapement, one sockeye in every fifty was tagged with an ordinary button tag having two white discs. Recoveries were obtained from the Indian fishery through the encouragement afforded by a reward of twenty-five cents and from stream surveys conducted by employees of the Fisheries Research Board and the officers of the Dominion Department of Fisheries. The total number thus tagged was 9,417. The returns to April 1947 were 1,739 distributed as follows: Indian fishery - 1,151, Federal fishery officers - 37, Fisheries Research Board gill nets - 2, Babine fence - 32 and stream surveys - 517. A few

more records are now available but these are not sufficient to affect the broad conclusions here reached.

Speed of Migration. The speed of migration was calculated as the time between the passage through the fence and that given on recovery. It is evident that errors in this figure can be caused by inaccurate reporting of the time of recapture, the retention of tags, etc. Certain general deductions may however be safely drawn:

(1) Sockeye after passing the Babine fence may reach Nilkitkwa lake immediately above on the same day and remain up to 52 days thereafter. Over 57% went through this lake in 5 days and the average time was 8.8 days.

(2) The assessment of time for the Babine river, Fort Babine and other areas where spawning occurs, is difficult because fish destined to spawn in each remain a long period and thus increase the average.

(3) The best indication of progression up the lake is probably given by recording the day after leaving the fence on which just over 50% of the recoveries had been made, e.g. Nilkitkwa - 4th day, Halifax - 6th day, Old Fort - 11th day, Topley Landing - 16th day and Pendleton Bay - 18th day.

(4) All fish which pass Babine fence live for at least ten days before reaching their spawning stream, depositing their sex products and dying. The ranges in length of life above the fence vary from river to river being smallest in the smaller streams.

(5) It is evident in almost every instance that the later in the season the sockeye salmon reach the Babine fence, the shorter is the period before they reach the rivers, spawn and die.

Segregation of Runs. There is undoubtedly partial segregation of the runs to various rivers in point of time at which they reach the fence. From July 7 to 30, fish from as many as six streams were involved. The runs to Donalds Landing, 9-Mile, 4-Mile, Twin and Pierre creeks appear at the very beginning of the migration in July. Those to Pendleton and 6-Mile are slightly later. After August 24, only 15-Mile, Fulton and Morrison are immediately concerned. Such information can be of interest in relation to the distribution and intensity of the Indian fishery which if operative at certain periods during the summer, will mainly drain one group of streams while at other times it will affect a different set of tributaries.

It has been maintained that in certain Babine lake tributaries two very definite runs occur - an early one followed by another a week or ten days later. The graphs show that such a separation may even be evident as the sockeye enter the lake. For Pierre and Twin creeks at least, there are definite modes early in the season followed by a period of low returns and then another mode.

The analysis of the data now available from approximately 5,000 fish tagged in the same manner in 1947 will be completed as soon as possible with a view to determining whether similar behaviour occurs from year to year and whether any other facts of interest from the viewpoint of conservation are demonstrable.

A. L. Pritchard and F. C. Withler Appendix No. 32

Estimation of Babine Spawning Population in 1946 and 1947 Through Proportionate Tagging at the Babine Fence

One of the objects of the present experiment at the Babine fence was to test the reliability of the method of estimation of populations by proportionate tagging. In 1946, this was accomplished by affixing button tags each day to a number of sockeye equal to 1/50 of the run during the previous twenty-four hours. This work began on July 17 at which time 8,337 sockeye had been counted. Heavier tagging was therefore carried out for a short time to achieve the correct proportion. There was a lag of one day behind the daily run represented but an exact method of calculating the number of fish to be handled was provided.

During the stream surveys, counts were maintained of live and dead fish tagged and untagged. Ratios were calculated only from counts of live and dead fish, and not from estimations.

From such ratios provided by the stream surveys in 1946, the estimate of the population passing the fence whether from live or dead counts was placed at approximately one million fish, whereas the number of sockeye salmon actually counted through the fence was 475,705 (100% error). Reasons for the lowering of the ratio of tagged to untagged individuals can be suggested. After consideration of the number of tags returned by the Indian fishery and of the catch which they reported, there appears to be a definite selection of tags in the Nilkitkwa lake area. That Indians sometimes gaff tagged fish in preference to untagged is also apparent. However, even on the assumption that the Indians catch only tagged fish (which is abundantly untrue), the estimation of the run through the fence is still high.

In 1947, certain refinements were made in the tagging procedure. Fish were handled in both the morning and afternoon, so that the early tagging represented the count of the previous afternoon and the late tagging the run of the morning of the same day. Every precaution was taken to make sure the tags were secure, although there were no observations in 1946 which indicated this to be a cause of decreased tag ratios. Every effort was made to ensure that the streams were covered at the specified eight day intervals. A notable change in 1947 was the reduction in the tagging ratio to 1/100 instead of 1/50.

With these refinements and changes, the estimated run from dead counts was 728,000, as compared to the actual run of 522,561. The estimation from the live tag ratio was again twice the actual count. If the tags from the Indian fishery, numbering approximately 950, are included in the estimation for both live and dead counts, and the Indian catch (estimated roughly at 30,000) is added to the inspected sums, the estimate becomes 530,000. This figure is quite close to the actual run passing through the fence.

Since estimates from tagging can be as much as 100% too high, and estimates from stream surveys appear to be as much as 50% too low (see Summary Report No. 25 - Stream Surveys - Babine lake), these methods of population enumeration must still be used with great caution. Until such time as they can be brought more into line by refinement of technique in the field or by changes in the methods of calculation, the adult counting fence must be accepted as the only certain way of accurate enumeration for spawning salmon.

F. C. Withler

Appendix No. 33

Studies on Environmental Changes of the Babine River during the Sockeye Run

As in 1946, records of water level and temperature were kept at the Babine fence in order to evaluate the effect of physical and chemical factors on the migration of the salmon. This was done by means of a level stake and a maximum-minimum thermometer. Level readings were taken at 9.00 a.m., immediately following the cleaning of the fence, so that all readings would be comparable. The thermometer was read at 5.00 p.m. each day.

The water level of the Babine river was consistently lower during the summer of 1947 than in 1946. Not until September 25 did the levels of both years reach the same height on the same date. Since the rise and fall of the Babine river is so gradual, the correlation of daily counts and water heights is much less striking than it is on short coastal streams.

In order to determine whether or not the daily counts of sockeye through the fence were indicative of the "natural" passage of fish up the river, the experiment involving the placing of tagged fish below the fence was repeated with slightly modified methods. Instead of ten fish, twenty were tagged every fifth day of the run. Since the tags for each trial were distinctively coloured, it was possible to record the time that the tagged fish returned through the pens.

In both 1946 and 1947, nearly 50% of the tagged fish returned within twenty-four hours after tagging. This is actually within twelve hours of trap operation, since the fence was closed during the hours of darkness. In 1946, in one week following tagging, 87% had returned through the fence; in 1947, in the same period 74% had returned. The remainder either came through later, passed through unnoticed because the tag was not discerned, or did not return before October 7 when the fence was taken out. The time required for the fish to repass the fence gradually increased throughout the season. This increased time of recovery may be related to the degree of sexual maturity of the fish behind the fence or to variations in population pressure.

From the data on the time of recovery and by the fact that observation below the fence failed to reveal any damaged or killed fish, apparently the runs pass through the fence with little delay, and certainly without any real damage.

J. A. McConnell

Appendix No. 34

Salmon Sampling at the Babine Fence

Sampling of salmon at the Babine fence varied only slightly from that initiated last year. In conjunction with tagging procedures, the length and sex were recorded for the sockeye salmon dipped randomly from a trap providing a proportionate sample of 1/100 of the run. The ranges in length (taken from the tip of the snout to the middle of fork of tail) for this sample was from 13.0" to 27.0". The overall sex ratio of 71.1% males to 28.9% females when broken down further indicates that there were 46.7% precocious males or jacks, 24.4% "normal" males and 28.9% "normal" females.

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It is interesting to note that this ratio of 46.7% "jacks" to 53.3% "normals" agrees very closely to that of 47.7% "jacks" to 52.3% "normals" from the separate differential count described under Summary Report No. 29 on enumeration.

The ovaries from 100 female sockeye were taken during the run for egg counts. Enumeration of the samples taken in 1946 has been completed, the mean egg content for the 64 samples being 3,287 with a range of 2,121 to 4,466. By way of comparison, this count is considerably lower than that of 3,888 made in 1939 on Lakelse lake sockeye by Dr. A. L. Pritchard and Mr. W. M. Cameron.

On the basis of the above data, an interesting series of rough calculations might be carried out for the 1946 sockeye run to Babine lake. Presented below, these serve to emphasize the size of the escapement and its vast potentiality.

Total count -	475,000
Probable no. of females -	237,500
Average egg content per female -	3,287
No. of eggs available for deposition -	780,662,000
Possible number of resulting yearlings -	15,613,000
(Basis: 2% survival)	

Detailed measurements and counts were made on 50 sockeye, 10 springs, 10 pinks and 10 cohos for Mr. D. J. Milne as part of his biological sampling programme.

7. STATISTICS

D. J. Milne Appendix No. 35

Skeena River Commercial Salmon Fishery - Introduction and Fishing Effort

As last year's summary gave much information on the general history, effort and catch statistics, the present report will deal mainly with the last few fishing seasons. The current season was observed from June 1 to September 15. Good cooperation was received from both the Fisheries Department and the commercial salmon industry.

The gill net fishing for spring salmon in the Skeena river estuary was good this year and that for sockeye was poor. As a result some of the fishermen preferred to use the large meshed spring nets ($7\frac{1}{2}$") throughout the season rather than to change over to the smaller nets ($5\frac{3}{4}$") during the sockeye season.

The sockeye season started off with good catches in the locality around the boundary line between the Nass and Skeena areas. For example, on July 8, forty-two boats, operating within one-half mile on either side of the boundary line near Finlayson island were averaging about 100 sockeye per day. These fish were all transported to the Skeena under a cooperative packing effort with the result that it was impossible to split the Nass and

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Skeena catches. Most canneries considered them to be Skeena fish and the few returns from tagging in this area suggest that most of them would eventually spawn in the Skeena river but more tagging is necessary to decide what proportion spawn in the Nass river. A similar situation, in which the fishing effort shifts north and the split of the catch is uncertain, has occurred at the start of each season since 1935. Prior to this the seasons opened earlier on June 20 and an eight mile closed district existed between the Nass and Skeena fishing areas so that the catches could be separated. At the present time the fish allotted to the Nass catch are those caught in Portland inlet and in the mouth of the Nass river itself.

After the middle of July the effort and sockeye catch fell off. Thus for the whole season the intensity of the fishery was light with only 740 gill net licences taken out. This is the lowest number since 1907 at which time the catch was about twice as large. The greatest number of boats in operation at any one time was about 550. Many boats transferred to fish as far south as Rivers Inlet and, as the run was anticipated to be small, no boats came north from the Fraser as in other years. This year the effort devoted to pinks was low in keeping with the catch.

