FISHERIES RESEARCH BOARD OF CANADA

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PACIFIC BIOLOGICAL STATION

for

1941

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FISHERIES RESEARCH BOARD OF CANADA

REPORT OF THE PACIFIC BIOLOGICAL STATION, NANAIMO, B.C. FOR 1941

BY R. E. FOERSTER, DIRECTOR

In spite of war-time conditions and the necessity of modifying both policy and operating routine, the work of the Station during 1941 has progressed most satisfactorily. While it cannot be said that the year's results have directly contributed to the war needs, a fact which has been of serious concern to members of the staff, nevertheless it is abundantly evident that from the long range point of view and considering fisheries conservation generally, the accomplishments have been of definite significance. They add, year by year, more contributions to our knowledge of the trends of the various fisheries or the characteristics of the life history of the commercial fishes, all of which are of value in preparing up-to-date effective measures for regulation and conservation.

Constantly changing conditions in the various fisheries, brought about by the increased value of the fish, the increased efficiency of fishing methods and/or the expansion of the fishing operations into new areas necessitate a close check being kept by the investigators on the trends of the individual fisheries and an attempt to evaluate the effects of such changes. For example, in the herring fishery a quota system of regulation has been under experiment for the past five years. During this time the fishery has been limited each year to specified tonnage and the effect of such regulation upon the catches and more particularly upon the spawning and general abundance of the fish has been closely followed. A second five-year experiment has been commenced in which the quotas have been altered, on the basis of the previously-acquired knowledge, and the reaction of the fishery will be carefully watched.

In the salmon fishery there has developed a tendency for the fish to be caught further and further from the river estuaries until in many cases it is now extremely difficult to tell what fish from which river are being exploited. Obviously for conservation this becomes a serious matter and requires further knowledge of the migratory routes of the salmon. More attention is being given to this problem.

The reduction in available fish products for Canadian consumption, by reason of the heavy shipments to Great Britain, has placed a strain on shellfish resources to fill, in some measure, this shortage. The demand for clams and oysters has risen phenomenally and with consequent very attractive prices offered, the exploitation of the beds has increased. For oysters, largely grown and cropped from commercially leased beds, the problem is of less consequence than for clams which are harvested almost wholly from public beaches.

Here the danger of over-exploitation and severe reduction of future potential supplies is very real. The extent of present digging, an assessment of the available supplies and the potential rate of recruitment are factors being investigated and on the basis of the data obtained and the situation revealed, directly beneficial conservation measures will be prepared.

The foregoing are but instances of the relationship of the work of the Station to the efficient management of the Dominion's Pacific fisheries, a natural resource which is of direct value in the present war effort but which will be of even more consequence in the post-war period. Other investigations are of equal importance and are being developed and planned to so fit together that with utmost efficiency the essential data may be speedily obtained for practical application in the field of conservation.

STAFF

During the year a number of the members volunteered for Active Service, obtained leave of absence and are now on duty. They are Mr. J.L. McHugh (Army), Mr. W.M. Cameron (Meteorological Service), Mr. D.B. Quayle (R.C.A.F.), Mr. Robin Fjarlie (R.C.A.F.) and Mr. L. Quickenden (Navy). With respect to the first three named, each of whom was responsible for certain research projects, special efforts were made to clean up work in hand and to leave records in such shape that the progress of the research was clearly indicated and the investigation could, if necessary, be carried readily ahead. These considerate actions have been very helpful. The departure of all of the men has had a definite effect upon the conduct of the work and has thrown added burdens of organization or routine on the senior members of the staff, particularly since suitable temporary assistance is extremely difficult to obtain.

Due to the enlistment of Mr. Quayle, who was in charge of the shell-fish research and which work it was deemed desirable to continue, a reorganization of the staff was made by transferring Mr. Neave from the Cowichan lake investigation to shell-fish. The Cowichan lake work was divided up, Mr. Neave to continue his interest in and supervision of the trout work, while to Dr. Pritchard was given responsibility for the salmon projects. With Mr. Epps resident at the Cowichan lake hatchery as field officer and directly superintending the routine operations, this new set-up is meeting the situation most admirably.

In July, Mr. Anderson returned to his duties as Junior Technician in Hydrography, after having been absent on compensation since October, 1940, when he was severely injured in an explosion in the Chemical Laboratory.

BOATS

The M.V. "A.P. Knight", transferred in the spring to Alberni Inlet for the hydrographical survey of that body of water, failed to meet the conditions demanded of it by the routine of the investigation. Built in 1926 it was equipped with a semi-diesel engine which for a number of years has given very indifferent service. Probably, too, frequent laying-up of the boat and the lack of

an experienced engineer have contributed to its condition. The boat was returned to Departure Bay in September and steps taken, through the Department of Fisheries, to purchase and instal a new power plant.

PUBLICATIONS

During 1941, the regular contributions to Progress Reports have been continued and the four issues during the year contained thirteen papers on various aspects of the Station's work. A list of these and of other scientific papers either published during the year or submitted for publication is appended hereto. In addition a number of manuscript reports on minor pieces of research or dealing with phases of major investigations have been prepared and placed in the library.

ACKNOWLEDGEMENTS

During the year the Provincial Fisheries Department contributed financially to the pilchard-herring and shell-fish investigations. For this and the advice and co-operation given on many occasions by the Assistant Commissioner, Mr. George J. Alexander, grateful acknowledgement is made. Relations with the officers of the Federal Department of Fisheries have been most harmonious and inspiring and, on behalf of the members of the staff, I should like to express deepest appreciation of the co-operation extended by Major Motherwell, Chief Supervisor of Fisheries for British Columbia, Supervisors Tait, Boyd and MacLeod and their many field officers. Their help is of very material benefit to our work.

SALMON INVESTIGATIONS

Pink salmon

During the spring of 1941 the sixth test of the efficiency of natural propagation of pink salmon at McClinton creek, Masset Inlet, was completed under Dr. Pritchard's direction. From the presumed deposition of 26,500,000 eggs in the autumn of 1940 a total of 5,061,000 fry migrated seaward, or 19.0 per cent of eggs deposited. This high percentage survival is in line with results obtained from previous small spawnings and tends to confirm by comparison with lower yields from larger age depositions, earlier evidence of a limited capacity for spawning beds, with respect to production of fry.

During the winter of 1940-41 Mr. Cameron remained at McClinton creek and made observations on the mortality of pink salmon eggs, alevins and fry during development. Certain spawning redds were marked at spawning time and subsequently dug up and inspected. While, from one year's findings, conclusions are hardly warranted the 1941 data show that the losses occurring from spawning to migration might be divided up as follows: Predation on adults and incomplete spawning - 10%; exposed by superimposition - 5%; erosion of spawning beds - 10%; during incubation and alevinage - 30%; due to predation on fry - 60%. It may be mere coincidence that the rough estimates above, when

applied to the 1940-41 spawning give a fry survival of 22%, very close to the actual determination - 19.0%. These experiments strongly suggest the practical value of certain stream management procedures such as stream improvement, predator control, etc.

Another important feature of the Masset inlet pink salmon investigation is the tracing of the migratory route of these fish on their return from the sea. The runs have been, in past years, of considerable commercial importance but very erratic in extent and returns in 1940 indicated that some exploitation of this run occurred in southern Alaska waters. Further information is desired and to this end 200,766 fry were marked in McClinton creek in the spring of 1941 by removal of both pelvic fins. These will return as adults in the fall of 1942.

Studies were made by Dr. Pritchard to determine whether, by comparison of mean gill raker or pyloric caeca counts, racial differences could be revealed between pink salmon populations. The results of 560 gill raker examinations suggest certain significant differences between northern areas, but not between streams within each area. Pyloric caeca counts (539) reveal no differences. The study is being extended to southern areas during 1941, for comparison between major areas.

Chum salmon

A collection of approximately 1200 chum salmon scale samples was obtained from various fishing areas. These were taken to study the age classes constituting the runs to the various coastal areas. The reading of the scales and the working up of the data will be completed by Dr. Pritchard this winter.

