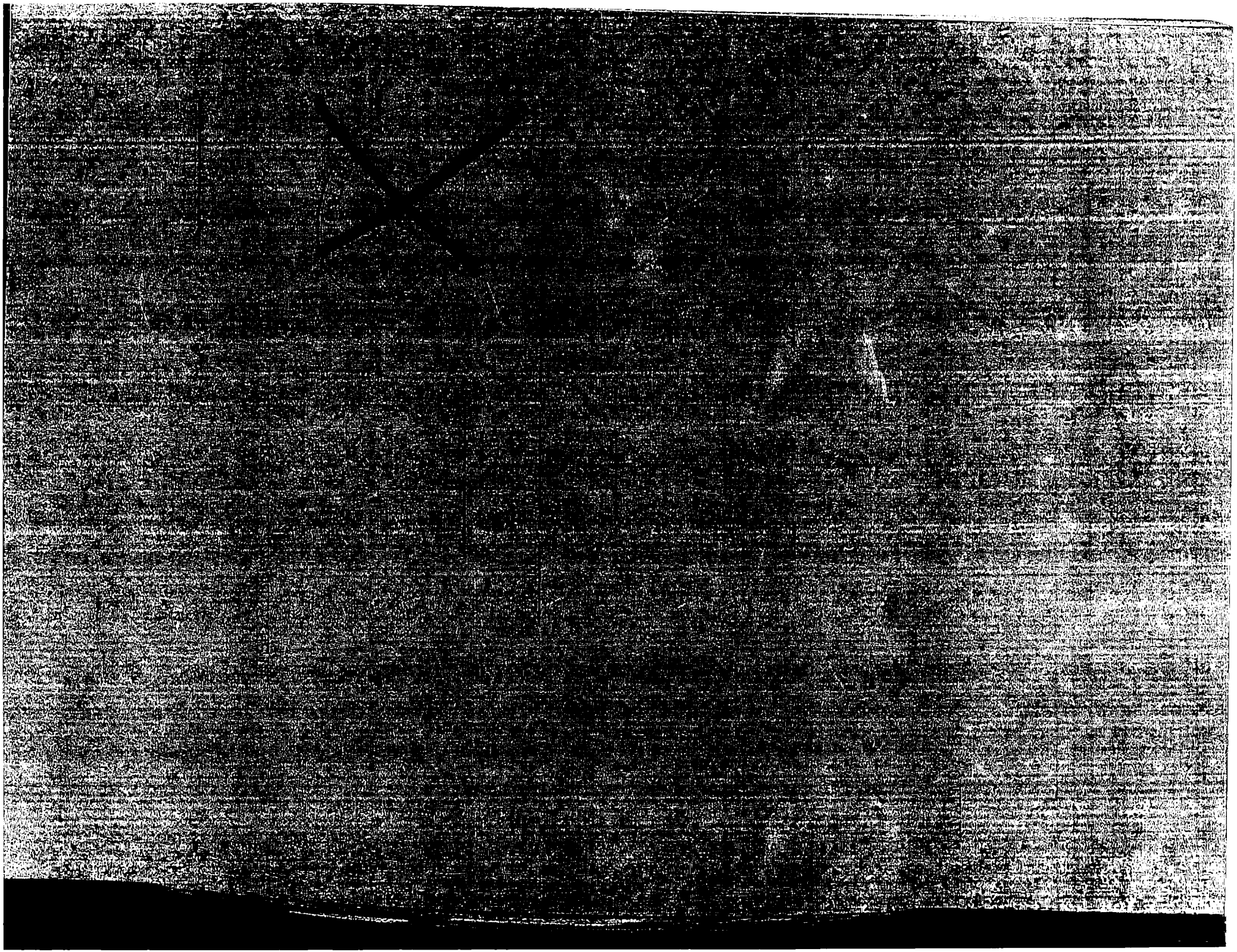


FISHERIES RESEARCH BOARD OF CANADA

REPORT OF THE

PACIFIC BIOLOGICAL STATION

NANAIMO, B.C.

for 1946

By R.E. Foerster, Director

The main function of the Station is to conduct such biological investigations of the fisheries of the British Columbia coast as will provide adequate information for intelligent and effective administration and regulation, the ultimate objective being to develop suitable "management" policies which will ensure reasonably stable sustained yields of fish products at a high level of production.

In order to supply such information it is necessary to know not only the life histories of the species involved, i.e., migratory movements, breeding habits, growth rates, etc., but also to initiate population studies which will reveal (1) the relationship of amount of spawning to extent of recruitment of young fish to the stock, the variations likely to occur from year to year in such relationship and the factors governing them, (2) the amount of spawning and recruitment necessary to maintain adequate populations, (3) the effect of fishing intensity on the stock and on the rate of recruitment, (4) the relation of mortality due to fishing, to natural mortality, and (5) many other not readily accessible features. The life history records are relatively easily obtained but the population studies, involving adequate sampling of the stocks and of the catches over several years and a relatively long record of the trends of the populations, as influenced by fishing effort, require careful and complicated analysis.

In general, fishing along the British Columbia coast whether by gill-net, long-line, troll, trawl or purse seine has reached a high level of exploitation. The problem thus becomes one of maintaining stocks of fish under the pressure of high fishing intensity, of endeavouring to increase natural production wherever possible and of stabilizing the fishing effort at as high a level of exploitation as is possible. Exploration to locate new fishing grounds is feasible only for the presently minor fisheries.

During 1946 very satisfactory progress was made in all departments of the Station's work despite the still-existing handicaps of limited trained personnel and shortages of supplies.

Skeena River Salmon Investigation. Under the direction of Dr. A.L. Pritchard, assisted by Messrs. D.J. Milne, J.R. Brett, D.R. Foskett, J.A. McConnell and a group of scientific assistants and field technicians, this major investigation undertaken to determine the present state and trend of the salmon fisheries and their reaction to present policy effort and now completing its third year, carried forward all phases of the work. (App. No. 1). Commencing in early

spring seaward migrating sockeye young were marked, by removal of certain fins, at Lakelse lake (100,967) and at Babine lake (88,972). (App. 3 and 4). Upon the return of these marked fish from the sea as adults in 1948 and 1949 and their recovery on the fishing grounds the routes of migration in from the ocean and the areas of capture in Alaskan and northern British Columbia waters, as well as times of arrival at the various fishing areas, can be traced.

During June and July incoming salmon were caught by purse seine at the river mouth and tagged (2,772, of which 2,135 were sockeye) in order to indicate the proportion of the run taken by the commercial fishery (30.1%) and the proportion allowed to proceed to the spawning grounds. Recovery of tags at up-river Indian fishing sites (137) and in the spawning areas (363) revealed when the fish returning to those regions had passed the commercial fishing areas. (App. No. 5) If distinct periods of migration through the fishing areas occur their elucidation may be of significance in explaining variations in returns to the spawning grounds as the result of heavy or light fishing at the time of migration and in indicating how regulation of fishing may best be applied to maintain or restore runs to particular spawning areas.

This season a counting fence in Babine river was constructed and operated and a total of 475,419 sockeye passed through. (App. No. 31 A). Subsequently a survey of the spawning areas in the Babine lake region was made by ordinary inspection methods (App. No. 25) and an estimate of 210,000 spawners derived. This suggests that the customary inspection estimates are at least 50% too low and if this condition applies in all areas of the Skeena the rough total estimate of 340,000 spawners should perhaps be raised to approximately 800,000. An escapement of 800,000 would compare favourably with the catch (commercial and Indian) of 600,000 and would indicate that the Babine lake escapement represented over one-half that of the total Skeena river area in 1946. Over the whole Skeena basin a good spawning escapement occurred, about one-half that of 1945.

Lake and stream studies were continued (App. Nos. 6-17) with particular attention given to the Lakelse and Babine lake areas. At the former, special observations were made on the seaward migration of young sockeye, (App. No. 2) a special fence of fine mesh seine netting having been devised by Mr. Brett in order to make possible a complete count of seaward migrants. In all, 557,400 sockeye were counted, as well as 72,000 coho and 50 springs. Factors affecting sockeye movement from the lake are being investigated. At Babine (App. No. 11) and other lakes special attention was given to the abundance of other fishes in the sockeye nursery areas and their possible effect, as predators, competitors for food, etc., upon sockeye production. Several new areas (App. Nos. 12-17) at the headwaters of the Skeena, reached by seaplane, were examined.

A special study of the statistics of the commercial fishery has been initiated by Mr. Milne (App. No. 32) in order to develop a reliable comparison of the catches from year to year and establish the trend, if any. A study of the Indian catches (App. No. 33) and their relationship to the spawning escapement is included.

Observations were made on the damage done to salmon gear and fish in the nets as well as general predation by hair seals. (App. No. 36). Damage to nets appeared to be slight but loss in fish is considerable in the early spring,

Perhaps also in autumn. Predation on the escapement above the fishing limits is appreciable as far up as Hazelton. It was estimated that the Skeena river hair seal population amounted to around 500 individuals. These mammals appear to be particularly vulnerable at pupping time on readily accessible sand bars of the lower river.

General Salmon Investigation. Initiated in 1945 this investigation, which has as its objective a study of the salmon runs, principally pink and chum salmon, to the coastal streams lying between the Fraser and Skeena rivers, has been carried forward by Mr. Ferris Neave, assisted by Mr. W.P. Wickett and several field assistants.

One phase of the investigation embraces a study of the natural propagation of pink and chum salmon in typical coastal streams in order to define (a) the normal degree of efficiency of propagation, (b) the factors which bear upon successful propagation and (c) possible means of improving production. For pink salmon at Morrison creek, Vancouver island, (App. No. 45) counts of seaward migrating fry in the spring (791,772) revealed a fry production of 6.7%, while for chum salmon at Nile creek (App. No. 46) the recovery of 138,388 fry indicated a production of but 3.0%. This low percentage efficiency was due largely to unfavourable variations in stream flow and to the spawners tending to mass in the lower reaches of the river and refusing to spread out along the stream and utilize suitable gravel stretches higher up. This appears to be a general condition and experiments are now underway (App. No. 47) to test out the practicability of removing a portion of the spawners, stripping them, developing the eggs to the "eyed" stage and planting them along the stream in suitable locations. This may well lead to more efficient production of fry from spawning escapements. At the same time the possible value of various stream improvement and water control measures are being investigated.

During the year surveys of as many of the coastal streams as possible were made, (App. Nos. 40-42) conditions observed and estimates of spawning escapement computed. In general the chum spawning escapements were very good in spite of a very high commercial catch but pink salmon escapements were late and on the light side.

A study of catch statistics for the pink salmon fisheries 1916 to 1944 has shown (App. No. 39) that in northern B.C. a significant downward trend has occurred. For southern districts the trend has been upward to 1938 but, on the whole, downward since then. Correlation data show the strict dependence of offspring on parent generation catches. For chum salmon catches in offspring and parent years show no significant correlation. While trends in the catches are suggested, downward in the north and upward in the south, emphasis is directed to the variability of the catches and the presence of periods of very low and high production.

In order to establish a usable relationship between environmental conditions and the success or otherwise of a given brood year, age-composition studies (App. No. 44) of the chum salmon runs to the various areas are being made through a comprehensive scale collection programme. For the Johnstone strait fishery in 1945 it was found that 17.4% of the fish sampled were in their third year, 81.5% in their fourth and 1.2% in their fifth. The information obtained is being correlated with meteorological conditions and stream flow

to determine the possible effect of these latter factors on fry production.

In 1945 a chum salmon tagging experiment was undertaken in Johnstone strait and Discovery passage (App. No. 43) of 2,387 fish tagged in the former, 33.9% were recovered, about one-third of the fish handled during each week of the tagging season being retaken. For Discovery passage, 21.6% of the tags were recovered. Returns indicate that around 10% of the chum salmon entering Johnstone strait from the north was taken by the fishery in that area. The chums move mainly southward, schooling in the bays and then dispersing through channels north and east to the mainland and south, through Seymour Narrows, to the strait of Georgia.

Cowichan River Salmon Investigation. This investigation has been carried on over a number of years and has resolved itself into a study of the variations occurring in a coho salmon run or population, subjected to commercial fishing along the west coast and in the Strait of Georgia and to an important sport fishery in Cowichan bay. It is desired to have a long-term record of a coho salmon run to determine what variations can occur and, by observing weather and water conditions, spawning conditions, effects of light or intensive fishing, etc., to gain knowledge of how these variations in the population can arise and to what extent. Nowhere yet is there any body of information of this kind. The study is directed by Mr. Neave as a part of the General Salmon investigation, with Mr. Epps, fish cultural officer, resident at the Cowichan lake hatchery.

For the Cowichan river coho runs there has yet been established no means of measuring the varying extent of drain caused by the commercial fishery. An analysis of the sport fishery effort is made by placing an observer at Cowichan bay during the angling season. A good estimate of the spawning run can be made by making observations and conducting tagging experiments at Skutz Falls. A check on spawning conditions and variations in production of young is made at a small creek, Oliver creek, just below Cowichan lake. Weather and water conditions are gathered at the Cowichan lake hatchery.

For 1945 the Skutz Falls tagging (861 cohos) and subsequent recovery on the various spawning grounds of tagged (71) and untagged (3,317) fish indicated that the run approximated some 41,000 individuals. This represents a smaller run than in 1944 (ca. 63,000) and than in the parent year, 1943 (67,000). During the 1946 season 1,017 cohos were tagged at Skutz Falls but spawning ground recoveries are not yet complete. (App. No. 49).

In the spring of 1946 the efficiency of fry production at Oliver creek, where the egg deposition was computed at 249,000, amounted to 22.2%. Records for previous years show fry production efficiency as: 14.4, 11.8, 30.4, 26.0, 25.6, 15.2 and 22.3%. (App. No. 48).

Otter-Trawl Fishery Investigation. This investigation, commenced in 1944, has as its objectives the development of a sound conservation policy which will provide a continual successful fishery for flatfish and a study of the competitio between trawls and other gear in areas where several types of fishing such as long-lining, jigging, sunken gill-nets, can operate. The investigation is directed by Dr. J.L. Hart, assisted by Messrs. Manzer, Taylor, Barraclough and Ketchen (part time).

The first requirement is, of course, an intimate knowledge of the life-histories of the species involved. There are over thirty species of fish caught by trawls and of these there are fifteen species of flatfish, three cod (black, gray and ling cod) and dogfish. In 1945 information was collected on habits, migrations, food relationships, spawning periods and areas, etc. This work has continued through 1946.

Collection of statistics is an essential phase of the investigation in order to ascertain the amount of fish taken from individual areas in relation to the amount of gear used and to trace the changes in abundance of different species over the course of years. These data are obtained from pilot house log books (partially successful) and from records taken by a field assistant assigned to the port of Vancouver to contact fishing vessels at time of landing and to interview skippers. (App. No. 66).

Sampling is also an integral part of the work and has occupied much time and effort. Determinations are made of species caught, sexes, lengths and ages. Consideration must be given to the catches made by trawls before selection for market has been undertaken, i.e., throwing back of undersized fish, unmarketable species, etc., and to the catches as landed at the ports. It is likely that the arrangements for sampling of catches at several landing ports, as well as for collecting statistics, will have to be extended another year.

Tagging is of course an important part of the programme (App. Nos. 69,70,77) and has already given useful information on movements of fish, spawning migrations, and rates of growth of individuals. Estimates of populations as based on tagging have not been possible as yet but it is expected that with a special vessel assigned to the investigation, this problem can be tackled successfully.

The studies carried out so far have indicated the complicated way in which the commercial catch is selected from the actual fish populations in the ocean. This has to be taken into consideration in any sampling programme and special fishing operations are desirable to extend our knowledge of the actual populations.

Herring Investigation. In the British Columbia herring fishery a real attempt has been made to develop and stabilize a fishery by limiting the catch to a definite quota tonnage. The coast was divided into several areas and arbitrary quota limits applied. That for the lower east coast of Vancouver island has been the only one really effective and since this area has provided the most intensive fishing the results have been of special interest. During the first four years of the quota experiment the quota was set at 25,000 tons and this quantity of fish readily caught each year. An extra 10,000 ton extension in 1939-40 was also readily filled. During the next five year period, which included the War years when all fishery products were in serious demand, the annual quota was raised to 30,000 tons but for three years, 1941-44, was extended to 50,000 tons. On the first two occasions the extended quota was filled but in the third it fell short by some 7,000 tons. Observations indicated that an annual catch of 50,000 tons in this region was too heavy, even as 30,000 tons seemed too low. It is now recommended that a new quota of 40,000 tons be set for the important lower east coast of Vancouver island district.

In every year comprehensive sampling of the commercial catches is undertaken

PUBLICATIONS DURING 1946

Barraclough, W.E. A new record of a species of Agonid, Occa verrucosa (Lockington) from the west coast of Vancouver island, British Columbia. Can. Field Nat.

Berkeley, E. and C. Notes on polychaeta from the coast of western Canada - III. Further notes on Syllidae and some observations on other Polychaeta errantia. Ann. and Mag. Nat. Hist., Ser. II, vol. XII, p. 316-335 (1945)

Brett, J.R. and A.L. Pritchard. Lakes of the Skeena river drainage. I.
I. Lakelse. Pac. Prog. Rep. No. 66, pp. 12-15.
II. Morice Lake. Pac. Prog. Rep. No. 67, pp. 23-26.

Brett, J.R. Lakes of the Skeena river drainage. IV. Kitsumgallum lake. Pac. Prog. Rep. No. 69.

Foerster, R.E. Some factors involved in the natural production of Pacific salmon. Trans. Roy Soc. Can. Sect. V, pp. 49-60, 1945.

Restocking depleted sockeye salmon areas by transfer of eggs. J. Fish. Res. Bd. Can. 6 (7), pp. 483-490.

An experiment to develop a sea run from landlocked sockeye salmon (Oncorhynchus nerka kennerlyi) transplants. Submitted to J. Fish. Res. Bd. Can. Mag.

Hart, J.L. Relationship between value and size of dogfish. Pac. Prog. Rep. No. 66, p. 16.

Kelley, Alice M. Effect of abnormal CO_2 tension on development of herring eggs. J. Fish. Res. Bd. Can. 6 (6), pp. 435-440.

Manzor, J.I. Interesting movements as shown by the recoveries of certain species of tagged fish. Pac. Prog. Rep. No. 67, p. 31.

First year returns of Lemon sole tags used off the west coast of Vancouver island. Pac. Prog. Rep. No. 68, p. 51.

McConnell, J.A. and J.R. Brett. Lakes of the Skeena river drainage. III. Kitwanga lake. Pac. Prog. Rep. No. 68, pp. 55-59.

Neave, Ferris. Biological investigation of commercial shellfish. Rep. British Columbia Fisheries Department, pp. 1945.

Condition of the butter-clam fishery in British Columbia. Submitted to Rep. British Columbia Fisheries Department, August.

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

Stevenson, J.C. Growth of herring along the upper east coast of Vancouver island. Pac. Prog. Rep. No. 67, pp. 32-35.

Taylor, F.H.C. Lemon sole spawning grounds in Baynes sound. Pac. Prog. Rep. No. 68, pp. 48-50.

Tester, A.L. Comparison of the Atlantic and Pacific herring and herring fisheries. Pac. Prog. Rep. No. 66, pp. 4-8.

Tagging of herring (Clupea pallasii) in British Columbia: insertion and recoveries during 1944-45. Rept. British Columbia Fisheries Department, 1945.

Tagging of herring (Clupea pallasii) in British Columbia: insertion and recoveries during 1945-46. Submitted to Rept. British Columbia Fisheries Department, July.

Tester, A.L. and J.C. Stevenson. Mortality in tagged herring. Submitted to J. Fish. Res. Bd. Can., July.

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

Circular Series. (Mimeographed)

No. 7. Prospects for the 1946-47 herring fishing season, by A.L. Tester and J.C. Stevenson. September, 1946.

SKEENA RIVER INVESTIGATION

1. GENERAL INTRODUCTION

A.L. Pritchard — Appendix No. 1

During the winter of 1945-46, it was possible to work over much of the material collected in 1944 and 1945 and thus to get a general picture of the progress of the investigation. The resulting conferences led to the inescapable conclusion that all plans for a summer campaign must be definitely laid, sanctioned and recorded before the first scientist leaves for the field. The necessary supplies to accomplish the proposed work must be on hand. In other words, every possible effort should be made to anticipate difficulties because the loss of one week's investigation during the short field period might result in an irreparable deficiency.

The first step to such an attainment was the efficient placement of the men available. Thus Mr. D.J. Milne was assigned to organize the work on Statistics - commercial and Indian-and to supervise the investigation on Moricetown Falls as a hazard to salmon migration; Mr. J.R. Brett was to arrange and direct the yearling investigation at Lakelse lake in the spring, to map out a complete programme for lake and stream survey work in the lower Skeena, and, later, to move to Babine lake to take charge of the lake and stream work in that locality and to run the Babine fence; Mr. D.R. Foskett was to handle the marking at Babine in the spring, and later conduct a general survey of the lakes of the northern area, and finally the writer, while assuming responsibility for the whole operation, was to set up and carry through the ocean tagging programme. Certain assignments were made of the University students in consideration of their ability and future plans. Mr. J.A. McConnell who anticipated coming on the staff during the next year, was given responsibility for the Lower Skeena area from the base at Lakelse. Mr. F.C. Withler was to assist in the tagging programme, but was transferred to Babine lake as immediate assistant to Mr. Brett, and with Mr. D.F. Alderdice and V. McMahon, two other men with some experience, was in charge of a field party there. Mr. H.D. Fisher continued his hair seal studies.

It was very apparent from previous experience that difficulties would arise unless each of the routine operations was definitely outlined. Accordingly a précis was drawn up accurately delineating what was desired in each operation in the field work. Complete yet concise descriptions were worked out for the following procedures: gill netting and sampling of fish, survey of salmon spawning streams, and limnological operations such as plankton collections, temperature readings, oxygen determinations, transparency readings and other minor efforts. Finally, a definite policy for recording each of these items was laid down. The result was consistency in effort and similarity in records.

It is unnecessary to present in detail the outlines of procedures but attention should be drawn to certain phases of the operations which are discussed in later appendices without complete explanation. These include gillnetting, plankton collections, temperature readings and oxygen determinations.

In gill netting the principal object was to obtain data on the fish populations within a given lake, and from lake to lake in some standard manner so that the records would be safely comparable. Each standard gang was there-

fore defined as being 250 yd. in length and constituted of five 50 yd. nets, one each of the 1,2,3,4, and 5 inch mesh group. A series must be either completely linen or wholly cotton but not mixed. In each area certain definite positions were selected and defined where the gangs could be set repeatedly or from year to year. If "shore" or "oblique" sets were made, with a graded series, care was exercised to reverse the meshes at times so that, for instance, each small mesh was in shallow water as often as in deep. No set was to be left more than 24 hours. The figures from such operations were used to calculate the catch per net-night.