Since 1925 the effort has declined along with the catch but at a more rapid rate with less fluctuation except for the marked reductions in 1925 when the Japanese were curtailed and in 1942 when they were eliminated entirely. A rough correlation exists between the effort and the catch by which such years as 1942, 1943 and 1947 produced a catch in keeping with the effort expended. This may, however, be the result of a compromise as the catch also regulates the effort to a noticeable degree. Fishing is carried on economically only where and when it is catching a certain number of fish. Peak years, such as 1940 and 1945, show high catches and low years, such as 1928 and 1933, low catches which are disproportionate to the effort and are probably the result of extremely favourable and unfavourable conditions affecting the size of the run. The period 1920 to 1930, when about 1,200 gill net boats operated in the Skeena (many fishing above the present river boundaries) is considered to be the time when the most noticeable overfishing occurred.

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Skeena Commercial Salmon Fishery - Catch Statistics

Numerous omissions were filled in and errors corrected in the past catch figures. In view of the doubtful split of the Skeena catch from the Skeena pack which now includes all fish caught from the 53rd parallel of latitude north to the Alaska boundary, the catches of sockeye and pinks for the Skeena river, Nass river and in Southeastern Alaska were compared.

In sockeye the trend is downward in the three regions but the cycles vary. For example, catches in 1940 and 1945 were large on the Skeena yet they were small on the Nass and about average in Southeastern Alaska. On the basis of Dr. Clemens' yearly age determinations from the commercial catches of the Nass and Skeena areas, there seems to be little possibility of crediting the Skeena with Nass fish as the large Skeena catch in 1940 was due to a large 4_2 age class and in 1945 to a large 5_2 age class, yet

the Nass failures in these years were due to the small size of the dominant age group, the 5_3's.

The 300 traps operating in Southeastern Alaska open about two weeks after the opening of the sockeye season in the above two areas and thus catch mostly pinks. The failure of the pinks in the Skeena since 1930 was not reflected as markedly in the Nass and Southeastern Alaska catches but the extreme failure of 1946 and 1947 was more general throughout the whole area. The highest catch recorded in Southeastern Alaska in 1941 failed to materialize in Canada.

A detailed examination of the monthly and annual catch returns submitted last year by the various companies to the Fisheries Office in Prince Rupert leaves much to be desired as to the accuracy of the Skeena catch figures. A comparison of the 1946 Skeena catch figures follows. "Monthly" (M) refers to the sum of the returns made each month during the year and "annual" (A) to the final record given at the end of the season.

		Sockeye	Pink	Coho	Chum	White Spring	Red Spring	Steel-head
Canneries (cases)	(M):	52,650	10,614	16,093	13,859	462	1,122	2,024
	(A):	48,852	9,942	13,370	9,829	690	1,218	2,337
Fresh fish Establish-ments (cwts)	(M)	326	809	9,835	2,337	1,349	10,761	1,240
	(A)	233	810	9,605	2,340	995	7,417	2,266

When each establishment is compared in detail, the differences are greater but many errors cancel each other in the final totals. It is debatable which are the most accurate figures.

This year, as the monthly forms have been changed so that only the total pack figures are required without any breakdown as to the area in which the fish are caught, an independent collection of the annual catch figures is being made to check on the accuracy of the published figures. It is impractical to place log books on each gillnet boat due to the large number of boats and the high percentage of illiterate fishermen (mostly Indians), so that the catch for the Skeena area must be obtained from the companies involved. Even here the need for keeping the catches from each area separate must be more strongly emphasized if the data are to be of any value in estimating the size of the Skeena populations. This is particularly necessary for species other than sockeye.

The catch indicates the availability of the fish for the period of fishing and, in salmon, probably the abundance of the fish since the competition between gear and the size of the catch regulate the intensity of the fishing effort. Thus the catch per unit of effort follows the catch and hence the abundance of fish, but it fluctuates only about one-half as much. However, the great reductions in effort when the Japanese were restricted in 1925 and 1941 are the chief changes in effort which have greatly affected the size of the catch. With more accurate data for the whole Skeena river area, it should be possible to regulate the size of the catch, as indicated by the catch of the first three weeks of fishing, so that the size of the escapement would always be adequate. Past experience has demonstrated this vital nature of conservation, constituting as it does a restraint, by Government control on the exploitation which is continually

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enhanced by technological advance, in order that a future supply may be assured.

This year the sockeye catch was similar to 1942 and 1943 with seasonal occurrence similar to 1942 which started off well and faded toward the end rather than the reverse as in 1943. Half the Skeena pack (65,000 cases) was caught in the Skeena (32,000 cases) while the remainder came from as far south as Rivers Inlet and as far north as the Alaskan boundary. The average catch per boat was about 600 sockeye which means under present conditions that the fishermen lost money as it now takes about 1,000 fish to pay expenses. Although the pink catch of about 13,000 cases was higher than last year, the two years are the lowest since the start of the fishery in 1910. The chum catch was exceptional and the spring and coho catches were good.

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Commercial Fishery - Biological Statistics

The difficulty of separating the Skeena salmon populations in the ocean catches lies in the intermingling of the salmon on their migration routes. The degree to which the Nass and Skeena populations overlap is considerable in the area south of the Alaskan boundary. The current tagging program in Southeastern Alaska from which about 200 tags were recovered in the Nass and Skeena areas should throw some light on the ocean migration routes especially in respect to the pinks. Judging from the catch data, the migration of all species is in a south-easterly direction. This is probably associated with the course of the fresh water from the mouths of the Nass and Skeena rivers but to date no oceanographic work has been done in this restricted area.

This year with the large number of small sockeye in the spawning escapement, the effect of the selectivity of the commercial gill nets presents a problem in conservation. This selectivity plus the time of fishing in relation to the time of the run renders the commercial catch, or any samples taken from it, unrepresentative of the total population in regard to age and sex.

From data on sockeye available at the present time the males on the average are larger yet more variable than the females. All those less than 19 inches in length are precocious males and are usually called "jacks". The males of each age group run prior to the females and the older age groups precede the younger ones. The commercial catch of the 5_2 age group has always contained more females than males. Up to 1935 when the season opened on June 20, the average percentage of females is 56, and since then, with the opening date as the last Sunday in June, it is 63 per cent. This is apparently due to the fact that more males than females in the group run prior to the opening of the fishing season. In the case of the 4_2 age group which runs later, the males averaged 53 per cent. up to 1930 at which time the mesh size was reduced so that the smaller females might be caught. Since then the male average dropped to 43 per cent. which means that some of the males either run prior to the fishing season or many mature a year earlier to comprise the jacks (3_2). The jacks appear to run later in the

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season than the other groups.

This year Dr. Clemens' scale samples, taken from sockeye caught by the commercial fishery using gill nets with a mesh size of $5\frac{3}{4}$ inches, contained only 6 jacks in 664 males. The females made up 66 per cent. of the samples or 1,305 fish. The number of jacks caught by the tagging boat using a mesh size of $3\frac{1}{2}$ inches, was 360 or 15.5 per cent. They increased in numbers as the season progressed, constituting 4 per cent. of the 422 sockeye tagged in June and 29 per cent. of the 678 caught from July 23 to 27.

Our own sampling program of the commercial catch also indicated a scarcity of jack sockeye and a high percentage of females. The situation was reversed for pinks and chums as the males were more frequently caught. In pinks, the sex selectivity is high as the samples contained 90 per cent. males in 1946 and 75 per cent. in 1947. In spring and coho the sex ratio is about equal but more jacks are observed upcountry than in the commercial catch.

In recent years the sockeye season has opened when the run is at least 15 per cent. under way and lasts until the end. If the present season which opens on the last Sunday in June and closes between August 15 and 25, was shortened to the period between July 1 and August 1 or lengthened from June 15 to August 15, it would fish the run more evenly as a whole.

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Commercial Salmon Fishery - Trend and Cycles in Sockeye and Pink Salmon

The downward trend and periods of decline in sockeye catch data were discussed in detail last year. To this might be added the fact that in recent years the cycle peaks have occurred at five year intervals but different age classes have caused the large catches at various times. The 5 and 6 year classes accounted for the peak catches in 1930 and 1945 while the 1940 high was due to the abundance of the 4 year olds. The 1935 peak did not materialize as all age classes failed although the catches in 1934 and 1936 indicate that a peak should have been expected. From the above the next peak should be expected in 1950.

The age and catch data at hand give poor predictions for the past and hence for future catches. One error is that the selective sampling of the total population by the commercial catch leaves the escapement picture in doubt. In addition there are all the unpredictable reactions of any population which is subjected to a variable environment. It will be interesting to see whether the large run of jacks (3_2's) this year forecasts a large run of 4_2's next year or whether the catch will be about 45,000 cases as predicted from age and catch data.

In pinks the story is different. As these salmon always mature at two years of age, each year represents a distinct population. Since the failure of the largest cycle of 1930 to repeat itself in 1932, the even year cycle has had only one success, 1936, while the odd year cycle took on increased importance with three successes to reach a peak return in 1945. The catch in the last two years has produced a record low in both cycles. What does the future hold? The catches of pink in Southeastern Alaska do

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not show the same cycles for the failure during the 1930's was not as bad as in northern British Columbia and all the last few years have been low with the exception of 1941 and 1942.

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Indian Fishery on the Skeena River

As in the previous two years all the Indian fishing sites were visited at least once during the summer. The large gill net fishery at Babine lake was studied at its peak during the first week of September and the gaffing at Moricetown falls was observed throughout the season in conjunction with the tagging programme there.

The number of salmon which the Indians took in the different areas in 1946, as estimated by the Fisheries Department, are given in the following table in comparison with the averages for the last 10 years. Final figures for 1947 are not yet available.

		No. of Fish					
Area	Indians	Sockeye	Coho	Spring	Pink	Chum	Steelhead
Bear lake	-	500	-	-	-	-	-
Babine lake	398	21,000	-	200	-	-	100
Moricetown falls	278	8,700	3,200	760	5	-	500
Hazelton	1,122	7,100	2,200	440	820	130	2,400
Kitwanga	313	1,300	60	300	250	110	220
Lower Skeena	-	450	1,100	560	1,500	100	125
Total:	2,111	39,050	6,560	2,260	2,575	340	3,345
10 year average:	2,000	73,000	15,000	6,600	11,000	140	1,700

It will be noticed that for all species except chum and steelhead, the numbers caught were well below average. The Babine figure of 21,000 sockeye is the lowest (average 44,000) since estimates were started in 1935. The Moricetown sockeye count is higher than the average (6,900) but all catches on the lower Skeena are less than average in conformity with the commercial catch at the coast. The Indian fishing effort was still curtailed by the good fishing jobs that are available at the coast since the removal of the Japanese and by the good money that can be made in the numerous logging camps. This may account for the heavy take of steelhead in the fall after the summer work was over.

It is difficult to rationalize the above estimates for sockeye catches with the number of tags returned by the Indians. In general the estimates appear to be too low and the number of tags returned too high. This is most evident in the fishing sites on the lower Skeena. The error in estimating the catch may be as much as 50 per cent. low and thus comparable with the error found in estimating the known escapement to Babine lake in 1946. On the other hand the gill net fishery may be selective for tagged fish and the number of tags returned may be too high. Although there was one tagged fish for every 1,360 fish arriving at Babine fence it seems more

reasonable to assume that the Indians caught about one tag in 300 fish. With these considerations in mind the following table is presented to show the number of tags returned with a more probable estimate of the number of fish caught.

