



FISHERIES RESEARCH BOARD OF CANADA

REPORT OF THE  
PACIFIC BIOLOGICAL STATION  
NANAIMO, B.C.  
FOR 1943

BY R. E. FOERSTER, DIRECTOR

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During 1943 the investigations of the salmon, herring, pilchard, lingcod, oyster and clam fisheries were continued. These studies, representing the further advancement of relatively long-term problems are now showing special significance due to the fact that with exploitation of most of the fisheries concerned practically at a maximum, their future depends largely upon proper management. This in turn, must be based on essential scientific knowledge of the present status of each fishery, the trends over the past few years and the more important controlling or limiting factors.

Continued attention was given to certain of the minor fisheries. Catch statistics for the eulachon fishery of the Fraser river were assembled, further recoveries of tagged dogfish were reported and recorded, and, in a co-operative research programme with the Department of Pensions and National Health, the occurrence of toxic products in butter clams and sea mussels was investigated.

During the year a comprehensive pink salmon tagging programme was undertaken in southern British Columbia, in co-operation with the Washington State Fisheries Department, and an investigation of the otter trawl fishery of the strait of Georgia was commenced. The hydrographic study of Alberni inlet with special reference to pollution possibilities was completed with the working up of the mass of data accumulated since 1938.

An appreciable amount of consideration was given, during the year, to the problems of Post-war Reconstruction and Rehabilitation in so far as the fisheries of the Pacific Coast and the advancement of fisheries research are concerned. As remarked above, certain of the major fisheries of the coast, viz.- salmon, herring, pilchard, seem at the present time to be fully exploited. Little increase in fishing to swell employment seems possible without running the danger of reducing the income first of the individual fishermen and eventually of the whole class. Much, of course, depends upon the extent of markets and prices available for our fishery products after the war but it seems reasonable to assume that the changes will not be in the direction of a much greater demand or a higher return to the fisherman.

In the case of our major fisheries, therefore, e.g., the salmon and herring, the problem is essentially a case of endeavouring to stabilize exploitation within the limits of optimum production. This can hardly be achieved without adequate biological knowledge of the fish and the trends in the fisheries. Such studies are now being conducted to the extent of our means but their extension to cover all species and all areas is strongly recommended.

Any increase that might be brought about in our Pacific fisheries would seem to involve either the extension of present effort to less readily accessible areas, such as lingcod, dogfish, flatfish and shellfish fishing off the west coast and in northern districts, or the greater development of those at present not widely exploited, such as the rockfish, flatfish, oyster, abalone, scallop, shrimp and crab fisheries in all B.C. waters. We require at the present time a fuller knowledge of the general distribution and abundance of these forms in coastal waters and a study of the possibilities of stimulating their more wide-spread exploitation as a seasonal part-time fishery either for local consumption or for utilization as specialty products.

These various developments involve initially carefully planned extensive field surveys throughout the year, with trawling, dredging and shore collecting the main features. Suitable boats would be required and adequate personnel of whom the majority need not be scientifically-trained. It has long been apparent that such an appraisal of the resources of the coast should be undertaken. By no other means can we have available detailed knowledge of the coastal areas indicating the general distribution of the various food forms, the extent of their abundance and their potential utilization. Without this information any properly planned system of exploitation would be difficult to achieve.

Correlated with such surveys and closely related, too, to a clearer understanding of the factors affecting the variations in distribution and abundance of our food fish species is the development of a comprehensive oceanographical research programme. This should include studies of currents, effects of land drainage, variations in temperature and salinity condition from year to year, plankton analyses and their seasonal and annual trends and variations, and the interrelationship of forms one to another. There is great scope for such work. Perhaps it should be confined initially to the more accessible and more highly exploited areas, such as the strait of Georgia, yet similar studies in the ocean adjacent to the west coast should not be overlooked, for their relation to the migrations of fish along the coast may be highly significant.

#### STAFF

During the year two new appointments were made. In July Mr. J. Cameron Stevenson, M.A. (Saskatchewan) joined the staff as Scientific Assistant in Biology, replacing Dr. Boughton, and will be associated with the herring investigation. In September Mrs. A.M. Kelly, B.A. (Saskatchewan) was engaged as Scientific Assistant in Chemistry replacing Mrs. M.K. Thomas (nee Merriam), M.A. (Dalhousie) who resigned in May. During July and August Mr. V.K. Chapman, M.A. (British Columbia) was employed as Scientific Assistant in Chemistry.

In November the Board acceded to an urgent request from the Department of Naval Service for the loan of the services of Mr. Tully, Scientific Assistant in Chemistry, for special work, Mr. Tully to remain on the staff of this Station and to continue his work there, with whatever extra assistance required to be supplied by the Naval Service.

The complete list of the scientific staff is given at the end of this report.

#### BUILDINGS

During November a special fire-proof library vault was constructed in the basement of the Administration building, the main purpose being to remove the valuable Station library as well as important files from the present second-storey quarters to a more secure, fire-proof location. The new facilities provided are an emergency measure only and will suffice until a new building can be obtained to meet more adequately the needs of the Station at the present time. The main administration and biological building as well as an adjoining museum and laboratory, both of wooden construction, are almost 35 years old and definitely a fire hazard. A new Station building of all weather and fire-proof construction and designed to accommodate all of the staff is urgently needed.

#### EQUIPMENT

The very practical value of using an echo sounder to detect and survey the position and size of schools of herring has been clearly demonstrated by Dr. Tester's experiments. It is believed that the instrument can be very helpful to the herring industry.

For similar reasons the provision of an echo sounder for Station use would very materially assist not only the herring investigators but also the lingcod and other trawl fishery studies in revealing the position, size and shape of reefs and the condition of trawling ground. It would be of definite value, too, to the Department in revealing the abundance of herring in deep water in the many collecting areas of the strait of Georgia and enable the officers of the Department to survey and estimate the relative size of the herring populations when requests for extensions were made.

If funds can be made available, therefore, installation of an echo sounder on the "A.P. Knight" would be strongly recommended as a very useful and valuable piece of equipment for many investigations, particularly the herring.

#### PUBLICATIONS

Four issues of Progress Reports appeared during 1943. They contained eleven contributions from this Station. Five scientific papers appeared during the year in the Journal of the Fisheries Research Board, one was included in the Canadian Pacific Fauna series and four were issued by outside publications. Two bulletins were prepared and published. In addition two manuscripts have been submitted for publication in the Journal, two are in press in the Transactions of the Royal Society of Canada and one Bulletin ms. has been accepted. A list of the Station's publications is appended hereto.

### ACKNOWLEDGEMENTS

During the year the Station continued to enjoy the active co-operation of both the Federal and Provincial Departments of Fisheries. The latter again contributed financially to the herring, pilchard and shellfish investigations. More and more the field officers of the Federal Department are being relied upon to supply local information and to conduct field observations within their respective areas. This service and co-operation has always been readily forthcoming and is herewith gratefully acknowledged.

During the herring spawning season the British Columbia Packers Limited and the Canadian Fishing Company again provided seine boats for tagging work and spawning ground surveys. In addition these two companies allotted space in their Steveston plants for the induction tag detectors and helped materially in their installation. Sincere thanks are extended for this generous co-operation. All companies willingly assisted in the collection and submission of the necessary statistics pertaining to the various studies.

In obtaining supplies of pink salmon for tagging the following fishing companies assisted materially in providing fish from the commercial catches: British Columbia Packers Limited, Canadian Fishing Company Limited, Nelson Bros. Fisheries Limited and J.H. Todd & Sons Limited. The latter firm, in addition, undertook the tagging at Sooke, through their trap employees. Deep appreciation and thanks are extended to all those concerned for this valuable help.

Grateful acknowledgement is also made of the very helpful co-operation given by the Washington State Fisheries Department through its Director, Mr. Fred J. Foster and its Biologist, Mr. J.A. Craig. The great value of such co-operative effort has been especially indicated in the joint pink salmon tagging work but has also been apparent in the recovery of marked salmon and in the dogfish tagging experiment.

### INVESTIGATIONS

Brief resumes only of the various scientific investigations conducted by the Station are given. Fuller and more detailed reports are contained in the investigators' summaries which appear as appendices hereto.