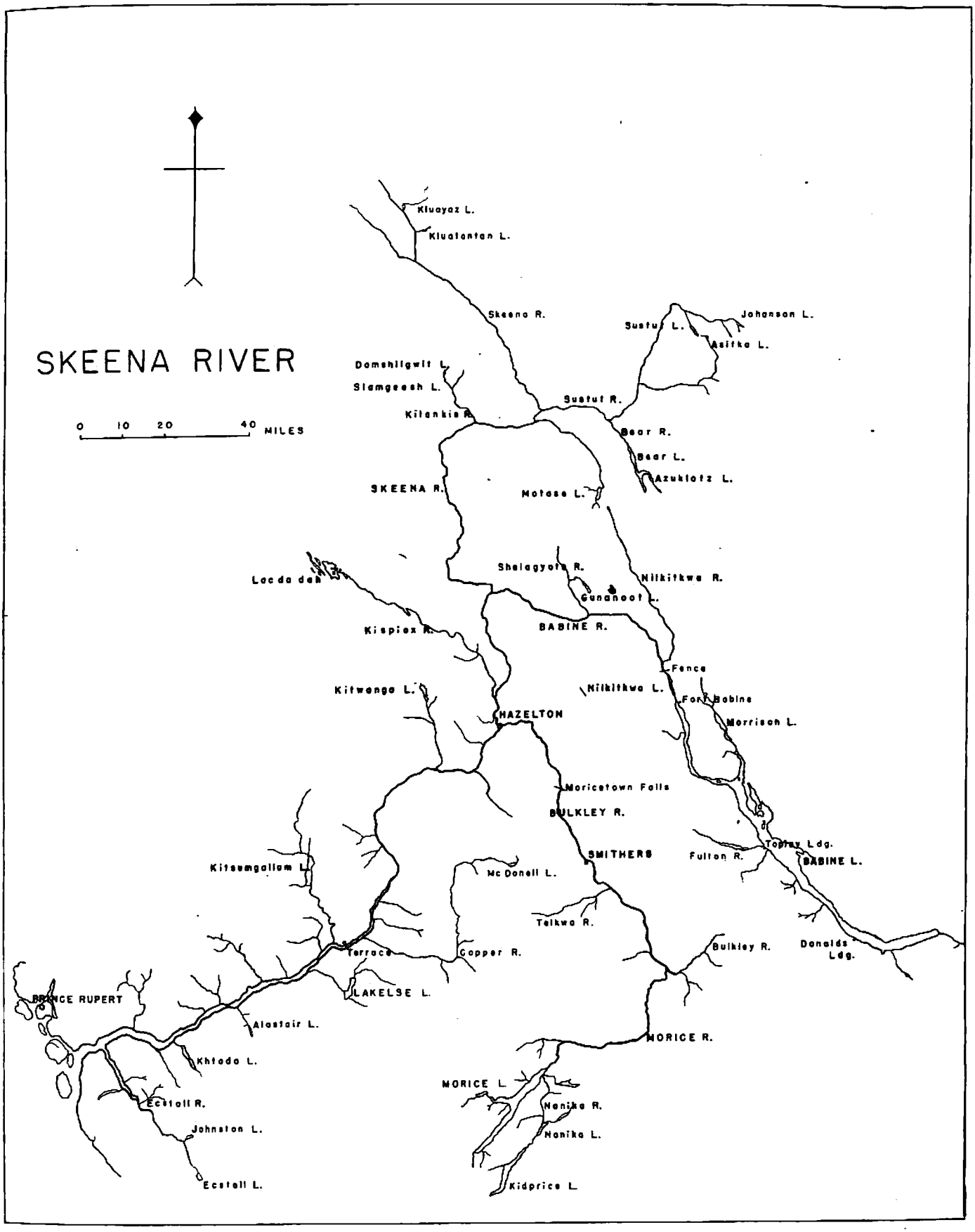
In order not to impose restrictions which would limit a qualitative and perhaps more general investigation of the fish population, varied gill netting was suggested. In this procedure, nets of any size or length could be set in any way indicated as worth-while by the individuality of the area. Catches were not, however, standard or random and thus were not considered in comparisons between lakes but merely taken as an indication of distributio

In making plankton collections a Wisconsin-B.C. closing net with #10 silk was employed. Hauls were to include at a chosen central station (a) a complete vertical, and (b) a stage series including at least, hauls approximately 20 feet from the surface to 20 feet below the thermocline, and one or two from the latter point to the bottom depending on the depth. Hauls were to be made at a speed of approximately 1 1/2 feet per second. Temperature readings were to be carried out at the same station with a reversing thermometer at sufficiently small intervals of depth to delineate the thermal gradient. Oxygen determinations by the Winkler method were usually confined to one at the surface, one in the epilimnion, one in the thermocline, one in the hypolimnion near the top and one near the bottom,

In the appendices which follow, the attainments for the year have been summarized as closely as the limited time for analyses of detail will allow. The various contributions are grouped under several major headings, viz.- Propagation Studies, Migration Studies (marking and tagging), Lake Surveys, Spawning Ground Surveys, Babine Fence Operations, Statistics, 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. It is unnecessary and inadvisable to treat these matters in further detail here since a general summary is submitted after the presentation. Since, however, in many appendices the names - both common and scientific - of many fishes appear, a list is submitted below. Throughout the rest of the discussion only common names will be used to avoid unnecessary typing and inconsistency.

(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 tschawytscha

(7) Cutthroat trout - Salmo clarkii
(8) Rainbow or steelhead trout - Salmo gairdnerii
(9) Lake trout - Cristivomer namaycush


SKEENA RIVER
0 10 20 40 MILES
Kluayaz L.
Kluatantan L.
Skeena R.
Sustut L.
Johanson L.
Asitka L.
Damshilgwit L.
Slamgeesh L.
Sustut R.
Kitanksis R.
Bear R.
Bear L.
Azuklotz L.
SKEENA R.
Motase L.
Shelagyote R.
Nilkitkwa R.
Gunanoot L.
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.
Kitseguecla L.
McDonell L.
Telkwa R.
Bulkley R.
Donalds Ldg.
Terrace
Copper R.
PRINCE RUPERT
LAKELSE L.
Alastair L.
MORICE R.
Khtada L.
MORICE L.
Ecstall R.
Nanika R.
Johnston L.
Nanika L.
Ecstall L.
Kidprice L.

(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 macrocheilus
(15)	Long-nosed sucker	- Catostomus catostomus
(16)	Squawfish	- Ptyocheilus oregonensis
(17)	Pea-mouth	- Mylocheilus caurinus
(18)	Shiner	- Richardsonius balteatus
(19)	Chub	- Couesius greeni
(20)	Ling	- Lota maculosa
(21)	Sculpin	- Cottus asper

Again in 1946, as in previous years, many persons besides the personnel actually employed by the investigation, have contributed to such success as has been achieved. Mr. I. Urseth, the acting-supervisor of Fisheries at Prince Rupert, has shown the keenest and most helpful interest and has stimulated his officers to extreme co-operation. Grateful thanks are due to Inspector Strachan and Inspector McDonell, in charge of the Skeena areas, for advice and much practical aid. The members of the Skeena River Advisory Committee, Messrs. J.H. Deane, C. Salter, T. Wallace, I. Urseth, B. Kristmanson and W. Johnson have been ready to and have helped in all difficulties. Our gratitude should also go to Messrs. E. MacMillan of Cassiar cannery, to Mr. N. Gerrard of the British Columbia Packers Ltd., to T.H. Sorenson of the Prince Rupert Fishermen's Co-operative as well as to many other members of the industry. To those members of the staff already mentioned should go unlimited credit for a job well done in spite of many difficulties and long hours. Others who have really contributed much by their ingenuity, intelligent approach and conscientiousness are: Messrs. G. Walther, A. Waldie, D.K. Foerster, A. Johnston, R. Hourston, H. Schachter, M.P. Shepard, G. Hunter, W. Walker, E. Rice, P.W.D. Tourner and P.T. Abear. Finally, to Dr. R.E. Foerster, the Director of the Pacific Biological Station, the members of the staff would extend their thanks for his efforts in co-operating to keep their wants supplied and arrangements complete in spite of the heavy responsibilities in other directions.

2. PROPAGATION STUDIES

J.R. Brett Appendix No. 2

Propagation Studies at Lakelse Lake

Since attempts in 1944 and 1945 to obtain yearling sockeye at Lakelse lake for marking purposes had been relatively unsuccessful, it was decided that in 1946 a fence should be constructed across the outlet stream by which not only the desired 100,000 yearlings for marking could be obtained but also a complete count of the seaward migrating young, thus making available data for a study of propagation efficiency.

One of the chief difficulties in previous efforts had been working in the swift water in the lower narrower section of the Lakelse river which is subject to rapid rises and peak spring currents of 5 to 6 miles per hour. A new location was chosen nearer the outlet from the lake where the water is shallow (3 to 5 feet), the stream much wider (ca. 800 feet), and the flow about 1/4 miles per hour.

The fence consisted of two 500 foot arms of 1/2 inch stretched mesh seine netting extending from bank to bank swinging down in a wide "V" to a central trap. The netting was held in place by attaching it at 15 foot intervals to a main guy rope by secondary guy ropes which extended at each point of attachment out from the cork line to the main guy, and back to the lead line. The cork and lead lines were separated by 8 ft. stakes which held the cork lin well above the surface and the lead line tight on the soft mud bottom, even depressing it some inches below this level. Every effort was made to insure a complete seal.

The trap was built of two sections, bolted together after each had been floated into place and sunk to the bottom. The first section was a large funnel entrance joined directly to the two arms of netting with an opening 12 feet wide and 6 feet deep which narrowed down to two separate openings 2 feet wide leading directly into the second section by adjustable doors. This latte portion consisted of 4 pens, each 8 feet square and 6 feet deep, forming a com plete 16 foot square, with the front two opening into the second two by a second pair of doors. These doors could be adjusted to either close or form a slit-like entrance operating in the fashion of the funnelled entrances of a minnow trap or fyke net. Thus a "trap" was obtained as well as an increased current to attract the entrance of the fish.

To remove the captured fish each pen had a false bottom lifted by means of a small pulley system attached to a high scaffolding over the whole structure. The fish were then brailed out for enumeration and marking, these operations being conducted on a large float which was moored alongside the trap.

From May 1 to June 20, the migrants were weighed in water and a weighed sample of over 25%, taken randomly throughout the run, counted. The final calculated total was 557,400. The highest daily "count" occurred on May 23 when 89,100 sockeye yearlings were passed through the fence. The total for coho and spring migrants were 72,000 and 50 respectively. The former species showed a rise and fall which spanned the same 7 week period as the socke while the latter species, being so few in number, has purely negative significance.

J.R. Brett Appendix No. 2

Seven other species of fish of varying sizes and ages also entered the trap and were enumerated along with the salmon. These included 232 cutthroat, 196 rainbow, 26 dolly varden, 212 Rocky mountain whitefish, 84 squawfish, 234 peamouth and 2,024 Columbia river suckers.

The age of the sockeye migrants showed that they arose almost completely from the parent year of 1944. In that year the total adult sockeye salmon run to the Lakelse lake system was estimated at 25,000. By applying to this figure the sex ratio recorded from counts made on the spawning streams (46% males, 54% females) and utilizing the data on egg counts made on Williams creek, Lakelse lake, in 1939 by Dr. A.L. Pritchard and Mr. W.M. Cameron (3,888 eggs per female), the percent survival from egg deposition to migrant can be calculated as approximately 1.06%.

This approximate reckoning may be compared with the results obtained by Dr. R.E. Foerster at Cultus lake, B.C. of percentage survivals of 1.13, 1.05 and 3.23, and by Mr. J.T. Barnaby for Karluk lake, Alaska, of from 0.45% to somewhat less than 1.0%.

This study in sockeye propagation at Lakelse lake is to be continued and expanded in subsequent years. An adult fence has been proposed for 1947 which will provide a complete and accurate count of the mature sockeye, and, along with the information now available and further investigations contemplated on the biological relations of Lakelse lake, should prove of immense value in obtaining a better understanding of these affinities.

3. MIGRATION STUDIES

J.R. Brett Appendix No. 3

Marking of Sockeye Salmon Yearlings at Lakelse Lake

As a result of the success attained in operating the "netting fence" at the head of the Lakelse river, no difficulty was experienced in obtaining sufficient numbers of sockeye salmon yearlings for marking. It was deemed impossible in view of limited personnel, to remove both ventral fins from the complete run of 557,400. However, starting on May 16 and continuing until May 29, a proportion was handled daily to give a final total of 100,967. The peak attainment was the marking of 14,000 by four men in one day.

D.R. Foskett and V. McMahon Appendix No. 4

Marking of Sockeye Yearlings at Babine Lake

As a result of experience gained through attempts in 1944 and 1945 to get sockeye yearlings for marking at Babine lake through beach seining, plans had been worked out in the early spring of 1946 for trying other methods in the event of failure. On May 14 the first beach haul was made although no

D.R. Foskett and V. McMahon Appendix No. 4

yearlings had been seen. Another attempt on May 15 after the young fish were observed, was likewise fruitless. Accordingly a long lead, ca. 200 feet, was constructed on the beach across from Fort Babine about 100 yards above the river. This lead of seine netting, held by small piling, stood at an angle of approximately 30° to the water flow and, extending about 150 feet from shore, cut off about 1/4 of the width of the lake. On May 20, a square trap was installed at the end of the lead. This structure was merely a box of wire screening with no top and a door in both the upstream and downstream sides. The sockeye moved down the seine web and into the trap. When enough were captured, the front door was closed. The downstream opening was to allow removal of debris. The fish were dipped from the open top.

Trapping began on May 19 and the catches rose quickly to about 22,000 on May 22. Many fish were in evidence until May 26 from which date the number appeared to drop. Marking was continued until June 23 when only small numbers were being taken. A total of 89,770 yearlings were caught and the adipose and both ventral fins were removed from 88,792. The mortality in the marking manipulation from all operations was thus less than 1%.

A.L. Pritchard Appendix No. 5

Salmon Tagging off the Skeena River in 1946

During the winter of 1945-46, plans were laid for expansion of the salmon tagging programme on the Skeena river by installing an experimental trap above the fishing boundaries where large numbers of fish could be tagged beyond the reach of the commercial fishery. The design was to discover through the operation of this trap the behaviour during upstream movement in relation to environmental conditions such as tides etc., and, with more recoveries, to definitely settle the period at which each population was moving through the fishery.

Profiting by the experience in 1945, when there was difficulty in securing supplies and equipment until it was too late to do the work, this year by May 1, all the material was on the Skeena. On May 9, all the men were moved to the site which had been chosen and considered suitable by several people who claimed to know the district. It was found that bed rock was very close to the surface and insufficient penetration was available anywhere in the vicinity. Reluctantly, the project was dropped before the expenses ran too high because no other location which was proven better was available. Actually, failure may have been a boon since the river remained very high throughout the summer and much drift came down. Operation would have been extremely difficult, if possible at all. Until a guaranteed locati is available, no further attempts will be made.

Arrangements had been made as in 1945 with Captain Wm. Leask on the "Lady V" who began seining operations on June 19 and carried through until July 28 mainly in localities in and adjacent to the mouth of the Skeena river off Inverness passage, Smith and Kitson island. One short trip was made to Mink Trap bay and End Hill off the west coast of Banks island, and one to Steamer passage in the Nass area. Later, in an attempt to increase the numbe of salmon tagged, the "Irene May" under Captain Haldane, was chartered to wor

in areas farther from the mouth of the Skeena on Banks, Porcher and Stephens islands where members of the Skeena Advisory Committee still thought numbers of salmon could be obtained. This charter was elastic enough to permit immediate cancellation in the event no fish were caught with the result that it lasted only two weeks.

Offshore Tagging

Although only a short period was occupied in endeavouring to get salmon in areas away from the Skeena river mouth, sufficient effort was applied to again demonstrate the utter unfeasibility of the method. There follows a list of the numbers tagged and the recoveries to date (in brackets): Nass area including Steamer passage, Union Bay, Finlayson island and Truro island - Sockeye - 47 (9), Spring - 9 (1), Coho - 19 (4), Pink - 3 (0), and Chum - 8 (2); and Principe Channel district including Mink Trap Bay, End Hill, and Oval Bay:- Sockeye - 233 (59), Spring - 1 (0), and Coho - 1 (0).

The distribution of recoveries adds little to the information gained in previous years. The sockeye from the Nass area were taken predominantly in districts near the point of tagging, one individual finding its way to Point Lambert on the Skeena river and one to the Babine fence. One spring moved to the Skeena river mouth. Of the four cohoes, one was local, one was found at Moricetown on the Skeena, and two down the outside coast at Stephens and Gil islands. All fish tagged in the Principe channel district were recovered nearby with the exception of two sockeye which found their way to Lucy island off the Skeena.

Inshore Tagging

The "inshore" tagging conducted in the main by the "Lady V" in the Skeena River Mouth area, was most successful except in the case of the pink salmon which did not appear in appreciable numbers. The following fish were handled: Sockeye - 2135, Spring - 155, Coho - 155, Pink - 290, and Chum - 37.

Sockeye Salmon Recoveries

Of the 2,135 tags affixed at the mouth of the Skeena river, the following have been reported to date: commercial fishery - 643 (30.1%), Indian fishery (exclusive of Babine) - 137 (6.4%), spawning grounds (exclusive of Babine) - 9 (.4%) and Babine river fence - 354 (16.6%). Although it was practice to remove all ocean tags at the Babine fence, 48 out of 354 were either examined and left on the fish or could not be taken from the fish which slipped past too quickly. Of these 48, 11 (22.8%) were later taken in the Indian fishery. Thus on the basis of the total recovery at the fence 22.8% of 354 or 81 tags should be added to the Indian take making the total for the system 218 or 10.2% of the number tagged. These percentages for the commercial and Indian fishery, 30.1 and 10.2, are slightly higher than those of 1945 - 25.5 and 9.0.

The percentage recoveries from each day's tagging by the commercial fishery show that there was a relatively small exploitation of fish which were off the Skeena river mouth up to June 28. Of those tagged from June 28 until June 30, about one-third were taken. In other words, fishing was good for two or three days after the season opened on June 30 and then dropped for about a

week. For salmon tagged after July 6, exploitation gradually rose to a peak of 50.9% for July 14 and maintained a high level until the end of the month after which time it gradually decreased. As in 1945 the Indian Fishery appeared to take relatively greater numbers of the fish arriving early in the season - up to July 13. For fish after that date exploitation was comparatively low. Of the total recoveries in the fishery, the Indians took, 25% this year as compared with 26% in 1945 and 14.4% in 1944.

The times taken for the sockeye to move upriver from the point of tagging to the locality of recapture are only roughly accurate since the salmon may be in a district some time before recapture. The figures however do show a general progression, viz.- to the eastern end of De Horsey island - 5.7 days, Point Lambert - 7.4, Terrace and Kitselas - 14.6, Cedarvale, Kitwanga and Skeena Crossing - 19.0, Hazelton, Hagwilget and Kispiox - 20.2, Babine fence - 27.4, Babine Lake streams - 55, and Moricetown 25.4. These periods are roughly similar to those for 1945. Since the fish remain in the lower river for an average of 5 days, the weekly closed season does not allow all which appear from Friday night to Sunday night to escape. As a matter of fact, the exploitation drops only slightly for those fish tagged on Thursday, Friday and Saturday. It remains heavy for those present at the beginning of each week.

The thorough routine surveys at Lakelse, the experiment at Moricetown where a close inspection was made of the Indian catches, and the operation of the Babine fence where all fish were examined, have produced the most reliable information thus far gathered on the time of migration of the runs through the fishery. No ocean tags were discovered in the Lakelse area from fish handled after June 19, once again indicating that this is an early migration and is practically over before the fishery can exploit it. Recoveries from Moricetown and Hagwilget (72), indicate that fish going to the Bulkley river are entering the Skeena throughout the season from June 18 to July 28. The small number of returns, although not too reliable, indicate the greatest percentage of Bulkley fish in the runs in the lower river in late June and early July. The 354 recoveries from the Babine fence came from fish tagged from June 18 to July 28 and from almost every day's catch in that period. The main concentration where the Babine recaptures rose to slightly over 20% of those tagged, was after the middle of July. Thus, with the exception of Lakelse lake, the runs appear to be thoroughly mixed but each may be relatively more numerous at certain times.

Recoveries for other Species

Of the 155 springs tagged, 35 (22.6%) have been recovered or seen as follows: commercial fishery at the mouth of the Skeena river - 24, Indian fishery - 5, Babine fence - 4, and Bear river spawning grounds - 2. While recaptures at Moricetown showed that some of the tagged fish were moving up the Bulkley, and the returns at the Babine fence that they were going into Babine, the only actual spawning ground records are from Bear river much farther inland.

Forty-two out of the 155 cohoes have been returned from the commercial fishery mainly at the mouth of the Skeena but one or two individuals did go to the Nass area, Gardner canal, Stephens island and Gil island. Seven have been taken by the Indians in the lower river to Hazelton and in the Bulkley at Moricetown. The total percentage recovery has been 31.6%.

No. 5 A.L. Pritchard Appendix No. 5

Forty of the 290 pinks tagged (13.8%) have been returned to date. Only four of the 33 from the commercial fishery were taken outside the Skeena River Mouth area, one each in Douglas channel, in Gardner canal, in Ogden channel and in Edye pass. Three were recovered at the Babine fence.

Only 5 chums have been reported out of 37 and of these, one found its way to the mouth of the Nass river.

Discussion

The main improvements in the collection of tags which resulted in greater numbers returned, appears in the more systematic coverage of the Indian fishery, in the regular examination of the spawning grounds, and in the operation of the Babine fence. In spite of this, over 46% of the tags have not been seen. While more refinements will still be injected into fishery and river surveys, it is doubtful whether these will produce as good results as more fences like that at Babine. Another is being planned for Lakelse next year. Areas such as Kitwanga could be considered but in places such as the Kispiox, Bulkley, and upper Skeena, the engineering and supply problems appear so difficult that it is doubtful whether they could be included under the present budget. However, serious consideration is being given to the problem.

4. LAKE SURVEYS

J.A. McConnell Appendix No. 6

Alastair Lake and Gitnadoix River

Although it was planned to make a basic survey of the Gitnadoix area during the summer of 1946, this part of the program had to be eliminated due to lack of time caused by the fact that at the last minute the guide who was hired, refused to come or provide boats. It was possible however to make a brief survey by airplane on August 10, which served to familiarize the investigator with the area and provide an opportunity to take a series of photographs.

Alastair lake and the Gitnadoix river lie in a narrow valley which pierces the belt of mountains on the south side of the Skeena river valley at a point about 40 miles east of Prince Rupert. This valley which extends southward for about 17 miles is bordered by snow covered mountains which rise abruptly from the floor of the valley to heights of 4500 feet or more. The lake, at the extreme southern end of the valley, is about five miles long and three-quarters of a mile in width. Since the mountains rise very steeply on either side and at the extreme southern end, the lake is probably quite deep. Although fed from glaciers and from snow fields draining into the lake through many small, steep draws, the water is very clear and light blue in colour.

At the northern end, the lake shallows off and merges with the marshland which is characteristic of most of the valley floor. Here, it empties into the Gitnadoix river which follows a rather meandering course through the valley. The greater part of the Gitnadoix river is smooth and rather slow flowing but the lower three or four miles is marked by a series of rapids, about 6 or 7 in number.

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Three large streams enter the Gitnadoix river, Kadeen creek from the west, Clay and an unnamed creek from the east. These creeks flow in from wide, open draws in the belt of mountains encircling the valley.

