R. S. Isaacson

CONFIDENTIAL

FISHERIES RESEARCH BOARD OF CANADA

- - - - - - - - - - - - - - - - -

ANNUAL REPORT

of the

PACIFIC BIOLOGICAL STATION

for

1948

C 2

With Investigators' Summaries as Appendices

by

R. E. Foerster, Director

NANAIMO, B.C. DECEMBER, 1948

FISHERIES RESEARCH BOARD OF CANADA

Report of the

Pacific Biological Station

Nanaimo, B. C.

for 1948

by R. E. Foerster, Director

The research activities of the Station during 1948 continued essentially along the same lines as in previous years, the objective being to elicit those biological facts concerning our commercially important Pacific coast fishes which have a significant bearing on their production and which are basic to proper and effective regulation and management. The total value of the British Columbia fisheries in 1947 amounted to $58,764,950 (according to the Advance Report on the Fisheries of British Columbia, 1947, issued by the Dominion Bureau of Statistics, November, 1948). Maintenance of this natural resource at a high level of exploitation is most desirable. The wider and more intimate our understanding of the factors governing sustained optimum natural production of our fish and of the effect of present fishing operations upon the stocks the more efficient the management regulations or policies can become in endeavoring to provide maximum catches consistent with adequate perpetuation of the species.

The major investigations included (1) a study of the sockeye salmon fishing of the Skeena river to determine whether the relatively low catches in recent years indicated a true decline and, if so, what were the contributing factors and how could they be overcome, and, further, what measures might be adopted to increase production of salmon for the commercial fishery, (2) a study of the runs of Pacific salmon, especially pink and chum, to all sections of the British Columbia coast and the factors affecting production, particularly those which might be contributing to the great variability in the extent of the runs from year to year, (3) a comprehensive study of the populations of herring frequenting the various coastal areas and contributing heavily to an important fishery and (4) a study of those species of fish which enter into the otter trawl fishery. This last is a somewhat more complicated problem than the others since there are three species of flat fish involved (brill, lemon sole, rock sole) as well as several species of round fish (ling cod, gray cod, black cod, dogfish and rockfishes). For the round fish the problem of competition with other types of gear also enters into the study.

During the year very satisfactory progress has been made in all investigations, as will be noted in the more detailed statements that follow. More essential information has been obtained and the significance of previous data more clearly determined. Gradually our findings are becoming of greater and greater value to the Department and to industry. For example, reference may be made to the fact that this year the salmon and herring researchers felt they had acquired a sufficient understanding of the factors governing the variations in production and in return of fish to the fishing areas that they might offer tentative predictions to the industry as a guide to possible extent of catch.

The reliability of these predictions rested solely on the reliability of the information available and the predictions were therefore subject to certain modifications if abnormal circumstances prevailed but, as it turned out, they were reasonably correct and of much significance. We are informed that such predictions are very valuable to the fishing industry, especially for those fisheries which fluctuate appreciably from year to year. As our understanding of the factors influencing variability in abundance develops the significance of our predictions should increase. It might here be mentioned, in passing, that pilchard studies a few years ago had reached a stage where reliable predictions of abundance each year could be made. Unfortunately the last prediction was for a severe decline in abundance due largely to no influx of new age-classes entering the fishery. This prediction was so well borne out that there has been no pilchard fishery for three years and our pilchard research has become temporarily very much reduced.

In addition to the four major investigations referred to above, the Station has been conducting a number of minor studies - those relating to crab, shrimp, oyster, anchovy and eulachon - in which only certain pertinent features have been investigated as funds, facilities and availability of material permitted. In many of our minor fisheries, at least presently minor, it does not seem advisable to devote too comprehensive attention to them at the moment. Consequently only certain phases, such as migration, catch statistics, reproduction, etc., are being considered with a view to answering immediate questions and eventually rounding out the studies as conditions permit.

Two new studies were commenced this year. These were whale and albacore. The first season's operations were largely exploratory and preliminary, but nevertheless very interesting and profitable. They serve to represent somewhat of a phenomenon, namely, the initiation of scientific study of a fishery before the fishery has shown a ruinous decline with all features very much abnormal. What the future of either of these fisheries will be remains to be seen, but for the albacore, the fishing for which was very profitable for many trollers this season, there will certainly be much interest aroused in 1949. The question as to whether albacore have always been present in off-shore waters cannot be answered with available data. Observations another season should be exceedingly revealing. If albacore do appear again in 1949 it may be very desirable to undertake a well-designed survey of the coastal region to compare the oceanographic conditions in the waters in which the tuna are present with those in which they are not found, thereby perhaps revealing those factors which govern their distribution and their appearance or disappearance in our waters. At the same time a comprehensive morphological study should be made to determine whether these albacore are racially the same as those taken in more southern waters or off the coast of Japan.

It has been emphasized by the Pacific Sub-Executive Committee, unanimously supported by the industry, that greater attention should be given to our Pacific salmon problems, particularly pink and chum salmon in those coastal areas where the runs have greatly declined. Such an agitation has much justification. It is particularly justified since studies to date have revealed that conditions in the streams affecting spawning and hatch of fry govern the production of fish to a much greater extent than any limitation of fishing is likely to do. In three out of four tests of chum salmon fry survival in recent years, the survival percentages have been so low that even with total closure of the com-

mercial fishery it is questionable whether the decline in the production of fry would have been arrested. If the decline in the fishery has been due to changing conditions in the streams which have reduced the level of fry production to too low a figure for maintenance of the species even with complete elimination of fishing, vigorous measures of stream improvement, water control or artificial propagation may be required. An appreciable expansion in the General Salmon Investigation programme would permit operation of a larger number of test streams in more areas and provide the necessary data on conditions governing fry production in quicker time.

It seems desirable to refer again to the growing need for a comprehensive oceanographic investigation of our Pacific waters, both coastal and offshore. For a number of years a valuable and illuminating series of data has been built up respecting temperature and salinity conditions in coastal areas - these data obtained from observations and water samples taken daily by certain lighthouse attendants along the coast. With the very promising possibility that it will soon be possible to get accurate statistics of fish catches according to the area of capture, it may soon be feasible to attempt correlations of fish catches (an approximate measure of abundance) with these coastal-water physical factors, but this would represent only one part of the picture. The conditions in offshore waters are perhaps of greater significance, certainly as related to movements or migrations of pilchard, albacore tuna and some species of salmon. Particularly for prediction purposes the knowledge of what the conditions are in the ocean, what variations are taking place, is essential.

It is our opinion that such an oceanographical investigation should embrace all the essential physical and chemical factors (temperature, salinity, oxygen, nitrates, phosphates, carbonates, etc.) likely to be of significance and all the biological factors (phytoplankton, zooplankton, larger marine fauna and fish) in order to establish their relationships and select, eventually, those "key" indicators which may be found to represent the changing conditions generally and which may be useful as guides for prediction of availability or abundance of fish from year to year.

Actually very little is known about the annual and seasonal changes in oceanographic conditions taking place naturally in any marine habitat and the time seems ripe for a fundamental study of a more or less enclosed salt-water lagoon or bay in order to determine what happens therein from season to season and from year to year and how the natural changes affect fish populations. Such a study might well be instituted to parallel the more general coastal and offshore oceanographic investigations.

One investigation which the Station has continued for many years, firstly under Dr. C. R. Elsey, then under Mr. D. B. Quayle and latterly under Mr. Neave, has come to an end, namely that dealing with shellfish, chiefly clams and oysters. This work has for some years had financial assistance from the Provincial Fisheries Department. During 1948 that Department has set up its own biological division under Dr. Quayle and is now in aposition to take over this work which comes directly under its jurisdiction and which it proposes to expand by giving scientific advice on proper culture procedures, etc., to growers. The Station has long enjoyed the very excellent association with the Provincial Fisheries Department and its Deputy Minister, Mr. G. J. Alexander. It looks forward to its continuance, wishes the Department and Dr. Quayle every success in the shellfish work and offers its facilities at any time.

REVIEW OF INVESTIGATIONS

Skeena River Salmon. According to the terms of reference this investigation, commenced in 1944 with the objective of determining (1) whether the sockeye fishery had suffered a decline, (2) if so, what factors had been responsible and (3) what measures might be used to increase the populations, was required to assess its results at the end of five years and submit a report of its findings and recommendations regarding further research to be done. This being the final year and with the report to prepare, the field operations were largely restricted to only those required to complete pertinent series of data. During the season Dr. Pritchard, who was in charge of the investigation, left the service of the Board and it fell to Mr. Milne, assisted by Messrs. Withler, McMahon, McConnell and Foskett to continue the field operations as originally planned.

The season's programme included, as in past years, (a) the marking of seaward migrating sockeye smolts from Lakelse and Babine lakes in order to trace the return of these races from the sea, through the fishery and to the natal breeding grounds, (b) the total count of migrants from Lakelse lake in order to determine percentage efficiency of natural propagation to this stage, (c) certain limnological studies at Lakelse, Babine, Morrison and Bear lakes, (d) tagging of salmon in the estuary of the Skeena to determine degree of exploitation by commercial and Indian fisheries and distribution to the spawning areas, and (e) spawning stream surveys to estimate the spawning escapement.

Due to abnormal flood conditions at Lakelse lake, the counting fence was rendered inoperative during the early part of the migration and a count of the outgoing sockeye smolts was impossible. Furthermore, only a few (4,709) of yearlings were marked. (Appendix 1 and 2). At Babine, capture of migrants by trap was again successful and a marking of 103,906 smolts resulted. These fish will return in 1950 and 1951. (Appendix 3).

Anticipating the return of marked adult sockeye from marking experiments at Lakelse and Babine lakes in 1945 and 1946, observers were stationed at all Skeena canneries during most of the fishing season to recover the marked individuals from catches landed. For the Lakelse group a very small percentage was obtained (0.07%), confirming information from tagging experiments that much of the Lakelse run of sockeye had passed the fishing areas before the season opened. For the Babine group a greater recovery was made (0.37%). Recovery of marked fish at Lakelse and Babine lakes was difficult since inoperation of the counting fences made it impossible to examine all fish readily and reliance had to be placed on observing marked individuals in the streams. It is hoped that better success will attend this work next season when a much larger number of marked adults should be available. (Appendix 4).

Tagging of salmon, chiefly sockeye, at the mouth of the Skeena resulted in 2,329 tags being affixed during the season. Subsequent recoveries were as follows: commercial fishery - 21.8%; Indian fishery - 11.1% and spawning grounds - 3.3%. The percentage recovery from the commercial fishery is relatively low as compared with other seasons (1944 - 40.1%; 1945 - 25.5%; 1946 - 30.1% and 1947 - 18.6%) and may have been due to inclement weather coupled with high water conditions. As in other years the Indian fishery exploited the

early run most heavily. Recoveries from the spawning grounds indicate that the Lakelse lake run occurs early and the greatest concentration of Babine sockeye enters the fishery in mid-season. (Appendix 5).

Lake surveys (Appendices 6 - 9) were confined to routine physical, chemical, meteorological and plankton studies at specified stations which have been maintained since 1945. A certain amount of gill netting was undertaken, except at Babine, in order to compare catches in 1948 with those of previous seasons. A series of net sets at Lakelse during February provided interesting data in comparison with summer sets.

Spawning stream surveys indicated a probably very limited seeding at Lakelse, (Appendix 10), a surprisingly heavy escapement to the Kispiox area (Appendix 11), excellent seeding in the many streams of Babine lake (Appendix 12) and a relatively poor escapement to Bear lake (Appendix 13). It was decidedly unfortunate that a washout occurred at one end of the Babine counting fence early in the season (Appendix 14), thus making the structure quite useless. Floods and abnormally high water occurred in all Pacific coast areas this year. Much of the repair work has been completed; the remainder will be done during low water next spring.

Predictions on the extent of the sockeye run in 1948 were that the low catch of 1947 would not be repeated and that as high as 60,000 cases might be obtained. The pack of approximately 90,000 cases was unexpected and was due in large part to an influx of four-year fish (Appendix 16), heralded, we now realize, by the large number of three-year-old grilse or "jacks" which were observed last year. It will be of interest to see whether a heavy run of five-year fish occurs next season, 1949. Analysis of the age composition of Skeena river sockeye (Appendix 18) reveals that in most years the five-year-old fish predominate, though in some seasons four year olds are more abundant.

General Salmon. This investigation, directed by Mr. Neave with Messrs. Hunter, Wickett and Robertson assisting and supervising some of the field operations, has as objectives an understanding of the present conditions of salmon fisheries along the coast, particularly pink and chum, an estimation of future runs and trends, a study of the factors governing the natural production of fry and seaward migrants and the development of methods for increasing such production. (Appendix 19).

In order to determine what takes place under natural conditions during spawning, during incubation and hatch of eggs and during seaward migration, two field stations have been established, one at Nile creek on the east coast of Vancouver island and the other at Port John creek, in the central coastal area between Namu and Ocean Falls. Here counting fences for both adult salmon and fry seaward migrants have been constructed (Appendix 21, 23) and records of percentage efficiency of natural propagation under varying climatic and stream flow conditions can be obtained over a period of years. For Nile creek, which is essentially a chum salmon stream (Appendix 20), a very low production of fry resulted from natural spawning in 1947-48, namely 0.38% of eggs deposited; at Port John creek, which not only chum salmon but also pinks, cohos and sockeye frequent, a record of 0.990% was obtained. For pinks in Port John creek a fry production of 0.866% occurred (Appendix 24).

Operations at both Nile and Port John creeks are being continued during 1948-49. The run of chum salmon to Nile is presently (November 23) in progress; that to Port John creek is over. Pinks, chums, sockeye and coho occurred, the two former in very low abundance. (Appendix 25). A good opportunity for testing the propagation of so-called "creek" sockeye is presented.

At Nile creek experiments are also being made to determine the value of adopting certain fish cultural methods to increase fry production. In 1947-48 it was found that by stripping the eggs from females, fertilizing them and planting them in a section of the creek where water flow could be controlled, a production of 3.40% of eggs available resulted, nine times the number obtained under natural propagation (Appendix 20), whereas if the eggs are placed in a hatchery and reared to the "eyed" stage before planting, a production of 10.62% was obtained, 28 times that from natural propagation. Studies of this kind are very important and records over a series of years must be obtained before conclusions can be drawn. Comprehensive records of weather conditions, stream flow, etc. are being taken and the relation of these factors to salmon fry production are being studied (Appendix 19). It is believed that if more field stations such as Nile and Port John creeks could be established in various parts of the coast much pertinent information could be obtained on the variation in efficiency of natural propagation as determined by varying stream conditions. Useful prediction data could be obtained concerning the probable size of runs of adult fish each year. Methods of overcoming hazardous stream conditions, either by stream control measures or by introducing some fish cultural procedures could be more widely and effectively tested.

Acclimation of salmon fry to salt water and the physiological processes concerned therewith have been the subject of study. (Appendix 22). Pink and chum salmon leave their freshwater environment and migrate to the sea as fry. Coho salmon, on the other hand, normally spend their first year in the streams where they are subject to heavy mortality. If this period of freshwater residence could be successfully reduced survival rates might be appreciably increased.

In an initial study of young pink and chum salmon in Departure Bay relative growth rates were determined, stomach contents examined, distribution and movement studied (Appendix 26). Diurnal changes are associated with available food supply. Group movement varies with the size of the fry.

Tagging of pinks and chums was again undertaken, this year in the Whale channel area, to determine migration routes and to obtain some estimate of fishing intensity. Recoveries of tags represented 30 percent of tags used for pinks and 16 percent for chums. In general most of the recoveries of each species were made in the tagging area. The fish appeared to be approaching their destination when tagged, with comparatively few showing long subsequent journeys north or south along the coast. (Appendix 27).

Age determinations of salmon are of value in indicating the normally dominant year groups for the various species in the many more or less distinct coastal areas and in enabling predictions to be made on the basis of the extent of previous cycle spawning escapements. Analyses of chum salmon scale samples collected in 1947 in several areas of the central coast showed

a dominance of four-year-old fish (70 to 90 percent) with a fair proportion of three year individuals. Samples taken at Sooke, at the south end of Vancouver island, revealed a different situation, however, with three-year fish representing 27 percent, four-year-olds 55 percent and five-year-olds 18 percent. (Appendix 28). For sockeye salmon in the Smith inlet area, the dominant age group was the five-year one (90 percent), substantiating previous years' findings.

For many years records of spring and coho salmon landings by the angling fishery at Cowichan bay, Vancouver island, have been collected. These data reveal the variations occurring, presumably naturally, in a salmon run over a period of years. In 1947 with 2,295 boats operating and 18,508 line-hours expended in the fishing, during the main period of fishing (six weeks) 3,751 coho salmon were taken, representing 4.9 line-hours per fish. This represents a marked improvement in both total catch and catch per unit of effort, as compared with the poor season of 1946 (6.3 line-hours per fish). A study of the correlation between availability of cohos to anglers (line-hours per fish) and the minimum summer flow of the Cowichan river two years previously reveals a very close relationship. It suggests that low water levels result in increased mortality among coho fingerlings through stranding in pools, increased predation and restriction of feeding areas, thus directly influencing the abundance of returning adults two years later. (Appendix 29).

Trawl Fishery. This investigation commenced a number of years ago as a study of the stocks of commercially-important flatfish in order to determine how these stocks were reacting to the then relatively heavy exploitation. It was felt that if intensive fishing pressure were maintained a decline in the populations might result. Suitable methods of regulating or control were desired. It was further felt that an attack on the problem should be made before any decline set in rather than afterward, thus enabling the investigators to know what might be considered normal and for what goal to strive if conditions deteriorated quickly.

Other species of fish besides flatfish are taken by trawl. Dragging for dogfish and lingcod is important and profitable, also for gray cod, black cod and various species of rock-fish. Some of these species, particularly lingcod and dogfish, were being taken by other types of gear as well, e.g., by sunken gill net, long line and by "jigging" for live lingcod which were kept alive until marketed. It was necessary, therefore, to expand the investigation and to include in its objective the rather complicated problem of competition between types of gear in order that where possible or feasible no important method of fishing would be destroyed.

The investigation, directed by Dr. Hart with Messrs. Barraclough, Ketchen, Manzer and Miss Bethune as assistants and with the M/V "Investigator No. I" as research ship, has endeavored to collect as much information as possible of significance to the conservation of the most important species, but has also very wisely maintained an interest in other fishes because of possible inter-relationships which may be intimately involved (Appendix 30). One very complicating feature is that certain of the species change in commercial importance rather suddenly. A year ago the rock sole was the most keenly sought species, now the brill is most popular. In certain areas one species will prove to be dominant, in others, other forms are most abundant. It becomes extremely difficult, consequently, to confine the research too narrowly.

Collection of catch statistics is of prime concern in such research and to obtain these, port observers are stationed at Prince Rupert, Vancouver and Victoria to record the particulars of catches brought in, ascertain where the fish were caught, the effort expended, etc. These are then submitted to the Station where the necessary tabulations are prepared (Appendix 31) and studied (Appendix 32).

Certain biological features of the fish are of special significance. Rate of growth studies and age analyses are important since they determine what size classes of fish are taken by the trawls. Such studies for lemon sole (Appendix 33), rock sole (Appendix 37), rex sole (Appendix 39), butter sole (Appendix 40), lingcod (Appendix 46, 47) have been made from samples taken from the fishery or by the M/V "Investigator No. I" and from lemon sole, brill and rock sole tagging experiments (Appendix 44). The relationship of growth rate to natural mortality rate is also an important consideration and has been the subject of a preliminary study. If its conclusions are suported by calculations based on more critical estimates of mortality rates it may be that no minimum size is required in order to obtain optimum yield or if a minimum size is required, there should be no restriction on amount of fishing if mortality rates found for adult fish apply also to those not yet entering the fishery. (Appendix 34).

Tagging experiments to determine the movement of fish and the likelihood of there being discrete populations or, conversely, appreciable mixing, are essential in an investigation of this kind. Certain tagging was continued during 1948 (Appendix 42). Recoveries in 1948 of tags used in earlier years substantiate the findings of other experiments, namely, that there is little or no significant mixing of flatfish populations in the strait of Georgia, the west coast of Vancouver island and Hecate strait. For brill off the west coast of Vancouver island and in Hecate strait there appears to be a northward movement during the spring and early summer and a return migration in late summer and fall. Rock sole and lemon sole in other areas display similar movements. (Appendix 43).

Food studies are an integral part of fisheries biological work. One food study, relating to the brill, (Appendix 36) has revealed that, among invertebrates, the euphausiids (red feed) were most important. Sand lance and herring also contributed appreciably to the diet.

The recent decline in vitamin "A" potency of livers of dogfish captured by sunken gill nets has been of concern to industry. It has been suggested that as a result of heavy exploitation in recent years the dogfish populations may be declining. Observations suggest, however, (Appendix 51) that the sunken gill net, having a selective effect and taking only the largest fish, may have appreciably reduced the older and larger individuals and is now taking faster growing and younger fish with a somewhat lower vitamin "A" liver oil potency. It is no indication, however, that depletion of the dogfish is occurring.

Pilchard. A pilchard fishery in 1948 did not exist. There are as yet no indications that an early rehabilitation will occur (Appendix 52). Consequently the Station's pilchard research consisted only of an analysis of accumulated catch statistics to seek information on the causes of pilchard

abundance and availability. Correlations between seawater and air temperatures and percentage annual catch of pilchards were attempted but until other pertinent meteorological data can be included no definite relationships can be established. (Appendix 53).

Eulachon. Since 1941 catch statistics for the Fraser river eulachon fishery have been collected by Department of Fisheries officers and submitted to this Station for analysis, particularly as to the trend from year to year as influenced by the fishery. Records were again available for 1948 and show (Appendix 54) a very heavy fishing effort, a heavy catch, but a relatively low catch per unit effort.

Anchovy. Fishing for anchovy in 1948 was relatively poor. In many cases no fish were seen; in others the populations seemed very meagre. This may possibly be attributable to a small recruitment of two-year-old fish to the commercially acceptable three-year-old class. There is evidence that populations of anchovy in some of the bays and inlets of the coast are capable of successful reproduction and may persist for several generations if not fished too intensively. No indication of separate populations in various areas along the coast has been found. The range appears to be from the strait of Georgia, throughout the bays and inlets of the east and west coasts of Vancouver island and northward along the mainland coast to Ogden channel. (Appendix 55).

Albacore. Due to the generous cooperation of the Department of Fisheries the Station was able to place a biologist aboard the Fisheries Protection Cruiser assigned to explore the off-shore waters of the west coast of Vancouver island in search for albacore tuna this summer. There being nothing to indicate whether or not albacore would be encountered, in what abundance or where, it was impossible to envisage what information the biologist might obtain or what useful material he could collect. All that could be done was equip him with all possibly useful experimental fishing equipment, bathythermograph, thermometers, plankton nets, bottles for water samples, etc. and direct that he make all the observations he could as conditions permitted. It was suggested that he obtain specimens of albacore for measuring, sexing, obtaining scales and stomach contents and, if possible, release some alive bearing a tag. In short, it was felt that it would be largely exploratory work and perhaps lead to a more adequately designed experiment another season. Dr. Hart directed the programme, the field work being carried out by Mr. Scagel.

While, due to the nature of the duties of the vessel, no definite and connected survey could be accomplished and due to the size and speed of the ship, some of the collecting proved to be difficult, e.g., plankton collecting, much useful information and material were obtained. It was found that fish were taken in water temperatures ranging from 57° F. to 63° F. with most fish captured in temperatures of from 58° to 60°. (Appendix 59). Salinity seemed to show no significant variation throughout the area traversed. The colour of the water exhibited a gradual transition from intense green in the coastal region to blue-green above the continental shelf and thence to an intense blue. The temperature of the water increased to seaward, the green coastal being around 52° F., the blue-green approaching 57° F. and the deep blue ranging from 59° F. in northern latitudes to 64° F. and higher further south.

It is suggested that albacore distribution may be correlated more closely with temperature than with colour of water. Samples of water were collected to determine whether predominance of any organisms might contribute to the colour differences, but no analysis has yet been made (Appendix 60). Plankton samples were taken over a wide area, but have not yet been examined. It was noted, however, that microscopic forms and larger plankton, tunicates, worms, ctenophores, coelenerates and crustacea were abundant. Stomach contents of tuna were taken, but have yet to be examined. It was noted, however, that saury, squid, small rockfish and "red-feed" - probably euphausiids - bulked largely in the diet. Various types and colours of lures were tested to establish any preference. Both feather baits and fast-towing plugs seemed effective and any preference seemed to favour amber-headed feather baits with red and white feathers and green-headed feather baits with white and green feathers (Appendix 61). A total of 140 albacore were tagged but no recoveries have been reported (Appendix 63). Long-line fishing with baited hooks at different levels and gill-netting were tested, but without success, though the Japanese practice the former quite effectively (Appendix 64).

In addition to operations at sea, certain shore work was also accomplished. Port observers at Prince Rupert and Victoria measured a large number of albacore landed and it was found that while the length range ran from 53 cm. (21 inches) to 82 cm. (32¼ inches), there were two modes apparent, one at 63 cm. (25 inches) and the other at 75 cm. (29½ inches). These modes probably represent age groups but the exact ages cannot be assigned. (Appendix 57). Since 1946 tuna log-books have been issued to tuna fishermen in order to collect information on catches made, water temperature, position, etc. In 1946 only one book was returned; in 1947 six were received; in 1948 a goodly number came to hand. While the data submitted were complete and representative for the respective season, no useful compilation can be made since circumstances in the three years were so different. For example, in 1947 no fish were caught north of 50° N. latitude, whereas in 1948 over 62% were taken north of this parallel. In 1946 the optimum temperature appeared to be 61° F. In 1947 it was found to be 65° F. In 1948, as mentioned above, it was within the range of 58° F. to 60° F.

Herring. After many years of intensive biological study of our Pacific herring populations along the coast, during which much pertinent information has been collected relative to the life history and habits of the fish and the effect of the commercial fishery on the stocks of fish, it has become possible to attack the problem of how best to regulate the fishery so that the greatest maximum sustained catch can be achieved.

Some years ago it was considered that perhaps a quota system of regulation would be most effective. This would permit a fishery to take what was considered a sufficient quantity of fish and leave an adequate supply for spawning purposes. It would, also, tend to stabilize the fishery and prevent years of "feast and famine". To test out the method, quotas were arbitrarily set for all of the important coastal areas where separate populations of herring existed (i.e. little intermingling occurred between them). The results were closely followed. In only one area, the lower east coast of Vancouver island, were the quotas selected found to be effective and they have thus continued to be used as an experiment in this type of management.

It was subsequently found that great variations take place from year to year in the success of spawning, hatch, survival of young and eventual recruitment of young fish to the herring stock. This was particularly the case in the west coast of Vancouver island area. It was observed that after years of heavy spawning heavy recruitment of young fish to the fishery did not always occur; conversely, light spawnings were frequently particularly successful in producing extensive additions to the stock. The question arose, therefore, as to whether, in view of such great natural variations in survival and production of young fish, quota regulations were really effective. Attempts to ensure large spawnings might only result in great wastage of fish which might have gone to the commercial fishery.

The importance of settling this problem which is basic to effective management of the fishery was realized. An experiment was therefore commenced in the 1946-47 season in the west coast of Vancouver island area whereby there would be no restriction to the commercial fishery except an annual closing date when the fish approached maturity and moved into shallow water to spawn. There are thus two experiments now under way, one involving quota regulation, the other permitting wide-open fishing.

The research activities on herring have therefore been largely confined to these two experiments, but a certain amount of work is also being carried on with regard to the herring stocks and the fishery in other coastal areas. where quota limits to fishing still apply. The work has for a number of years been directed by Dr. Tester but, with his departure on September first to the University of Hawaii on a year's leave of absence, the supervision has fallen to Mr. Stevenson, assisted by Messrs. McMynn, Lanigan, Glover (to September 30) and Outram (from November 1) and a competent staff of field technicians. (Appendix 66).

Three very essential phases of the work have been carried on over the years. These are collection of catch statistics, sampling and tagging. Accurate records of catch statistics are required (Appendix 67) in order to reveal the place and date of all catches, the number of active fishing days (fishing effort), the availability of fish (catch divided by fishing effort) and general abundance. These records are obtained chiefly from Pilot House Record books compiled by each seine vessel captain. Daily landing forms submitted by processing plants give the data on total catch from each area and method of disposal. During the 1947-48 season, 171,700 tons of herring were taken, the largest annual catch on record. In spite of increased fishing effort the west coast of Vancouver island fishery was 23 percent less than in the previous year. New runs came inshore during the spawning season, however, and resulted in a good seeding. A spectacular fishery developed in Ogden channel in the northern sub-district in late January and early February and resulted in a catch of 30,000 tons for this area.

Tagging experiments fulfil the dual purpose of revealing the extent of intermingling populations of herring between major districts and among the various areas of each district and of indicating the fishing intensity. Results of tagging in 1947-48 showed, as in previous years, that the west coast population is essentially discrete. Little intermingling between west and east coast populations occurred. Considerable mixing was again noted between individual west coast areas and the tendency for fish to wander in a south-

easterly direction along the coast was again indicated. For the west coast of Vancouver island the rate of exploitation in 1947-48 was approximately 2.7 times that in 1946-47. Data are not yet available for other districts (Appendix 68, 69, 70, 71). During tagging operations in the spring of 1948, a total of 45,577 herring were tagged in the strait of Georgia and along the west coast of Vancouver island (Appendix 72). Since tagging operations must have some detrimental effect on the fish tagged, observations were made on the condition of tagged individuals recovered at the shore plants (Appendix 73). All specimens showed completely healed wounds, with a scar on the inside of the body wall being the only visible evidence of the tagging incision. Usually the tags were found lying loosely in the body cavity or attached to the mesenteries of stomach, intestines or gonads by scar tissue. In a few cases tags were found imbedded in the gonads. More tagged males were recovered than tagged females, suggesting that the males survive the tagging operation more successfully. Tests conducted in Station retaining tanks showed a mortality from tagging of between 50 and 60 percent. (Appendix 74).

Sampling of herring catches throughout the season for each fishing area is a long, laborious task. It must be undertaken, however, if pertinent information is to be available on the fluctuations in abundance and size of the successive year-classes and their influence on the catch. During the 1947-48 season a total of 383 samples comprising 37,631 fish was examined (Appendix 75). The results thereof (Appendix 76, 77, 78, 79, 80, 81, 82) reveal the extent to which the various age classes (chiefly III, IV, and V, but occasionally also II and VI) contribute to the populations and result in a good, medium or poor fishery. An abundant age or year class normally boosts the population and hence the fishery for three years and therefore age-composition data are of great significance in preparing predictions (Appendix 86) which for the past few years have been of much interest and value to the industry.

Herring ground spawning surveys are made each spring by members of the staff of the Herring division and also by Department of Fisheries officers. They are useful in indicating the potential extent of spawning or seeding. In 1948 spawning was much more extensive than in the previous year and appeared to be quite satisfactory. (Appendix 83). The subsequent survival of eggs and young is of even greater significance in arriving at an estimate of the probable recruitment of young fish to the herring stocks and progress is being made in this phase of the work (Appendix 84, 85) by carrying out surveys along the west coast of Vancouver island during the spring and early summer months when herring larvae are present and are developing, through metamorphosis, into young herring. Studies are being conducted on movements of the larvae, abundance of food, predators, etc. Different types of collecting gear are being tested.

In 1947 and again in 1948 some enterprising fishermen attempted to try out a method of catching herring by trawl. Bottom trawls were used but have not proven particularly effective. It is conceivable that trawls designed to operate at intermediate depths may be more effective when used in conjunction with echo sounders which indicate the positions of the schools of herring. Very little experimentation was attempted this fall. (Appendix 87).

Oyster. Research in this field, under Mr. Neave's supervision, embraced only further experiments in rearing oyster larvae to the spatting stage in retaining tanks, a continuation of tests initiated two years ago. Unfortunately the large tank developed leaks which allowed too great an escape of water to be replaced by water preheated to keep the tank temperatures at a minimum of 20° C. The temperatures of Departure bay were too low this summer to permit pumping water direct. For most of July oysters were quite immature. Though by stimulation and subjecting them to rise in temperature spawning would occur, the larvae were very poor and short-lived. Salinities were low during early summer and until they reached 27.00 it was impossible to keep them more than 7 to 8 days. A temperature of at least 22° C. for the first 10 days gives best survival and development. After 10 to 12 days the larvae appear to tolerate temperatures as low as 18° C. for short periods. Control of flagellate protozoa in the tanks and elimination of larger forms appear necessary. (Appendix 89).

Whale. With the resumption of whaling off the northern west coast of Vancouver island this season by a new company, Western Whaling Corporation, it was agreed that a biologist should be stationed at the Coal Harbour shore plant to collect pertinent information required by the International Whaling Convention and to make such observations and obtain such material as might be of interest scientifically. (Appendix 90). This was done, the biologist working under the supervision of Dr. Hart.

A total of 182 whales were landed of which 113 were humpback, 39 finback, 2 sei and 28 sperm. Humpbacks therefore predominated, a characteristic apparently common in many areas when whaling is commenced, and which disappears as further whaling operations proceed. A large number of the 64 humpback females taken were pregnant; 38 were carrying young. Of the finbacks, only 13 percent of the females were pregnant. A large proportion were immature. All of the sperm whales were males. Sizes of whales varied according to species, the average lengths taken being as follows: humpback - 40 feet; finback - 58 feet; sei - 46 to 47 feet; sperm - 45 feet. (Appendix 91).