Coho salmon

Further data were obtained by Mr. Neave relative to the efficiency of natural propagation of coho salmon in two small tributary streams, Oliver and Beadnell creeks, of the Cowichan river. In 1940 the percentage efficiencies were 11.8 and 40.0 respectively and it was indicated that the difference may have been largely due to the much greater cutthroat trout population in Oliver creek. In 1941, the percentages were 30.4 and 30.1 respectively. Beadnell creek apparently supported the larger trout population but the presumed coho spawning in it was much less (74,100 eggs) than in Oliver creek (481,560 eggs).

Recoveries of marked fish from the Cowichan river have indicated, in the experiment conducted on the individuals of the 1937 brood year, a return of 1.55 per cent of the fingerlings released, or 0.273 per cent of the eggs collected. This represents the spawning escapement which remains after the commercial and sport fisheries have taken their toll of the returning fish. Cohos marked in 1939 (brood year, 1938) are now being recovered on the spawning beds. Returns from the fishing areas show that this Cowichan run was tapped at various points on the west coast of Vancouver island, in the strait

of Juan de Fuca and in the strait of Georgia. These experiments indicate the migratory routes of these salmon and the interesting recoveries in 1941, in spite of relatively little direct publicity, illustrate what valuable data may be obtained in later years when a definite recovery campaign is launched.

Collections of stomachs of coho salmon were made from the various fishing areas of the B.C. coast and the contents examined by Drs. Pritchard and Tester. A great variety of food organisms was found. Although fish occurred in great numbers, invertebrates were also important constituents of the diet.

Spring salmon

From the release of 25,000 marked spring salmon fingerlings in 1937 and again in 1938, it was anticipated that some recoveries would be made this autumn. No marked springs were reported and the reasons for their non-appearance are not clear. However, information concerning the migratory routes of these fish and also of the extent to which they are taken by the commercial fishery is of considerable importance, hence a collection of 300,000 spring salmon eggs was made on the Cowichan this fall, the resulting fingerlings to be marked next spring.

During 1941, a third collection of spring salmon stomachs was made, embracing as many fishing areas as possible. The 1939 returns showed that herring and sand launce were the two most important food constituents; in 1940, pilchards entered the diet as well. It is expected that the findings from the examination of the 650-700 stomachs collected in 1941 will complete the study, except probably for investigations of individual areas.

COWICHAN RIVER INVESTIGATIONS

Salmon

The studies conducted by Mr. Neave on the coho and spring salmon runs to the Cowichan river, pertaining to propagation and migration, have been already dealt with in the preceding section. Reference should be made, however, to the records of the angling activity for spring and coho salmon in Cowichan bay, collected for Mr. Neave by observers during the late summer and fall (Aug. 23 to Oct. 31). Similar data were obtained in 1939 and 1940 and reveal the general size and character of the runs of these species to the Cowichan river.

During 1941 the number of anglers was greater than in either of the two previous years, representing 23,319 line-hours, as compared with 19,006 in 1939 and 16,707 in 1940. The total catch in 1941 - cohos and spring combined - was 5,731, slightly below the 5,782 caught in 1939 and much greater than the 3,472 taken in 1940. Expressed as number of line-hours per fish the three years' records are: 1939 - 3.3; 1940 - 4.8; 1941 - 4.07. In comparison with the escapement to the river the sport fish catch does not severely reduce the populations of either species of salmon.

Trout

One of the principal studies, with respect to the trout of the Cowichan system, is that of the migratory habits of the various species. Information has been collected largely from releasing and subsequently recovering marked individuals. The following data have been assembled over the past three years:

(1) For cutthroat trout the 101 recoveries to date have all been within a few miles of the point of liberation but they show local movements between the lake and the river and between the river and its small tributaries.
(2) For steelheads only 54 recoveries have been made from the 80,834 marked fingerlings liberated and all except one were from fresh water. Recovery of sea-running individuals is expected this winter.
(3) Of 2,976 rainbow trout liberated in January, 1941, nine have been returned, all near the point of release and of small size.
(4) For Kamloops trout, only 20 recoveries have been made from 74,161 individuals liberated. All were from the release of 33,097 fingerlings of the 1939 brood. Considerable dispersion throughout the river system had occurred but the paucity of returns is most striking.
(5) On the contrary, among brown trout, a return of 53 was obtained from a liberation of but 303 during April, 1939. All returns were within half a mile of the point of release. The fish had experienced remarkably rapid growth.

It is not anticipated that any further markings of trout will be attempted in the Cowichan system but efforts to recover those already marked and released will be continued.

The investigation of the steelhead runs in the Cowichan river was continued by Mr. Neave during the 1941 winter fishing season (January to March) and showed a reduced catch, on the basis of catch per unit of effort, namely one fish for 5.8 hours fishing, as compared with 4.9 hours in 1940 and 3.5 in 1939. The reduction in catch was apparently due to a relative scarcity of fourth year fish which in other years constituted the bulk of the winter run. The reduction in this year class is not considered to represent any depletion since the number of fish taken by anglers in recent years has constituted a small part only of the run.

MARINE FISH INVESTIGATIONS

Herring

The herring investigation has resolved itself largely into the collection and analysis of the data pertaining to the annual populations, both in the fishing areas and on the spawning grounds. The pertinent features thereof, such as abundance, availability, year classes and size, are studied and their significance evaluated. Certain studies are also being continued on migration of herring and the relationships of the various geographical stocks.

During the 1940-41 herring season the total catch amounted to over 94,000 tons, of which 76.7% was taken in the fishing grounds in the vicinity of Vancouver island, while the balance, 23.3% came from northern areas. In the previous year the larger catch of over 150,000 tons was taken as follows, 45% in waters adjacent to Vancouver island, 37% along the central coast line and 18% in northern areas. The decrease in 1940-41 is largely due to the general failure of herring to appear in the central and northern fishing grounds prior to the closure of the season. In the southern areas, on the contrary, the availability of the fish was much higher than in the previous year.

From 21 samples (2233 fish) taken from the strait of Georgia fishing grounds and 37 samples (3959 fish) from west coast of Vancouver island areas it was found by Dr. Tester that the herring were larger than in the two previous years, suggesting that in 1940-41 no precociously mature fish were present, as in the two former seasons. This was borne out by age analyses which revealed that the 1938 year class (III year fish) made up the bulk of the catch. For the Queen Charlotte sound area, at the north end of Vancouver island, (15 samples containing 1402 fish) great variation in age composition was found between districts. In general the fish from the area were small and they were also older, on the average, than those from older-established fishing grounds.

Studies of herring from northern areas by Dr. Boughton were somewhat less informative as far as comparison with former years is concerned because of the general scarcity of fish during the fishing season. Extensive scouting occurred and several new areas were exploited for the first time. Comparison of mean length and age with samples examined last year is possible in only five cases and the data indicate generally a decrease from the 1939-40 averages. It is suggested that this is due to the reappearance of younger year classes which failed during the previous year to appear in normal numbers.

Spawning ground studies were made by Dr. Tester in all areas, with the co-operation and assistance of Department of Fisheries officers. For the strait of Georgia the spawning appeared to be slightly greater than that of 1940 whereas on the West Coast of Vancouver island it was slightly lighter. In the Alert bay area it was also lower than in 1940 but northern areas showed perhaps a slight increase. These records are exceedingly valuable indices and an effort is to be made to improve their accuracy and significance.

One of the important contributions of the year has been the completion by Dr. Tester of a memorandum covering the five year test of a quota system of regulation for the herring fishery. Quotas were set up for both east and west coast of Vancouver island areas, old-established fishing grounds, and the general reaction of the herring populations to them assessed, it having been found that these major areas were almost completely segregated as far as intermingling of population was concerned. During the five-year period the east coast fishery has been fairly stable and limited by the quota but on the west coast the catch declined in 1938-39 and then increased. The quota was only reached in one year, 1936-37, therefore has not appreciably limited the catch. On the average the spawn deposition has been much less on the

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INDEX TO SUMMARY REPORTS FOR 1941

A.L. Pritchard

No. 1

Natural Propagation of Pink Salmon in McClinton Creek, Masset Inlet, B.C. - The Fry Migration in the Spring of 1941

The investigation of the natural propagation of pink salmon was continued in 1941 at McClinton creek, Masset inlet, with the count of the fry migrants leaving the stream in the spring. The data collected are now complete for six cycles, viz.- 1930-31, 1932-33, 1934-35, 1936-37, 1938-39, and 1940-41. The present report gives certain detail of this year's work and submits a general table of counts for comparative purposes.