Area	No. of sockeye (Fish. Dept. estimate)	No. of ocean tags returned	Average no. of fish estimated per tag	More probable estimate of no. of fish caught (based on 1 tag in 300 fish)
Babine	21,000	123 #	170	37,000
Moricetown	8,700	41	210	12,000
Hazelton	7,100	62	114	8,500
Kitwanga	1,300	16	81	5,000
Lower Skeena	450	12	38	3,500
Total	39,050	255		76,000

- Calculated on the basis of 17 returns out of 48 ocean tags allowed through the fence out of a total of 347 tags.

In other years similar low estimates occur and although the Indian catch may fluctuate with the size of the run, especially at Moricetown, there is a tendency for the number of fish taken each year to be more constant than either the commercial catch or the escapement. Thus in a good year most of the Indians earn more money fishing at the coast and fish upriver only up to their usual requirements while in a poor year they have little money and fish harder to try and attain their full requirements.

This year, due to the poor season at the coast, many fished hard but at Moricetown the sockeye catch was small (3,200), the lowest estimate since 1942, and the spring catch (1,150) was high. The total counts on the other species are not available yet but more pinks were used this year. The low efficiency of the gaffing method was checked and indicates as in other years that about 40% of the fish are lost after suffering various degrees of damage and a recommendation for a less wasteful method of catching fish such as the dip net used in the Fraser canyon is still in order.

The gill net fishing at Babine lake was satisfactory to all the Indians, contrary to reports to the reverse. At Nilkitkwa they were able to catch 30 to 50 sockeye and 5 spring per night or a total for the season of 30,000. Twenty smokehouses operated in comparison with 14 last year and they fished with about 35 nets of which most were short sections of coastal nets rather than of the type issued free by the Indian Department every two years. It is difficult to say how selective these nets are to the larger fish but the Indians apparently catch and use few jacks. When the length frequency data of tagged fish to returned fish are analysed, a more definite statement can be made. In sharp contrast to the fish wasted at Moricetown due to gaffing, the Babine Indians employ all parts of the fish, even making use of the heads, tails and eggs.

8. INFLUENCE OF ENVIRONMENTAL CONDITIONS ON SKEENA SALMON RUNS

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Effect of Weather on Sockeye Salmon Fishing in the Skeena River

As the fish run a gauntlet of nets at the river mouth and as the fishing is concentrated over a short period (sockeye less than six weeks), any interference due to weather changes the effort and hence the catch. The fishermen believe that the weather affects sockeye fishing as follows: South-easterly winds bringing rain, fog and storms, drive the fish deeper so that they are caught near the lead line (4 fathoms) or miss the nets altogether; westerly winds, bringing good weather, cause the fish to frequently leap at the surface and to be caught near the cork line which results in better catches.

To check on this belief, the records of Carlisle cannery for 1943 to 1947 were examined. They give the daily average fish per boat and the type of weather on the fishing grounds. It was noted that in general the best days fishing are bright and a continued period of rainy weather results in low catches. One week of bad weather in July 1945 was particularly striking in this regard. When the catch was split into high, medium and low, and the weather into rainy, dull and bright for each year and totalled, the dull and bright days yielded about equal catches which are higher than those on rainy days. This difference is statistically significant by the Chi-square test and could be expected to occur only 3 times in 100 by chance alone. Thus rainy days are significant in reducing the number of fish caught. Whether this is due to effect of the rain on the movements of the fish or on the effort of the fishermen, is still an open question. It is of interest that 1943 had the fewest days of rain yet the lowest catch, and that 1946 had the most rain, one-half the days and about twice that of 1943, yet almost twice the catch.

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Effect of Stream Levels on Pink Spawning

When one realizes that the last two pink catches are the lowest on record yet the seedings were good, especially in 1945, and that the condition is more general than in the Skeena area alone, it is evident that the cause should be sought. In this report the effect of rainfall and the resulting stream discharge are considered.

The rainfall data indicates that August and September 1945 were dry, which corroborates the field observations that the pinks had difficulty getting from the main Skeena river into the tributary streams and that the areas available for spawning were reduced. Following this dry period exceptionally high rainfall around Terrace in October and November resulted in extreme freshets which undoubtedly scoured the spawning beds quite thoroughly. In 1944 the conditions were reversed as the rainfall was high during July, August and September and low for October, November and December. This would result in easy access to the spawning beds with probably later drying out and frost damage to the eggs, as reported from Gold creek during the winter of 1945-46.

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Following the General Salmon Investigation's method, the catch plus escapement estimates of the Skeena river pinks have been compared with the sum of the means of the stream discharges in August and September. The following sources of error must be kept in mind. In pinks the Skeena catch is poorly separated from the total Skeena pack. The escapement figures are quite inaccurate as they are based on subjective estimates. It is of interest that in the odd years the escapement estimates vary with the size of the catch but in the even years a similar relationship does not exist. The best stream discharge records available are for the Bulkley river where comparatively few of the pinks spawn. However, in general they show fluctuations similar to the discharge of the lower Skeena. In all cases the September discharges are uniform and add such slight variations to the August discharges that the latter can be used alone.

The mean August discharges of the Bulkley river when compared with the catch or the escapement figures of the even years from 1930 to 1946, show in general a poor causal relationship. The discharges of the spawning year to the catch and escapement are as similar as those of the same year so that the few similarities that occur could be attributed to coincidence. The severity of the 1946 failure is not indicated. The inclusion of the variable discharges of October and November does not help the interpretation as the extreme freshet in November 1936 is related only with a slight decline in the 1938 catch and the drought of November 1938 had no effect on the 1940 catch. It is of interest that if a relationship did exist, the 1948 catch should be lower than the 1946 which would be very low indeed.

The odd year cycle presents a similar picture but the catch, which is related to the escapement in this case, is more similar to the discharge of either the spawning year or the same year, than any of the data for the even years. The 1947 failure is indicated by the low August and September discharge but the difference shown does not appear to be severe enough to account for the result.

Thus the failures of 1946 and 1947 still remain for the most part as inexplicable as those of 1931 and 1932. No doubt the above data are too inaccurate for the solution of this very complex situation and a better correlation should be expected under the more closely related conditions found in short coastal streams.

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Re A Climatological Study of the Skeena River with Particular Reference to its Significance in Sockeye Production

A study has been made of the meteorological conditions throughout the Skeena river from the records presented in "Climate of British Columbia." Within the area of the Skeena river drainage there exist at the present time seven stations which report for twelve months of the year and one which operates during the spring and summer months only. The periods of operation for these vary in date of commencement and in continuity of observation with the result that some areas cannot be compared for more than a few years of synchronous operation. Sufficient data are presented, however, to permit a relatively detailed consideration of the conditions existing from 1915 to the present time.

By such a study it was hoped that some indication of the relation between climatological conditions and the degree of success or failure in returns of sockeye in the Skeena river might be ascertained. The following questions were considered pertinent to the problem:

1. What are the climatological characteristics of the Skeena drainage?
2. Has there been any significant change in climate throughout, or in any particular area?
3. Is there a cyclic nature to the climatological fluctuations, particularly in four to six year periods?
4. Do the variations in climate, annually or seasonally, correspond in any way to the variations in production of sockeye, either throughout the area or in any particular zone?
5. What records might be taken to assist in understanding and predicting the variations in production of sockeye?

A brief summary of the findings and conclusions arrived at for each of these questions is presented under their respective headings.

1. Climatological Characteristics - The climate of the Skeena river varies from the coast inland changing rapidly from the moderate temperature and heavy precipitation near the ocean to more extreme temperatures and less precipitation as the limit of the eastern side of the Coast range mountains, in the vicinity of Terrace, is approached. Beyond 100 miles from the coast a relatively extreme climate is characteristic of the area. The rainfall rarely exceeds 2 inches per month at any time, and although high temperatures are infrequent, extremes of low temperature occur. In brief it is a comparatively dry, extreme climate.

Approximately 75 per cent. of the drainage area is over 100 miles from the coast and it would appear that the final distribution of the sockeye on the spawning beds is in the same ratio.

2. Constancy of Climate - Any series of records of climatic conditions will usually show odd variations of an extreme nature which can be classified as exceptional. In 1939 there was an exceptionally heavy rainfall in the Skeena river district and elsewhere in that northern territory but it would appear that neither this, nor any other so-called exception can be used to demonstrate any particular change in the general climatic conditions.

The annual precipitations recorded for all observational stations show no greater variation above or below the mean at any one period of time, or particularly in later years, than at any other time since 1916. A similar statement can be made for the annual temperature averages for this period.

3. Cyclic Trends - Between four and six years from every peak in the sockeye commercial catch there has occurred another peak (1909 to the present). These peaks have arisen twice 4 years apart, three times 5 years apart and twice 6 years apart. The precipitation tables have been studied for an indication of any such trends, or cyclic fluctuations of a greater or lesser extent. For the thirty year period investigated, no indication of cyclic trends of any duration within this span of years is apparent. The answer to the question of cyclic trends, at least in precipitation which appears to be as important as any one factor in relation to salmon production is distinctly a negative one.

4. Climatic Conditions Correlated with Sockeye Production - The term "production" as applied here is considered to be the total from the commercial catch corrected for age class. Thus the product of the seeding in a given year is calculated as the sum of the fractions of the catch which is composed of four-year-old to six-year-old sockeye in the succeeding four to six years. This assumes that, (1) the parent stream theory is applicable, (2) that the catch is indicative of the escapement, i.e. that a high catch signifies a good escapement and (3) that the age composition of the catch may be applied to the escapement. There appears good reason to credit each of these with a certain amount of accuracy although perhaps least in the case of No. 3 where the three-year-old precocious males are not caught by the gill netters to any appreciable extent.

Adversities of climate can be catastrophic if they coincide with critical times of development. A low efficiency of production from a given escapement may be the result of sudden freshets washing out spawning beds, extreme temperature conditions and drying up or reduced flow in streams either at spawning time or some time thereafter. The area of spawning ground presented during the critical spawning months of August and September is in part dependent on the height of the rivers which in turn depends on the average rainfall during these months. This is the one factor which appears to hold promise as being the most profitable index of the efficiency of returns for salmon in certain areas of the west coast (sockeye) and the stream discharge in the late months of the fall (chum). Thus, if the rainfall in August and September is taken to be indicative of efficiency of spawning then the relation between seeding and precipitation should give a measurable answer in terms of production. The figure on precipitation presents a problem in itself for although an estimated 75% of the spawning occurs beyond the 100 mile line from the coast, and this zone is of a fairly similar climatic type, there are sufficient dissimilarities between precipitation records for the same years from the different observation posts to introduce only a partial representation of the area by using the observations from a single station. Only the records for Babine have been used since the best approximations to date credit the Babine area with possibly 50 per cent. of the total spawning for the whole system.

