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REPORT OF THE
PACIFIC BIOLOGICAL STATION,
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FOR 1940

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INTRODUCTION

The main objective of the work of the Pacific Biological Station is to undertake those scientific studies of the commercially important fishes of British Columbia which will provide the Department of Fisheries with accurate data for its guidance in establishing suitable regulatory and conservation measures for the continued safe exploitation of the fisheries. Some of these studies, - those recently commenced, - are fairly general in nature and result in an increase in our knowledge of life-histories, etc. Others have been carried somewhat further and embrace particular features, such as growth rate, migration, variation in abundance, etc. Then there are those that have reached the point where fundamental factors governing the reactions of the fish are being investigated, such as those which control migration, those which produce variations in growth rate, abundance of fish, propagation, etc. All are definitely of what might be termed economic importance as well as of scientific value but some naturally seem of more obvious significance than others. As research progresses, however, the fundamental phases become the primary concern of investigation and, in final analysis, they constitute the essential problem. They hold in so many cases the key to the explanation of the phenomena which, on the surface, are of importance in regulation and conservation.

The work of the Station during 1940 has progressed most satisfactorily. Some investigations have made notable progress. Others have added a wealth of data which has yet to be analyzed. Some have encountered obstacles which have had to be overcome before further advance could be made and in some cases other more pressing problems have interrupted the main research. Nevertheless the contributions for the year are quite gratifying.

In three studies, salmon, herring and shell-fish, where the research is passing into the more fundamental stages of population densities and variations therein, whether on the spawning grounds or in the feeding areas, in the sea or in the streams, of propagation efficiencies, etc., it is becoming increasingly necessary to keep well abreast of the literature. Research elsewhere is expanding and advancing so rapidly that, relatively speaking, the opinions of today are replaced tomorrow by new ideas revealed by some new method of attack. The staff members have kept themselves fully in touch with the published literature and, by correspondence or personal contact, are made

acquainted with current research in other institutions. Thus they may properly analyze the data collected and arrange their research programs and methods to conform to the newer approaches and understandings. This requires a considerable portion of their time yet is effort well invested for it undoubtedly eliminates ineffective and inaccurate methods and interpretations.

The unsettled conditions within the Dominion, brought about by the war situation, and the concentration of effort throughout the country designed to meet the demands created are clearly appreciated. Every member of the staff is prepared to co-operate in whatever way he can best serve. For the present the attitude adopted is that in prosecuting his research as keenly as possible, a valuable service is being rendered but there will be no hesitation if, in the opinions of those directing the policies of the Station, the individual effort may better be expended in another direction. As suggested in last year's report there may arise need for intensification in certain investigations and initiation of new ones. At the same time there are a number of studies in progress in which a break in the continuity of observations or collections of material would be rather serious. These can probably be carried forward, in skeleton fashion at least, while diverting most of the effort elsewhere.

With reference to staff changes during the year, the most important undoubtedly was the resignation of Dr. Clemens from the Directorship after sixteen years' continuous occupancy of that position. During that period Dr. Clemens has seen the scientific staff increase from two to eleven. The extent of the research increased accordingly. The organization and supervision of such expansion was no small undertaking and there is abundant evidence that Dr. Clemens' endeavours and leadership were eminently successful. Dr. Clemens accepted the position of Head of the Department and Professor of Zoology at the University of British Columbia and it is heartening to know that in that office he will continue his interest in the work of the Station and be ever ready to lend advice and assistance whenever desired.

A second staff separation occurred in September when Dr. G.C. Carl accepted the position of Assistant Director, later Acting-Director, of the Provincial Museum at Victoria. In his research connected with the Cowichan lake investigation Dr. Carl had undertaken a very comprehensive and ambitious program of limnological and fresh-water biological studies, intended to demonstrate the relationship between the trout populations and ecological conditions, food, etc. in the lake. Dr. Carl was also keenly interested in conditions governing the artificial propagation of salmonidae and the pond rearing of young.

Perhaps it would not be too out of place for the writer to indicate here his great pleasure in returning again to the service of the Board, particularly at the Pacific Biological Station. It is earnestly hoped that the high quality of the work will be maintained and the interests of the Board as keenly prosecuted. The members of the staff have co-operated most generously and a very stimulating feeling of fellowship and mutual interest in the Station's success prevails.