Much material has been collected for subsequent examination, such as ovaries, foetuses, parasites, stomach contents, glands, organs, etc.

Shrimp. During the summer season certain observations were made on species of fish and other crustaceans taken by shrimp trawlers operating out of Vancouver. (Appendix 92). Small specimens of rockfish, midshipmen, eelpouts, hake and whiting were abundant, flatfish and ling cod much less so. Stomach content analysis indicated that many of these fish were feeding on shrimps. While fishing in the strait of Georgia off Lasqueti island one shrimper landed a quantity of shrimp not commonly utilized commercially, Pandalus montagui tridens Rathbun. (Appendix 93).

Crab. Further tagging experiments were undertaken during the summer to determine for the populations of crabs along the north coast of Graham island the migratory habits of the crabs and the effect of present fishing intensity. The conditions in Naden Harbour, where a sizeable fishery has again been established, are being followed with interest. A quota regulation has been suggested to ensure no over-fishing. (Appendix 94).

Lobster. In June, 1946, the British Columbia Packers Limited purchased and brought to the Pacific coast a shipment of around 2,000 "canner" size Atlantic coast lobsters with a view to determining whether these crustaceans, commercially-valuable on the east coast, would survive and develop normally in Pacific waters and whether they would reproduce. The Fisheries Research Board consented to give scientific advice and supervision to this experiment.

The lobsters were duly delivered to and liberated in a well-enclosed salt-water lagoon on Lasqueti island. While it was originally intended to block off the lagoon and thus prevent outward migration of lobsters, the cost was considered prohibitive and no barrier was erected, it being thought that perhaps the shallowness of the lagoon outlet would discourage any large escapement.

For two years efforts to recapture lobsters in the lagoon have been made with indifferent success. Very occasionally an individual would be trapped. A small number of lobsters were kept in a retaining cage for observation purposes. These have done well and have moulted and mated satisfactorily. Growth rates have been comparable with those reported for lobsters on the east coast. (Appendix 95). One lobster has been trapped outside the lagoon.

During the summer of 1948 an attempt was made to hatch the eggs and rear the larvae from two berried lobsters. A small hatchery unit, similar to those used on the east coast, was provided. Larvae were hatched but all appeared to be premature and abnormal, attributable probably to very reduced salinities of the seawater as a result of Fraser river floods. A repetition of this work is proposed for next season. (Appendix 96).

Oceanography. Conditions of salinity and temperature in coastal waters of the Pacific coast were again investigated through the daily collection of surface seawater samples and temperature reading at eleven lighthouse stations along the coast. Previous years' data are being tabulated and mimeographed and to date all records from 1914 to 1943 have been compiled into six volumes and distributed to interested scientists, scientific institutions and government departments. (Appendix 97).

During the summer of 1948 an investigation of the approaches to the Skeena river was undertaken. (Appendix 99). The purpose was to describe the behaviour of the water discharged from the Skeena river in Chatham sound during maximum and normal runoff and to relate that behaviour to daily observation of river discharge, weather, and surface seawater observations taken at the Triple island lighthouse. From the records obtained it is anticipated that the movement of salmon from the ocean to the Skeena and Nass rivers may be more clearly delineated. This work formed a part of the programme of the Pacific Oceanographic Group under Dr. J. P. Tully, with Mr. W. M. Cameron as Associate Oceanographer.

Polychaete Studies. Mr. and Mrs. Berkeley continued, on a voluntoer basis, their taxonomic studies of Polychaete worms. A portion of their recent work is now in press, the remainder being prepared for publication. (Appendix 100).

Fish Parasites. Collections of marine fish parasites and of endo parasites from fish in the Skeena river system were made during the summer. Identifications are being undertaken by Dr. Adams. A survey of available published records and of manuscripts on parasites of marine fish in this area was made and a host-parasite list has been compiled. (Appendix 101).

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the continued generous cooperation of the following agencies and the officers thereof whose kindly interest, assistance, advice and encouragement have made the season's work so pleasant and so effective: the Federal Department of Fisheries, the Provincial Fisheries Department, various Departments of the University of British Columbia, especially Zoology, the Water & Power Bureau of the Department of Mines and Resources, the Provincial Game Commission and other federal and provincial departments. The Provincial Fisheries Department again contributed financially to the herring and pilchard investigations and the personal interest and support of the Deputy Minister, Mr. George J. Alexander, have been most appreciated.

We are again deeply indebted to those fishing companies who, through Mr. R. E. Walker, Chairman of the Pacific Sub-Executive Committee, have so graciously loaned the Station fishing vessels when required. They are the British Columbia Packers Limited who made available vessels for both spring and fall herring operations, the Canadian Fishing Company Limited, Nelson Bros. Fisheries Limited and Francis Millard and Company Limited. Without this assistance much of our herring field work would have been severely handicapped. In all cases the salaries of crew and operating expenses of the vessels were met by the Station.

The members of the Skeena river salmon consulting committee, Messrs. I. Urseth, Supervisor of Fisheries for District No. 2 (subsequently forced to retire due to ill-health and replaced by Mr. G. S. Reade), T. Wallace, C. E. Salter, W. Johnson and B. Kristmanson, continued to give valuable assistance and support to the Skeena river salmon investigation. Their sincere interest, suggestions and criticism have been most encouraging and keenly appreciated.

The visit of members of the Executive Committee and other Board members to the Station in June and to certain field stations was a happy event, very much appreciated by the staff of the Station. Such contacts as are thus made are of incalculable value, especially to the scientists, and it is regretted that they can not be more frequent. The interest and encouragement displayed by the Chairman and Vice Chairman have been most stimulating.

STAFF

During the year the Station suffered the loss of two of its senior scientists, Dr. Pritchard and Dr. Tester, members of staff who have been associated with the institution for many years. Such separations in order to enter fields of greater responsibility or to take up work of a different nature must be expected and accepted. It is a tribute in many respects to

the training which results from service with the Board. Two of the Station's junior workers also left the staff, Mr. J. H. Glover, Junior Scientist, and Miss Winona Bethune, Senior Research Assistant, the former to enter commercial work, the latter to join the faculty of Victoria College. To each of our departing colleagues the staff extends sincerest wishes for every success.

Only two additions to the scientific staff have been made, Mr. R. G. McMynn, B.A. and Mr. D. N. Outram, B.A., both graduates of the University of British Columbia. Both have been assigned to the herring investigation. Mr. McMynn has had one season's field experience with the crab study on Graham island, Q.C.I., while Mr. Outram has had two summers with the Skeena river salmon investigation.

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

Mr. J. R. Brett, M.A., University of Toronto, for Ph. D.
Mr. K. S. Ketchen, M.A., University of Toronto, for Ph. D.
Mr. F. H. C. Taylor, B.A., Scripps Institution of Oceanography, for Ph. D.
Mr. W. M. Cameron, M.A., returned from Scripps Institution of Oceanography July 1st and has taken up his work as Associate Oceanographer with the Pacific Oceanographic Group.

PACIFIC OCEANOGRAPHIC GROUP

This unit of the Joint Committee on Oceanography which conducts cooperative research for the Royal Canadian Navy, the National Research Council and the Fisheries Research Board has proven to be a most useful and effective adjunct to the Station. The staff members are also members of the staff of the Station, though in some cases salaries are paid by one or other of the cooperating institutions.

P. O. G. has assumed responsibility for the lighthouse sampling work, has compiled five volumes of data related thereto and is now working on the remaining records (from 1944) to bring them up to date and continue with annual mimeographed compilations. It has undertaken a comprehensive survey of the waters off the Skeena and Nass rivers, reported elsewhere. Dr. Tully has completed his report and bulletin on the Alberni inlet survey and is endeavoring to put together the data collected several years ago in a study of the strait of Georgia.

At all times the members of P. O. G., when at the Station, are available for consultation on limnological or oceanographic problems and their interest and cooperation are most helpful. In turn the Station endeavors to provide suitable accommodation, facilities and advice on biological matters. It is hoped that the present cooperative effort, the pooling of interests and facilities, will enable the early initiation of the much-needed coastal and offshore oceanographic investigations referred to elsewhere.

BUILDINGS AND GROUNDS

New Biological Laboratory. Construction of the new, fully-fireproof building appears to be proceeding satisfactorily. Excavation commenced early in September and by November 30th the walls and columns of the second floor should be completed and the third floor slab ready to pour. According to a "Progress Schedule" prepared by the contractors, Dominion Construction Company Limited, the building is to be completed by mid-February. This may prove to be slightly over-optimistic. Already inclement weather has delayed operations several days. Considerable attention will have to be given to grading and appropriate landscaping and beautification of grounds once construction is completed. This will presumably be done next spring.

Warehouse. Utilizing sections of the old laboratory building a reasonably commodious warehouse has been built behind the Garage. Supplies and miscellaneous equipment are now conveniently stored, in charge of a competent store-keeper.

Boathouse-workshop. During the summer our boathouse-workshop, situated on the waterfront below the Chemistry Building and in course of being enlarged and renovated, was totally destroyed by fire. Wholely of frame construction the structure burned fiercely and all that could be done was to save the nearby Chemistry Laboratory and Director's residence. This was successfully accomplished due to the fact that the day was calm with no wind. The loss of a workshop has been keenly felt and it is hoped that a new building may soon be authorized. It is recommended that it be of cement or cinder block construction, hence partially fire-proof. Power tools and other equipment were also lost and must be duly replaced.

Fire Protection System. Plans have been prepared for a complete remodelling of the fire protection system in order to provide more water to a greater number of hydrants strategically placed about the buildings and grounds. A new fire pump has been installed to supply salt water to the existing system and is housed in a concrete-block pump house erected behind the retaining tanks. Delay has occurred in obtaining adequate supplies of pipe, but this matter is now well in hand. Walsh Construction Company Limited of Vancouver has given valuable advice and has submitted a tender to install the new piping, etc.

Grounds. Following completion of the new Laboratory Building relocation of existing roads and parking areas may be necessary. A new fence around the Station property will be required and steps will be taken to clear out underbrush and level off the terrain. The Station being a working institution, it is desirable to have the grounds reasonably attractive without being too artificial and too great an attraction for tourists and picnickers and requiring a disproportionate amount of Station appropriations for maintenance and upkeep.

VESSELS

At the present time the Station possesses only one vessel, the "Investigator No. 1", which is attached to the trawl fishery investigation. There is an urgent need for a competent ship for the herring investigation, one adequate to operate in west coast of Vancouver island areas for tagging work, larval herring studies, etc. A 70-75 foot vessel with adequate power is desired. In addition a replacement for the M/V "A.P. Knight" is required for general Station use. A vessel of a similar size and similarly equipped but with accommodation altered somewhat to make more effective use of space would suffice. A smaller vessel, 35 to 40 feet in length, will be required by the General Salmon investigation as the work expands.

PUBLICATIONS

The appearance of only one paper from this Station in the Board's publications (other than Progress Reports) during the year and the submission to the Editor of only three manuscripts - one for the Journal and two for the Bulletin series - deserves explanation. In some respects it may tend to signify a lack of attention to this phase of the Station's work, admittedly an important phase since proper dissemination of results of researches is highly desirable, but this is not quite the case. Reference to the list of manuscripts already submitted for publication will show that a goodly number (five) were presented before Section V of the Royal Society of Canada at the June meeting in Vancouver. With most of the investigations presently in a stage when voluminous data are being collected it is yet too early to draw significant conclusions and present results. Consequently there is a definite limitation to the number of papers which can be prepared. The Station is at the moment passing through a period when there are not enough small researches or problems in progress whose results can be quickly obtained and reported and the major investigations have not proceeded sufficiently far enough to report any particular phases.

Ten Progress Report articles have been prepared and published and a further issue is planned before the end of the year. Some of these articles might be considered suitable for the Journal, but distribution to the industry and interested scientists is much wider and quicker when issued as Progress Reports.

PUBLICATIONS DURING 1948

Barraclough, W.E. The Hag-fish (Polistotrema stoutii) in British Columbia. Prog. Rep. Pac. No. 75, pp. 57-58.

Brett, J.R. The design and operation of a trap for the capture of migrating young sockeye salmon. Trans. Amer. Fish. Soc. Vol. 75, pp. 97-104.

Cameron, W.M. Fresh water in Chatham sound. Progress Rep. Pac. No. 76, pp. 72-75.

Foerster, R.E. Fisheries Research in British Columbia. The Victoria Naturalist. Vol. 4, No. 8, pp. 87-91.

Prospects for Managing our Fisheries. Bull. Bingham Oceanographic Collection, Vol. XI, Art. 4, pp. 213-227.

Gibson, J.S.T. Lobsters and allied crustacea: Distinguishing points. Prog. Rep. Pac. No. 74, pp. 13-17.

Milne, D.J. and A.L. Pritchard. The true picture of the 1947 Skeena river sockeye run. Prog. Rep. No. 75, pp. 46-47.

McMahon, V.H. Lakes of the Skeena river drainage. VII. Morrison lake. Prog. Rep. Pac. No. 74, pp. 6-9.

McMynn, R.G. Crab fishing off the Queen Charlotte islands. Prog. Rep. Pac. No. 76, pp. 81-84.

Pritchard, A.L. Efficiency of natural propagation of the pink salmon (Oncorhynchus gorbuscha) in McClinton creek, Masset inlet, B. C. J. Fish. Res. Bd. Can. 7 (5), pp. 224-236.

Sockeye salmon tagging off the Skeena river in 1947. Prog. Rep. Pac. No. 75, pp. 40-42.

Ricker, William E. and R.E. Foerster. Computation of Fish Production. Bull. Bingham Oceanographic Collection, Vol. XI, Art. 4, pp. 173-211.

Robertson, J.G. Smith inlet sockeye. Prog. Rep. Pac. No. 75, pp. 31-34.

Tully, J.P. Pollution research in Alberni inlet. Prog. Rep. Pac. No. 76, pp. 66-71.

Withler, F.C. Lakes of the Skeena river drainage. VIII. Lakes of the Lac-da-dah basin. Prog. Rep. Pac. No. 74, pp. 9-12.

Observations of Sea Water Temperature, Salinity, and Density on the Pacific Coast of Canada. (Mimeographed compilations of daily records).

Volume I,	including	data	from	1914 to 1934.	Distributed - May, 1947.
Volume II,	"	"	"	1935 to 1937.	Distributed - September, 1947.
Volume III,	"	"	"	1938 to 1939.	Distributed - January, 1948.
Volume IV,	"	"	"	1940 to 1941.	Distributed - March, 1948.
Volume V,	"	"	"	1942 to 1943.	Distributed - July, 1948.

The distribution list of these volumes of raw data includes 23 agencies in Canada (46 copies), 21 agencies in the United States (26 copies) and 13 in Great Britain and western Europe (15 copies). In all cases the recipients have expressed keen appreciation of the records and many references to the great value of long-term continuous series of such data have been received.

Volumes VI and VII, bringing the records up to the end of 1947 are in preparation. Thereafter annual volumes will be issued for 1948 and succeeding years.

MANUSCRIPTS SUBMITTED FOR PUBLICATION

Barraclough, W.E. Measures of abundance in dogfish (Squalus suckleyi) and soup-fin shark (Galeorhinus galeus). Trans. Roy. Soc. Can., Section V. Submitted June, 1948.

Berkeley, E. and C. Annulata. Polychaeta errantia. Can. Pac. Fauna. Fish. Res. Bd. Can.

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

Hart, J.L. Increased abundance of an unusual British Columbia fish, the California pompano. Canadian Field Naturalist. Submitted April 4/48.

Age and growth rate in the Butter sole, Isopsetta isolepis (Lockington). Trans. Roy. Soc. Can., Section V. Submitted June, 1948.

Neave, Ferris. Fecundity and Mortality in Pacific Salmon. Trans. Roy. Soc. Can., Section V. Submitted June, 1948.

Pritchard, A.L. A discussion of the mortality in Pink salmon (Oncorhynchus gorbuscha) during their period of marine life. Trans. Roy. Soc. Can., Section V. Submitted June, 1948.

Tester, A.L. The efficiency of catch limitations in regulating the British Columbia herring fishery. Trans. Roy. Soc. Can., Section V. Submitted June, 1948.

Populations of Herring along the west coast of Vancouver island on the basis of mean vertebral number, with a critique of the method. J. Fish. Res. Bd. Can. Submitted July, 1948.

Tully, J.P. Oceanography of Alberni inlet. Bull. Fish. Res. Bd. Can.

Prediction of pulp mill pollution in Alberni inlet. Bull. Fish. Res. Bd. Can.

(with H.J. Hollister, R.L. Fjarlie and W. Anderson). A hydraulic model of Alberni harbour. Bull. Fish. Res. Bd. Can.

CIRCULAR SERIES (Mimeographed)

Hart, J.L. The Pilchard Situation. No. 11, 2 pp. January 24.

Hart, J.L. with W.E. Barraclough, G.C. Pike, Winona Bethune. Accumulated data on Albacore (Thunnus alalunga). No. 12, 12 pp. May 10.

Neave, Ferris and W.P. Wickett. Prediction of Salmon Runs. No. 13, 2 pp. May 11.

Milne, D.J. and A.L. Pritchard. Prospects for the 1948 salmon catch on the Skeena river. No. 14. May.

Stevenson, J.C. Prospects for the 1948-49 Herring Fishing Season. No. 15. September.

STAFF

PACIFIC BIOLOGICAL STATION

1948*

R.E. Foerster, M.A., Ph.D., F.R.S.C.	Director
J.L. Hart, M.A., Ph.D., F.R.S.C.	Senior Biologist
A.L. Pritchard, M.A., Ph.D.	Senior Biologist (to July 12)
Ferris Neave, M.Sc.	Senior Biologist
A.L. Tester, M.A., Ph.D.	Senior Biologist (to September 4)
J.P. Tully, M.B.E., D.Sc., A.I.C., F.C.I.C.	Senior Oceanographer
W.M. Cameron, M.A.	Associate Oceanographer (returned from leave July 1)
J.R. Brett, M.A.	Assistant Biologist (on leave from Nov. 1)
J.G. Hunter, M.A.	Assistant Biologist
K.S. Ketchen, M.A.	Assistant Biologist (on leave from Oct. 1)
D.J. Milne, M.A.	(Assistant Biologist (to March 31) (Associate Biologist (from April 1)
V.H. McMahon, B.A.	Assistant Biologist
J.C. Stevenson, M.A.	Assistant Biologist
F.C. Withler, M.A.	Assistant Biologist
W.E. Barraclough, M.A.	(Junior Biologist (to March 31) (Assistant Biologist (from April 1)
D.R. Foskett, B.A.	(Junior Biologist (to March 31) (Assistant Biologist (from April 1)
J.I. Manzer, B.Sc.	(Junior Biologist (to March 31) (Assistant Biologist (from April 1)
W.P. Wickett, B.A.	(Junior Biologist (to March 31) (Assistant Biologist (from April 1)
J.S.T. Gibson, M.A.	Junior Biologist
J.H. Glover, B.Sc.	Junior Biologist (to October 2)
J.A. Lanigan,	Junior Biologist
J.A. McConnell, B.A. —	Junior Biologist
R.G. McMynn, B.A.	Junior Biologist (from May 10)
D.N. Outram, B.A.	Junior Biologist (from November 1)
J.G. Robertson, B.Sc.	Junior Biologist
F.H.C. Taylor, M.A.	Junior Biologist (on leave)
Winona Bethune, B.A.	Senior Research Assistant (to October 7)

Seasonal:

J.R. Adams, M.A., Ph.D.	Assistant Biologist (May 17 to Aug. 31)
Alice M. Hirsch, B.A.	Junior Biologist (June 22 to Sept. 4)

*As of December 1st, total staff numbered 62, consisting of scientists - 23, administration and clerical - 16, technicians - 17, boat crews - 6.

R.F. Scagel, B.A.	Junior Biologist (May 13 to Sept. 10)
D.F. Aldordice, M.A.	Senior Research Assistant (May 18 to Sept. 2)
W.R. Hourston, B.A.	Senior Research Assistant (May 1 to Sept. 11)
E.W. Burridge, B.A.	Assistant Technician (May 11 to Sept. 17)
B.M. Chatwin	Assistant Technician (May 11 to Sept. 2)
A.C. Johnson	Assistant Technician (May 11 to Aug. 31)
Dorothy M. Furk	Senior Research Assistant (May 3 to Sept. 17)
H. Godfrey, B.A.	Senior Research Assistant (May 13 to Sept.14)
D.N. Outram, B.A.	Assistant Technician (May 11 to Oct. 31)
G.C. Pike, B.A.	Assistant Technician (May 17 to Sept. 24)
H.W. Spencer	Senior Research Assistant (May 6 to Sept. 4)
J.W. Stokes, B.A.	Assistant Technician (May 7 to Sept. 12)
R.D. Harris	Assistant Technician (May 1 to Sept. 13)
M.D. Wheeler	Assistant Technician (May 1 to Sept. 11)
K.V. Aro	Assistant Technician (May 8 to Sept. 2)
S.B. Smith	Assistant Technician (May 1 to Sept. 2)
G.H. Towers	Assistant Technician (May 14 to Sept. 15)
T.H. Butler	Assistant Technician (May 17 to Sept. 18)
R.O. Palmer	Assistant Technician (May 25 to Sept. 15)
C. Berkeley, F.C.I.C.	Volunteer Investigator
E. Berkeley	Volunteer Investigator

Technical and Clerical:

G.B. Starr, B.Sc., M.E.I.C.	Civil Engineer (to May 31)
G.F. Hart	(Executive Assistant Grade 1 (to March 31)
	(Supervising Clerk (from April 1)
Ethel E. Robinson	Clerk, Grade 3
Irma J. Hilton, B.A.	Clerk, Grade 3
Evelyn M. Keighley	Clerk, Grade 2
E.K. Inch	Clerk, Grade 2 (from September 9)
Anne Bravar	Clerk, Grade 1 (to November 30)
Fay V. Collins	Clerk, Grade 1
Hazel J. Cox	Clerk, Grade 1 (from September 1)
Marjorie E. Elliott	Clerk, Grade 1
Enid M. Marsh	Clerk, Grade 1
Margaret K. Philp	Clerk, Grade 1
J. Martell	(Mainten. Super. Gr. 3 (to March 31)
	(Mainten. Super. Gr. 4 (from April 1)
T. Russell	Caretaker, Grade 4
A. Rigby	Caretaker, Grade 2
C.J. Morley	Storekeeper, Grade 1 (from November 1)
H.K. Pinchin	Ship's Captain
R.E. Hirst	Ship's Captain
R.A. Zanelli	Ship's Engineer (from July 28)
K.R. Sutherland	Ship's Engineer
R.T. Hearns	Ship's Mate (from July 1)
W.R. Brandon	Cook-Deckhand (from September 20)
R.H. Eaton	Technician Grade 1
E.V. Epps	(Assistant Technician Grade 2 (to March 31)
	(Technician Grade 1 (from April 1)
H.J. Hollister	Technician Grade 1

A.G. Paul	(Assistant Technician Grade 3 (to March 31)
	(Technician Grade 1 (from April 1)
W.G. Calderwood	Assistant Technician Grade 3 (to October 7)
W. Caulfield	Assistant Technician Grade 3 (from Nov. 1)
C.R. Forrester	Assistant Technician Grade 3 (from Nov. 1)
J.H. Larkman	Assistant Technician Grade 3
A.I.R. McLeod	Assistant Technician Grade 3, (from Aug. 30)
R.C. Wilson	Assistant Technician Grade 3
R.A. Wilson	(Assistant Technician Grade 2 (to March 31)
	(Assistant Technician Grade 3 (from April 1)
A.J. Dodimead	Assistant Technician Grade 2 (from May 3)
R.C. Issacson	Assistant Technician Grade 2
D.G. Odlum	Assistant Technician Grade 2 (from May 1)
W.L. Tait	Assistant Technician Grade 2
E.A.R. Ball	Assistant Technician Grade 1 (from July 15)
R.H. Herlinveaux	Assistant Technician Grade 1 (from Feb. 23)
K.J. Ross	Assistant Technician Grade 1 (from Aug. 1)
E. Baldwin	Watchman (from October 1)
L. Baldwin	Watchman (from Aug. 9 to Sept. 30)
B. Wildman	Watchman (from Aug. 25)

INDEX TO SUMMARY REPORTS FOR 1948

SKEENA RIVER INVESTIGATION

1. PROPAGATION STUDIES

J.A. McConnell and J.R. Brett — Appendix No. 1

Propagation Studies at Lakelse Lake

In 1946 and 1947, a netting type fence was installed in the lakelse river through which were enumerated the migrating yearling sockeye salmon. The temporary structure was replaced this year with a sturdier, more permanent one involving part of the adult sockeye fence built in 1947. Work on the new project began on March 21 so that the fence was operating on May 18, in spite of considerable delay occasioned by a late spring break-up. The screened panels, (8' x 10'), covered with small mesh seine notting, were inserted in slotted piling and arranged in a V leading to a central trap. This trap, a modification of the previous one, had a 4" x 4" timber framework and strong wire netting surrounding the four pens. The system of doors, leads and double bottoms which were installed, made the device more efficient in that virtually all the fish entering the trap were captured and held. Handling of the fish was reduced by use of a pair of large graduated tanks in which the volumes of all the migrants were taken and a sample of approximately 25% of the run counted to obtain the volume-number ratio.

The fence was only in operation for a few days before the effects of the unusually high water began to tell. The level reached a peak on May 29 which was 16 inches higher than the peak in 1946 and 21 inches higher than that in 1947. In spite of all efforts to brace and strengthen the panels, five were washed out on the night of May 29 and efforts to obtain a yearling count had to be abandoned. It is felt that the fence as designed but with additional strong permanent braces will be quite satisfactory in the future, the loss of the count this year being due to very exceptional flood conditions.

During the period of operation, May 18 to May 29, a total of 349,000 yearling sockeye were passed through the fence. A statistical treatment of the daily runs up to May 29 in relation to those of the previous years indicates that the sockeye migration would probably have totalled 1,500,000. This total would be approximately 3 times the 1946 run and 4 times that for 1947. It would indicate a percent survival to yearling stage of 1.93 from the 1946 seeding by an estimated 40,000 adults.

2. MIGRATION STUDIES

J.A. McConnell and J.R. Brett — Appendix No. 2

Marking of Sockeye Salmon Yearlings at Lakelse Lake

It was planned to continue as in 1946 and 1947 the marking of 100,000 yearling sockeye migrating down the Lakelse river. However, the unexpected loss of the yearling fence early in the season prevented completing this, and in the three days prior to May 29 only 4,709 yearlings were marked by removal of both pelvic fins.

V.H. McMahon Appendix No. 3

Marking of Sockeye Salmon Yearlings at Babine Lake in 1948

The marking of 103,906 yearling sockeye salmon by removal of the adipose and both ventral fins was carried out in the spring of 1948 from May 23 to June 9.

The method of capture was identical to that employed in 1947. Some difficulty was experienced this year when high waters threatened to wash out the lead, but this was overcome by the addition of supporting piles on the downstream side. As a last challenge to the fast rising water, the lead was extended in height and stilts were installed on the bottom of the trap.

A total of 468 was preserved for later analysis, this being approximately equal to 1/50 of one man's marking total. It was estimated that less than 1% of the fish caught died as a result of manipulation during the marking process.

Factors which might affect the yearling migration were again observed and recorded. These included water level and temperature, climatic conditions, the time range of the daily migrations, etc. In addition water temperature series were collected from seven points along the axis of the lake as far south as 10 miles from Fort Babine. The first 5 points were approximately 1 mile apart while the last 2 points were at 2-mile intervals. Temperatures were taken at the bottom, at the 20, 10 and 5 metre levels and at the surface. Most positions were sampled every 5 days throughout the marking period.

Another feature of this year's marking program was the observation from a high vantage point of the migration "routes" over the entire width of the lake. This was carried out about 5 miles south of Fort Babine. In general it was discovered that schools close to shore move faster and apparently with more directed movement than the offshore schools.

D.J. Milne Appendix No. 4

Return of Marked Salmon in 1948

During 1948 a considerable number of recoveries of four-year-old individuals were expected from 100,967 young sockeye marked at Lakelse lake in 1946 by removing both ventral fins and from 88,972 marked at Babine the same year by removing the adipose and both ventral fins. In addition there might also be encountered a few five-year-old fish from smaller markings of 1945 (ca. 10,000) and a small number of three-year-olds from the 1947 experiments involving approximately 200,000. In order to assure adequate collection, an observer was stationed at each of the six operating canneries to examine all the sockeye taken in the Skeena gill net area during July. During August approximately one quarter of the catch was examined. Close observation was also maintained of the spawning adults on the streams tributary to Lakelse and Babine lakes.

From approximately 800,000 sockeye examined in the Skeena river, the following legitimate and undoubted marks were obtained: Babine - 327, Lakelse - 72. From cannery to cannery, the concentration of the Babine recoveries varied from 1 in 1900 to 1 in 5000 and the Lakelse marks from 1 in 7700 to 1 in 14,000. Since equal application was given to inspection throughout, the difference is attributed to the disposition of the various fleets, in relation to the migration routes. Fish from both lakes were apparently widely distributed through-

D.J. Milne Appendix No. 4

out the area to Stephens, Finlayson and Tugwell islands and at the mouth of the river. The Lakelse sockeye were obtained generally in the early part of the season with 70% of the returns being made by mid-July at which time only 40% of the Babine recoveries had been recorded. The greatest concentration of Babine recaptures was during the last three weeks in July. While the Lakelse run must still be considered early, the marking returns have certainly indicated a later effect than was previously shown by tagging.

A large number of fish (159) were discovered which had damaged fins or lacked one or more of the specified appendages. There is no doubt that the majority of these have been rightly ignored as natural deformities but it cannot be denied that some were the result of poor marking procedure. It is difficult to determine just how many should be considered as legitimate but as a result of observations on the spawning grounds it appears that approximately 10% might be so assigned.

The concentration of Skeena marked fish as determined by examining samples in areas definitely outside the Skeena influence, was low, e.g. Smiths inlet - 1 possible Lakelse in 1,000, Rivers inlet - 2 doubtful in 500, Butedale - 1 doubtful in 100, Lowe inlet - 0 in 7,000 and Nass river - 0 in 30,000. Off Banks island where Skeena fish are known to run, the numbers were 2 Lakelse, 1 Babine and 1 doubtful in 4,000.

The examination of 58,600 spawning adults at Babine produced 63 legitimate marks and 7 doubtful. The percentage of marked individuals with fins not cleanly cut was lower than the proportion on the coast but still amounted to over 10%. From 6,000 fish at Lakelse, 9 legitimate marks were recovered.

In general the total returns may be considered small when compared with other experiments but they have been valuable in demonstrating the distribution of the sockeye from these areas in point of time and place.

A.L. Pritchard Appendix No. 5

Salmon Tagging off the Skeena River in 1948

From June 10 to July 18, 1948, Captain Leask as in four previous years, seined for the salmon tagging in the northern areas. Two trips were made to the Nass area including Steamer passage and Finlayson island from June 10 to 13 inclusive and July 13 to 15 inclusive. The remainder of the time was spent at the mouth of the Skeena off Smith and Lelu islands. In all the following fish were tagged - Nass area - Sockeye - 121, Springs - 77, Coho - 6, Pinks - 123, Chums - 138, and Steelhead - 1; Skeena River Mouth Area - Sockeye - 2,342, Springs - 159, Coho - 9, Pinks - 19, Chums - 6, and Steelhead - 9. Since returns from the Nass tagging and from that for spring, coho, pink and chum off the mouth of the Skeena have been relatively limited and add little to the indications of migration recorded in previous years, the recoveries from the Skeena River Mouth area for sockeye only are treated herein.

Sockeye Salmon Recoveries. Of the 2,329 tags affixed to sockeye salmon, the following returns have been recorded to date: Commercial fishery - 510 (21.8%), Indian fishery - 261 (11.1% and spawning grounds - 77 (3,3%).

The percentage recovery from the commercial fishery (21.8%) is relatively low, cf. 1944 - 40.1%, 1945 - 25.5%, 1946 - 30.1% and 1947 - 18.6%. It is possible that the generally inclement weather early in the season coupled with high water may have had some effect in this connection.

A.L. Pritchard Appendix No. 5

Following the usual outline of the last four years, the percentage recoveries from each day's fishing varied greatly (13.3% to 61.9%). They were relatively low for fish off the Skeena river mouth up to June 27, high for salmon in early July dropping off on July 17 and 18.

As in other years, the Indian fishery exploited most heavily the early run, those present off the mouth of the river up to June 26. The drop-off toward the end of the run was, however, not so great as usual. This early fishing has been attributed to a desire to get fresh food as soon as possible after the winter. The total percentage recovery was 11.1 which is normal by comparison with 6.9 in 1944, 9.0 in 1945, 10.2 in 1946 and 12.2 in 1947.

The times taken for the sockeye to move upriver from the point of tagging as calculated from dates of tagging and return, show the same general progression as previously. They are as follows (1947 figures in brackets): to the eastern end of de Horsey island - 4.5 (5.6) days, Point Lambert - 6.4 (5.9), Terrace and Kitselas - 10.6 (14.3), Cedarvale, Kitwanga and Skeena Crossing - 20.3 (19.0), Hazelton, Hagwilget and Kispiox - 19.0 (16.7), Babine Lake streams - 37.0 (46.7) and Moricetown - 22.3 (25.4). Even though the fish remained in the lower river up to Point Lambert for a slightly shorter time in 1948 (4.5 as compared with 5.6 days), the limited value of the weekly closed season of forty-eight hours is again indicated.