It is hoped that in 1947 more information can be obtained on this area which is reputed to maintain salmon runs. Plans are being formulated to either carry out an expedition upriver by boat from the Skeena or to enter the lake by plane. Such a survey will be arranged when the Lakelse runs are at their peak and thus when the salmon should be in the Gitnadoix system if they frequent it at all.

J.A. McConnell and J.R. Brett Appendix No. 7

Lakelse Lake Area

During the winter months analysis of the data collected from each of the lakes of the Skeena river indicated strongly that increased emphasis must be placed on the study of Lakelse lake to obtain a clearer understanding of the biological relations involved and the interpretation of the readings obtained from the methods in use. By so doing the differences and comparable features revealed from the other lake studies would be open to a fuller interpretation. Of necessity this involves repetition and enlargement of the phases of the investigation already in vogue.

Certain indices had been already introduced while others have recently been added. In the lake study itself, these may be listed in part as catch per net-night, predation index, competition index and food index, involving the programme of netting, stomach analyses, plankton, sampling and dredging for bottom fauna. In the physical and chemical field certain levels have been classed as limiting. Increased standardization of technique was imposed on all phases of the investigation.

The number of standard net sets at Lakelse this year totalled 39 with an additional 6 sets made by floating nets at the surface. These sets were made by utilizing six different gangs of five nets each, always including mesh sizes from 1 1/2" to 6", one in each inch group. To summarize the catches, a table showing the total catch and catch per net-night for 1946 is included, with the complete total of the past 3 years for comparison.

Species	Total catch for 1946	Catch per net-night for 1946	Total catch 1944-1946	Over-all catch per net-night
Peamouth	1162	5.95	2568	5.69
Squawfish	255	1.30	738	1.57
Cutthroat	210	1.07	417	.89
Sockeye	161	.84	355	.76
Whitefish	62	.32	145	.31
Sculpin	51	.26	168	.36
Columbia river sucker	38	.19	159	.34
Dolly varden	7	.03	16	.03
Total	1946		4566	

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With the continued desire to provide an absolute interpretation of the value and equivalent in actual population of "catch per net-night", the netting effort has and will remain high and will be combined with the program of marking coarse fish in the lake. This latter was commenced in 1945, was continued, and resulted in a total of 197 peamouth, 35 aquawfish, 976 suckers, 41 whitefish, 1 cutthroat and 45 rainbow trout being marked from the yearling trap in the Lakelse river; 237 peamouth, 59 squawfish, 6 suckers, 7 whitefish, 7 cutthroat and 4 sculpins being marked from gill nets in the lake and 370 peamouth, 19 squawfish, 13 suckers, 6 cutthroat, 154 sculpin and 3 coho fry being marked from a fyke net set in one of the smaller tributaries of the lake. From a sum total for both 1945-1946 of 1659 marked fish, only 37 have been recovered in netting. Unfortunately these are too few to be of particular significance. It is hoped that increased returns will follow.

This marking programme will be of value in examining the selective action of gill nets for various species. For example, although 976 suckers were marked at the yearling trap in 1946, only 1 was recovered in gill netting indicating the possibility that the "catch per net-night" for suckers might be considerably less than some other species although equally abundant.

To cover an over-all comparison of the different lakes special indices of predation, competition and food supply have been set forth taking into account the size, abundance and food habits of each species of fish. These have stemmed from an examination of the Lakelse lake data which now places this lake among the top three in the Skeena river system for abundant predation. A particular study is being commenced this winter on the squawfish and cutthroat as predator fish in this lake.

In the field of food supply, a detailed study has now been made of the plankton as the fundamental factor. The plankton samples taken in 1945 were used. This study provides information for seven months of the year on the seasonal variations in abundance and the vertical distribution of the crustaceans which form the food supply of the young sockeye salmon. The forms which occur in the greatest numbers are the copepods, Cyclops bicuspidatus, Cyclops serrulatus and Epischura nevadensis. They show peaks of abundance in July and August. The chief Cladocerans, Bosmina longispina and Diaphanosoma leuchtenbergianum increase in numbers twice during the summer, in June and late July. Thus, the potential food organisms of young sockeye are most abundant in the months from June to September. The index which is now being applied for basic comparisons between lakes and within lakes is the number of plankters per 10 meter haul.

The study of the bottom fauna was reduced somewhat this year. Twenty dredgings were made which will be of value as comparisons with those taken in 1944 and 1945.

An analysis of the past physical-chemical data has been made with a view to publishing them. In this regard, certain of the literature has been reviewed and no limiting factor has been discovered or is likely to occur. Although during the winter the winter of 1945-46, the Lakelse area received a heavy snowfall and there were resultant high water levels throughout the spring and an abundance of water in the spawning streams during August and September, the possibilities of extreme high or low water levels and exposure of gravel beds is a feature which should be given further examination.

Since none of the physical-chemical features can be classified as

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limiting, it is planned to discontinue much of the twice-monthly routine examinations of temperature, transparency, oxygen and pH and substitute a more detailed examination of certain features.

The study of the physico-chemical features was started earlier than in previous years, on April 11, when two-thirds of the lake surface was still covered with ice, and continued through the spring turnover, and through the summer stagnation period to the middle of September. Arrangements have been made to obtain readings of temperature, bottom oxygen, water level, a plankton sample and data on ice conditions and snow coverage twice monthly throughout the coming winter, thus spanning the complete year.

Records of vertical distribution of temperature were taken at least every five days with a bathythermograph. These records will make possible a study of the distribution of heat through the lake by conduction and convection and the development of the thermocline.

In the hope of being able to correlate the variations in lake conditions with the climatic changes in the area and eventually to discover the effect of both on the behaviour and movements of the fish, particularly the young sockeye, a series of meteorological observations was instituted in 1946. The Meteorological Division of the Department of Transport kindly supplied maximum and minimum air thermometers, wet and dry bulb thermometers, a rain gauge and a sunshine recorder. Along with these readings, daily observations of the weather were taken including barometric pressures, wind direction and force, sky type and coverage. To these were added special daily records of the water level change, of surface temperature variations and more frequent operations of the bathythermograph to outline the thermal conditions in the deeper waters of the lake. Although particular interest was focussed on April, May and June when the yearlings were migrating, nevertheless the records were continued throughout the summer.

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Kitsumgallum Lake

Each year since 1944 visits have been made to Kitsumgallum lake to investigate general limnological conditions to assess the role of the lake in comparison with others of the Skeena system in so far as sockeye salmon production is concerned. During the summer of 1946, two trips were carried out and the additional standard series were taken. For this effort the writers wish to express their appreciation to Messrs. D.K. Foerster and A. Johnston. These data have served to confirm impressions previously held and outlined below.

Kitsumgallum lake is predominantly a heavily glaciated, deep, cold body of water and now appears to be an area of low salmon productivity. The steeply inclined shores and deep water result in no areas of rooted aquatic vegetation so characteristic of shallow, more productive bodies of water such as Lakelse. Six of the nine tributary streams are rocky and turbulent with a heavy, steep gradient from the mountains while the other three are more sluggish but contain heavy glacial silt in suspension. These latter apparently have the effect of making the lake water extremely opaque, the mean depth of

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disappearance and reappearance of a Secchi's disc being 1.6 feet in clear summer weather.

This low degree of transparency and its effect on limiting light penetration keeps the phytoplankton production low, consequently the zooplankton forms, the food of young sockeye salmon, are comparatively few in number. Although Morice lake has similar characteristics - cold, deep, glaciated - its transparency is at least three times that of Kitsumgallum and the number of Copepoda per unit depth is greater in the same proportion. Allied with lack of light penetration, the low heat content undoubtedly helps to inhibit plankton production by inhibiting the growth rate of organisms.

Another factor which likely adds to the low sockeye salmon productive capacity is the high degree of predation by the cutthroat trout. The dolly varden, another predator, is also present but in smaller numbers so that the damage is less important.

The conditions existing in Kitsumgallum lake would appear to be the worst yet discovered in the Skeena system for the production of sockeye salmon.

J.A. McConnell Appendix No. 9

Kitwanga Lake

The studies on Kitwanga lake this year were directed towards checking of last year's data, and some expansions. Two visits were made for the collection of records of water conditions and samples of the plankton and fish populations.

In general the physical and chemical conditions in the lake were much the same as in 1945. Surface temperatures were again high in both parts of the lake, the bottom waters of the northern section being only 3°C. cooler than the surface and a thermocline was again present in the southern part with low temperatures of 5° to 7°C. (41° to 44.6°F). Confirmation of the 1945 oxygen records was obtained in that the oxygen in the bottom waters of the southern part of the lake was almost exhausted by mid-summer. However, the condition was found to be local with the upper strata (above thirty feet) being quite habitable.

The plankton, as sampled by the standard #10 mesh net, was made up of a comparatively small number of species but some of these forms were very abundant. A total of 22 phytoplankton and 16 zooplankton genera was identified. Of the phytoplankton, the diatoms were the most abundant. A Cladoceran, Daphnia pulex, and a Copepod, Cyclops bicuspidatus, were the chief animal forms. It would appear that there is an abundance of food for young sockeye at least during the summer.

The fish population was sampled by a standard gang of 5 linen nets (mesh sizes 1.5", 2.0", 3.5", 3.9", 5.0"). Considerable variation occurred in the numbers of each species captured this year and in 1945 illustrating the need for more adequate sampling in the future to obtain a significant "catch per net-night" relationship. The total catch and the catch per net-night for 1946 and the average catch per net-night for both years are as follows:

J.A. McConnell Appendix No. 9

Species	Total Catch	Catch per net-night	Average catch per net-night for 1945 and 1946
Peamouth	156	6.24	3.67
Squawfish	27	1.08	2.14
Cutthroat "	8	.32	.64
Long-nosed suckers	3	.12	.36
Rocky mountain whitefish	2	.08	.78
Kokanee	2	.08	.17
Dolly varden	1	.04	.07

From an examination of the stomach contents of the two main predators squawfish and cutthroat trout, taken in August 1945, it would appear that predation on salmonoids at this time of year by cutthroat trout is not heavy but that predation by squawfish may be. The stomachs of the cutthroat trout contained only 5 per cent salmonidae, probably young sockeye salmon, insects and other species of fish being the chief foods. In the case of the more abundant squawfish, 20 per cent of the contents were salmonidae, with insects, molluscs and other species of small fish making up the remainder.

F.C. Withler Appendix No. 10

Lac-da-dah District - Kispiox System

Since the survey of the Kispiox river and Lac-da-dah basin consisted mainly of stream observation, little was done in the nature of lake surveys. However, a linen gang of five 50-yard nets of 1 1/2", 2", 3", 4" and 5" meshes was packed in to Stephens lake, where two net sets were made. Both sets were made in positions established in 1945. Lengths, sex, scale samples and stomach samples were taken.

The low water level of Club creek and the short period of time made the transportation of the boat and nets to Club lake and Swan lake impossible.

The catch per net-night for the two sets in Stephens lake was as follows:

Long-nosed sucker	2.8
Rocky mountain whitefish	2.4
Sockeye	0.9
Dolly varden	0.6
Rainbow	0.1
Coho	0.1
Spring	0.1

These figures indicate for the species almost the same order of abundance as that of 1945.

J.R. Brett Appendix No. 11A

Babine Lake - General Introduction

In view of the increasing importance of Babine lake, which, on the basis of analyses to date, appears to carry as much as one-half of the sockeye escapement to the whole Skeena system, a concentrated effort was made to bring this large lake up to the standard attained in many of the smaller lakes with respect to the basic studies of netting, limnology, physico-chemical characteristics, and general ecology.

To achieve this objective, the lake was subdivided into three main "divisions" and a party of two men, sometimes three, made responsible for each. The "division" lines were purely arbitrary and merely designed to mark off a workable portion of the lake in which one party was to carry out the various studies, e.g. limnology, stream surveys, etc. In each of these "divisions" an "area" was indicated with its centre at the camp headquarters and its radius equal to ten miles. Centrally, also, was established the "station" where all physical and chemical, and limnological readings were made for the section. The standard netting was restricted entirely to the ten mile areas.

The object has been to "sample" the lake at these three distinct and separated points, analyse the data for each separately, compare them, and then compile them to form a picture of the statistical whole, i.e. the whole lake.

Physico-Chemical Conditions - The studies on physical and chemical features were considerably increased through the operation of complete recordings of temperatures, oxygen saturation, surface water temperatures and certain meteorological observations. The first four determinations were performed routinely while sampling the plankton, whereas the latter group were recorded as daily observations at set times of day. Similar observations, usually at the same time, and when possible, for fortnightly operations, on the same day, were carried out at each of the stations.

Plankton and Bottom Fauna - Commencing on June 18 and operating thereafter on appointed days approximately two weeks apart, plankton hauls were made with a No. 10 Wisconsin-B.C. type net. These included usually one complete vertical haul and stage hauls at 10 metre intervals to 10 metres below the thermocline, the hypolimnion thereafter being covered by a single haul. The final series was performed in late September.

For purposes of standardization of the relative efficiencies of the plankton nets in use, not only on Babine lake, but also on Lakelse, Kitsumgallum and Kitwanga lakes, a series of hauls was performed at this station in a fashion as uniform and as similar as possible. These data all await analysis.

In Morrison lake, a biological study was planned which would provide data for a more critical consideration of productivity. Three stations were established at which plankton hauls were to be made.

To further the knowledge of food supply and availability, series of dredgings were outlined for each division.

To these will be added a series of recordings twice per month at Station III, Fort Babine. These are to cover, throughout the winter months, the bottom oxygen concentrations, the vertical temperature changes, the water level fluctuations, ice and snow conditions and once complete vertical haul for plankton collection, thus spanning the complete year for this aspect of the investigation.

J.R. Brett Appendix No. 11

Meteorological Recordings - The geographical position of Babine lake apparently predetermines in some respects the type of climatic conditions to be expected. The coast range between it and the Pacific acts as an effective barrier against a large portion of the heavy precipitation which is characteristic of the coast, nevertheless the frequent passage of heavy "fronts" across the mountains gives Babine an annual rainfall of about 14 inches. Numerous observations have been made and the results are briefly outlined for each division to give a picture of general conditions. Later analyses, it is hoped, may result in correlations between some of the factors and fish behaviour.

Sounding- Certain parts of Babine lake had been sounded in previous years. The aim for 1946 was to complete the larger portion which remained and eventually draw a complete depth contour map.

Ecology - The general ecology of any area is perhaps more directly connected with fish propagation than is usually assumed. The size and number of gravel beaches, the type of vegetation which affects the run-off and control the height of the lake, etc. may be very important. For this reason each party has been asked to make a general survey in this connection. Only brief summaries are submitted.

The final analysis of the data already collected will, of course, influence plans for the future. At present such intensive work is not contemplated for Babine lake in 1947. It seems reasonable to consider filling in the gaps found in the data and go further with more generalized netting of an exploratory nature.

V. McMahon Appendix No. 11

Division I - Babine Lake

Division I included from its southern boundary - 50 miles from the south end of the lake - the more central and widest portion of the lake stretching northwestward 20 miles down the lake to the Indian village of Old Fort and thence up the valley of the northern arm, or Hatchery Arm, to include Morrison river and Morrison lake. The "base camp" was close to the southern border at Topley Landing off which was established Station I, the original locality reported in previous years.

Physico-Chemical Conditions - In Division I, both the Babine lake findings and those at Morrison lake show distinct variations, none of which can be classified as limiting on the basis of the standards set up at Lakelse lake. At a depth of 60 metres, Station I, Babine lake, the temperatures varied but little throughout the year reaching a peak of 5°C. on August 23. The region of greatest variation extended from surface down to 25 metres.

Plankton and Bottom Fauna - The first plankton series was carried out at Station I on June 18 and others at approximately fortnightly intervals there after giving a total of 7 for the season.

In Morrison lake two series were performed at each of three stations with an additional series for Station I only. Thus 7 series were provided for this smaller area in keeping with the desire for more complete information there.

Dredgings involved two separate lines covering various types of bottom and depths up to 100 metres.

Meteorological Recordings - Since Babine lake lies in a basin with high ground to the east and west, it seems logical that the strongest and most

prevailing winds should be from the north and south. This is confirmed by the data for the period June 24 to August 12 during which time it was found that 75% of the winds were either in the sector NW-NE or SW-SE.

The surrounding high ground is also very conducive to the formation of cumulus and the resultant cumulo-nimbus or thunderclouds. This is also verified from the data where it is seen that during the total period there have been no cloudless days and only 7 in which the coverage was 4/10 or less, so that even during the better weather these clouds were present.

Sounding - The soundings for Division I were completed in the Babine section, those for Morrison lake having already been accomplished. Hatchery arm was distinctly shallow with a maximum depth of 30 metres, while Hagan's arm was considerably deeper striking a maximum of nearly 90 metres at its centre. The deepest portion of the main lake was found to be 146 metres., located off Newman Peninsula, about midway between shores.

Netting - In the Babine lake portion of the Division, 4 standard gill-net sets were made at each of eight selected positions and 8 random or varied sets were also made. In general, four shore sets were made at each position, two with linen series and two with a cotton series. Each series consisted of five 50 yard nets, one each of the 1,2,3,4 and 5 inch mesh groups. Depths of the various meshes were recorded at each position.

Three standard positions were set up at Morrison lake, and at each 3 sets were made in a manner similar to those on Babine. One varied set was also made.

In the table below are shown the species obtained and the catch per net-night for each:

	Catch per net-night	
	Babine Lake	Morrison Lake
Peamouth	.54	.12
Kokanee	.49	.40
Eastern whitefish	.31	3.14
Rocky mountain whitefish	.30	--
Sockeye	.30	.02
Lake trout	.12	.44
Squawfish	.07	.48
Common sucker	.04	.06
Rainbow trout	.03	.08
Ling	.02	.08
Coho	.01	.02
Average catch per set -	2.21	4.84

Ecology - The shore line of Morrison lake is almost entirely composed of large stones skirted by vegetation of various types. Reeds and water lilies grow out to a depth of about 1.5 m. along about 80% of the shore-line and though their roots are in mud, even in these areas rocks and stones line the water's edge. The southern third of the lake and the entire west shore are thickly wooded with heavy timber whereas two-thirds of the east shore is relatively barren as the result of a fire in 1922.

V. McMahon Appendix No. 11 B

Hatchery arm and Hagan arm are more or less continuous in the same valley system with Morrison lake and are of an intermediate ecological status between the latter and the major section of Babine lake in which there is presented every type of shore line from the precipice-like banks of Red Bluff to the gradual sandy beaches off Topley Landing. The west side of the division ha draining into it the Fulton river, Tachek creek and several other creeks of smaller dimension, whereas the east side is practically devoid of streams, salmon or otherwise. Both shores (east and west) are fairly heavily wooded, in th most part, with spruce and other evergreens, while the southern third of the east shore has thick stands of deciduous trees. This portion of the lake shore is characterized also by the presence of red gravel beaches along almost its whole extent. The other two-thirds of the east shore and about 90% of the west shore have large stones along the water's edge and running out to a depth of several metres.

D.F. Alderdice Appendix No. 11 C

Division II - Babine Lake

The division includes the southern 45 miles of the lake and extends from the vicinity of Port Arthur Harbour, 5 miles south of Topley Landing, to the south end, with headquarters at Donald Landing, a nearly central location.

Physico-Chemical Conditions - The station was set up off Donald Landing at a depth of 243 feet in a position subject to all typical weather conditions. Samples were taken bi-weekly from June 18 to Sept. 12 and thermal stratification was evident in each case. The average surface temperature was 15.4°C. and the average bottom temperature, 4.2°C. Although no true thermocli was found to exist at any time, the region of greatest temperature change lay approximately between 20 and 120 feet. A temporary thermocline at the surface was experienced on July 23 when the surface temperature was 18.3°C. and the temperature at 2 feet was 15.4°C. Weather conditions promoting this phenomeno were infrequent and it is probable that the fall overturn, because of the depth of the lake, is late and occurs at a low temperature. Dissolved oxygen concentrations were not found below 80% at any time. Concentrations at the surface were approximately 100% and those at the bottom 80-90%. Transparency readings with a Secchi disc showed a maximum light penetration of 21 1/4 feet. The only major variations in transparency appeared due to the effect of weather conditions at the time readings were taken. A water level stake inserted at Donald Landing demonstrated a drop of 3 feet 2 inches from June 18 to Septembe 24, the average daily drop being 2/5 inch.

Plankton and Bottom Fauna - Plankton samples, taken along with the temperature - oxygen series at the station, consisted of total vertical sample and 10 meter stage hauls. Bottom fauna was sampled on two occasions, July 24 and 25. The two lines were run from 1 to 100 meters.

Meteorological Recordings - Weather recordings were obtained for a period between July 21 and August 31. Using the Beaufort scale of recording, the cloud coverage varied from 80% to 20% and averaged 53%. Wind velocity var

between 0 and 3 and averaged 2.6. Wind direction was exceedingly variable. The prevalent winds usually blew in the direction followed by the land contours enclosing the lake, the most common wind being southwest followed by northwest and the least common southeast.

Sounding - 52 sounding lines were run. The greatest recorded depth found was 635 feet, although 680 feet has been recorded. Generally, the lake is deepest at the southern part becoming shallower to the north. Depressions and submerged ridges were recorded.

Netting - 36 gang sets or a total of 186 individual net sets were made from June 21 to August 27. Netting was restricted to 10 constant positions at which the depth of each net was known. Two gangs of 5 nets, each 40 to 50 yards in length were used, in graded series:- No. 1 - 1 1/2", 2 1/8", 3 3/8", 4", 5", and No. 2 - 1 5/8", 2 3/4", 3 1/2", 4 1/2", 5 1/2". Stomach samples, length, sex and scales of predator fishes were taken and a maximum of 10 samples of competitors per month. The catch per net night in order of abundance of species follows:

	Babine Lake proper	Wright Bay
Sockeye (adult)	.83	--
Kokanee	.58	.8
Rocky mountain whitefish	.53	1.6
Long-nosed sucker	.35	.3
Trout (Rainbow & Cutthroat)	.14	.2
Eastern whitefish	.13	.5
Lake trout	.12	---
Coho (young)	.11	--
Common sucker	.07	.4
Ling	.04	.1
Peamouth	.02	4.7
Sculpin	seen but not netted	

Wright bay, although a part of Babine lake, differs from it in ecology, and the catch per net-night is shown separately. The figures are not strictly comparable but serve to indicate marked differences. The Wright bay figures are based on two sets made there on July 13.

Ecology - The shoreline, which is usually narrow and drops off sharply into deep water, can be arbitrarily divided into six confluent types: 1- gently sloping sand and mud shore - 20%, 2 - gently sloping fine gravel - 19%, 3- gently sloping broken rock and boulder - 4%, 4- more steeply inclined shore with fine gravel soon replaced by coarse gravel - 42%, 5- broken rock on a precipitous slope - 8% and no shoreline, bluffs - 4%.

The southern end of the lake is shallow and low level muskeg and willow swamps continue up the Sutherland river valley to Grizzly creek, a distance of 8 miles. Aquatic vegetation is limited to river bars and shallow bays on the shore line, and is generally sparse excepting in Wright bay and at the southern end.

F.C. Withler Appendix No. 11 D

Division III - Babine Lake

Division III includes the northern arm of Babine lake, from Old Fort to Fort Babine, and Nilkitkwa lake, with the streams entering these areas and connecting the lakes. Headquarters for the division were situated at Fort Babine.