Another development of considerable interest and grave concern occurred when Mr. Wm. Anderson, Technician in the Chemistry laboratory, suffered severe injuries from an explosion on October 18. Mr. Anderson had been carrying through a routine recovery of silver nitrate from a mixture of concentrated nitric acid and metallic silver, the latter previously reclaimed from an accumulation of silver chloride, the product of chloride determinations of sea water. Most of the silver nitrate had been recovered successfully but in the process of washing the last small lot with alcohol, the mixture exploded in the beaker. Two fingers of his left hand were so badly injured that they had later to be amputated and his right ear was severely cut. The greatest concern, however, was felt for his eyes into which had been blown some of the silver nitrate and alcohol. Mr. Anderson was given first aid treatment, rushed immediately to the hospital and medical aid summoned. Suffice it to say that he is still in hospital having recovered from all other injuries except his eyes and these are clearing up gradually, the left one rather slowly. His sight, it is expected, will not be seriously impaired.

A court of inquiry, consisting of senior members of the staff, was set up after the accident to investigate the cause and fix responsibility. It was the finding of the court that apparently in the recovery procedure, after nitric acid and the silver had been combined, some nitric acid and free silver must have been present when the alcohol was added and thus silver fulminate, a very unstable explosive, was formed. When the crystals of silver nitrate were dried and scraped in the act of removing them from the beaker to an evaporating dish, sufficient friction was applied to detonate the fulminate. In view of the fact that (1) the recovery method had been tested before being adopted and had been satisfactorily used on a number of previous occasions, (2) all of the steps in the procedure were standard chemical practice when considered individually and (3) the possibility of fulminating silver being produced had been investigated by Mr. Tully, by reference to standard inorganic chemistry texts, no responsibility for the accident could be fixed. Needless to say the procedure for recovery of silver nitrate was immediately changed.

During the year three members of the staff, Messrs. Neave, McHugh and Anderson, joined local units of the non-permanent active militia. This involved weekly training periods and a two-weeks' residence in camp. Mr. McHugh recently completed his Officers Training Course and has been gazetted as a 2nd Lieutenant. Mr. Hollister is now serving his thirty day training under the National Resources Mobilization Act, although not yet called, in order that his proposed work on Alberni Canal during the next year will not be interrupted.

In concluding this general section of the report, thanks are tendered, on behalf of all members of the staff, those officials of both Federal and Provincial Fisheries Departments who have assisted so generously with information or facilities during 1940. The happy relationships thus existing add greatly to the interest in and success of the work. The Provincial Fisheries Department continued to share financially in the herring, pilchard and shellfish investigations.

Salmon Investigations

Pink Salmon.

The pink salmon investigation at McClinton creek, Masset inlet, Queen Charlotte islands, under the direction of Dr. Pritchard assisted by Mr. Cameron, is now the principal salmon study undertaken by the Station. It is essentially a direct study of the natural propagation of the pink salmon in situ, i.e., under definitely natural conditions. The primary objective has been to follow through, from the arrival of the mature adults upon the spawning beds to the seaward migration of the fry, the various stages of spawning, embryo, alevin and fry development. The conditions prevailing at each stage and the factors affecting survival and mortality are investigated, hence the critical periods of development and the factors affecting them are revealed. By such means a better understanding of the variations in productivity in different years, as resulting from varying physico-chemical conditions or varying numbers of spawners on the beds, etc. is obtained.

By marking portions of the seaward migration by removing certain fins, an attempt has been made to trace the return of pink salmon to the creek. Information is being obtained as to the route of migration from the sea, areas in which the returning run is subject to drain through commercial fishing, the possible wandering of spawners to other areas or streams, and the degree of return to the parent stream.

In addition, data are obtained as to size, sex ratio, etc. of returning adults, size and condition of seaward migrants and physico-chemical factors affecting migration.

During 1940, the return of adults to McClinton creek was studied, this being the sixth such count made. A very moderate run occurred, 35,525 individuals. The 16,454 females, having an average egg content of 1,619 eggs, indicated a potential deposition of 26,500,000 eggs. This run of 1940 was the return from the spawning of but 10,577 adult pinks in 1938, demonstrating again a very unusual correlation in which after a "small" year a significantly larger return results, and vice versa. Of course the extent of the relative commercial catch each year is an integral factor in such a relationship and until further information is available concerning these catches, no conclusions can be derived. From the recovery of marked adults in the commercial fishery in 1940, it was found that some recoveries were made in Alaskan waters. This indicates that the Alaskan fishery may in some years exploit the Masset inlet pink salmon run to a certain extent. Until a clear picture of the migration of adult pinks from the sea and the points of commercial drain are known, together with some general data as to the extent of such drain, the complement reaching the spawning stream means little. With further reference to the return of marked adults in 1940, it has again been found that much the greater recoveries were made in McClinton creek or in the Masset inlet fishery. In spite of careful observation of the pink salmon fishery of the Nass, Skeena river and more remote fishing areas, only 2 returns of marked pinks were obtained, both from the Skeena. For Masset inlet itself, examination