For these data there exists a relation which is better than random but not sufficiently significant or consistent to warrant use in prediction. It supports rather than negates the relation of above average rainfall in August and September and better than average success in sockeye catch returns. Given that it can be demonstrated that no one factor is overly and obviously dominant in limiting sockeye, as is the case on the Skeena, then it appears that the success of a given seeding is the result of an integration of many more subtle influences including the fluctuation in extent of food supply, competition, abundance and habits of predators and physical conditions in both streams and lakes.

Records Desirable for Assisting in Understanding the Variations in Production of Sockeye.

Setting aside the problem of prediction there is much to be gleaned from an analysis of the interrelationships when the production is known. It would seem very desirable to maintain every effort now in practice

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to determine the escapement each year numerically, the age composition of the escapement, its distribution to the various spawning areas and the precipitation at least in August and September for each of these areas. The figures for the catch of Skeena river sockeye and the age composition are equally essential. The degree to which the success on the spawning beds plays a role in the total production might then be calculable. It would indicate how much might be expected from a conscientious effort at stream control and increase in spawning area in comparison with such other remedial measures as predator control.

9. STUDY OF OBSTRUCTIONS

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Further Study on the Effect of Moricetown Falls on the Salmon Spawning Migration in the Bulkley River

The study of the effect of Moricetown falls and the Indian fishery (discussed under Indian Fishery) on the salmon spawning migrations up the Bulkley river started in 1945, was continued in 1946 and 1947 in the hope of covering the range of conditions due to seasonal variations. As the water remained turbid much later this year, not clearing until August 22, a condition associated with the wet summer which resulted in high water conditions, no spot count estimates were possible as in other years.

Water heights were taken by reading a sounding line lowered from the bridge below the falls to the surface of the water. During July the water was lower than last year but comparable with 1945 while from August 7 to 21 the water was higher than either of the previous years. The flow through the west channel, the best passage for sockeye, did not reach the critical low observed after August 20 in 1945 and, as a result, the fish passed the falls with about the same ease as in 1946.

To supplement a contour survey of the falls carried out by Mr. G. B. Starr in April, soundings taken below the bridge on August 28 indicated a uniform depth of 55 feet.

From July 9 to August 27 a total of 1,215 fish were caught below the falls by means of a dip net and tagged. Damage to adult sockeye in the run is again evidenced by the condition of the 741 sockeye handled, wherein 64 (8.6%) bore gaff marks; 34 (4.6%) gill net marks and 43 (5.8%) other scars. The total number of fish tagged and the returns from each species at the falls up to October 31 are given below:

Species	No. Tagged	No. Returned	% Returned
Sockeye	741	100	13.6
Coho	228	27	11.8
Spring	160	15	9.4
Pink	75	6	8.0
Steelhead	13	--	--.
Total	1,215	148	12.1

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In addition to the aforementioned, nine fish (8 sockeye and 1 pink) were returned from over 30 miles below the falls, two sockeye even descending the Bulkley to Hazelton and ascending the Skeena to be taken at Babine lake; nine fish (5 sockeye, 3 coho, 1 spring) were returned from over 30 miles above the falls and 24 tagged fish (18 sockeye, 2 coho and 4 spring) were recaught and again released during tagging operations below the falls.

On the basis of the number of days the tagged fish remained below the falls as indicated by the date of recapture (majority less than a week) and from the number of fish observed to be held up in the pool below the falls during September, the salmon were delayed for periods similar to 1946 which were less than 1945.

To determine the degree to which the Indians were able to gaff selectively for tags, alternate fish were tagged with white and clear tags. For sockeye, where 363 white opaque tags were affixed, 56 (15.4%) were recaptured by the Indians and 6 (1.6%) were recaught during tagging. Of 356 clear transparent tags affixed, 39 (11.0%) were caught by the Indians and 12 (3.4%) while tagging. The selectivity exhibited by the Indians for white tags is reasonable but why such a high proportion of clear tags should be recovered while tagging can only be explained on the basis of the small number of these returns, by non-random sampling, or by the disproportionate number of tags left after the selective fishing by the Indians. Although returns from the other species are not complete they indicate that a higher selective fishing for white tags occurs during late August and September when the water is low and clear.

This year the spring run was greater and the sockeye run smaller than in the previous two seasons. The runs reached the falls at the same periods as in 1945 or about a week earlier than in 1946. The fish were again sampled by taking scales, length and sex for 170 sockeye, 44 springs, 28 pinks, 132 coho and 15 steelhead and by more detailed data of body measurements and identification counts for 42 sockeye, 19 springs, 10 pinks, 20 coho and 5 steelhead.

This year the sockeye run contained a large proportion of jacks (fish less than 19 inches) which was especially plentiful toward the end of the run. Of the 741 sockeye caught by dip net for tagging purposes, 214 (29.0%) were jacks, and of the 170 sockeye which had been gaffed by the Indians for food and examined for scale samples, 9 (5.3%) were jacks. The size selection by the two methods differs considerably and probably accounts for the lower tag returns this year.

10. AGE DETERMINATIONS

D. R. Foskett Appendix No. 44

Age Composition of Sockeye Salmon Runs

During the past year the sockeye salmon scale collection for 1945 was mounted and read and two thirds of the 1946 sample was mounted. Certain preliminary analyses of the former material have been made.

The following table gives the size of the sample and the percentage composition of the main age groups for the three tagging localities covered in the 1945 program. The 1944 percentages are included for comparison.

D. R. Foskett

Appendix No. 44

Area:	Skeena Mouth		Mink Trap Bay		End Hill Bay
Year:	1945	1944	1945	1944	1945
No. in sample:	2,234	858	340	396	165
Age Group					
3_2		0.4%			
4_2	18.9%	48.1	16.9%	2.3%	70.9%
5_2	57.8	40.6	69.5	80.0	26.1
6_2	0.4	3.2	1.2	12.4	
5_3	12.2	5.5	3.8	0.8	2.4
6_3	10.3	2.2	8.6	4.5	0.6

A comparison of the Mink Trap bay figures for 1945 and 1944 show how even a small local population can vary from year to year. In addition the End Hill bay and Mink Trap bay 1945 figures show how adjacent local populations can vary considerably. The 1944 Mink Trap bay sample was composed largely of 5_2 individuals (80%) while the 1945 sample had only 69.5% 5_2's. In 1945 the 4_2 group was 16.9%, a marked increase from the 2.3% of 4_2's in the 1944 sample. Both these groups had small percentages of individuals which had remained in fresh water more than one year.

The Skeena mouth sample for 1945 showed a very high percentage of 5_2 fish with a decrease in the number of 4_2 individuals and small increases in the 5_3 and 6_3 year classes. There was a similarity between the percentages for the Skeena mouth area and the Mink Trap bay area for 1945. An examination of records of samples from the commercial catch on the Skeena taken by the Provincial Government in previous years shows that the 5_2 year class had not formed such a large percentage of the sample of catch since 1924.

The following table shows the percentage of the four principal age classes in the commercial gill net catch and the average length of each class @, and for comparison, the same data as obtained when tagging, i.e., comparable data from sockeye taken by means of a purse seine.

	Commercial Catch				Tagged Fish			
	1944		1945		1944		1945	
Age Class	% of Catch	Av. Length	% of Catch	Av. Length	% of Catch	Av. Length	% of Catch	Av. Length
4_2	37.0	21.8	20.0	22.4	49.9	21.35	19.1	21.37
5_2	52.2	24.2	63.5	24.4	42.1	23.67	58.3	24.13
5_3	6.5	22.1	11.6	22.9	5.7	22.14	12.3	22.15
6_3	4.3	24.4	4.8	24.7	2.3	22.78	10.4	24.09

@ - Taken from Dr. Clemens' reports in B. C. Provincial Fisheries Report for 1944 and 1945.

The table shows that while time spent in fresh water has some effect on the relative size of the fish, in general fish having spent equal time in the ocean will be more nearly equal in size than fish of the

D. R. Foskett Appendix No. 44

same ages which have spent different proportions of their life in fresh and salt water. That, is, the 4_2 and 5_3 age classes having each spent two years in salt water will be more nearly equal in size than the 5_3 and 5_2 age classes which have spent respectively 2 years and 3 years in the ocean.

In general the fish caught by purse-seine have a smaller average size than those caught in the gill nets. This may be due to the fact that the purse seine has a smaller mesh than the commercial gill nets, and thus samples the smaller individuals.

11. HAIR SEAL STUDIES

A. L. Pritchard Appendix No. 45

Studies of the Hair Seal in the Skeena River

During the spring of 1947, Mr. H. D. Fisher completed his analyses and summary of the data gathered during 1945 and 1946 on the hair seal in the Skeena river, and presented the paper in the form of a thesis at the University of British Columbia in partial fulfilment of the requirements for a Master of Arts degree. From this material a memorandum was prepared and submitted to the Board. This account outlined the following findings and conclusions:

1. Damage to gill nets by seal action is small.
2. Monetary loss due to the seals damaging or removing salmon from gill nets may be high during fishing for spring salmon in April, May and June, decreases in the sockeye season (July and August), and increases in the autumn when cohoes are being taken.
3. During the sockeye fishing, when a large number of boats are in the river, the seals move upstream above the fishing boundary and here can do considerable harm to the spawning escapement.
4. Hair seals have definite "hauling out" bars in the area, the location of which is given together with an estimate of the numbers on each.
5. Regarding the movement of the animals, it has been found that:

(a) The population is relatively static and does not move out of the area, and up and down the coast for long distances.

(b) Daily local movements are usually caused by the tides which cover the bars and cause the animals to migrate a few hundred yards to more favourable locations.

(c) Seasonal movements occur usually in coordination with feeding or some biological phenomenon. Seals may follow an eulachon spawning run. They migrate upriver after the spawning salmon.

6. The bounty system of control as now practised is not effective in the Skeena river estuary since fishermen are too busy to kill them and waste time collecting the carcasses in the fast water. It is also considered dangerous to carry out promiscuous shooting with so many boats in the vicinity.
7. It is apparent that reduction or elimination can best be carried out here by the use of trained hunters who could take

A. L. Pritchard Appendix No. 45

7. (cont'd)
advantage of vulnerable periods in the life history described fairly fully for the first time. One of these periods is the pupping season when the pups are on the bars and when the females remain close to protect their young. These men could also try other methods such as dynamiting not yet fully tested. A review of this work has been published in the Progress Reports No. 72 from the Pacific coast stations.

12. SUMMARY

A. L. Pritchard Appendix No. 46

Skeena River Salmon Investigation - General Summary and Deductions

This report is submitted in an effort to bring together the main findings from the various appendices, to summarize them briefly with a view to indicating the accomplishments to date, and to outline the possible trends for next year, the last for the general phase of the Skeena River Salmon Investigation.

Migration Studies

Marking of the minimum objective of 100,000 sockeye yearlings was carried out with little real difficulty at Lakelse and Babine lakes, through the use of the efficient "net block" in the former and the modified lead and trap in the latter.