Returns from the spawning grounds, though few, still show that the run to Lakelse is early. No tags were recovered there which were affixed after June 23. The greatest concentration of Babine sockeye was moving through the fishery just after the middle of July. On the whole, however, the runs were mixed.

3. LAKE SURVEYS

J.R. Brett and J.A. McConnell Appendix No. 6

Lakelse Lake

The regular physical, chemical, meteorological and plankton studies of Lakelse lake have been continued as in past years and amplified with monthly temperature series and plankton hauls taken during the winter months. Mr. V.H.B. Giraud, the fisheries inspector at Terrace, has been most helpful with this winter work.

Standard netting was reduced to 4 sets made during a winter trip in February and 5 sets in the latter part of June. The catch and catch per net-night are tabulated below:

	Winter - 1948		Summer - 1948	
Species	Catch	Catch per net-night	Catch	Catch per net-night
Peamouth	-	0.00	156	6.24
Squawfish	-	0.00	41	1.64
Cutthroat	14	0.70	13	0.52
Rocky mountain whitefish	3	0.15	13	0.52
Sculpin	-	0.00	2	0.08
Columbia large-scaled sucker	-	0.00	2	0.08
Dolly varden	2	0.10	-	0.00

J.R. Brett and J.A. McConnell — Appendix No. 6

It will be noted that the winter catches were very different from the typical summer catch in that no peamouth or squawfish were caught. The stomachs of the cutthroat trout contained 98% fish whereas in the summer they take only about 60% fish. The predation upon young sockeye, though, was much the same, the extra fish taken by the winter samples being sticklebacks.

Virtually all the available fish stomachs from Lakelse lake have now been analysed and these data applied to our knowledge of predation and competition.

V.H. McMahon — Appendix No. 7

Babine Lake Area

With the majority of the summer workers at the canneries from June 22 to August 3, relatively little lake work was carried out at Babine this year.

Water temperatures were taken and plankton samples collected at approximately two-week intervals throughout the summer at Stations I and III. Meteorological records were kept for Division I during periods of camp operation.

There was no attempt to catch fish by netting in the lake, but a series of trolling experiments were carried out in Division I. A weighted main line on which leaders and baited hooks were fastened at 5-metre intervals was let down and towed at slow speed. No fish were caught after several trial runs and the experiment was discontinued.

The sounding of Babine lake was completed in 1948 with a more comprehensive coverage of Morrison and Hagan Arms.

V.H. McMahon — Appendix No. 8

Morrison Lake

The work on Morrison lake in 1948 was confined to a one-day trip in July and a five day visit in August. Water temperatures and plankton samples were taken at Station III in both months, and a short netting program was carried out in August.

On the later visit a fourth netting position was set up near the north end of the lake, and was netted in a standard manner, i.e. a standard series of nets was set perpendicular to the shoreline with the large meshes inshore for the first set and the series reversed each succeeding set. This effort yielded a total catch of 10 Eastern Whitefish, 10 squawfish, 9 kokanees, 6 peamouth chubs, 2 lake trout, 1 burbot and 1 sucker. In addition, 3 experimental bottom sets were made using one or two nets at depths of 5, 12 and 25 metres in the hope of capturing predator fish. No such fish were taken.

D.R. Foskett Appendix No. 9

Bear Lake Area

This year a party was in the Bear lake area from July 21 to October 5. Temperature records were obtained, plankton collections made and a netting program carried out.

Temperature records show that the lake warms up until the second week in August and then commences to cool again. As was noted in 1947, layers of warm water sometimes occur in the cold water at various depths in the lake. The theory that these are caused by mineral springs seems to be the only reasonable explanation.

Plankton samples and transparency readings appeared to be normal, though a small algal developed in August instead of September as in other years.

The netting programme was extended to include sampling of the Bear river fish and additional areas in the lake especially over the sockeye redds. In 18 sets, a total of 73 net nights, 536 fish were caught of which 152 were sockeye, 27 were predators and 357 were other species. Netting in lake spawning areas to assess predation on the eggs in the redds accounted for the high catch of sockeye, a large proportion of which were returned to the water. Further netting in these areas in the spring when the fry are emerging from the gravel is essential for a complete understanding of the extent of predation in this type of spawning. That it may be considerable was evident from information gathered from the Indians regarding the catches of predators in the spawning areas in the spring.

4. STREAM SURVEYS

J.R. Brett and D.F. Alderdice Appendix No. 10

Lakelse Lake Area

In 1947 an apparently feasible and inexpensive type of fence was constructed in the Lakelse river to provide a count of the numbers of adult sockeye salmon entering Lakelse lake. It did not function properly due to the lack of a strong current to bring the fish into the pens. The fence was reconstructed this year in May and June with the short shear or funnel, built last year to increase flow through the pens, being extended almost to the banks. In addition, new pens were installed, designed to hold up water as little as possible. Although this did increase the current through the pens to approximately 5 miles per hour the fish still would not enter in satisfactory numbers. Considerable difficulty was also experienced in maintaining a seal in the clay bottom and it was felt that the shear would increase scouring in spite of sandbagging, etc. to the point where labour to maintain the fence would be prohibitive. Thus, after every possible effort had been made to ensure success, the project had to be abandoned.

If a propagation study is to be carried on at Lakelse it would appear that a more expensive platform and picket type fish fence will have to be constructed farther down the Lakelse river in swift flowing water.

The fence, operating at low efficiency, did capture 3,796 sockeye between June 19 and August 19. These were examined for marks, 2 being observed

J.R. Brett and D.F. Alderdice — Appendix No. 10

as were 6 ocean tags. A total of 298 sockeye was tagged at the fence. Lacking a fence count, a good estimate of the total run was formed by recording recaptures of these tags in samples of the population taken by seining in Blackwater bay. Four seine hauls were made on July 26, 27, 28 and 29 in this bay where the Lakelse sockeye congregate before moving into the spawning streams. Some 19 fence tagged fish and 986 untagged fish were recorded, giving by statistical analysis a total run of 15,000.

In the past, an estimate of the total run has been made by using a tagged to untagged ratio from counts made on the spawning streams. That method was not feasible this year even though the routine 8-day stream counts were made. Heavy rains caused unusually high and murky water in the main spawning stream, Williams creek, resulting in relatively small and inaccurate counts. Eliza and Scully creeks were less murky and on the basis of counts in them the distribution to the creeks was probably:

Williams creek	13,000
Eliza creek	800
Scully creek	1,200
Granite creek	0
Total	15,000

Granite creek, which in recent years has become increasingly jammed with logs and spread out, was inaccessible to salmon this year.

J.A. McConnell — Appendix No. 11

Kispiox System - Lac-da-dah District

In order to add another area to the year's stream observations it was arranged to accompany Fisheries Inspectors V.H.B. Giraud and W.K. Elliott on an airplane inspection trip to sockeye spawning streams in the Lac-da-dah basin. In the one-day trip on September 22, a landing was made first on Swan lake and surveys made of Falls creek and the upper end of Club creek. An amazing heavy run was spawning in Falls creek with approximately 10,000 fish jammed into the short spawning area. Also a school of several hundred were observed off the mouth in Swan lake. Spawning was at its peak at the time and large numbers of whitened eggs in all the pools and eddies gave evidence of egg wastage. Upper Club creek, the outlet of Swan lake, was well seeded, there being 550 live and 16 dead sockeye on this short spawning area.

A second landing on Stephenslake gave access to Lower Club creek, the main spawning stream of the area. Here 3,000 live and 550 dead sockeye were observed in the creek and in addition, a large school of between 500 and 700 coho salmon was present off the mouth in Stephens lake. A few coho and spring salmon were observed at the upper end of Stephens creek, which drains the chain of lakes into the Kispiox river.

The total sockeye escapement for the area was probably 15,000 but it is felt that because of the egg wastage in Falls creek, the effective escapement would have to be considered somewhat less.

F.C. Withler — Appendix No. 12

Babine Lake Area

With the loss of an absolute count at the Babine fence in 1948 as a result of the washout, enumeration of the runs to the streams in the Babine area became essential. As in previous years, surveys were carried out at 8 to 10 day intervals, and in addition to the counts of live and dead fish, sex ratios, mark recoveries, water levels and obstructions were recorded. Comparison of the runs to various streams is given in the following table:

Sockeye Runs - Babine Area

	1946	1947	1948
Lower Babine river	9,000	10,000	15,000
Upper " "	9,000	10,000	12,500
Trail creek	100	75	0
Unnamed creek	0	0	0
Five Mile creek	50	200	1,300
Nine Mile "	1,000	600	3,900
Fulton river	100,000	115,000	115,000
Tachek creek	6,500	12,000	5,700
Sockeye creek	320	1,400	600
Pierre creek	16,000	19,000	19,600
Twin Creek	9,500	9,700	5,100
Pendleton creek	2,000	1,800	1,300
Fifteen Mile creek	28,000	25,000	25,500
Four Mile creek	1,100	1,800	3,300
Six Mile creek	340	800	2,700
Grizzly creek	3,500	4,900	8,800
Morrison river	20,000	28,000	30,000
Salmon creek	5,000	5,000	7,000
Total	211,410	245,275	257,300

Since the estimates of runs to streams in 1946 and 1947 totalled approximately one-half of the run through the Babine fence in those years, it becomes possible to estimate the probable run through the Babine fence in 1948. On the basis of the ratio in the past, the fence count this year would have been in the neighbourhood of 560,000, or approximately 40,000 greater than in 1947.

In terms of effective spawning population, the run to Babine lake in 1948 is much greater than in 1947. Precocious male or "jack" sockeye were much fewer than in 1947, when they formed 48% of the run through the fence. Thus, the effective escapement to the Babine area in 1948 could well be 200,000 larger than in 1947.

D.R. Foskett — Appendix No. 13

Bear Lake Area Spawning

The count at the Bear lake fence and the subsequent recovery of tags on the lake shore indicated that the sockeye run to the area this year was the

D.R. Foskett Appendix No. 13

lowest recorded during the investigation. The stream counts, however, indicate that these runs were normal for the area and therefore the decrease must have been in the lake spawning population. The small number of sockeye recovered on the lake shore, 260, as compared to the 1,244 of 1947 supports this assumption. Adding to the sockeye tagged, those put over the fence which had tags, and eliminating recoveries from gill netting and stream recoveries, the net total of tags on the lake population was 132. The number of tags recovered from fish on the lake shore was two and four fish having unmistakable tag scars were found. That is a total of six tags for 260 sockeye, indicating a population of 5,720. While several factors tend to reduce the value of this estimate, it is directly comparable to that of 1947 which indicated a population of 40,000 sockeye for the area. As no tagging program was carried out in 1945 and 1946, estimates for those years cannot be compared with those of 1947 and 1948. From observation, however, it is known that the 1945 population exceeded the 1947 run by a very large amount and the 1946 run was equal to and probably better than the 1947 run.

The spring salmon run in the Bear river was as large as in 1945 when an estimated 9,000 spawned there. The run was at least two weeks later this year. Coho were present in approximately the same numbers as in previous years though spawning was just commencing towards the end of September. Pink salmon were absent as is normal in even-numbered years in this area.

In view of the very great fluctuations in the size of sockeye runs to this area and the desirability of knowing more about the conditions affecting the fry, it is recommended that the area should be examined during the spring months, especially with regard to water conditions under the ice and predation on the redds when the fry are emerging.

5. SALMON COUNTING FENCES

J.A. McConnell Appendix No. 14

Babine Fence

In the spring of 1948 work was started to put the Babine fence in condition for a third year of operation. A sixth trap was added, the panels drilled, and the pickets spaced with steel rods. It became apparent late in May that exceptionally high water levels were to be expected in June and the half of the panels which had been installed earlier were removed to eliminate strain on the fence. At this time additional filling was done with boulders around the cribbings on each bank. With receding water levels late in June, the panels were replaced and the fence sealed on July 2 for the expected beginning of the sockeye run.

A cautious watch was maintained on the structure for the next week and there was no indication of weakness. On the morning of July 9, however, a washout occurred which in a very short time cut a hole 15 feet into and under the east cribbing and 32 feet out and under the fence floor, removing the sheet piling and the new trap and reaching a depth of some 4 to 6 feet. The panels were removed immediately and attempts were made to block the hole. However, the strong force of the water made the efforts ineffective and the fence had to be declared inoperative for the season. It became necessary

J.A. McConnell Appendix No. 14

then to switch the manpower over to stream surveys and to preparations for repair of the fence during the fall low water.

It was decided to extend the fence at each end into the present abutment cribbings and rock fill them prior to filling the hole and re-driving the washed out sheet piling. Mr. O.A. Ragsdale, the original builder, agreed to do the repair work in the fall and in the meantime all possible preparations were made, viz. collecting rock for the fill, logs for piling and cribbing, transporting the lumber and piledriver to the fence site. The repair work commenced on October 2 and continued until November 2. Completion of the work will be carried out in the low water period of early spring.

D.R. Foskett Appendix No. 15

Bear Lake Fence

Construction of the Bear lake fence this year was accelerated by the use of one-inch mesh stucco wire and the fact that, despite high water, the framework of the 1947 fence was for the most part intact. However, the ability of the sockeye to break through the wire resulted, in the end, in a fence which was almost as heavily picketted as that of 1947.

The fence was in operation from July 27 to September 23, during which period it is estimated that 90% of the sockeye run entered Bear lake. The count of 3,021 sockeye represents a large proportion of the salmon entering the lake as it was very seldom that any hole was not patched within 24 hours. Of the sockeye counted through the fence 139 (4.6%) were tagged. The sex ratio was relatively even, 1,395 being females and 1,626 being males of which 45 were jacks. The two peaks recorded for the run, about August 10 and August 30 are believed to represent the peak of the stream and lake spawning runs respectively.

The count of coho this year, 191, was very similar to that of 1947 and as was the case then, large numbers were just below the fence at the time it was removed. Only 5 spring salmon entered the pens at the fence which is above the spawning grounds of this species.

Of the local fish populations, 76 rocky mountain whitefish, 23 eastern whitefish, 38 long-nose suckers were caught as well as one dolly varden char and one rainbow trout. Of these, the dolly varden char, 4 rocky mountain whitefish, 9 eastern whitefish and 16 northern suckers were tagged. One northern sucker tagged in 1947 was again captured at the fence and released.

6. STATISTICS

D.J. Milne Appendix No. 16

Commercial Fishery - 1948 season

As previous summary reports have reviewed the commercial fisheries in past years the present report will be confined to the 1948 season. In general it has been an exceptional year, especially for the sockeye fishery.

The weather, which was particularly fine for most of the spring and summer months may have been an associated factor. The spring flood of the Skeena river was the most extreme since 1936. It had been predicted that the 1948 sockeye catch would not repeat the low catch of 1947 (32,000 cases) but might be as much as twice as large. The catch recorded of three times this size could not be anticipated in the light of past data.

In detail, the sockeye fishing started off slowly, with daily averages of 30 fish per boat reported for the first two weeks in July. The average for the third week rose to 60, and dropped to 55 during the fourth week. Up until this time the catch had followed the upper range of expectancy. However the last week of July and the first two weeks of August produced catches which were the largest for the season with the result that the total catch was about 98,000 cases. This large catch late in the season gave a date for the 50% point at July 25, which is two days later than any season since 1935, the period for which detailed records are available. Thus the catch for this season could not be reliably predicted either in total or at the end of the first four weeks of fishing.

This season's large catch attracted and sustained the fishing efforts of 827 boats. With the exception of 1946 this is the largest number of boats licensed since 1941. These boats averaged over 50 fish per day and 1,500 fish for the season. As it is only three years since the last large catch in 1945 the regularity of the five-year cycle has been broken for the second time in the last twenty years. The fish comprising the catch were smaller (5.6 lbs or 13.4 fish per case). This small size and the lateness of the run may indicate that the large run of jacks in 1947 was probably followed by a large run of four-year-old fish. It remains to be seen if the age determinations will substantiate such a supposition. As the estimated escapement has not been wholly in keeping with the large catch, it would appear that the commercial catch may have taken more than the usual proportion (approximately 50% of the run).

The pink salmon catch this season of over 50,000 cases has followed the two lowest catches on record in 1946 and 1947. This indicates that the run for the even year cycle has probably reverted to an average condition and it will be interesting to see if the odd year cycle will do the same in 1949. The pink run appeared earlier in July from which a random sampling of 100 fish yielded 57% males. In August, 68% of the 156 fish sampled were males which is considerably lower than the percentages obtained for 1946 or 1947. The chum catch was again exceptionally high and the spring and steelhead catches were good. The coho catch was only fair so that for this species the catches have dropped each year since the peak catch in 1941.

In contrast to the Skeena salmon catches, it has been reported for southeastern Alaska that the sockeye catch has been the lowest on record and that the pink catch is lower than in 1947 or has been the lowest since 1927. The chum catches were good in both regions.

The general results from the oceanographic study of the dispersal of fresh water from the Skeena river indicate that during the sockeye fishing period the fresh water passes northwards along the shore to meet the fresh water from the Nass river in the northernportion of the Skeena gillnet area. This picture is in general agreement with the ocean migration routes of sockeye bound for the Skeena river as deduced from tagging experiments and fishing experience.

D.J. Milne Appendix No. 17

Indian Fishery on the Skeena River

As in previous years all the Indian fishing sites were visited during the summer. The final estimate of the number of fish taken in 1947 by the 2,200 Indians (650 families) on the Skeena was 41,000 sockeye, 5,700 coho, 6,700 spring, 1,800 pink, 13 chum and 1,900 steelhead. The estimates for 1948 are not yet available.

In the case of sockeye it was pointed out last year that these estimates may be low by as much as 50% and that the number of ocean tags returned by the Indian fishery appears much higher than would be expected. This is particularly true for 1947 and 1948 for in both years the Indian fishery returned approximately one-half as many tags as were returned by the commercial fishery. This year evidence was found of some tags which had been caught at the coast in the commercial fishery and were brought up river to be sold at such places as Kitwanga, Hazelton and Kispiox. Due to the flood conditions in 1948 the river was high and muddy throughout most of the summer. Associated with this the fish arrived from one to two weeks later at most of the fishing sites. In contrast to 1947 few jacks were caught in 1948.

The gillnet fishery in Nilkitkwa lake attained its normal requirement in both 1947 and 1948 despite the fact that there were fewer sockeye present in 1947, especially when the small jacks are not considered, than in 1948. This was accomplished by a greater effort in 1947 when 21 of the 23 smokehouses operated compared to only 13 in 1948. The 35 nets used in 1947 averaged 30 to 50 sockeye per night while the 25 nets in 1948 averaged 50 to 100 sockeye per night. In each year the deeper and longer nets brought up from the coast caught about twice as many fish as the nets issued free by the Indian Department.

At Moricetown falls the gaff fishery took 3,300 sockeye in 1947 and 8,800 in 1948, which is in keeping with the commercial catches. This year, as in previous years when a large catch is made, there was more evidence of wastage and of peddling fish to the whites in the district.

To complete the study of Moricetown falls as an obstruction to the salmon on their spawning migration, water levels were again recorded. The water was highest around June 5, dropping rapidly up to July 5 and more gradually during the rest of the summer. However, it remained at a higher level throughout than during any of the previous three seasons of observation. It appears that during this year's flood the Bulkley river was higher than in 1936 while the Skeena river north of Hazelton was lower. Probably this high water accounts for the fact that all species of salmon were about two weeks later in arriving at the falls and that less obstruction was presented by the falls than in other years.

7. AGE DETERMINATIONS

D.R. Foskett — Appendix No. 18

Age Composition of the Skeena River Sockeye Salmon Runs

During 1948 the reading was completed of sockeye scales taken in 1946 and 1947 incidental to tagging off the mouth of the Skeena river. A summary of the age composition for 1944, 1945, 1946 and 1947 follows.

Table I. Age Composition of Sockeye Salmon off the Skeena River Mouth

Year:		1944	1945	1946	1947
No. of samples		872	2,129	2,105	2,317
Age Class:	3_1	%	0.05%	%	0.04%
	4_1		0.09	0.10	0.12
	5_1		0.05		0.09
	3_2	0,34		0.19	11.18
	4_2	47.25	18.60	26.65	25.98
	5_2	41.40	58.90	58.34	53.04
	6_2	3.21	0.42	0.38	0.17
	4_3			0.10	0.86
	5_3	5.50	11.65	3.90	4.83
	6_3	2.29	10.15	10.31	3.58
	7_3			0.05	
	5_4		0.05		
	6_4		0.05		

The 1946 run of sockeye to the Skeena river consisted largely (58.3%) of the 5_2 year class. The other two year classes prominently represented were the 4_2 class (26.6%) and the 6_3 class (10.3%). In 1947 the 5_2 class represented 53.0% of the population and the 4_2 class represented 26.0%. The main divergence from the 1946 figures was in the 3_2 class which formed 11.2% of the fish sampled. This age class, composed almost entirely of males, formed the bulk of the "jacks" present in the 1947 run.

D.R. Foskett

Appendix No. 18

Analysis of age of the tagged fish returned throws some light on the distribution of different age classes.

Table II. Age Composition of Tag Returns from Skeena River

Area:	Commercial fishery		Lower Skeena		Upper Skeena		Babine		Bulkley	
Year:	1946	1947	1946	1947	1946	1947	1946	1947	1946	1947
No. of Returns:	622	429	50	65	404	656	310	572	72	40
Age Class:										
4_1	. %	0.2%	%	%	%	%	%	%	%	%
5_1						0.2				
3_2		3.0		4.6	0.2	9.1	0.3	8.6		
4_2	23.6	17.0	18.0	26.2	23.3	33.4	21.0	35.3	27.8	12.5
5_2	60.8	69.2	66.0	58.5	68.1	53.7	77.4	54.0	34.7	57.5
6_2	0.2	0.2								
5_3	4.2	6.1	2.0	4.6	1.0	1.8	0.3	1.2	2.8	12.5
6_3	11.3	4.2	14.0	6.2	7.2	1.8	1.0	0.9	33.3	17.5
7_3					0.2				1.4	

Percentages of age classes taken in the commercial fishery in 1946 (Table II) do not vary to any great extent from percentages caught by the seiner for tagging purposes (Table I). Upriver recoveries (Table II) are shown with recoveries for the area from the commercial fishing boundary to Hazelton designated "Lower Skeena" and above Hazelton on the Skeena proper designated "Upper Skeena". The figures for the Babine and Bulkley river runs are also shown separately. From these it is readily seen that the age composition of runs to specific areas with different ecological conditions may show a great deal of variance both from each other and from the population as a whole.

In 1947 return of tags from the commercial fishery showed that the 5_2 class accounted for the bulk of the catch. Seine catches indicated that the 5_2 age class formed 53% of the population while gill net catches had 69% of the fish from this class. The jacks which formed only 3% of the gill net catches according to tag returns formed 11% of the tagged fish.

Upriver returns, which are chiefly Babine figures, in Table II show the main change from 1946 seems to have been an increase in the percentage catch of the 4_2 group and a decrease in the 5_2 year class. The Bulkley river returns, however, show increases in the percentage of the 5_2 and 5_3

groups with decreases in the 4_2 and 6_3 classes.

On the whole, the 1947 tagged fish showed a greater diversity of age classes with a more even distribution of fish in the age groups than was shown by the 1946 population.

Ferris Neave Appendix No. 19

General Salmon Investigation

As in previous years, this investigation has been largely concerned with problems relating to the pink and chum salmon fisheries. Some attention has also been given, however, to coho and sockeye salmon in certain areas.

Studies have been mainly directed towards (a) an understanding of the present condition of the various fisheries (b) the estimation of future runs and trends (c) the development of methods for increasing the production of seaward migrants.

Evaluation of existing conditions

As a necessary basis for diagnosing the conservational requirements of different species and different areas, the year's work has included (a) compilation of data relating to catches (including the stationing of a recorder at Cowichan Bay) (b) studies of the age- and size-composition of commercial chum salmon catches from various localities and of sockeye salmon catches from Smith inlet (c) spawning stream surveys (d) tagging of pink and chum salmon in the Whale channel area, to provide information on migration routes an fishing intensity (e) quantitative studies on the natural propagation of chum salmon at Nile creek and of chum, pink, coho and sockeye salmon at Port John.

Estimation of future prospects

Analysis of the factors associated with variations in the production of seaward migrants has been continued at Nile creek and inaugurated at Port John. From observations made on these and other streams and from correlations which appear to exist over relatively large areas between stream flow conditions and subsequent catches, it is hoped that a useful and widespread system for the prediction of runs can be developed. The apparent correlation between water levels at spawning time and cycle-year abundance of chum and pink salmon was noted in last year's report (appendix no. 51). More recent studies have indicated that the size of coho runs is related to the minimum stream flow prevailing during the summer of the year which the young fish spend in fresh water (two years prior to maturity). The recent establishment (in cooperation with the Dominion Water and Power Bureau) of several new gauging stations in various coastal areas should materially assist in the prosecution of these studies.

Before the commencement of the 1948 fishing season, predictions were made and circulated to the Industry, concerning the pink salmon run to the central area and the chum and coho salmon runs to the Vancouver island area. While final reports on the escapements are yet to be received, it appears that the predictions were substantially correct in each case.

Methods for increasing production of young salmon

In view of the very low production of chum salmon fry recorded from natural propagation at Nile creek and in the belief that this stream is representative of conditions obtaining in many others, much attention has been given to exploring the possibilities of improving production by methods which might

be economically applied on a large scale. The conclusion that the most serious losses occur prior to hatching and that (at least on the east coast of Vancouver island) they are associated in a considerable degree with the occurrence of sudden floods, has encouraged fish-cultural experiments on the better protection of the eggs. Two such experiments were attempted during the past year and are reported in appendix 20. In the more successful operation, involving the planting of eyed eggs, the production of seaward migrants (on a percentage basis) was about 28 times greater than the production from natural propagation in the same stream. In the other experiment (in which "green" eggs were planted in a controlled water flow) the breaking of a dam rendered the experiment less satisfactory. A production equivalent to about 9 times that of the natural propagation was, however, recorded. These experiments are being repeated at the present time.

Preliminary tests were made, with encouraging results, of the feasibility of acclimatizing young coho fingerlings to salt water (appendix 22). If such a procedure is found to be practicable, it might be effective in eliminating much of the heavy loss which this species (and also the sockeye) incurs during the prolonged period of freshwater existence.

Recommendations

By continuing along the present lines, it is hoped and expected that the Investigation will in the near future produce results of practical significance (already foreshadowed) in the fields of prediction and fish-culture. Attention is drawn, however, to the desirability of enlarging the scope of the Investigation in certain directions.

(1) the very low natural production of young chum and pink salmon migrants which has been recorded in recent years at Nile creek, Morrison creek and Port John, suggests that in certain areas relative failures of adult runs are likely to occur, irrespective of any restrictions which may be placed on the fishery. It is very desirable that the seriousness and frequency of low fry-production be investigated in various districts, in order that remedial action, if needed, may be taken promptly and on a sufficiently large scale. The setting up of counting weirs on several additional streams is regarded as essential.

(2) The west coast of Vancouver island, which has hitherto received no intensive study, should be investigated in 1949 with respect to (a) chum salmon production, believed to be potentially large but which has fallen below expectations in a number of recent years (b) sockeye production, which has shown a striking decline (c) the offshore troll fishery for spring and coho salmon, which is engaged in by both Canadian and American fishermen and which probably affects fisheries and spawning runs in many parts of southern British Columbia and in states south of the line.

(3) The sockeye fishery of the Rivers inlet area has shown marked fluctuations. Investigation of these would seem desirable and might well throw light on sockeye problems in other parts of the province.

Ferris Neave Appendix No. 20

Natural and Artificial Propagation of Chum Salmon at Nile Creek

As explained in previous reports, the investigations at Nile creek include a study of natural propagation (and the factors by which it is limited) and also a series of experiments in methods of increasing the production of seaward migrants. Attention has been devoted primarily to chum salmon, although information on the natural propagation of cohos has also been collected. The present notes refer to the former species.

Nile creek is regarded as sufficiently typical of a large number of coastal streams to be suitable for the testing of conservational methods which might have wide application. The present establishment includes a [illegible], an eyeing station and water supply system and counting weirs dividing the stream into three stretches.

The lowest stream section is used for the study of natural propagation and also serves as a "control" for experiments conducted in the other two sections. During the 1947-48 season no chums were allowed to enter the middle section. Eggs which had been fertilized artificially and incubated to a late stage in the eyeing station were planted in this portion of the stream in February and March. The third stream section also received plantings of artificially fertilized eggs. These, however, were planted "green". In lieu of the protection presumably afforded by retention in an eyeing station, the stream flow in section 3 was controlled by a dam, excess water being diverted through another channel. Unfortunately an exceptionally severe flood on December 13 caused a break in the dam just after plantings in this section had been completed. Repairs were made and the structure effectively resisted subsequent floods, but the test cannot be regarded as satisfactory.

The sea-going migrants were counted during the spring of 1948 at the weirs constituting the lower boundary of each section. Results are compared in the following table:

Section	Type of propagation	Eggs available	Fry counted	%age efficiency
1	Natural	1,275,681	4,808	0.38
2	Eyed egg planting	490,774	52,109	10.62
3	Green eggs, controlled water	421,531	14,331	3.40

At intervals during the seaward migration, marked fry were liberated at or near the head of each section. The percentage of these which failed to show up at the counting weirs was taken as a guide to the relative severity of predation to which the migrating fry were subjected in each section. General average losses were: Section 1, -43%; Section 2, -36%; Section 3, -37%. These differences are not sufficient to account for any considerable part of the recorded disparity in production.

While admitting the probability that natural production was unusually low in this season, it is concluded that a very considerable increase in production can be effected by giving increased protection to the developing eggs. In the current repetition of these experiments, special attention is being given to obtaining a true comparison of the respective merits of the two artificial procedures outlined above, bearing in mind the expense involved in each case.

Ferris Neave — Appendix No. 20

The technical operations involved in the 1947-48 experiments were conducted by Mr. W. F. Baxter, assisted by Messrs. W. Caulfield and H. Neate.

W. P. Wickett — Appendix No. 21

Operation of Nile Creek Field Station. Summer and Fall 1948.

During July and August, the fry screens were cleaned, lacquered and stored, the planting bed in the controlled section smoothed and widened, deflectors and settling ponds built, and dams repaired.

In September, installations were modified in the light of past experience. Pickets of both fences were arranged so that all vertical sections were two feet high with 3 1/2 foot horizontal sections in contact with their tops. Eighteen inch "jumping panels" were placed four to six inches behind the trailing edge of the horizontal pickets and with their bottom edge six inches below the horizontal pickets. The "jumping picket" sections were set in slots, but with floods they could not be removed. They have since been hinged so that they will drop back to become an extension of the horizontal pickets during periods of exceedingly high water and/or much debris. An overnight two foot rise of water behind the fences, three feet in front of the fences, with continued high water, has been handled with no night work nor extra help. There is no indication as yet that fish passed over the fences during the flood. Branches and leaves have been abundant as usual but raking has only been done in a routine manner. In the hatchery, slides have been placed in the boxes to facilitate handling of the trays.

By November 19, 386 chum, 151 coho have been counted through the lower fence. Six fish marked in 1946 as fry have been handled. Eggs are being taken from other streams for the hatchery and the planting bed. To date, there are in the natural spawning area 564,300 eggs; in the hatchery there are 124,769; in the planting bed 42,600. The run is very small so far, but with the fishery now closed there may yet be a sizable late run.

By means of stand pipes, temperatures and water samples can be taken in the gravel of the controlled section. Indications are that the surface water does not flow into the gravel at the bottom of a riffle or into the gravel that is covered with much silt and detritus.

W. P. Wickett — Appendix No. 22

Acclimation of Coho Fry to Sea Water

The feasibility of transferring coho fry to salt water was investigated during May, June and July. A 3' x 3' x 2' floating cage was built and moored in the estuary of Nile creek or moored to a 500 foot pulley line set out into the sea just south of the estuary. Due to the shoal nature of the foreshore, the pen was subject to grounding at zero tides and to extreme movement during strong winds. Successful long term experiments therefore were not made, but mortalities in the twenty-four hour period after transfer to sea water (1/2-2/3 full salinity) are encouraging.

W. P. Wickett — Appendix No. 22

1. Direct transfer — 79/100 = 79% mortality
2. After 3 days with 3 approximately one hour exposures to salt water in intertidal zone — 32/150 = 21% "
3. After 5 days with four approximately 4-hour exposures to salt water in intertidal zone — 7/75 = 10% "

Chum salmon fry were placed in the pen with the coho in experiments 1 and 3 for comparison.

1. - - - - - - - - - - - - - 3/100 = 3%
3. - - - - - - - - - - - - - 5/100 = 5%

Four of the five chum mortalities recorded in #3 were observed to have the posterior portion of the body paralyzed. On removal, the abdomen was found to be incompletely closed. Coho with Saprolegnia on the tail died first on transfer to the sea.

In #2, which met the least disastrous hydrographic conditions, there was a 36/150 = 24% survival after seven days in the sea.

In #3 after five days in the sea, there was a 1/75 = 1% survival of coho and a 79/100 - 79% survival of chum fry.

A controlled eight day experiment at Nanaimo with seven experimental fish and seven controls showed a loss of one undersized coho fry on the first day. The fish were transferred to aerated Departure bay sea water (50% salinity) for 15 minutes the first day, two 1-hour periods the second, 6 hours the third, and then remained in sea water (50% full salinity) until the end of the experiment.

Subsequent experiments with large numbers of fish were unsuccessful, probably due to conditions in the water supply.