The first fry migrating seaward was taken at the fence on February 11. Thereafter until March 6 only a few individuals appeared. From March 7, when 245 were taken, the numbers increased. The main portion of the run, amounting to over 70,000 per day, took place between April 3 and May 1, with a maximum of 571,000 on April 28. The migration was approximately two weeks earlier than usual, a condition reported as being fairly general on the coast and ascribed to the comparatively moderate autumn and winter conditions.

The counting fence was operated from February 11 until May 29, a total of 108 days. Water conditions were particularly favourable in that it was necessary to remove the screens on only four nights, - at 2.00 A.M. on March 23, and all night on March 6, May 15, and May 18. It was fortunate that two of these mishaps occurred early in the run when few fish were migrating and that the other two took place when the run was almost over. Even if the fish which escaped were neglected entirely, it is felt that the resulting error in the figure for hatching efficiency would be small. Estimates have been made, however, using certain incomplete counts and the general qualitative knowledge of the behaviour of the fry during migration. The figure is set at 28,000.

The total number migrating, 5,060,725, was calculated as follows: counted - 2,030,979, weighed - 2,995,746, and estimated - 28,000. Since the potential egg deposition was determined to be 26,500,000, the hatching efficiency can be seen to be 19.0.

The following summary includes the counts for six cycles at McClinton creek:

Year	Males	Females	Total	Av. No. of Eggs	Potential Egg Deposition	Fry Migrants	% Hatch
1930	32,955	33,198	66,153	1,535 ± 12	50,950,000	5,384,000	10.6
1932	8,003	7,599	15,600	1,758 ± 15	13,360,000	2,230,000	16.7
1934	77,477	77,710	155,196	1,799 ± 11	139,000,000	12,600,000	9.1
1936	24,221	28,091	52,312	1,899 ± 12	53,345,000	3,675,000	6.9
1938	5,549	5,028	10,577	1,698 ± 19	8,500,000	2,020,000	23.8
1940	19,071	16,454	35,525	1,619 ± 17	26,500,000	5,061,000	19.0

In a Summary Report for 1939 the writer pointed out the fact that the small spawning of 1932 had given rise to the high percentage hatch of 16.7, while that of 1938 produced 23.8%. Thus the relatively small deposition of both years was compensated to a certain extent by the raised efficiency. This advantage was further maintained this season by the 19% return. The fry migration was almost as large as that from the 1930 run where nearly twice as many eggs were involved.

A.L. Pritchard No. 1

General conclusions are certainly not warranted without the accompanying intimate discussion of the results. However, attention should be drawn to the fact that from the three relatively small egg depositions, namely,- 1932, 1938, and 1940, significantly higher percentages in fry migrants resulted. It is frankly admitted that these do not produce as many young fish in actual numbers. The phenomenon indicates, however, a strong resilience on the part of the species, and suggests that it may build up quickly from a reduced population.

A.L. Pritchard No. 2

Efficiency of Counting, Weighing and Estimating in Assessing Numbers of Pink Salmon Fry

In the preceding Summary Report, the total count of fry was shown as divided under three captions, viz.- counting, weighing, and estimating. The first two methods might be termed direct and the last indirect. In order to gain an idea of the general accuracy of the whole experiment, it is necessary to assess the efficiency with which all three procedures may be carried out. Each year, insofar as possible, experiments have been conducted to check. The following report summarizes the results obtained during the migration of 1941 and makes comparison with those of other years.

Counting - In the actual counting manipulation, a number of fry are placed in a shallow cheesecloth tray set in a trough filled with water. From this they are dipped with a dessert spoon three or four at a time into a deep wire basket which is also suspended in the same trough. Each hundred is rung on a tally hung in a convenient location. The method of checking involves having the complete crew of workers count out a number of fry which are transferred to a retaining trough, in this case in the eyeing station on the premises. Later a direct recount is made or the number is obtained when the fish are marked out. The difference in the two counts is taken as the possible error.

The following data were obtained from the 1941 experiments:

Date	First Count	Second Count	Error
May 2 & 3	10,156	10,196	+40 or + .4%
May 6	3,857	3,934	+77 or + 2.0%
May 8 & 9	4,520	4,471	-49 or - 1.1%
TOTAL	18,533	18,601	+68 or .4%

The error obtained in 1941 was slightly larger than that shown by the combined checks for 1933 and 1937, .4% as compared with .1%. It still remains so small as to be almost negligible, amounting in the total count of 2,000,000 fry to approximately 8,000 individuals.

A.L. Pritchard

No. 2

Weighing - The method of weighing which was employed this year was similar to that which was previously described in some detail in a Summary Report in 1939. Briefly, a number of fry were poured from a dip net into a wire basket and weighed on a Pelouse dairy scale. Certain of the weighed groups were counted before release while others were dumped without counting. From the ratio obtained between the weight and numbers in the groups counted each day, the fry released without counting could be assessed. Error was minimized by having the same operator carry out all the weighings in as nearly as possible the same manner.

To gain some idea of the accuracy, certain groups which would ordinarily have been dumped without counting were transferred to the hatchery troughs. Later, when the fish were being marked, the actual count was obtained.

The following table lists the results of nine such tests:

Date	Weight in lb.	Estimated No.	Actual No.	Error
April 19	8.37	13,905	13,844	- 61 or - .4%
" 19	8.47	14,071	13,938	-133 or - 1.0%
" 20	8.43	13,692	13,542	-150 or - 1.1%
" 20	8.70	14,131	14,061	- 70 or - .5%
" 21	8.92	14,347	14,548	+201 or + 1.4%
" 21	8.43	13,559	13,664	+105 or + .8%
" 22	8.57	14,087	14,013	- 74 or - .5%
" 30	12.25	19,159	19,973	+814 or + 4.1%
May 1	9.47	15,053	15,380	+327 or + 2.1%
TOTAL	81.61	132,004	132,963	+959 or + .7%

The errors listed above appear quite uniform with the possible exception of that obtained on April 30. In this case the large discrepancy may be due to the fact that near the end of the period of the pink salmon fry migration large numbers of coho and chum salmon fry make their appearance. The mixture of these three species of fry of different sizes lowers the accuracy of the operation.

If the nine experiments are gathered into one, the error amounts to 959 fish or + .7%, a figure which agrees very closely with that obtained from the combined data for 1931, 1935, 1937, and 1939, namely - + 1.1%. In 1941 when approximately 3,000,000 individuals were weighed, there was possibly an over-estimation of about 21,000 fry. This is an amount which is almost negligible in the calculation of the efficiency of hatching since such large figures are involved.

Estimating - The error caused in the final calculations by estimating the run of fry during the period when the fence is out will, of course, vary from year to year. In the spring of 1941 weather conditions were such that it was not necessary to remove the screens for any extended time. The fence did not operate for three complete nights. On March 6, the first of these, the migration was just beginning to increase and amounted to only 200 to 300 per day. On May 15 and 18 there were only 3 or 4 individuals showing every twenty-four hours. Partial loss

A.L. Pritchard No. 2

of count occurred on March 23 when the fence was lifted at 2.00 A.M. The fish which escaped were estimated by calculating the number taken per hour of darkness up to the time of lifting and multiplying that figure by the hours which remained before dawn. It is considered that, if anything, this assessment would be high because the fry are known to drop off sharply with the approach of daylight. In all the number which escaped without capture is set at 14,000.

If the error of estimation is considered to be double that which has been set, viz.- 56,000 instead of 28,000 -, the total discrepancy for the year could possibly be: counting - 8,000; weighing - 21,000, and estimating - 56,000 or 85,000 fry. This amount would change the figure for the efficiency of hatch from 19.0 to 19.3% which is a negligible quantity.