Recoveries during the year 1947 were expected to be few since the fish involved were the product mainly of only 5,788 marked in Lakelse and 5,283 handled at Babine in 1945. It was hoped that an adult counting fence would be in full operation at Lakelse, but, due to circumstances which could not be controlled at the time when they arose, the structure could not be used efficiently for the whole run. No recoveries were made amongst the 3,825 sockeye examined and none of the group was caught in the commercial fishery. From the Babine experiment, one marked sockeye was taken by the seine boat "Lady V" on July 20, tagged and released. It was recaptured by a fisherman in the lower river on July 31. At the Babine fence, 145 unquestionable marks were discovered, 36 of which were from the brood year of 1944 and appeared as 3 year old jacks. While the time spent in endeavouring to locate the marked individuals from these experiments involving small numbers has perhaps not been repaid in information gained, it has served to stress the fact that there are many difficulties involved and to enable the operators to improve their methods for succeeding years when the larger returns from the markings of over 80,000 at each of Lakelse and Babine may be expected to appear in the fishery.

Experience thus far in the collection of returns has merely stressed the fact that the number of recoveries and thus the benefit to be derived is directly proportional to the amount of effort applied in the collection. There is definitely no use relying on the fishermen to recognize and save marked fish during the busy season. The cannery employees will not look for them diligently as they are fed into the "iron chink" unless

they are constantly urged to do so. The only really effective means is to place an observer in every plant with the sole purpose of examining the catches. These men can also keep interest stimulated at all times. In addition it is essential that both the Babine and Lakelse fences be operated efficiently throughout the runs to those districts. Since there is little hope of getting information on the movements, distribution and behaviour of the two populations of sockeye salmon which have already been marked without concentrated effort of the above type, plans for 1948 will involve the establishment of a number of these examiners in the canneries, and redoubled endeavours to modify the design of the Lakelse fence toward complete operation.

Tagging arrangements in 1947 were curtailed to include the employment of only one purse seine boat to work off the mouth of the Skeena river. This vessel was very successful in obtaining 2,329 sockeye and smaller numbers of spring, coho, pink and chum. Recaptures have again given a good appreciation of the exploitation this season by the commercial and Indian fisheries, of the time at which the various runs enter the river and of their distribution in the commercial fishery and on the spawning grounds. With the operation for part time of the Lakelse fence, and the full count at Babine together with thorough and repeated surveys of the spawning grounds, much data have been added on speed of migration, etc.

Lake Surveys

Further summarizing of the lake survey data from previous years during the winter of 1946-47, made the fact abundantly clear that there was almost enough information to complete a general picture of the main lakes in the Skeena system. For this reason as indicated in the introduction, it was decided that the summer's investigation should be concentrated mainly in Lakelse and Babine with only incidental trips to other areas to fill in information deemed essential.

Although the investigation of the absolute population density of the different species of coarse fish in Lakelse lake was forwarded greatly by the series of experiments carried out in an effort to determine the real value of the unit "catch per net-night", it seems apparent that the method of marking and recapture (Petersen method) is still the most productive although not in itself particularly successful. The more comprehensive study of the action of gill nets has revealed their very low efficiency in sampling the complete population and certainly in reducing it to any extent. A very considerable number of gill nets in constant operation particularly during the months of May and June would be required to effectively reduce predators and/or competitors even in a lake of such small size. For much larger bodies of water like Babine and Morice, gill netting operations would appear to be impractical for such purposes. Intensive angling might produce better results in reducing at least the predaceous fish. For the present a comparative index as opposed to an absolute one will have to be applied to the accumulated data for the lakes of the Skeena drainage.

Analyses of the physical, chemical and limnological data have continued. While no factors have been found which could be considered as limiting sockeye salmon production, it is clear that the summer heat income of these northern lakes is below the average reported for other areas. Thus the actual location of the lake may be one of the main reasons why the

productive capacity is more limited than one would expect by comparison with work done elsewhere.

One of the chief limitations in any attempt to ascribe the causes of mortality from the stage of egg deposition to that of young migrant sockeye, apparently results from the unknown losses which occur during the first phases of development prior to the fry entering the lake. No direct experiment is on record in which the survival for sockeye salmon from egg to free swimming fry has been investigated. The method of liberating fry from the hatchery at Cultus lake indicated that some 36 per cent. mortality had occurred prior to the lacustrine existence. If conditions in Lakelse lake were not materially different between the years 1945 and 1946 as indicated by the data, then the reduction in survival of yearlings obtained in 1947 (0.34%) as opposed to 1946 (1.06%) might indicate that the losses could rise to 60 or 70 per cent. during the early stages. Although a fry fence perhaps cannot be considered as part of the present portion of the investigation, there would seem no doubt of its necessity, for, without a definite count, there is no means of calculating the numbers of young sockeye within the lake at a given time except through indirect and rough calculations from the number of yearlings counted as they leave for the sea in the spring.

The reason for the very high losses in the period from free swimming to migrant stage is still attributed (but not definitely proven) to the action of predators. This belief appears to be well founded when the postulation as to the size of the absolute populations of predators in the Lakelse lake are considered along with the consumption necessary (100 per predator) to cause the loss during the period.

In this connection it is now felt that more intensive checks should be made at Lakelse lake during the coming season and that work should be started in a lake such as Nilkitkwa through which all the yearlings leaving Babine lake must migrate.

Stream Surveys

Further progress has been made in mapping the main streams for the system. Rough outlines showing the location and type of spawning beds are now available for the Lakelse, Babine and a number of other areas. In other cases a fairly complete written record is on file. During the year one new area, the Gitnadoix , was entered and carefully surveyed. The results not only gave a description of a hitherto unexplored lake, Alastair, but showed that a sizeable run of sockeye together with other species of salmon spawned there. The escapement is considered roughly one-half to two-thirds that of Lakelse and is also constituted of an early run which is little exploited by the commercial fishery.

The refining of the accuracy of estimating the escapement has improved but it is still very much in error. The Babine fence has been a great help in that it allows an actual test of the visual observations. Here population estimates by the usual observational method have shown that the sockeye salmon escapement might be 245,000 fish yet the count at the fence was 522,561. If the same error occurred over the whole system, the total escapement of 345,000 will become about 736,000. If the commercial catch is taken as 385,000 fish and the Indian take approximately 40,000, the total run was thus 1,161,000. The exploitation by the commercial fishery

would thus be 33.2% instead of 18.6% determined from the tag returns. The error in the reconciliation of the two figures might be due to many factors amongst which are faulty reporting of tags, inaccurate estimation of escapement, etc., yet the possibility of comparison of the calculation by two different methods has given a much better idea of the relative accuracy and has opened up new avenues through which refinements might be made toward final absolute accuracy.

The general summary this year would assume a good escapement of sockeye salmon perhaps in the same range as that of 1946. The tagging at the coast, however, indicates that there was a large number of jacks - precocious three-year-old males under 19 inches in length - in the run, viz. 300 out of 2,329 or 15.5% in the tagged sample. Observations at Moricetown showed a similar condition to hold. Jacks were also reported in fair numbers at Bear lake. The best estimate of the actual proportion is provided at the Babine fence. In the total run of 522,561, the overall average of jacks as determined by sampling throughout the year was 47.7 per cent. accounting for a total number of 249,500 fish. In the remaining 273,000, the sex ratio was 45.8% males and 54.2% females which would seem sufficiently in balance to ensure efficient fertilization. Most of the jacks were thus excess and not needed for the escapement. If the same situation held elsewhere, the effective spawning population would become about 351,000 rather than the 736,000 suggested above. This is an entirely different picture and makes the present year's escapement much lower than that of 1946.

The spring salmon fishery and escapement were excellent, in fact quite the best of any of the four years of investigation. The coho run seemed good and normal. A heavy run of chums entered the tributaries of the lower river. As was the case last year, the pinks were a definite failure in spite of the medium escapement in 1945.

There is still a distinct lack of information regarding the biological, physical and chemical conditions in the river which might affect the migrating yearling salmon. An attempt was made this spring to check the situation in the Bulkley and the Skeena at the time when the fish were migrating, but without any success whatsoever due to the heavy silt, strong current and high water. It may be that a smaller river is indicated as a base in which to work out better methods of approach. Obviously Lakelse would be appropriate for this purpose since a party is established in the near vicinity. At one time there was a suggestion that some information might be gained if only from the point of view of time of migration through the use of radio-active isotopes. The fish could then be captured and recognized later.

Statistics

The study of the commercial statistics has now reached the place where it appears that sufficient data for previous years have been collected to make generalizations. The inaccuracies in the records do not warrant a more detailed examination at the present time. Emphasis must be laid on compilations for the season in progress. The industry will have to regard more carefully the question of recording the areas in which catches are made and pay stricter attention to the district boundaries laid down if the statistics are to be of any biological value whatsoever. As far as the Skeena is concerned, the whole matter should be reviewed by the interested parties

in order to increase the accuracy in the statistics so that a more complete and accurate story may be outlined.

The programme for next summer will depend on developments for its final detail but should include in the main a filling in of certain limited gaps in past data, a close study of the 1948 season, an investigation of net selectivity and a further attempt to separate populations in the ocean fishery particularly in the region of the Nass-Skeena boundary. Refinements will be made in the statistical form for annual catch records which is to be circulated and tried during the present winter.

Prediction accuracy at the present is poor. If the large number of jack salmon this year does not indicate an abnormally heavy success for the 1944 brood, the sockeye catch should reach 45,000 cases or slightly more than in 1947. The pinks at present are unpredictable. The seeding was small but it is possible that a high resilience may offset this to give a fair run.

In the case of the Indian fishery, it is manifestly evident that the estimates of catch are low by perhaps as much as 50 per cent. These will have to be carefully checked to see if the discrepancy can be rectified. There is no doubt that the time is now ripe to clarify the regulations governing the Indian fishery and to see that the rules are enforced. With the development of the country, temptation to sell fish will become greater and greater. A strong stand now on the basis of a clear well-stated set of regulations will save trouble and confusion later.

Moricetown Falls as a Hazard to Salmon Migration

After three years' investigation at Moricetown, in conditions which varied from extreme high to low water, sufficient data are now available to make a statement on the effect of the falls. Mr. Starr has made a contour survey and indicated what seems the best location for fishways should action to alleviate the difficulties be desired. In the coming year it should suffice to record water levels, collect ocean tags and observe the Indian fishery.

Age Composition Studies

Progress has been made in mounting and reading the sockeye salmon scales already collected, but much remains to be done. Mr. Foskett will complete the study of this year's tagging sample and be able to carry on with the interior collections. Special effort will be made to finish so that this very important data on age will be available for the final analysis.

Hair Seal Studies

Mr. Fisher's report has brought this phase of the investigation to a close. A memorandum has been submitted through the Fisheries Research Board to the Department of Fisheries. Further developments must now await the decisions reached either by that Department alone or in conference with officers of the Fisheries Research Board.

Summarizing and Analysis of Data

With the increased staff, it is hoped that much greater progress will be made in analyzing and summarizing the data on file. Responsibilities

in this connection have already been clearly defined. Mr. J. R. Brett will gather together the material on the limnological conditions in the lakes and generally supervise the fresh water field. Mr. Withler will concentrate on the analyses of the net records. Mr. McMahon will work over the plankton and competitor stomachs paying particular attention to his Morrison lake investigations. Mr. McConnell will continue with his predator stomach examinations. Mr. Foskett will be responsible for age analysis. Mr. Milne will spend the winter working over the commercial and Indian statistics. Arrangements will be worked out to give all possible time to Mr. Brett and Mr. Milne for writing up the information.