Specimens were preserved for study of the chloride-secreting cells in the gill epithelium. Next year the experiments will be repeated and extended, for it appears practical at present to use tidal changes in tanks at tide water to transfer coho fry from stream to sea. This would eliminate the first year in fresh water which is believed to be an important factor in limiting production.

J. G. Hunter — Appendix No. 23

Installation and Operation of a New Type of Counting Weir for Young Salmon

In view of troubles previously experienced in the operation of weirs intended to screen out small salmon fry, a new type of installation was set up at Port John early in 1948 and was used throughout the season of seaward migration. The structure conformed in principle to a type of trap used successfully in Sweden by Mr. Philip Wolf, who kindly supplied plans and details and also discussed the matter personally during his visit to Canada in 1947.

The "Wolf" trap consists essentially of a dam over which the water flows through a short trough. The water falls onto a slightly inclined wire screen which leads to a wire mesh trap. About 95% of the water passes through the screen while the remaining 5% carries the young migrants into the trap.

As modified for use at Port John, the dam is fitted into the structure of the adult counting weir and the number of screens and traps is increased. The installation was designed by and constructed under the direction of Mr. G. B. Starr. The dam is made of 4" x 6" stop-logs, 6 feet long and extends completely across the stream. The stop-logs fit between the A-frames of the adult

J. G. Hunter Appendix No. 23

fence. The dam is 3'8" high and consequently backs up a considerable volume of water. This body of water has a greatly reduced stream velocity and thus acts as a settling pond for much of the debris which is ordinarily carried downstream. The inclined screens are 6' x 4' with mesh apertures of 0.06". They are set at 5° from the horizontal. There is an individual trap for each screen. Each is a 42" x 72" x 24" screen cage, with front and top sides open. The bottom six inches of each trap is a watertight box. Excess of water coming into the trap runs through the screen near the six-inch level, thus keeping a constant amount of aerated water for the contained animal life.

Although the traps operated quite well over a wide range of water levels, experience showed that there was an optimum for the amount of water falling on the screens. This could usually be maintained by controlling the number of traps in operation.

The fence was easily kept free from debris without injury to the fish. An ordinary dock-broom was used to keep the inclined screens clean, while material which passed into the traps was taken out in the same manner as the fry and yearlings, that is, by a screen dip-net. The only drawback experienced with the fence was in its original size. It was found that the screens would not handle the large volume of water during flood conditions. Some mortality of fry occurred through the resulting rush of water into the traps. After the number of spillways and traps was doubled the fence operated very well. The 1948 migration of fry and yearlings occurred between March 10 and June 19. The total fence mortality for the migration was 6.14% of the total number of fish counted.

J. G. Hunter Appendix No. 24

Production of Seaward Migrants at Port John

The fry fence, as already described, was put into operation on March 10. A few pink and chum fry started to move downstream almost immediately. The pinks reached their peak on April 16, the chums on May 6. Sockeye and coho yearlings were later in making their appearance and were most numerous in May. The largest numbers in each instance coincided with periods of high water.

The course of the run is indicated in the following table.

Week ending	Pinks	Chums	Sockeyes	Cohos
Mar. 13	11	8	0	0
20	115	63	0	1
27	123	282	0	0
Apr. 3	1614	731	2	4
10	3393	1605	0	1
17	10208	5590	19	8
24	6067	5176	689	5
May 1	4722	16043	3572	32
8	5606	40514	4063	1029
15	1384	31606	4557	1494
22	91	5345	3333	3148
29	13	1020	1035	1833
June 5	3	662	74	348
12	0	94	3	44
19	0	7	0	10

J. G. Hunter Appendix No. 24

The following table records the total numbers counted and the percentage survival of pinks and chums in relation to the potential egg deposition, as estimated in the autumn of 1947.

Species	Adults ♂	Adults ♀	Average no. of eggs	Potential deposition	Downstream migrants	Percentage survival
Pink	2650	2926	1316	3,850,616	33,350	0.866
Chum	4896	5210	10106	10,977,470	108,746	0.990
Sockeye	158*	216*	2511	542,376*	-	-
Coho	449	216	2313	499,608	-	-

* Count probably incomplete.

From the foregoing data it is evident that the mortality of pinks and chums was very high. Observations showed that some of the losses could be attributed to floods and also to the superimposition of redds. Both these agencies caused the removal of eggs from the gravel. Numerous eggs (probably mostly taken while drifting downstream) were found in the stomachs of gulls and ducks frequenting the stream.

Samples of eggs taken from redds above the main fence in January showed high mortality, 86.2% of the chum eggs and 96.8% of the pink eggs examined being dead. Nearly all were heavily overgrown with Saprolegnia. An interesting observation was made that eggs taken at the same time from the tidal portion of the stream, where they were subjected at times to saline water, showed much less mortality (94.4% survival in chums, 25% in pinks, in the samples examined). No Saprolegnia was observed (Very small concentrations of salt are lethal to this fungus).

A marking programme was carried out in which 11,360 pink fry and 55,592 chum fry were marked by removal of the two pelvic fins. In addition, 10,012 sockeye fry were marked as they entered the lake. The survivors should be recovered as yearlings at the main fry fence next spring and their numbers should throw light on the mortality occurring in the intervening period.

Detailed records of precipitation, stream levels and temperatures have been maintained throughout the entire year.

J. G. Hunter Appendix No. 25

Adult Salmon Migration at Port John, 1948

This year saw the Port John fence ready for operation on August 17. The fence was lengthened by twelve feet after this date, but the addition in no way interfered with operations.

In addition to the main fence at tidewater, a second weir was installed at the mouth of a tributary flowing into the lake, some three miles from salt water. This tributary is frequented by sockeyes and cohos. This fence was ready for operation on September 10.

The first sockeyes passed through the main fence on August 20. Pinks began to enter the stream on August 24 and continued through until October 24. They were much fewer in number than in 1947. They reached their peak on September 21. Chums, which were also much fewer than in 1947, first appeared at

J. G. Hunter

Appendix No. 25

the fence on August 27 and continued until November 7, reaching their peak on October 4. Cohos have been very erratic in their upstream migration, a few entering on every large freshet. Sockeyes showed a peak on August 24. It is evident, however, that an early run of this species occurs during July, before the main fence was put into operation. These fish remained in the lake until late in September and were subsequently trapped as they moved up the tributary.

The fence at the lake experienced the adversities of weather and situation. The count of the run was broken but by close observation of the creek it is believed that a reasonably good estimate was obtained.

The following table gives by weeks the numbers of fish entering the main stream.

Week ending	Aug. 21	Aug. 28	Sept. 4	Sept. 11	Sept. 18	Sept. 25	Oct. 2	Oct. 9	Oct. 16	Oct. 23	Oct. 30	Nov. 6	Nov. 13	Total
Pinks	0	84	81	32	123	616	95	122	3	5	5	0	0	1164
Chums	0	4	8	5	20	228	88	365	87	111	55	34	4	1009
Sockeyes	9	203	16	2	0	0	0	0	1	0	0	0	0	231
Cohos	0	54	104	3	16	247	2	92	5	6	5	13	0	549
Precip.	.71	7.21	5.42	.23	1.34	4.14	1.30	8.59	.87	3.09	3.31	2.05		

The lake fence had the following numbers of sockeyes and cohos:

Week ending	Sept. 25	Oct. 2	Oct. 9	Oct. 16	Oct. 23	Oct. 30	Nov. 6	Nov. 13	Total
Sockeyes	146	35	298	109	21	13	25	0	647
Cohos	0	0	0	1	0	6	24	0	31

The average egg content was determined by counting the eggs in every sixtieth female. Results were: Pink, -1341.5; Chum, -2101.5; Sockeye, -1830.1; Coho, -2336.1.

The potential egg deposition calculated for each species was: Pink, -808,924; Chum, -1,052,851; Sockeye, -296,476; Coho, -407,767. This represents a great reduction from the previous year in the seeding of pinks and chums.

J. G. Robertson

Appendix No. 26

Observations on young chum and pink salmon in Departure Bay, 1948.

An investigation of the chum and pink fry in Departure bay was carried out this spring to further our knowledge on the life-history of these salmon.

The initial study was necessarily general in aspect, equipment being limited to a rowboat, dip-nets, plankton nets, and specimen bottles. The period of sampling began shortly after the appearance of the fry and continued until they could no longer be obtained. When available, the fish were collected weekly and the specimens measured for length and weight. Where the sex

J. G. Robertson Appendix No. 26

of the fry could be determined by microscope the stomach contents were analysed and enumerated. From skin samples scale formation was studied in both species.

The fry were first observed about May 10 which is a rather late date considering a recorded March 4 arrival. They were most readily observed at full tide. They were particularly abundant May 18, June 12 and June 23. From June 24 to July 8 there was a decline in number, none being seen after the latter date.

The first samples, taken on May 17, showed average weight and length measurements of .426 grams and 4.11 cms. for chum fry, and .358 grams and 3.98 cms. for the pinks. The last group of specimens were captured on the night of June 12 where corresponding figures were 1.60 grams, 5.10 cms., and 2.42 grams, 6.17 cms. Of the 365 fry taken from an average depth of one foot 57.8% were chums. The distribution of the sexes showed a preponderance of males (66.9%) among the chum fry, while in the pinks they were in a slight minority (48.4%).

The most important food (41.3%) was copepods. Another important part of the diet was larval crustaceans, nauplius (13.8%) and cypris (10.5%) overshadowing the zoea, metazoea and megalopa forms (.32%). Other components were cladocera (8.4%), the larvae and pupae of chironomid flies (4.9%), copepod eggs (.74%), algae (.38%), ostracoda (.28%), gammaridea (.24%), cirripedia (.05%) and debris (.23%). The remaining 11.2% consisted of amphipods and other crustaceans not readily identified, along with some diptera (1.82%) and coleoptera (.05%).

The skin samples revealed that the scales form in the anterior peduncle region and are laid down anteriorly in oblique rows extending ventrally and dorsally from the lateral line. Scale papillae were first observed in chums at a length of 36 mm.; in pinks at 49 mm.

General conclusions were:

(1) Diurnal changes in distribution of the young fish are associated with available food supplies.

(2) Chum, pink and even herring fry, travel together.

(3) Group movement varies with the size of the fry.

(4) Fraser river pinks contributed to the number of fry present in Departure bay (since local pink production is insufficient to account for the numbers present).

(5) Differentiation between the chum and pink fry and fingerlings is made easy by examining the progress made in scale development.

Ferris Neave Appendix No. 27

Tagging of Pink and Chum Salmon in the Whale Channel Area

In order to obtain information on the migratory movements of maturing pink and chum salmon in the north-central coastal area and also on the fishing intensity to which they are exposed, tagging operations were carried out in and near Whale channel between August 16 and September 1. Live fish were obtained by purchase from seine-boats and were tagged and released by Mr. R. C. Wilson, operating the Station launch "Siliqua". The return of tags was stimulated by the wide distribution of placards and envelopes and by personal contact with fishermen and fish buyers.

Ferris Neave — Appendix No. 27

The number of tags applied and the returns (to date) were as follows:

Week ending	PINKS Tags applied	PINKS Returns Number	PINKS Returns Percent	CHUMS Tags applied	CHUMS Returns Number	CHUMS Returns Percent
Aug. 19	504	168	33.13	63	9	14.29
26	178	50	28.09	20	4	20.00
Sept. 1	117	23	19.66	35	6	17.14
Total	799	241	30.04	118	19	16.10

Of the pink salmon tags recovered, 195, or 81%, were from the general area in which the tags had been applied. The remainder were reported as follows: Skeena and Ecstall rivers (4); Ogden channel (1); Grenville channel and Lowe inlet (4); Gardner canal (7); Khutze inlet (2); Laredo sound and inlet (8); Mathieson channel (11); Masset and Naden harbours (4); unknown (5). Some of these records (for example, those from the two harbours on the north side of Graham island) must be regarded as unverified, in view of the fact that fish from different localities sometimes become mixed during transit or at the canneries, before the tags are recovered. The period of time between tagging and recapture varied from a few hours to 25 days.

Of the 19 chum tags recovered to date, 14 (74%) came from the general vicinity of Whale channel. Single returns were reported from the Nass river; Lowe inlet; Gardner canal; Bella Bella; Kwatna inlet. The time out varied from one to 28 days.

In general, the percentage of recoveries for each species was very similar to that obtained in the previous year, when operations were conducted in the Fitzhugh sound - Seaforth channel area. In both cases the fish appeared to be approaching their destinations when tagged, with comparatively few showing long subsequent journeys north or south along the coastline.

J. G. Robertson — Appendix No. 28

Age- and Size-Composition of Chum and Sockeye Salmon in 1947 and 1948

To facilitate the study of population fluctuations among the chum salmon of the Central and Vancouver Island areas, and the sockeye from Smith inlet, sampling from the commercial catch was continued in 1947 and '48.

The age- and size-composition of samples from Namu, Bella Bella, River and Smith inlets, Butedale, Dean channel and Koeye river (Central area), and Growler cove and Sooke (Vancouver island area) are as follows:

Age- and Size-composition of Chum Salmon from Central and Vancouver Island Areas

Year	Locality	3_1 Av. Weight	3_1 Av. Length	3_1 %	4_1 Av. Weight	4_1 Av. Length	4_1 %	5_1 Av. Weight	5_1 Av. Length	5_1 %	No. of Samples
1947	Namu	--	27.0	25.7	--	28.2	69.7	--	28.2	4.7	1188
1947	Bella Bella	8.4	26.6	20.8	9.2	27.1	75.5	11.5	29.0	3.7	387
1947	River's and Smith's inlets	10.4	28.1	12.9	11.6	29.4	79.8	12.1	30.8	7.3	302
1948	Butedale	7.2	24.3	9.1	10.1	27.1	90.9	--	--	--	111
1948	Dean channel and Koeye river	9.9	26.8	18.9	12.3	29.1	74.8	15.3	31.5	6.3	127
1948	Growler cove	8.0	25.7	6.3	9.0	27.3	87.5	10.0	28.0	6.3	32
1948	Sooke	8.8	26.9	27.3	11.8	29.1	54.5	13.5	31.1	18.2	44

J. G. Robertson — Appendix No. 28

Smith Inlet Sockeye, Percentage of Age-groups, Sex and Average Weights (lbs.) and Lengths (inches) 1948.

Age-group	4_2		5_2		6_2	
Percentages	7.3		90.0		2.7	
Sex	M	F	M	F	M	F
Percentages	79.2	20.8	41.7	58.3	11.2	88.8
Average Weight	5.1	5.4	7.6	6.9	10.3	7.5
Average Length	21.9	21.7	25.0	24.3	26.7	25.0

As was anticipated from the 1946 sampling results in the Central area there was a high percentage of fourth-year chums in 1947. This indicates the success of the 1943 brood-year which contributed so substantially to the third-year fish (38.9%) in 1946. The more even contribution of the three year-classes to the 1948 population at Sooke may be significant but a more adequate sampling programme is necessary before any conclusions can be made.

The Smith inlet sockeye analyses show a high preponderance of fifth-year fish which has been established previously. A more detailed study might help to account for the below-average pack this year when the cycle fluctuations indicated an average catch.

Ferris Neave — Appendix No. 29

The Salmon Angling Fishery at Cowichan Bay

Since 1939 an observer has been appointed each year, during at least a large part of the fishing season, to collect data on the salmon landed by sportsmen in this area. In 1947 records were kept by Miss Gertrude Paul from September 11 to November 15.

The reported number of fish taken, and the estimated fishing effort involved in their capture, can be summarized as follows:

Boats	Line-hours	Springs		Cohos		Total fish
		Large	Jacks	Large	Grilse	
2,839	22,080	192	287	4,018	152	4,649

Particular interest attaches to fluctuations in the annual catch of cohos, for which the locality is celebrated. The fishery is based on the important runs to the Cowichan and Koksilah rivers. For comparative purposes statistics are given for a six-week period beginning on the Sunday nearest to September 22. This period covers the main season of coho fishing.

Ferris Neave Appendix No. 29

Year	Boats	Line-hours	Cohos		Line-hours per large coho.
			Large	Grilse	
1939	1,708	12,432	3,362	585	3.6
1940	1,470	10,694	1,813	61	5.8
1941	2,435	16,287	3,435	417	4.7
1942	2,671	18,796	3,867	566	4.8
1943	2,849	19,875	3,903	116	4.9
1944	2,967	19,931	3,575	225	5.2
1945	2,895	18,798	3,660	55	5.1
1946	1,517	12,271	1,936	486	6.3
1947	2,295	18,508	3,751	56	4.9

The figures for "grilse" are not included in calculating the availability of fish, since the main purpose in obtaining the data is to aid in a study of the annual fluctuations in the spawning run. Many of the so-called grilse are immature, feeding fish which do not form part of the spawning migration.

The main feature of the 1947 season was a marked improvement in both the total catch and the catch per unit of effort, as compared with the very poor season of 1946.

A study of the considerable series of records now available has shown that from 1940 to 1947, inclusive, an excellent correlation exists between the availability of cohos to anglers (line-hours per fish) and the minimum summer flow of the Cowichan river two years previously. The two poor years of 1940 and 1946 followed particularly low river levels in 1938 and 1944. The apparent statistical correlation was noted after observations indicated the likelihood that low water levels resulted in increased mortality among coho fingerlings through stranding, increased predation and restriction of feeding areas.

J.L. Hart Appendix No. 30

Otter Trawl Investigation

The rapidly changing otter trawl investigation has been studied and followed during 1948 by maintaining a system of fisheries statistics, by sampling and examining otoliths taken in sampling, by tagging, and by experimental fishing.

Collection of fishery facts

Substantial improvement has been made during the year in collecting information about the quantity of each species landed in the main ports. Contact men have been stationed throughout the year in Vancouver (R.M. Wilson) and Prince Rupert (W.G. Calderwood and A.R. McLeod), and during the busy summer season in Victoria (D.G. Odlum). Their reports form the basis of a statistical system which indicates the relative importance of the fish species and also provides a basis for judging changes in availability. As an example of the former the change from the 1947 predominance of rocksole in the catches to the 1948 emphasis on brill is strikingly shown by comparing the tables in a following summary report with the corresponding table in the reports for 1947. The records make no pretense of being complete but are believed to present a reasonably random sample of the fishing.

Some fisherman have continued to send in log-book sheets. These have proved valuable for checking but have not been finally tabulated for 1948.

Port contact men have passed on numerous observations about fish or fishing. As far as practical these are being abstracted and filed according to subject matter. On many occasions port contact men have assisted other investigations by accepting tags, supply information, collecting samples, and in other ways.

Sampling

Sampling has been of two kinds. Samples of commercial landings have been taken at ports of landing. This has been done by the port contact men at Prince Rupert and Victoria and by a special sampler at the busier port of Vancouver (T.H. Butler). Other sampling has been done in connection with experimental fishing carried out by the "Investigator No. I" usually associated with some specific problem. In most cases otoliths have been taken in sampling and for some series of samples the preliminary results of otolith reading are presented in summary reports which follow. In general, however, it is not proving possible for the readers to keep up with the collections. This has indicated a proposed modification of programme in which port samplers will measure, sex, and record many large samples of each species and take otoliths only from enough and large enough samples to give a key to the causes for changes in length distribution.

Tagging

The tagging programme has been concentrated more on purposefulness than on attempting to get out a great number of tags. The recoveries which have resulted from experiments in which this policy has been pursued in former

years have been very gratifying in the coherent analysable results they have produced. These results indicate the practical value of applying correction factors to the results to compensate for such errors as arise from differences between tagged and untagged parts of the fish population, and an experiment is planned to assist in calculating the necessary factors.

Gear experiments

Gear experimentation is proving very time consuming and has not progressed as quickly as could be desired. Some essential preliminary work has been completed on the reproducibility of hauls with the same gear on the same drag. Some tests have been made also by changing, on the same drag, nets of similar design differing only in mesh size. The results obtained in this way to date give no suggestions as to a course of practical action. The fish caught by larger meshed nets averaged larger than those caught by smaller meshed nets but the overall distributions indicated that as used by us mesh size did not critically control the sizes of fishing caught. It is proposed to continue and modify the experiments as opportunity offers.

Cape Lazo and Nanoose Experiments

The original closures in the strait of Georgia were made on the understanding that the areas as defined could be modified on the basis of advancing knowledge. Representation by certain fishermen led to the belief that areas south of Cape Lazo and just outside Nanoose bay be re-opened at certain seasons with a net gain to longterm fisheries production. In collaboration with the Fisheries Department these areas were opened during February and March of 1948. Close check was maintained on all important-appearing aspects of the fishery. A report on the observations which bear most closely on the practical aspects of the fishery has been prepared and supplied to the Fisheries Department with the suggestion of a repetition of the experiment with the opened period at Cape Lazo in the early winter rather than the late winter. Other reports on observations of less immediate importance are on file.

Investigator No. 1

This vessel has given excellent service and many of the more desirable features of the investigation would have been impossible without her. She is hardly large enough for some types of work which should be attempted but serves a very useful function. Placing a technician more or less permanently aboard has substantially increased the facility with which the work can be carried out.

Fish Concerned

It is scarcely possible to give a full list of the fish species taken by the otter-trawl fishery. In the following table are given the common and scientific names of the species in the reports which follow.

J.L. Hart

Appendix No. 30

Shark	Hexanchus griseus, etc.
Soup-fin shark	Galeorhinus galeus
Dog-(fish)	Squalus suckleyi
(Big) skate	Raja binoculata
Rat (fish)	Hydrolagus colliei
Sturgeon	Acipenser transmontanus (?)
Herring	Clupea pallasii
Hake	Merluccius productus
Whiting	Theragra chalcogramma
Tomcod	Microradus proximus
(Gray) cod	Gadus macrocephalus
Perch	Demalichthys vacca
Perch	(Taeniotoca lateralis ?)
Sand-lance	Ammodytes personatus
Wrymouth	Delolepis giganteus
Rockfish and Bass	Sebastodes sp. (principally flavidus, melanops, alutus, pinniger, brevispinis, maliger)
Lingcod	Ophiodon elongatus
Blackcod	Anoplopoma fimbria
Turbot or long-jaw flounder	Atheresthes stomias
Sand. sole	Psettichthys melanostictus
Slender sole	Lyopsetta exilis
Flat-head sole	Hippoglossoides elassodon
Brill	Eopsetta jordani
Rock sole	Lepidopsetta bilineata
Lemon sole	Parophrys vetulus
Butter sole	Isopsetta isolepis
(Starry) flounder	Platichthys stellatus
Rex sole	Glyptocephalus zachirus
Dover sole	Microstomus pacificus
Crab	Cancer magister
Prawn	Pandalus platyceros
Devil fish and Octopus	Polypus hongkongensis

Observations on the biology of many of these above species have been made but it is scarcely feasible to present them in summary report form.

J.L. Hart

Appendix No. 31

Tabulation of Trawl Landings recorded on Trip Reports

Port contact men in Vancouver (R.M. Wilson), Prince Rupert (G. Calderwood, A. McLeod), and Victoria (D.Odlum) have as far as practical interviewed all trawlers making landings and completed trip report similar to those included with 1946 summary reports. The results have been tabulated in regard to species, month, area of capture by Miss Winona Bethune, C. Forrester and W.E. Barraclough. Various useful summaries are presented herewith in two tables, one including all information available and the other giving only that information accompanied by suitable records of fishing effort.

MONTH	TOTALS: MISC SOLE	LEMON SOLES	ROCK SOLES	BRILL	FLDR.	TRAWL REPORTS: GR. COD	LINGCOD	ROCK FISH	SKATE	PERCH	DOG LIVER
1947											
Nov.	59,109	27,143	873	183,586	8,005	27,371 L.731	9,520 L.125	2,863	2,163	29	19,242
Dec.	92,590	10,258		111,716	38,553	51,321	12,238 L.143	5,741	4,590 L.95	439	16,271
1948											
Jan	58,225	22,847		26,883	3,427	14,275 L.248	2,944 L.40	1,564	350 L.38	60	2,039
Feb.	475,646	54,444	6	30,055	34,796	52,032 L.2,417	1,555 L.48	5,852	1,898	55	5,301
Mar.	85,084	525,411	13,445	62,176	17,511	128,683 L.427	47,819 L.1,180 1/2	10,876	2,574 L.878	3,034	10,822
Apr.	148,785	585,114	6,428	312,656	22,067	184,168 L.2,372	72,433 L.693	7,292	9,048 L.1,237	398	65,350
May.	70,224	486,666	68,592	1,008,950	5,305	113,480 L.60	182,623 L.1,090 Visc. 34	6,376	11,911 L.407	337	95,864
June	32,850	52,903	729,616	1,327,938	14,445	46,136	130,995 L.1,180 1/2	4,121	2,021		160,259
July	263,426	9,409	401,190	1,151,799	2,557	78,201 L.71	146,771 L.2,341	2,307	667		142,948
Aug.	194,286	9,229	195,778	716,842	358	49,732	125,060 L.1,176	3,344	1,686		74,518
Sept.	290,167	1,948	130,155	390,082	807	35,280 L.86	219,240 L.4,260 1/2	1,326	3,073	5	40,188
Oct.	59,798	8,815	70,690	226,820	1,429	78,209 L.194	59,930 L.1,336	12,424	3,146	206	34,040
Totals:	1,830,190	1,794,187	1,616,773	5,549,503	149,260	858,888 L.6,606	1,011,128 L.1,361 1/2 Visc. 34	64,086	43,128 L.2,655	4,563	666,842

MISC. SOLES:

Soles--1,079,090; Dover--109,730; Rex--111,830; Butter--513,600; Sand--7,950

MISC. FISH

Devilfish--1,358; Rat Liv.--6,906; Crab--3,815; Scrap Liv.--13,342; Mink feed--43,842; Hake--60; Turbot--1,815; Octopus-45; Bait herring--295 1/2 tons; Prawns--168; Black cod--24,392; Shark Liv.--345 1/2; Wrymouth--25; Sturgeon--452; Black cod Visc.-63; Bass--670.

MONTH	HOURS FISHED	TOTALS SOLES ? MISC. SOLES	LEMON SOLE	ROCK SOLE	TRAWL REPORTS BRILL	FLDR.	GR. COD	LINGCOD	ROCK FISH	SKATE	PERCH	DOG LIVER
1947												
Nov.	738	44,501	19,975		156,159	5	17,061	3,729 L.125	456	608	8	16,729
Dec.	909	67,731	10,258		111,716	36,810	31,303	9,415 L.143	4,481	2,906 L.95	439	7,236
1948												
Jan.	3,735	57,275	22,847		28,883	3,427	14,275 L.248	2,944 L.40	1,164	350	60	1,735
Feb.	1,121	424,775	24,866	6	30,055	34,796	23,623 L.520	1,555 L.48	2,955	1,466	55	4,295
Mar.	2,276	75,065	515,536	13,445	61,026	17,511	112,120 L.16	35,651 L.717 1/2	9,133	2,069	3,034	10,169
Apr.	3,046	101,474	540,032	6,428	273,671	20,659	109,656 L.330	64,659 L.48	6,226	7,472 L.141	380	63,552
May	3,412	29,507	465,001	66,592	880,858	5,258	98,643 L.60	115,490 L.753	5,781	10,437 L.407	258	82,258
Jun.	2,973 1/2	15,032	52,903	679,465	1,207,022	14,445	39,732	121,608 L.1,103 1/2	3,162	1,770		141,819
Jul.	3,253	89,413	9,190	368,404	1,079,507	2,547	76,369 L.71	140,396 L.2,178	1,498	202		115,968
Aug.	1,998	126,671	9,229	168,802	594,549	330	47,634	101,340 L.900	2,687	1,230		64,189
Sept.	796 1/2	188,041	1,948	130,155	324,989	529	26,285 L.86	166,527 L.3,408 1/2	1,326	2,376		29,571
Oct.	723	26,953	8,735	65,085	213,414	1,341	62,645 L.194	41,768 L.769	11,934	2,182	200	24,337
Total	23,980 1/2	1,246,438	1,680,520	1,498,382	4,959,849	137,658	659,346 L.1,525	845,082 L.10,233 1/2	50,703	33,068	4,434	561,858

MISC. SOLES

Soles--548,209; Dover--117,293; Rex--110,016; Butter-- 463,980; Sand--6,950.

MISC. FISH

Devilfish--6,785; Mink feed--39,636; Hake--60; Turbot--1,815; Rat Liv.--3,888; Scrap Liv.--749; Crab--1,365; Octopus--45; Bait herring--295 tons, Prawns--168; Black Cod--23,017; Liv.--158; Shark Liv.--341; Wrymouth--25; Sturgeon--452; Black Cod Visc.--63; Bass--670.

W.E. Barraclough — Appendix No. 32

A New Trawling Ground in Hecate Strait

During the spring months of this year a new trawling ground for brill (Eopsetta jordani) was located by the trawler "Finella" in an area 11 miles SSW off Oval hill on Porcher island. The actual trawling ground covers only a few square miles but a tabulated 2,372,000 pounds of brill alone have been taken from these grounds by the otter trawl fleet from April to August.

The total poundage of brill caught on these grounds and landed at Prince Rupert, Vancouver and Victoria were tabulated from the trip reports filled out by Mr. W.G. Calderwood, Mr. R. M. Wilson and Mr. D.G. Odlum at the above ports respectively. The weight in pounds landed are approximately as follows:

	Brill landed in Prince Rupert	Brill landed in Vancouver	Brill landed in Victoria	Total weight brill landed
April	135,000			135,000
May	127,000			127,000
June	242,000	222,000		464,000
July	735,000	370,000	65,000	1,170,000
August	476,000			476,000
Total weight	1,715,000	592,000	65,000	2,372,000

These figures alone warrant a continued investigation of the brill in Hecate strait in order that the migrations may be followed and the mortalities studied to determine the extent of the depletion of the stock. Each year more boats are entering the trawling fishery in Hecate strait where some of the largest single hauls are made by the trawl fleet. Investigations off the important grounds such as Banks island, Goose islands and Cape Scott have been limited in the past because of the lack of a research vessel large enough but further expansion of the investigations in these important areas is planned.

K.S. Ketchen — Appendix No. 33

Lemon sole age composition at Cape Lazo in 1948

Sampling of the stock of lemon soles present on the cape Lazo grounds during the spawning season of 1948 was carried out at the following intervals: (I) two weeks prior to the opening of the grounds to the fishery, (II) from the commercial catch at the height of the fishery, (III) ten days after the close of the fishery, (IV) one month after the close of the fishery. Samples I, III and IV were taken from the "Investigator No. I". The following table contains the age and distribution in percent:

K.S. Ketchen Appendix No. 33

Lemon sole age composition at Cape Lazo in 1948

Sampling of the stock of lemon soles present on the cape Lazo grounds during the spawning season on 1948 was carried out at the following intervals: (I) two weeks prior to the opening of the grounds to the fishery, (II) from the commercial catch at the height of the fishery, (III) ten days after the close of the fishery, (IV) one month after the close of the fishery. Samples I, III and IV were taken from the "Investigator No. I". The following table contains the age distribution in percent:

AGE	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Sample I											
Male (240)	3.8	7.9	22.9	22.0	22.0	14.2	5.4	1.3	0.4	-	-
Female (173)	1.2	4.0	16.2	14.5	19.7	22.0	13.9	6.4	1.7	-	0.6
Sample II											
Male (305)	-	1.3	9.8	23.6	29.5	20.7	12.1	2.0	1.0	-	-
Female (168)	-	-	2.4	9.5	22.0	29.8	23.8	8.3	3.6	0.6	-
Sample III											
Male (368)	1.4	6.3	23.1	26.4	23.9	13.3	3.8	1.9	-	-	-
Female (119)	3.4	9.2	10.9	16.8	20.2	16.0	14.3	7.6	1.7	-	-
Sample IV											
Male (122)	-	-	4.9	18.0	30.3	24.6	15.6	4.1	2.5	-	-
Female (29)	-	-	(3)	-	-	(7)	(8)	(7)	(2)	(1)	(1)

There is considerable difference in age composition between sample I and II. In the former 57% of the males were under 6 years of age and 36% of the females were under that age. In the latter only 35% of the males and 12% of the females were under six years of age. In sample III the composition of male fish was somewhat similar to that in sample I, but the mode in female fish had dropped from VII to VI years. This may have been due to differences in the areas fished, or to the time of fishing (that is, differences due to the complexity of the spawning migration). Sample IV suggests that older fish remain longer on the grounds after spawning than do the younger ones.

K.S. Ketchen Appendix No. 34

A Study of Minimum Size Limits for the Lemon Sole

An understanding of the relationship of growth rate to natural mortality rate is of great importance in fishery investigation because of its bearing on the study of optimum yield. Rates of natural mortality of the lemon sole have been determined from the age distribution in recently exploited populations in Hecate strait. These data have been employed together with data on growth rate in determining minimum size limits for optimum yield under varying fishing intensities, and in determining the best fishing intensity when the minimum size is kept constant.

The method employed was that described by Ricker (Copeia, 1945, 2).

As it has been possible to determine the natural mortality rates of adult fish only, several assumptions have been made regarding the mortality rate of juvenile fish which are believed to be reasonably accurate in the light of present knowledge. Never-the-less they are open to criticism, and are deserving of a great deal more investigation. For the present, however, it has been assumed that a rate of 43% natural mortality for adult fish (both sexes combined and weighted according to the sex ratio) is applicable to age groups over one year of age but which have not as yet entered the fishery.