A.L. Pritchard No. 3

Pink Salmon Marking Experiments During 1941

During the autumn of 1940 recoveries were obtained from another marking experiment on pink salmon fry from McClinton creek, Masset inlet. The results have been presented in the Summary Reports for that year (No. 3, Page 3) and in Progress Report (Pacific) No. 48. Three facts were worthy of note. In the first place, at McClinton creek itself only 2.2 per cent. of the marked fry were recaptured as compared with 8.8 per cent. of the unmarked. In the second place, spawned out individuals lacking both ventral fins (the McClinton mark) were discovered in two other rivers tributary to Masset inlet. This condition, involving as it does, an emigration of marked fish from McClinton and the necessary acceptance of the belief of an immigration of unmarked fish to McClinton, was considered to account for at least a part of the discrepancy in proportion above noted. In the third place, a relatively large number of returns were received for the first time from south-eastern Alaska. As a result of these findings, it was recommended that further experiments be conducted to check the indications which had already been given.

The mark assigned for pink salmon fry at McClinton creek in 1941 by the co-ordinating agency for the Pacific Northwest was the adipose and both ventrals. This enabled separation from the previous cycle when both ventrals were removed. It also involved the use of more than one fin and thus reduced the chances of confusion with natural deformities. Unfortunately labour conditions were such that it was impossible to get men for marking who had been previously trained. The workers obtained experienced great difficulty in removing the adipose cleanly. This trouble greatly reduced the speed of manipulation and left the chance of confusion if the poorly cut adipose fins regenerated. Accordingly the use of the double ventral mark was again requested and granted. Although this is the same as that of the previous cycle, it is felt that no confusion can possibly arise since no pink salmon have yet been found which were older than two years.

During the early part of the downstream migration 2,469 fry were marked by the removal of the adipose and both ventral fins. The remaining 198,297 out of the total of 200,766 were marked by removing both ventrals

A.L. Pritchard

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only. Every effort was made to mark each day while the other fry were running. The number involved, however, made it necessary to mark most heavily at the end of the run when few fry were going to sea. This unavoidable procedure may slightly affect the proportionate return of marked and unmarked adults since the small numbers at the end of the migration may be more subject to predation. This problem is discussed in another report elsewhere in this series, viz.- W.M. Cameron - Mortality of Pink Salmon Fry During Downstream Migration.

Recommendations

The writer has pointed out many times that the returns from marking experiments are almost directly proportional to the energy expended in their collection. For this reason examiners should again be placed in representative canneries in 1942 as they were in 1940. Arrangements are again under way with the United States Fish and Wildlife Service to maintain one inspector in south-eastern Alaska and perhaps increase the number. More intensive efforts will be made to ensure that the cannery managers and other members of the industry as well as the officials of the Fishery Department are entirely familiar with the fact that returns are expected.

W.M. Cameron

No. 4

Some Physical Characteristics of Pink Salmon Eggs and their Relation to Redd Sampling

In the study of the mortality of pink salmon during its freshwater existence, one aim was to determine the percentage mortality during incubation and alevinage. This figure, calculated from the ratio of dead to live eggs and dead to live alevins, will be sensibly affected by any decomposition of the individuals to a condition in which there is differential recovery of live and dead. A certain amount of experimentation was therefore necessary to permit the correct interpretation of the material recovered from the digging.

During the winter and early spring of 1939-1940, tests were performed on coho salmon eggs at Cowichan lake in an attempt to determine the proper allotment of shells and egg fragments which were known to constitute a small proportion of every sample. A resume of the findings has been submitted in summary report No. 9 for 1940 (page 13). Throughout the winter of 1940-1941, similar and further experiments were conducted on pink salmon at McClinton creek. All the data are presented in brief herein.

1. The source of whole shells in the sample.

Breakage of live or translucent eggs results in the appearance of shells in the collecting net. These shells are typically clean, translucent, and exhibit a single split seldom embracing more than half the circumference. They may represent either live or infertile eggs which have not become opaque. Experimentation involving the crushing of samples has demonstrated that while individual variation is great, there is no significant difference in the resistance of the "chorion" of the two types to rupture.

The proportionate recovery of these categories under natural conditions was checked by burying known numbers of each together and digging them up in the normal way. The discrepancy favoured the fertile eggs very slightly but it was concluded that in the proportions which are known to exist in nature this difference would have no noticeable affect on the final figure.

2. The recovery of disintegrating eggs

Dead eggs are known to break at much lower pressures than live ones. Due to the coagulation of the yolk and subsequent infection by fungus, the shells are usually noticeably different from those of live eggs and can be so allotted. It was necessary, however, to check the possibility of lower recovery which might result from disintegration.

In the case of coho salmon, two lots of eggs were expressed from mature females. One of these groups was fertilized. At the end of six weeks in the hatchery, the infertile eggs were agitated to injure the vitellus and allow infection by fungus. One month later the infertile eggs were heavily fungused, soft and broke up readily when disturbed. Equal numbers (250 of each) of infertile and live eggs were counted out and buried together in the gravel of a small stream nearby. They were immediately collected in the normal manner. From the resulting material it was necessary to estimate the number of a great proportion of the infertile eggs by piecing together small fragments. The greater the fragmentation, the less was the relative recovery of the dead. The average figure for four experiments was .72 with a range from .64 to .90.

In the fall and winter of 1939-1940, closely similar experiments were carried out on pink salmon developing in the colder waters of McClinton creek. Here fragmentation was much less and from five tests the range was .94 to 1.00 with a mean relative recovery of .99.

About the middle of February, 1940, five attempts were made to determine the decomposition of eggs which had been killed during the pre-eyed and eyed stages. Instead of burying these samples, they were placed in a large tub with gravel and an effort was made to duplicate the amount of crushing which would occur in the process of excavation. The eggs were then washed into the net and the recoveries examined. In two cases more eggs were obtained than were used originally due probably to piecing together the dead eggs. The average relative recovery of .98 was not significantly different from perfect efficiency.

3. Recovery of dead alevins

Dead alevins were handled in a similar manner to the eggs recorded immediately above. The recovery from five experiments was .98 which was remarkably efficient.

Artificial conditions such as were represented in the experiments do not necessarily produce similar results to those present in nature. It was observed that some alevins recovered from redds showed relatively less growth of fungus than those which had been dead for the same length of time in the hatchery. A light growth might possibly be less effective in holding together the dead material and thus cause a lower recovery. The problem calls for more study in an effort to duplicate a variety of natural conditions. At the present time it is proven that the calculation of mortality from excavated collections should be made with caution but there is a general indication of the error involved.

W.M. Cameron

No. 5

Mortality of Pink Salmon Eggs During Incubation and Early Alevinage

In summary report No. 8, p. 11, for 1940, an outline was submitted of the beginning of a series of experiments designed to produce quantitative information on the losses occurring during the incubation and early alevinage of the pink salmon eggs in McClinton creek. Detail was submitted of the methods of marking the redds, the apparatus and manipulation involved in sampling, and the general treatment of the material. During the winter further digging was carried out until 84 redds were sampled. These were considered to be representative of most of the conditions present in the stream.

For each sample the eggs or fry were immediately designated as live or dead. The live eggs were then separated into two categories viz. 1 - shells and 2 - complete eggs and alevins. The dead eggs were recorded under 1 - shells, 2 - heavily fungused, 3 - pre-eyed, 4 - eyed and 5 - alevins.

To assist in the comparison of results it was considered advisable to calculate the pre-eyed mortality for each sample. This procedure involved the intelligent assignment of dead shells and heavily fungused eggs to their respective categories. The division of the dead shells in the same ratio as the unbroken, lightly-fungused eggs appeared most reasonable. Heavily fungused eggs were allotted in their entirety to the pre-eyed group. Undoubtedly this procedure is open to criticism but any other division produced, in isolated instances, peculiar values which did not seem compatible with the general situation.