In addition to those papers listed in last year's summary report, the following Progress reports have been published this year:

J. R. Brett - Lakes of the Skeena River Drainage - No. 4, Kitsumgallum lake.
D. R. Foskett - Lakes of the Skeena River Drainage - No. 5, Bear lake.
D. R. Foskett - Lakes of the Skeena River Drainage - No. 6, Lakes of the upper Sustut river.
A. L. Pritchard - Sockeye Salmon Tagging on the Skeena River in 1946.
H. D. Fisher - The Harbour Seals in the Skeena River, B. C.

At the present time No. 7 and 8 in the lake series on Morrison and the Kispiox lakes respectively are almost prepared.

Other related papers have been submitted and published as follows:

J. R. Brett - The Design and Operation of a Trap for the Capture of Migrating Young Sockeye Salmon.
A. L. Pritchard - Fish Cultural Problems involved in the Conservation of Anadromous Fish with Particular Reference to the Skeena Area.
A. L. Pritchard - Efficiency of Natural Propagation of Pacific Salmon.

As a result of the co-operative arrangement between the Department of Zoology at the University of British Columbia and the Pacific Biological Station, the following theses were submitted in addition to those listed last year:

H. D. Fisher - The biology, economic status, and control of the harbour seal (Phoca vitulina richardii) in British Columbia with particular reference to the Skeena river area. (M.A.).
D. K. Foerster - A study of the squawfish as a limiting factor in the natural production of sockeye salmon. (B.A.).

Three others are in preparation this year, viz:

V. McMahon - A comparison of the limnological features of Morrison and Lakelse lakes to determine their suitability as areas for the natural propagation of sockeye salmon.

F. C. Withler - A study of the factors of predation in the lakes of the Skeena drainage.

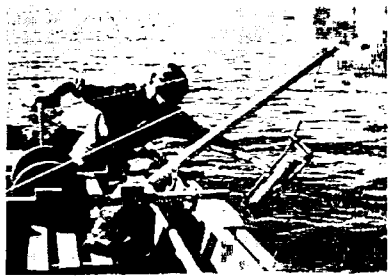
INVESTIGATION OF SKEENA RIVER

GILL NET LIFTED - KITWANGA LAKE

"SQUAWFISH EATS WHITEFISH"

DRAG SEINE SET - STEPHENS LAKE

COLLECTING FISH IN SHALLOW WATER



WATER BOTTLE AND THERMOMETER

FOR TEMPERATURES, OXYGEN CONTENT, ETC.

SILK NET USED TO ASSESS

PLANKTON SUPPLIES IN LAKES

SAMPLING SALMON EGGS - FULTON RIVER,

BABINE LAKE, IN WINTER

TEMPERATURES AT LAKELSE LAKE IN WINTER

WATER BOTTLE LOWERED THROUGH HOLE IN ICE

A. L. Pritchard Appendix No. 46

H. Godfrey - The whitefishes of the Skeena drainage.

Finally it should be stressed that the general portion of the investigation will draw to a close next year and thus first priority must be given to preparing answers for the questions submitted in the terms of reference. This does not entirely relieve the investigators from the responsibility of pointing out the problems which still remain. There is no doubt that present survey methods will only carry such work to a certain state of solution. To produce the material necessary for more complete explanation, more and more experimental work will have to be tried. Fisheries science in its development has passed through the observational stage and has now reached what might be called the statistical period. Experimental work will follow inevitably if the questions are to be answered. The pressing problem now is to decide whether this should be begun intensively in an area such as the Skeena where the basic facilities are already established.

Ferris Neave Appendix No. 47

Programme of the General Salmon Investigation

During the past year the Investigation has continued to be concerned chiefly with problems relating to the pink and chum salmon fisheries. The work has been directed along the following main lines:

1. Statistics of the fisheries. Efforts have been made to supplement published statistics by the study of company records, etc., in order to obtain more complete data on annual catches for the province and for various areas. Such figures are necessary to permit valid conclusions as to annual variations in catch or longer-term trends. Dr. W.S. Hoar has investigated this matter and has also assembled information on annual variations in average weight of individual fish, thus providing a more accurate basis for estimating the number of individuals represented by catch-weight and indicating seasonal variations in marine conditions.

The age-composition of commercial catches of chum salmon has been studied by means of scale samples obtained at various fishing centres. The object is to ascertain the relative importance of different year-classes and to obtain indications of the size of the runs in the following year. Chum scale collections made in 1946 have been examined by Mr. W.P. Wickett. 1947 samples are being studied by Messrs. J.S.T. Gibson and G. Robertson. Sockeye scale collections from the Rivers Inlet and Nitinat river areas have been worked through by Mr. D.K. Foerster.

2. Evaluation of factors causing mortality and estimation of future runs. Fresh water mortality is being closely investigated in Nile Creek and Port John Creek and in a more superficial way by short visits to many other streams. Indications that very high losses can be attributed directly or indirectly to variations in stream flow have led to much time-consuming analysis of existing stream-flow data. Correlations which appear to exist between stream discharge records and the salmon runs of cycle years offer hopes that intelligent predictions of future runs can be made. Mr. W.P. Wickett has made much progress in this direction and was materially assisted during the first six months of 1947 by Mr. H.M. Neave. Steps have been taken to remedy deficiencies in existing records by the establishment, in co-operation with the Dominion Water and Power Bureau, of new stream gauging stations in various coastal areas.

Fishing mortality has been investigated in the case of pink and chum salmon in the Central area by means of a tagging programme carried on through the seining season. Tagging was conducted by Mr. R.C. Wilson, accompanied at various times by Messrs. G. Robertson, J.S.T. Gibson and R.H. McDowell.

3. Investigation of methods for increasing the output of seaward migrants. A series of experiments is being undertaken at Nile creek to determine practical methods of increasing fry production which could be applied on a large scale for the benefit of the commercial fishery. One section of the stream is reserved for natural spawning under unmodified conditions and serves as a "control". Another section was used in 1947 for fry-production from eggs which had been held under artificial conditions until February. This experiment is

reported in Appendix 53. It is being repeated in 1947-48 and a further experiment, involving a third stream section, is now in progress. This will test the efficiency of controlled stream flow as a means of reducing mortality, the eggs in this case being planted in the "green" condition after artificial fertilization. Messrs. W.P. Wickett, W.F. Baxter, G. Robertson, A.W. Kilby and D. Milburn have been associated with the Nile Creek experimental programme.

4. Establishment of a field station at Port John, Fisher Channel. In view of the importance of the Central coastal area in the production of pink and chum salmon, it was decided to establish a field station in this general district, which differs markedly in rainfall from the southern parts of the coast. It was desired to select a locality which would permit intensive study of a representative stream and at the same time serve as a base for observations on the fishery and salmon waters of the district as a whole. After a thorough survey, Port John was selected as having the advantages of (1) a stream of suitable size and character, (2) sizeable runs of both pink and chum salmon, (3) a satisfactory harbour, (4) a central situation with respect to the main channels of salmon migration, (5) proximity to important fishing areas and to tagging operations being currently undertaken, (6) relative proximity (16-20 miles) to settlements and sources of supplies.

In July and August a cabin was set up at the stream mouth and a weir-and-dam structure was installed on the creek, prior to the commencement of the salmon run. Mr. G.B. Starr was in charge of the construction work, which was also carried out by Messrs. E.V. Epps, J.G. Hunter, G. Robertson, R. Wilson and R.H. McDowell.

Counting of the adult migrants has now been completed. Mr. J.G. Hunter has been in charge of the biological studies, assisted by Messrs. Robertson, Gibson, Wilson and McDowell.

By the establishment of this field station it is hoped to ascertain the biological facts necessary for a sound conservation programme in this district and in particular to assess the interspecific effects of pink and chum salmon occupying the same spawning areas.

5. General surveys of salmon streams. In addition to the intensive and necessarily localized investigations indicated above, observations have been continued, as opportunity permitted, on salmon streams in various coastal areas. Although such observations are brief and discontinuous, information is accumulated concerning the special characteristics of the streams visited and the general problems of the various areas. During 1947, the demands on personnel and boats for construction work, tagging and other operations resulted in a reduction in the number of stream surveys. About 30 rivers and creeks were visited (some more than once), these being situated in the north-central, central, Rivers Inlet, Alert Bay and Strait of Georgia districts.

A brief visit, with Mr. Ph. Wolf of Sweden, was made in September to South-East Alaska, where several salmon streams were visited and problems of mutual interest were discussed with representatives of the U.S. Fish and Wildlife Service.

W.S. Hoar Appendix No. 48

The Chum and Pink Salmon Fisheries of British Columbia 1917-1947

The statistical and historical studies of chums and pinks have been extended with the object of providing a clear picture of the course of these fisheries and learning whether there are any evidences of overfishing and depletion. Two lines of investigation were followed: first, a study of average size variations occurring from place to place and from year to year and second, a collection of statistics for production of fresh and frozen pinks and chums. These data should enable us to improve the picture obtained from studies of the cannod salmon pack.

Prior to 1945, seine-caught pinks and chums were sold by the piece. In 1944 the Salmon Canners Operating Committee weighed large numbers of pinks and chums at different places and in 1945 instituted a system of buying pinks and chums by the pound. Thus, average weights are available for the seasons 1944-1947 inclusive. For the years prior to 1944 certain fishing companies have provided figures for the number of fish per 48-pound case canned. From these data it has been possible to show:

1. A weekly improvement in average weight of upper Johnstone Straits pinks (1945-46) probably associated with the migration of progressively larger fish through the area;
2. A weekly decline in average weight of the pinks in northern areas;
3. A weekly decline in average weight of chums at all points on the coast except for the appearance of exceptionally large chums in the Rivers Inlet area toward the end of the season;
4. Place to place differences in average weight of both pinks and chums. These differences are great enough to demonstrate statistically different populations of fish in different areas;
5. That on the west coast of Vancouver Island the chums in the north are larger than those in the south, with an orderly change in weight from one region to the other. The same is suggested for chums from upper Johnstone Straits but the data are not so clear cut (compare statement #1 above);
6. Significant annual differences in average weights. These differences are more striking for pinks with their precise 2-year cycle. For example, pinks were as much as one pound lighter (average) in 1946 than in 1945;
7. That the fish for any season are usually large, average or small over the entire region. Whatever it is that influences size seems to operate over a wide area. A comparison of average sizes for a 20-year period shows no cyclical change and as yet the variations have not been correlated with anything in particular.

An effort was made to obtain a more complete picture of the disposal of the pink and chum catches. Some estimate of the small amounts salted, cured and pickled has been made. Aside from the canned pack, however, the marketing of frozen chums is the only major factor to be considered. From 30% to 60% of the fresh and frozen salmon used in Canada is British Columbia chum salmon. As a conservative estimate it is believed that 30% of the chums and 2% of the pinks caught are marketed in this way. It proved impossible to obtain precise figures from all of the producers for the period under survey (1917-1947). However, it has been possible to make an estimate of the annual production of frozen pinks and chums for the past thirty years. To do this we have used figures for the total frozen fish production in Canada in association with data supplied by certain large producers and the Salmon Canners Operating Committee.