On the basis of a fishing mortality of 40%, similar to that for the strait of Georgia (summary report, 1947), the catch for every 100 lbs. of fish reaching one year of age (140 mm.) for a series of minimum sizes is as follows:

Min. size (mm.)	321	314	305	297	286	275	262	247	232	215	193	170
Catch (lb.)	170	180	190	199	211	220	227	232	233	236	238	241

Progressive decrease in minimum size limit to a point far below the present market minimum size brings about an ever increasing yield. If the fishing rate is increased to 55% then the results for the same series of minimum sizes are as follows:

Min size (mm.)	321	314	305	297	286	275	262	247	232	215	193	170
Catch (lb.)	180	190	200	209	219	227	233	236	237	238	235	235

In this case a minimum size of 215 mm. produces the optimum catch. There is of course considerable range over which there is little change in yield. Still further increase in fishing rate of 63% gives an optimum yield with a size limit of 232 mm. Here again considerable range is shown where there is little change in yield, and consequently the size limit could be increased to 275 mm. without significant loss in yield.

Assuming that the market would not accept fish below the present minimum of 300 mm., it is advisable to determine the best fishing mortality for optimum yield.

Annual fish. mort. (%)	40	45	50	55	59	63	67	70	73	75	78
Catch (lb.)	192	198	199	200	201	197	192	190	187	184	180

Optimum yield is obtained with a fishing mortality of 55 - 59%. Rates above and below that bring a decreasing yield. However, a fishery stabilized at a rate of 45% would yield appreciably the same weight of fish as one operating on a considerably higher level, such as 63%.

If an adequate spawning stock is allowed to survive each year, and the afore-mentioned assumptions are reasonably correct, then it would appear that no restrictions should be placed on the size of fish taken in order to obtain optimum yield, or if the minimum size limit is to be maintained then no restriction should be placed on the

K.S. Ketchen — Appendix No. 34

amount of fishing. Thus one of the foremost problems in the management of the lemon sole fishery appears to be the determination of the factors which tend to limit maximum recruitment to the fishery.

A paper on this subject was presented orally to the meeting of the Royal Society of Canada in June 1948.

K.S. Ketchen — Appendix No. 35

The Sex Ratio of Young Lemon Soles

In connection with the study of minimum size limits it was found advisable to make sex determinations of fish in their first year of growth. In beach seine samples taken in the summer of 1946 at Departure Bay it was found that 38% were females, while 30 miles to the north at Qualicum beach, 36% were females. In 1948 samples at Departure Bay, once again 38% were females.

These results are of considerable significance in the light of what is already known about the differential viability of males and females in the fishery.

W.E. Barraclough — Appendix No. 36

Food of the Brill

Since the brill is one of the most important species of flatfish marketed today in British Columbia a summary of the stomach examinations to date is presented below. Many stomachs contain more than one kind of food, therefore the numbers shown under the different food headings add up to more than the number of stomachs examined. The food studies were done to increase the knowledge of the general biology of the species as well as to contribute to the study of the interrelationship between the various species of flatfish and their habitats.

Kind of food	West Coast of Vancouver Island	Strait of Georgia	Hecate Strait (Goose Islands, Banks Island Butterworth Rks.)
Number of stomachs found empty	12		160
herring		1	40
whiting		1	4
tomcod			1
sandlance	2		65
blennies (sp.?)			6
sebastodes (sp.)			1
agonids (sp.)			2
long-jaw flounders			1
rex soles			1
fish remains	1	2	49
hydroids (sp.?)			1
worms (mostly polychaets)	2		6

W.E. Barraclough

Appendix No. 36

Kind of food	West Coast of Vancouver Island	Strait of Georgia	Hecate Strait (Goose Islands, Banks Island, Butterworth Rks.)
brittle stars (sp.?)			3
sand dollars			4
schizopods	39		
euphausiids	335		616
shrimps			28
crabs (sp.?)	1		40
hermit crabs (sp.?)			5
clams (sp.?)			20
squids (sp.?)			
octopus			
miscellaneous (sand, gravel)			12

The most important food item among the invertebrates are the euphausiids often classed as red feed. Sand lance and herring also contribute considerably to the diet of the brill in certain areas in Hecate strait such as off Banks island and the Goose islands.

The data on brill (the most important of British Columbia trawl-caught flatfish) is presented herewith as an example of the type of information which is being accumulated on a considerable number of species.

K.S. Ketchen

Appendix No. 37

Rock Sole. Length Frequency Distribution, 1944-48

Graphic analysis of length frequency distributions of rock sole samples taken between 1944 and 1948 have been carried out for the purpose of gaining some preliminary understanding of the trends in the fishery until the age analysis is completed. Examination of samples from grounds in Queen Charlotte sound and Hecate strait has revealed that, at comparable times of the year, there are marked differences between the frequency distributions of fish on grounds which are more or less adjacent to one another. There is, for example, little similarity between the samples of fish from the Scott island grounds and the Goose island grounds in Queen Charlotte sound, or between the Goose island grounds and the Horseshoe grounds in Hecate strait, or between the Horseshoe grounds and the Butterworth Rocks grounds. This dissimilarity in the frequency distributions suggests that these four important grounds are to some degree independent of one another. That any mixing does take place between these grounds has not as yet been shown by tagging experiments.

On the Butterworth rock grounds, a sharp drop in average length of fish occurred between 1945 and 1946, from 39.6 cm. to 36.5 cm. This parallels the results of the lemon sole investigation. In the latter case the drop in average size was produced by the influx of a relatively strong year class to the fishery. That a similar situation has occurred in the rock sole fishery has been indicated by the preliminary age analysis.

K.S. Ketchen Appendix No. 37

On the Horseshoe grounds the mode increased from 41 cm. to 42 cm. between 1945 and 1946, but in 1947 dropped to 38 cm. and remained at that point until the early part of 1948.

Still further to the south, in Queen Charlotte sound, the rock soles comprising landing from the Goose island grounds were of much smaller size, averaging 36.3 and 37.3 cm. in 1945 and 1946 respectively.

The shapes of the left-hand limbs of the frequency curves of rock soles taken from off the northern part of Vancouver island and also on the Horseshoe grounds in Hecate strait do not seem to have been determined by market selection. Small fish are not being exploited on these grounds. This condition is in marked contrast with that exhibited by the Butterworth rocks and Goose island grounds.

K.S. Ketchen Appendix No. 38

The Relation of Distribution to Spawning Condition of Rock Soles

During an investigation of the Queen Charlotte strait area in late April 1948, opportunity arose to study quantitatively an important problem in the life history of the rock sole--namely, the absence of spawning female fish from trawl catches during the spawning season.

Off the western end of Malcolm island drags were made parallel to shore from deep water into shallow water to determine the geographic relationship of male to female fish, the relative proportion of each sex and the state of maturity. For the sake of comparison catches from drags in seven different depths were adjusted to a half hour drag basis. In the following table are given the relative number of fish at various depths with spawning condition given in percent:

Female

Depth f.	Relative number	immature	mature	clear	running	spent
43	--	--	--	--	--	--
30	54	61	13	2	--	24
24	131	51	28	--	--	21
22	163	34	31	--	--	35
19	270	32	20	--	--	48
15	70	20	26	1	--	52
10	30	--	27	--	--	73

Male

Depth f.	Relative number	immature	mature	running	spent
43	--	--	--	--	--
30	12	83	--	17	--
24	40	63	2	35	--
22	31	52	--	45	3
19	66	46	5	54	--
15	83	6	2	92	--
10	44	10	--	90	--

K.S. Ketchen Appendix No. 38

The greatest number of female rock soles was found at a depth of 19 fathoms, while the greatest number of males was found at 15 fathoms. In both sexes, maturity decreases with depth. The percentage of spent female fish decreased with depth, being highest at the shallowest depth sampled. In a similar manner the percentage of running males was highest in the shallow water.

There were few mature (but not spawning) or spent males. Mature females seemed to be fairly evenly distributed over the area. In only two isolated instances were fish bearing clear eggs discovered. No spawning females were found.

If it can be assumed that spawning female rock soles were present in the vicinity of the sampling area, the fact that the highest percentages of spawning males and spent females were found in shallow water drags suggests that the spawning females were between the beach and the 10 fathom mark. The fact that the ocean bottom became progressively rougher towards shore may have had significance, namely, that the spawning of female fish is associated with shallow water and rough bottom. Attempts to get closer to shore than 10 fathoms were unfortunately fustrated by strong winds and tide.

It cannot be overlooked that spawning females may have been nowhere in the area fished, and that those fish sampled were but representatives of two spawning runs with different stages of maturity, one early and one late.

W.E. Barraclough Appendix No. 39

Examination of Rex sole landings and Rex sole otoliths

Although the rex sole (Glyptocephalus zachirus) is very palatable it is not one of the more important species of soles landed for the commercial market because the fillet recovered from the body of the sole is very thin. This species has assumed some commercial importance in Prince Rupert where numbers of these soles are landed in quantity throughout the year and especially in the winter months.

Examination of trawl landings shows that 95% of the rex soles landed in this northern port are female fish. Seldom does the proportion of male rex soles landed exceed 5% of the catch. Part, but only part of the explanation lies in the fact that the minimum length of the rex soles accepted by the dealers is about 350 mm (13 3/4 in.) and only relatively few male rex soles have been observed over 360 mm. or 14 1/4 in.

Examination of the otoliths reveals that the rex soles do not enter the commercial fishery until their 5th year. During the 5th year both the male and female rex soles reach sexual maturity. The age best represented by rex soles landed in Prince Rupert is about 7 years at a length of 420 mm. or 16 1/2 in. These soles are caught in an area from 3 to 8 miles SW of the Butterworth rocks in Hecate strait in depths from 40 to 44 fathoms. Reading of the rex sole otoliths for age determinations is being continued.

J.L. Hart and Winona J. Bethune Appendix No. 40

Age distribution and growth rate in butter sole

The butter sole is a flatfish of considerable importance in British Columbia certain features of whose life history lend themselves to investigation. Otoliths from some fifteen thousand fish taken during five years were examined to determine which could be used in calculating growth rates and estimating relative strengths of year classes. Part of the data were also used in an examination of the influence of selection on these important characteristics and the results were given in a paper presented at the meeting of the Royal Society of Canada.

The results on growth rate are given in the following tabulation in which average lengths in millimetres for males and females of each age are given.

Age	II	III	IV	V	VI	VII	VIII	IX	X
Males	143	210	261	294	318	335	343	346	352
Females	190	237	284	334	355	366	376	385	394

It is evident from this table that females grow faster than males throughout their lives. Tabulation of the numbers of each fish show that females have a lower mortality rate. Consequently all of the largest fish are females. There is no evidence in our results indicating great variation in year-class strength. Both sexes show declining occurrence in the abundance of older fish in succeeding years, thus:

Percentage of fish more than seven years old

Season	1944	1945	1946	1947	1948
Male	11.6	8.3	11.8	4.0	1.4
Female	34.3	14.8	9.5	8.2	2.9

The decline is probably but not certainly a result of the intensive seasonal fishery for the species and is an expected concomitant of normally heavy exploitation.

Winona Bethune Appendix No. 41

Fecundity of butter sole

Fecundity determinations are being made for various species in connection with life history studies. These were carried out for butter soles by means of counting and weighing the eggs in the small sample of ovaries. From the average weight per ovum and the total dried weight of the ovary total egg numbers were calculated for 25 fish. These ranged from 332,000 to 2,079,000. Older and larger fish had more eggs in them than younger or shorter ones but fish weight was the feature most closely associated with egg number. The relationship was examined

Winona Bethune Appendix No. 41

by calculating a multiple regression with the following equation resulting: Egg number equals 2,871,700 minus 33,420 times age in years minus 142,460 times length in centimetres plus 6,287 times weight in grams.

J.I. Manzer Appendix No. 42

Flatfish Tagging during 1948

The purpose of the otter-trawl tagging programme, as stated in previous reports, was (1) to obtain information on the migratory habits of the commercially important species of fish contributing to the trawl fishery, (2) to add to the general knowledge of their life histories, and (3) to derive information of a quantitative nature on the commercial fish populations.

In keeping with the programme, two organized tagging trips were carried out with the use of the Station's research vessel, the "Investigator No. I"; one to the west coast of Vancouver island, and the other to Hecate strait.

The first trip, under direction of the writer, took place during the period June 14 - 29 in the vicinity of Barkley sound and had as its primary purpose the continuation of the study of the brill commenced off the west coast of Vancouver island in 1947. Although inclement weather prevailed throughout the trip, 279 brill were tagged 12 miles SSW of Lennard island.

The second trip, under direction of W.E. Barraclough, took place during the period July 29 to August 31. The purpose of this trip was to study the population of rock soles found south-west of the Butterworth rocks during the late spring and summer. Tagging was conducted prior to the arrival of the fishing fleet upon the grounds, and consequently random distribution of the tagged fish throughout the general population in that area can be assumed. A minimum recovery of 10.4 percent has been recorded to date (November 1). In addition to the 1,538 rock soles, 18 brill and 11 lemon soles were also tagged.

In all, 1,846 flatfish were tagged during 1948 as compared with 4,724 in 1947, 3,497 in 1946, 4,185 in 1945 and 2,083 in 1944. Recoveries from the taggings carried out in the different years continue to be made, the results of certain of these experiments being reported on elsewhere.

J.I. Manzer Appendix No. 43

Recovery of Tagged Flatfish

Tags received during 1948, have yielded valuable information on migrations, population limits, and growth rates for some of the commercially important species of flatfish studied by the trawl investigation. Assisting in the collection of the recovery data have been the shore contact men in Vancouver, Victoria, and Prince Rupert who now virtually examine on shore most of the recaptured tagged fish. To compensate the recoverer for the loss of the individual fish and also to indicate appreciation of their co-operation and interest in the tagging programme,

the recovery reward has been increased from 50 cents to 75 cents for those who submit the tagged fish to the contact men for examination. Introduction of this practice has resulted in increased reliability and usefulness of the recovery data.

In general, the results agree with those of other years in that little or no significant mixing occurs between the strait of Georgia, west coast of Vancouver island, and Hecate strait. The only exchange evidenced is by two confirmed recoveries. One is a lemon sole tagged in Boat harbour, strait of Georgia, during the winter of 1945 - 46 and recovered off Port Renfrew on the west coast of Vancouver island during September of this year. The other exchange is shown by a brill tagged off White rocks, Hecate strait, during February 1947, and recovered off Umatilla light, (Washington coast) in June 1948. These movements are the first of their kind for both species and are to be considered as exceptions rather than the rule.

For the brill off the west coast of Vancouver island, tag recoveries indicate some intermixing between the populations tagged in Checleset Bay and Sydney Inlet during July 1947, as well as dispersion of the fish from each tagging locality. Fish tagged in Checleset bay (Area 26) reportedly have been recovered from the following statistical areas: 11(2) (Cape Scott), 26(11) (Kyuquot), 25(2) (Nootka), 23(3) (Barkley sound), and 21(1) (San Juan). The numbers of fish recovered from the Sydney inlet (Area 24) experiment according to statistical areas are 7(2) (Goose island), 25(5), 24 (142) (Sydney inlet), 23(4), 21(1), Washington coast (5), and the Oregon coast (1). From the information available, the tag returns indicate north and southward dispersion from the tagging localities. The southern limit for both experiments is the waters off the coast of Washington and Oregon. The northern limit for the Checleset bay experiment is the Scott islands and for the Sydney inlet experiment Queen Charlotte sound.

Interpreting these movements on a seasonal basis, the fish moving northward from Checleset bay appear to do so during the winter and early spring and those moving southward do so during the summer, with an indicated northward return to Barkley sound in the fall. Fish from Sydney inlet were recovered in the northern areas during the spring and early summer and in the far southern areas during the late summer. The northward return in the fall to Barkley sound is in greater evidence than that shown for the Checleset bay experiment. The southward movement of brill from Sydney inlet during the summer and fall essentially agrees with what already has been reported but the return northward may occur earlier than previously believed. Additional tagging experiments off the west coast of Vancouver island are necessary in order to obtain a clear understanding of the movements of these fish.

In the Hecate strait area, brill tagged off the White rocks in February 1947, show a northward movement during the spring and early summer to the fishing grounds off Oval Hill and Seal Rocks, an area approximately 20 miles from the tagging location, and a return movement during the fall. This population has recently become subjected to an intensive summer fishery.

Additional tag returns have been received from tagging experiments carried out on lemon sole found off White rocks. The new data further support the belief that these fish move northward from this area to the Butterworth rocks grounds during the early spring.

J.I. Manzer Appendix No. 43

The tagging of rock sole off Butterworth rocks, Hecate strait, in two successive years has resulted in reliable information concerning movements and appearance of the fish upon the known rock sole fishing grounds. Recoveries from the 1947 experiment show that these fish reappear off the Butterworth rocks as early as April and continue to increase in availability until June and July. Thereafter, the availability of this species declines until September, when few fish are to be had. Recoveries showing movement suggest that the rock sole move southward during the summer and early fall to an area approximately 20 miles southwest of Oval Hill, Hecate strait.

Growth rates of male and female lemon sole, brill, and rock sole in certain areas have been determined from tags which were recovered 11 - 13 months after release. The treatment of the data and the information derived therefrom is reported on elsewhere.

Numerous recoveries have also been made from experiments carried out on a smaller scale. Their interpretation is still to be attempted.

J.I. Manzer Appendix No. 44

Rate of Growth in Flatfish as Determined by Tag Returns

The growth rates of certain species of flatfish have been determined from tagged fish which have been recovered 11 - 13 months after release. Length measurements at time of tagging were plotted against reliable length measurements at time of recapture, and a regression curve was fitted to the points. From this curve minimum average annual increases in length for fish of different sizes can be obtained. A table illustrating the average absolute annual growth increments and percentage increases is presented below for male and female lemon sole, brill and rock sole of different lengths.

Species	Area	Sex	Average Annual Increase in Length for Fish of Different Size Groups								
			300	325	350	375	400	425	450	475	500
Lemon Sole	Butterworth Rocks, Hecate strait	♂	Mm. 12.5	10	8	5	3	.5			
			% 4.2	3.3	2.3	1.3	0.8	0.01			
		♀	Mm. 20.5	19	18	17.5	15	14	12.5		
			% 6.8	5.8	5.1	4.7	3.8	3.3	2.8		
	Boat Harbour Gulf of Georgia	♂	Mm. 18	14	11						
			% 6.0	4.3	3.1						
		♀	Mm. 35	29	25	22	18	14			
			% 11.7	8.9	7.1	5.9	4.5	3.3			
Brill	West Coast Vancouver island	♂	Mm. 42	35	28	21	14	7			
			% 14.0	10.8	8.0	5.6	3.5	1.6			
		♀	Mm. 65	57	49	41	33	25	18	10	2
			% 21.7	17.5	14.0	10.9	8.3	5.9	4.0	2.1	0.4

J.I. Manzer Appendix No. 44

Species	Area	Sex	Average Annual Increase in Length for Fish of Different Size Groups								
			300	325	350	375	400	425	450	475	500
Rock sole	Butterworth Rocks	♂ Mm.	36	29	21	14	7				
		%	12.0	8.9	6.0	3.7	1.8				
	Hecate Strait	♀ Mm.	42	36	30	23.5	17	11	5		
		%	14.0	11.1	8.6	6.3	4.3	2.6	1.1		

The rate of growth for male and female lemon sole from Boat Harbour is more rapid than for lemon sole from Butterworth rocks. Expressing the absolute average annual increase in length as percentage values, male fish of 300 mm. in length from the Butterworth Rocks grow 4.2% of this length whereas male fish from Boat Harbour grow 6.0%. The more rapid growth rate of the Boat Harbour males is shown to exist for all size groups for which data are available. Also, Boat Harbour lemon sole show a greater percentage increase in length for female fish of 300 mm. in length than do Butterworth Rocks fish of the same length (11.7% and 6.8%, respectively), but the rate of growth decreases to equality (3.3%) for female fish of 425 mm. in length. At present it is difficult to say whether or not the differences in growth rates of lemon sole from the two areas is related to the extent and rate of exploitation, the oldest and most highly exploited population growing most rapid, or latitude.

The rate of growth for brill is the most rapid of the three species considered, The range for males is from 42 mm. for fish of 300 mm. to 7 mm. for fish of 425 mm. For females the range is from 65 mm. for fish of 300 mm. to 2 mm. for fish of 500 mm. Expressing the limits as percentage values, the rate is 14% and 1.6% for males and 21.7% and 0.4% for females.

The rock sole grow more rapidly than lemon sole but not as rapidly as brill. The percentage annual rate of increase for males of 300 mm. in length is 12% and this rate decreases to 1.8% for fish of 400 mm. Females of 300 mm. grow 14% of this length in one year while females of 450 mm. in length grow 1.1%

From the above data it would appear that female lemon sole, brill and rock sole grow faster than the males for the area for which information is available.

J.I. Manzer Appendix No. 45

Experimental Tagging of Flatfish

Ever since commencement of the flatfish tagging programme it has been suspected that the presence of the tag (Petersen type) may distort essential life history constants (such as mortality and growth rates) of the tagged part of the population and that the extent of the distortion may vary with the size and sex of the fish and details of tagging method. Knowledge of the effect of the tag is essential if rates of mortality, rates of growth, population abundance, fishing intensities, etc. are to be determined. To assist in obtaining more accurate estimates of these vital

J.I. Manzer Appendix No. 45

statistics, preparations are now being made to conduct controlled tagging experiments on tagging mortalities and tagging techniques to provide the information required.

K.S. Ketchen Appendix No. 46

The Growth of Young Lingcod

No satisfactory means have as yet been developed for the determination of the age of lingcod. However, it has been found possible to distinguish the first two age groups simply by the frequency distribution. During the winter of 1947-48, sampling in the cape Lazo area showed that young lingcod fell into two distinct size groups. In the smaller of the two groups the range was 190-310 mm. and the average size was 263 mm. In the larger group the range was 350-490 mm., and the average size was 409 mm. In all probability these two average sizes, 263 mm. and 409 mm. represent the mean growth of lingcod in the first two years of life.

Summer sampling of young lingcod from the same general area contained fish ranging in size from 120-180 mm. with an average size of 153 mm. These fish were in their first year of growth. In view of the previous results it would seem reasonable to believe that by the time of sampling (July 15th) approximately 55% of the year's growth had been completed.

W.E. Barraclough Appendix No. 47

Age Determinations of Lingcod

Considerable difficulty has been experienced in determining the age of lingcod (Ophiodon elongatus) but since the lingcod is one of the economically important ground fish some time and effort has been spent in determining the age by a study of the otoliths and scales. The otoliths were found to be more satisfactory than the scales for age determination. A collection of scales and otoliths was examined from lingcod caught off Cape Lazo during the months of April and July, and the results are given in the following table.

Number of annuli counted on the otoliths and scales

	II	III	IV	V	VI	VII	VIII	IX
	immature			Males				
Number of lingcod	20	6	6	1	2	2	1	
Average length (mm.)	287	415	463	550	625	727	840	
				Females				
Number of lingcod		8	4	3	6	6	1	1
Average length (mm.)		424	477	601	655	815	900	1,000

These results show that the lingcod grows about 100 mm. or 4 inches each year. This growth is in agreement with Dr. J.L. Hart's results.

W.E. Barraclough Appendix No. 47

Dr. Hart found that the commercial sizes of lingcod grow from $1\frac{3}{4}$ in. to $5\frac{1}{4}$ in. each year. The age determinations by otoliths for lingcod did not prove as satisfactory as the results obtained when reading sole otoliths. The ages determined by means of otoliths and scales are greater by one year than the ages estimated some time ago in Dr. Hart's conclusions based upon the sizes of lingcod at different times of the year or those deduced by K.S. Ketchen in another summary report for 1948. They found that the lingcod are about 10 in. long at the age of one year, 14 or 15 in. long at the age of two years, and 18 in. long at the age of three years. It may also be noted that the lingcod usually enter the commercial fishery during their 4th or 5th years. The discrepancy between conclusions reached by the two methods suggest the possible existence of a constant non-annual check in the centre part of the lingcod scales and otoliths. This calls for careful study before attempting further work in aging individual lingcod.

K.S. Ketchen Appendix No. 48

The Reproducibility of Trawl Hauls

The initiation of experiments which would produce reliable results of the effects of trawl nets of various mesh sizes has required preliminary investigation of the reproducibility of trawl hauls with nets of a given mesh size. Experiments of this sort were carried out during the winter of 1947-48 in Baynes sound, an area in which the general geography lends itself to the more or less accurate repetition of drags over fixed distances. As the lemon sole appeared in greatest abundance in the catches, that species was chosen as the subject of the analysis.

The length frequency distributions of five pairs of drags, that is, consecutive drags, were subjected to chi-square tests in making determinations of the degree of association. The chi-square values had the following probabilities: 1 in the range .05-.10, 3 in the range .20-.30, and 1 in the significant range. In testing for association then, four out of the five chi-squares were well within the limits of non-significance. One value was just bordering on significance. Thus successful reproduction was achieved.

In view of the many factors tending to disrupt the reproducibility of trawl hauls, it is unlikely that higher degrees of association might be obtained. Among these disrupting factors are (1) irregularities in the distribution of fish on the grounds, (2) differential reaction to disturbance, (3) the effect on escapement by the number and species of fish in the net, (4) mechanical variations in the performance of the net, and (5) slight variations in the amount of ground covered in dragging.

K.S. Ketchen Appendix No. 49

Gear for the Capture of Larval and Post-larval Flatfish

A small dredge-like net of iron frame and fly-screen mesh proved very effective in the capture of larval and small post-larval lemon sole and starry flounders. Operation of this gear in shallow water along a sand-bar in early April netted approximately 100 fish ranging in size from 8 mm. to 15 mm.

Observation of live specimens showed that metamorphosis (the assuming of the side-swimming behaviour) was complete in fish of 10 mm. in length. Fish 8 to 9 mm. were in an intermediate stage, swimming half way between the vertical and horizontal positions.

Later drags with this net in the early part of May produced larger fish, but the average size was much lower than that of fish taken by beach seine at the same time of the year. Thus it was shown that the gear was fishing selectively, and therefore would have been of no use in quantitative studies by that time of year.

K.S. Ketchen Appendix No. 50

The Cape Lazo and Nanoose Bay Experiments

In 1947 almost all of the profitable groundfish areas in the strait of Georgia were closed to trawlers in order to safeguard the interests of the hook and line fishery for lingcod. Such closures, although presumably of benefit to the lingcod fishery, all but eliminated the winter supply of other important trawl fish to the market. It was therefore of considerable importance that areas be located which are not productive of lingcod, and which therefore could be recommended for re-opening to enable more efficient utilization of other species of fish.

Surveys of two productive trawling areas, south-east of cape Lazo and in Nanoose bay were carried out at the beginning of 1948, to determine the relationship of the abundance and distribution of lemon sole, grey cod, and dogfish to that of lingcod.

1. Cape Lazo

At the beginning of February the cape Lazo area was subjected to thorough dragging, designed to sample as many depths and as wide an area as possible. Briefly the results were as follows:

(a) Lemon soles were concentrated in greatest abundance in the northern part of the ground between 35 and 40 fathoms.

(b) Small lingcod (1 year of age) were at that time of year confined to depths shallower than 35 fathoms. Drags in one area, in 31, 35 and 40 fathoms produced 37, 15 and 0 fish, respectively. In another area at the same depths the catch was 33, 2 and 0 fish.

(c) In the deeper waters (over 35 fathoms) very few lingcod of larger size were taken. The average was less than one fish per 15 minute drag.

On the basis of the facts revealed on the limitation in the depths inhabited by young lingcod, and on the sparsity of larger lingcod in the deeper waters, recommendations were made which would enable the trawl fleet to take advantage of the lemon sole fishery.

In the middle of February the grounds were re-opened and close contact was kept with the fishery during the productive phase of its existence. By the fifth day eleven effectively fishing boats were on hand. In the relatively small area where this fishery operates it was not surprising, therefore, that a sharp decline in total catch had occurred by the end of the sixth day. The catch per boat began to decline after the fourth day. The following table exhibits the trend of the fishery during the first eight days:

Days after opening	Number of boats	Total catch (pounds)	Catch per boat per 2 hr. drag
1	1	600	300
2	2	2,600	400
3	5	9,000	450
4	10	19,000	510
5	11	20,000	450
6	10	11,300	360
7	3	1,900	270
8	2	600	210

The decline in catch was due mainly to the intensive fishery, but may have also been due partially to the movement of the fish off the grounds to undisturbed or inaccessible territory.

Direct observation of numerous 2 hour commercial hauls showed that lingcod were not being caught in great numbers. The boats voluntarily stayed away from the shallower regions which harboured the lingcod of one year's growth (group I fish).

In the commercial hauls, group I lingcod (20-34 cm.) averaged 2.8 per drag, and Group II lingcod (over 40 cm. but under commercial size) averaged 5.5 per drag. Lingcod of commercial size averaged 1.5 per drag. Thus in comparison with the weight of other fish landed the destruction of lingcod was low.

Because of the dissatisfaction on the part of the industry over the poor quality of the lemon sole taken, it has been proposed, that if the grounds are to be opened in 1949, that it be during an earlier period of the season when the fish are not so far advanced in spawning condition. The poor quality was due partially to the high proportion of small male fish in the catches, a characteristic of the Cape Lazo area which has been apparent since the investigation began several years ago.

2. Nanoose Bay

In this area the problem concerned the determination of the relationship of the abundance of lingcod to that of greycod and dogfish. The ground was opened contemporaneously with the cape Lazo area, but because of the smallness of the ground and its consequent unsuitability to fishing

K.S. Ketchen Appendix No. 50

with the double gear of the "Investigator No. I", adequate sampling prior to the date of opening was not achieved. However, very few lingcod were taken in those drags which were completed.

Greycod and dogfish were the principal species caught, and, as was the case at Cape Lazo the number of lingcod taken was negligible, but at times considerable numbers of small blackcod appeared in the catches. Department of Fisheries reports state that 42,000 lbs. of greycod were taken during the open period. In the first nine days of the fishery the average number of boats per day was 3 the average total catch per day was 2,300 lbs. of greycod, and the average catch per boat per drag was 280 lbs.

W.E. Barraclough Appendix No. 51

Summary of the study of measures of abundance of dogfish

The decline in production of vitamin "A" from dogfish livers has been studied by analysing the tally slips for individual sunken gill-net boats operating in western Hecate strait. The decline is believed to be associated with a drop in availability. The decline in potency of Vitamin "A" is indicated in the following table.

The average number of USP units per gram of liver oil determined from the livers of dogfish which were landed only by sunken gill-nets in Hecate strait, near the Queen Charlotte islands from 1944 to 1947

	Average number of USP units per gram of liver oil	Total poundage of dogfish livers tested
1944	14,648	148,191
1945	13,183	514,000
1946	9,784	446,448
1947	9,075	572,486

The sunken gill-net fishery is rather a selective one for size. Only the largest fish are caught, the smaller ones tend to pass through the webbing, thus eliminating those of no commercial value. The decline in availability and total catch would indicate that the larger fish are becoming less abundant on the fishing grounds in Hecate strait. The consistent falling off in vitamin "A" potency suggests that the older dogfish in the size groups selected by the sunken gill-net have declined more rapidly than the younger ones, and that the fishery is relying to an increasing extent upon the faster growing, moderately old individuals. As the older age classes of dogfish are removed from the population, the number of larger dogfish with livers of a high vitamin "A" potency available to be caught in sunken gill-nets would become less. This situation is not surprising in a species which has been fished so agressively and so intensively throughout its range and against whose largest members a special fishery has developed. Such a selective fishery which is dependent upon the older fish is probably necessary to secure the maximum production

W.E. Barraclough Appendix No. 51

from the fish population. It cannot be considered that the decline in availability of the dogfish and the drop in vitamin "A" potency of the dogfish livers is sufficient to indicate biological depletion. The economic condition in which reduced yield per boat is accompanied by reduced value per unit is quite different and is a matter of real concern.

The results of this study were prepared for publication and presented orally at the 1948 meetings of the Royal Society of Canada.

J.L. Hart Appendix No. 52

Pilchard Fishery

The pilchard fishery as such did not exist during 1948 and unless landings of fish are made from the inlets during the herring season the total production will be nil. No landings were made in Washington. Oregon catches were less than in 1947. No statement concerning California production to date is possible owing to price dispute so that there are no possible grounds for hope of early re-habilitation of the fishery.

D.M. Furk Appendix No. 53

Factors related to pilchard landings

The analysis of accumulated pilchard catch statistics was continued in the hope of obtaining information on causes of pilchard abundance and availability.

A revision of the link relative indices as reported last year was undertaken on the basis of the criterion that before data could be included, the individual annual tonnage had to be at least one-third that of the largest tonnage of pilchards caught in the respective season, on the assumption that even the smallest boats should be able to catch at least one third of the catch of the largest boats if they fished all season. The revised indices do not differ greatly from the original ones.

Catch per seine per day data were treated by link relatives with the resulting indices.

1926	0.74	1933	--	1940	0.69
1927	0.97	1934	1.29	1941	1.00
1928	0.81	1935	1.20	1942	1.00
1929	0.97	1936	0.78	1943	1.61
1930	1.00	1937	0.90	1944	0.96
1931	1.21	1938	0.87	1945	0.41
1932	1.05	1939	0.13	1946	0.09

These indices in general follow those obtained by previous other methods. It appears likely that such discrepancies as do occur are due to the differences in the length of season.