A study of the pre-eyed mortality of the 84 redds demonstrated a great variation in the figure over the length of the sampled area (2.1 to 84.3%). It has been observed that there is a tendency for losses in neighbouring localities to resemble each other in magnitude. Isolated exceptions to this tendency are in some cases due to particular conditions peculiar to the small area in which the redd was situated.

It was beyond the capacity of an investigation such as this to dig all redds immediately before the fry emerged from the gravel. Comparison of pre-eyed mortality shown by the samples which were taken early with that of those dug before hatching, showed a difference which was such that it was felt that the mortality shown by the alevin samples was higher than would have been discovered if all the redds had been dug during alevinage. An attempt was made to calculate what the mortality would have been if the digging had all been delayed until just before emergence.

Plotting the mortality shown by the alevin samples against their pre-eyed mortality suggests a definite relation between them. A cubic parabola passing through the origin was fitted to the data and used to calculate the mortality which would probably have been exhibited if the early samples had been dug during alevinage. This method, though an approximate one, permitted the use of all of the available data in estimating the loss during incubation and alevinage.

A study of the derived mortalities in the form of a frequency distribution showed the mean "total" mortality in incubation and early alevinage to be in the neighbourhood of 30%.

Nine redds out of the 84 marked were destroyed by flood action shortly after deposition. The eggs were probably entirely lost. It might be suggested that they would lodge in the gravel downstream. Since, however,

W.M. Cameron No. 5

most of the erosion occurred during the early stages of incubation when the eggs are quite sensitive to jarring, it is possible that they might not survive the disturbance. The possibility of some of the dead eggs being recovered in the collection of other redds must not be overlooked but it is felt that such duplication will affect the average figure very little. The loss through erosion can therefore be approximated at 10%.

The mortality due to superimposition of redds was apparent but was probably largely evidenced in the figure given for redd losses, since the number of eggs uprooted and lodged in adjacent depressions did not make up a large percentage of the total deposition for the area. Five per cent. is considered a maximum limit and will include the eggs lost in spawning under conditions detrimental to their lodging in the redd.

W.M. Cameron No. 6

The Effect of Physical Conditions on Pink Salmon Eggs During Incubation and Early Alevinage.

In an effort to gain some idea of the effect of the physical conditions of the environment upon the incubation and alevinage of pink salmon eggs, certain observations were made and notes recorded for each of the sample redds which were marked and dug at McClinton creek during the autumn and winter of 1940-1941. Three factors were specially examined, viz.- the size of the gravel, the degree of water circulation, and the general condition of the redd with respect to silting and plant debris. Each of these items was graded according to the following legend:

Gravel:	A - Medium to coarse; B - Fine with a tendency to shift in changing currents, and C - Large rocks or boulders (usually associated with poor circulation, silting and plant debris).
Circulation:	A - Good; B - Fair, and C - Poor.
Condition:	A - Clean; B - Silt; C - Silt and plant debris (twigs, spruce cones, leaves, etc.), and D - Dead branches, logs embedded in redd.

Although these observations were strictly qualitative in nature, a study of the records in comparison with the mortality definitely demonstrated that the best conditions involved medium to coarse gravel, good water circulation and absence of silt or plant material. In some cases good returns were encountered where there was comparatively heavy silting but it is believed that this deposit was of recent origin (probably the result of a freshet) and had not had sufficient time to cause damage before digging was completed.

W.M. Cameron No. 7

Mortality of Pink Salmon Fry During Downstream Migration

Pink salmon fry, on emergence from the gravel after completion of alevinage, migrate downstream immediately. The movement to the sea takes place only during the hours of darkness. During the time taken to reach the salt water, the fry are exposed to the depredation of predators. An attempt was made to estimate the losses which might occur from these attacks.

Two methods of studying the problem were evident. The first considered was to examine the food of the predators. In order to reach a final figure for total predation in such a method, it would also be necessary to know the habits, abundance, distribution and behaviour of all the predators. The labour and time involved were manifestly impossible of attainment. The second method which was employed, was to release marked fry at intervals along the stream and calculate the mortality from the number of individuals which were later recovered at the fence near the mouth of the river.

The success of this second chosen method is dependent upon the minimizing of the detrimental affects of marking, transporting and releasing the animals, as well as insuring that they are released in such a way as to react normally. The choice of mark is controlled by the fact that it must be inexpensive and easy of application and of recognition among large quantities of fry, yet it should not handicap the fish in any way. Investigation of the use of stains, scarring, and branding were tried and rejected as unfavourable (Summary Report No. 10 for 1940, p. 14). To date the most satisfactory method was the insertion of variously-colored fine silk threads through the back of the fish under the dorsal fin. The operation was performed under anaesthesia induced by a dilute solution of chloretone. Recovery was rapid and complete. Recovered individuals did not give indication of greater loss than controls when maintained in the protected environment of the troughs.

The general procedure was to select fish at random, mark them and retain them overnight and through the following day in the hatchery. The following evening, when fully recovered, they were taken in quart sealers to the point of release particular care being taken to renew the water on the upstream trip. Retention at the point of liberation for twenty-four hours before release did not appear to affect subsequent mortality so the fish were deposited at selected stations and released on the downstream trip.

On recovery the "threaded" fry appeared to react normally but an effort was made to discover whether there was any differential mortality on exposure to natural conditions. At the beginning and end of the run when the nightly migrations were relatively small so that each fish could be closely examined, fry marked by the removal of fins were handled similarly and released at the same location as "threaded" individuals. For two experiments conducted on March 9 and 12 as the migration was increasing, no difference in susceptibility to mortality could be detected in the various lots. Toward the conclusion of the run (May 5 and May 6) similar tests were made with the result that it was demonstrated that the "threaded" fish were being lost in significantly greater proportion. The reason for the difference in the two sets of experiments is not definite. It is possible that under the degree of predation experienced early in the run (estimated at 50%) there is little or no selection by the predators. As the population of young in the river decreases, the "threaded" fry are taken in increasingly greater numbers. It is also sug-

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gested that the reason for the heavier mortality at the end of the run is an increased capacity in the predator whose appetite might be enlarged and whose diet, exclusively fry, was more limited. It was readily observable that the trout and coho fingerlings were concentrating above the fence, apparently moving down from the upper reaches.

Inspection of the findings suggests that the total recovery was in general determined by the time taken by the fry to get from the point of release to the fence. The more remote stations showed a lower total recovery. The rate of migration was not uniform throughout the season. When the height of the water was above normal, fish moved out more quickly and mortality was relatively smaller than on other days when the stream was low.

This demonstrable increase in mortality with distance travelled indicates the necessity for continual liberation in proportion to the entrance of all fish into the phase of the life history for which estimates are being made. Particularly is this true of fish being marked for migration experiments. The release of a greater proportion of marked fish under conditions tending to excessive mortality may lower the proportion of the marks in the population as a whole.

Realization of the interrelations of the factors causing mortality in a fry migration, prevents a too definite estimate of the losses experienced by the pink salmon in McClinton creek. It is considered however that the mortality should be fairly constant during the main portion of the run. For this reason the losses for the period between March 22 and May 3 are considered. If it is assumed that "threaded" fish during this time did not suffer disproportionately, the figure of 60 per cent. loss due to predation may be considered a reasonable estimate for the main portion of the run.

W.M. Cameron No. 8

General Consideration of Mortalities Occurring in Pink Salmon During their Freshwater Life.

Since the writer has for the time being discontinued the investigation of the mortalities occurring in the life of the pink salmon from the time when they enter fresh water to spawn (Autumn) until the time when the resulting fry migrate to sea (late spring), it is considered appropriate that a general statement of the findings should be made. The results derived from the runs of 1940 are therefore summarized.

Qualitative observations during the adult spawning runs and examination of spawned out females leads to the belief that loss occasioned by the action of predators on the fish and through incomplete spawning is relatively light. It is here placed at approximately 10 per cent. of the potential egg deposition. Mortalities due to the superimposition of redds one on the other was apparent but limited. Five per cent. is considered to be a maximum estimate of the proportion exposed by the action of late spawning females. Mortality due to disturbance without dislodgement will be included in the figure submitted for redd losses. Erosion has been suggested as causing 10 per cent. mortality, since 9 out of 84 redds were completely cut away while the eggs were in an early and

tender stage of development. Loss during incubation and alevinage has been fully discussed in another report and is set at about 30 per cent. No figure is available for the mortality due to non-emergence of fry but a study of water conditions at the time when this occurs and during spawning would lead one to believe that it is not severe. The loss of fry during migration due to predators is heavy having been set elsewhere at 60 per cent.