of samples of pink spawning in tributary streams showed that while 791 marked individuals were taken in McClinton, one was found in the Mammon river, out of 3,400 examined, and one in the Detlamen out of 400 observed. These latter recoveries indicate that possibly some slight wandering of spawners to streams adjacent to the parent stream may occur.

One interesting study at McClinton creek has been the distribution of spawners on the spawning grounds and the effect of freshets upon such distribution. By tagging the fish as they pass the counting fence in such a way that they can be individually recognized again, it has been found that, immediately before or during a rise in creek level, the fish proceed to the upper areas of the stream. Those tagged after the peak of the rise congregate in the lower reaches. When a later freshet occurs if these latter are approaching maturity, they move farther up along with new arrivals. If, however, they are about to spawn, they pass into the adjacent shallower water and begin to construct their nests.

This study has incidentally provided valuable information concerning the accuracy of using tagging of a small fraction of a run to estimate the size of that run. Such a scheme has been suggested for streams where counting fences are not practicable. It is found that since the distribution of fish in a stream is not random, but influenced by water conditions such as freshets which affect also the proportion of fish tagged at that time, serious error must inevitably result unless a large portion of the dead fish population can be examined throughout the length of the stream and the season. This is an important problem and is being given more statistical study.

Another promising phase of the pink salmon investigation relates to the losses occurring during incubation of the eggs. Natural redds are marked after spawning has been completed and careful examination made during the winter and spring to determine the percentage loss during various stages of development. Critical periods of survival are thus indicated. Factors affecting the survival at each stage are also investigated. The data are being obtained by Mr. Cameron who is spending the winter at McClinton.

Racial studies of pink salmon have also been commenced, with particular reference to gill raker, pyloric caecae, vertebrae and scale counts. The value of such work in isolating different races or populations is being tested. If significant differences are obtainable, the method has a wide usefulness.

Sockeye Salmon.

The only sockeye salmon study conducted during 1940 was the annual analysis of the size, age and sex ratio of the catches in the Rivers inlet, Skeena and Nass river areas during 1939, by Dr. Clemens, on behalf of the Provincial Fisheries Department. It represents the twenty-eighth consecutive report on these sockeye populations.

Age-classes were present in all areas in practically the same ratios as in former years, but sizes varied notably. For Rivers inlet both lengths and weights were low; for the Nass the lengths were somewhat higher, the weights somewhat lower than average; while for the Skeena the lengths were considerably above the average for the past 27 years of record, and the weights decidedly below the past twenty-five year aver-

age. For the Skeena the sex ratio showed a very low male representation, only 38 per cent, the lowest in twenty-five years.

Chum salmon.

During the spring of 1940, a preliminary investigation of chum salmon natural spawning in two small streams near Ladysmith was made by Dr. Pritchard and Mr. Cameron. While conditions did not permit an early study of the nests after spawning, to determine the percentage of fertilization, the subsequent data suggest that, in general, fertilization was probably high, comparing favourably with that, approximately 98 per cent, found elsewhere for sockeye and pink salmon. The nests were dug up when the eggs were well advanced. The results indicate a variation in mortality of from 2.0 to 100.0 per cent depending largely on the type of gravel in which the eggs were deposited and the subsequent degree of silting. Further work of this nature with attention paid to the amount of stream bed of each type of gravel, numbers of fish frequenting same, and possible means of improving unfavourable areas, would have very definite practical importance.

An attack is being made also, by Dr. Pritchard, upon the age analyses of chum salmon runs to various areas and streams. This is essential to determine the incidence of cyclic runs and general growth rates. Racial analyses may also be undertaken in the future to determine the probability of segregation of runs to different river systems, etc.

Spring Salmon.

The study of the natural food of spring salmon in various areas of the British Columbia coast, initiated in 1939 by Drs. Pritchard and Tester, has been continued during 1940, with the collection of double the number of stomachs, 618, and an increase in the areas of collection. The results have not been completed but from an examination of 124 stomachs from the west coast of Vancouver island, from March to June, it was found that the contents, - sand lance, young herring, euphausiids and anchovies, - were roughly similar in quantity to the previous year's findings. Young pilchards appeared in some stomachs, these fish showing up quite unexpectedly along the coast during the season.