Physico-Chemical Records - Station III in Babine lake, where oxygen, temperature and transparency records, and plankton samples were taken, is situated approximately one mile south of Basil's point. The depth of the station was 40 metres. Records and samples were taken every two weeks.

Thermoclines were found on every day that records were taken, at no time below a depth of 15 metres. Average bottom temperature was 5.1°C., the lowest being 4.8°C. and the highest 17.0°C.

The oxygen content of the water at all depths was relatively high. No stagnation could be found at the bottom during the summer.

The average transparency reading with the Secchi disc at Station III was 5.4 metres with the lowest record of 4.0 metres on July 11 and the highest of 6.9 metres on September 8.

Station III-N, located approximately one mile from the south end of Nilkitkwa lake, had a depth of 19 metres. Readings of temperature, oxygen and transparency were taken at two week intervals one day after the records taken at Station III.

The average bottom temperature at Station III-N was 8.0°C., the lowest being 7.8°C. and the highest 8.6°C. The average surface temperature was 14.8°C., the lowest being 14.0°C., the highest 16.4°C. No thermocline was recorded at any date during the summer at Station III-N.

Oxygen saturation was high at all times in Nilkitkwa lake. Little difference was recorded between surface and bottom oxygen concentration.

The average transparency reading of the Secchi disc was 5.0 metres, with least transparency recorded on July 11 (4.0 metres) and greatest on August 24, (6.0 metres).

A maximum-minimum thermometer was set up in Babine lake directly in front of the camp at Fort Babine. Readings of the surface temperature were taken each day, the highest recorded being 67° F. (19.4°C.) on August 31, and the lowest being 42°F. (5.6° C.) on July 22.

Water level readings were made from a stake set up directly in front of the camp at Fort Babine. From June 19 until June 28 the water level rose 1.2 inches, then from June 28 until August 31 fell 24.9 inches. This gives an average daily drop of 0.39 inches between the above dates.

Plankton and Bottom Fauna - Plankton hauls were made at the same time as the physico-chemical determinations at Stations III and III-N. The hauls included a total vertical, stage hauls, and one or two surface tows each time plankton was taken.

Bottom fauna was sampled by running two lines of dredgings at specified depths. Eighteen dredgings were taken, the type of soil and presence of live or decaying plant material being noted, as well as samples of the organisms present in each dredge haul.

Meteorological Records - Meteorological records were taken at Fort Babine twice daily from June 14 to August 30. The average wind velocity for the summer was 2.1 (Beaufort scale), and the most prevalent wind was south, the next most prevalent being from the west and north. In general, at Fort Babine, south and north winds were accompanied by fine weather, and west winds brought

stormy weather. The average cloud coverage for the summer period was 57%. Cloud coverage was considerably higher in June and July than in August.

Soundings - Sounding in Division III on Babine lake had been carried out from Fort Babine to Nine-mile point in previous years. This summer, the sounding was completed from Nine-mile point to Old Fort with a series of 22 sounding lines. The greatest depth found was 103 metres between Old Fort Village and Old Fort point. Compared with depths of Divisions I and II, Division III is relatively shallow. Except for the region around Old Fort, little of the north arm exceeds 30 metres in depth.

Netting - Netting in Division III in Babine lake was confined to ten netting positions. These were distributed between Fort Babine and Ten-mile point. Each position was sounded, so that the depth of all meshes was known. Two gangs of five nets each were used: a cotton gang with approximately 50 yards each of 1 1/2", 2 1/2", 3 1/2", 4 1/2" and 5" meshes, and a linen gang with 50 yards each of 1 1/2", 2". 3", 4" and 5" meshes. Thirty-one sets were made in Babine lake.

Netting was also carried on in Nilkitkwa lake in three positions. Only four sets were made before sockeye became too numerous.

The catch per net-night in Division III, Babine lake and in Nilkitkwa lake follows:

	Catch per net-night	
	Division III Babine lake	Nilkitkwa lake
Sockeye	0.26	2.60
Peamouth	0.22	--
Eastern whitefish	0.20	--
Lake trout	0.09	--
Kokanee	0.06	--
Ling	0.03	0.20
Rainbow trout	0.02	0.10
Squawfish	0.02	0.15
Cutthroat trout	0.02	--
Common sucker	0.01	0.10
Coho	0.01	--

Ecology - The hillsides around Division III are covered with spruce and poplar trees, with a few burnt-over areas covered by bushes of different kinds, chiefly willow. The shoreline in general is moderately sloped, so that only in a few bays is there an extended shallow area. It may roughly be divided as follows: Reeds and mud - 29%, gravel and small boulders - 23%, gravel - 22%, small boulders - 20%, coarse sand - 2%, rock bluff - 2%, large rocks - 1%, fine sand - 1%.

Nilkitkwa lake is relatively shallow, and the shoreline tends to be more gently sloped, giving a high percentage of reedy areas as follow: Reeds and mud - 56%, gravel and small boulders - 24%, and gravel - 20%.

D.R. Foskett Appendix No. 12

Slamgeesh, Damshilgwit and Damdochax Lakes

The Slamgeesh river, a branch of the Kilankis, lies between the 2,000 and 2,500 foot contours about 80 miles north and slightly west of Hazelton. It is in a broad U shaped valley with luxuriant vegetation and fringed by mountains between 5,000 and 6,000 feet in height. Coniferous trees, chiefly fir and spruce, predominate in the forests with devils club the most noticeable, if not the most abundant, member of the undergrowth. Willows and alders predominate along the margins of the streams. The area may be reached by pack train from Hazelton via the Telegraph trail or by plane to Damdochax lake and from there by back-packing the 12 miles to Damshilgwit lake. The latter method was the one chosen for the 1946 trip.

The Slamgeesh river is a clear stream with three lakes on its course. The lower two only were visited on this trip and soundings, temperatures and plankton were taken and some netting was done.

Slamgeesh lake is located on the Slamgeesh river about a quarter mile above its mouth. It is shallow (26 feet deep), about 1/4 mile by 1/4 mile with extensive weed and water lily beds around its margins. Small fish were abundant in these beds and especially so in the upper part of the outlet. On July 27, the surface temperature was 12.3°C. and the bottom temperature was 11.4°C. A Secchi disc could be seen to a depth of 12 feet. Plankton samples were taken.

Gill netting was carried out with a gang of three nets, 1 1/2", 3 1/2" and 4 1/2" meshes, each 50 yards long. Two sets were made and the species caught and the catch per net-night were as follows:

Rocky Mountain whitefish	-	4.33
Dolly varden char	-	2.67
Rainbow trout	-	0.33
Long-nosed sucker	-	0.50
Kokanee	-	0.02

Damshilgwit lake, three miles upstream from Slamgeesh lake, is larger, 1/2 mile by 1/4 mile, deeper - 40 feet, and less weedy than Slamgeesh. Its surface temperature on July 24 was 13.8°C. and this followed a steep gradient to 8.9°C. at the bottom. The same nets were used here that were used in Slamgeesh lake and the catch per net-night was:

Rocky Mountain whitefish	-	3.83
Dolly varden char	-	1.83
Rainbow trout	-	0.17

Though close to the Slamgeesh area, Damdochax lake is on the Nass river system. It is a clear lake, 1 1/2 miles long by 1/2 mile wide, and is at least 78 feet deep. There are fairly extensive shallows and weed beds. The following species were netted (figures give the catch per net-night):

Sockeye	-	4.67
Kokanee	-	2.33
Dolly varden char	-	2.33
Rocky Mountain whitefish	-	3.00
Long-nosed sucker	-	1.67
Cutthroat trout	-	0.33

D. R. Foskett — Appendix No. 13

Kluayaz Lake

Kluayaz lake is situated on the headwaters of the Skeena just north of the 57th parallel of latitude about 80 miles northwest of Bear lake. It is on Kluayaz creek about 100 yards above its entrance into the Kluatantan river at an altitude of about 3,800 feet. Kluayaz creek, the main inlet, arises in the glaciers to the northeast and is responsible for the silted character of Kluayaz lake.

The body of water is approximately 2 miles by 1 mile. The northern half mile and the southwest portion are quite shallow. The maximum depth found, 64 feet, lies in a depression of about $\frac{1}{2}$ mile diameter having a general depth of over 50 feet.

Temperatures were taken on August 13 and August 21. During the interval the surface temperature increased from 10.7° to 11.2° C. and the lake became stratified, the thermocline being between the 10 and 25 foot depths. A Secchi disc was visible only to a depth of 6 inches in this lake. The heavy silt content and cold water apparently account for the scarcity of plankton.

Gill netting was carried out with a gang of nets consisting of 50 yards each of $1\frac{1}{2}$", $3\frac{1}{2}$", and $4\frac{1}{2}$" mesh. The species caught and the catch per net-night were as follows:

Long-nosed sucker	3.25
Rocky mountain whitefish	2.33
Sockeye salmon	0.25

The whitefish caught were all small, (largest $10\frac{1}{4}$").

D. R. Foskett — Appendix No. 14

Motase Lake

Motase lake lies at the head of the Squingula river 10 miles west of the southern end of Bear lake at an altitude of 3,350 feet. It is surrounded by high peaks in which are large glaciers. The lake, between 3 and 4 miles long and a mile wide, has an hour glass shape with the main axis in a north-south direction. The water is heavily silted, (Secchi disc - 8 inches) and when seen from a distance has a greenish tinge. The deepest sounding made was 105 feet. At the time the lake was visited, late September, the autumn turnover had apparently already taken place. On September 26 the surface temperature was 6.75° C. and the bottom temperature was 6.3° C. Plankton appeared to be scarce.

Gill netting using a gang of 50 yards each of $1\frac{1}{2}$", $3\frac{1}{2}$" and $4\frac{1}{2}$" meshes yielded the following species (figures indicate the catch per net-night):

Coho salmon	1.00
Long-nosed sucker	0.33
Dolly varden char	0.33
Rocky mountain whitefish	0.33

D. R. Foskett — Appendix No. 15

Bear Lake and Azuklotz Lake

At Bear lake the main emphasis this year was on the netting. At Azuklotz

D. R. Foskett Appendix No. 15

lake, soundings were made and physical conditions recorded for the first time. The latter lake, 4 feet higher than Bear lake, is connected to it through Tsaytut bay by a stream about fifty feet long.

Physical conditions in Bear lake paralleled those of 1945. The surface temperature at Station I at the north end was the same, 15.2°C. on both August 26 and September 5. On the latter date two thermoclines were present as was the case last year. The surface temperature was 16.5°C. at Station II at the south end on August 26. Plankton samples were taken at both stations on August 26 and in addition, at Station I on September 5. Secchi disc readings were 16 feet and 12 feet at Station I on August 26 and September 5 respectively. At Station II on August 26 it was 14 feet.

Azuklotz lake was found to be shallow, 35 feet being the greatest depth discovered. It had a surface temperature of 17°C. on August 29. There was a marked temperature gradient from top to bottom though it did not reach thermocline proportions, the bottom temperature being 12.9°C. A Secchi disc could be seen to a depth of 15 feet in this lake. Plankton samples were also taken.

Despite the proximity of the lakes to one another and the ease with which fish can migrate between them, gill net catches showed marked differences in each. The species obtained and the catch per net-night determined through the use of standard gangs of five mesh sizes, $1\frac{1}{2}$", $2\frac{1}{2}$", $3\frac{1}{2}$", $4\frac{1}{2}$" and 6", were as follows:

	Catch per net-night	
	Bear lake	Azuklotz lake
Sockeye salmon	1.90	1.7
Rocky mountain whitefish	1.67	3.0
Eastern whitefish	1.13	-
Long-nosed sucker	0.43	-
Ling	0.23	0.4
Lake trout	0.10	-
Common sucker	0.10	-
Kokanee	0.03	-
Dolly Varden char	-	0.3

D. R. Foskett Appendix No. 16

Sustut and Asitka lakes

These two lakes 25 miles north and 15 miles west of Bear lake are at an altitude of 4,250 feet. Sustut is in a narrow valley bordered by high peaks while Asitka lake, 2 miles to the east, is at the junction of this valley and the much broader one through which the Ingenika trail goes north to McConnell creek. Sustut lake which is $3\frac{1}{2}$ miles long and 1/2 mile wide reaches a depth of 61 feet while Asitka lake, 3/4 by 1/2 mile, reaches 26 feet. Both slope gradually to the deeper areas which are in neither case extensive.

Sustut lake had a surface temperature of 14.8°C. with a temperature gradient of thermocline proportions in the lower 30 feet. Asitka lake with a surface temperature of 13.5°C. had a gradient of similar proportions in the bottom 20 feet. Secchi disc readings were 30 feet in Sustut lake and 18 feet in Asitka. Plankton samples were taken in both areas.

D. R. Foskett Appendix No. 16

Gill netting, using 50 yards each of 1½", 3½" and 4½" mesh was carried on in Sustut lake for the first time in 1946. Two sets were made, the species caught and the catch per net-night being as follows:

Sockeye salmon	6.00
Rocky mountain whitefish	11.50
Dolly varden char	1.67
Steelhead trout	0.33
Coho salmon	0.17

Other fish known to be present in this lake are ling, shiner, and chub minnow.

No netting was done in Asitka and the only fish seen in the lake was the sockeye, though coho were spawning in the outlet a few yards below the lake.

D. R. Foskett Appendix No. 17

Johanson Lake

Johanson lake is situated about ten miles east of Sustut lake at an altitude of 4,730 feet. A narrow lake with several islands, it lies in a trough bordered with high peaks. It is moderately deep, the shores dropping off rapidly to a depth of at least 162 feet. One main tributary, the outlet for an unnamed glacial lake 1/2 mile south, enters the lake. A third lake, also very silty and glacial, lies to the southwest and empties into Johanson creek 1½ miles below Johanson lake.

Johanson lake is 3 miles long by 1/2 mile wide at the widest point. The surface temperature on September 16 was 11.5°C, with the thermocline between the 35 and 50 foot levels. A Secchi disc could be seen to a depth of 30 feet. Plankton samples were taken but the catch appeared to be light.

Gill netting was carried out with a gang of nets consisting of 50 yards each of 1½", 3½" and 4½" mesh. The species caught and the catch per net-night were as follows:

Sockeye salmon	2.30
Rocky mountain whitefish	3.00
Dolly varden char	0.89
Coho salmon	0.10

Steelhead trout were seen in the lake on several occasions but none were caught.

5. SPAWNING GROUND SURVEYS.

H. D. Fisher — Appendix No. 18

Ecstahl System - Johnston Lake

In the years prior to 1936, commercial fishing was permitted in the lower reaches of the Ecstahl river and it is considered by some that overfishing may have resulted in a reduced escapement to the spawning streams. Preliminary work was started on this area in 1946 in order to ascertain its productive capacities. This consisted of a basic survey on August 26 of one of the tributaries of the Ecstahl river, Johnston lake.

The Ecstahl river enters the south side of the Skeena about 8 miles from its mouth through a deep cleft in the Coast mountains stretching southeastwards for about 40 miles. It flows through very rugged terrain, the mountains on each side in the lower area dropping steeply into the river bed. Tidal influence extends up the Ecstahl about thirty miles to the "forks" where Johnston lake enters from the east through Johnston creek.

Johnston lake, about two miles long and three quarters of a mile in width, has steeply inclined shores dropping off rapidly into a deep basin exceeding 165 feet in depth. The water contains a slight glacial silt suspension rendering it opaque at a depth of about 15 feet.

Two fairly large, turbulent glacial streams enter the lake at the northeastern end but very few potential spawning areas are present in them and no salmon were seen. The only sockeye salmon spawning observed was on five small localized gravel beds around the shore of the lake where 30 live and 70 dead sockeye were noted. Although this poor showing might be only the beginning or end of a larger run, it would appear that the capacity of this lake for salmon production is somewhat limited.

In Johnston creek draining the lake into the Ecstahl, fair spawning beds are present throughout much of its mile long course but only one spring and twelve chums were present during this visit. According to reports a good spring salmon run usually spawns in this creek around the end of August.

It is hoped to continue and expand this study of the Ecstahl system including visits to Ecstahl lake at the head of the river and a return to Johnston lake.

J. A. McConnell — Appendix No. 19

Lower Skeena and Tributaries (from Hazelton west)

Brief surveys were made by the Lakelse party of 25 of the 30 streams entering the lower Skeena between its mouth and Hazelton. Those west of Terrace were covered between August 22 and 30 and the remainder between September 11 and 14. At these times it was hoped to intercept the peak of the pink salmon spawning. Similar counts were made to the 1945 survey but this year (1946) they were extended to include Khtada and Scotia rivers.

In general the pink run was much lower than last year as is evidenced by the commercial catch for the Nass-Skeena area which was 221,021 cases on September 8, 1945 and only 46,307 cases at the same time in 1946. In only three streams, Kitwanga, Gold and Lakelse did a heavy run appear and this was not of the same intensity as last year. The following is a table listing the streams

J. A. McConnell Appendix No. 19

and the comparative numbers of spawners in them:

Spawning Intensity	Streams
Heavy	Kitwanga, Gold, Lakelse
Medium	Mission, Stoney
Light	Kitsequecla, Deep, Price, Exchamsiks, Khtada, Khyex.
None	Sealey, Whiskey, Coyote, Little Oliver, Legate, Chemdimash, Copper, Simacord, Shames, Exstew, Kwinitsa, Scotia.

Although very few fish were noted in the streams below Terrace it is quite likely that small numbers did enter some of them later in the season.

The Skeena river proper showed a distinct contrast to 1945 in that little evidence was seen of pinks spawning on gravel bars in it or of dead pinks on the banks.

Light runs of chum salmon were observed in Kitwanga, Gold, Deep, Khtada and Khyex creeks. These were probably the forerunners of the main group which were taken in above average numbers by the commercial fishery this year.

It was reported that an obstruction in the form of a canyon was present in the lower Copper river and since it is known that sockeye salmon spawn in the headwaters of the Copper at McDonnell lake and that coho, chum, pink and steelhead are also reported in the upper Copper, an investigation was made on September 5 by Mr. D. J. Milne. The canyon, about 5 miles up from the mouth was narrow (about 35 feet) and the high water line was about 15 feet above the moderately low level of September 5. The flow was fast (5 m.p.h.) and the water turbulent and opaque. In general there is no obvious blockage to fish migration at this season. Pink salmon would probably be held up here as they are at Hagwilget at certain water levels, but not coho and steelhead.

J. A. McConnell Appendix No 20

Lakelse Lake Area

Lakelse lake is the most important of the small sockeye salmon nursery lakes in the Skeena river system. In 1944, it was estimated that approximately 9% of the total escapement spawned in the streams tributary to Lakelse whereas in 1945 the run was believed to amount to about 13% of the total.

The sockeye run this year first appeared in the upper Lakelse river on June 12 but was held up until June 20 when the barrier of the yearling trap was removed. As in 1945 the tagging in the mouth of the Skeena resulted in very few recoveries from the Lakelse area. Only three of the 2,135 sockeye tagged were recaptured therein. These had been tagged on June 18 and 19, almost two weeks before the commencement of commercial fishing, thus adding further confirmation to the belief that the Lakelse run is little affected by the fishery.

The tagging program within the lake was repeated to give an aid in estimating the total run. Some 969 fish were tagged near the mouth of Williams creek as in previous years, and, in addition, 271 were tagged off Scully creek, a location at which earlier tagging efforts had proved unsuccessful. During stream surveys 357 out of the total 1,240 tags were observed on live fish and 38 were recovered

J. A. McConnell Appendix No. 20

from dead individuals. From the results of the tagging and through comparison with data from 1944 and 1945 the total number of sockeye spawning in Lakelse lake was estimated at 42,800. In 1944 the estimated run was 25,000 and in 1945, 56,700, so that this year's spawning appears to be slightly above the general average.

Estimates of the numbers of sockeye spawning in the various creeks have been made and are as follows:

Williams creek..	37,000
Eliza creek (tributary to Williams).....	4,000
Scully creek.....	1,500
Granite creek.....	100
Others.....	200
	42,800

An effort was made to assay the extent of predation by bears on the salmon in the Lakelse spawning streams. Fresh dead fish with definite bear marks were examined. Out of 142, only one was an unspawned fish indicating that bears tend to procure only the spawned-out fish which are in a weakened condition.

J. R. Brett and J. A. McConnell Appendix No. 21

Kitsumgallum Lake Area

A. Kitsumgallum lake and tributary streams - The sockeye salmon run to Kitsumgallum lake and the three spawning streams entering at its northern end was estimated in 1944 to be about 4% of the total escapement to the Skeena system, and in 1945 about 2%. These estimates and the one for this year were made during short visits to the area in the first week in September when the run appears to be at its peak. Such surveys give at least comparative data since accurate counts on the main spawning stream, the Cedar river, are impossible due to the heavily glaciated water.

The number of spawners in the Cedar river and along the lake shore near Rosswood appeared to be just slightly greater than last year. In Clear creek where visibility is good, slightly more fish were present than in 1945. Again, the run was small in Dry creek, a spring fed tributary of Clear.

The following are rough estimates of the numbers of sockeye spawning in the Kitsumgallum area in 1946:

Cedar river	3,500
Clear creek	1,200
Dry creek	100
Kalum lake	5,500
	10,300

The water levels in these streams were somewhat lower than at the time of previous visits in 1944 and 1945. The log jam on one of the outlets of the Beaver river cannot yet be considered as a complete obstruction to upstream salmon migration.

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B. Kitsumgallum river and tributary streams - The Kitsumgallum river, about 20 miles in length, drains Kitsumgallum lake and enters the Skeena river about 3 miles west of Terrace, B. C. It is fairly fast flowing except for the upper 4 miles where expansions known as Sand and Mud lakes are present. A fairly deep long canyon occurs about 6 miles from the mouth but it presents no definite obstacle to salmon migration. All other parts of the river are free from difficult obstructions.

Examinations of this river and its tributaries were made between July 29 and August 1, and on September 8 and 9. A brief summary of the findings is submitted in the following table.

River or Creek	Relative amounts of spawning gravel	Extent of possible migration	Spawning intensity
Spring	very little	1 mile	None
Deep	fairly good	1 mile	light (pinks & few chums)
Lean-to	very little	1½ miles	none
Glacier	very little	1 mile	none
Pontoon	none	--	--
Alice	very little	¼ mile	light (few chums)
Star	" "	1 mile	none
Goat	" "	1¼ miles	none
Luncheon	not examined	--	--
Kitsumgallum	moderate	20 miles	?

The writers who have been in charge of arrangements for the Kitsumgallum surveys during 1944, 1945 and 1946, wish especially to pay tribute to Messrs. A. Johnston and D. K. Foerster for carrying out the examinations this year.

J. A. McConnell — Appendix No. 22

Kitwanga Lake Area

It was only possible to visit the Kitwanga lake area for one day, September 14, and little more can be added to the information on spawning facilities which was gathered during August last year.

The unnamed creek which enters at the northeastern corner of Kitwanga lake was surveyed for a short distance up from its mouth but time did not permit a survey of the upper reaches of the stream where redds may occur. About 150 sockeye were noted in the part of the stream covered. It appears that the sockeye do spawn in this stream, probably at a considerable distance from the lake or they may spawn in the lake itself. None were seen in the Kitwanga river which drains the lake.