A tentative table is submitted outlining the estimates in their very approximate value and the proportion of the potential egg deposition which these values will affect:

Mortalities	Percentage of eggs or fry available	Percentage of potential egg deposition	Percentage eggs or fry remaining
Predation on adults and incomplete spawning	10	10	90
Exposed by superimposition	5	5	85
Erosion	10	8	77
Incubation and alevinage	30	23	54
Fry predation	60	32	22

The agreement of the final figure (22%) with 19 per cent. which was the actual efficiency obtained from the enumeration of the runs, is closer than one might expect from the approximate nature of the estimations and should not be accepted as any indication of their accuracy. The study suggests, however, that increase in efficiency may be in the direction of predator control and stream improvement. Decreasing the predator populations should result in an increase in the numbers of fry. In such a programme, however, consideration would have to be given to the fact that some of the predators might be economically valuable in themselves and that the so-called ecological balance might be upset.

The information also suggests that the numbers of adult individuals constituting the spawning escapement may not be the only factor influencing the assurance of an adequate fry migration. In general early migrating adults spawn before those that enter the stream at the end of the run. If these give rise to early-running fry, they may be less subject to predation than those which come later. The establishment of a concentrated spawning period might reduce the effect of predation but might increase losses due to fish having to spawn in unfavorable locations.

Since escapement, predator control, and stream improvement appear to be intimately associated with efficient conservation, continued observation on their interrelation would seem highly desirable.

A.L. Pritchard No. 9

Racial Studies on Pink Salmon

In the Summary Reports for the Pacific Biological Station for 1940 (No. 11, page 15), a brief synopsis was submitted of a proposed investigation to determine whether so-called racial differences existed between pink salmon runs of different streams. The characters selected to indicate such differences, if they existed, were the number of gill rakers on the first gill arch, and the number of pyloric caeca.

During the 1940 season collections were made from eight streams on the Queen Charlotte islands. The counts and analyses have now been completed and a summary is submitted herein.

GILL RAKERS

In the following table are presented the numbers used in each collection, the ranges and the average.

	Number	Range	Average
McClinton creek	136	27-33	30.32
Deenan river	58	28-33	30.55
Yakoun river	100	27-34	30.22
Mammon river	98	28-34	30.40
Detlamen river	65	28-34	30.34
MASSET INLET	457	27-34	30.35
SKIDEGATE INLET (Haan's cr.)	24	27-32	29.83
CUMSHEWA INLET (Palent cr.)	79	28-32	29.94

If the probable errors of each average are considered in the comparisons, no significant difference exists in number of gill rakers between the collections from any of the rivers in Masset inlet nor between those from Skidegate inlet (Haan's creek) and Cumshewa inlet (Palent creek). A difference was demonstrable between the whole sample from Masset inlet (on Graham island) and that from each of the other inlets on Moresby island. A similar difference was noticeable in most cases when individual rivers from these larger areas were considered.

PYLORIC CAECA

The data for the pyloric caeca counts are tabulated below:

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	Number	Range	Average
McClinton creek	128	106-163	133
Deenan river	55	108-166	131
Yakoun river	104	111-166	133
Mammon river	95	111-156	136
Detlamen river	68	106-160	134
MASSET INLET	450	106-166	134
SKIDEGATE INLET (Haan's cr.)	10	107-128	114
CUMSHEWA INLET (Palent cr.)	79	106-195	136

No significant differences in the pyloric caeca counts can be demonstrated from the above samples with the exception of Haan's creek compared with all the other streams. Little reliance is placed in this variation because the sample used is of such a small size.

In summary the material thus far gathered permits of no definite conclusions concerning racial differentiation in pink salmon. Variations are indicated between rivers in the gill raker counts but none are evident in the counts of caeca. In order to pursue the matter further samples have been taken from southern British Columbia during the present year, viz.- Morrison creek, tributary to Puntledge river on the east coast of Vancouver island, - 100; Harrison river near Harrison rapids, tributary to the Fraser river - 110; Harrison river below railway bridge - ca. 25; Chehalis river, tributary to Harrison river, - 100; Lorenzetti creek, tributary to the Fraser near Hope - 100, Sucker creek, tributary to the Coquahalla river at Hope, - 69. This total of approximately 400 samples is now being worked over.

A.L. Pritchard

No. 10

The Age of Chum Salmon in British Columbia

In a Summary Report for 1940 (No. 12, page 16) the writer pointed out the desirability of making available information on the age of the chum salmon in journals which could easily be procured by the members of the fishing industry and the conservation authorities. The first step in accomplishing this aim was to locate and summarize the data which have already been collected. The second necessity was to obtain further collections from areas which have not been represented and to duplicate in other districts for comparative purposes.

To date approximately 4,600 determinations have been discovered for the following localities: Qualicum, Nanaimo, Chemainus, north coast of the Queen Charlotte islands, and Nootka sound. During the season of 1940, 332 scale samples were collected from fish taken on the east coast of Moresby

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island, Queen Charlotte islands. During 1941 more material was procured with the help of certain canneries as follows: 400 sets of scales from Athlow bay on the west coast of Graham island, Queen Charlotte islands, through British Columbia Packers Pacofi cannery, 180 from the Barkley sound district, west coast of Vancouver island, through British Columbia Packers Kildonan cannery, 542 from the Nootka sound area, west coast of Vancouver island, through Nootka Packing Company's Nootka cannery, and approximately 100 from the strait of Georgia through British Columbia Packers Imperial cannery. Our thanks are extended for the fine co-operation which has been received in this experiment.

The actual examination of the scales and the summarizing of the material is somewhat tedious and will probably consume two to three weeks time. It is hoped, however, that this period will be available during the coming year so that the data on the complete series of approximately 6,000 samples may be presented.

R.E. Foerster and A.L. Pritchard No. 11

Relation of Egg Content to Total Length and Weight in the Sockeye and Pink Salmon

In the course of the investigations of the natural propagation of the sockeye and the pink salmon in British Columbia, it was necessary to make counts of the eggs contained in a sample of mature females to allow the calculation of an average per individual. From this average and the total number of females in the run, the potential egg deposition was calculated.

The following sockeye salmon were handled at Cultus lake, British Columbia: 1932 - 46; 1933 - 47; 1934 - 75; 1935 - 55; 1937 - 35, and 1938 - 47. In addition 112 females bearing the distinctive Cultus lake mark were taken from the fishing areas in 1933. The total involved was thus 417. For pink salmon at McClinton creek, Masset inlet, British Columbia, the following were employed: 1930 - 97; 1932 - 73; 1934 - 165; 1936 - 91; 1938 - 40, and 1940 - 70, or a total of 536.

All the eggs in each ovary were counted, particular care being exercised to consider only specimens with unbroken ovaries. In order to avoid the introduction of age as a variable factor, only sockeye in their fourth year were considered. This age-class includes the majority of spawners at Cultus lake, and therefore, where the separation on the basis of age was impossible, it is not believed that any appreciable number of older or younger fish was included. Since all pink salmon thus far encountered have been found to mature in their second year, no similar difficulty was apparent.

For both sockeye and pink salmon females, there is a significant positive correlation between the number of eggs contained in the ovaries and 1 - the total length (from the tip of the snout to the middle of the fork of the tail), and 2 - the total weight. The yearly mean number of eggs for the runs, when plotted, show similar trends of increase in each species.

Inspection has shown that for any run the straight line obtained from the original data by the method of least squares, the regression line of eggs on length and eggs on weight calculated from the correlation coefficient

and the "power" curve obtained by applying the method of least squares to the number of eggs and the logarithms of the lengths and weights, for the ranges exhibited, fell very closely together. For this reason the straight line equations were employed for comparisons.