W.S. Hoar Appendix No. 48

A consideration of statistics in connection with the historical data collected indicates the reliability of the general trends described in last year's report but does not confirm the cyclical nature of the chum fishery described at that time.

W.P. Wickett Appendix No. 49

Age-and Size-Composition of Chum Salmon Catches in 1946

The age-composition of commercial catches of chum salmon varies considerably in different years and in different runs. It is felt that a fairly comprehensive annual study of these variations is necessary to assess the relative success of different year-classes and thus to provide a basis for interpreting or predicting fluctuations in the availability of fish.

In 1946, scale sampling books and measuring boards were placed at Namu, Klemtu, Rivers Inlet, Bones Bay, Kildonan and Sooke, to cover the Central and Vancouver Island areas. Two thousand samples were read, giving over-all percentages of 38.86% third-year fish, 57.81% fourth-year fish and 3.32% fifth-year fish. The distribution, by age and locality, was as follows:

	3-yr-olds		4-yr-olds		5-yr-olds		Total no.
	No.	%	No.	%	No.	%	of fish
Namu	48	35.2	75	55.1	13	9.5	136
Klemtu	408	53.6	321	42.2	31	4.1	760
Rivers In.	91	46.7	95	48.7	9	4.6	195
Bones Bay	21	23.6	68	76.4	0	0	89
Kildonan	198	25.7	565	73.4	6	0.8	769
Sooke	26	20.9	91	73.3	7	5.6	124

Average lengths (in inches) of the fish sampled were:

	3-years	4-years	5-years
Namu	28.45	31.03	32.34
Klemtu	26.18	27.66	28.81
Rivers In.	28.51	29.50	30.97
Kildonan	26.84	27.64	28.16
Sooke	27.44	28.72	29.42

A striking feature of the age-composition table is the high percentage of third-year fish in the Central area (Namu, Klemtu and Rivers Inlet). Previous sporadic samples from Central and Southern localities in various years have shown a general preponderance of fourth-year fish. Presumably the proportions noted in 1946 could have been caused by (1) oceanographic conditions, bringing in fish which would normally have run in 1947, (2) a relatively high degree of success in the brood-year of 1943, which would probably result in a heavy run of fourth-year fish in 1947, (3) a low degree of success in the brood-year of 1942, reducing the proportion of fourth-year fish. A continuation and expansion of the sampling programme in forthcoming seasons should permit conclusions to be made on such points.

D.K. Foerster Appendix No. 50

Age-and Size-Composition of Smith Inlet Sockeyes

In order to obtain information on the relative success of different brood-years and possible indications of the magnitude of forthcoming runs, landings of sockeyes in certain fishing areas have been sampled with respect to length, weight, age and sex.

Scale collections made at Smith inlet in 1945 and 1946 have been examined, with the following results:

Age group	4_2	5_2
1945 (222 fish)	44.6%	55.4%
1946 (404 ")	11.8%	88.6%

Other comparisons were as follows:

Age	4_2		5_2	
Sex	Male	Female	Male	Female
Average length (inches)				
1945	22.15	21.90	24.98	24.45
1946	21.3	22.3	24.8	24.0
Average weight (lb.)				
1945	4.85	4.74	7.02	6.51
1946	4.62	5.65	7.30	6.63
Percentage of sexes				
1945	71.6	28.4	51.3	48.7
1946	78.3	21.7	35.6	64.4

Age-determinations and other data have also been obtained on 800 sockeyes taken at the Nitinat river in June, 1947. A complete analysis of the findings has not yet been prepared.

W.P. Wickett Appendix No. 51

Correlation between Stream Discharge and Pink and Chum Salmon Catches

Catches and spawning reports for several areas have been studied and graphed from the government statistics for the years 1915-1946 and discharges from the Water Resources papers of the Department of Mines and Resources.

Two effects are noted. Extreme discharge during the time the eggs and fry are in the streams brings about a reduction in the catches in the next cycle, and in the absence of freshets, catches are proportionate to discharge at the time of spawning in the parent year.

W.S. Hoar's 1946 analysis of relation of parent to offspring catches is confirmed. A closer correlation is obtained for pinks if the spawning population is included and a closer correlation for chums is obtained if the parent spawning population is omitted. For pinks, an "index of production", $\frac{S_2 + C_2}{S_0}$

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is used, where S_0 is the parent spawning population, S_2 the offspring spawning population and C_2 the offspring year total catch. For chums, $S_4 + C_4$ is correlated with discharge in the parent year. The apparent lack of effect of the chum spawning population may be due to a normally very low percentage survival of eggs.

Spawning population by areas from 1930 on were taken from the annual reports of the Department of Fisheries by an unbiased associate and converted to a scale of seven: very light, light, light-medium, medium, medium-heavy, heavy, very heavy. Where tagging information on percentage catch was available it was used to assign a numerical value to the scale of seven, and in its absence values were arbitrarily assigned to the scale. Once the numerical value was assigned to any one value of the scale, the rest of the values were calculated. If in a given year 200,000 cases were caught and tagging gave a return of 50% and the escapement was medium, then scale 4 = 200,000, very light = 50,000 etc. That this method must be improved by compilation of all the spawning reports of all the streams from 1930 to the present is realized. Some 1400 reports for 17 years for five species must be examined.

The bad effect of freshets is easily understood and is frequently obvious from casual observation. Extreme floods have been few, five or six including 1917. In the Vancouver Island area 1939, 1940, 1941 were freshet winters, accounting for the low catches of 1944 when chums of year-classes 3,4 and 5 were reduced. General stream levels determine the number of eggs deposited with a minimum of interference from overdigging, predation, and poor distribution.

It is a pleasure to acknowledge the work of Mr. Hugh Neave and Mr. D.K. Foerster in the compilation and analysis of data.

The correlations which have been obtained from the data presently available encourage the belief that a detailed record of the discharge of a sufficient number of suitably located streams would be a valuable aid in the prediction of chum and pink salmon runs. The establishment of new gauging stations has been recommended and it is hoped that the studies outlined above can be expanded in the near future.

J.S.T. Gibson Appendix No. 52

Tagging of Pink and Chum Salmon in 1947

The tagging of Pink and Chum Salmon carried out this year in Fitzhugh Sound, Fisher and Seaforth Channels had two main objects. These were to obtain data on the fishing intensity in the area, and to collect evidence about the migration routes followed and the spawning streams used by the fish.

The table given below shows the number of fish tagged in each week of the season, and the number and proportion of tags that were returned from recaptured fish.

J.S.T. Gibson

Appendix No. 52

PINKS				CHUMS			
Week	Number tagged	Number of tags returned	Percentage returned	Week	Number tagged	Number of tags returned	Percentage returned
Aug 4-7	306	114	37.25	Aug 4-7	75	26	34.67
Aug 11-14	324	70	21.6	Aug 11-13	59	14	23.7
Aug 18-21	278	42	15.11	Aug 18-21	86	19	22.1
				Aug 25-29	--	--	--
Sept 8-13	6	1	16.7	Sept 1-5	--	--	--
				Sept 8-10	186	48	25.8
				Sept 18	101	6	5.9
				Sept 22-26	323	10	3.1
Totals	914	227	24.84		830	123	14.82

Making some allowance for tags not returned, it would appear that in the first part of the season between 1/2 and 1/3 of all the Pinks and Chums were captured, and that the proportion declined markedly in September.

The greater chances of survival which the later runs enjoy may be attributed to the fact that many of them have not reached the spawning streams when the season closes, and so they are immune from the risk of being caught during the latter part of their migration. This is particularly clearly shown in the case of the Chums, which were being tagged right to the end of the seining season (Sept. 26).

With regard to the migration routes followed, out of 224 Pinks tagged in Fitzhugh Sound and Fisher Channel between Koeye River and Stokes Island, at the mouth of Johnson Channel, 75 were recovered within the tagging area, 89 in Dean Channel, 35 in Burke Channel and North Bentinck Arm, 5 were captured in the Bella Bella area (including Seaforth Channel) and 15 in Johnson Channel and other waters to the north, which might have been reached from the tagging area by way of Johnson Channel or Seaforth. The farthest north recovery was from Gardner Canal, 150 miles north of the tagging point at Stokes Island. The journey took the fish 14 days. Five pinks were recaptured from south of the tagging area, of which one, tagged at Lagoon bay, was caught in Rivers Inlet, 55 miles to the south (4 days), one tagged at Koeye River was caught near Growler Cove in Johnstone Straits 106 miles to the south (7 days) and another tagged at the same place was probably recovered in Jervis Inlet 240 miles to the South (13-14 days). The time between tagging and recapture for the Pinks varied from a few hours to 45 days, with the average time out 7.06 days, and the average distance covered per day 5.56 miles (max. 25). Four tagged Pinks were recovered from the fence at Port John, of which three had been tagged in Fisher Channel near Lagoon Bay (5 miles south of Port John) and one at the entrance to Troup Passage (about 25 miles N.W.). The first three took 21, 45 and 45 days respectively to make their journeys and the last took 28 days. It will be noted that these fish recovered from the fence were all out for well over the average time.

J.S.T. Gibson Appendix No. 52

The migration routes followed by the Chums were on the whole very similar to those taken by the Pinks. Out of 57 Chums tagged in the Fitzhugh Sound-Fisher Channel area, 21 were recovered from the same area, 27 from Dean Channel, 4 from Burke Channel and North Bentinck Arm, one from Roscoe Inlet, to the north, two from Rivers Inlet, and one (record somewhat doubtful) from the Fraser River.

Out of 64 Chums tagged in the Seaforth Channel area, 56 were returned from the same area, four from further north (three from Roscoe Inlet, one from Bullock Channel), one from Rivers Inlet, two from rivers draining into Lama Pass, and one from Port John fence. This last was out 24 days between tagging at the entrance to Troup Pass and recapture at the fence, 24 miles away.

The average time out for the Chums was 10.05 days (maxima 49, the alleged Fraser River recapture, and 37 days). The average distance covered per day was 3.68 miles, (max. 32).

Ferris Neave Appendix No. 53

Propagation of Chum Salmon at Nile Creek

Since previous observations on the natural propagation of chum salmon had indicated the occurrence of very heavy losses due to environmental conditions during the incubation period, an experiment was conducted at Nile Creek in 1946-47 to test the possible advantages of planting eyed eggs which had been incubated under artificial conditions. It was thought that by retaining the eggs in a "hatchery" until February they might well escape the effects of the destructive floods which frequently occur in early winter. Moreover since no provision had to be made for the holding and feeding of young fish, it would be possible to handle large quantities of eggs in a limited space, with a very small water supply and at small expense. In the autumn of 1946 a system was installed whereby water could be pumped into a large storage tank, whence it was delivered by gravity to a head trough in the eyeing station. The eggs were to be incubated in trays stacked in wooden cases and kept moist by water dripping through the trays from the head trough.