An attempt was made to assess the fluctuations in the length of the pilchard season by determining the smallest number of ten-day periods necessary to catch stated percentages of the catch. A definite

D.M. Furk Appendix No. 53

shortening of the season was evident from 1925 to 1932.

Comparisons between sea water and air temperatures and the percentage annual catch of pilchards were attempted, but until other meteorological data can be included with the comparisons, no definite relationships can be established.

D.M. Furk Appendix No. 54

Eulachon Catch Statistics

Continuing the programme established in 1941 catch in pounds of eulachon per 100 square fathoms of gill net was calculated for 1948 on the basis of information collected by the Department of Fisheries. The results given in the last column in the following table may be compared with those for previous years. The upper figure in each pair is the catch per unit effort: the lower figure the number of units of effort put forth during the period.

	1941	1942	1943	1944	1945	1946	1947	1948
Week 00	2)	--	--	--	--	0)	--	--
	65.6)					1.1)		
Week 0	5)	--	--	4)	4)	--	--	--
	202.3)			23.4)	10.2)			
Week I	10)	7)	0)	3)	3)	1)	7)	6)
	440.7)	10.5)	0.2)	55.6)	20.7)	6.6)	35.2)	85.4)
Week II	10)	32)	74)	7)	12)	7)	18)	6)
	619.0)	155.8)	71.9)	145.0)	103.5)	37.8)	73.3)	199.7)
Week III	55)	57)	85)	8)	18)	6)	129)	24)
	442.8)	282.2)	407.3)	422.1)	308.8)	121.0	269.3)	208.2)
Week IV	135)	222)	134)	60)	36)	22)	281)	100)
	583.3)	412.3)	411.6)	660.6)	680.8)	161.1)	595.6)	1185.2)
Week V	74)	219)	265)	144)	110)	100)	318)	158)
	224.9)	383.8)	407.7)	511.0)	853.2)	701.5)	254.1)	1360.2)
Week VI	10)	102)	116)	74)	93)	193)	146)	127)
	57.4)	165.1)	59.0)	199.5)	763.6)	409.1)	5.2)	178.6)
Week VII	--	--	--	10)	225)	510)	--	10)
				3.0)	39.9)	32.9)		0.2)

It is difficult to obtain a single composite figure representing abundance in any one year and positive statements are hard to justify. It is evident that there is no obvious trend and one is tempted to the opinion

D.M. Furk Appendix No. 54

that there is obviously no trend.

In former years the results of the calculations have been in keeping with the opinions gained by general observations of fishermen and fisheries officers. This conformity broke down during 1948 which was calculated to be a smaller-than-average year but was popularly regarded as a very good one. Certainly the catch was very heavy which may have influenced the general view or the catch per unit fishing effort may have been decreased by competition. Data are being collected to test other possible explanations as suggested by Mr. T. Taylor of the Department of Fisheries.

G.C. Pike Appendix No. 55

Anchovy Investigation

An extension of the anchovy investigation during 1947 will be made with the examination of this year's catch records and samples of the individual catches made. The intensity of the fishing this year has shown a marked decline. This possibly is attributable to a small recruitment of two-year-old fish to the commercially acceptable three-year-old class, and also to a decreased demand upon the fishery by the companies concerned. Such fishing effort as has been expended has proved unprofitable.

The investigation has followed four lines: The study of age by scales, otoliths and length frequencies; the study of spawning and reproduction by ovary examination; the collection of information through questionnaires to fisheries officers; and log-book records from fishermen. These lines of study have led to certain conclusions and inferences which, it is hoped, will be substantiated by sampling of occasional catches in the future. Evidence of a sample of small one-year-old fish captured in Jervis Inlet, reports of the occurrence of small 1 to 2-inch fish in the inlets, and occurrence of ripe or nearly ripe ova in the ovaries of females during June, July and August all lend support to the conclusion that the anchovy in the bays and inlets of this coast are capable of successful reproduction.

Preliminary results of the investigation indicate that anchovy spawn more than once during a spawning season lasting through June, July and August. The onset of maturity occurs in females ranging in length from 119 mm. to 130 mm. Anchovies in their first and second year do not mix to any extent with the mature three and four-year-old fish. The consistency between samples from the various areas is such as to give no indication of separate populations at various places along the coast. The range appears to be from the Strait of Georgia in the south, throughout bays and inlets of the waters on the east and west coasts of Vancouver island, and northward along the mainland coast to Ogden channel.

Overfishing of the existing stocks of anchovy seems unlikely in view of the relatively light demand made upon the fishery by commercial interests. Should exploitation become intense, however, the small residual population could be vertually eliminated.

Mr. J.L. McHugh at the Scripps Institution of Oceanography is carrying out a coastwise racial investigation of anchovy some of whose results will be applicable to British Columbia conditions. British Columbia workers have co-operated with Mr. McHugh by supplying samples of northern material.

J.L. Hart Appendix No. 56

Albacore Fishery

The albacore resource available to fishermen is one of unknown size and potentialities. It would appear, however, to provide one of the more promising directions for extension of Canadian fishing activity. With this in mind and appreciating the desirability of making use of the halibut fleet which would be released for other activities shortly after a very brief season the Department of Fisheries detailed one of its boats to assisting the albacore fishery by helping in the search for fish, monitoring information about albacore fishing, and in other ways. The Pacific Biological Station accepted an invitation to place an observer on the vessels engaged in this work. Numerous records were made on albacore and on water conditions generally some of which are summarized in summary reports by Mr. Scagel. In most cases the information collected was less systematic and critical than is desirable or could have been attained if the biological work had not been secondary to the main object of providing immediate aid to the fishery.

To a large extent because of the help given by fisheries patrol vessels and also because of considerably increased fishing effort the albacore catch was the greatest in Canadian history. Most of the fish were caught off the west coast of the Queen Charlotte Islands in an area opened up as a direct result of scouting by public servants. For the first time Prince Rupert, Butedale, and Klemtu became ports of landing for albacore.

The possibility of increased importance of the albacore fishery has been realized for several years. Various observations on the species have accordingly been made from time to time since 1941. As a background for further work all the results to the end of 1947 were compiled and an account of the results distributed to the industry as circular No. 12.

J.L. Hart Appendix No. 57

Albacore Sampling

In studying a fishery it is reasonable to attempt to learn as much as possible about the fish constituting the catch. To this end substantial samples of commercial landings of albacore were measured at Vancouver by R.M. Wilson and T.H. Butler, at Victoria by D. Odlum, at Prince Rupert by G. Calderwood and A. McLeod. The results of these measurements are given herewith in tabular form according to major fishing area:

J.L. Hart

Appendix No. 57

Cm.	North of Cape St. James	Cape St. James to Cape Cook	Off Ucluelet and southward	Total
53			1	1
54	1		2	3
55		1	6	7
56	2	3	14	19
57	5	4	19	28
58	21	12	28	61
59	44	18	33	95
60	101	59	70	230
61	215	83	100	398
62	369	92	116	577
63	447	104	104	655
64	422	80	53	555
65	304	47	28	379
66	149	17	19	185
67	82	9	7	98
68	69	5	3	77
69	54	4	3	61
70	74	9	2	85
71	54	5	7	66
72	70	4	5	79
73	75	12	5	92
74	88	5	9	102
75	92	7	8	107
76	69	9	10	88
77	60	4	5	69
78	34	4	5	43
79	26	3	2	31
80	13	2	1	16
81	1			1
82	2			2
83				
84				
85				
	2,943	602	665	4,210

Pending careful analyses two observations on the measurements are worth mentioning. There are two modes in the size distribution, one at 63 cm. length, and one at 75 cm. length. These correspond in position with the size modes recorded in other years although there has been substantial irregularity in the positions and relative sizes of the modes. The modes probably represent year-broods of fish which cannot as yet be assigned to definite age groups.

The second point worthy of note is that the more northerly fishing grounds produce larger fish. The main mode corresponds to larger fish off the Queen Charlotte islands and in that area a larger proportion of fish is more than 69 cm. in length.

W.J. Bethune Appendix No. 58

Water Temperature and other Oceanographic Conditions in Relation to Commercial Catch as Indicated by Albacore Log-book Records

Tuna log-books were first issued to fishermen in 1946. The fishermen were asked to fill in information as to date, time of recording, position, direction and speed of wind, water temperature, the number of fish caught, and any other information of interest. Each sheet was in duplicate so that the fisherman could keep the original copy and send the carbon copy to the Pacific Biological Station. Records of books issued were kept by the issuing officers. Similar books were issued in 1947 and 1948. Each year more books were issued than in the previous year, and, as was hoped, the returns increased in each year.

In 1946 a method of analyzing the data was evolved. Each complete reading (i.e. one containing at least the position, the water temperature, and the number of fish caught) was given a number, more or less chronologically. Then each reading was plotted on a map with a notation re the temperature and the number of fish caught at that point. The maps were divided into areas so that each area was one half degree of longitude wide and one half degree of latitude long. Each area was given a numeral for designation purposes.

Although the books issued during the three years were identical and the same treatment followed each year, it is difficult to make a fair comparison of the results between any two of the years. In the years 1946 and 1947, the same areas were fished; but in 1946 there was only one fisherman who sent in a complete set of logs. In 1947 six men sent in complete sets with a total of one hundred ninety-six recordings. It was not felt that the information provided by one man could be taken as being representative of the entire fleet. Although that provided by the six men in the following year left much to be desired, it could be taken as being reasonably representative. The 1948 results could be considered representative, as many fishermen sent in good reports (750 valid recordings); but from some points of view conclusions reached from this year's data cannot be successfully compared with previous years because of the complete shift in fishing locality. In 1947 no fish were caught north of 50°N latitude, and in 1948 over 62% of the catch was made north of this parallel.

For the above reasons, the results obtained over the last three years will be given, but no effort to compare them will be made. In 1946, the best areas lay between latitudes 46°30'N and 47°N, and longitudes 125°30'W and 126°30'W. The optimum temperature in that year was 61°F. In 1947 the most efficient area was found to be bounded by the parallels 126°30'W and 125°W longitude, and 46°30'N and 47°N latitude. In that year, the temperature found most effective was 65°F. The results of the 1948 analyses show the best area lying between latitudes 52°30'N and 53°N and longitudes 132°W and 133°W; the most efficient temperature being between 58°F and 60°F.

From the information given in the reports in the first two years, it was possible to compute the hours spent in each area. But in the 1948 reports any attempt at computing time would have involved, of necessity, so much presumption and guess-work as to make the final results valueless in a scientific investigation. Also, in the 1948 reports, often an accurate temperature reading was not given, particularly in the optimum area. It would seem that the fish were so abundant in that area that the

W.J. Bethune — Appendix No. 58

fishermen did not have the time to make adequate temperature recordings; and, as a rule, gave their reading as "between 58°F and 60°F", which proved to be the most efficient temperature.

No definite conclusions can be drawn from the results of the data collected in the last three years, but they do provide a background for planning future investigations. There is no support in the records on hand for the view that albacore catches are inflexibly related to water temperature.

R.F. Scagel — Appendix No. 59

Temperature Conditions in Relation to Albacore Occurrence and Catches

During the summer of 1948 from June 22 until September 8 surface temperatures were taken from on board the Fisheries Protection Vessels "Kitimat" and "Laurier" during their patrol of the "tuna" fishing grounds. Although the number of recordings taken is not sufficiently large nor the coverage sufficiently complete to trace isotherms with any high degree of accuracy an indication of the structure of this offshore region of water has been shown. Also comparison of temperatures over the summer season indicates that the configuration of these isotherms changes as the season progresses, moving inshore considerably by late August as compared to the position found in July.

Comparisons of midsummer and late summer temperatures are only available for the southern region (off the West Coast of Vancouver Island) but these show that it was necessary to proceed southwest from Barkley sound in mid July 60 miles before water reaching 57 degrees F. was attained, whereas in August the same temperature was encountered within 20 miles of shore. Similarly, water temperatures of 57 degrees F. were reached within 20 miles of shore in mid July, but were encountered within 10 miles of shore in August southwest of Cape Cook, where the continental shelf is restricted in its extent and may be related to the greater proximity of the warm water to the land at this point.

A limited number of bathythermograph recordings were made, indicating that this stratum of warm water, which comprises the Japanese Current, is in the neighbourhood of 50 feet in depth.

It was found that in proceeding off shore there was a gradual transition from the cold coastal waters, which are generally about 52 degrees F., to the warmer waters of the Japanese Current, and that once the continental shelf was crossed one could expect the water to become warmer more rapidly. The "edge" of this current is not sharply defined but the warmer water is encountered close to shore or far out according to the extent of the continental shelf. The significance of this factor is shown by the fact that the most intensive fishing was carried out this year off the west coast of Moresby Island, at times within 10 miles of the shore in the region off Tasoo Inlet. Along this portion of Moresby Island the continental shelf is very restricted, or even non-existent, which is apparently the reason why the warm water of the Japanese Current comes in so close at this point.

R.F. Scagel Appendix No. 59

The lowest temperature at which albacore were caught during the investigation was 56.8 degrees F. and the highest temperature was 63.0 degrees F. The best fishing, however, was experienced at temperatures between 58 and 60 degrees F. During the investigation 513 fish were caught. The distribution of these fish, comparing temperatures to the nearest whole degree, is as follows:

Temperature °F.	Number of Fish Caught
57	7
58	147
59	149
60	135
61	74
62	0
63	1

Although blue water was encountered in close proximity to the Queen Charlotte Islands (within 10 miles of the shore off Tasoo Inlet), no water temperatures over 60 degrees F. were recorded in this region, whereas in more southern waters off the West Coast of Vancouver Island and Washington temperatures of from 57 to over 64 degrees F. were recorded in blue water.

R.F. Scagel Appendix No. 60

Other Oceanographic Conditions in Relation to Occurrence and Catch of Albacore

1. Salinity: random water samples were taken over wide areas in the offshore region but these show no significant variation.

2. Color of Water: as one proceeds offshore there is a gradual transition in the water color from the intense green (and occasionally brown) water of the coastal region, through a blue-green region in the vicinity of the continental shelf, until finally the water becomes an intense blue and is extremely clear. The color transition parallels the temperature transition. The green water, generally in the neighbourhood of 52 degrees F. close to shore, is decidedly cold; the blue-green approaches 57 degrees F. and once the blue water is reached the temperature change takes place rapidly, reaching in northern waters 59 degrees or slightly higher, but in southern waters reaching 64 degrees F. or higher.

The point of rapid change from blue-green to blue and from cold to warm seems to be in close proximity to 57 degrees F. It is believed that once the water has reached close to 57 degrees F. that albacore may be expected. Although the water is believed almost invariably to be blue where albacore are taken, this factor seems to be a companion factor and although it may contribute directly or indirectly to the distribution, it seems to be secondary factor in the distribution of the albacore.

R.F. Scagel Appendix No. 60

Large samples of various colors of water were collected to determine whether predominence of any organism contributes to this phenomenon, but these have not yet been analyzed.

3. Plankton: the microscopic and near-microscopic life in this offshore region has been found to be abundant and varied. Unicellular forms--protozoa and algae, tunicates, worms, ctenophores, coelenterates and crustacea have all been found in adundance.

Plankton samples have been taken over a widespread area in both blue and green waters but a detailed study of these has not yet been completed.

R.F. Scagel Appendix No. 61

Feeding of Albacore

A number of stomachs were taken from albacore during the summer as well as collections of stomach contents thrown up by fish on the deck during fishing operations. Some samples have also been submitted by various fishermen. Complete examination of these has not yet been carried out. The feed taken is composed of an extremely wide assortment of forms, but the items which bulk largest in the diet of the albacore are saury, squid, small rockfish and "red feed".

Various types and colors of lures were tried in an attempt to determine whether any preference exists. Both feather baits and fast-towing plugs seemed equally successful in taking albacore on trolls and any preference which exists seems to be in favour of amber-headed feather baits with red and white feathers and green-headed feather baits with white and green feathers, although the evidence is hardly conclusive.

R.F. Scagel Appendix No. 62

Collection of Albacore Scales

Lengths, weights, and scale samples from various locations on the body, of a number of albacore were taken. The scales have as yet not been critically studied, hence no conclusions as to the possibility of age determination using this method can be drawn.

R.F. Scagel Appendix No. 63

Tagging Albacore

During the summer between July 17 and September 14, 140 albacore were tagged and released in offshore waters at points ranging from off Destruction Island to off Langara Island (West Coast of Queen Charlotte Islands). The fish were tagged with the button-type celluloid tags using nickel pins. The fish were tagged through the tail close to the leading

R.F. Scagel Appendix No. 63

edge and near to the insertion of the tail at the caudal peduncle. The distribution of the fish tagged is as follows:

Position Caught and Released	Number of Fish
Off Cape Cook (20-75 miles southwest)	24
Off Cape Flattery and Destruction I. (75 miles southwest of Flattery to 70 miles southwest of Destruction I.)	41
Off West Coast of Moresby I. (35 miles southwest of Big Inlet to 35 miles southwest of Tasoo Inlet).	51
Off Cape St. James (30 miles southeast)	6
Off Graham Island (80 miles southwest of Langara I.)	18

With one exception all fish swam rapidly away as soon as released. Only fish which were not severely hooked or damaged were tagged. The majority of fish taken, however, were only slightly injured by the hooks, which were barbless.

No recoveries, to date, have been recorded and considering the comparatively small number which were tagged little hope is held of any recovery.

R.F. Scagel Appendix No. 64

Albacore Fishing Experiments

Long-line fishing at various depths using hooks baited with salted herring, fresh frozen anchovy, squid and feather baits all were tried but none proved successful in catching albacore. Blue sharks, however, were very commonly taken by this gear and a few soupfin sharks.

Gill-netting was also attempted, and while it too fished blue sharks and also soupfin sharks, this method was not successful in taking albacore.

Fishing albacore with trolls at depths was attempted and while albacore were taken from lines maintained at several fathoms depth, proof that these fish did not take the lines as the weighted lines were being hauled in was lacking.

R.F. Scagel Appendix No. 65

Recommendations for the Future Study of Albacore

The nature of the investigation has prevented systematically investigating any phase of the problem.

The analysis of the data accumulated, however, would seem to indicate some measure of success may be anticipated:

(1) by systematically investigating the temperature distribution in the offshore region throughout the season, as well as immediately before and after the "normal" season in an attempt to learn more about the movement of and arrival of the Japanese Current, and hence when and where to expect occurence of albacore.

(2) by systematically investigating the other forms of life present in the offshore and transitional areas and comparing with the populations of more coastal areas, as a counterpart to (1).

(3) by carrying on at least one intensive tagging programme, whether any returns are received from the 1948 season or not.

(4) by endeavouring to learn something of the movement of the saury, which are present in such abundance in the offshore region and believed to influence the movements of the albacore.

J. C. Stevenson Appendix No. 66

Herring Investigation: General Introduction

In 1947-48 the herring investigation for the second successive year concentrated on the study of the west coast of Vancouver island herring population, which under a plan formulated in 1946 by Dr. A. L. Tester, is not subject to catch restrictions, except for closure date. In addition, efforts were continued to obtain comparable data from the lower east coast of Vancouver island population, on which catch restrictions are imposed by a fixed quota. The purpose of the large scale west coast "experiment" is to discover whether quota restrictions on herring populations are necessary to prevent a downward trend in population abundance or whether the system of fixed quotas is an inefficient conservational practice because of the large "natural" fluctuations which occur in population abundance. The solution of this problem will permit the formulation of a policy of fisheries management applicable to all the B. C. herring populations and assuring maximum utilization of the resource in perpetuity.

The immediate aims of the investigation are directed to obtaining biological information on (1) the causes of natural fluctuations in recruitment and advance information on these fluctuations, (2) the general relationship between the number of spawners and the number of resultant recruits, (3) the minimum spawning population necessary to produce an approximately constant supply of recruits, (4) the effect of various rates of exploitation on the fishable population, etc. To accomplish these aims the research activities on the west coast population were continued along lines similar to those of the first year of the study. During the 1947-48 fishing season every effort was made to obtain accurate catch statistics, intensive sampling of the catches for length, weight, sex and age was maintained, and tag recovery was continued by means of three tag detectors (two on the west coast and one on the east coast) and magnets installed in all the reduction plants. In the late winter and early spring of 1948 detailed spawning ground surveys were again undertaken in the west coast areas by the investigators in connection with the tagging programme, and during the spring months an intensified investigation of the young herring of the 1948 year-class was carried out. Tagging and tag recovery, sampling of the catches and the spawning runs, and the detailed collection of catch statistics were also continued in the strait of Georgia. Within the limits of finances and staff, the continuity of the general investigation was maintained in all other herring populations, resulting in the continuation of the collection of catch statistics and the sampling of the catches from the other sub-districts. As in previous years the fishery officers of the Department of Fisheries made surveys of the extent and intensity of spawning depositions in all sub-districts.

Dr. Tester has been largely responsible for the planning, direction, and accomplishments of the herring investigation as outlined in this annual report, the writer having taken over general supervision as of September 1st.

Permanence of staff members during the present research is highly desirable, but unfortunately for many reasons the staff of the investigation has undergone numerous changes during the past year and this is expected to continue in greater or lesser degree in the ensuing year. In November, 1947, the scientists of the investigation totalled four, and since then two have resigned and two new members have been acquired. The present members (as at November, 1948) include the writer, acting head of the investigation since

J. C. Stevenson Appendix No. 66

August, 1948, and three junior biologists (Messrs. Lanigan, McMynn, and Outram). During the fall and winter months when the fishery is active, the members of the staff are principally engaged in tag recovery, sampling, and compiling catch returns; in the spring surveys the staff is occupied in tagging, making spawning surveys and collecting data on the young herring; the summer months permit the analysis of the data and the writing of reports and papers. It is hoped that with increase in experience the junior biologists will be able to take over responsibility of the research in certain phases of the investigation. To this end Mr. J. A. Lanigan has been concentrating his attention on tagging and tag recovery, and Mr. R. G. McMynn has been devoting most of his time to the young herring research. Mr. J. H. Glover (who resigned October 1, 1948) and Mr. Lanigan were responsible for making age determination of the fish sampled, as well as assisting in the general conduct of the sampling studies.

In the following Appendices the results of the investigation during 1947-48 are briefly outlined. These are summarized in the final Appendix on herring.

J. C. Stevenson and R. S. Isaacson Appendix No. 67

Catch Statistics for the 1947-48 Herring Fishery

The collection of detailed catch statistics by means of Pilot House Record Books and Daily Landing Forms was continued during the season. Pilot House Records are compiled by each seine boat captain and record the place and date of all catches, together with the total number of active fishing days (fishing effort) spent on the grounds, providing comparative data on availability (catch divided by fishing effort) and abundance. Daily Landing Forms submitted by the processing plants provide information on the total catch from each area and the method of disposal.

The total catch during the 1947-48 herring season amounted to 171,700 tons. This was the largest annual catch in the history of the fishery and approximately 48,000 tons greater than that of the previous season. The distribution of the catch is shown in the following tabulation:

Sub-district	Catch		Availability
	Tons	Percent	Tons/seine/day
Queen Charlotte islands	---	---	---
Northern	39,000	22.7	238.5
Central	28,500	16.6	54.7
Upper east coast of Vancouver island	7,300	4.3	34.5
Discovery passage	6,000	3.5	94.7
Lower east coast of Vancouver island	45,700	26.6	71.0
West coast of Vancouver island	45,200	26.3	47.9

No herring fishery took place in the Queen Charlotte islands sub-district although reliable reports stated that there was a good concentration of fish in late January in the vicinity of Darwin sound (Area 2A). Good fishing in the northern and central sub-districts and the fact that the

transport of herring across Hecate strait is a hazardous winter operation were probably the main reasons why the sub-district did not support a fishery.

A spectacular fishery developed at Ogden channel (Area 5) in the northern sub-district in late January and early February (Area 5 was previously a part of the central sub-district but evidence from the Ogden channel fishery and other sources indicated that it should be considered in the northern sub-district; this change was officially adopted in the fall of 1948). Although the fishery continued for only two weeks, after which time the area was closed for conservation purposes, a total catch of 30,000 tons was obtained. This catch was definitely limited by the capacity of the packing boats and plants. This was the only fishery in the northern sub-district during the season.

In the central sub-district short periods of good fishing prevailed during November and December being centered mainly in Areas 8 and 9. In January a few good catches were obtained at Klemtu passage (Area 6), but it was not until after the completion of the Ogden channel fishery that any intensive scouting took place in this sub-district. During the second week in February large schools of herring were located in the vicinity of the Bardswell Group (Area 7). These schools provided excellent fishing until the close of the season. It is notable that the main run to Surf and Laredo inlets was not fished this season.

Fishing in the upper east coast sub-district was average. The major portion of the catch was again taken from the Clio channel-Bones bay vicinity (Area 12). Some good but erratic fishing took place in Belleisle sound (Area 12).

The Discovery passage sub-district quota was obtained two weeks earlier than in the previous season. All the fish were taken from Deepwater bay. The run was marked by two large influxes of fish, one arriving about the middle of October and the other the last week of the month.

In the lower east sub-district the main fishery commenced earlier than usual, particularly in Nanoose bay (Area 14B). Consistently good catches obtained from Nanoose bay and Swanson channel (Area 18) enabled the sub-district quota to be completed by November 5, one month earlier than in the previous season.

Reports of a large body of herring in Baynes sound were received in late November and early December. In view of the need for additional scientific information concerning the herring population of the northern part of the strait of Georgia, a five thousand ton extension was granted with the proviso that all the fish were to be taken from waters in the northern part of the sub-district. This extension was completed after only twenty-seven hours of fishing, the entire catch being taken from Baynes sound.

The total catch in the west coast sub-district was smaller than in the previous season. (45,200 tons as compared to 59,000 tons). After the completion of the lower east coast sub-district quota intensive scouting took place throughout the west coast areas, but it failed to reveal any large concentration of fish. Small catches containing a large number of fish of age I and II were made at Queen cove and Tahsis inlet (Area 25) during the first part of November, and later in the month herring were located in "outside waters" off Florencia island (Area 23) and off Nootka light (Area 25). The fishery which developed in these "outside" localities lasted only a few days, being hampered by rough seas and high winds. This fishery is notable in that

J. C. Stevenson and R. S. Isaacson — Appendix No. 67

it was the first time that herring had been caught successfully in the open waters off the west coast of Vancouver island. In past years the fishermen have waited until the fish entered the sounds and inlets along the coast. During the Christmas holiday period a large body of fish moved into Barkley sound (Area 23) and when fishing was resumed in January a high availability producing excellent catches prevailed for two weeks, then declined suddenly. Good fishing took place at Port Eliza and Queen cove in Nootka sound (Area 25) during January. A few small sets were obtained near the mouths of Kyuquot and Crowther channels (Area 26) in the early part of the season, but no fishery developed in either Clayoquot (Area 24) or Quatsino (Area 27) sounds. Further influxes of fish entered the areas after the closure date to spawn.

J. C. Stevenson and J. A. Lanigan — Appendix No. 68

Tag Recoveries by Plant Crews from Magnets for 1946-47

During the 1946-47 season a total of 380 decipherable tags were submitted from eleven reduction plants, but were not analysed in time for inclusion in the 1947 annual report.

A major difficulty in studying data from "magnet" recoveries is the determination of the area from which the tagged fish (which originally bore the tag) was taken. The probable or certain areas of recovery are unbiased interpretations based on knowledge of (a) the "time lag" (time between when the tagged fish enters the plant and when the tag reaches the magnet) obtained from the efficiency tests conducted on magnets during the season, (b) the catch history of fish passing through each plant, and (c) the detector recoveries. In a number of cases the interpretation was broad, including several areas, and in some cases (totalling 11) no interpretation was given because of an excessive "time lag" in the plant or because of incompleteness of data submitted with the tag recoveries by the plant crews.

Of the 369 tags (no interpretation for 11 tags could be given regarding area of recovery) 259 originally inserted on the west coast were recovered on the west coast. Fifteen tags taken in west coast catches were used in taggings in sub-districts other than the west coast, but no tags inserted on the west coast were recovered in other areas. The opportunities of the latter recoveries were, however, limited in the 1946-47 season. This analysis indicates only limited mixture of fish between the west coast population and those of other sub-districts, a result similar to that obtained from the analysis of the 1946-47 tag detector returns. In the following tabulation the magnet recovery data are summarized:

	Area of recovery		
Area of tagging	West coast	Other sub-districts	Total
West coast	259	--	259
Other sub-districts	15	95	110
Totals	274	95	369

Further discussion of the 1946-47 returns is included in the following Appendix.

J. C. Stevenson and J. A. Lanigan Appendix No. 69

Herring Tag Recovery for 1947-48

Herring tagging and tag recovery, in its twelfth year, is conducted to determine the extent of movement of the fish, the amount of mixture which takes place between runs, information on population abundance, rate of recruitment, rate of mortality and similar vital statistics. The data obtained in the 1947-48 season and a discussion of the 1946-47 and 1947-48 results are briefly presented below.

Tag Detector Recovery

During 1947-48 the old-type tag detector, used at Steveston as in past years, again gave a very satisfactory performance with an operating efficiency of 90%. The new-type detector installed at Kildonan (Area 23) still had a low efficiency although giving better results than in previous years. This low efficiency (53%) was probably in part the result of the vibration of nearby plant machinery, which affected the detector in such a way that it had to be operated at a relatively low sensitivity. The fact that the fish pass through the Kildonan coil in great "splurges" after coming from the weighing machine rather than going through in a continuous stream, as occurs in other installations where the weighing machine is situated beyond the coil, probably had some bearing on the low efficiency of the set. The third detector (similar to the one used at Kildonan) was operated at Nootka, and although it recovered some tags it gave generally unsatisfactory results because of the development of a "short" in the "pick-up" coil. Its estimated efficiency was on the average similar to that of the Kildonan set (53%). Consideration is being given to devising methods of improving the Kildonan installation; the Nootka detector has been returned to the manufacturers for complete overhaul.

A record total of 562 tags were recovered by tag detectors in the 1947-48 season, of which 420 were taken by the Steveston detector, 127 by the Kildonan detector, and 15 by the Nootka detector. Of these recoveries 368 were from catches made on the west coast of Vancouver island, 131 from catches made along the lower east coast of Vancouver island and 63 from catches in other areas. Knowing the percentage of the catch searched for tags by the detectors and the efficiency of the tag detectors, the probable number of tags in the catches may be calculated. The following tabulation gives the probable number of tags in the lower east coast and the west coast sub-district catches according to area of tagging.

	Area of Recovery		
Area of tagging	West coast	Lower east coast	Totals
West coast	2,598	159	2,757
Lower east coast	8	267	275
Totals	2,606	426	3,032

The mixture of fish between the two sub-districts was relatively small; 5.8% ($\frac{159}{2,757}$) of the west coast tag recoveries were from the lower east coast catches, and 2.9% ($\frac{8}{275}$) of the lower east coast tag recoveries were

from the west coast catches. Thus in 1947-48 emigration of fish from the west coast was greater than immigration to the west coast. This differed from results of the previous year which showed that immigration to the west coast was greater than emigration from the area.

As in previous years considerable mixture between west coast areas was noted. The dispersal of fish which were at liberty almost two years was found to be considerably greater than those which were tagged in the spring immediately prior to recapture, (63% and 30% respectively). There seemed to be a greater tendency for fish to move in a south-easterly rather than a north-westerly direction, a situation similar to that found in 1946-47.

Magnet Returns

A total of 1,662 decipherable tags were recovered by plant crews from 14 reduction plants, of which 1,426 were originally used on the west coast of Vancouver island and 236 used in other sub-districts. A large proportion (98%) of the tags originally used on the west coast was interpreted as coming from west coast catches, the remainder coming principally from the lower east coast catches (Note: Interpretation of the origin of many of the latter tags was difficult since the processing plants, other than those on the west coast, operated on fish from several sub-districts). Ten tags recovered from west coast catches were inserted in sub-districts other than the west coast (6 were inserted on the lower east coast, 1 in the upper east coast, and 3 in the central sub-district); tags used in sub-districts other than the west coast and not taken from west coast catches totalled 226. In tabular form these data can be represented as follows:

	Area of recovery		
Area of tagging	West Coast	Other sub-districts	Totals
West coast	1,400	26	1,426
Other sub-districts	10	226	236
Totals	1,410	252	1,662

These results (as those of 1946-47) support the results obtained from analysis of detector returns in showing that the west coast population is essentially discrete.

The probable total number of west coast tags in the catches is calculated on the basis of magnet recoveries as well as on the basis of tag detector returns. From data obtained by the former calculations it was shown that the small fishery which developed in Trevor channel (Area 23) had not mixed uniformly with the general run to the area. Age composition and growth studies have also suggested in this and in previous years that the Trevor channel-Banfield inlet group of fish tends to be unique.

One tag inserted in Area 23 and recovered in the fall of 1947 off the Washington coast indicated that some west coast herring wander southward to offshore feeding grounds.

J. C. Stevenson and J. A. Lanigan Appendix No. 70

Discussion of Tag Recoveries in 1946-47 and 1947-48

A similar probable total number of tags in the west coast catches was calculated on the basis of magnet returns as obtained on the basis of tag detector recoveries, pointing to a general reliability of the data from both sources. In 1947-48 the probable total numbers as calculated from detector recoveries was less than those calculated from magnet recoveries, partly because the latter method of recovery sampled the catches from the northern areas of the west coast for tags more completely than the former method.