Salmon. During 1943 research on the Pacific salmon was again confined chiefly to the pink and coho salmon under the direction of Dr. A.L. Pritchard. Its main purpose continued to be the clearer elucidation of pertinent phases of the life history, particularly those which might vary appreciably from year to year and which might have a definitely direct effect on the abundance of the fish or their availability to the fishermen. The variations which occur in the efficiency of natural propagation and the causes thereof form important studies while others relate to migratory habits of the fish, for example, the probable extent of migration, the routes taken in the mass movement from the sea to the rivers, the proportional catch in different areas and by different types of gear, the percentage return to the river system and the distribution within the river.

Pink salmon. With the closing down of the studies at McClinton creek, Masset inlet, a new experimental area in southern British Columbia waters was selected, namely Morrison creek, flowing into the lower reaches of the Puntledge river near Courtenay. This was formerly an important pink salmon area and Morrison creek itself possesses a sizeable run which occurs in the odd year, 1941, 1943, etc. Data obtained here should be not only of value in themselves as indicating the variations in conditions prevailing in southern waters but also of particular interest in offering comparison with results obtained in the north.

During the summer of 1943 a counting fence was constructed in Morrison creek and in the fall the first count of adults was made. A total of 15,765 pinks passed through of which 7,654 were males and 8,101 females, representing a potential deposition of 15,300,000 eggs (Appendix No. 1).

In the spring of 1941, a marking of 101,194 pink fry was undertaken, the marked adults of which returned this fall (Appendix No. 2). The purpose was to trace the migration of the returning fish from the sea to the river, to check the per cent return to the natal stream and to discover what wandering into other spawning areas might occur. Only two recoveries were made in the fishery, one in Puget sound, the other in the north, Johnstone strait, thus suggesting that fish bound for Morrison creek, entered the strait of Georgia from both the south - strait of Juan de Fuca - and the north - Johnstone strait. By extraordinary coincidence these two marked fish were captured by taggers, were duly tagged and subsequently were recaptured at the Morrison creek trap. A total of 424 marked males and 441 marked females were retaken at the trap in Morrison creek, thus showing a return of 0.85 per cent of the originally marked fry. Only one marked recovery was made in other streams, this a somewhat questionable scar from the adjacent Tsolum river. While these data clearly suggest once again a definite parent stream tendency, the lack of returns from the fishery indicates that adequate recovery of marked adults requires special attention and close scrutiny by observers of fish landed at the canneries.

In co-operation with the Washington State Fisheries Department a pink salmon tagging experiment was undertaken in the summer of 1943 (Appendix No. 3), the general purpose of which was to ascertain the migratory routes followed by the pink salmon entering into the southern B.C. and Washington fisheries, the relation of the commercial catch to the spawning escapement, and the contributions of the various rivers to the pink salmon population. A total of 7,997 fish were tagged - 4,497 in Johnstone strait, the northern entrance to the strait of Georgia, 960 at Sooke in the strait of Juan de Fuca and 2,540 in American waters, the southern approach to the strait of Georgia. To date the recoveries total 3,129 or 39.1%, most of the returns coming from the fishery. The data have not yet been fully analyzed but it is clear that pink salmon enter the strait of Georgia from both north and south, that they spread widely and definitely overlap in distribution not only in the fishery but also in the streams which they ascend for spawning.

During the fall Dr. Pritchard, in company with the various resident fishery officers concerned, visited many of the pink salmon spawning streams tributary to the strait of Georgia and the Fraser river to assess the size of

the spawning runs and the general prospects for the 1945 season (Appendix No. 4). Only one river system on the east coast of Vancouver island had a worth-while run, namely the Puntledge-Tsolum. On the mainland shore Burrard inlet had a light seeding only while for the Fraser from Hope west the streams on the south side showed a very light spawning whereas those on the north were very well supplied.

Coho salmon. All of the coho research has been confined to the Cowichan river system where observations and experiments have been in progress since 1938. It is felt that a reasonably long-term series of data showing the natural variations as produced under naturally variable climatic and other conditions will materially assist in understanding, perhaps forecasting the situations prevailing or likely to prevail in other important river systems.

The data pertaining to the spawning run of 1942 in the Cowichan river are now complete and may be summarized as follows, the numbers in brackets being the similar estimates or counts for the preceding year, 1941:

During the summer and autumn angling season at Cowichan bay approximately 4950 (4300) cohos were taken by anglers (Appendix No. 10). The spawning escapement to the river is estimated, from tagging experiments, (Appendix No. 7) at 82,000 (80,000) fish of which 67,000 (65,000) passed upstream to areas above Skutz falls while 15,000 (15,000) spawned in tributary streams below. The runs of 1941 and 1942 were thus of approximately the same magnitude. Observations on the behaviour and distribution of the fish in the river system (Appendix No. 8) indicated that, in general, they reached the spawning grounds in 20-30 days (one to two months in 1941) and are spawned out in 30 to 60 days.

Continuing the study of the natural propagation of cohos in two small tributary streams, Oliver and Beadnell creeks (Appendix No. 9), the resulting fry in Oliver creek, - from the spawning of 208 males and 38 females, or 199,500 eggs presumably deposited, - amounted to 51,030 or 25.6% whereas for Beadnell creek, with 36 males and 28 females or an egg deposition of 78,100, there were counted only 12,676 fry or 16.3%. For the past five years the records of percentage efficiency of natural propagation have been: Oliver creek - 14.4, 11.8, 30.4, 26.0 and 25.6% and for Beadnell - 40.0, 30.1 and 16.3%. In two years counts at Beadnell creek were not made. It is evident that over the years the percentages have varied considerably, due largely to climatic conditions. During the last three years, however, the success of propagation in Oliver creek has been remarkably similar.

The 1943 angling catch index of spring and coho salmon in Cowichan bay, 4.9 line-hours per fish (Appendix No. 10), was considerably higher than that for 1942, 3.9 line-hours per fish, in fact is the highest since records were commenced in 1939, and indicates an appreciably increased effort required in order to capture the fish. It may be interpreted as indicating a smaller population of fish. Although the numbers of fish landed, 1612 springs and 4,781 cohos were not greatly less than the landings of 1942, namely 1,958 springs and 4,952 cohos, the effort, line-hours, was much greater, 31,285 and 26,787 respectively.

During the year Drs. Pritchard and Tester completed their study of the food of the spring and coho salmon in British Columbia waters (Appendix No. 12) and a bulletin report prepared. The food of the spring salmon was

found to consist principally of fish forms, largely herring and sand lance, with invertebrates, chiefly "red feed" or euphausiids, making up the balance. Between central areas certain differences were found. On the west coast of Vancouver island sand lance was consistently more important in northern areas than in Barkley sound where herring predominated. Coho salmon also subsisted largely on herring and sand lance but the range of diet appeared more extensive, tending more strongly toward invertebrates. One point brought out by the investigators is that when salmon fishermen seek to attribute poor salmon fishing to the decrease in herring food as a result of herring seining, they must first establish that the poor fishery is actually due to a reduced supply of salmon and furthermore that, if such shortage is evident, it is not caused by other natural agencies.

Recoveries of marked fish originating in Cowichan river and marked in 1939 (brood year 1938) were again anticipated from the fishery in response to general advertising but only two returns were received, one in April from Cape Mudge, Strait of Georgia, the other in June from Ucluelet, west coast of Vancouver island. These two recoveries confirm the general wide distribution of Cowichan spring salmon and indicate that some do not mature and return to spawn until their fifth year. Eight recoveries from the fishery were made in 1942.

Trout. During 1943 Mr. Neave's trout studies were confined solely to recovery of marked individuals resulting from markings and liberations in earlier years. The recoveries served to complete and confirm earlier findings as follows: Cutthroat trout show a seasonal migration (not connected with spawning) from river to lake during the spring and irregular local movements at other seasons. Brown trout do not migrate extensively but move into small streams to spawn. Little or no migration to or from the lake took place. Kamloops trout have yielded only few returns, perhaps due to poor survival in the Cowichan environment. Recaptures of young fish have shown irregular wandering tendencies. Steelhead trout go to sea when one or two years old, after somewhat irregular local movements between tributary streams and the river or between lake and river. Adults commonly return from the sea in their fourth year. Rainbow trout tend to remain in the river during the first two years and thereafter make seasonal non-spawning migrations to and from the lake where they appear to spend the summer.