For both species it was evident that the differences in these lines from year to year were not statistically significant, but merely the result of the inherent variability of the sample. Generalized relationships were therefore worked out by calculating the equations of the straight lines for all the data for each species by using the method of least squares on the mean egg numbers for the various length and weight groups. These lines showed that for the ranges involved, for each centimetre increase in length and for each gain of one kilogram in weight the number of eggs rose for sockeye 135 and 1,100 respectively, and for pinks 57 and 472.

Two important implications are suggested:

1. - In the exploitation of salmon any effort which tends to remove larger fish will proportionately reduce the egg deposition and thus militate against the normal conservation of the species.
2. - Since egg content varies directly with size, due caution must be observed in using data pertaining to this characteristic to indicate racial differences between salmon in various streams. Variation as a result of sampling may be sufficient to demonstrate a significant difference between two separate collections from a given run in the same year.

Ferris Neave No. 12

Natural Propagation of Coho Salmon in Tributaries of the Cowichan River

In continuation of previous investigations, a record was kept of the spawning run of 1940-41 in Oliver and Beadnell creeks, two small tributaries of the Cowichan river. Counts were again made of the fingerlings descending these streams between the beginning of March and the end of August. The work entailed the part-time assistance of one man during about six months.

Figures for the upstream migration of adult fish were as follows:

	Oliver	Beadnell
Total no. of cohoes	810	99
No. of females	293	39
Dead, spent and stripped females	46	1
Females remaining	247	38
Eggs presumed available for deposition at 1,950 per female	481,650	74,100

Downstream migrants resulting from these eggs were counted as follows:

	Oliver	Beadnell
Number of fingerlings	146,279	22,274
Percentage of presumed deposition	30.37	30.06

A few fish remained in Oliver creek when the necessity of providing for the passage of upstream migrants in the fall of 1941 made counting impracticable.

A record was kept of potential predators appearing in the traps with the young cohos. These included yearling cohos and yearling and older brown trout, cutthroat, steelhead and char, in the following numbers:

	Coho	Brown	Cutthroat	Steelhead	Char
Oliver	560	33	608	37	5
Beadnell	1,061	183	316	85	0

While it would seem that the small population of Beadnell creek supported the heavier total population of predators, conclusions on this point would have to take into account the size of individual predators and the relative destructiveness of different species. The cutthroat appears to be the greatest consumer of first-year cohos.

A comparison between the production of cohos in 1941 with findings in previous years is appended.

Ferris Neave

No. 12

	Oliver		Beadnell	
	Potential deposition	Percentage trapped as fingerlings	Potential deposition	Percentage trapped as fingerlings
1939	330,176	14.42	-	-
1940	665,280	11.84	433,440	40.01
1941	481,650	30.37	74,100	30.06

Ferris Neave

No. 13

Return of Marked Cohos of 1937 Brood Year

The 1940-41 coho run in the Cowichan river included fish which had been marked as fingerlings at the Cowichan lake hatchery. Records of these marked cohos from salt water were given in a summary report, 1940. Data regarding the number returning to certain spawning grounds are presented herewith. This information was obtained mainly in connection with the investigation outlined in the previous report.

The marked fish (25,739) were the hatchery-raised product of 146,277 eggs collected from seventy-four females entering the Oliver creek and Beadnell creek traps in the run of 1937-38. They were released in the upper Cowichan river in the fall of 1938 and spring of 1939.

In the spawning run of 1940-41, 315 marked fish were trapped in the two creeks from which the eggs had been taken, this number representing 36.7 percent of the total run of 858 fish of this brood year. Since the eggs from which the marked fish were derived represented only 19.4 percent of the estimated deposition in these streams, mortality of the hatchery fish would seem to have been considerably less than that attending natural propagation in this instance.

An additional twenty-five marked cohos were caught in the upper Cowichan river, thus accounting for 340 which had reached the neighbourhood of their spawning grounds. In view of evidence (through tagging of fish caught in the river) that a considerable number of marked fish did not enter Oliver or Beadnell creek, it is unlikely that fewer than 400 returned to the upper Cowichan river. This would represent a return of 1.55 percent of the fingerlings released, or 0.273 percent of the eggs collected.

It may be added that eight cohos bearing the proper marks of the 1937 brood year have appeared in the 1941 run to these streams. It is tentatively concluded that these fish, or some of them, are cohos which have waited until their fourth year to return to fresh water.

Ferris Neave

No. 14

Return of Marked Cohos of 1938 Brood Year

Hatchery-raised fingerlings released in the Cowichan lake pool in October, 1939 were marked as follows:

Lot 1. Offspring of third-year males and females, 23,544, adipose and both ventrals removed.

Lot 2. Offspring of third-year females and second-year ("jack") males, 8,567, dorsal and adipose removed.

Six from lot 1 and three from lot 2 were recovered as jacks in the run of 1940-41 at or near the point of liberation.

Further data regarding marked fish have been obtained in the summer and autumn of 1941 by the present writer in collaboration with Dr. A.L. Pritchard.

Recoveries reported from salt water are as follows:

Lot 1.

Locality	Date	No. of returns
Swiftsure banks	July	3
Cape Flattery	July, August	4
Porlier pass	July	1
Hornby I.	July	1
Cape Lazo	July	1
Ucluelet	August	1
Neah bay	September	3
Point Roberts	October	1
Cowichan bay	September, October	6
	Total	21

Lot 2.

Crofton	December, 1940	1
Kyuquot	August	1
Camano I.	September	1
Cowichan bay	April, October	4
	Total	7

Nine marked fish (of both lots) were reported from a total of 3,560 cohos landed at Cowichan bay between August 23 and October 31.

Return of marked fish to the Cowichan river system was investigated at Skutz falls in September and October and subsequently in certain tributary streams near Cowichan lake. At the former locality 1,189 cohos (including 67 jacks) were obtained, mainly by dip-net. These included twenty-two marked fish of lot 1 and seven of lot 2. Operations here entailed the attention of three men (including an investigator) for two weeks and the part-time presence of an investigator and an assistant for an additional two weeks. All fish

Ferris Neave

No. 14

secured were tagged for the purpose of securing data regarding the size of the run and the percentages of marked and unmarked fish appearing subsequently on certain spawning grounds near Cowichan lake.

Interim figures relating to the spawning runs in Oliver creek and Beadnell creek (from which the eggs were originally obtained) are as follows:

Number of unmarked cohos (excluding jacks)	197
" " marked "	142
Lot 1.	52
Lot 2.	90
Percentage of marked fish in runs	41.9

It is probable that less than half the total run has entered the creeks to date. The investigation is being continued and observations are being made on other tributaries of the Cowichan river system.

A.L. Pritchard and A.L. Tester

No. 15

Studies on the Food of the Coho Salmon in British Columbia

During the three years, 1939, 1940, 1941, during which collections of salmon stomachs have been made from fish taken in the commercial catches, although the major attention was paid to the spring, a goodly number of cohoes have also been received. These amounted to 44 in 1939, and 131 in 1940. The returns for 1941 are not yet complete but it now appears certain that a sizeable quantity will be on hand for inspection. The food items have been examined in a similar manner to those contained in the spring salmon.

The following organisms have been identified: Coho salmon (Oncorhynchus kisutch), Lantern fish (Lampanichthys nannochir), Pacific herring (Clupea pallasii), Pilchard (Sardinops caerulea), Anchovy (Engraulis mordax), Sand lance (Ammodytes personatus), Capelin (Mallotus catervarius), Saury (Cololabis saira), Black cod (Anopoploma fimbria), Whiting (Theragra chalcogramma), Hake (Merluccius productus), Rockfish (Sebastodes sp.), Red feed (Euphausida), Amphipods, Isopods, Crab larvae, Goose Barnacles and Velella (Coelenterate).

No attempt should be made to draw definite quantitative conclusions from the data. Such a course is unjustified on the basis of only 175 samples. It may be stated, however, that a wide range of organisms is included in the diet. In addition although fish appear in great numbers, invertebrates occupy a more important proportion than they do in the case of the spring salmon. These studies are being continued in co-ordination with those on the related species.