From these data the rate of exploitation in 1947-48 can be estimated at about 2.7 times that in 1946-47. Fishing effort was greater in 1947-48 than in the previous year. Since Ricker has shown that increased fishing effort produces a less than proportional increase in rate of exploitation with uniform recruitment, these data suggest that decreased recruitment on the west coast caused a decrease in the abundance of the fishable stock. The decrease in abundance on the west coast was indicated by reduced availability in 1947-48 as compared with that of 1946-47 (48 tons/seine/day as compared to 76 tons/seine/day). The decreased recruitment in 1947-48 was due to a relatively less abundant year class (that of 1945) entering the fishery as III year fish.

From 1946-47 to 1947-48 the rate of decrease in west coast population abundance is estimated at 0.70, but considering the increase in rate of exploitation this figure is considered somewhat low.

Tag recoveries again indicated that although there was some intermixture between the herring of the lower east coast (Areas 14B, 17 and 18) and those of the northern part of the strait of Georgia and Discovery passage (Areas 13, 14A, 15 and 16) they should be considered as two separate populations. The probable number of tags in the catches according to areas of tagging and areas of recapture are given below (as based on detector returns):

	Areas of recapture		
Areas of tagging	13 and 14A	14B, 17 and 18	Total
13, 14A, 15, 16	396	96	492
14B, 17, 18	33	267	300

The tendency for the fish to return to the region in which they were tagged was $\frac{396}{492}$ or 80% for the population in the northern part of the strait of Georgia and Discovery passage, and $\frac{267}{300}$ or 89% for the lower east population.

Possible differences in the relative recovery of tags inserted by different taggers were given some attention. Usually two taggers (one more experienced and one less experienced) tagged at the same time in the same spawning locality. Comparisons were made of the relative recovery of tags from each of the pair of taggers, and although the returns from taggings made by the experienced tagger were generally better than the returns from the taggings made by the less experienced man, these differences were not found to be statistically significant. It can be concluded that differences in tagging efficiency between taggers do not have to be considered in interpreting the tagging recovery data.

J. C. Stevenson and J. A. Lanigan Appendix No. 71

Efficiency tests on Magnets in Reduction Plants

Magnets, placed in the meal line of reduction plants, are used to recover herring tags, but the efficiency of recovery varies from plant to plant and from one season to the next. In the analysis of magnet recoveries it is necessary to know this efficiency ("magnet" efficiency) and the time it takes for tags to pass through the machinery and reach the magnets (time lag). Magnet efficiency is dependent on both the nature of the magnet installations, the conscientiousness of the plant crews in searching the magnet and other plant machinery for tags, and the accuracy of the data sent in by plant crews with recovered tags. It is used in calculating the probable total number of tags in the catches. The "time lag" is important in interpreting the probable place of capture of the fish originally bearing the tag. The latter is particularly important when plants are running on fish caught in several different localities.

To obtain this information, efficiency tests were conducted again on six west coast of Vancouver island plants during 1947-48. Each test (two per plant) consisted of placing tags in approximately fifty fish and scattering them in the bins. The tags were later recovered from the magnets and other plant machinery by plant crews in the same manner that the bona-fide tags were recovered. A reward of 25 cents was paid for test tags and 50 cents for bona-fide tags.

In 1947-48 great variation was again noted in magnet efficiency and time lag. All except two plants showed an increased efficiency over the previous year and the average efficiency of the plants increased from 63.6% to 73.5%, due chiefly to the increased interest among the plant crews. In most of the plants the majority of tags was recovered within five days of plant operation after the test. Those not recovered in the fall clean-up probably will be recovered during the 1948-49 season. The following table shows the results of tests conducted in the six west coast plants (each plant was given two tests):

Area	Plant	No. of tags used	No. recovered (days after test) 0-5	6-10	11-20	21-30	?	Total Recovery	% Recovery 1947-1948	1946-1947
23	Kildonan	100	63	8	12	0	-	83	83.0	73.8
	Ecoole	98	5	10	-	-	61	76	77.6	32.9
	Port Albion	98	89	3	0	0	-	92	93.9	90.0
25	Nootka	95	52	3	0	0	-	55	57.9	77.1
	Ceepeecee	97	69	3	3	1	-	76	76.0	50.5
	Hecate	100	38	0	13	0	-	51	52.6	56.0
								Average	73.5	63.6

In general the data submitted by the plants with the tags were satisfactory. However, the tag recovery information (with reference to both test tags and bona-fide tags) supplied by the Ecoole plant was mostly incomplete and unreliable. Partly due to the inaccuracy of the data accompanying the tags and partly due to the great time-lag in the Ecoole plant, a

J. C. Stevenson and J. A. Lanigan Appendix No. 71

large number of 1946-47 test tags (and presumably bona-fide tags also) were recovered during the 1947-48 season. Out of 25 such "hangovers" returned by west coast plants, 21 were from Ecoole. Thus it was found necessary to exclude this plant from the analysis of the 1947-48 magnet returns. It is hoped to improve the accuracy of the tag information from Ecoole in the coming season.

Two types of magnets are in current use in the reduction plants, D. C. Electro-magnets and Bepco permanent magnets. Three magnets of the latter type have been purchased in 1948 for installation in reduction plants located in the Vancouver vicinity.

J. C. Stevenson and J. A. Lanigan Appendix No. 72

Herring Tagging during the Spring of 1948

The herring tagging program carried out in the strait of Georgia and along the west coast of Vancouver island during the 1948 spawning season was highly successful, resulting in the tagging of 45,577 fish, as compared to a total of 41,551 in the previous year.

Three boats were used during the tagging season. The "Pacific Sunset" operated in the strait of Georgia from March 1 to March 25 and on the west coast of Vancouver island from March 16 to March 26. The other two boats were devoted exclusively to west coast of Vancouver island work, the "Great Northern No. 3" from March 3 to March 29 and the "B. C. Pride" from February 16 to March 24.

The following are a list of taggings made during the 1948 spawning season:

Sub-district	Area	Place	No.
Lower east coast of Vancouver island	14A	Baynes sound, Mud bay	2,514
	14B	Departure bay, Newcastle island	1,513
	14B	Departure bay, Horsewell point	2,028
	14B	Hammond bay	2,538
	15	Malaspina strait, Sliammon	1,988
	17	Ladysmith harbour, Coffin point	3,049
West coast of Vancouver island	23	Banfield inlet	1,511
	23	Macoah passage	1,053
	23	Macoah passage	2,082
	23	Macoah passage	2,025
	23	Toquart bay	2,548
	24	Herbert inlet, Whitepine cove	3,063
	24	Refuge cove	2,516
	25	Ewin inlet	1,986
	25	Kendrick inlet, Lagoon at head	2,019
	25	Kendrick inlet, Lagoon at head	1,503
	25	Esperanza inlet, Gillam channel	1,985
	25	Queen cove	1,524

J. C. Stevenson and J. A. Lanigan — Appendix No. 72

West coast of Vancouver island (cont'd)	26	Union island, Kyuquot channel	2,043
	26	Malksope inlet	1,515
	27	Klaskish inlet	1,381
	27	Forward inlet, Mathews island	3,193
			45,577

A total of 4,502 fish were tagged in the northern part of the strait of Georgia (Areas 14A and 15), 9,128 in the southern part of the strait of Georgia (Areas 14B and 17), and 31,947 on the west coast of Vancouver island (Areas 23 to 27). West coast tagging was particularly satisfactory, taggings being made in every area: 9,219 fish were tagged in Area 23, 5,579 in Area 24, 9,017 in Area 25, 3,558 in Area 26, and 4,574 in Area 27. Tagging in Area 27 was conducted for the first time since 1941 in the vicinity of Forward inlet, and for the first time on record in Klaskish inlet.

The tags used during the 1948 spawning season, along with those of previous years, will be liable for recovery during the 1948-49 fishing season.

Of considerable interest during the 1948 tagging operations was the fact that herring in the strait of Georgia seemed unusually sluggish and much less vigorous than those on the west coast. A report received from the fishery officer in the Pender harbour area (Area 15) stated that gulls were observed offshore picking herring out of the water after spawning was completed. This suggests that during 1948 the herring in the strait of Georgia might have suffered a greater-than-average mortality, which should be apparent in in the analysis of the 1948-49 tag recovery.

J. C. Stevenson and J. A. Lanigan — Appendix No. 73

Examination of Tagged Fish Recovered by Detectors

Each tagged herring recovered by tag detectors is subjected to careful examination in order to procure the tag, to determine its position in the body, and to note the condition of the tagging wound. In addition the length, weight and sex are determined, and several scales from each fish are taken to ascertain the age. It has not yet been possible to analyse completely these data accumulated since 1942-43. It is expected that valuable information on the amount of recruitment of a year-class to the fishery will be obtained by a study of the age and growth data.

However, certain data from tagged fish recoveries were given some attention and reported in Appendix No. 91 of the 1947 Annual Report. Comparable data obtained in 1947-48 have also been studied. All fish tagged in the spring and retaken during the following winter fishery showed completely healed wounds, with a scar on the inside of the body wall being the only visible evidence of the tagging incision. Usually the tags were found lying loose in the body cavity or attached to the mesenteries of the stomach, intestines or gonads by scar tissue. However, in certain cases tags were noted embedded in the gonads.

It was calculated that from 1942-43 to 1946-47 the recovered tagged fish with tags embedded in the gonads amounted to 13% of all detector recoveries (data presented in last year's Annual Report). On the basis of know-

J. C. Stevenson and J. A. Lanigan Appendix No. 73

ledge of tagging operations, this percentage was considered too low; since tagging of ripe fish frequently occurs and since it is very difficult to tag ripe fish without puncturing the gonad, the percentage of fish tagged in which the gonad is punctured by the tag would be expected to be considerably greater than 13%. Thus it appears extremely likely that mortality of fish caused by puncturing the gonad is exceptionally high, resulting in relatively few survivals and, hence, few recoveries.

In 1947-48 the percentage of recovered fish in which the tags were embedded was unusually low as compared to that of most previous years (e.g. 9.8% as compared to 15.7% in 1946-47). There are several possible explanations for this difference, among which are: (1) A smaller proportion of ripe fish might have been tagged in the 1947 tagging operations than in those of 1946; (2) since more inexperienced taggers were used in 1947 than in 1946, more ripe fish might have had their gonads punctured by the tag in 1947 than in the previous year; and (3) although it seems somewhat unlikely it is nevertheless possible that tag detector operators were on an average less careful in 1947-48 than in 1946-47 in noting the position of the tag in the body cavity.

As in past years more tagged males were recovered in 1947-48 than tagged females (373:186). Since the sexes appear to be present in approximately equal numbers (on the basis of the sampling of the spawning runs) this suggests that males survive the tagging operations more successfully than females. In 1947-48 this tendency for a greater number of males than females in the recoveries was accentuated, the rates being about two males to one female (the rates were about 4:3 in the 1946-47 season).

J. C. Stevenson and R. S. Isaacson Appendix No. 74

Mortality in Tagged Herring

For several years experiments have been conducted during the winter and early spring to determine the nature and the extent of the mortality due to tagging. Data of this type are essential in studying rates of recruitment and mortality in herring populations and in making calculations of abundance. The most successful experiments resulted in showing a tagging mortality of 50 to 60%.

Two concrete tanks were used to impound the fish, instead of one tank divided across the middle by fish net as used in past experiments. The volume of water in both tanks was approximately the same, although one tank was shallower and longer than the other. The walls of Tank B had been painted with a black sealing compound and it appeared that during the night the fish had difficulty in seeing the walls, consequently damaging themselves about the jaws. An electric light was placed in the tank at the end of the first week of the experiment and it seemed to relieve the condition to some extent. Partial changes of the water in each tank were made during each twenty-four hour period.

The herring were caught on March 9, while spawning at Horswell point. On March 13, three taggers each tagged 100 fish into each tank (total of 600 fish). In addition, 200 fish were tagged after the tags were immersed in 3% phenol solution, half of them being released in each of the tanks. This was done to determine whether or not sterilizing the tags before use would reduce

J. C. Stevenson and R. S. Isaacson — Appendix No. 74

the chances of infection and promote more rapid healing of the wound. One hundred controls were placed in each tank. The experiment was continued for about eight weeks throughout which time daily inspections of the tanks were made and the dead fish removed and examined.

The data obtained from the 1948 experiment have not as yet been completely analyzed. A preliminary study of the results showed no appreciable difference in mortality among the fish tagged by the three taggers or between the two tanks. In the first five weeks of the experiment the mortality was relatively greater in the fish tagged with the unsterilized tags than in either the controls or the fish tagged with the sterilized tags. The latter two groups showed a remarkably similar mortality during this period. By the end of the fifth week the mortality of the fish with unsterilized tags decreased, but not until the end of the sixth week did the mortality decrease in the other two groups.

The mortality of fish with sterilized tags surpassed the mortality of the controls only in the sixth and seventh week of the experiment. It appears that the sterilizing of the tags resulted in greater survival during the first few critical weeks following tagging. However, in the last two weeks of the experiment, when unsterilized tagged fish and controls showed similar mortalities, a relatively greater mortality occurred in the fish with sterilized tags. No explanation for this can be offered at the present time. By the end of the experiment about the same percentage of sterilized and non-sterilized tagged fish remained (about 10%).

The weekly percentage mortality of the fish in both tanks (all taggers combined) is given in the following tabulation:

Week No.	Unsterilized Tags	Sterilized Tags	Controls
1	6.3	5.0	3.5
2	7.3	2.6	3.6
3	13.0	5.4	4.3
4	27.8	14.9	14.6
5	53.2	44.3	41.4
6	41.8	61.4	44.9
7	16.9	34.4	10.2

Examination of the condition of the tagging wound of the fish that died showed that a greater percentage of fish with sterilized tags had non-infected or healed wounds than was the case with fish which had the unsterilized tags. Almost 16% of the latter had enlarged and apparently infected wounds, whereas the former in such a condition amounted to slightly less than 4%.

J. C. Stevenson — Appendix No. 75

The Sampling of Herring in the 1947-48 Season

The principal purpose of sampling the catches and spawning runs is to study the fluctuations in the abundance of the successive year-classes and their influence on the catch. Data are obtained on age composition, sex ratio and development, length and weight at each age, etc.

J. C. Stevenson Appendix No. 75

During the 1947-48 season a total of 383 samples comprising 37,631 fish was examined, of which 361 samples were from the commercial catches and 22 samples from the spawning runs. This represented a record sampling programme. About 85% more samples were taken from the catches than in the previous year, due partly to an increase in intensity of the sampling from the west coast catches, and partly to the fact that the largest total catch in the history of the B. C. herring fishery was taken in the past season. Each sample consists of 100 randomly chosen fish.

The distribution of the samples was as follows (numbers of fish in brackets):

Sub-districts and Areas		Fishing Samples		Spawning Samples	
Northern Sub-district		48	(4721)	---	
Area 5	Ogden Channel	48	(4721)	---	
Central Sub-district		46	(4462)	---	
Area 6	Aaltanhash inlet	2	(200)	---	
	Klemtu pass vicinity	6	(590)	---	
	Hd. of Gardner canal	1	(100)	---	
	Poison cove vicinity	5	(500)	---	
Area 7	Cultus sound vicinity	9	(850)	---	
	Raymond channel	3	(300)	---	
	Safety cove	2	(190)	---	
Area 8	Kemsquit	5	(447)	---	
	South Bentinck arm	4	(400)	---	
Area 9	Rivers inlet	1	(100)	---	
	Moses inlet	5	(500)	---	
	Drainey inlet	3	(285)	---	
Upper East Coast of V. I. Sub-district		37	(3700)	---	
Area 12	Kingcome inlet	2	(200)	---	
	Mackenzie sound	2	(200)	---	
	Belleisle sound	10	(1000)	---	
	Retreat pass	1	(100)	---	
	Bones bay	15	(1500)	---	
	Knight inlet	7	(700)	---	
Discovery Passage Sub-district		19	(1833)	1	(100)
Area 13	Deepwater bay	19	(1833)		
	Quartz bay	-	---	1	(100)
Lower East Coast of V. I. Sub-district		94	(9091)	5	(500)
Area 14A	Baynes sound	22	(1935)	1	(100)
Area 14B	Nanoose bay	27	(2670)	---	
	Departure bay vicinity	-	---	3	(300)
Area 17	Porlier pass	11	(1094)	---	
	Walker Rock vicinity	2	(200)	---	
	Ladysmith harbour	-	---	1	(100)
Area 18	Swanson channel vicinity	32	(3192)	---	

J. C. Stevenson — Appendix No. 75

West Coast of V. I. Sub-district		117	(11634)	16	(1590)
Area 23	Middle channel vicinity	6	(560)	---	
	Effingham inlet	19	(1900)	---	
	Florencia island	14	(1391)	---	
	Toquart bay vicinity	6	(600)	2	(200)
	Sechart channel vicinity	12	(1194)	---	
	Banfield inlet	1	(100)	1	(100)
	Uchucklesit inlet	3	(300)	---	
	Macoah pass	-	---	3	(300)
Area 24	Refuge cove	-	---	1	(100)
	Whitepine cove	-	---	1	(100)
Area 25	Tahsis inlet	13	(1300)	---	
	Queen cove vicinity	8	(800)	1	(100)
	Maquinna point vicinity	7	(700)	---	
	Nootka sound vicinity	16	(1600)	3	(300)
	Esperanza inlet	1	(100)	1	(100)
Area 26	Kyuquot sound vicinity	11	(1089)	1	(100)
	Malksope inlet	-	---	1	(90)
Area 27	Forward inlet	-	---	1	(100)

The samples from the catches in the southern part of the province were procured by members of the investigation directly from packers at various canneries and reduction plants (Steveston, Kildonan, and Nootka), and worked over on-the-spot or transported to the Biological Station for examination. Samples from catches on the upper east coast of Vancouver island and from catches in the central and the northern areas of the coast were taken mostly by arrangement with members of plant crews, and shipped to the Biological Station in either a frozen or salted condition. The plant workers were paid $1.00 per sample for their assistance.

Virtually all members of the herring staff assisted at one time or another in working over the samples and in compiling the vast amount of data. Mr. J. H. Glover and Mr. J. A. Lanigan were responsible for the age determinations.

The results are given in the following appendices according to sub-district.

J. C. Stevenson and J. H. Glover — Appendix No. 76

Age and Growth of Herring on the West Coast of Vancouver Island, 1947-48

The average percentage age composition of the sub-district catches for 1946-47 and 1947-48 (weighted to the number of fish caught in each area) and also that of the catch from each individual area in 1947-48 are given in the following table:

Sub-district Av.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1946-47	+	5.0	53.0	32.1	6.0	2.5	0.9	0.5	0.1	+	-
1947-48	+	2.4	58.2	27.8	8.5	2.1	0.5	0.3	0.1	+	+
Area 23 - 1947-48	+	3.6	61.6	25.0	8.0	1.4	0.2	0.1	+	-	-
Area 25 - 1947-48	-	1.0	55.5	30.4	8.6	2.8	1.0	0.5	0.2	+	+
Area 26 - 1947-48	-	0.1	36.9	40.9	15.2	5.2	1.1	0.3	0.3	-	-

J. C. Stevenson and J. H. Glover Appendix No. 76

The sampling of the west coast catches in 1947-48 showed the 1945 year-class (as III's) to be the greatest contribution to the fishery, producing more than half of the fish caught. This was similar to the situation in the previous season when the 1944 year-class (III's) constituted about the same percentage of the catch. However, it has been calculated that the 1945 year-class contributed a smaller actual number of fish to the fishery this year than the 1944 year-class did in the previous year (240.2 million fish as compared to 284.1 million). This, plus the fact that a greater fishing effort was expended in making the 1947-48 catch, in spite of its being smaller than the catch in 1946-47 (45,200 tons as compared to 59,000 tons), indicate that the 1945 year-class was relatively poorer than that of 1944. Tag recovery data also support this conclusion (cf. Appendix on tag recovery in 1947-48 appearing earlier in the report). This method of determining year-class strength is based on evidence that herring in southern British Columbia enter the fishery in greatest abundance as III year fish.

Ability to assess year-class strength before the year-class enters the fishery is an aim of herring research. At present the main source of information relating to the prospects for new year-classes lies in the abundance of II's in the catches. Accuracy of prediction depends on several assumptions about many of which knowledge is very incomplete. Included among these assumptions are (1) that a more or less constant proportion of each year-class joins the main population as II year fish, (2) that the fish available to the fishermen form a more or less constant proportion of the whole population, (3) that the fish which join the main population at age II are more or less uniformly distributed throughout the population, etc. On this basis the relative strengths of the 1943, 1944 and 1945 year-classes on the west coast were predicted with considerable accuracy. The occurrence of II's in the west coast catches of 1947-48 (they formed a much smaller percentage of the catch than they have in any season since 1941-42) points to the possibility that the 1946 year-class will be poorer than that of 1945. This in turn suggests that the 1948-49 west coast catch might be less than the catch in 1947-48. However, the year-class (as II's) appeared more strongly in the spawning runs than in the preceding commercial runs and thus it is probable that the new recruits were later than usual in joining the main population.

Relatively large numbers of immature fish of age I were found in Effingham inlet (Area 23) and in Tahsis inlet (Area 25) in 1947-48. The significance of the appearance of these small herring on the fishing grounds is not known. It will be enlightening to find out if this occurrence was an indication of the strength of the 1947 year-class.

The tendency for older fish to be relatively more numerous in the more northerly west coast areas was again noted in the past season, the average ages according to area being 3.41 (Area 23), 3.63 (Area 25), and 3.91 (Area 26). In Area 23 the 1945 year-class (III's) was more prominent than in any other area, while in Area 26 the 1944 year-class dominated the catches. The latter situation might possibly be related to the fact that no fishery developed in the area in 1946-47.

The average growth in length and in weight for the 1947-48 season was comparable to that of the 1946-47 season suggesting that spring and summer feeding conditions for the west coast population were similar in the two years.

J. C. Stevenson and J. H. Glover — Appendix No. 76

The average growth in length and weight of herring in the west coast catches for 1946-47 and 1947-48 is given below:

Year	I	II	III	IV	V	VI	VII	VIII	IX	X
Average Length										
1946-47	-	166	187	203	213	222	228	233	235	-
1947-48	-	161	188	201	210	220	226	233	236	-
Average Weight										
1946-47	-	57	86	113	133	151	170	183	177	-
1947-48	-	53	90	110	129	150	164	179	185	-

Growth in length and in weight tended to be slightly less in Area 23 than in Areas 25 and 26 in the 1947-48 fishery.

J. C. Stevenson and J. H. Glover — Appendix No. 77

Age and Growth of Herring on the Lower East Coast of Vancouver Island Sub-district, 1947-48

The age composition of the lower east coast catches of the 1947-48 fishery was generally similar to that of the 1946-47 fishery. The 1945 year-class (III's) constituted about one-half of the fishery in the past season while the 1944 year-class (IV's) came next in importance. The 1943 year-class, one of the strongest year-classes of the past 25 years, formed about three-quarters of the 1945-46 fishery as III's, showed up prominently in the 1946-47 fishery as IV's, and once again as V's it appeared in relatively large numbers in 1947-48, following the pattern of an exceptionally abundant year-class. In the past season this year-class appeared more strikingly in Area 18 (Swanson channel) than in any of the other areas of the sub-district.

The percentage age composition of the sub-district is given below for 1945-46, 1946-47 and 1947-48, as well as that of the constituent areas in the 1947-48 season:

Sub-district Av.	I	II	III	IV	V	VI	VII	VIII	IX
1945-46	0.2	7.7	76.0	14.5	1.3	0.2	0.1	-	
1946-47	2.0	7.0	47.9	36.0	6.0	0.8	0.1	0.1	+
1947-48	0.6	2.2	49.9	32.8	11.5	2.6	0.4	0.1	-
Area 14B, 1947-48	0.8	3.7	43.7	37.8	10.6	2.8	0.4	0.1	-
Area 17, 1947-48	0.1	2.2	52.9	32.4	9.7	2.3	0.2	0.1	-
Area 18, 1947-48	0.5	0.8	54.0	28.6	13.0	2.4	0.6	0.1	-

In Area 14B the 1944 year-class (IV's) dominated the catch in about one-third of the samples, in Area 17 it occurred most predominantly in only one-sixth of the samples, while in Area 18 the year-class reached dominance in no samples from the catch. This tendency for the 1944 year-class to appear relatively more abundant in the more northerly areas of the sub-district was also noted in the west coast sub-district.

J. C. Stevenson and J. H. Glover Appendix No. 77

It was pointed out in the preceding Appendix that the II year fish formed a relatively small proportion of the 1947-48 catches on the west coast, suggesting that the 1946 year-class would be poorer than average when it entered the fishery in force in the 1948-49 season (as III's). Likewise the II's entered the lower east coast catches in unusually small numbers in the past season. In the most northerly area of the latter sub-district (Area 14B) II's were more abundant than in the areas to the south, whereas on the west coast II's were more abundant in the most southern area (Area 23). The former point has been noted in past years and discussed in previous annual reports.

No appreciable difference in the growth (in length and weight) of fish from the lower east coast was found between the 1946-47 and the 1947-48 catches; suggesting that spring and summer feeding conditions were similar in the two years. A comparison of the growth in length and in weight in the last three seasons on the lower east coast is given in the following tabulation:

Year	I	II	III	IV	V	VI	VII	VIII	IX
Average Length (mm.)									
1945-46	101	162	192	203	213	217	220	-	-
1946-47	97	160	188	202	212	218	225	221	224
1947-48	104	153	192	204	212	220	226	226	-
Average Weight (gms.)									
1945-46	10	56	99	118	139	156	150	-	-
1946-47	11	54	91	114	139	154	200	-	-
1947-48	11	45	95	115	131	142	160	162	-

The growth in length and in weight was slightly less in Area 17 than in the other lower east coast areas. On the whole the growth in length and in weight was generally similar in the west coast and the lower east coast sub-districts.

In 1947-48, Area 14A again supported a fishery (Baynes sound). As in past years the age composition of the catch differed considerably from that of the lower east coast population. Tagging data have shown that herring in the northern part of the strait of Georgia (including Areas 14A, 15 and 16) are part of the population which contributed to the Deepwater bay fishery (see following Appendix). For these reasons a middle east coast sub-district, including the northern part of the strait of Georgia and the Discovery passage sub-district, will be officially recognized in the coming season, and future reports will deal with these fisheries as a separate entity.

Fish of age IV (1944 year-class) dominated the Area 14A catches in 1947-48, but to a lesser degree than IV's (1943 year-class) in the previous year. There was a considerable relative reduction in the percentage of II year fish in the past season, suggesting (as in the lower east coast and west coast sub-districts) that the 1946 year-class was of less than average strength. The fact that fish of age VI and older were relatively more prominent in the 1947-48 catches than in those of 1946-47 cannot at present be adequately explained.

J. C. Stevenson and J. H. Glover — Appendix No. 77

The percentage age composition of samples from the 14A catches in the two years is as follows:

	I	II	III	IV	V	VI	VII	VIII+
1946-47	0.5	3.7	23.3	46.6	21.6	4.0	.03	-
1947-48	-	0.7	25.4	35.9	22.8	12.3	2.6	0.3

The growth index (sum of the average lengths of the III and IV-year fish in millimeters) indicated no noticeable difference in growth in the two years (394 for each season).

J. C. Stevenson and J. A. Lanigan — Appendix No. 78

Age and Growth in the Discovery Passage Sub-district, 1947-48

In 1942 year-class (relatively poor in the west coast and lower east coast sub-districts) entered the Discovery passage fishery as an exceptionally good year-class, considerably better than that of 1943 which contributed heavily to the other populations of southern B. C. The 1942 year-class dominated the Discovery passage catches as II's in 1943-44, as III's in 1944-45, as IV's in 1945-46, and it made a greater than usual contribution, as V's, to the catch in 1946-47. However, by 1947-48 its influence on the fishery had subsided, and the 1945 year-class (as III's) formed the bulk of the catch. It appears the 1945 and 1946 year classes will sustain the fishery in the 1948-49 season, unless the 1947 year-class (as II's) makes a greater than average contribution.

The 1945 year-class (III's) appeared more prominently than the 1944 year-class (IV's) in the catches of the Discovery passage area, whereas the catches in the northern part of the strait of Georgia showed the 1944 year-class to be better represented. These two groups of herring (embracing Areas 13, 14A, 15 and 16), as pointed out in a previous Appendix, are considered to belong to the same population, which in future seasons will be called the middle east coast of Vancouver island population. Variable but limited intermingling takes place between this population and those of the upper east coast and the lower east coast.

The percentage age compositions of the Discovery passage catches in the past three years are given in the following tabulation:

	I	II	III	IV	V	VI	VII	VIII	IX	X
1945-46	-	0.9	44.1	46.4	5.0	2.3	0.8	0.2	0.1	0.1
1946-47	3.8	20.0	33.1	25.5	14.5	2.1	0.7	0.3	-	-
1947-48	0.4	22.4	43.7	23.6	7.0	2.3	0.6	0.05	-	-

In general the growth index of the Discovery passage fish in 1947-48 was less than that of the fish from the northern part of the strait of Georgia (370 and 394, respectively).

J. C. Stevenson and J. A. Lanigan Appendix No. 79

Age and Growth in the Upper East Coast of Vancouver Island Sub-district, 1947-48

Five sub-areas of Area 12 were fished in the 1947-48 season: 12A (Mackenzie sound), 12B (Belleisle sound), 12D (Retreat passage), 12E (Clio channel), and 12F (Upper Knight inlet). As in past years considerable variation in age composition was apparent in the different fisheries.

The percentage age composition of the catches from the sub-areas are given below, with comparative data from the 1946-47 season:

	I	II	III	IV	V	VI	VII	VIII	IX+
12A									
1946-47	-	46.0	34.5	8.0	3.0	0.5	2.0	1.5	4.5
1947-48	-	6.4	18.0	33.8	13.3	9.7	6.0	5.8	6.9
12B									
1946-47	1.0	38.7	55.3	4.0	0.7	0.3	-	-	-
1947-48	1.0	34.9	32.4	27.4	2.8	1.2	0.1	-	0.1
12D									
1947-48	-	-	10.6	54.3	19.2	7.5	6.4	2.1	-
12E									
1946-47	0.2	17.8	33.4	16.0	18.0	10.2	2.2	1.0	1.0
1947-48	7.7	45.9	21.1	17.7	2.7	2.5	1.7	0.4	0.2
12F									
1946-47	-	24.5	74.5	0.5	-	-	0.5	-	-
1947-48	-	49.7	19.6	26.2	2.2	1.6	0.1	-	0.6

The age composition of the catches from Areas 12A and 12D were similar, with IV's (1944 year-class) the dominant age group. In the other localities (12B, 12E, and 12F), fish of age II (1946 year-class) dominated the catches in 1947-48; in the previous year the 1944 year-class (III's) was the greatest contributor. There appears to be a tendency in many of the Area 12 fisheries for the even-numbered year classes to be better than the odd-numbered. This is very striking in Area 12F where, without exception, every second year-class (those of 1940, 1942, 1944, and 1946) has risen to dominance as II's in one year and as III's in the next.

The highly variable nature of the age composition in the different localities of the upper east coast sub-district appears to be due mainly to the presence of several different inshore populations which at some time during the year intermingle in varying degrees. Samples from Area 12E, where the most important fishery takes place, usually show wide differences in age composition from one day's catch to the next.

As in age composition, growth in length varies greatly from one sub-area to another, and also from year to year. In 1947-48 growth indices were greater than in 1946-47 in Areas 12A and 12B and smaller in Areas 12E and 12F. As noted in certain years prior to 1945-46 fish in Area 12D tended to have a greater growth index than fish in the other localities. In general the growth of herring in the sub-district was much less than that in the other sub-districts of southern B. C.

J. C. Stevenson and J. A. Lanigan — Appendix No. 79

Growth indices are given below for the various sub-areas in the last three years:

	12A	12B	12D	12E	12F
1945-46	341	338	-	369	333
1946-47	305	318	-	360	342
1947-48	329	329	349	342	331

One sample of very slow-growing fish (growth index, 271) was obtained from Area 11 in 1947-48. The 1945 and 1946 year-classes (III's and II's, respectively) formed over 90% of the sample. The percentage age composition was as follows:

II	III	IV	V
42.6	48.9	5.3	3.2

J. C. Stevenson and J. A. Lanigan — Appendix No. 80

Age and Growth of Herring in the Central Sub-district, 1947-48

Herring catches in the central sub-district were made in the following areas: Area 6 (Kaltanhash, Gardner channel, Meyers pass, David bay, Poison cove, and Klemtu), Area 7 (Bardswell group), Area 8 (Kimsquit), and Area 9 (Rivers inlet). In Area 6 the III's (1945 year-class) dominated but in all the other areas, IV's were most abundant.

The following tabulation gives the average percentage age compositions of the 1946-47 and 1947-48 fisheries in the central sub-district (Note - Group 1 of Area 6 refers to samples from the main offshore population, whereas group 2 refers to the local inshore runs):

Area 6	I	II	III	IV	V	VI	VII	VIII	IX	X
1946-47 (1)	-	62.8	28.8	3.7	3.7	-	1.0	-	-	-
(2)	-	0.7	54.2	19.8	12.7	9.8	2.7	0.1	-	-
1947-48 (2)	1.0	26.7	52.5	15.1	2.2	1.8	0.6	0.1	-	-
Area 7										
1946-47	-	0.6	64.0	19.7	9.5	4.1	1.5	0.6	0.1	-
1947-48	-	0.1	12.5	70.1	11.2	3.4	0.8	0.9	0.9	0.2
Area 8										
1947-48	-	6.4	24.5	53.5	7.6	3.2	4.0	0.6	0.1	0.1
Area 9										
1947-48	0.2	18.6	28.2	43.5	6.0	2.1	1.0	0.3	-	-

The fishery in Area 6 in 1947-48 exploited only the local inshore runs; the main north central population was not fished, presumably because it did not arrive on the fishing grounds until after the close of the season. In both years III-year fish dominated the inshore runs.