Herring. In view of the fact that the herring season extends from September through to February or March of the following year the reports cannot be feasibly divided into calendar year periods. Therefore the present summary embraces not only those studies undertaken during 1943 but also the results of the observations and experiments pertaining to the fishery of 1942-43. The work carried out by Dr. Tester, assisted by Dr. Boughton (to Dec. 31, 1942) and Mr. Stevenson (from July, 1943) has involved the continuation of the statistical study of the fishery, the sampling of the populations for size and age characteristics, tagging experiments to determine the migratory habits of the fish as well as a study of herring egg mortality along the southern section of the east coast of Vancouver island in the spring of 1943 and experiments on the use of the echo sounder to detect schools of fish. The Provincial Fisheries Department again assisted financially in this investigation.



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Appendix No. 1

Natural Propagation of Pink Salmon Morrison Creek, Vancouver Island -  
The Mature Salmon Run of 1943.

Following the cessation of the investigation of the natural propagation of pink salmon at McClinton creek, Masset inlet, it was decided that information of a similar nature should be obtained for an area in southern British Columbia. Accordingly Morrison creek, a tributary to the Puntledge river at Courtenay, Vancouver island, was chosen. This river now supports a good natural run of pink salmon and is in a district which at one period was famous for the size and consistency of its pink salmon spawning. At the present the runs are certainly unpredictable and for the most part are small. Any information concerning them would be of definite value.

During the early summer of 1943, an adult counting fence was installed under the direction of Mr. E.V. Epps. This structure was similar in nature to those at Cultus lake and at McClinton creek but considerably smaller in size. One retaining pen was considered sufficient to handle any number of fish which might appear.

The first fish reached the pen on August 6 but the run proper did not commence until September 11. From that date until October 25, the migration continued. As in other areas, the numbers were not constant each day but were definitely influenced by the effect of the rainfall on the water height of the creek. From October 4 to 6, during the heaviest freshet, 9,407 out of a total of 15,780 were handled.

Individuals of both sexes appeared at approximately the same time with males maintaining a slight superiority in numbers for the first part of the runs, up until October 4. From this date the females predominated to produce the final disposition on the spawning grounds of 48.5% males and 51.5% females. The discrepancy from the 50:50 ratio should have no serious affect since one male will serve more than one female.

The average number of eggs per female, determined from the actual counts of eggs contained in 35 individuals selected at random throughout the run, was 1,779. The potential egg deposition was thus 15,300,000.

The following table gives a summary of the counts for the 1943 adult run:

Year	Males	Females	Total	Av. No. of eggs	Potential Deposition
1943	7,654	8,101	15,755	1,779	15,300,000

The data show only that the run of pink salmon to Morrison creek during 1943 was good for a spawning area of such a size. During the spring of 1944, the resulting fry should migrate downstream. It is hoped that screens will then be installed to obtain a count of the young so that the efficiency of hatch may be obtained. This figure will indicate the general conditions in the area.

With many other programs in operation at the same period as the counting fence at Morrison, it was impossible for the writer to give full time to the experiment. Mr. Alex MacDonald, the fisheries inspector at Courtenay, out of keen interest in the project, undertook the supervision during the early and late phases of the run when the numbers were not heavy. When

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the investigator was faced with insufficient help at the critical period of heavy migration, he received unlimited aid from Dr. Foerster and Mr. Neave. To these men, sincere thanks are due since, without their work, it is doubtful whether the count could have been efficiently completed.

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Appendix No. 2

Recovery of Pink Salmon Marked at Morrison Creek in 1942

In an attempt to gain some information on the pink salmon in the Courtenay area on the east coast of Vancouver, 101,194 fry were trapped in Morrison creek in the spring of 1942, marked by the removal of both ventral fins, and released to proceed downstream. Every effort was made to recover the adult fish which were expected to appear in the fishery during the summer and autumn of 1943. Many trips were made throughout southern British Columbia to make personal contact with the fishermen, the fisheries inspectors, and the members of the industry. Explanatory posters were placed in prominent places. Finally each fisherman received with his license a letter notifying him of the marked pink salmon which might appear.

In spite of the elaborate precautions taken to make sure that no one connected with fishing was in ignorance of the experiment, only two marked pink salmon were recovered in the fishery. These have, however, an interesting history. On August 19, 1943, a male was procured from the seiners for tagging at Deep Water Bay in Johnstone straits between 40 and 50 miles north of the river of origin. On August 30, two Washington State taggers operating off Lopez island in Puget sound, 60 to 70 miles south of the Morrison river, tagged another marked male. Neither fish was recognized as marked when tagged. Both reached the fence at Morrison creek on the same day, October 6. These records demonstrate that the fish to Morrison may come in from the open sea around either end of Vancouver island. They also prove that pink salmon may go far beyond the parent river influence and yet return. It is certain that with the large tidal interchange in the area, no trace of Morrison creek water could have penetrated either to Deep Water bay or Lopez island where the marked fish were first handled.

Marked fish began to appear at the counting fence at Morrison creek on September 18 and continued in goodly numbers until October 23. The total amounted to 424 males and 441 females exclusive of the two reported above, or a return of .85 per cent.

In connection with the tagging program reported elsewhere, close examination of many thousand dead pink salmon was made in creeks on the east coast of Vancouver island, Burrard inlet and the Fraser river. Only one possible marked fish was discovered, a female in Wolf creek, a tributary of the Tsolum river. This is another branch of the Courtenay system about 8 to 10 miles from Morrison creek.

The marking of pink salmon has again demonstrated the general attainment of maturity in the autumn of the second year. It has shown that while some individuals may reach another creek in the vicinity, the majority do show up in the river of origin. In making the return to the spawning grounds, Morrison creek pinks may come in from the open sea around either end of Vancouver island.

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The lack of returns from the fishing industry in this experiment is disappointing but perhaps explicable. Concurrent with the examination for marked fish, close watch was being maintained for tags. These latter were much easier to spot and doubtless diverted attention from the other program. It is certainly evident, however, that to obtain best results, observers should be stationed in the canneries with the sole purpose of checking the species concerned. It is perhaps too much to expect fishermen and cannery employees to pick out marked salmon in the rush of processing, when taggers handling fish individually and slowly would not recognize them.

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Appendix No. 3

Pink Salmon Tagging in British Columbia and Washington in 1943

During the last few years the pink salmon runs to areas in southern British Columbia and the State of Washington have in many cases become smaller and in all cases unpredictable. This situation had led to concern and provoked a desire for more detailed information on the behaviour of the fish involved. Accordingly in the spring of 1943 after consultation, a co-operative investigation was arranged between the Pacific Biological Station and the Washington State Department of Fisheries. As a beginning during the first year, a comprehensive tagging program was outlined. Under agreement the State investigators under Mr. A. DeLacy were to be responsible for all work in American waters and the Canadians for endeavours in the fishing areas of British Columbia. Methods of tagging, of collecting returns, of recording data and of stream examination were standardized so that the data might be combined at the conclusion of the work.

In all it has been possible to tag 7,997 pink salmon in three widely separated areas viz. 4,497 in the district near Deep Water bay in Johnstone straits, B.C., 960 from the traps at Sooke, B.C. and 2,540 from Puget sound. To date Canadian recoveries have amounted to 1969 and American to 1150, a total of 3,119 or 39.1%. In the following discussion of the findings both collections have been combined.