From observations for short periods in the middle of August on sockeye moving into the lake from the river, it might be estimated that the run was about 4,000 fish.

A heavy pink salmon run had entered the Kitwanga river by September 14 and was spawning on the numerous gravel areas throughout its 20 mile length from the lake to the Skeena river. From the numbers of dead pinks on the banks and in the stream, it appeared that the run was at its peak. Small numbers of chum salmon were also present in the river but no cohoes were in evidence. A few pink salmon were noted in the lower stretches of Moon creek but again none were present in Kitwancool creek.

F. C. Withler Appendix No. 23

Kispiox System

A. Lac-da-dah district. When compared with the conditions observed in 1945, the water levels of the streams in this district appear very low. However, the surveys were made approximately ten days later than those in the previous year, and fish were present in all creeks.

Falls creek on September 16 showed a total of 33 live sockeye and 67 dead, all of which had been bear-killed. A school of an estimated 1,000 sockeye was present at the mouth of the stream, probably because of the extremely low water level of the creek. Since rainy weather set in on September 19, it may be expected that at least a few of these fish were able to enter the creek after that date. One fish at the mouth of Falls creek showed definite signs of a tag scar in the region of the dorsal fin.

Club creek when surveyed on September 17 showed a count of 2,611 live untagged sockeye, 2 live tagged sockeye, and 126 dead sockeye. Of the 126 dead counted, 49 had been bear-killed. The depth of water at the lower end of Club creek made the recovery of the tagged fish impossible. The water level of Club creek was lower than on September 7 of last year. Spawning appeared to have just begun, and sockeye were congregated and apparently spawning in areas of the creek where the bed consisted of boulders 3 to 6 inches in diameter.

Stephens creek was surveyed on September 18 for the first half mile below Stephens lake, which is the only portion of the creek which appears suitable for spawning. In this area, 21 live spring, 3 live coho and 1 dead spring were seen. Less signs of bear were apparent than on either Club creek or Falls creek.

B. Streams draining into the Kispiox below Stephens creek. All streams south of Stephens creek exhibited extremely low water levels as compared with the same period in 1945. Pinks were observed in the Kispiox only as far as 22 miles above Hazelton, and only in small numbers. A few coho could be seen at Kispiox Village and near Seventeen-mile bridge.

Bierne's creek (September 9) was low and muddy in the lower stretches, with scarcely any water flowing. This creek is normally quite small, and of little importance as a spawning area, although local residents report a few pinks and coho later in the year. No fish were seen.

Grouse creek (September 9) revealed 4 live pinks and 105 dead pinks. The water level was considerably lower than in 1945.

Willoo-wha creek (September 10). No fish were seen. Later in the year a few cohoes may be present at the mouth.

Carrol creek (September 10). No fish were seen. It is doubtful if any fish enter this stream.

Scounsnosit creek (September 11). No fish were seen. A few coho spawn at the mouth later in the year.

Sweetin creek (September 11). No fish were seen in the creek itself, although a small school of chums could be seen congregated at the mouth. Since there are no lakes at the head of Sweetin creek, and the water is cold and glacial, it is unlikely that it is a sockeye spawning stream.

Mongeese creek (September 11) revealed no fish at this time. No carcasses were seen to indicate a pink run this year. Although the water level was low, there was sufficient water to support a run of fish.

Ammoanook creek (September 12) revealed no fish of any species at this time, although there are two lakes at the headwaters which could be visited by sockeye. No detailed survey of the lakes and their streams, if any, was feasible.

A. L. Pritchard — Appendix No. 24

The Morice River System and the Upper Bulkley.

As a result of the 1945 survey of the Morice river and lake, the decision was reached that "no understanding or true conception of the number of salmon in the system could be forthcoming by direct observation." The waters in the main are glacial, silty and opaque and otherwise swift and turbulent. For that reason no extended trip was made in 1946 and the estimate of escapement was formed from the observations at Moricetown falls. Examinations of the Upper Bulkley were limited, being designed merely to check certain conditions known to be unfavourable to salmon movement.

That the salmon were reaching the spawning grounds in Morice river and lake without serious hindrance was demonstrated from records given by Inspector McDonell and his fishery guardian. At the time of his visit in August, weather conditions were such that observation was relatively good and more fish than usual were seen. At Moricetown, sockeye were observed ascending the falls at rates varying from 60 to 250 per hour, about one-half the rate of 1945. The Indian catches of all species with the exception of steelhead, were lower, the total sockeye, about 8,500, being approximately one-half. Spring salmon appeared in nearly the same ratio, 800 as compared with 1,600. With this information as a guide, and knowing that the Indians recovered 183 sockeye out of a total of 942 tagged (19.4%), it can be roughly estimated that the escapement was approximately 42,000 which is about one-half the 80,000 set down for 1945. In the same manner it is suggested that there were in the neighbourhood of 5,000 springs.

Very little difference was noted in the size of the escapement to the Upper Bulkley. A very small early run appeared again in July and August but in September, the water level was low and passage difficult. During the spring of 1946, because of extremely warm weather melting heavy snows, this river was in freshet for an extended period. The log jams already reported were increased and the flow was diverted in many places to such an extent that it endangered the Canadian National Railway nearby. In the autumn when the water was low, these jams were almost impassable to fish. In addition, late in the year the beaver dams were again being completed.

The situation in the Upper Bulkley is now demanding the attention of not only the Fisheries Department but also the residents and the Canadian National Railway. These latter are being affected through flooding and would undoubtedly cooperate in any effort to alleviate the conditions. While it may be contended that salmon will not move into this section of the river even if it is absolutely clear, it would appear reasonable to help in any project as an experiment, and later, in the event of failure of fish to appear, to endeavour in some other way to increase the run.

Consideration is still being given to a method of getting a more accurate assessment of the spawning runs to the Upper Bulkley and the Morice as well as to obtaining a more reliable report on general environmental conditions.

J. R. Brett — Appendix No. 25

Spawning Ground Surveys - Babine Lake.

The main spawning streams in Babine lake number seventeen. These were visited at approximately eight to ten day intervals during the spawning run, requiring some 72 separate excursions. Each party leader was responsible for the rivers

in his own area and the following summary is set forth from the reports of the separate divisions.

A new interest was added to these excursions in the abundance of tagged fish on the spawning grounds resulting from the programme of tagging in a 1:50 ratio carried on at the Babine river fence throughout the complete adult sockeye run. Particular efforts were made to reclaim as many of these tags as possible. The experiments on tagging were kept as a separate issue as well as the total of sockeye present in the lake and rivers known from the fence records. The following estimates and total of the runs to each stream, therefore, are here presented as estimates made in the same manner as those for the past two years. In this way the accuracy of these figures, recognized as minimal, has been put to the test. Some consideration of the discrepancies, the utilization of tag ratios for estimates, etc., has been dealt with under "Babine Fence Operations", Appendix No. 31A.

Sockeye Runs - Babine Area

Babine river, lower.....	9,000
" " upper.....	9,000
Trail creek.....	100
Unnamed creek.....	0
Five mile creek.....	50
Nine mile creek.....	1,000
Fulton river.....	100,000
Tachek creek.....	6,500
Sockeye creek.....	320
Pierre creek.....	16,000
Twin creek.....	9,500
Pendleton creek.....	2,000
Fifteen mile creek.....	28,000
Six mile creek.....	340
Grizzly creek.....	3,500
Morrison river.....	20,000
Salmon creek.....	5,000
Total.....	210,310

The total of approximately 210,000 is surprisingly close to the pre-estimated total of 200,000 for 1946 which was based on a consideration of the past estimates, (150,000 in 1944 and 240,000 in 1945) and the general features of the variable cyclic nature derived from a consideration of the commercial catches. It is a long way from the actual total of 475,419 counted through the Babine fence.

Each of the parties has submitted rough maps of the streams in their "divisions" from which it is anticipated that some conception of the extent of the potential, or available, spawning grounds may be drawn up. With the aid of these data, the reduction imposed by low water conditions, by barriers, by lack of salmon or any other pertinent feature lowering the apparent spawning capacity of the area can be followed more accurately from year to year.

In general, the Babine lake area has been characterized in its stream conditions during the period of the runs, mainly August and September, by low water levels. This feature has been stressed by each of the investigators. In certain the smaller creeks, such as Six-mile and Five-mile, the "run-off" was sufficiently reduced to result in a virtual temporary drying up of these streams. Consideratio

J. R. Brett — Appendix No. 25

is being given to the most feasible means of maintaining the water flow and possible experiments on a selected creek are contemplated for 1947.

D. R. Foskett — Appendix No. 26

Slamgeesh Area

The main streams in this area are the Kilankis river, the Slamgeesh river and Shilahou and Shaslomal creeks. As only a few spring salmon had appeared in the area when it was examined, very little can be said about the spawning. Some good gravel was present in all the streams though generally the beds were not extensive.

The Kilankis river is glacial in origin and at the time of our visit was heavily silted. About half a mile above its confluence with the Slamgeesh river, there is a large falls which prevents salmon from going farther up this stream. The Slamgeesh river is clear and has some good spawning gravel. Salmon are known to spawn in the lower portion where 12 springs were seen on July 30. There are gravel beds in the upper part as well but in some cases these are in regions where the stream bed is shifting and thus they may not give good results as spawning grounds. Shilahou creek also has good gravel but this creek apparently shifts its course to some extent with floods and thus may have little value as a spawning stream.

Coho fry were found in all parts of this area.

About ½ mile below the mouth of the Kilankis river there is a section on the Skeena where the channel is narrowed to about 1/3 of its normal width. This may be a point of difficult passage for salmon but at present no real information is available.

Sockeye spawning was just commencing in Damdochax creek above Damdochax lake (Nass river drainage) at the end of the first week in August. Many of these fish had scars on their heads of the type believed to be associated with obstructions such as canyons and falls.

D. R. Foskett — Appendix No. 27

Kluayaz-Kluatantan Area

The Kluayaz-Kluatantan area is one of the most northerly spawning grounds on the Skeena river system. It includes the Kluatantan river, Kluayaz creek and lake, and Kluatantan creek and the First and Second Kluatantan lakes. This area, 80 miles north-west of Bear lake straddles the 57th parallel of north latitude just west of the 128th meridian west longitude. The area is high, none of it being under about 3,500 feet. Most of the water is glacial and heavily silted, Kluatantan creek and the Kluatantan lakes being the main exceptions.

The Kluatantan river is turbulent and rock-strewn with occasional gravel riffles. Spring salmon spawn in these riffles though the turbidity renders accurate counting impossible. No other salmon were noticed spawning at the time of our visits, August 16 to 22, though some sockeye were seen apparently migrating upstream.

Kluatantan creek, on which are located the two Kluatantan lakes, is tributary to the east side of the Kluatantan river approximately 8 miles above its mouth. The lower part of this creek has excellent gravel and at the time of our visit, August 18, about 60 spring salmon were spawning. There were two small log jams and one beaver dam on the creek but these do not appear to be complete obstructions.

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Coho fry were numerous throughout the creek and were also in the First Kluatantan lake. An Indian reported that sockeye also spawn in this locality but none were seen during the inspection.

Kluayaz creek, on which is located Kluayaz lake, is so silted that ordinary observation is of very little use for locating salmon. Two net sets in Kluayaz lake after salmon had been seen in the river below, yielded 3 sockeye. A survey of the creek above the lake proved worthless due to the opacity of the silt-laden water.

The Kluatantan system must be visited later in the season another year if the spawning grounds of the various species of salmon here are to be located. However, unless fences are installed no reliable estimate of the population can be obtained.

Two falls, observed from the plane below the confluence of the Kluatantan and Skeena rivers, are very likely to be points of difficult passage for the salmon.

D. R. Foskett Appendix No. 28

Motase Lake Area

Though three rivers arise within a few miles of Motase lake only two are part of the Skeena river drainage. These are the Squingula of which Motase lake is one of the headwaters and the Nilkitkwa river which enters the Babine river about three miles below the counting fence. In the short time available for the survey only those waters immediately adjacent to Motase lake could be examined along with one lake on the Nilkitkwa river.

Motase lake has two main tributaries both of which are fed by glaciers and silted. The largest and most heavily silted which enters at the south end, has a falls about two miles above its mouth. Extreme care had to be exercised when walking near this stream as quicksand areas were present. The other tributary enter the lake on the west side just north of the narrows. As no salmon were seen in these creeks and only coho salmon were caught in the nets in Motase lake, it is possible that this is the only species present in this area. Indian reports that grizzly bears are numerous on the Squingula river seven or eight miles below Motase lake may indicate that other salmon are spawning in the locality since the presence of these predators is often the only visible evidence of a run in a heavily silted stream.

The trip to the unnamed lake on the Nilkitkwa river was made to check on reports of a sockeye run to that district. Though not more than half a dozen sockeye were seen, the indications were that they must have been merely the last stragglers of a run. The number of salmon spawning could not be estimated as bears and eagles and other predators had left only a few bones here and there. It is difficult to imagine why there should have been such a concentration of eagles unle a considerable quantity of salmon was available, especially since they were within easy reach of the Bear river with its large number of fish carcasses.

D. R. Foskett Appendix No. 29

Bear Lake Area

Surveys in the Bear lake area showed that the spawning populations of all the species of salmon were less than those of 1945. The sockeye seen on the redds

D. R. Foskett Appendix No. 29

were about one quarter of the number seen in 1945. A high proportion of jacks (small fish) were present. This may be an indication that the run in 1947 will be much greater than it was in 1946.

In the Bear river the spring salmon run was under half of the 1945 total. The population was estimated at 3,000 when it was visited on September 2. However spawning was not in full swing at the time and salmon were still moving into the river. Two tagged spring salmon were recovered by Indians in the river during 1946. There were no pinks present this year.

Mink creek with 1,500 sockeye, half the number present in 1945, was the spawning ground least affected by the general decrease. Conditions with regard to predators, particularly bears, were much better in the stream this year than in 1945. Two tagged sockeye were seen though only one tag could be recovered.

Willow creek had only 25 sockeye although there were 600 in it in 1945.

Sockeye spawning in Bear lake on September 3 were estimated at 125 fish. This population was just commencing to build redds and thus was unlikely to have reached its maximum number.

Observations at the Bear river falls this year confirmed the conclusions drawn last year that the falls are passable at high water by all the salmon, but are a block to the larger fish at low water. Some excellent pictures of the falls were obtained by Mr. Abear.

With the smaller run of sockeye in 1946 the Indian catch was correspondingly smaller. It was reported to be around 500 fish. Only the first four days' spring salmon fishery were observed, but during this time, about 600 spring salmon were taken. It is unlikely that this would be more than one-third of the catch as any lack in numbers of sockeye caught would have to be made up in spring salmon to avoid experiencing extremely hard times during the winter.

D. R. Foskett Appendix No. 30

Sustut and Johanson Area

The sockeye spawning in this area is apparently confined to the lakes as no fish have been seen in any of the streams during the 1945 and 1946 surveys. Indian reports confirm this assumption.

In Sustut lake the known redds are located in the southern third wherever seepage into the lake occurs. Forty-two sockeye were counted in this locality and a school off the mouth of Cloudy creek was estimated to contain 30 sockeye. The gill net catch of 48 salmon for six net-nights indicates a heavier population than the counts, especially since no large mesh was used and there was no noticeable decrease in the visible population despite the moderately large catch. Four dead females were examined and were completely spawned.

Only 24 sockeye were observed on the redds on the west side of Asitka lake and near the outlet. Two were seen in Asitka river two miles below the lake but they were probably on their way to the lake as no signs of spawning could be seen in the area. Coho were spawning in the river in small numbers. A prospector reported that about September 15 the pools were black with salmon ten miles below the lake. These were probably coho which were not ready to spawn.

Though sockeye were present and undoubtedly spawning no redds could be located in the Johanson lake area. Excellent gravel was present in the one main tributary to the lake and in the outlet and its tributaries below the lake but no sockeye were seen in any of these streams. No spawning sockeye or redds could be

D. R. Foskett Appendix No. 30

found in moderately shallow water along the shoreline of the lake though spawned or partly spawned salmon were taken in every gill net set. A prospector reported that there were many dead salmon on the shores of the unnamed glacial lake to the south-west of Johanson. It is probable that these were sockeye though no proof was available.

One Indian family of about ten persons was fishing at Johanson lake this year. Gill nets and spears were used to catch the salmon in the creek below the lake. One gill net catch of about 30 fish was $\frac{3}{4}$ coho and $\frac{1}{4}$ steelhead. When spearing the Indians take steelhead almost exclusively. No estimate of the catch can be given as the Indians, distrusting our motives, refused to give any information on either species or number taken. It is doubtful if any sockeye were obtained in the area this year.

The maximum depth of water in which sockeye will spawn is not known but it has been observed very close to the limit of visibility in Sustut lake (Secchi disc - 30 feet). In Johanson lake where the clarity is of the same order as that of Sustut lake, no spawning could be observed in any of the areas where the bottom was visible, despite a careful search. Under such conditions it is impossible to estimate the size of the escapement to the area. It is possible that it was of the same order as the lake spawning in Bear lake.

The installation of counting fences in this district would be comparatively simple from the engineering viewpoint. The principal cost would arise from the transport of material and supplies by air.

6. BABINE FENCE OPERATIONS.

A. L. Pritchard and J. R. Brett Appendix No. 31A

Enumeration of Salmon at the Babine Fence

During the year 1946, a salmon counting fence was completed on the Babine river about one-half mile below lower Nilkitkwa lake, after almost two years of effort in which lack of suitable labour and material introduced many difficulties. Full descriptions of the structure and blueprints are now on file. The main object was to get an absolute assessment of the salmon escapement to Babine lake, the largest single spawning district in the Skeena system. In addition the structure was designed to give the opportunity of efficient collection of tagged and marked fish, of sampling the run for detailed measurements and of determining what effect the physical and chemical changes in the environment might have on the migration behaviour.

The routine procedure was to open the inlet doors allowing the fish to enter the four traps at 6.00 A.M. and commence counting them out by 7.00 A.M. This was continued throughout the day with the inlet doors constantly open and the outlet doors opened periodically when the traps were deemed sufficiently filled to warrant liberation. During the high period of the run in late July, August, and into September, counting was almost a continuous process. The inlet doors were closed at 7.00 P.M. and the remaining fish counted out down to a few last individuals before the outlet doors were closed. In the latter part of September and early October the hours were shifted forward because of poor lighting conditions towards evening.

A. L. Pritchard and J. R. Brett — Appendix No. 31A

To facilitate counting and species identification white chutes, 32 inches long, were placed just below the outlet doors on the upstream end of the traps for both the high water and low water exits. One or more Veeder Root counters were kept in operation on each trap.

Sockeye Salmon - The first sockeye commenced to trickle through on July 5, mounting to between 1,000 and 2,000 by July 15 and remaining at this level until the fourth week of that month. In August, the daily average for the whole month was 10,995 with the highest run on August 21 when 16,002 were counted through. In September the run fell from a daily average of 7,118 in the first week to an average of 303 in the last week. In the first four days of October, the average was slightly over 100 sockeye and on the last day of operation, October 4, the total was exactly 40. Before removing the panels of the fence on October 5, inspection was made below the fence with no observations of sockeye and none were seen to pass over the platform in the remaining few days prior to the final departure. The run had lasted exactly 67 days between the dates July 15 to September 20, when 1% and 99% respectively had been counted. The final total was 475,419.

Pink Salmon - The even years have now become the "off" years for pink salmon so the total of 28,161 is very low by comparison with what must have been present in 1945, an exceptionally good year, and with what is expected for 1947. The first of these fish appeared on August 20, a peak was reached on September 1 with 2,234, and the run stopped by October 1. The average daily count during the last two weeks was only 44 pink salmon.

Coho Salmon - The coho salmon were next in abundance with a sum total of 12,489 by October 4. Although they averaged less than 100 per day during the last two weeks of enumeration, they are known to be the latest of the various species on the spawning grounds. It may therefore be suspected that the complete run was not over although the data would indicate that by far the large majority had entered the lake.

Spring Salmon - Because of the high freshet conditions in the spring of the year and of the main interest being focused on sockeye salmon, the last of the panels to close off the river were not inserted until June 18. Prior to this date, it is known that some spring salmon had already entered the upper part of the Babine river in an early run. Observations at that time would point to the total of this escapement being certainly less than 1,000 fish. They did not again reappear as a spawning run until July 13 and only averaged 64 fish per day for the rest of that month and the subsequent month. A peak of 549 was reached on September 12 with a final count of 25 on October 4 bringing the total count to 11,528.

Chum Salmon - Chum salmon are known to utilize spawning rivers fairly close to the ocean. That they do migrate considerably further in rather exceptional cases was proven by the identification of a total of 16 at the Babine fence, appearing between the dates of September 4 and 20.

The final grand total of all species of salmon enumerated was 527,615.

J. R. Brett — Appendix No. 31B

"Ocean Tag" Recoveries at the Babine Fence

In order to be sure of obtaining tagged salmon moving through the traps of the Babine fence, a wire "basket" was inserted on top of the outlet chute. This was so constructed that the upstream end, normally open, could be quickly closed, thus

J. R. Brett Appendix No. 31B

allowing the observer to trap particular fish for observation and study. In the open top of the "basket" a removable glass viewer was inserted which permitted excellent visibility, an essential requisite to identification of species and to discovery of marked and tagged salmon.

The total number of ocean tags recorded was 354. Of these, 4 were on spring salmon, 3 on pinks, and the remainder, 347, on sockeye. Amongst the 347 were 301 which were either removed completely from the fish or from which the serial numbers were recorded, 37 which passed through but were not closely inspected, and 1 which had a baffle only. The remaining 6 individuals did not have any tags at all in position, but appeared on examination to have scars which obviously indicated that they had previously carried one.

The reclaimed ocean tags clearly demonstrated that Babine salmon were present in the population at the mouth of the Skeena river on every day tagging was carried out (June 18 to July 28). The greatest concentrations seem to occur after the middle of July when over 20% of those tagged were of Babine origin. The time occupied in the migration from Smith island to the fence, approximately 300 miles, varied from 20 to 39 days, with an average of 27.4. It was apparent also that fish running late in the season made the trip at a slightly faster rate.

It is interesting to report that if the running daily averages of tag recoveries are plotted against the daily averages for the complete escapement, there is a close correlation with the exception that the tag returns dropped off about two weeks before the total count was finished. Inadvertently, therefore, the tagging at the Skeena river mouth had attained a certain degree of proportionality at least in so far as the Babine salmon are concerned, and probably in the case of most other runs which appear to move through the river at the same time. This fact is of extreme importance if an attempt is made to use the tagging data to calculate the relative distribution of the escapement to the whole system.

A. L. Pritchard Appendix No. 31C

Return of Marked Sockeye Salmon from the 1942 Brood Year at Babine Lake

During the spring of 1944 at Babine lake, 24,690 yearling sockeye, the progeny of the brood year of 1942, were marked by clipping the adipose and both ventral fins, and released. The majority of the recoveries from this experiment were expected in the autumn of 1946 in the fishery and at the Babine fence since the usual sockeye run to Babine is constituted predominantly of individuals in their fourth year.