Dr. Pritchard completed a study of the ages of spring salmon taken in the troll fishery, from 1927 to 1930. A total of 2,834 samples of scales were read. For west coast of Vancouver island areas, the average age increased as the sampling area moved north. Samples at Ucluelet had an average age of 3.8 years; at Kyuquot and Quatsino - 4.4; off the Queen Charlottes - 5.5 years. Samples from "offshore" areas contained older fish - average age, 5.0 to 5.6 years - than "inshore" districts, such as Hecate strait, Milbanke and Fitzhugh sounds, etc., where the average age ranged from 3.7 to 4.4 years.

The explanation suggested is that the young fish migrating from their natal streams, Columbia, Fraser, etc., move northward along the coast of Vancouver island on a leisurely "feeding" migration, and subsequently return on a more rapid spawning migration. Catches providing a cross section of the spring salmon population will include more immature fish in the south while the northern samples will contain preponderantly older fish near the limit of their northern movement. Similarly for inshore and offshore populations.

Coho Salmon.

As part of the Cowichan river investigation, carried out by Mr. Neave and Dr. Carl, certain work was done on coho salmon which might here be reviewed.

The production of young coho from two small streams, Oliver and Beadnell creeks, adjacent to the Cowichan lake hatchery, was studied. Counting fences permitted a count of the adult spawners entering the creeks and the young fish passing seaward. In Oliver creek, from a presumed deposition of 665,000 eggs, 78,789 fry or fingerlings were obtained, or 11.84 per cent of eggs deposited. In 1939, a survival of 15.52 per cent was reported. In Beadnell creek, from 433,000 eggs, 174,036 young cohos resulted, or 40.01 per cent of eggs deposited. The notable difference in per cent survival was accounted for, in part at least, by the presence in Oliver creek of considerably more predator fish, particularly cutthroat trout, viz. 985 in Oliver and 231 in Beadnell. Other fish, coho yearlings and brown trout, were present in the creeks in relatively the same abundance.

In 1938 and 1939 young cohos of the brood of 1937, which had been reared in the hatchery, were marked and liberated in the upper Cowichan in the vicinity of Oliver creek. A total of 26,000 fingerlings was used, being marked by the removal of adipose and left ventral fins. During 1940 rewards were offered for the recovery of such marked cohos, and to date fifty-nine have been reported from the fishery. They were taken in areas extending from Cape Flattery, through Puget sound and lower Georgia strait, to Cape Mudge at the south end of Seymour narrows. Twenty-two were taken in commercial gear, the remainder by anglers, chiefly in Cowichan bay.

In the Cowichan river itself, complete counts are possible only at Oliver creek, to which had already returned 127 coho, of which 93 were marked. Further data are being collected. Nevertheless the tentative findings indicate the value of such work in tracing the extent of migration of salmon from known streams or rivers and the extent to which the fish form a part of the commercial fishery

Mortality among Salmon.

Again in 1940 a sudden mortality of salmon occurred, this time in Cowichan bay and involving primarily spring salmon. About 500 deaths are reported to have occurred and sport fishing was largely at a standstill for two weeks. The writer and Mr. Tully investigated the situation, at the request of the Department through the Fisheries Officer, Mr. Sherman, and after a number of visits to the bay concluded that unusually high alkaline conditions of the water very likely caused a disturbance of the respiratory system which proved fatal. No factors such as dynamiting, poisoning, etc. seemed to be involved. The occurrence but emphasizes the need for further knowledge of the optimum limits of tolerance of salmon to environmental factors and conditions.

Cowichan River Investigation

As intimated in the report for 1939, the problem in the Cowichan river system investigation is to determine the deficiencies in the production of the various fish, rainbow, cutthroat, and brown trouts, spring, coho and chum salmon, and to develop effective measures for overcoming them. In short, some type of fisheries management was desired. The river system, including Cowichan lake and tributaries, is too large for a general, inclusive program of study, hence certain features only could be studied. These have been selected for their general applicability and for their fundamental importance. It was the hope of the investigators, Mr. Neave and Dr. Carl, that in time the data could be all gathered together and a general understanding of the system and the necessary management scheme derived.