It is unnecessary and unwise in the present report to enter into detail but a certain amount of analysis is informative. For that reason the following table has been set up:

	<u>Johnstone St.</u>	<u>Sooke</u>	<u>Puget sd.,</u>	<u>Total</u>
No. tagged	4,497	960	2540	7997
<u>Ocean Returns</u>				
Alert bay to Deep bay	578	9	17	604
Howe sd., Burrard in., off Fraser r.	175	13	50	238
Puget sound, Wash.	123	250	748	1121
Sooke vicinity, B.C.		20	1	21

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	Johnstone st.	Sooke	Puget sd.	Total
<u>River Returns</u>				
Fraser river fishery	611	102	261	974
Spawning areas:				
Bute inlet	11			
Toba inlet	2			
Courtenay river	56	4	7	
Howe sound	1	1		
Eurrard inlet	4		2	
Fraser river	11	2	11	
Puget sound	<u>8</u>	<u>7</u>	<u>37</u>	<u>164</u>
Totals	1580	406	1134	3122
Unallotted tags				7

Recoveries from the fishery (2958) compose almost all the returns. No quantitative conclusions can be drawn from comparisons between them and the river returns since it is evident that all spawning areas were not covered and many tags might have been missed. The sea returns do indicate definitely that the run through Johnstone straits is not entirely travelling to the Fraser river and Puget sound. In fact well over one-third of the recoveries were made in northern inlets, viz. Knight, Loughborough, Ramsay arm, Phillips arm, Bute, Toba, and connecting channels. For the first time, it has been indicated that the pinks may migrate almost to Seymour narrows and return northward again. The Sooke and Puget sound records have demonstrated that pink salmon entering the strait of Juan de Fuca are limited to the southern fishery and to southern spawning grounds. From both these areas of tagging recoveries were made as far north as Knight inlet and also in the Deep Water bay area where the other tagging experiment was in progress.

Such river returns as are available show a wide distribution to every area. The fact that the tags from the Courtenay system were mainly of an early date and those from the Harrison river, a tributary of the Fraser, of a later period, demonstrates a segregation of runs through the fishery.

Reference has been made in another report to the significance of fish previously marked at Morrison creek, Courtenay, being tagged in Puget sound and Johnstone strait and later reaching the natal stream.

Only the most striking features of the results have been mentioned. There is little doubt that the experiment has been most successful. This attainment is not due to any one circumstance or individual but to many. In the first place, the industry has co-operated whole-heartedly. Arrangements were made for procuring fish for tagging in Johnstone straits before the experiment started. The companies involved instructed the fishermen and explained the situation. Speed in tagging, ease in manipulation, simplicity in bookkeeping, and efficiency in operation were thus attained. J.H. Todd and Sons actually assumed full responsibility for the Sooke tagging and carried out their bargain to the letter. Fishermen were keen to make returns. The

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canneries co-operated in some cases even to the extent of slowing their operations. The officers of the fisheries department, many of whom are mentioned in a spawning ground report elsewhere, not only looked for tags in the ordinary course of their duties but arranged their programs to stress the collection maintaining that the application was equally as beneficial to them as to the scientists involved. Finally other members of the staff at the Pacific Biological Station, in particular Dr. Foerster, filled in when help was essential.

The attempt at complete co-operation between two established scientific bodies of two nations has thus far been an unqualified success. The responsibility of maintaining the standard must now rest with the two particular scientists involved in working up the data and presenting the detailed results.

A.L. Pritchard

Appendix No. 4

Survey of Pink Salmon Spawning Rivers in Southern B.C. in 1943

During the autumn of 1943 many rivers in southern British Columbia were inspected at the height of the pink salmon spawning in an effort to discover tagged and marked fish, to gain a general idea of the expanse and quality of the spawning areas, and to form an estimate of the escapement. Complete details are not desirable in a report of this nature but certain general deductions are submitted for each area.

1. East coast of Vancouver island area. The main pink salmon spawning areas below Campbell river were inspected thoroughly. These included: the Oyster river and its tributary, the Little Oyster, the Courtenay system, viz. the Puntledge with its tributaries, Morrison creek and Brown river, and the Tsolum including Wolf creek and Dove creek, the T'sable river, Nile creek and Coal creek.

Actually this is not an expected big year for pink salmon in the Oyster but the numbers are definitely lower than in 1941. The main concentration of pinks was in the Courtenay system and particularly the Tsolum branch. The Puntledge which two years previously had a fairly heavy run, showed only medium numbers. On the other hand, the numbers in the Tsolum were very much increased. The run on the whole was heavy and involved 50,000 to 100,000 fish as shown by counts of over 13,224 on the examination trips. No pinks were seen in the other rivers.

2. Burrard inlet area. Indian river at the head of Burrard inlet showed a fair run of approximately 10,000 fish. This is considered not quite equal to the escapement of the previous cycle. Over 3,112 were examined to give 4 tags and no marks.

Fraser river. The following streams on the south shore of the Fraser from Hope west were examined: Coquahalla river, Sucker creek, Silver creek, Hunter creek, Lorenzetti creek, Jones creek, Popkum creek, and the Vedder system.

The Coquahalla river showed a few fish but the run was definitely smaller than in 1940. Only a few individuals had reached the tributary Sucker creek. Silver creek farther west apparently had a light run. Hunter creek has no great expanse of spawning bed. Lorenzetti was too low for the fish to enter but Jones creek had a good run. For its size Popkum creek was well seeded. Of particular interest was the fact that the fish ladder in the dam at the bottom of Popkum was operating. The Vedder which usually carries a big run was disappointing. A few fish were present in the lower reaches and about 2000 in Sweltzer creek. The numbers are definitely lower than those present in 1941, the cycle year.

On the north shore of the Fraser inspections were made in Miriah Slough, the Harrison-Chehalis system, Squakum creek, Inch creek, Suicide creek, Silverdale creek, Whonnock creek, and the Pitt lake area including Pitt river, its tributaries Four-Mile and Seven Mile creek and Silver creek. A brief visit was also made to the North and South Alouettes.

The Harrison-Chehalis area showed an extremely heavy run of pink salmon. Spawners were spread in every available area. Estimation is difficult but approximately 40,000 dead fish were actually counted. There is little doubt that the complete run was in the neighbourhood of 100,000. Silverdale creek just below Mission had approximately 3000 pinks. This is a heavy run for the small spawning area. Whonnock creek at Whonnock will be heavily seeded with 5000 to 5000. The run to Pitt lake was definitely a failure revealing only about 75 pinks in three days' inspection of miles of spawning beds. Even a brief survey of the north and south Alouettes showed an extremely heavy seeding.

Considering the Fraser as a whole, the escapement was encouraging and well above that of the cycle year of 1941. In fact the numbers were surprising in view of the small catch. Although the streams to the south shore received only light to medium runs, the heavy escapement to the north side more than made up the discrepancy.

General Conclusions. If reports from fishery officers are considered along with personal inspections the following general assessment of the escapement in southern British Columbia can be made: East coast of Vancouver island from Oyster river south has a fairly heavy run to the Courtenay which results in a fair seeding for the whole area, - Howe sound is definitely poor. Burrard inlet received only a light seeding. The Fraser river is good. In general the numbers over all are better but certainly not all that could be desired to remove all fears for the future.

In all inspections the fishery officers co-operated fully, providing transportation and acting as guides. Thanks are due not only to Supervisors MacLeod and Tait but to Messrs. MacDonald at Courtenay, Lockwood at New Westminster, Brown at Mission, Barker at Chilliwack and Lightly at West Vancouver. Without their help in arranging and carrying out trips and in making examinations, it would have been impossible to see nearly as much of the area covered. The co-operation has undoubtedly proved helpful to both departments.

A.L. Pritchard

Appendix No. 5

The Age of Chum Salmon in the Commercial Catches in British Columbia.

During 1940, 1941, and 1942 collections of chum salmon scales were obtained from the commercial catches on the Queen Charlotte islands, the west coast of Vancouver island, Johnstone strait and the strait of Georgia. In summarizing, data from previous scale readings by the writer were included with those of Dr. C. McLean Fraser from fish taken in 1916 and 1917. The general conclusions have been submitted in Progress Report of the Pacific Coast Stations, No. 54.

All scales examined are of one general type. In the centre, there is no indication of the close-ringed, fine lined nucleus typical of fresh water but only moderately coarse circuli relatively far apart. The remainder of the scale pattern may differ only in the number of winter rings which appear. The chum, therefore, migrates to sea as a fry before the scale has formed and spends the remainder of its life in the ocean habitat until they return to spawn. Evidence of late downstream migration is indicated in the small first year's growth in certain scales. That the young may remain in more or less brackish bays for a time is demonstrated in some cases by nuclear circuli of medium coarseness moderately close together.