A.L. Pritchard

No. 16

Spring Salmon Marking Experiments

During the year 1941 returns were expected from 25,000 spring salmon fingerlings from the brood year of 1937 and a similar number from the brood year of 1938. These were marked on the Cowichan river, the former by the removal of the adipose and right ventral fins and the latter by the removal of both ventrals only. Up to the present no returns have been received.

Several reasons can be advanced for the lack of recoveries. In the first place, the numbers marked each year were comparatively small. If mortality were heavy, only a few individuals could be expected to appear in the commercial fishery and these might easily be overlooked. There is no place on the Cowichan river itself where the springs may be racked and examined. The second explanation of the failure may be in the lack of sufficiently wide advertising of the experiment. At the time of marking the main object was to obtain some idea of what fish were taken in the game fishery in Cowichan bay. The contribution of the Cowichan to the general commercial catch was not under examination. Thus though extensive inspection was made in Cowichan bay itself, other areas were neglected. The third interfering factor was the change in the spring salmon fishery. During recent years individuals of the species have been used principally for the fresh and mild-cure market. In this field extreme care is exercised to procure fish in good condition without blemish (lacking scales or with cuts). If springs are in poor shape or injured, they are immediately graded down to half price or even less. Trollers therefore are chary of removing fin-scars. As a matter of fact they prefer not to report them. A fourth explanation may be that since these fish were held until August before marking, they may well have been retained beyond the time when the natural stimulus to go to sea normally occurs. They may therefore remain at sea an extra year and return next fall, 1942.

In spite of the lack of returns this year further marking experiments are desirable. The spring salmon fishery is highly important and as much information as possible should be obtained to allow sane and efficient regulation and conservation. Not the least important of such data are the migration routes of the various runs. It can readily be realized that no sensible restrictions for a certain river population could be placed unless it was known where the fishery exploited it. Furthermore, with the increase of industrial development on the Columbia river - dams, diversions etc. - some fear is felt for the maintenance of its run which is one of the most important on the coast. It is now an opportune time, therefore, to assess the contribution of a river such as the Cowichan to the general fishery. Although we hope the situation may never arise, it may be that such rivers will eventually be the main support of the industry.

The difficulties listed are not entirely insurmountable. More fish should be marked in any given experiment. Allowance for this has been made by collecting approximately 300,000 spring salmon eggs on the Cowichan this year. A thorough advertising programme should be conducted so that no one will be unfamiliar with the fact that recoveries are expected. A beginning was made during the present year but due to circumstances beyond control, the time at which the start was made was too late. In the next year it is hoped that through the co-operation of the Department of Fisheries, a letter may be handed to each troller who gets a license. During the winter the whole matter will be discussed

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with as many fishermen's organizations as possible and the industry will be fully informed. The actual collection programme will have to be revised to suit the new conditions of the fishery. In this it is hoped that the usual co-operation of the fishery officers and the buyers may be forthcoming. The fisherman can report the mark to the buyer who can keep it separate until inspection can be made by a fishery officer or other accredited examiner. It will thus be unnecessary to damage the fish in removing the scars.

It should be stressed that this effort should be as widespread as possible. There have been at least 50 spring salmon marking experiments carried on in Washington, Oregon and British Columbia from which returns are expected. Every pressure should be exerted to obtain recoveries which will furnish so much valuable information. Already the co-operation of the Washington State Fisheries Department and the United States Fish and Wildlife Service in collecting and paying rewards has been unstintingly offered. No doubt much time will have to be used in advertising and collecting but it would appear that the results would justify the effort expended.

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Studies of the Food of Spring Salmon in British Columbia in 1941

This is the third year in which spring salmon stomachs have been collected from fishes taken in the commercial catches throughout the fishing areas in British Columbia. During 1939, 333 samples were taken, and during 1940, 467. The results of the analyses have been summarized in Progress Reports (Pacific) No. 42 and 47 respectively. As a result of the analysis in 1939, it was discovered that herring and sand launce were the two most important food items. Red feed (Euphausids) assumed some prominence in certain districts such as Kyuquot and Barkley sounds. Other fish were taken in considerable numbers. The proportion of the various foods in the diet varied from area to area and from month to month. In 1940, herring, sand launce and pilchards appeared as the three most important items. The addition of pilchards was undoubtedly due to the unusual appearance of large amounts of small individuals of the species along the coast during the spring and summer of 1940. Other conclusions drawn in 1939 were confirmed.

In 1941, an increased effort was made to enlarge the scope of the experiment by increasing the number of collectors, by extending the range of collection, and by thus making available more stomachs for examination. The table which follows will present a comparison of the effort for the three years:

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Area of Collection	Number of Collectors 1939	1940	1941
Queen Charlotte is. and Prince Rupert areas	6	7	7
Central British Columbia	1	4	3
Strait of Georgia	0	1	5
Cowichan bay	0	1	1
Saanich inlet	0	0	2
Sooke and Victoria	0	0	2
West coast of Vancouver island	2	5	5
	9	18	25

A few collectors have still to make returns but the following have now been received:

Queen Charlotte is. and Prince Rupert areas	149
Central British Columbia	65
Strait of Georgia	51
Cowichan bay	62
Saanich inlet	2
Sooke and Victoria	17
West coast of Vancouver island	309
	655

It is possible that some of the stomachs listed will be found to be devoid of food. In addition a few cohoes may be included. It is fairly certain, however, that the collection will be larger than those of the preceding years and that it will embrace a wider range of territory. To date only about thirty stomachs have been examined from the west coast of Vancouver island with no outstanding discoveries.

Recommendations

It must be realized that an experiment such as this has its limitations. The samples obtained from selected individual fishermen at best can only give a sound representation of the food of the spring salmon taken in the commercial catches during the fishing season. It is not the final statement of the diet throughout the life of the fish. Undoubtedly the gear is selective taking mostly larger individuals. Some seasons of the year are not represented. To extend the collection in order to complete the information would involve setting up a major programme, and entail quite sizeable expenditures of money. Until the Fisheries Research Board considers that this is necessary, it is recommended that the investigation be discontinued. The work of the three years has given as much general information as can be expected under the limited conditions.

Ferris Neave No. 18

The Salmon Angling Fishery in Cowichan Bay

In 1941 a record was again kept of angling activities in Cowichan bay. It is felt that these records provide valuable information regarding the relative size and character of the annual spring and coho runs to the Cowichan river and in the case of the latter species an opportunity is afforded for noting the incidence of marked fish among the migrants.

Landings of marked fish and data relating to angling effort were obtained through voluntary assistance from June 4 until August 25. Thereafter, until November 9 an observer was continuously employed. The following statistics were obtained.

	Boats	Lines	Line-hours	Springs		Cohos		Total
				Large	Jacks	Large	Grilse	
June	109	198	558	93	3	16	22	134
July	181	318	838.5	170	2	8	187	367
Aug.	680	1,227	3,477	394	30	19	247	690
Sept. 2	2,015	3,692	11,988.5	824	312	1,205	367	2,708
Oct. 1	1,259	2,451	8,825.5	32	19	2,336	234	2,621
Nov.	78	141	464	0	0	117	5	122
	4,322	8,027	26,151.5	1,513	366	3,701	1,062	6,642

The following table shows comparative figures for three years for the period August 23 to October 31, this period including the most important part of the fishing season.

	1939	1940	1941
No. of boats	2,803	2,464	3,758
No. of lines	5,278	4,629	7,005
No. of line-hours	19,006	16,709	23,319
No. of springs (large)	553	1,121	1,069
(jacks)	750	292	357
No. of cohos (large)	3,410	1,899	3,560
(grilse)	1,069	160	745
Total fish	5,782	3,472	5,731
No. of line-hours per fish	3.3	4.8	4.07

The number of anglers engaged in 1941 was apparently greater than in either of the two preceding years. Cohos were undoubtedly much more plentiful than in 1940 and spring salmon were also present in large numbers.

The fishery does not appear to have any serious effect in reducing the size of the spawning runs to the Cowichan river.