In April and May, posters were prepared to advertise the fact that fish lacking fins could be expected, and that a reward of 50 cents was payable for record thereof. These were widely distributed and personal contacts were made at all canneries. In some cases the foremen were interviewed and asked to co-operate. In most instances the Chinese boss was told of the experiment and asked to explain the situation to the man feeding the fish into the "Iron Chink". He, of necessity, handles every individual and would most likely notice the lack of fins. Throughout the season further contacts were made at least once a week. At the Babine river counting fence, close observation was maintained of all salmon passing over the white counting boards described in a previous appendix.

No returns were received from the commercial fishery in spite of every urging and in spite of the fact that many of the Chinese who were watching, had had much similar experience on the Fraser river. This result should perhaps not be

A. L. Pritchard — Appendix No. 31C

unexpected since the marked individuals would be very "diluted" in the total run. They could have constituted at a maximum 24,000 in about 1,400,000 or 1 in 58, but when losses are considered, they probably made up less than 1 in 1,000. The failure merely demonstrates again the fact that large numbers of yearlings must be handled to assure worthwhile returns.

At the Babine fence, 19 fish which undoubtedly lacked the adipose and both ventrals, were seen and examined. Fifteen other fish lacked one or more fins. While some of these latter could have been Babine sockeye marked faultily, most of them were more likely natural deformities which are known to occur not infrequently in nature. Since no marks were reported from other areas where many fish were examined, it does not seem unreasonable to assume that the "homing tendency" holds to a degree at least.

The experiences of 1946 have stressed the fact that when the returns from the larger markings are expected, great effort will have to be expended in the collection of returns. It may even be necessary to place a man in each of the operating canneries solely to examine the catches for fish lacking fins. Each year the inspection of fish at Babine and other fences will become more efficient so that little trouble should be experienced.

J. R. Brett — Appendix No. 31D

Tagging at the Babine Fence

Sockeye salmon were tagged at the Babine fence for two main purposes:

(1) To procure information on the migration up river and through the lakes to the spawning tributaries and whether there was any segregation in time of arrival and movement of the populations to particular rivers.

(2) To provide a fair ratio of tagged to untagged individuals on the spawning grounds to check the method of estimating numbers by the ratio between these two types.

Numbers Tagged and Recovered - Distribution and Speed of Migration - To analyze in detail the tagging returns from the experiment will require considerable time for checking. From the total of 9,444 tagged between July 17 and September 29, 1,665 or nearly 18% were returned. A reward of 25 cents was paid to the Indians who were encouraged to turn in those caught by their nets, but discouraged from gaffing in the streams. In this way 964 were obtained or about 12% of those tagged. It will be interesting to see whether the final total for the Indian catch, which is recorded fairly accurately, will be around 12% of the total migration (ca. 57,000).

The remainder of the recoveries (701) were taken from salmon during stream surveys. They were present in at least fifteen streams, in fact all of those examined which carry an appreciable run.

Superficial examination fails to reveal any distinct pattern either to migration routes or to the times of appearance on particular creeks in relation to the time of passing through the fence. The recaptures in Nilkitkwa lake, situated between the upper and lower Babine rivers and about a mile above the fence, were made from the same day to as late as three to four weeks after tagging.

Check of the Method of Estimating by a Tagging Ratio. Earlier experiments have demonstrated that large error might be introduced if tagging was not carried out in proportion to the size of the run. On the basis of an estimate made prior to

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commencement of operations at the Babine fence, namely, a total of 200,000 sockeye, it was decided that 1 in every 50 could be tagged with the usual serially-numbered disc tags. Actually there were 475,419 sockeye and considerably more fish than anticipated had to be tagged. The investigators were aware that the estimates to the spawning grounds previously made were necessarily minimal but had had no previous opportunity to check the error accurately. In spite of the large count, spawning ground reports did not indicate an unusually large escapement of sockeye in the area, but, rather it may be inferred that past estimates have been as much as 50% low. This is well illustrated in the total count of 210,000 from the spawning ground surveys and the actual total through the fence of 475,419.

The actual system was to tag 1/50 of the total daily run on the day immediately subsequent to the specific count. Tagging lagged thus one day behind the run but provided a means of knowing each day exactly how many fish were to be tagged. In the face of quite marked daily variations - from a few hundred to a few thousand although following a fairly normal curve - a change to tagging each afternoon in proportion to the morning's run, and in tagging the next morning in proportion to the count of the previous afternoon, is likely to supplant this year's technique.

Obviously complete analyses cannot be expected at the present time. The inspections and counts on the spawning streams have been made. During the winter an estimate of escapement will be worked out on the basis of usual observational method and on the basis of the tagging ratio for comparison with the actual count. This should permit the derivation of the most probable escapements for past years in this area and for other districts where standard inspections only are made.

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

One of the objectives of the programme at the Babine fence was to determine what effect the physical and chemical changes in the environment might have on the migration behaviour of the salmon. As a beginning in the accomplishment of this aim certain readings were attempted.

In the early stages of the run the water levels and river temperatures were recorded by a level stake and hand thermometer. These were later supplanted by a constant recording thermograph and Liquid Level Gauge which merely required standardization and replacement of the recording graph paper every seventh day. Atmospheric pressures were recorded by a standard anaeroid barometer.

That it should be possible to draw any conclusions concerning such relations depends on a consideration of how "natural" the migration is as it takes place through the fence. In order to check the delay factors imposed by the obstacle of the fence an experiment using tagged fish was introduced by putting 10 tagged sockeye every 5th day below the fence and recording the times when these fish reappeared. The returns vary from a reappearance on the same day to an extreme in a few instances of never being seen again. In general it appears that as an obstacle to migration, the greatest delay per individual is produced by the combined features of low water and many fish. Despite these limitations the average delay was rarely past the 3rd day so that running averages should provide a sufficiently accurate picture of a "natural migration".

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Salmon Sampling at the Babine Fence

The sockeye dipped randomly from the trap from which the tagged fish were obtained constituted the "sampled fish" and can be considered as a representative sample in so far as they were composed of 1/50th of the run, taken proportionately throughout the run. While the fish were being held in the tagging box they were sexed, measured for total length, and also measured with callipers for length from the nares to the tip of the snout. This latter measurement was used to give a key to the extent and variation of maturation of the sockeye as they entered the lake. Throughout the run, for egg counts and degree of maturation, 100 females were taken.

In addition, detailed measurements and counts were carried out on 20 sockeye, 10 spring, 5 coho, 2 chum and 1 pink for Mr. D. J. Milne in order to fill out his biological data. The measurements involved were: total length, head length, length from nose to eye, body depth, depth of caudal peduncle, interorbital width, eye diameter, and also counts of the numbers of gill rakers, anal rays and scales in the lateral line.

7. STATISTICS

D. J. Milne — Appendix No. 32A

Skeena River Commercial Salmon Fishery - Introduction and General History

From May 15 to September 15, information was collected in the Skeena river area on the history, past and present, the effort and the catch of the salmon fishery. Most of the data was obtained from the files of the Dominion Fisheries Office in Prince Rupert and at Sunnyside, Carlisle and Cassiar canneries, on the river itself. Excellent co-operation was received from all sources. The 1946 catch of all species of salmon was sampled for biological data, at the fresh fish houses in June and at the canneries in July and August.

Processing Establishments. The first cannery was built in 1887 and by 1906 there were 14 operating. Since 1925 the number has steadily decreased until now there are only 6 in operation. However, a comparison of the canneries of 1910 and 1945 shows that the efficiency and size has increased about 3 times. The six canneries now operating pack about twice as many fish as the twelve did in 1910. With the decrease in runs, this has necessitated bringing fish from other fishing areas.

The first fresh fish house was built in 1914 and the number has increased to 10, of which 3 have freezing and cold storage facilities.

Fishing Effort. The gillnet fishing area is chiefly in the river mouth. Here the upstream limits were lowered and the ocean boundaries extended in 1925 and 1935 as the fishery expanded. The purse seines were restricted in 1926 to certain definite districts. Trolling is carried on in all outside waters. The gill nets catch all species of salmon but especially the sockeye and pinks. The trollers are very selective on coho and spring while the purse seiners catch largely pink and chum. Actually only a few changes (less restrictive) have been made in the salmon fishing regulations since they were laid down in 1894 and the enforcement problem has been very difficult in this vast north country.

The number of gillnet boats increased from 270 in 1890 to 850 in 1910 and 1,300 in 1920, but have since decreased to about 800. Various boat-rate commissions

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have sponsored these changes. Gasoline-powered boats were introduced in 1924 and by 1940 had completely replaced the original sailboats. Little increase in the actual number of fish caught per boat has resulted but more sets can now be more conveniently made. The introduction of the mechanical net-drum in 1942 has resulted in a further reduction of manual labour. Trollers and purse seiners, by the use of gasoline engines, gurdies (1920), live rollers (1922), power winches etc., have increased their fishing range and efficiency greatly. There are now about 500 trollers and 30 purse seiners operating in this district.

The efficiency of the hard working Japanese was very marked until their removal (295 gill netters) in 1941. From a detailed study of Sunnyside cannery records, the extremely low catch in 1942 and 1943 was due in part to the removal of the experienced Japanese and the recruiting of a smaller number of relatively inexperienced Indian fishermen. The average daily sockeye take at Sunnyside from 1935 to 1941 was 37 fish for Japanese, and 29 for both whites and Indians. In recent years a better type of white and Indian fishermen with more efficient gear has been attracted to replace the Japanese, so that there is little doubt that the discrepancy between their present catches and those of the Japanese if they were allowed to return, would now be considerably less.

From the data at present available, it is impossible to calculate a true index for unit of effort but the general trend in the fishing effort has been obtain It must be remembered that every effort is devoted toward catching as many sockeye as possible while the season lasts. The catch of sockeye, the most desired species, influences greatly the effort directed toward capturing the other types of salmon, especially pinks.

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Skeena River Commercial Fishery - Catch Statistics

The methods used to collect the Skeena catch and pack figures have been examined and the figures evaluated in comparison with the cannery records. The number of cases of sockeye packed in the Prince Rupert area prior to 1924 is comparable to the catch since that year rather than with the total number of cases packed which includes fish brought in from areas other than the Skeena river. For the other species, it is impossible to separate accurately the Skeena catch from the total pack.

Only a summary of the fish canned is published so it has been necessary to obtain the numbers of fish handled fresh, frozen, smoked and mild cured. For this the following conversion factors were necessary. The average weight per fish is: sockeye - 6, red spring - 12, white spring - 18, jack spring - 4, coho - 9, pink - chum - 9, and steelhead - 8. If 72 lb. of green fish is taken as equivalent to a case (48 one-pound tins) then the number of fish per case can be obtained by dividi 72 by the above weights.

The yearly wall charts recording the daily sockeye catch per boat at Sunn side cannery from 1935 to 1945 yielded detailed data which were of value in elucidating the efficiency of the Japanese and in indicating that a comparison of the cumulative totals of the first two weeks of fishing provides a basis for predicti the size of the present season's catch. The sockeye catch at Sunnyside appears to be quite representative of the total Skeena catch, of which it constitutes about

For this reason a comparison of the effort (total days fishing) together with the number of fish caught each season was worked out in the case of this cannery and seems to give the best index of catch per unit effort for sockeye. The effort is maintained at a certain level throughout a season but varies from year to year. The run is usually under way when the fishing season opens but is virtually over when it is closed.

Data on the number of fish of each species handled by the separate establishments were obtained from the weekly, monthly and annual forms of the Department of Fisheries in some cases as far back as 1922. When the totals of these packs and catches are compared with the total British Columbia and Alaska figures, the major fluctuations that are peculiar to the Skeena river populations should become evident. The annual value of the Prince Rupert salmon fishery is about $4,000,000 which includes salmon canned, fresh, frozen, mild cured and oil and meal. Most of the sockeye (99%) and pink (95%) are canned while much of the spring, coho and steelhead are handled by the fresh fish houses.

The Skeena river sockeye catch, disregarding those brought in from other areas, increased with the development of the fishery (1880-1900) to over 100,000 cases. From 1904 to 1924, the catch decreased slightly (the trend line computed by the least squares method dropped 8,000 cases over 21 years). Similarly the catch from 1925 to 1945 has been decreasing (12,000 cases) but for some reason the trend line for this latter period is about 30,000 cases below the 1904-1924 period. Thus when the whole period 1904-1945 is considered, there is a sharp decline of about 50% (59,000 cases in 41 years) or when the overlapping period 1915-1935 is taken, there is a decrease of 23,000 cases in 21 years. Much of this drop seems to occur around the 1925 period when the number of Japanese licenses was decreased from 640 to 295, the river boundaries lowered, and when the first attempt was made to separate the Skeena catch figures from the total Skeena pack figures. From 1925 to 1945 the total pack increased (16,000 cases) due to the increase in fish brought in from other areas and packed on the Skeena. The average sockeye catch for the last 20 years is 68,000 cases (20% of the total British Columbia pack) and the average total pack is 81,000 cases.

The large annual fluctuations of the Skeena catch follow the total British Columbia pack if due consideration is given to the large catches on the Fraser river every four years. This condition is not apparent when compared with the Alaska pack. From a study of the weekly catches, the size of the run in progress can be predicted with good assurance after the first two or three weeks of fishing. When the season starts (last Sunday in June) the run is usually under way, reaches a peak the last week of July and is almost over by the middle of August.

The Skeena river pink catch increased until 1930 but the largest cycle year (even years) has never recovered from the drastic failure of 1932. In this regard the Skeena catch is similar to the total British Columbia pack and it is probable that the cause was the same. Lately in the Skeena, the catch in the odd years has been the largest. The 1945 pack was the largest in recent years while the 1946 pack is the smallest. The average catch in the Skeena proper for the period 1925-1945 is 82,000 cases (16% of total British Columbia pack) while pinks packed on the Skeena amounts to twice this figure. The size of the run in progress cannot be predicted with any degree of accuracy after the first two weeks of fishing as in sockeye. The run starts the last week of July and is over by the end of August.

The average catch of coho in the Skeena for 1925-1945 is 27,000 cases, (15% of the total British Columbia pack) while the coho packed on the Skeena is more than twice this amount. The pack has steadily increased from 1905 to the present with 1941 being the biggest year on record. The British Columbia pack is similar. In recent years the fresh fish houses handled from 25 to 60% of the coho. Because

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of the long migration of this species and use of the trolling method of capture far out in the ocean, it is difficult to obtain a true picture of the Skeena coho population. The run starts in June with a peak in August and ends in October.

The average catch of springs on the Skeena for 1925-1945 is 8,000 cases (35% of the total British Columbia pack) while the springs packed on the Skeena during the past few years has been more than twice this amount. The Skeena spring catch has dropped off slightly since 1920 as did the total British Columbia pack, but, as in the case of the coho, it is a difficult to obtain a true picture of the Skeena population. This would involve a proper evaluation of the fresh-fish industry which handles 60 to 90% of the spring catch. The spring season lasts from May to August with peak fishing in June.

The average Skeena chum catch from 1925-1945 has been 9,000 cases (2% of the total British Columbia pack) and the fishery has fallen off with fluctuations similar to the total British Columbia production. The 1946 catch was above average. The run starts in July, has a peak in September and is over in November.

The average Skeena steelhead trout catch for 1925-1945 has been 1,500 cases which is most of the total British Columbia pack. The take has remained uniform for years with about 25% being used fresh. The run lasts from July to September.

In salmon, since there is often a limited supply of fish with a high percentage of capture, an index of relative abundance based on catch per unit of effort may not be logical. An increase in the number of boats simply divides the catch and reduces the return per unit of effort. However, detailed data are available for Sunnyside cannery to assign an index of relative abundance for sockeye based on catch per unit of effort.

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Skeena River Salmon - Biological Statistics

On the basis of tagging returns, the spring and coho salmon may be captured in an area 100 or more miles in any direction from the Skeena mouth. The sockeye have a more local distribution of 30 miles except in a northwesterly direction from whence they may come at least 150 miles. The pinks and chums have a still more restricted range. Thus, for all species of salmon it is difficult to separate the Skeena population from the ocean catches.

The only past data available on Skeena salmon are Dr. Clemens' collections on sockeye which are published annually in the Provincial Fishery Department's reports. From these data which cover the years 1912 to 1944, the Skeena sockeye ages are: 50% - 4_2, 35% - 5_2, 11% - 5_3, and 4% - 6_3. The weight and length have remained constant and average 5.72 lbs. and 23.5 inches for the years 1914-1944. In general the males are larger and run earlier in the season than the females which usually comprise the larger portion of the commercial catch. The number of years spent in the ocean determines the ultimate size of the fish as the 4_2 and 5_3s are similar but smaller than the 5_2s and 6_3s.

Data on the other species are obtainable from a small sampling programme of 1 in 10,000 fish carried out during this past summer. The stratification of this sampling included time, relative importance of species, gear and location and type of processing plants. Each sample of ten specimens was picked at random to avoid bias in sex and size.

D. J. Milne Appendix No. 32D

Skeena River Salmon Fishery - Periods of Decline in Sockeye

From data already presented it is taken for granted that there has been a decline in the sockeye fishery since 1910. These periods of decline are demonstrated by the "index of success of return" as applied by W. F. Thompson in 1945 to the Fraser river sockeye. Years of depletion are those in which the catch failed to repeat itself judged on the basis of age composition and the size of the catches of the parent year or years. In the past 28 seasons there were 16 years of depletion, an indication of the general decline. The 1916, 1920-21 and the 1925-29 cases involved decline in all age classes. The 1933-35 period also involved all age classes but the 4_2 and 5_2 groups exchanged positions of importance. In the 1937-38 period only the depletion of the 5_2's and 6_3's persisted. The 1942-44 period was due to the 4_2's and 5_3's alone. In general the 4_2 group (50%) has controlled the time of depletion but the 5_2's (35%) have added variations to the size and duration of these periods.

All age classes show depletion as a result of the same spawning year (overfishing or poor spawning conditions) except for the last period which is due almost entirely to the 4_2 group. On the basis of the 1944 scale data 90% of the 4_2's reaching Hazelton go to the upper Skeena. What has happened to the 4_2 run to Babine or the upper Skeena in recent years? However, over the years the older age groups have been most adversely affected as indicated by the ratio of the number of years of abundance to years of depletion (5_3 = .40; 6_3 = .66; 5_2 = .75; 4_2 = 1.10).

The accuracy of prediction of the catch on the basis of age groups and size of catch is poor. This is no doubt due to inaccuracies in the data, the great regenerative powers of any fish population to survive, the apparent low efficiency resulting from a heavy spawning, the intense weeding-out that takes place in a large run and the unknown relationship between catch, escapement and resulting ocean return. Thus, although the catch may not give a sound picture for prediction of the possible take or decline of the population by itself, it does indicate the exploitation by the fishery which is all-important to so many.

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Indian Fishery on the Skeena River in 1946

During the summer of 1946 all the Indian fishing sites observed in 1945 were revisited. In addition the net fishery conditions at Babine lake were studied in detail since it was indicated that about one-half of the total estimated Indian catch during the last ten years was taken there. At Moricetown inspections were again made in conjunction with the tagging programme at the falls.

It is apparent that the various species of salmon are used by the Indians in accordance with their desirability, their abundance, and the time and ease of capture. Sockeye are preferred for smoking, plentiful and easy to take. The coho are more suitable for salting but are less abundant. On the other hand, because of low water conditions late in the season, they are usually easy to catch when the Indians return upriver from the canneries in the autumn. Springs are desirable for smoking or salting but less abundant and harder to catch because the water levels are usually higher at the time they run. Pinks are not highly prized since they are usually nearly sexually mature when caught and thus thin, with dry flesh and red skin. In some years, however, they are plentiful and can be taken without trouble.

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Steelhead are selected as fresh fish in the spring and for salting in the autumn. Chums are not numerous on the Skeena.

The estimated number of salmon taken by Indians in the four main regions in 1945 is submitted in the table below in comparison with the averages for the last ten years. Final figures for 1946 are not yet available.

Area	Number of - Indians	Families	Smokehouses	Number of fish - Sockeye	Coho	Spring	Pink	Chum	Steelhead
Babine	398	129	44	29,000		500			
Moricetown	278	71	7	16,000	1,200	410			1,400
Hazelton	1,122	325	18	9,000	3,000	420	1,600	51	190
Kitwanga	313	92	6	830	800	60	400		120
Lower Skeena	____	24	__	2,500	800	240	350	__	280
Totals	2,111	641	75	58,330	5,800	1,630	2,350	51	1,990
1935-44 average:	2,000			73,300	15,200	6,600	11,000	140	1,700

The average number of fish taken per person in 1945 was: Babine - 74, Moricetown - 68, Hazelton - 14, and Kitwanga - 7. The Babine catch was lower than the ten-year average for the district, 29,500 as compared with 44,000, mainly due to the fact that many of the Indians were making good wages lumbering and cutting pit props. The take at Moricetown was much higher (16,000 sockeye as compared with a ten-year average of 6,900). Here extreme low water made fishing easier. The total catch of each species for the four areas was lower than average with the exception of steelhead.

On the basis of the ocean tags returned (761), the Indians in 1945 recaptured 27% (198) while taking approximately 5% of the total catch (commercial plus Indian) while the commercial fishermen recovered about 73% from 95%. It would appear either that the Indian fishery estimates must be low or that the Indians have a better opportunity to catch tagged salmon.

The history of the previous weir fishery on the Babine river has been investigated. Until about 1910, it seems that three picket fences were operated below Nilkitkwa lake at approximately the site of the Fisheries Research Board counting fence. Since that time, as a result of a special treaty with the Babines, the Indian Department has issued free every two years about 60 nets 200 feet long, $5\frac{3}{4}$ inch mesh $25\frac{1}{2}$ meshes deep. Certain bartering practices have been allowed. Most of the fishing is carried out by the women who set the nets at night and lift them in the morning. Conditions are primitive as indicated by home-made floats, rocks for leads, bark for anchor ropes, spruce dugout canoes for boats, and sometimes bark roofs for smokehouses. There are persistent rumours of the use of much salmon for dog food but since the number of dogs is now much less than formerly, and because the moose has been abundant since 1920, the number of dried salmon used for dog food is small and is decreasing every year. In 1946, 14 out of 32 smokehouses were operating on Nilkitkwa lake below Fort Babine.

Old stories and Father Morice's history of the interior of British Columbia suggest that about 100 years ago, rocks fell into Hagwilget Canyon completely blocking the Bulkley at that point. There is no indication of how long this blockage

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remained but it was sufficiently severe to cause the Moricetown Indians to move to Hagwilget and fight for fishing rights there. Now the Indians are back at Moricetown, their 1946 catch of sockeye (Ca. 8,500) being larger than the previous ten-year average, but smaller than that of 1945. The spring catch of about 800 was low, the coho (Ca. 3,200) low, the steelhead (Ca. 500) low while pinks were almost non-existent.

The efficiency of the gaffing method at Moricetown was again checked by spot-counts in 1946. This year 61% of the tries were successful and the fish were landed while 39% of the salmon were lost after suffering various degrees of damage. These figures compare very closely with the 65% and 35% of 1945.

The more the Indian fishery is investigated, the more it becomes apparent that the regulations governing it should be more clearly and concisely defined so that all concerned may be advised and forced to keep within the law. At least one method of fishing, gaffing at Moricetown, appears destructive. There may be reasons why it cannot be replaced but the matter should be reviewed with the Departments concerned, namely Fisheries, Indian and Fisheries Research Board.