Amongst the individuals taken by the commercial fishery in B.C. are individuals in their third, fourth, fifth and sixth years. Only occasionally does a fish in its second appear. The percentage age composition is not constant but may vary from area to area and year to year. For all practical purposes chums in their third, fourth, and fifth years are most important. In no case did others make up 20% of the total.

There is an indication that the average age increases as the area of collection moves northward, viz. Johnstone st. and strait of Georgia - 3.8, west coast of Vancouver island - 4.3, and Queen Charlotte island - 4.9.

The summarizing of these data completes for the present the study of chum salmon scales. Further work is not anticipated unless a special problem should arise.

A.L. Pritchard

Appendix No. 6

Return of Cowichan River Marked Cohoes of the 1939 Brood Year.

During the spring of 1940, an attempt was made to mark all the coho salmon fry leaving Oliver and Beadnell creeks tributary to the Cowichan river, chiefly with a view to discovering whether on their spawning migration there was any appreciable wandering of the mature individuals from the "parent" stream or whether there was any noticeable influx of unmarked individuals from other creeks. Each day in each stream the fry were taken from the traps, marked, and released. It is possible that a few were missed late in the summer after the fences had been removed. It is also known that in Oliver creek, a small group remained to migrate as yearlings in 1941. In spite of these evident errors, more than 95 per cent of the total run was handled. The marking operations, completed under the supervision of Mr. Neave and Dr. Carl, involved the following:



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Appendix No. 6

Oliver creek - Dorsal and adipose 73,768  
 Beadnell creek - Dorsal and left ventral 169,991

In 1940, later in the summer, Mr. Weave located the fingerlings at various places nearer the mouth of the Cowichan, even as far down as the Quamichan. This indicated a seaward migration after leaving the tributary streams. No record of the whereabouts of the fish during their second year of life (1941) has been discovered. No marked "grilse" were recovered either in the fishery or at the counting fences.

In June and July, 1942, in their third year, one of each type was taken on the troll off Kyuquot on the west coast of Vancouver island. These recoveries confirmed the conclusions drawn from the marked 1938 brood, namely, that Cowichan river cohoes may range far up the west coast of Vancouver island.

In October, 1942, one adult female coho lacking the dorsal and adipose fins was captured in Cowichan bay. In November of the same year, a male and female each lacking the dorsal and left ventral fins, and one with no dorsal or adipose were dipped at Skutz falls approximately 16 miles upstream from the mouth. These last four recaptures again demonstrate an upstream spawning migration in the third year.

The returns to the counting fences at Oliver and Beadnell creeks during the autumn of 1942 were as follows:

<u>Oliver creek</u>		<u>Beadnell creek</u>			
<u>Unmarked</u>	<u>Marked</u>	<u>Unmarked</u>	<u>Marked</u>		
	Dors. & Ad.	Dors. & L.V.	Dors. & Ad.	Dors. & L.V.	
286	11	10	64	1	2

The minimum percentage return from the 169,991 fry lacking the dorsal and left ventral was .01 (16 fish), and from the 73,673 dorsal and adipose cohos .02 (15 fish). The figures are smaller than those obtained in previous years.

In the spawning run to Oliver creek only 6.8 per cent were marked and at Beadnell only 4.5 per cent in spite of the fact that over 95 per cent of the fry of 1940 from which the fish should have originated lacked either combination of fins. There are several possible causes for this change of proportion. The marking operation might not have been perfect. Due to faulty clipping the fins might have regenerated or the fish might have been injured sufficiently to cause a heavy mortality. Another possibility is that there was an emigration of marked fish to other streams coupled with an immigration of unmarked individuals into the two creeks under consideration. Of this there are some indications but no convincing proof.

The present marking experiment has drawn attention sharply to the problem of return to the "parent" stream. In an effort to discover more information on the usual behaviour in this respect, further markings of all migrating fry were carried out in the spring of 1941 and 1942. The recoveries from the first of these are due in the autumn of 1944.

The Size of the Coho Salmon Run in the Cowichan River in 1942

In Appendix No. 8 of the Summary Reports of the Pacific Biological Station for 1942, attention was directed to the advisability of having a fairly reliable yearly estimate of the number of the coho spawning in the Cowichan river. This information would provide a valuable indication of whether the runs were maintaining themselves and a demonstration of the possible contribution of the stream to the fishery as a whole.

The method of assessment chosen in lieu of counting fences which were impossible of installation and maintenance, was to tag a known number of individuals during the upstream migration. Later the fish were examined on the spawning grounds. From the ratio of tagged to untagged cohoes and the number tagged, the total can be calculated. For example, if 100 were tagged originally and released, and, if, later in the season, 10 tagged and 100 untagged individuals were discovered, the total would evidently be  $\frac{100 \times 100}{10} + 100$  or 1,100

Admittedly the method is only a substitute for a definite count and can, at best, produce only a moderately accurate estimate. Previous tests have shown, however, that conditions at Cowichan are such that they should not introduce too great an error. Dipping at Skutz Falls was carried on each day throughout the run. When a large migration occurred the cohoes were easier to capture, and more were tagged, and vice versa. The numbers handled were thus somewhat in proportion to the numbers migrating. For mixing of tagged and untagged individuals there was available about 8 miles of river and a large lake. A long period of about 60 days elapsed between tagging and spawning. Examination of streams could be and was made fairly thorough.

In 1942 from October 22 to November 20, button tags were affixed below the dorsal fins of 1478 cohoes dipped at Skutz Falls. This group was constituted as follows: Males - 661, Jacks (two-year-old males) - 37, and females - 780. During December, 1942, and January, 1943, inspections were made in 23 spawning creeks tributary to Cowichan lake and river exclusive of Oliver and Beadnell. During these visits 1,751 untagged and 41 tagged cohoes were observed. The run on the basis of these observations would thus be:

$1,478 \times \frac{1751}{1478} + 1,478$  or 65,000. In Oliver and Beadnell creeks, counting 41 fences were operated and each fish was examined. There appeared 366 untagged and 3 tagged. The total run would thus be:  $\frac{1,478 \times 366}{8} + 1,478$  or 69,000. These figures agree very closely as they did in 1942. It is our belief that this indicates that, before observation, the cohoes had become randomly distributed.

It would appear that 67,000 is a fairly accurate estimate for the escapement of cohoes above Skutz Falls in 1942. In 1941, the run was assessed at 65,000. Although there are only qualitative observations for the spawning population below the falls, it is considered to be almost the same as 1941. The runs of 1941 and 1942, were thus sizeable and almost equal in numbers. This statement is further confirmed by the examination of the angler's catch in Cowichan bay in the two years. In both the average effort needed to catch a coho was the same, viz.- 5.4 line hours.

A similar experiment is being conducted for the 1943 run. Since the angler's catch already analysed, indicates a smaller escapement, it will be interesting to have the results of the river inspections.

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The Behaviour and Distribution of the Coho Salmon above Skutz Falls in the Cowichan River During the Spawning Run of 1942.

The recovery of coho salmon bearing serially numbered tags affixed at Skutz falls in the autumn of 1942, gave certain interesting information on the behaviour of the fish proceeding to the spawning grounds.

The actual tagging was carried out at a location near the head of the falls. From qualitative observations it appeared that most individuals immediately upon release headed upstream very quickly. That such behaviour did not always take place, however, was shown by the recapture of 40 tagged cohoes in the traps. Three of these appeared on the day of tagging, 30 - one day later, 3 - two days later, 3 - three days later and 1 on the fifth day. Evidently at least some again descended the falls since tags were seen in the pool below. These data served to stress the necessity of care in estimating the size of runs by direct counts. If the fish make several ascents and are observed each time, the final figure will be too high.

In general the rate of migration upstream from Skutz Falls in the main river appeared slower in 1942. One coho was seen at Lake Cowichan village - 8 miles away on the day after tagging. Another individual did not arrive for 37 days. Two others had spawned and were dead after 70 to 75 days.

Fish entered Beadnell creek in about 20 to 22 days. Four were taken at the trap at Oliver, three after 20 days and one after 45. The latter was a marked fish lacking the dorsal and left ventral fins which had been discovered in dipping at Skutz falls.