In order to make possible a direct comparison between natural propagation and the artificial procedure outlined above, Nile Creek was divided by weirs into two sections. Natural propagation was allowed to take place between a weir situated close to the stream mouth and another weir situated 450 yards upstream, this being the portion of the stream which is occupied by the great majority of naturally spawning fish. The stream above the upper weir was reserved for eggs incubated in the eyeing station. These eggs were secured from the following sources: (a) the relatively small number of females which attempted to pass the upper weir, (b) fish which spawned in the river mouth without even attempting to pass the lower weir, (c) fish which were captured in other streams in the general vicinity of Nile Creek. These last represented the largest source of eggs.

Eggs available for natural deposition in the stream were estimated by sampling females during the run.

Eggs available for artificial incubation were estimated by measuring, accompanied by frequent counting of samples and by actual count of all eggs

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discarded during incubation. All female fish used for artificial propagation were incised to ensure a complete count of available eggs.

Eggs available for natural deposition were estimated as 2,000,000. Eggs available for artificial fertilization and incubation, 761,500.

Floods of considerable magnitude were experienced in the stream on November 27-28, December 2-3, December 10, January 18, and January 25. Destruction of redds and dislodging of eggs were observed on these occasions.

Eggs held in the eyeing station suffered heavy mortality, associated with much fungal growth. Only 33.4% of the originally available eggs were planted. These were set out during February above the upper weir, over a length of stream corresponding approximately with the lower stream section.

Downstream migration of fry took place between April 9 and May 30, the migrants being counted at each weir. Results:

	Available eggs	No. of fry	Percentage efficiency
Natural propagation	2,000,000	8,843*	0.44
Artificial "	761,500	21,235*	2.79

*On one day (May 2) only partial count obtained in each case. Numbers for this day estimated by averaging previous and succeeding days.

It may be pointed out that most of the hatchery eggs were taken and fertilized under quite unfavourable conditions, namely by rough and ready methods, with such equipment as could be dragged by hand up relatively inaccessible streams. Many of the eggs were taken from partly spent females and transportation was effected for considerable distances by truck.

The heavy loss during incubation can probably be ascribed in part to these circumstances and should be preventable to a considerable extent. The fact that in spite of these handicaps, the artificially handled eggs were more than 6 times as effective as the naturally spawned eggs in the production of sea-going migrants, offers encouragement for future experiments.

J.G. Hunter Appendix No. 54

Operation of Port John Counting Fence

Port John Creek has been selected for a series of studies on the freshwater phases of Pacific salmon. The programme is being initiated by an investigation of natural mortality in a stream having a mixed population of sockeye, coho, pink and chum salmon. It is hoped that instructive comparisons can be made between this stream and those previously investigated in other areas. It is also thought that by observation of the distribution and spawning habits of different species in the same stream system and a comparison of their respective efficiencies of propagation, the main causes of mortality can be elucidated.

To date, the work has involved the counting of the adult run of 1947 with respect to species and sex of all individuals, and the estimation of potential egg deposition by sample counts. For the latter purpose, every sixtieth female taken from the trap has been utilized.

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Construction of the field station and fence was begun on July 20 and was completed on August 13.

A few sockeye and coho appeared in the stream on August 16 but the run (for all species) really began on September 3, a period of rain after decidedly dry weather.

The general course of the run, which involved four species, is indicated in the following table:

Week ending	Sept. 6	Sept. 13	Sept. 20	Sept. 27	Oct. 4	Oct. 11	Oct. 18	Oct. 25	Nov. 1	Nov. 8	Nov. 15
Sockeye	290	44	8	0	5	3	15	2	0	0	0
Coho	190	123	43	5	129	12	146	12	1	11	5
Pinks	261	1591	809	356	1370	494	564	26	2	3	0
Chums	20	166	168	251	2754	2365	3092	925	251	69	39
Rainfall	3.2	2.9	1.5	0.0	4.6	2.3	9.5	6.0	3.4	6.5	

In general, peaks in the migration of the various species coincided with times of heavy precipitation. The main runs of sockeyes, pinks and cohos took place between September 3 and October 15. Although the first chums appeared at the same time as these other species, they did not arrive in quantity until October 1. They continued to run in large numbers until October 26.

The total number of each species counted to November 15

Sockeye		Coho		Pinks		Chums	
M	F	M	F	M	F	M	F
158	216	449	228	2650	2981	4893	5206

The average number of eggs per species are:

Sockeye	Coho	Pinks	Chums
2511	2256.5	1285.6	2132

The counts made at the fence have been supplemented by observations on the distribution of spawning fish in the stream system and on predators. A detailed record of stream levels, precipitation and temperatures has been maintained and will be continued through the winter months.

Points of interest which have emerged at this early stage in operations are: (a) the heavy precipitation which has been experienced (amounting to over 24 inches in October), (b) the relatively large and mixed nature of the run, in comparison with the size of the water-system.

J.S.T. Gibson Appendix No. 55

Returns of Cowichan River Marked Salmon in 1947

A total of 22 returns of Cowichan marked Salmon have been sent in this year. Of these, 17 were Springs and 5 were Cohos. The Springs were all four-year fish, belonging to brood-year 1943, of which 47,477 were marked. The Cohos were all three-year fish, resulting from the marking of 38,610 of the brood-year 1944.

The majority of all these fish were caught off the more northerly part of the West Coast of Vancouver Island, between Cape Scott and Esperanza Inlet. Of the 17 Springs, 13 were caught in this area, 2 were caught further south off the West Coast, (one off Cape Beale and one off Bamfield), one was caught off Nahwitti Bar at the extreme N.E. corner of Vancouver Island, and one off Lund, on the mainland coast East of the Island. Of the 5 Cohos, 2 were caught off the stretch of coast between Cape Scott and Esperanza Inlet, one off the extreme N.W. corner of Vancouver Island (10 miles N.N.W. of Cox Island), and one in the Fraser River. The place of capture of the remaining Coho was not reported.

These catches were distributed through the season in accordance with the table below:

	Spring	Coho
April	1	-
May	8	-
June	-	1
July	8	1
August	1	2
September	-	1

In addition to the fish enumerated above there are a further 3 Springs and 2 Cohos with doubtful markings, which may possibly have come from Cowichan. The Springs were all recovered from the West Coast. The Cohos were evenly divided, one from the east and one from the west coast of Vancouver Island.

Returns were also sent in for another 19 fish (14 Spring, 4 Coho and 1 Sockeye) which had been marked by other agencies (the U.S. Fish and Wildlife Service, International Pacific Salmon Fisheries Commission, Washington State Fisheries Department and Oregon Fish Commission). There were a further 20 returns of fish with a single fin missing, many of which probably came from local experiments in the Columbia River, and there were 41 with markings that were certainly not connected with any experiment.

It was very noticeable that whereas the genuinely marked fish were nearly all recovered from the West Coast of Vancouver Island, the non-genuine returns were far more evenly distributed between the East and West Coasts. This would suggest that the co-operation of fishermen is equally good in both areas and the proportions of genuinely marked fish recovered from each therefore give a reliable indication of the migration routes followed.

Ferris Neave Appendix No. 56

The Salmon Angling Fishery at Cowichan Bay in 1946

As in previous years, an observer (in this instance Mr. H.H. Pegler) was stationed at Cowichan Bay to collect data on the landings of salmon made by sport fishermen. In 1946 records were kept between September 20 and November 10. This covered fairly well the coho fishing season but did not provide a record of spring salmon fishing, which takes place mainly in August and September.

Figures obtained for landings and fishing effort during the period indicated, were as follows:

Boats	Lines	Line-hours	Springs		Cohos		Total Fish
			Large	Jacks	Large	Grilse	
1566	2870	12,614	169	226	2000	502	2897

In order to permit a comparison with previous seasons, statistics have been compiled for a similar "coho period" in each year. This has been taken as a six-week period beginning on the Sunday nearest to September 22.

	1939	1940	1941	1942	1943	1944	1945	1946
Boats	1708	1,470	2,435	2,671	2,849	2,967	2,895	1,517
Lines	3240	2,680	4,579	5,128	5,539	5,791	5,492	2,788
Line-hours	12,432	10,694	16,287	18,796	19,875	19,931	18,798	12,271
Springs-large	124	241	351	268	266	304	185	169
-jacks	516	109	220	984	457	246	88	222
Cohos -large	3,362	1,813	3,435	3,867	3,903	3,575	3,660	1,936
-grilse	585	61	417	566	116	225	55	486
Total fish	4,587	2,224	4,423	5,685	4,702	4,350	3,988	2,813
Line-hours per fish	2.7	4.8	3.6	3.3	4.2	4.5	4.7	4.4
Line-hours per large coho	3.6	5.8	4.7	4.8	4.9	5.2	5.1	6.3

It is evident that there was a marked drop in the fishing effort in 1946 as compared with the five previous years. This can be ascribed largely to the relatively poor results obtained from fishing. With respect to "large" cohos, which provide the chief attraction at this season, the catch per line-hour was the lowest in the series of annual records. To some extent, this low availability undoubtedly reflected a light run of fish (see appendix 56). Subsequent observations, however, also indicated another cause, namely that a large proportion of the coho run was unusually late in arriving and was probably present in the bay after most of the fishing operations had been suspended.

Ferris Neave Appendix No. 57

The Coho Salmon Run in the Cowichan River in 1946-47

In conjunction with records of the Cowichan Bay coho fishery which have been maintained since 1939 (Appendix No. 55) attempts have been made each year to estimate the size of the escapement reaching the upper part of the Cowichan river system. It is felt that a long-term record of this kind will provide useful data for any future investigation of the fluctuations in abundance of this species.

As in previous years, fish were captured by dip-net at Skutz falls during the course of the upstream migration and, after being tagged, were released to continue their passage to the spawning grounds. The ratio of tagged to untagged fish was estimated by subsequent surveys of the tributary streams which (normally) are the main spawning grounds for this species. Both tagging and stream survey operations were conducted under the direction of Mr. E.V. Epps.

Tagging was carried out between October 22 and November 30, a total of 1,017 tags being applied. In December and January, eighteen streams tributary to the river or to Cowichan lake, were examined. Statistics obtained from these visits were as follows:

Live fish seen,- 232; dead fish seen,- 413; total,- 645
Tags recovered,- 10; tags seen,- 9; total,- 19.

On the basis of the ratio established by these observations the run above Skutz falls should have been: $\frac{1017 \times 645}{19} + 1017$, or roughly 35,000 fish. This is the smallest run computed since 1940, but the figure is in keeping with the experience of anglers at Cowichan Bay and with general observations on the river. Estimated runs since 1939 have been as follows:

1939,- 60,000; 1940,- 30,000; 1941,- 65,000; 1942,- 67,000; 1943,- 56,000; 1944,- 63,000; 1945,- 41,000; 1946,- 35,000.

Two unusual and probably related features characterized the 1946 run. (a) The peak of the migration at Skutz falls occurred between November 26 and November 29,- more than a month later than in the previous seven seasons. (b) A large proportion of the fish spawned in the main river instead of entering the smaller tributaries.