8. STUDY OF OBSTRUCTIONS

D. J. Milne Appendix No. 34

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 on the salmon spawning migrations up the Bulkley river, started in 1945, has been continued. Daily observations of the temperature and turbidity of the water were taken. In general the water was colder than in 1945, with a range during July and August of 10° to 15° C. The greatest daily range was 2° C. The turbidity of the water did not clear until August 8 as there was more rain this year during July. After August 5, a few spot estimates were made, by counting the salmon surmounting the narrow west channel during five minute periods at different times throughout the day and part of the night, The data indicate that the sockeye run is diurnal with great fluctuation in intensity at different times.

The water height was taken each day by reading both a gauging board located at a point in the river immediately above the falls and a sounding line lowered from the bridge below the falls to the surface of the water. This latter method proved to be more satisfactory but the former was continued so that the 1945 readings might be correlated with the bridge readings. On April 6, the water was extremely low (10 feet lower than the bridge reading of July 17). Above the falls, the water was only about one foot deep and the current so slow that one could almost wade across. There was little evidence of the fishway steps blasted in the middle of the channel by the Fisheries Department in 1929. The water levels during the summer of 1946 were higher than last year by an amount varying up to one foot except for the period August 10 to 20 when the 1945 readings were one inch higher. The water passing through the west channel did not reach its critical low (last year August 20) until September 5 by which date the runs of both spring and sockeye salmon were virtually over. The runs of both species were smaller this year by about one-half and were about one week later. Even the coho run which started on August 10 was able to navigate the falls with more success in 1946. The run of pinks was small and the steelhead run was late.

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From July 8 to September 8 a total of 1,298 fish were caught below the falls by means of a dip net and tagged. Of these 81 (6.2%) had gaff marks, 78 (6.0%) gill net scars and 33 (2.5%) bore other scars as evidence of the heavy predation on the spawning run of adult fish. In comparison with last year the gaffing marks were three times more numerous and the gill net marks were in the same proportion. The total number of fish tagged and returned for each species up to October 12 is given below:

Species	Number Tagged	Number Returned	% Returned	Number of Fish Caught by Indians
Sockeye	942	183	19.4	8,500
Coho	260	10	3.8	3,200
Spring	76	3	4.0	800
Pink	2	-	-	3
Steelhead	18	-	-	500
Total	1,298	196		13,003

In addition to the above, 22 fish (17 sockeye, 4 coho and 1 steelhead) were returned from over 30 miles downstream from the falls. Only one tag was returned from above the falls due to the small amount of fishing here. On the basis of the number of days the tags were out at Moricetown (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 less obstructed by the falls this year than last.

During July, August and September the fish were sampled. Scales, length and sexes were taken on 441 sockeye, 60 spring, 90 coho, 8 steelhead and 1 pink. In addition more detailed data, which included body measurements and identification counts, were collected on 60 sockeye, 16 spring, 30 coho and 7 steelhead.

Although further studies are necessary to provide complete data to cover the whole range of seasonal variations, it is now apparent that to assure an easier and more efficient passage to all species of salmon every year and at all river heights, it is necessary to make some provision to eliminate the difficult water and perhaps the heavy fishing conditions which exist at the falls, particularly in a year when the water is extremely low.

9. AGE DETERMINATIONS

J. D. Campbell Appendix No. 35

Age Composition of Sockeye Salmon Runs

During the year 1945-46, efforts were directed toward devising a method of scale mounting, reading, and summarizing of data which was not so cumbersome and time-consuming as mounting scales on glass slides in glycerin jelly, tracing each scale on a separate sheet of paper, listing data on long foolscap sheets, sorting and analysing therefrom, etc. With this new method established, the desire was to work through all the incidental collections on hand and proceed as far as possible with those from the Skeena after 1944. That for the latter year had been finished and reported in 1945.

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Eventually a card, $2\frac{1}{2}$ by 3", was devised on the face of which could be noted code number, species, number of circuli, size of growth increments, date, location, length, weight, sex and age. On the back could be drawn the annuli tracing. In one corner was a hole, $\frac{1}{4}$" by 1", where through the use of cello-tape the scales could be mounted in water glass. Various types of cello-tape were tried and the best selected for the purpose (American "International Plastic" $\frac{1}{2}$" wide). Other gadgets such as tape dispensers, trays to soak scales etc., were perfected. As a result the mounting operation was carried through at a slightly faster rate and permanent mounts were available which carried complete data and were easy to file. Sorting for various factors was much more simple and quicker and slide washing was a thing of the past.

Certain large collections of sockeye scales were on hand from Alberni canal on the west coast of Vancouver island and from Lowe Inlet on the north coast. The Lowe Inlet sockeye are of passing interest to the Skeena river investigation since they are usually canned in the Skeena canneries. The Alberni age composition is set down for record.

Age Group	Lowe Inlet (drag seine)		Lowe Inlet (general fisheries area)		Alberni Canal 1943	
	No	%	No	%	No	%
4_1	-	-	1	.1	-	-
4_2	129	33.1	527	37.6	56	38.1
5_1	-	-	1	.1	-	-
5_2	202	51.8	787	56.2	91	61.9
5_3	45	11.5	69	5.0	-	-
6_2	5	1.3	2	.1	-	-
6_3	9	2.3	12	.8	-	-
	390		1,399		147	

The first series of scales from Lowe Inlet was taken from fish caught in an Indian drag seine at the mouth of the river and therefore should represent the run to that area. The second series is from the general fisheries area and thus has samples not only from Lowe Inlet proper, but also from a number of outside channels as far north as the Skeena river mouth in the same year (1944). There is little difference in age composition between the two and both are not too dissimilar from that for the Skeena river mouth in the same year (1944). The latter, however, appeared to have a slightly larger percentage of 4_2's (481) and less 5_2's (406). Alberni canal shows a large percentage of five-year old fish.

Further progress has been made with the Skeena scales in the mounting of about one-half the 1945 sockeye collection. There still remains the rest of the 1945 scales together with some 3,000 which were added in 1946.

10. HAIR SEAL STUDIES

H. D. Fisher — Appendix No. 36

Studies of Hair Seals in the Skeena River

During the summer of 1946 from late May until the middle of September, the study of the hair seals in the Skeena river was continued as part of the Salmon Investigation. The assignment to the project of a small gill-net boat with an engineer helped greatly in keeping a close check on the activity of the animals and on the damage which they caused.

Following the general survey of 1945, the work was organized to include five main objectives:

(1) To determine the effect of the hair seals on the gill net fishery in causing damage to nets and to the salmon.
(2) To study the effect of hair seal predation on the salmon run. This involves an assessment of the food habits of the species.
(3) To determine the numbers present in the lower Skeena, their distribution and movements.
(4) To outline the life history of the hair seals within the Skeena area.
(5) To study possible methods of control giving particular attention to the effect of the bounty method now practised.

Effect of Hair Seals on the Skeena River Gillnet Fishery - Early in May mimeographed forms were distributed to selected fishermen asking them to record for each set made, the number of fish caught, the number of these bitten, the percentage of the body destroyed, the original weight and the weight of the remains, and the actual monetary loss suffered. It was particularly desired that records be obtained early in the season since previous examination had shown that at that time in the early and mid-part of the spring salmon fishing, seal depredation is apparently at its worst.

Co-operation from the fishermen in filling out the forms proved poor on the whole. Since, however, only 25 boats were fishing on the Skeena by the middle of May, the few forms returned may be considered as fairly representative of the loss during the spring salmon season.

The majority of spring salmon caught were of the red-fleshed variety which in 1946 brought the fishermen 20 cents per lb. For individuals partly damaged, e.g. with a mouthful of meat torn from the belly, the price dropped to 10 or 6 cents per lb. depending on the extent of mutilation. If mutilation was excessive, no credit was given. As an example of loss in revenue, in two sets on June 4, one fisherman caught eight spring salmon. As shown on his form, two of these were seal-bitten, one being 50% destroyed and the other completely mutilated. The original weight of each was judged at 20 lb. No credit was granted for one and 6 cents per lb. was received for the remaining 10 lb. of the second. A loss of $7.40 for that day's fishing resulted. This is no exception but typical of the data submitted for May and June. If the run is large, the money made in spite of seal damage may still be considerable. If the run is not particularly good the monetary loss becomes a matter of great concern. Furthermore, it must be remembered that hair seals frequently remove salmon completely from the nets and thus the damage is considerably above that recorded. Seals, moreover, seem to be more active in raiding the nets when fishing is poor possibly because of the fact that the salmon are more difficult to cature upriver under natural conditions and the nets offer a ready and obtainable meal.

H. D. Fisher Appendix No. 36.

With the beginning of sockeye salmon fishing on the last Sunday in June, the number of boats increases greatly. At this time the seals move upriver to the bars above the fishing boundaries and thus seal damage becomes negligible in the commercial fishery.

Verbal reports, fairly well substantiated, indicate that the damage again increases during the coho salmon season in September when the number of boats is again reduced. This could not be confirmed by records in 1946.

Damage to nets from seal action was found to be small. On odd occasions a seal may become tangled in the mesh and cause wide tears but in the over-all picture this is not too serious.

Effect of Hair Seal Predation in Reducing the Salmon Run - One essential to reaching a decision on the effect of hair seal predation on the natural run of salmon, is to collect a representative series of stomachs to gain a definite idea of the importance of the salmon in the food relationship. To get a large number of stomachs was well nigh impossible. Many animals were shot and killed but most of them sank immediately in deep water. Of the 28 specimens recovered, 5 were adults and in three of these, the stomachs were empty. The remaining 23 were pups which early in the season mainly had milk in their stomachs. There were no bounty hunters in the district to whom appeals for cooperation could be made and the fishermen very rarely manage to recover those which they shoot. Eight samples were obtained from the Haida Indians for the east coast of the Queen Charlottes and are considered to be representative of salt water areas.

In spite of the limited number of stomachs, observations suggest that the most serious depredations in numbers of salmon by hair seals take place upriver above the fishing boundaries. On the east coast of the Queen Charlotte islands, the food consisted of squid, gastropods, crabs, rockfish and unidentified cottoids. At Gibson island immediately off the mouth of the Skeena on August 14, they seemed to be taking shrimps, squid, rockfish and small cottoids. Upriver they undoubtedly feed on salmon since they have been frequently observed during the last two summers in both the Ecstahl and Skeena rivers struggling with salmon at the surface of the water. One pup stomach from an upriver locality contained a whole coho salmon. If each seal destroys even 10 lb. of salmon per day, the four to five hundred animals in the Skeena will certainly afford a sizeable or even serious problem of predation.

Numbers of Hair Seals, their Distribution and Movements in the Skeena River - During 1945 and 1946, six hauling out grounds were discovered and inspected in the lower river and at its mouth. These included the Gibson islands, Genn island, De Horsey island, Raspberry island, the sand bar 4 miles above Skeena City, and the sand bar about 2 miles below Falls creek, Ecstahl river. Around 400 seals were observed. In addition 45 were flushed into the Skeena from the gravel bank at the mouth of the Lakelse river.

A definite seasonal upriver movement of hair seals takes place in the Skeena river coinciding in general with the salmon run. This is not a mass migration but appears to occur gradually, the numbers upriver steadily increasing as the number of salmon rises. The extent of distribution upriver appears to depend on the size of the salmon escapement. The initial phase of the movement coincides with the onset of the pupping season. From May 18 to 20, no hair seals were seen above Skeena City. On June 11, at which time 200 were seen, there were signs that the bars had been occupied for bearing young.

To estimate the population in a given area is difficult. Some animals will still be in the water while many are hauled out on the bars. The investigators feel, however, that for the population at the mouth of the Skeena up to Telegraph

36. A. L. Pritchard Appendix No. 37

Migration Studies

Marking of sockeye salmon yearlings met with greater success in 1946 than in any previous year. A very efficient "net block" and trap were installed in the Lakelse river. No difficulty was experienced in removing both ventral fins from 100,967 migrants. A different method, consisting of a lead toward shore and a small pen, worked well in Babine where 88,972 were marked by clipping the adipose and both ventral fins. There should be little trouble in continuing with equal success in future years in at least these two areas.

Only a few recoveries are expected during 1947 from the marking of 5,788 yearlings at Lakelse in 1945 and of 14,142 at Babine. This will give ample opportunity to improve and perfect the collection procedure both in the fishery and upriver. During 1946 in spite of all urging and of constant visits to the canneries, no recoveries were made by the fishermen. Some efficient method will have to be evolved perhaps even going so far as to put a man in each cannery to watch for scarred individuals. After all, the amount and thus the value of the information which can be gained from such programmes, depends directly on the efficiency of collection. Upriver, the installation of more fences like Babine where close examinations can be made, is being seriously considered and methods of inspection for marks during stream surveys are not being neglected.

The success attained in the operation of the "net block" at Lakelse has shown that it will be possible to get a complete count of yearling migrants there. With the daily figures, and numerous observations of limnological conditions in the lake together with frequent standard meteorological readings, it should be possible to determine the factors which may stimulate and affect migration and with what weather conditions such factors are correlated. In addition, the installation of an adult fence, which now seems possible, will open the way for propagation efficiency counts.

Tagging plans for 1946 apparently suffered a severe blow when it was found impossible to instal the trap above the boundary in the lower Skeena. This failure was to some extent compensated by additional effort and success on the part of the seine boats in increasing their numbers tagged and by placing special stress on the collection of returns upriver. The installation and operation of the Babine fence has indicated that the tag recoveries in the commercial fishery may give a far more accurate idea of exploitation than previously suspected, and that a larger number of recaptures are most productive in indicating the time, duration, and contribution of the run in the fishery. The addition of an adult fence at Lakelse will help further and possibility of others is being seriously considered. It seems logical that no further attempt should be made to instal a trap without an absolute guarantee of success but collection of returns should be stressed to make the present method - purse seine tagging - as efficient and productive as possible.

Lake Surveys

The summaries for the lake surveys show these bodies of water to be fitting into a composite picture in so far as their possibilities and limitations for the production of sockeye salmon are concerned. The general plan has been to stress Lakelse lake, which is of reasonable size and accessibility, and to use the results there as a means of interpreting similar but not such extensive observations made under the same standard procedures in other areas.

It would now appear that there are seven predator fish. Of these the

squawfish is the most abundant in point of numbers but not the most widely distributed. Following this is the cutthroat trout which along with the squawfish has been caught 67 times in every 100 predators. The others are rainbow trout, lake trout, dolly varden char, ling and sculpin. On the basis of analysis to date the only lakes in which predators can be considered abundant are Kitwanga, Kitsumgallum and Lakelse. Actually the average concentration in these three bodies of water appears to be about five times as great as in the remaining lakes studied. Of the three, it seems that Kitwanga has the highest numbers, the main predator being squawfish.

Analyses of the physical, chemical, and limnological data resulted some time ago in the arbitrary division of the lakes into two major categories: (1) deep, cold bodies of water almost opaque and gray from glacial silt, containing relatively little plant and animal life, and (2) rather shallow bodies of water, clear, of moderate temperature and with comparatively abundant plant and animal life. Kitsumgallum lake is the most extreme example of the first group yet encountered. Here it is clear that the production of sockeye salmon is limited by the physical and environmental conditions so that there is practically no hope of increasing the run to any great extent through such things as predator control, stream improvement, etc. Lakelse lake is taken as the example of the second group where it would seem that possibilities exist, from the biological viewpoint, of improving propagation efficiency by a sizeable amount. There are some lakes which have characteristics of both types and for the present these are termed "intermediate".

The following grouping is accepted on the basis of information now available although further observations may necessitate later transfer: Group 1 - Johnston, Kitsumgallum, Morice, Kluayaz and Motase lakes; Group 2 - Lakelse, Kitwanga, Stephens, Swan, Morrison, Nilkitkwa, Slamgeesh, Azuklotz, Sustut and Asitka; Group 3 - (intermediate) - Babine, Bear and Johanson.

Stream Surveys

Information is piling up on the purely physical aspects of the spawning streams. Many of the obstacles have been located, described, and recorded but with the exception of one or two small streams such as the Upper Bulkley, these have not been found to hold up migration to the detriment of the runs. Rough maps are now available for many of the better known rivers showing the kind and extent of the spawning areas. The falls at the headwaters, e.g. on the Fulton, Twin and Pierre, are being considered in the light of expansion of the spawning grounds by artificial aids. In 1946 several new areas were investigated, viz. Slamgeesh, Kluayaz, Motase, and Johanson.

The accurate estimation of escapement is still a difficult problem although the operation of the Babine river fence this year has thrown new light thereon. Population assessments in the Babine lake tributaries carried out in the usual manner have suggested that there were 210,000 sockeye, yet it was known that there were actually 475,419. It is not unreasonable to assume that the same error was made elsewhere on the system where a similar method of estimation was used. Thus the rough total of 340,000 for escapement should perhaps be 800,000. The catch of sockeye on the Skeena river this year (Indian and commercial) amounted to approximately 600,0 If the percentage return of tags is accepted as moderately accurate, this amounts an exploitation of 40.3%. The escapement would thus be about 890,000. The discre ancy is thus a little over 10% which reveals much more accuracy than in any previ attempt at assessment. Further more intensive efforts are planned to work out mo definitely the number of spawning migrants and thus the relation between catch an

escapement which is essential to any sound conservation.

The general survey revealed a good escapement of sockeye which was about one-half as large as that of 1945. Spring and coho salmon were fairly numerous. A medium run of big chum salmon appeared in the tributaries to the lower Skeena but, with the exception of the Kitwanga, Gold and Lakelse rivers, pinks were very scarce.

There is a distinct lack in the present investigation from the point of view of information on the biological, physical and chemical conditions within the rivers which may affect the young salmon on their way to sea. Much thought is being given to methods of approach to the problem at the present time. Perhaps selected and limited sections of particular streams will have to be intensively examined and used as representations of the general picture.

Statistics

The study of the commercial fishery statistics is now beginning to develop. The reliability of the various sources of data has been assessed and certain ones chosen where the information will be most accurate yet representative. The effect of such things as increase in efficiency of the processing plants, boats and gear is becoming evident. The possible reasons for the apparent decline in catch are being gradually discovered. Suggestions as to improvement in collecting figures which will be of greater value to the conservationist, are now being outlined. This is a long and tedious study but essential to a full understanding of the salmon relationships.

In the case of the Indian fishery much information is becoming available. Certain practices are being carefully assessed so that a definite statement may be made on their desirability, e.g. gaffing, trading, etc.

Moricetown Falls as a Hazard to Fish Migration

The much more intensive investigations of the conditions at Moricetown falls in 1946 merely confirmed last year's findings and emphasized more strongly that fish are held up at certain water stages. Fortunately bad conditions of flow were present for only a short period this year and affected mainly the last of the sockeye salmon, some cohoes and steelhead. The plans are to continue similar work not only because it will give additional data, but also because, at present, examinations in this locality give the best idea of the numbers of salmon proceeding to the upper Bulkley and Morice. During the year an engineer's survey of the contours is planned as a basis for suggestion of remedial measures should they be required.

Age Composition Studies

As has been pointed out there are still large collections of scales to be examined. Since the data are essential for analysis of much related material, plans are being explored to replace Mr. Campbell by transfer or adding further help.

Hair Seal Studies

The study of hair seals advanced greatly in 1946. Much information is now available on the monetary loss caused in nets and fish, the effect of their predation on the salmon runs, the numbers present, their distribution and movements, and their life history. Feasible methods of control have been suggested.

A. L. Pritchard Appendix No. 37

Summarizing and Analysis of Data

From the inception of the investigation, it has been felt that the data might pile up because of lack of personnel to summarize and analyze it. During the first two years concentrated efforts have been made to cover in one way or another each year's collections. Summaries have been placed on file and in addition the following Progress Reports have been published:

A. L. Pritchard	Sockeye salmon tagging off the Skeena river in 1944.
A. L. Pritchard	Sockeye salmon tagging off the Skeena river in 1945.
A. L. Pritchard and J. R. Brett	A sockeye salmon tagging experiment at Lakelse lake.
J. R. Brett and A. L. Pritchard	Lakes of the Skeena drainage No. 1. Lakelse lake.
J. R. Brett and A. L. Pritchard	Lakes of the Skeena drainage No. 2. Morice lake.
J. R. Brett and J. A. McConnell	Lakes of the Skeena drainage No. 3. Kitwanga lake.

At the present time No. 4 in the lake series on Kitsumgallum is ready and that on Bear lake partially prepared.

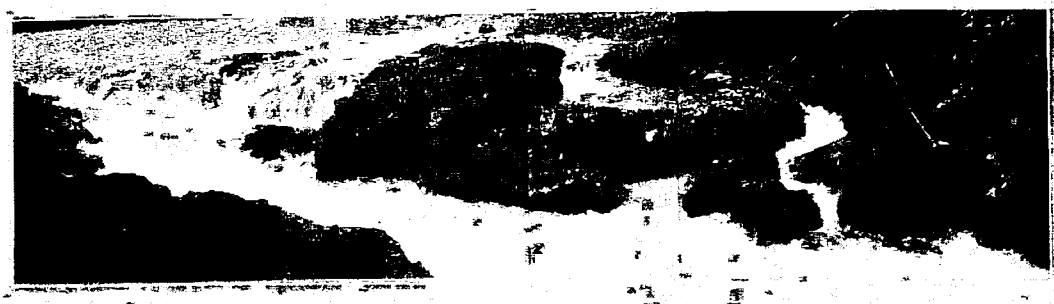
With the co-operation between Dr. W. A. Clemens at the University of British Columbia and Dr. R. E. Foerster, a system of allowing the use of material for theses has been worked out. Restrictions have been placed only in the limitation on the amount of material which may be taken, on the time it may be away from the station and in the fact that the material must first be worked up in the manner demanded by the investigation. Already two Bachelor theses are on file:

D. F. Alderdice - A study of the limnetic plankton of Lakelse lake.
J. A. McConnell - A limnological study of Kitwanga lake.

This year three more are in preparation:

D. K. Foerster	- Predation study on squawfish in Lakelse lake.
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.

While the procedures have thus far been very productive, it is now manifestly evident that the organization will have to tend to increase time spent on summarizing without interfering with the field programmes. More personnel of a moderately junior status will help and arrangements must be made to give the more senior workers time to analyse the results and assemble the scientific papers. The fact that a complete report on the first phase of the investigation is due at the end of 1948, cannot be neglected.



THE MORICETOWN FALLS - LOW WATER

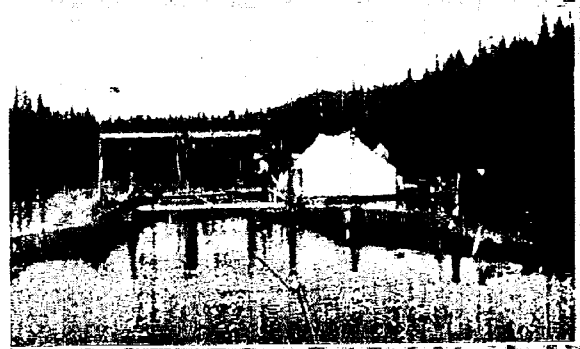
MORICETOWN FALLS - WINTER

INDIAN FISHING - MORICETOWN FALLS

FALLS ON BEAR RIVER

BABINE RIVER COUNTING FENCE

LAKELSE RIVER NETTING FENCE



FUNNEL ENTRANCE LAKELSE FENCE

Ferris Neave Appendix No. 38

The General Salmon Investigation - Introduction

The General Salmon Investigation, which is charged with the study of problems in salmon conservation in the territory between the Fraser and Skeena river systems, has thus far been almost entirely concerned with pink and chum salmon. The latter species has received particular attention because of the great irregularity in the size of the annual catch and the lack of information concerning the causes of this fluctuation.