Most of the individuals found in the other spawning tributaries were dead and spawned out. As a record, the range of time is submitted:

	1/2 mi. above Skutz Falls	67 days
Bear Cr.	Ca. 6 mi. " " "	26 to 30 days
Lost Lake Cr.	Ca. 8 mi. " " "	25 to 63 days
Grants Cr.	Ca. 8 mi. " " "	46 to 97 days
Greens Cr.	Ca. 8 mi. " " "	29 to 69 days
Robertson R.	Ca. 13 mi. " " "	30 to 56 days
Sutton Cr.	Ca. 17 mi. " " "	22 to 39 days
Bear Cr.	Ca. 15 mi. " " "	33 days
Krone's Logging Cr.	Ca. 15 mi. " " "	18 days
Meade's Cr.	Ca. 20 mi. " " "	15 to 29 days
2nd Cr. E. of Prices	Ca. 11 mi. " " "	36 to 42 days
Price Cr.	Ca. 13 mi. " " "	87 days
1st Cr. E. of Coon	Ca. 14 mi. " " "	47 to 55 days
Coon Cr.	Ca. 15 mi. " " "	30 to 40 days
Cottonwood Cr.	Ca. 16 mi. " " "	48 days
	Ca. 23 mi. " " "	49 days

Although there is a great variation in the period taken, in general the cohoes will reach the spawning grounds in 20 to 30 days and will have spawned in 30 to 60.

Natural Propagation of Coho Salmon in Oliver and Beadnell Creeks in 1942-43.

In 1938 Mr. Neave and Dr. Carl commenced checking the efficiency of the natural propagation of the coho salmon in Oliver and Beadnell by making counts of the adult spawning migrants. In the spring of 1940 the resulting fry were enumerated. From these two figures and the potential egg deposition, calculated from the average number of eggs per female previously determined and the number of females spawning, the efficiency of the phase from egg deposition to fry migration can be determined.

In continuation of this experiment which has been carried on during the intervening years, the following records were obtained for the autumn of 1942 and the spring of 1943.

	<u>Oliver</u>	<u>Beadnell</u>
No. of males	208	36
No. of females	88	28
Dead and spent females	<u>11</u>	<u>3</u>
Total	307	67
Average number of eggs per female	2,267	2,790
Presumed egg deposition	199,500	78,100
No. fry migrating (spring 1943)	51,030	12,767
Per cent efficiency	25.6	16.3

For the purposes of comparison the egg depositions, and percentage efficiencies for the duration of the experiments are submitted below. The figures for seasons prior to 1942 are from Neave and Carl.

	<u>Oliver</u>		<u>Beadnell</u>	
	Egg deposition	% efficiency	Egg deposition	% efficiency
1938-39	330,176	14.4		
1939-40	865,220	11.8	433,400	40.0
1940-41	481,650	30.4	74,100	30.1
1941-42	564,900	26.0	discarded due to wash-out	
1942-43	199,500	25.6	78,100	16.3

It is apparent that over a period of years, the percentage efficiency of natural propagation may be subject to considerable variation. Such a condition is to be expected in view of the possible changes in climatic conditions. In spite of this, the returns from Oliver creek have been almost similar over the last three years. In Beadnell fluctuations have been great.

Data such as those presented herein are valuable not only in indicating the possible productivity of any one brood year but in building up a series to demonstrate the average productivity over a period of time.

A.L. Pritchard

The Salmon Angling Fishery in Cowichan Bay in 1943

The practice of maintaining a record of the angling fishery in Cowichan bay begun in 1939 was continued through the season of 1943. There has resulted a series of catch data for comparison with earlier years and an examination of over seven thousand spring and coho salmon for marked individuals.

The following is a record of the current seasons catches from August 12 to November 11 while the main fishing was being prosecuted:

Month	Boats	Lines	Line-hours	Springs		Cohoos		Total
				Large	Jacks	Large	Grilse	
Aug.	1,086	2,094	6,862	403	36	201	390	1,030
Sept.	2,053	3,948	13,081	514	351	946	281	2,372
Oct.	2,063	3,995	14,816	83	122	3,149	51	3,485
Nov.	91	176	608	--	--	101	36	137
	5,293	10,213	35,351	1,000	789	4,497	738	7,024

N.B. Large springs vary from about 11 to 40 lbs., Jacks from 2 to 5 lbs., large cohoes run from 7 lbs. up and grilse up to 5 lbs.

The time of abundance of the various species is very similar to that of 1942. The heavy run of spring salmon continued from the week ending August 21 to that ending October 2 with a mode of 376 in the week ending September 18. Cohoes were present in large numbers from the week ending September 25 to that of October 30. Maximum catch of 1239 was obtained in the week ending October 9.

The catch of grilse (small coho) was definitely divided into two periods. The first of these from August 11 to September 28 appeared to depend mainly on small fish leaving the Cowichan river for the open sea. The second from October 10 to November 11, was sustained by precocious individuals returning to spawn.

Below are submitted comparative figures for the several years in which examination was carried out. The period included for each season is from August 23 to October 31, when the heaviest and most important fishing takes place.

	1939	1940	1941	1942	1943
Boats	2,803	2,464	3,753	3,999	4,647
Lines	5,278	4,629	7,005	7,635	8,979
Line-hours	19,006	16,707	23,319	26,767	31,285
Spring- Large	553	1,121	1,069	748	831
- Jacks	750	292	357	1,210	761
	1,303	1,413	1,426	1,958	1,612

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	1939	1940	1941	1942	1943
Line-hours per spring	14.6	11.8	16.4	13.7	19.4
Coho - Large	3,410	1,899	3,560	3,928	4,533
- Grilse	<u>1,069</u>	<u>160</u>	<u>745</u>	<u>1,024</u>	<u>448</u>
	4,479	2,059	4,305	4,952	4,781
Line-hours per coho	4.2	8.1	5.4	5.4	6.5
Total fish	5,782	3,472	5,731	6,910	6,593
Line-hours per fish	3.3	4.8	4.1	3.9	4.9

The number of boats and lines used and the number of line-hours consumed in catching fish in Cowichan bay was the highest on record in 1943. This increase is not considered to be due to the increase in the efficiency of the collection of statistics, since the same observer has been employed over the last three years. The rise merely demonstrates quantitatively a fact observed qualitatively, namely that, in spite of war time restrictions, anglers are coming to the bay in ever-increasing numbers. The choice of this area may be the result of its easy accessibility.

The number of line-hours consumed in catching a fish is the highest of all years indicating a small run. The spring salmon, resulting mainly from the brood year of 1939 are scarce thus requiring on an average nine-teen hours for capture of one individual. While the cohoes appear more abundant than in the brood year of 1939, (6.5 as compared with 3.1 line hours per fish), the run is small when compared with the two years previous. In general, therefore, both runs were reduced in abundance although nearly 6400 fish were taken. This conclusion is being borne out by observations of the migrating adults at Skutz Falls, on the Cowichan river.

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Marking of Salmon Fry During 1943

Spring Salmon

In 1938 a series of marking programmes was commenced on spring salmon of Cowichan river origin in an effort to gain information on the distribution of these fish in the sea and the extent of their contribution to the commercial and game-fish fishery. During 1938, 1939 and 1940 less than 30,000 commercial and game-fish fishery. During 1938, 1939 and 1940 less than 30,000 individuals were involved. In 1942, 255,373 were released. In 1943 both ventrals were removed from 89,484. This mark is distinctive in that it was not used on the same species in any other area during 1943.

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Eggs to produce the fry for marking were obtained from adults dipped at Skutz falls during the spawning run in the autumn of 1942. The total collection amounted to 141,483. Losses were slightly higher than in the 1941-42 experiment due mainly to the difficulty of procuring males for fertilization at the proper time. Nevertheless, from May 5 to June 2, 1943, 89,484 fingerlings were marked by the removal of both ventral fins and released into the hatchery pool. Recoveries from this group should appear mainly in 1945 and 1946 when the individuals are in their fourth and fifth years.

The gross cost of this marking amounted to approximately \$220.00 or a rate of about .25 cents per fish.