For the salmon one of the first endeavours was to obtain some measure of the anglers' catch in Cowichan bay in order that the variation in this drain from year to year might be determined. At the same time the composition of the run, as sampled by angling gear, could be revealed, as to age, size and sex ratio of individuals. For coho, only two age classes are commonly found, two-year grilse and three-year adults. For spring salmon, while four and five year individuals most commonly appear, others of two and six years may occur.

A comparison of the angling activity of 1939 and 1940 indicates that while for a similar period, August 23 to October 31, the number of line-hours dropped from 19,006 to 16,707, the catch of large spring salmon was doubled (553 to 1,121) while that for "Jacks" decreased from 750 to 292. The 1940 catch of coho was much reduced, from 3,410 large and 1,069 grilse to 1,599 and 160 respectively. The abundance of small fish varies exceedingly from year to year, and is only very indirectly indicative of a trend in the fishery. The general result of the two-year comparison is reflected in the line-hours per fish index, which was 3.3 for 1939 and 4.8 for 1940.

For trout, a study was made of the seasonal variation in Cowichan lake pool, below the lake, which is the most productive stretch of the river. Gill nets were used to sample the population. Rainbow trout proved to be the dominant form during winter, September to May, while brown trout were most abundant in July and August. The summer decline of the rainbow is attributed to a migration to the lake during late spring, that of the brown trout in early winter to their spawning migration to the small river tributaries. The brown trout appears to exhibit a stronger tendency to remain in the river during the summer than the rainbows and hence are tending to fulfil the hopes of the anglers. The rod catch of brown trout, however, is not proportional to their percentage occurrence in gill-net catches, presumably because there is less fishing in summer months and the feeding habits of the browns give them greater protection from anglers.

One problem in the Cowichan sport fishery has been to determine definitely the relationship between sea-run and stream-dwelling forms of Salmo gairdneri, the steelhead. Three varieties seem to be present in the system, the normal sea-running steelhead and a fresh-water type, provisionally termed "rainbows", and also Kamloops which have been introduced. To get accurate data, specimens of each type have been raised

in the hatchery, marked and then liberated in the river. Subsequent recoveries by anglers and others will permit collection of size measurements, scale samples, and other material for racial analysis.

During the year a limnological study of Cowichan lake was continued by Dr. Carl. This involved chiefly regular periodic temperature readings at fixed stations and determination of oxygen content and pH. Quantitative plankton samples were taken in vertical series at regular intervals by means of a plankton trap. The data are being analyzed.

During the summer Mr. Idyll continued his study of the food habits of the trout of Cowichan river and lake. Additional data concerning the natural food and feeding of the rainbow, cutthroat and brown trout were obtained, to be added to a very comprehensive and valuable report now in preparation. A quantitative study of the bottom fauna at a series of stations in the river and tributaries was also made by Mr. Idyll.

Ocean Fisheries Investigations

Herring.

The herring investigation represents perhaps the most direct and comprehensive biological study of a fisheries yet undertaken by the Station. It embraces a thorough study of the trend of the abundance of the populations, spawning intensity from year to year, age composition, intensity of the fishing effort, etc., as well as pertinent biological features such as migration, distinction of races and the characteristic features of populations, e.g., size, vertebral counts and rates of growth. The work has been carried on by Drs. Hart, Tester, Boughton and Mr. McHugh.

At the present time four major herring fishing areas are recognized, namely, west coast of Vancouver island, east coast of Vancouver island, central area of the mainland coast and northern area (Queen Charlotte islands, Prince Rupert, etc.). These are believed to have distinct populations of herring, with very little if any, intermingling. Hence the exploitation of the fisheries therein represents separate problems and involves individual study.

During the 1939-40 season the system of Pilot House Record Books was continued. This provides for the collection of daily catch statistics whereby the catch in each area and the fishing effort involved can be calculated and the availability of herring computed as the average catch per seine per day's active fishing. The total catch in 1939-40 amounted to over 150,000 tons, the largest in the history of the fishery. The old established areas of the east and west coasts of Vancouver island contributed 32%, the central area, 37%, the northern area, 18%, and 13% was taken on new grounds on the north-east coast of Vancouver island (Alert bay area). Comparison of the abundance of herring in the respective areas with previous years, as indicated by availability figures, shows that, on the south-east coast of Vancouver island, herring were less abundant and individual sets were smaller (83.6 tons per double seine per day); on the west coast, while still very poor, the fishing improved slightly (17.5 tons); in the central area the catch (78 tons/