During 1946 two full-time scientific workers (Ferris Neave and W.P. Wickett) have been employed in the investigation. Dr. W.S. Hoar contributed valuable services for two months in the summer. In view of this limited scientific personnel and the great size of the area it has been necessary to direct and confine the investigation to a limited number of definite objectives. These objectives may be summarized as: (1) Determination of the present status and trend of the fishery through the compiling and correlation of records and information available for previous years (2) Assessment of the spawning runs to different streams and areas and determination of the existing conditions under which the freshwater period of the life cycle is spent (3) Diagnosis of the factors limiting production of young salmon and of the causes of fluctuations in the annual catch, with a view to the prediction of the size of future runs (4) The testing of procedures intended to increase the output of salmon streams. Some progress has been made in each category.

A contribution to the first objective has been made by Dr. Hoar and is summarized in Appendix No. 39.

Work pertaining to the second category is represented by stream surveys, which in 1946 were carried out principally in the Butedale, Alert Bay and Vancouver island areas (Appendices 40-42). Also related to this aspect of the investigation is the determination of the proportion of returning fish taken by the fishery and the relation between the fishery and salmon travelling to different streams or areas (Appendix No. 43).

In order to establish a relationship between environmental conditions and the success or otherwise of a given brood year (category 3) a knowledge of the age-composition of the annual runs is essential. Hence a fairly comprehensive programme of scale collection in different areas has been initiated. The material collected during the current year has not yet been worked up but the results obtained from scale samples taken in the Johnstone strait area in 1945 are presented in Appendix No. 44. The information gained is being applied to a study of meteorological conditions and stream flow in coastal areas, in the belief that certain of these physical conditions exert a strong influence in determining the size of the salmon runs. Already some degree of correlation has been found to exist between the run-off in certain streams in certain months of the year and the size of the chum salmon catches four years later. This is a promising line of investigation, which is being pursued by Mr. Wickett.

In the case of chum salmon the evidence of frequent heavy losses due to physical conditions previous to the time of emergence of the fry is so definite that it has been thought advisable to start without delay a series of practical tests of remedial measures. The first of these experiments is now in progress at Nile creek (Appendices Nos. 46,47).

During the latter part of the summer a small field station was established at Nile creek to serve as headquarters for this and other experimental

Ferris Neave Appendix No. 38

work. The building provides living quarters for the personnel engaged in this work and facilities for the rearing of salmon eggs to the eyed state. Two new counting weirs were installed on the stream. In the design and construction of these various units and in the performance of the subsequent experimental work, the invaluable services of Mr. W.F. Baxter should be recorded, together with the efficient assistance rendered by Messrs. R. Wilson, D. Milburn and A. Kilby.

W.S. Hoar Appendix No. 39

Catch Statistics of the British Columbia Pink and Chum Salmon

The history of the pink and chum salmon in British Columbia has been studied from the governmental statistics for the years 1916-44.

During this period the pink salmon catches have shown a significant downward trend in all of District 2 (northern B.C.). The trend for the period has been upward in southern B.C. (districts 1 and 3) but this upward trend really ceased in 1938 and since that time catches have, on the whole, declined. For all areas the catch in the offspring generation is frequently below that of the parent year. Correlation data show the strict dependence of offspring on parent generations (catches) of pink salmon and suggest that the escapement has not been sufficient in recent years.

There are several interesting points of contrast between the chums and the pinks. Chum catches in offspring and parent years show no significant correlation. On the other hand there is a significant correlation with the catch of the previous year. These correlation data, as well as the catch figures and the index of success of return, indicate that there have been three alternating periods of very low and high catches of chum salmon. The periods have not coincided exactly in the different areas. The low chum catches are not associated with economic conditions (on basis of chi-square measurements) but may be associated with abnormal river water conditions in spring or autumn--again on basis of chi-square tests.

In general, the chum catches in the northern waters (north of Rivers Inlet) have declined while there has been an upward trend to the catches in the south. However, the trend has been significant for the 29 years only in the Vancouver Island, Smith-Rivers Inlet and Nass River Areas. The variability of the chum catches and the presence of periods of very low and high catches rather than a definite upward or downward trend is emphasized.

W.P. Wickett Appendix No. 40

Butedale-Laredo Inlet Stream Surveys, 1946

This survey of pink and chum streams was confined to those that can be traversed on foot, thus eliminating streams such as the Kitimat and the Kitlope. The work was split into two parts: a general survey of the northern portion through Graham Reach, Ursula Channel, Devestation Channel, Kitimat Arm and Douglas Channel, and an intensive study of Laredo Inlet. August 3rd to August 9th was spent on the first part and August 10th to August 30th on the second part, during the 1150 mile trip in the motor-boat "Ketonca". Mr. Neave and the

W.P. Wickett Appendix No. 40

writer made a second trip in the area in the M.V. "A.P. Knight" from September 28th to October 2nd.

Twenty-five streams were visited, distributed as follows: Verney passage - Evelyn creek; Devestation channel - Deer creek; Kitimat Arm - Eagle bay creek, Bish creek, Jesse lake; Ursula channel - Goat river, Fishermans Cove creek; Graham Reach - Khutze river, Marshall creek, Indian river, Aaltanhash river, Dome creek, Klekane river, Scow bay creek; Laredo inlet - Quigley creek, Powles creek, Blee creek, Bloomfield creek, Dally creek, Tyler creek, Pyne creek, Nias creek, Arnoup creek, Buie creek, Lomax creek; Tolmie channel-McKay creek.

Stream levels were moderately low during August with sufficient water for the fish to enter and ascend the streams. The gravel beds were half covered with water. Streams rose to high level in the third week of September. Butedale area has a large proportion of streams which have falls of various heights near the mouths, seventeen out of the twenty-five being of this kind.

Pinks moved into the inlets about the first of August and the main body of the run started up the streams during the last week of August. A small proportion of pinks ran the streams during the second and third weeks. Chums were about a week later. No spawning was observed until the last of August, the fish remaining in schools in the pools and moving from pool to pool as new migrants arrived behind them. Pinks tagged in the bay off Nias creek on August 20th were still there on the 28th and no tags were seen in the creek up to that time. By the end of September, the fish had spread out in the streams and were spawning. A small early run of chums entered the streams by the first week in August but the main body arrived after the pinks.

Pink spawning is evaluated as medium and chum as light. Closures by the Department prevented a very light spawning of pinks but chum supplies were so small that even the closures could not produce a medium escapement. Numerous coho fry were observed in all streams.

Watersheds are well forested and stream beds and banks free from shifting. Water levels during the spawning period are considered of major importance, the small run of chums this year being probably due to the dry summer of 1942. The area is considered one in which the installation of small fishways would prove of great value as low and high discharges are apt to stop a large proportion of pink and chum spawning runs.

The courtesies extended by Mr. MacDonald, Head Guardian of Butedale area, and by Mr. Malcolm, manager of Butedale cannery, and the excellent work of Mr. A.G. Paul, who accompanied the writer, are acknowledged.

W.P. Wickett Appendix No. 41

Bella-Bella Stream Surveys, 1946

On the return trip from Laredo Inlet at the beginning of October, three streams were visited, the Tankeeah in Ellerslie Channel, Deer Pass creek in Troup Pass and the Clatse in Roscoe Inlet.

The third-of-a-mile stretch to the lake on the Tankeeah consists of rock and stones, yet heavy spawning of pinks and chums was found to be in progress. Eggs were being deposited in places nearly free of any gravel. 1500 chums and 1000 pinks were estimated to be in the stream.

W.P. Wickett Appendix No. 41

In the Clatse, a medium-heavy spawning was observed in the three-fourths mile to the falls. 8000 chums and 7000 pinks were seen. Chums were still jumping in the bay off the mouth. The stream averaged eight inches deep through most of its length and the water was clear over a gravel bottom. To test visual estimation while travelling along the banks of a stream with heavy brush and many windfalls, Mr. Neave, the writer and Mr. R. Edwards, Inspector of the area, made independent checks on the return from the falls. The estimates were within one thousand of each other.

In the third of a mile stretch to the falls on Deer Pass creek, 2000 chums and 2000 pinks, a heavy spawning, was surprising, as the stream is rocky and stony.

Finding heavy spawning in two streams containing little gravel emphasizes the importance of the present studies of conditions and spawning migration.

W.P. Wickett Appendix No. 42

Alert Bay Area Stream Surveys, 1946

Using the M.V. "A.P. Knight" from October 29th to November 6th, a survey was made of streams between Mackenzie Sound and Knight Inlet. Glacial streams visited were the Wakeman, Kingcome, and Kakweiken; non-glacial were the Embley, Mackenzie, Glendale, Bond, Charles and Viner. The Nimpkish on Vancouver island was visited briefly.

Stream levels had been high the previous week in the non-glacial streams and had dropped to moderate height at the time of the survey. The peak of the chum spawning was just passed in the small streams. The fish were well spread out the length of the spawning beds. From local reports, the runs to the large glacial rivers had come in three weeks before. No signs of fish were seen in the Wakeman and Kingcome so evidently they passed on up to the higher reaches. Up to the time of the survey, the glacial stream runs were light-medium (Wakeman and Kingcome from report) and the small streams medium-heavy.

Few pink salmon were observed as their spawning period was nearly over, but from the dead bodies visible there appeared to have been a fair escapement.

Discharges were measured on all streams to enable correlation to be made with rainfall in order that the behaviour of the streams may be studied. Conditions up to the time of the survey appeared very favorable for the proper deposition of eggs.

Ferris Neave and W.P. Wickett Appendix No. 43

Chum Salmon Tagging and Recoveries by the Fishery in 1945

The tagging of chums was carried out between August 3 and November 1945 but was mainly conducted after September 24. The few early tags were affixed during the pink salmon tagging programme, reported last year.

Of 2,387 chums tagged in upper Johnstone strait and adjacent waters 33.9% were recovered by the fishery and reported. Of 1,566 tagged in and near

Ferris Neave and W.P. Wickett — Appendix No. 43

Discovery passage, 21.6% were reported. About one-third of the fish handled during each week of the tagging season were caught. Fish tagged in upper Johnstone strait yielded the following percentage returns (dates indicate termination of a weekly tagging period): Sept. 29, 32.7%; Oct. 13, 38.5%; Oct. 20, 31.5%; Oct. 27, 32.8%. In Discovery passage the figures are: Oct. 6, 33.1%; Oct. 27, 22.7%; Nov. 3, 15.6%. Exploitation thus appears to have been very uniform. The drop in recoveries for the last two weeks' tagging in Discovery passage was probably due to the closure of the season on November 3, the fish being thereby exposed to the fishery for only a short time.

Recoveries were made in all main areas between Simoom and Thompson sounds in the north and Puget sound in the State of Washington. Returns indicate that about 10% of the chum salmon run entering Johnstone strait from the north was captured during its passage through the strait. Like the pink salmon, the chums move mainly southward through Johnstone strait, schooling in the bays, and then dispersing through the channels northward and eastward to the mainland and through Seymour narrows to the strait of Georgia. Once in the latter, the fish proceed to the mouths of the spawning streams, where they school again.

Fish proceeding to the various areas are present in Johnstone strait throughout the season, but certain peaks were recognized for fish travelling to different areas. The succession in which the runs to certain large areas passed through the Johnstone strait fishery is indicated below.

Maximum incidence in Johnstone strait fishery (week ending)	Destination (general area)
Sept. 29	Toba inlet
Oct. 6	Jervis inlet
Oct. 6	S.E. Vancouver Is.
Oct. 27	Fraser R.
Oct. 27	Puget sound

Average travel times in days from upper Johnstone strait to certain important fishing localities are listed below. The two sets of figures reprexent the number of days elapsing between tagging and recovery for fish tagged during the first and last weeks of the tagging season respectively. Hanson I - 4.2; Thompson sound 18, -; Phillips arm 23,-; Discovery passage 11.7; Sliammon 16, 11; Qualicum 11,8; Fraser river 20,27; Chemainus 18,-.

Travel times from Discovery passage were: Hanson I. 8,-; Phillips arm 16,-; Pender harbour 12,3; Qualicum 10, 4; Fraser river 20,24; Chemainus 13,-. In most instances the migration speeds up as the season advances.

W.P. Wickett — Appendix No. 44

Age Determination of Johnstone Strait Chum Salmon

During the 1945 chum tagging programme, scales were taken from 2,086 fish. These fish were measured and weighed. Fork-length to the nearest half inch and weight to the nearest quarter pound were used. 1,334 fish were taken in upper Johnstone strait just south of Alert bay and the following areas in the same vicinity: Double bay, Robson Bight, Boat harbour,

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Blackfish Sound. 751 were taken from Camp Point, Granite bay, Deep Water bay and Knox bay in Discovery passage. The results are tabulated below by weeks.

Age

		U 1	U 2	U 3	U 4	L 5	U 5	U 7	U 8	L 8	L 9
3 yr.	362	2	0	0	36	9	69	56	40	33	117
4 yr.	1700	7	9	2	237	89	386	326	148	139	356
5 yr.	24	0	0	0	6	1	5	4	1	3	4
	2086	9	9	2	279	99	460	386	189	175	477

Percentages

3 yr.	17.4	22.2	0	0	12.9	9.1	15.0	14.5	21.2	18.9	24.4
4 yr.	81.5	77.8	100	100	85.0	89.9	84.0	84.5	78.3	79.4	74.8
5 yr.	1.2	0	0	0	2.1	1.0	1.0	1.0	0.5	1.7	0.8

Average weights

3 yr.	11.00	--	--	8.75	9.08	8.26	9.02	8.73	8.74	8.86
4 yr.	13.14	12.36	10.10	10.00	10.50	10.01	10.40	10.21	10.04	10.47
5 yr.	-	-	-	10.50	13.00	11.40	13.63	13.00	11.02	10.75

Upper Johnstone strait - 3 yr. 9.15, 4 yr. 10.89, 5 yr. 12.13

Discovery Passage " 8.89 " 10.27 " 11.59

Average length

3 yr.	28.25	-	-	26.06	26.61	26.00	26.45	26.32	26.94	26.15
4 yr.	29.53	29.72	28.13	27.58	26.99	27.49	27.97	27.67	27.55	27.56
5 yr.	-	-	-	28.60	30.00	29.30	30.27	30.00	28.34	27.75

U - Sampling in Upper Johnstone Straits
L - " " Discovery Passage

Figures represent weeks of sampling for the weeks that ended as follows: 1. August 11; 2. August 18; 3. August 25; 4. September 29; 5. October 6; 6. October 13; 7. October 20; 8. October 27; 9. November 3.

The fourth year class is dominant. The older and larger fish tend to run earlier, as in the fourth week there is a percentage of 2.1 in their fifth year, and in the ninth week a percentage of 24.4 in their third year. For the whole season, the run consisted of 17.4% in their third year, 81.5% in their fourth year, and 1.2% in their fifth year. The upper Johnstone Strait sample consisted of 15.2% in their third year, 83.6% in their fourth year and 1.2% in their fifth year. The Discovery Passage sample consisted of 21.2% in their third year, 77.7% in their fourth year, and 1.1% in their fifth year.

Age composition by recovery areas gives too small samples for definite conclusions to be made, but there is no marked deviation from the above results.

W.P. Wickett — Appendix No. 45

Natural Propagation of Pink Salmon at Morrison Creek, Vancouver Island

In continuation of the quantitative studies begun by Dr. A.L. Pritchard in 1943-44, the efficiency of natural propagation in Morrison creek was again investigated. The fry migrants resulting from eggs deposited in the autumn of 1945 were handled at a weir operated close to the mouth of the stream In spite of occasional expected difficulties due to high water, a satisfactory count was achieved.

The run began on March 18 and continued until May 4, more than 80% of the fry passing the weir between April 10 and April 28.

Both the total number of fry produced and the percentage efficiency were apparently greater than in the previous cycle year. A comparison is presented herewith:

Year	Males	Females	Total	Average no. of eggs	Potential deposition	Fry migrants	Efficiency of hatch
1943-44	7,654	8,101	15,755	1,779	14,400,000	670,841	4.7%
1945-46	6,980	6,431	13,411	1,862	11,928,000	791,772	6.7%

This year's fry counting operations were conducted by Messrs. W.F. Baxter, A.G. Paul, R. Wilson and the writer.

Ferris Neave — Appendix No. 46

Natural Propagation of Chum Salmon at Nile Creek, Vancouver Island

The initial steps in this study were reported in Appendix 28 of the 1945 summary reports. The adults migrating in the autumn of 1945 were counted at two weirs, one situated close to the stream mouth, the other at a point 7/10 of a mile upstream. The following figures were obtained:

Lower weir: Males - 1,498, Females - 1,564, Total - 3,062
Upper weir: Males - 175, Females 50, Total - 225

Average egg content of females was 2,922

The total potential egg deposition above the lower weir was estimated at 4,570,000. The potential deposition above the upper weir was therefore only about 3.3% of the total, in spite of the fact that there were no obstructions to the passage of fish up to this point or for a distance of three or four miles beyond. It was evident that only the lowest 600 or 800 yards of stream bed were being extensively used by spawning fish. A not inconsiderable number of fish spawned below the lower weir in water subject to tidal influence and of varying salinity.

The seaward migration of fry took place between April 1 and May 28, 1946. Complete enumeration of the fry reaching the upper weir was not possible owing to difficulties encountered in the course of freshets, but a satisfactory count at the lower weir gave the total output of the stream as 138,388, or 3.0% of the potential egg deposition. This is a very low efficiency in comparison with figures available for other species of salmon at a corresponding stage of development.

Ferris Neave Appendix No. 46

The losses occurring during the downstream migration were investigated by marking fry at the upper weir and noting the number of these which were recovered at the lower weir. These experiments showed a mortality of 38% believed to be due almost entirely to predation. The average loss during seaward migration was probably less than this, since most of the fry had a much shorter distance to travel than the experimental fish. The latter may also have been rendered more vulnerable by reason of the marking and the manner of release.

Considering the whole period from the arrival of the eggs in the stream to the escaping of the fry into salt water it is indicated that as much as 95% of the losses may have occurred prior to the emergence of the fry from the gravel. Observations made on the redds during the winter tended to confirm the belief that very heavy losses occurred during the early stages of development. These losses are believed to have been due in large part to removal of gravel by flood and by the activities of the later-spawning fish, and to deposition of silt on other portions of the stream bed.

During the migration, a total of 43,000 fry was marked by fin-clipping at the two weirs. About 40,000 of these were released or passed below the lower weir.

Ferris Neave Appendix No. 47

Artificial Propagation of Chum Salmon

In view of the evidence (see previous appendix) that chum salmon eggs are frequently subject to heavy mortality before hatching, an experiment to test the efficiency of egg planting as a remedial measure is being carried out at Nile creek. Two weirs of improved design have again been installed on this stream, one being situated at the former site close to the mouth, the other about 450 yards upstream. The portion of the stream between the weirs covers most of the spawning grounds utilized by this species for natural propagation. The chum run to this section of the stream is being allowed to spawn in a natural manner. No fish are allowed to spawn above the upper weir, this portion of the stream being reserved for experimental planting of eyed eggs.

These eggs are being obtained from (a) the small number of fish which would normally occupy the upper portion of the stream (b) fish occupying the tidal area at the stream mouth and showing no inclination to proceed upstream even as far as the lower weir (c) fish captured in other streams in the same general area. The eggs are being incubated in trays stacked in wooden cases. They are kept wet by dripping water supplied from a 5,600 gallon wooden tank, which is filled by pumping at intervals from the stream. This system requires only a small water supply and relatively inexpensive equipment. The eggs will be incubated to an advanced stage and then planted in situations deemed to be favourable for survival. Counts will be made of the number of fry reaching each of the two weirs.

At the present time the counting of adult fish is nearing completion. In spite of occasional severe strain placed on structures and personnel by sudden floods (the stream flow has varied from about 5 cubic feet per second to at least 500 c.f.s. during the operations) the weirs have been maintained intact. It is evident that this year's escapement to Nile creek has been small.

Ferris Neave Appendix No. 47

Up to November 30 a total of 1,861 chum salmon (953 males, 908 females) passed the lower weir. The trap at the upper weir has yielded 127 males and 98 females. Taking into consideration the fish remaining below the lower weir, it is evident that at least 90% of the total potential egg deposition was confined to the lowest quarter-mile stretch of the stream.

About 620,000 eggs have been taken for incubation. It is hoped to augment this number in the immediate future.

Ferris Neave Appendix No. 48

Natural Propagation of Coho Salmon in Oliver Creek in 1945-46

The cohos passing into Oliver creek in the autumn of 1945 were counted as in previous years and the efficiency of fry production was again estimated by counting the young fish descending the stream in the spring and summer of 1946. Mr. E.V. Epps conducted these operations.

Results were as follows:

Adult males	204
Adult females	115
Average no. of eggs (10 females)	2,370
Potential egg deposition	249,000
No. of fry migrants	55,325
Percentage efficiency	22.2

The potential egg deposition, although relatively light, was somewhat larger than in the previous year, which was estimated at 173,000. The percentage efficiency was almost exactly the same (22.3 in 1945). This is slightly above the 8-year average of 18.2% for this stream. The figures obtained for the period during which these experiments have been conducted are:

Year	Egg Deposition	% Efficiency
1938-39	330,176	14.4
1939-40	665,280	11.8
1940-41	481,650	30.4
1941-42	564,900	26.0
1942-43	199,500	25.6
1943-44	326,000	15.2
1944-45	173,000	22.3
1945-46	249,000	22.2

Ferris Neave Appendix No. 49

Size of the Coho Run in the Upper Cowichan River in 1945

The estimate was again based on taggings carried out at Skutz falls during the course of the upstream migration, followed by observations on the ratio of tagged to untagged fish on the spawning grounds in the upper part of the river system.

Between October 26 and November 8, 1945, 861 cohos were caught by dip-net and tagged at Skutz falls. Between December 6, 1945 and January 14, 1946, 22 streams tributary to Cowichan lake and the upper part of the Cowichan river were inspected, the observed number of tagged and untagged fish being recorded. The fish passing the weir on Oliver creek, which yielded 3 tags, were included in the totals. In all, 71 tagged fish and 3,317 untagged fish were observed. Assuming that this ratio represented fairly the proportion of the run which was tagged, the total number of fish which passed upstream beyond Skutz falls would be approximately 41,000. This indicates a smaller run than in 1942, the parent year, when the calculated number was approximately 67,000.

In addition to the reports presented herewith relating to the Cowichan river, a record of the game fishery in Cowichan bay was maintained by Mr. H.H. Pegler from September 19 to November 10. The coho run in the Cowichan river in the autumn of 1946 was again observed at Skutz falls, where 1,017 fish were tagged. The run was unusually late in appearing. Analysis of the data obtained in these operations has not yet been made. The same applies to records of salmon marked at Cowichan lake and reported during the past season from the fishery or recovered in fresh water.