Coho Salmon

The coho salmon fry-marking which has been conducted for a number of years in connection with the investigation of the natural propagation of the species at Oliver and Beadnell creeks, Cowichan river, was continued during the spring of 1943. All fry and yearlings leaving the streams were marked by the removal of both ventral fins. The numbers were: Oliver creek - fry - 50,824, yearlings - 1,217, total - 52,041; Beadnell creek - fry - 12,723, yearlings - 1,323, - total - 14,046. The yearlings from this experiment should return in 1944 and the fry in 1945. In those years it will be possible to obtain not only an indication of distribution in the sea but also a measure of wandering from the parent stream since all downstream migrating individuals were marked.

Due to the fact that the downstream migration was spread over almost three months, and that there were so few individuals, much time was lost waiting for material on which to work. The cost per individual was therefore high, amounting to approximately .44 cents per fish as compared with .25 during the previous year.

Chum Salmon

During the spring of 1943 an attempt was made to mark a number of chum salmon fry which were trapped in enclosed pools at the mouth of the Cowichan river by the low water conditions. The aim of this experiment was to discover the fate of these fish when salvaged as well as an indication of the fate of many others saved and released from the same area by the officers of the Department of Fisheries. Unfortunately for the experiment and fortunately for the fish, water heights were favourable for migration. In the six days occupied for the project, it was possible to seine and mark a total of 28,673, - 1,796 by the removal of the adipose and both ventral fins and 24,877 by the removal of both ventrals only. Recoveries should be made in 1946.

In the three experiments some 182,000 fry have been marked. This number is considerably less than the 330,000 of 1942. The programs were, however, designed to fill in certain deficiencies in our knowledge of the species. For that reason it is strongly recommended that every effort be made to gather returns at the time when they appear in the fishery.

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Appendix No. 12

Studies of the Food of the Spring and Coho Salmon in British Columbia

During the year 1943, the data obtained from the analyses of 1383 spring and 257 coho salmon stomachs collected in the fishing areas of British Columbia from 1939 to 1942, have been finally summarized and prepared for publication in the Bulletin series of the Fisheries Research Board of Canada. This publication, in more or less popular style, will contain a map showing the collecting areas, actual photographs of the more important items of diet and diagrams of the percentage composition of the food.

In general the food of spring salmon was similar in each year in that fish predominated (Ca. 95 per cent.) and invertebrates formed the remainder. Of the fish, herring and sand lance were most important and, of the invertebrates, "red feed" (euphausiids). In certain areas during 1940 and 1941, small pilchards were abundant. This occurrence coincided with the known distribution of an unusual run of small pilchards in these years. There was some variation in the kind and considerable variation in the proportion of the various organisms between areas and years. For example, on the west coast of Vancouver island sand lance was consistently more important in the Quatsino and the Kyuquot sound areas and herring in the Barkely sound district. Seasonal trends were indicated by the gradual change in length and size groups of the sand lance present in spring salmon taken off the west coast of Vancouver island. No significant difference in the food of red and white spring salmon was demonstrated.

The food of coho salmon was similar to that of the spring in that herring and sand lance were the two most important items. The coho had a greater range of diet and tended more extensively toward invertebrates.

There does not appear to be active selection of the kind of food eaten by either species. Both appear to take whatever food of suitable size is present in sufficient quantity to repay them for the effort.

While the herring must be regarded as an important food of spring and coho salmon, the sand lance was for the most part of equal importance and other fish and invertebrates were also occasionally eaten in large quantity. Before attributing poor salmon fishing to a scarcity of food brought about by the herring fishery, it must first be shown that the poor fishing is due to the low abundance of salmon, and that this low abundance may not have been caused by numerous other factors which might limit numbers and which might not be associated with local food supply.

Thus the general information on food has been gathered and summarized. It is recommended that the collection be discontinued until the need arises for a more intense and detailed study of any area or areas.

A.L. Pritchard

Appendix No. 13

Recoveries from Cowichan River Spring Salmon Marking Experiments

In another summary report in this series, the effort expended in endeavouring to obtain records of marked salmon has been outlined. While many obstacles have been surmounted, and certain valuable information has been obtained for some of the programs conducted by American organizations, little new knowledge has been added to the history of the Cowichan spring salmon.



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Appendix No. 13

During the year 1943, recoveries should have come in from the following experiments initiated at Cowichan Lake hatchery by Mr. Neave and Dr. Carl:

Brood Year	Mark	No. Marked
1937	Adipose and right ventral	21,967
1938	Both ventrals	25,515
1939	Dorsal and left ventral	9,388

Recoveries from 1937 Brood Year

The adipose and right ventral mark employed in this operation was unfortunately duplicated by the United States Fish and Wildlife Service on the same year's spring salmon brood in Delph creek, a tributary to the Clackamas river which empties into the Columbia. Recaptures, therefore, cannot be definitely assigned to one or other of the experiments. Provisions have been made to avoid such conflict in future operations.

Thus far six recoveries have been reported and are here submitted merely for a general record.

- August 17, 1941 - off Seikiu, Washington
- " 25, 1941 - " Long Beach, west coast of Vancouver is.
- June 1, 1942 - " Raffel pt., west coast of Vancouver is.
- " 2, 1942 - " entrance to Ucluelet hbr., west coast of Vancouver is.
- August 12, 1942 - " Rugged pt., Kyuquot, west coast of Vancouver is.
- " 30, 1943 - Sooke traps, south coast of Vancouver is.

Recoveries from the 1938 Brood Year

The double ventral marking used on the progeny of the 1938 brood of spring salmon was not duplicated elsewhere on the same species in the same year. The data collected can thus be definitely assigned.

The following recaptures have been made:

- May 25, 1942 - off Kyuquot, west coast of Vancouver is.
- " 30, 1942 - " " " " " "
- " 31, 1942 - " Sidney inlet, west coast of Vancouver is.
- June 30, 1942 - " Barkley sound, " " " " "
- July 6, 1942 - " Ucluelet, " " " " "
- August 8, 1942 - " Cape Mudge, strait of Georgia
- " 8, 1942 - " Kyuquot, west coast of Vancouver is.
- " 12, 1942 - " Swiftsure banks, entrance of strait of Juan de Fuca
- April, 24, 1943 - " Cape Mudge, strait of Georgia
- June, 12, 1943 - " Ucluelet, west coast of Vancouver is.

Recoveries from the 1939 Brood Year

Although the mark used, viz. - dorsal and left ventral fins, is distinct and separate for the 1939 Cowichan brood of spring salmon, no returns have yet been received.

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The recoveries from these experiments have been few to date but they do indicate that Cowichan springs appear in the fishery mainly in their fourth year and fifth years but some individuals may be taken in the third or in the sixth. They may be distributed as far north on the west coast of Vancouver island as Kyuquot, as well as in the northern portion of the strait of Georgia.

Present spring salmon marking programs at Cowichan have been modified to include many more individuals (in the neighbourhood of 100,000) in the hope that with the additional concentration of marks in the fishery, the number of recoveries may be increased.

A.L. Pritchard

Salmon Marking Experiments on the Pacific Coast

In Appendix No. 15 of the Summary Reports for 1942, the writer outlined the organization of the central recording agency through which combinations of fins could be assigned for each experiment so that no conflicts would exist to cause confusion in the case of sea recoveries. This procedure has been adopted again in 1943 and has resulted in a list being distributed from the Pacific Biological Station embodying notification of the following assignments in Washington, Oregon and British Columbia; Spring - 70, Coho - 40, Sockeye - 26, Pink - 3 and Chum - 4.

The effort put into the collection of sea recoveries from many of these marking experiments was increased slightly. The Canadian area was well canvassed. Several trips were made through the Strait of Georgia area and one to northern British Columbia and the Queen Charlotte islands. All possible canneries and processing plants were contacted. The need for co-operation was outlined in the fishermen's periodicals. The help of the large Co-operative Associations was enlisted. Each fisherman received with his license a letter telling him of the importance of any marked fish which he might encounter. Over 600 posters illustrating the Canadian experiments from which returns were expected, were distributed throughout the fishing areas in prominent places.

When the recoveries were reported, the age of the fish was determined, and the collector was informed of the origin and history of the fish. Awards were forwarded for all organizations through the Pacific Biological Station and inter-organization adjustment was made later. In all 112 records have been handled. Of these 31 were legitimate. The following summary gives an idea of the variety.

Species	No. of experiments producing returns	No. of legitimate returns
Spring	8	20
Coho	4	11

A.L. Pritchard

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It may be maintained that 31 recoveries do not justify one to two month's effort in building up lists of markings, advertising, and requesting co-operation in addition to the time involved in looking after the recoveries. The fact must be remembered, however, that an equal number year after year will eventually result in a large amount of material which should indicate the migrations of the various groups of salmon.

During the next two or three years marked fish from the large Cowichan river experiments should enter the fishery. It would therefore seem wise to maintain and further the co-operation, both national and international, in an effort to collect all possible data from experiments for which the major portion of the work has already been completed.

Ferris Neave

Appendix No. 15

Recoveries of Marked Trout in the Cowichan River System

During 1943 certain recoveries of trout marked and liberated in previous years have been made. These serve to supplement existing knowledge of the movements of fish in these waters. The experiments represented in these recent records can be summarized as follows:

<u>Kind of trout</u>	<u>Brood year</u>	<u>Number released</u>	<u>Place of release</u>	<u>Place of recovery</u>	<u>Number of returns</u>	
					<u>in 1943</u>	<u>total</u>
Cutthroat	1940	921	Meade cr.	Lake	1	6
"	1941	2,044	River	Lake & river	6	16
Brown	1941	1,014	River	River	1	1
Kamloops	1941	52,384	Lake	River	2	5
Steelhead	1939	35,445	River	River	9	35
Rainbow	1940	2,976	River	River	2	57

("Place of recovery" refers only to fish recaptured in 1943)

The nine steelhead recorded were sea-run fish which had returned to the locality (at the upper end of the river) in which they were liberated. Their capture probably indicates a considerable run of marked fish in the river, since they were obtained from a total of only 19 fish examined at this locality during the season. Their presence in 1943 is in agreement with previous findings that the greater number of steelhead breeding in the Cowichan river are four years old.

On the basis of marking and tagging operations carried out during the past few years, the following brief conclusions are presented. Cutthroats show a seasonal migration (not connected with spawning) from the river and its tributaries to the lake during the spring, and irregular local movements at other seasons.

Brown trout show no extensive migrations but move into certain small streams to spawn and tend to congregate in the relatively deep Hatchery pool in summer. Little or no migration to or from the lake takes place.

Kamloops trout have yielded very few returns in proportion to the numbers marked and no mature fish have been recovered. Recaptures of young fish have shown irregular wandering tendencies.

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Steelhead. The offspring of sea-run parents go to sea at an age of either one or two full years. Previous to this they show irregular local movements between lake and river and between river and small tributaries. Adult fish commonly return from the sea in their fourth year.

Rainbow trout tend to remain in the river during their first two years and thereafter to make seasonal non-spawning migrations to and from the lake, where they live during the hotter months. Racial differences between rainbow trout and steelhead are discussed in a manuscript which has been submitted for publication.

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Catch Statistics of the Herring Fishery During 1942-43.

The collection of daily catch statistics using Pilot House Record Books was continued with the assistance of the Department of Fisheries. The returns were satisfactory for fishing areas in the vicinity of Vancouver island but were incomplete for areas to the north where very poor fishing was encountered. As in past years the availability of herring (average catch per seine per day's active fishing) has been calculated from the daily records.

The total catch for the province amounted to 79,035 tons, distributed as follows:

	Tons	Per cent
Queen Charlotte islands	-	-
Northern coastline	-	-
Central coastline	4,563	5.8
Queen Charlotte strait	2,731	3.5
Discovery passage	3,084	3.9
Lower east coast of Vancouver island	51,668	65.2
West coast of Vancouver island	16,989	21.5

Failure of fishing at the Queen Charlotte islands and along the Northern coastline, and the small catch along the Central coastline are attributed chiefly to the failure of herring to appear in inshore waters in quantity during the fishing season. This, in turn, may possibly be related to the cold weather conditions which obtained during January and February, 1943. The best fishing along the Central coastline was encountered at Rivers inlet during early March. Only a small catch was made in the formerly productive Laredo inlet and Meyers passage area. The quotas (20,000 tons, Northern; 40,000 tons, Central) were not attained.

In the Queen Charlotte strait area, fishing showed some improvement and the availability (23.5 tons) was higher than in the two previous years (13.9 and 14.9 tons), possibly related to the fact that fewer boats were fishing. The fish were taken chiefly from Clio channel and the head of Knight inlet. The quota of 8,000 tons was not reached.

In the Discovery passage area, most of the fish came from Deepwater bay and the availability (23.5 tons) was somewhat greater than in the previous year (18.1 tons) although still relatively low. The quota of 5,000 tons was not reached.

Along the east coast of Vancouver island there appeared to be an abundance of herring and two extensions were granted allowing a total of 50,000 tons of fish to be taken. Fishing was centered at Nanoose bay in October and November (23,411 tons), at Satellite channel during November and December (20,497 tons) and at Deep bay in January (7,760 tons). The availability for the area was high (86.6 tons) although slightly less than that of the previous year (97.3 tons). There is no proof that the heavy fishing of the last two years has seriously reduced the spawning population in general, although in at least one area (Nanaimo) where large catches were made no spawning took place for the first time in many years.

On the west coast of Vancouver island fishing remained sporadic, as has been the case in the last few years. The catch, slightly less than that of last year, and considerably below the 25,000 ton quota, was attained

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only through time extensions beyond February 5, granted for all areas. Good fishing was encountered at Cuoukinsh inlet in December and at Queens cove and Quatsino sound in February. In the latter area, the sub-quota of 3,000 tons was reached. The average availability for the west coast was 27.1 tons compared with 21.0 tons in the previous year. Spawning reports indicate that there has been no substantial increase in the spawning population as a whole. Fishing cannot be expected to improve under existing conditions unless a particularly successful year-class enters the fishery.

A. L. Tester

Appendix No. 17

The Recovery of Herring Tags During the 1942-43 Season.

The current programme is a continuation of an investigation designed (1) to add to the general knowledge of the life history of the herring, (2) to determine the extent of herring movements, and (3) to determine the strength of the tendency for herring to form local populations. As in previous years, internal metal tags were recovered by induction detectors located in the conveyor systems of canneries and by magnets in the meal lines of reduction plants. The results for 1942-43 have been published in the Report of the British Columbia Fisheries Department for 1942, but are reviewed here briefly.

Two induction detectors were used throughout the 1942-43 season, one at the Imperial Cannery and the other at the Gulf of Georgia Cannery, Steveston. In the latter, a new method of trapping the tagged fish, involving recovery from a moving belt by means of hinged gates, was used successfully. In spite of considerable time spent during the summer in overhauling the equipment, electrical difficulties developed in both detectors which were eventually overcome but which required the constant attendance of the writer during October and November. In spite of these difficulties, the Imperial detector (operated by A. Paul) ran efficiently on 75% and the Gulf of Georgia (operated by F. Johnson) ran efficiently on 65% of the fish passing into the plant and together they succeeded in recovering 77 tags. In addition, magnets and incidental recoveries contributed 190 tags.

In general, the results for 1942-43 agreed with those of previous years in showing the relative independence of the populations in major areas. However, the degree of mixing which took place was apparently somewhat greater than in former years even after correcting the data for differences in the tonnage taken on the various fishing grounds and for discrepancies introduced in the returns by canning operations. There was a dispersal, probably of considerable magnitude, of Queen Charlotte strait fish to northern fishing grounds of the strait of Georgia (Deepwater bay and Deep bay) and to southern fishing grounds of Central British Columbia (Rivers inlet). There was also a dispersal of some Central British Columbia fish to the more westerly fishing grounds of the west coast of Vancouver island.

As in past years, there was a tendency towards segregation of the populations within major areas. This was the case on the west coast of Vancouver island, although there was a considerable movement of Quatsino sound fish to Cuoukinsh inlet. It was also the case in the strait of Georgia; fish tagged in the northern part of the strait were recovered mostly from northern