J. C. Stevenson and J. A. Lanigan — Appendix No. 80

The age composition of the large Area 7 catch (from the main south central population) showed a follow-through of the strong 1944 year-class, which in both the 1947-48 and the previous seasons (as III's and IV's respectively) dominated the catches.

Fish of this year-class made up the largest proportion of the catches from the local inshore populations in Areas 7 and 8.

Growth indices according to area in the 1947-48 season are as follows: Area 6, 332; Area 7, 369; Area 8, 296; Area 9, 315. The greater growth exhibited by the Area 7 fish is in keeping with the fact that fish of the main offshore populations grow more rapidly than those belonging to inshore populations.

J. C. Stevenson and J. A. Lanigan — Appendix No. 81

Age and Growth in the Northern Sub-district, 1947-48

Since the first fishery developed in Area 5 in 1944-45, the catches were presumed, for the time being, to have come from the main north central population. However, the large Ogden channel fishery in the area in 1947-48 strongly indicated that the area should be considered as part of the northern population. The fishery at Ogden channel was larger (39,000 tons) than any fishery which has developed in the northern sub-district in previous years. Since 1941-42 very small catches were made, probably due to the fish arriving on the fishing grounds after the closure date.

The percentage age composition of the catches in Area 5 is given below for the 1946-47 and the 1947-48 seasons:

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1946-47	-	17.3	57.6	11.5	8.9	3.6	1.0	-	-	-	-
1947-48	+	9.8	12.4	58.4	10.2	5.5	3.2	0.6	+	-	+

The 1944 year-class, as III's in 1946-47 and as IV's in 1947-48, constituted the majority of the fish in both seasons. It was pointed out in the previous Appendix that this year-class was also abundant in the south central population.

The large age spread of the fish caught in the past season is probably partly the result of the small catches made in the sub-district in recent years.

The growth index in Area 5 (351) was found to be considerably smaller than that of the south central population (369). Growth in the main offshore B. C. herring populations, decreases toward the north; the north central herring typically exhibit a growth index intermediate between those of the populations referred to above.

Two samples of herring were obtained from Ketchikan, Alaska, in 1947-48. Their percentage age compositions were as follows:

II	III	IV	V	VI	VII	VIII
17.5	30.5	39.5	7.5	4.5	-	1.0

J. C. Stevenson and J. A. Lanigan — Appendix No. 81

The age composition resembles that of the northern sub-district in the dominance of the 1944 year-class (IV's). The 1945 year-class (III's) and the 1946 year-class (II's) however, were better represented in the Alaskan samples. Fewer older fish were found amongst the latter, suggesting the difference in the intensity of the two fisheries. Growth index (359) was higher in the Alaskan fish, but since this figure was based on data from only two samples it might not be reliable.

J. C. Stevenson — Appendix No. 82

The Age and Growth of Herring in the Spawning Runs of 1948

Sampling of the spawning runs in 1948 resulted in the taking of 22 samples, most of which were from the west coast sub-district. The percentage age compositions of the samples, as well as the growth indices, are as follows:

Area	Place	I	II	III	IV	V	VI	VII	VIII	IX	Growth Index
13	Quartz bay	6.1	21.2	45.4	17.2	5.1	4.0	1.0	-	-	373
14A	Baynes sound	-	-	36.7	45.9	11.2	5.1	-	1.0	-	391
14B	Newcastle isl.	-	-	17.5	58.8	19.6	4.1	-	-	-	376
	Hammond bay	-	-	44.3	41.2	10.3	4.1	-	-	-	381
	Departure bay	-	6.0	65.0	27.0	2.0	-	-	-	-	383
17	Ladysmith hbr.	-	9.0	66.0	22.0	2.0	1.0	-	-	-	371
23	Macoah passage	-	3.1	47.9	37.5	10.4	1.0	-	-	-	392
	Macoah passage	-	2.0	61.2	26.5	10.2	-	-	-	-	391
	Macoah passage	-	5.1	59.2	22.4	10.2	3.1	-	-	-	389
	Benfield inlet	-	22.7	37.1	12.4	21.6	5.2	1.0	-	-	389
	Toquart bay	-	21.0	57.0	21.0	1.0	-	-	-	-	391
	Toquart bay	-	8.2	71.4	17.4	3.1	-	-	-	-	381
24	Refuge cove	-	10.2	61.2	23.5	4.1	1.0	-	-	-	383
	Whitepine cove	-	32.0	40.0	25.0	3.0	-	-	-	-	368
25	Gillam channel	-	-	44.4	36.4	10.1	5.1	3.0	1.0	-	393
	Kendrick inlet	-	13.5	55.2	27.1	1.0	2.1	1.0	-	-	379
	Kendrick inlet	-	9.1	57.6	20.2	5.1	4.0	1.0	2.0	1.0	385
	Queen cove	-	2.1	42.7	49.0	4.2	2.1	-	-	-	391
	Ewin inlet	-	19.4	63.3	14.3	3.1	-	-	-	-	389
26	Kyuquot inlet	-	6.2	34.4	38.5	12.5	5.2	3.1	-	-	386
	Malksope inlet	-	7.2	56.7	24.7	-	-	1.0	-	-	385
27	Forward inlet	-	-	67.4	28.6	2.0	1.0	1.0	-	-	388

It will be noted that the 1945 year-class (as III's), which dominated the age compositions of most of the catches in the 1947-48 fishery, was prominent in the majority of spawning runs sampled in the spring of 1948. As in past years, the age composition of the spawning runs resembled that of the winter fishery in most areas in which sampling of the spawning stock was undertaken. The spawning samples from Areas 13 and 14A resembled in age composition the samples from the Deepwater bay catches (Area 13), this similarity applied also in greater or lesser degree to the spawning and fishing samples from Area 17 in the lower east coast sub-district as well as in all the west coast areas.

J. C. Stevenson Appendix No. 82

However, considerable variation was found in the age compositions of three spawning samples in Area 14B taken in the vicinity of Departure bay. One possessed a relatively high percentage of IV's as found in the spawning runs and fishery of Area 14A, another resembled the Area 17 spawning sample in having III's the dominant age-group, and the third showed III's and IV's in approximately equal numbers. It appears, from age composition, that the first of the three samples represented a run which belonged to the northern strait of Georgia population and which had moved further south than usual to spawn, and that the third group was possibly a mixture of the other two. This is, of course, not conclusive since the number of samples was possibly inadequate.

An important point in connection with the west coast samples (mentioned in an earlier appendix) was the greater proportion of II-year fish (1946 year-class) in the spawning runs than in the winter fishery (10.2% as compared to 2.4%). It appears that possibly the 1946 year-class is more productive than their numbers in the fishing runs signified. It might be that the II's were merely later than usual in joining the main runs of mature fish.

Growth indices of fish in west coast spawning runs were less, on the average, than those of the fish in the catches. However, the former are based on considerably fewer samples than the latter, a fact which might at least in part account for the difference. This point is even more applicable when considering the indices of the few spawning samples from other sub-districts, which might explain the small growth indices of the samples from Area 14B.

J. C. Stevenson Appendix No. 83

Herring Spawning Conditions in 1948

Herring spawning ground surveys were again made in all sub-districts by officers of the Department of Fisheries. In addition the herring investigators undertook detailed surveys of the west coast spawning grounds, as in the previous year. The latter surveys were made primarily for the purpose of obtaining, as accurately as possible, the extent of the spawning depositions, providing information useful in estimating in relative terms the amount of herring left after the fishery has taken its toll. The drag-rakes used in 1947 for collecting spawn in places too deep for visual observations were again found valuable, and large-scale charts of the spawning grounds were used to record some of the data. On each spawning ground the length, average width, and intensity of the egg deposition were determined. Also, samples of the spawn were taken and preserved for further analysis in connection with studies to determine egg mortality, extent of bird predation on spawn, and accuracy of spawn intensity estimations (see following Appendix).

General Survey

Results of spawning surveys conducted by fisheries officers are given in the following tabulation for 1947 and 1948. The miles of spawn deposited are listed for each area with the spawning indices (miles of spawn weighted to estimated intensities of spawning) in brackets.

J. C. Stevenson

Appendix No. 83

Sub-district and Area	1947		1948	
Queen Charlotte Is.				
Area 2A (East Coast)	17.4	(72.4)	23.8	(94.3)
Northern				
Areas 3 and 4 (Skeena and Nass)	14.3	(51.4)	14.6	(50.1)
Northern Central				
Area 5 (Grenville-Principe)	1.0	(1.9)	6.4	(19.1)
Area 6 (Butedale)	24.4	(90.7)	26.6	(100.2)
	25.4		33.0	
Southern Central				
Area 7 (Bella Bella)	23.6	(93.2)	22.1	(89.3)
Area 8 (Bella Coola)	5.7	(11.4)	+	(+)
Area 9 (Rivers inlet)	7.6	(20.4)	3.4	(11.9)
Area 10 (Smith inlet)	5.0	(19.8)	2.6	(6.4)
	41.9		28.1	
Upper East Coast of V. I.	13.2	(49.2)	12.2	(36.8)
Strait of Georgia				
Area 13 (Discovery passage)	0.4	(1.6)	0.3	(1.1)
Areas 15 and 16 (Pender harbour)	4.2	(19.2)	7.3	(26.4)
Area 14A (Comox)	15.5	(67.1)	7.6	(28.2)
Area 14B (Nanaimo)	1.5	(3.0)	5.7	(10.3)
Area 17 (Ladysmith)	6.1	(26.0)	7.9	(25.0)
Area 18 (Cowichan)	2.2	(4.9)	3.7	(9.2)
Area 19 (Victoria)	0.1	(0.2)	0.1	(0.1)
	30.0		32.6	
West Coast of V. I.				
Area 23 (Barkley sound)	7.2	(24.3)	4.7	(13.5)
Area 24 (Clayoquot sound)	6.3	(24.6)	5.1	(16.5)
Area 25 (Nootka sound)	1.7	(8.3)	5.9	(26.9)
Area 26 (Kyuquot sound)	1.5	(3.8)	1.4	(5.1)
Area 27 (Quatsino sound)	1.5	(4.5)	5.8	(11.4)
	18.2		23.0	

For the third successive year spawning in the Queen Charlotte island sub-district has increased. The 1948 spawning was the largest spawning recorded in the area since 1942. Apparently the lack of a fishery in the last five years is chiefly responsible for the present large population.

In spite of the large Ogden channel catch in the preceding fishing season, which was presumably drawn from the Northern sub-district population, the 1948 spawning in the sub-district was good, similar to that of the previous year.

Spawning was better in the North Central sub-district than in the previous year, but less extensive in the South Central sub-district. The latter sub-district produced a greater-than-average fishery in 1947-48.

The spawning on the upper east coast of Vancouver island was somewhat less than that of last year but much greater than the 1946 spawning.

J. C. Stevenson Appendix No. 83

The total miles of spawn in the strait of Georgia was slightly greater in 1948 than in the previous year, but the average intensity of spawn deposition was less. Spawning was greater in the southern part of the strait of Georgia than in the northern part in 1948, whereas in 1947 spawning was more extensive in the latter area. The indications are that the unusually large population in the northern part of the strait of Georgia in the past few years has been somewhat reduced.

Herring fishing without quota restrictions in the west coast sub-district apparently has not adversely affected the amount of spawning. In the spring of 1947 after a record catch the spawning was close to that of the average over the past ten years, and this spring following a moderately large catch the spawning was greater than in 1947.

Detailed West Coast Sub-district Survey

In 1947 and 1948 detailed surveys of the west coast spawning grounds undertaken by the herring investigators showed that the fishery officers tended to underestimate the extent of the spawnings by almost 50 per cent. The mileage of west coast spawnings in 1947 obtained by fisheries officers amounted to 18.2, as compared with 32.4 obtained by the investigators; in 1948 the mileages were 23.0 and 43.8, respectively.

The extent of the spawning (in miles) estimated by the investigators for each west coast area in 1947 and in 1948 was as follows:

Year	Area 23	Area 24	Area 25	Area 26	Area 27
1947	13.2	6.0	9.3	2.5	1.4
1948	10.9	8.4	12.8	2.0	9.7

After the close of the fishing season influxes of spawning fish entered inshore waters in both years from February to April to provide good spawnings. Only Areas 23 and 26 showed decreases in spawning in 1948, but in general the intensity of spawning was less in 1948 than in 1947. It appears that the amount of spawn deposited on the west coast in 1948 (and therefore the tonnage of spawning fish) was at least equal to and perhaps greater than that of 1947. The large increase in the extent of spawning in Area 27 in 1948 is noteworthy. The area has not supported a fishery for several years.

Spawning in 1948 followed a pattern similar to that in 1947. Early spawnings occurred in Macoah passage and at Useless inlet (Area 23), at the entrance to Nuchatlitz inlet (Area 25), at Malksope inlet (Area 26), and at Kiaskish inlet (Area 27). During March general spawning took place on the usual grounds. Late spawnings (in April) occurred in Mayne bay (Area 23) and at Leeson harbour and Holberg inlet (Area 27). The Holberg inlet spawning is of special interest since spawnings are very rarely found toward the heads of the long inlets on the west coast.

During the larval herring survey evidence was obtained indicating that small unreported spawnings sometimes occur in places not usually frequented by spawning herring. On occasions small larvae were obtained in places where no spawning had been reported.

It is planned to continue and, if possible, to improve the detailed spawning ground surveys on the west coast in 1949.

J. C. Stevenson Appendix No. 84

Spawn Samples from West Coast Spawning Grounds

In connection with the tagging operations and general spawning ground survey in the spring of 1948 a total of 133 samples of spawn was taken from west coast spawning grounds at various depths. The main purposes for which these samples were taken were (1) to obtain information on the mortality of spawn during the incubation period, (2) to determine the amount of spawn eaten or destroyed by birds, and (3) to assess the accuracy of the field estimates of spawning intensity.

Laboratory study of the samples revealed an average egg mortality of 5.6%, almost twice as great as was found in 1947. However, the sampling was more intensive in 1948 and it is possible that the previous year's figure was not representative of all spawning grounds. Egg mortality in relation to depth and embryonic development is given in the following tabulation:

Depth in relation to zero tide. (ft.)	Stages in development	
	early	late
+ 11.0 to + 1.6	1.9%	11.6%
+ 1.5 to - 1.5	2.0%	3.3%
- 1.6 to -24.0	4.8%	6.8%

It will be noted (1) that greater mortality occurred in samples which were in the later stages of development than in those in early stages, and (2) that mortality in the later stages was less around the zero tide level than either in deeper water or higher up on the beach. Considerably higher egg mortality was found on some spawning grounds than on others. At Cypress bay (Area 24) the mortality was almost twice that at Refuge cove (Area 24) and four times that at Macoah passage (Area 23). An early spawning in Macoah passage probably suffered destruction by the action of heavy seas, as evidenced by a ridge of eel grass bearing dead eggs (from one half to three feet high and five to twenty yards wide) extending about 1600 yards along the beach.

On certain spawning grounds samples of spawn were taken from six square inches of beach at intervals during the incubation period. The numbers of eggs in these samples were counted and the weight of vegetation obtained. The results, although not conclusive, indicated that bird predation at times was probably an important source of egg mortality. For instance, it was calculated that bird mortality on spawning grounds at Cypress bay was of the order of 35% in seven days. At Queen cove a 25% loss was indicated over a three day period. The amount of vegetation was also considerably reduced by bird activity especially on grounds covered by rockweed. Further investigations of this source of mortality are planned for future surveys.

Estimations of the intensities of the spawning depositions have been part of both the fishery officer's surveys and the more detailed surveys of the herring investigators. These estimates in the past have been of a general nature and not primarily based on actual counts of the eggs present per unit area. Prior to the 1948 survey, however, the numbers of eggs per linear or square inch of vegetation was determined for very light, light, medium, heavy, and very heavy spawnings. Laboratory counts on all samples were made and each sample catogorized after the completion of the survey; these were then compared with the field estimates obtained during the survey. It was found that in 69% of the samples the field estimates coincided with the laboratory estimate, and in 29% of the samples the difference between the estimates was only one catogory.

J. C. Stevenson and R. G. McMynn Appendix No. 85

Young Herring Investigation 1948

In the spring of 1947 a preliminary study of the larval herring was initiated on the west coast of Vancouver island. This study was continued and expanded in the spring of 1948 in an effort to obtain information on the natural variation in the survival of early stages in the life history. The fact that the strength of a year-class, as assessed by its contribution of mature fish to the fishery, bears little or no relationship to the abundance of spawn from which it was derived suggests that a variable natural mortality is operative during certain critical periods in the early life history.

In the 1948 survey four cruises were made up and down the west coast of Vancouver island between April 7 and June 14, using a seine boat loaned by the industry (the "Dominion No. 1") and its 18-foot tender. Larvae were sampled from virtually every west coast spawning ground and from localities at various distances from the spawning grounds; larval sampling was also carried out off-shore. Considerable effort was devoted to locating and capturing the post-larvae after schooling had taken place.

Equipment and methods used in the survey

Several methods were used to sample the young. These included the conventional-type conical silk nets, specially designed metal nets of brass mesh, and a portable centrifugal pump. The silk nets (four feet long and two feet in diameter at the mouth) were hauled at various depths behind the tender at a speed of two knots; also they were used to make vertical hauls where larvae were very numerous. The metal nets (5 feet in length) were towed from the seine boat at a speed of nine knots. The pumping system pumped water from the sea through a pipe extending three feet below the surface; a silk net placed in a barrel strained the larvae from the water. The silk nets were used mainly in sheltered localities where most of the spawnings took place, the metal nets being used mainly in exposed or semi-exposed localities. The pump was used in all localities, but because of its small straining capacity as compared to the nets it was most suitable in localities close to the spawning grounds where the larvae were abundant. Another limitation of the pumping method was that it was unsuitable for sampling below a depth of three feet unless the seine boat was stationary or moving at a slow speed. The difficulties encountered in the use of the metal nets were mostly structural. They were large and cumbersome to handle, and in spite of their apparent sturdiness had to be frequently reinforced. The brass mesh quickly disintegrated (presumably a result of chemical interaction between the brass, the sea water and the solder used to fasten together the fine inner and the protective outer screens) and was in need of almost constant repair. However, in spite of these and other difficulties, which are to be expected in the development of new types of gear, valuable experience was obtained and important scientific data were gathered.

Attempts were made to sample the post-larvae after they had schooled by using a purse seine (2 fathoms deep and 20 fathoms long), and by attracting them to a 100-watt light submerged just below the surface of the water. Scouting trips were made at various hours of the day and night to locate the schools.

Results of the survey

Detailed analysis of the large amount of data accumulated in the course of the survey is as yet far from complete, thus only general remarks on the findings can be made. The fact that the 1948 survey was begun abut ten days earlier than that of 1947 resulted in the capture of tremendous numbers of larvae near the spawning grounds. In some ten-minute hauls up to 30,000 or more larvae of one week or less in age were obtained. During April and the first part of May the larvae in the inshore localities decreased in numbers until by the beginning of the third cruise (May 20) no larvae could be collected in most localities.

As the larvae became less abundant in the vicinity of the spawning grounds they became more numerous in localities away from the spawning grounds. As in 1947, dispersal from the spawning grounds was greater in Area 23 (Barkley sound) than in any other area. In offshore localities very few or no larvae were obtained, corroborating the evidence of the 1947 survey which indicated no significant movement of larvae between the major statistical areas. Again in 1948 as in 1947 night hauls consistently provided larger numbers of larvae than day-time hauls. Data relating to depth distribution, although not yet worked up, appear to be similar to that of 1947, insofar as the 2-4 fathom zone contained more larvae than the zones above or below.

With regard to larval predators little can be said until the data are completely analyzed. As in the 1947 survey ctenophores were found feeding on larvae, but it appears that this predation was somewhat less in 1948. Of considerable importance in studying ctenophore predation is to what extent does predation occur after the organisms are captured and crowded together within the confines of the net. In other words, does the extent of predation which obtains in the samples hold for the population as a whole under natural conditions?

Predation by jelly fish was again found in 1948. This type of predation is apparently caused by only one or two species and the extent of their predation is not as great as that of the ctenophores.

In addition to the above sources of larval mortality predation by arrow worms, (Sagitta sp.) was definitely established in 1948. There was no evidence of this mortality being widespread since only one Sagitta (20 mm. in length) was found in which a larval herring (about 9 mm.) was, with the exception of the head, completely engulfed.

During the latter part of the 1948 survey numerous and continuous efforts were made to locate and capture post-larval herring subsequent to their schooling. Unlike their larval predecessors, the unmetamorphosed fish, they could not be taken by means of either plankton or metal nets. In addition the post-larvae were not distributed over extensive areas as were the larvae, but were only located in scattered compact schools. This added to the difficulty of locating them. As a matter of fact, despite intensive searching during both day and night, no schools were observed in either Areas 23 or 24. On three occasions schooled metamorphosed herring were encountered, once at dusk near Union island (Area 26) on June 10 and twice at dawn near Nuchatlitz village (Area 25) on May 31 and June 10.

Schools showed a tendency to appear at the surface at dusk and dawn during which time, providing the water was calm, they were observed to flip at the surface. This flipping, accompanied by the silvery flashing of their

J. C. Stevenson and R. G. McMynn Appendix No. 85

bodies, gave rise to a characteristic "crackling" sound. Often this crackling was the means of locating the schools of fish.

The capture of these schooled herring was always a problem and during the 1948 survey no really satisfactory method was devised for their capture. Due to their extreme wariness it was found to be impossible to obtain specimens with the shallow purse seine. The fish would both sound and scatter. Perhaps a longer and deeper seine than the one employed last year would aid in their capture. One sample of schooled herring and on other occasions specimens of partly metamorphosed young were obtained by the use of a dip net above which a 100-watt light was suspended. The fish, attracted by the light, were then scooped up. However, the light method was not always so successful, very often in an area where schooled herring had been observed earlier, none would be attracted later in the evening.

Preliminary study of the young herring captured in this manner, approximately 12 weeks old, averaged 35 mm. in total length.

A summary of the field work done during the survey is given below:

Method	Time of day				
	Day	Dusk	Night	Dawn	Total
Silk net hauls, horizontal	84	15	265	16	380
Silk net hauls, vertical	-	-	15	2	17
Pump samples	86	5	63	1	155
Metal net hauls, horizontal	67	6	51	-	124
Light samples	-	-	26	1	27
Scouting trips	13	12	3	10	38
Seine hauls	1	9	-	1	11
Stomach analyses	1	-	-	-	1
Totals	252	47	423	31	753

J. C. Stevenson Appendix No. 86

Forecasts of the Herring Fishery

The fourth annual circular (No. 15) dealing with the prospects for the herring fishery in the 1948-49 season was issued to members of the industry and other interested parties in September, 1948. The forecasts provide information relating to the expected abundance and size of the herring in various sub-districts.

In making predictions it is essential to have some prior knowledge of the relative strength of the year-classes which are expected to form a large percentage of the population. At present the main source of this knowledge comes from careful consideration of these year-classes in the previous year's fishery and in the spawning runs of the previous spring. Pertinent data are obtained from the percentage age compositions of the preceding season's catches and of the spawning runs, from the abundance of the fish left over from the previous year's fishing (as determined by the extent of spawning), from catch statistics, and from the history of the particular fishery.

The forecasts lack a sound statistical basis, and thus, much caution is used in the wording of the circulars and some of the forecasts are somewhat

J. C. Stevenson Appendix No. 86

vaguely stated. In addition to this fundamental limitation there are other factors which increases the difficulty of predicting accurately. It must be assumed that herring will be available to the fisherman in proportion to the expected abundance of the population. Furthermore, it is not possible at present to predict whether a run will be early or late in arriving on the fishing grounds; in some seasons certain runs of considerable magnitude, have not arrived on the fishing grounds until just before spawning, after the closure date for the fishery. Thus, even though the prospects may be reliable for the population as a whole (in spite of the fact they have no sound statistical basis), there is no positive assurance that they will be applicable to that portion of the population available to the fishermen. Studies on factors relating to this availability have so far been fruitless, but further efforts along this line are planned.

In spite of the limitations of the forecasts, a considerable degree of accuracy was obtained in the prospects of the herring fishery for 1947-48 (Circular No. 8). As predicted, the quota on the lower east coast was easily obtained but it was not anticipated that the catch would be taken in such a short period of time (six weeks). A smaller catch was obtained in the west coast sub-district than in the previous year; it was forecast that between 30,000 to 40,000 tons would be caught, whereas the final catch amounted to 45,200 tons. As expected Area 23 was the most productive west coast area, but a greater catch was predicted from Area 24 than was actually obtained. The taking of the quota in the Discovery passage sub-district was anticipated and it was pointed out that prospects were good for a fishery in the Cape Lazo area (a Baynes sound fishery provided 5,500 tons in about 27 hours). As expected the upper east coast yielded normal catches. Better catches were predicted in the Bella Bella area of the central sub-district than in the Laredo area; the former area actually provided a catch about eight times greater than the latter area. Mainly on the basis of extensive spawnings the previous spring, good catches were predicted in the northern and in the Queen Charlotte islands sub-districts if the fish entered inshore waters before the close of the fishing season. In late January and in early February a record catch was taken in Ogden channel in the northern sub-district; along the east coast of the Queen Charlotte islands scouting revealed the presence of herring before the close of the season but fishing operations were not carried out primarily because of herring being plentiful in other areas closer to processing plants.

J. C. Stevenson Appendix No. 87

Herring Trawling Operations in the 1947-48 Season

During the last week of January and the first two weeks of February 1948, five trawlers were granted permits to fish herring on an experimental basis. The trawl-nets were lined with herring web of the same mesh used in herring seines, and some of the trawlers made other minor modifications, such as increasing the fullness in the forward part of the trawl to provide a larger opening. Herring were located by means of echo sounders when they were close to the bottom during the daylight hours. Drags of from five to fifteen minutes resulted in catches of twenty tons of herring or less. The

J. C. Stevenson Appendix No. 87

fishery took place in Trincomali channel (Area 17) and produced a total of 330 tons of herring, most of which was frozen for bait. The trawl catches almost entirely consisted of herring, with other species as grey cod and flatfish being taken on very few occasions. On two trips to the fishing grounds, herring, investigators saw no small, undersized flatfish in the catches.

Samples of the trawl-caught herring taken by the investigators showed the fish to be in as good condition as those caught by seiners. No evidence was obtained suggesting that there was selection in trawl-caught herring.

Two limitations in trawling for herring became apparent in the initial attempt: herring could only be caught when they were on the bottom, and the process of clearing the herring from the net was lengthy and tedious. If a suitable method were devised to fish at various depths it would permit trawling for herring in areas where the nature of the bottom now prevents trawling operations, and, trawlers could fish at times of the day when herring were off the bottom. A simpler process of clearing the net would permit more frequent drags and thus make this method of fishing more efficient. Some of the trawl captains expressed interest in devising gear which would overcome the shortcomings of the present gear. European trawlers have obtained highly successful herring catches by making modifications in the design of the conventional trawl, but as yet full descriptions of these modifications have not been found in the literature.

For herring trawling to become a commercially successful venture factors other than improvement in gear will have to be considered. Regulations will have to be amended to permit this method of fishing and it will be necessary to decide whether or not the catches will be included under existing quotas. The trawlers must be assured of a market for their catches. They will probably have to face strong competition from the seining fleet, both in catching the fish (if both seiners and trawlers are fishing on the same grounds) and in marketing their fish. It is possible that the trawlers might be able to develop a summer fishery if they can fish off the bottom. Although the fish tend to be scattered in the late summer months and, therefore, difficult to catch, this might be compensated by the fact that the fish are then in prime condition and should demand a high price.

J. C. Stevenson Appendix No. 88

Herring Investigation: General Summary

Study of the West Coast of Vancouver Island Population

During 1947-48 the intensive investigation of the west coast of Vancouver island herring population was in its second year. An immediate aim of the study is to procure sufficient information to permit a scientific appraisal of the utility of the quota system of regulating the catch. Except for the limitation imposed by a closure date the catch in the west coast subdistrict is unrestricted. For the purpose of comparison catches on the lower east coast of Vancouver island are rigidly kept on a fixed quota basis. In the past season the west coast catch amounted to 45,200 tons, 23% less than in the first year of the investigation. The fishing effort required to make this smaller catch increased over that of the previous year. When fishing

ceased, 12 days before the prescribed closing date of February 5, few fish were left in inshore waters, but during the spawning season new runs came in and permitted a good spawning, as good or better than that of the previous spring.

Results of tagging showed, as in the previous year, that the west coast population is essentially discrete; intermingling between the west coast and lower east coast populations was small. Emigration from the west coast was greater than immigration to it, a reverse situation to that obtained in 1946-47. Considerable mixture was again noted between the individual west coast areas, and the tendency for fish to wander in a south-easterly direction along the coast was indicated as in 1946-47. The rate of exploitation in 1947-48 was calculated to be about 2.7 times greater than that in the first year of the west coast study. In view of the increase in fishing effort in 1947-48 it was considered likely that the decreased abundance, indicated by a decrease in availability, was due primarily to a small recruitment from a relatively less-abundant year-class, viz., that of 1945. Analysis of sampling data indicated that the 1945 year-class was relatively poorer than either that of 1943 or of 1944.

The prospects for the 1946 year-class were not good if the relative numbers of II-year fish in the catches can be used as an indication of year-class strength. Greater numbers of I-year fish were noted on the fishing grounds than in previous years; it is not known if this is of any significance with regard to the strength of the 1947 year-class.

The study of the larvae and post-larvae (of the 1948 year-class) was carried out more intensively than in the preliminary survey in 1947. The analysis of the data is as yet very incomplete, but certain results of the 1947 survey appear to be confirmed. Experience was gained in capturing samples from the schools of post-larvae. Considerable attention was given to the improvement of equipment for sampling the larvae.

Other Studies

Investigation of herring populations in other sub-districts of the B. C. coast was continued in 1947-48 within the limits of staff and appropriation.

Further evidence from tagging and sampling data was obtained suggesting that the herring of the northern part of the strait of Georgia and of the Discovery passage sub-district should be treated as one herring population. Varying degrees of intermixture appear to occur between this population and that of the lower east coast of Vancouver island.

The 1945 year-class (as III's) entered the fisheries of southern B. C. as the most abundant year-class, while in the northern part of the coast the 1944 year-class (as IV's) continued to dominate the catches of the major populations for the second year in succession. In general the 1945 year-class appears less productive than that of 1944. The 1946 year-class (as II's) entered the northern sub-district fishing runs in relatively large numbers, but it was poorly represented in most fisheries of other sub-districts, suggesting that the year-class might prove to be of less than average strength.

Spawning in 1948 resulted in more extensive depositions in most sub-districts than in the previous year. Reports from only the south central and upper east coast sub-districts showed a decrease in total miles of spawn

deposited. The spawning in the Queen Charlotte islands sub-district was the greatest since 1942.

Attention was given to the experimental herring trawling operations in Area 17 in the winter of 1948. A total of 330 tons of herring was caught by five trawlers in three weeks. The success of this method of herring fishing will depend largely on the development of more efficient gear and on the capability of the trawlers to compete with the seiners for markets.

Moderate success was achieved in predicting for 1947-48 the expected abundance and size of the fish in each sub-district. At present little knowledge on the time of appearance of the runs has been accumulated.

In 1948 several changes in the regulations of the herring fishery were proposed to the Department of Fisheries and later adopted. These changes were in accordance with the increase in knowledge of the various herring populations during recent years. Among the more important changes were the following: (1) the creation of a "Middle East Coast of Vancouver island Sub-district" which acknowledged the evidence that herring caught in the Discovery passage sub-district, (Area 13) those caught in the Baynes sound vicinity (Area 14A), and those which spawn along the opposite mainland shore, (Areas 15 and 16) belong to the same major population, and (2) the placing of Area 5 in the northern sub-district, due in part to the fact that data from the Ogden channel fishery of the past season strongly suggested that the catches were from the northern population.

A quota of 10,000 tons was placed on the middle east coast sub-district, the quota of 8,000 tons on the upper east coast was raised to 10,000 tons, the northern sub-district quota was increased from 25,000 to 30,000 tons, and a clarification of the 40,000 ton quota in the central sub-district was made.

The acquisition of a full-time herring research vessel is again strongly recommended. It is urgently needed for contacting the seining fleet and the reduction plants during the fall and winter months (as well as for transporting staff and equipment to field stations, etc.), for tagging and spawning ground surveys in the late winter and early spring, for conducting the young herring studies in the spring, and for investigating summer herring during the summer months. In attempting to provide a substitute for the proposed herring vessel a boat was chartered or loaned from the industry in each of the past two seasons, but the arrangements were for several reasons far from satisfactory. For young herring work in the springs of 1947 and 1948 the industry also generously provided a vessel but difficulties were experienced, chiefly because of the boat not being properly fitted for this type of research work. It should be pointed out that even with a new vessel two additional boats will be needed for the tagging and spawning ground surveys in late February and early March, and it is hoped that arrangements can be made with the industry to continue to supply these boats.

Alice M. Hirsch

Appendix No. 89

Experiment on Tank Propagation of Oysters

For the 1948 experiment with larval culture it was decided to use only the large oyster tank (100,000 gallon capacity) for actually rearing the larvae. The smaller covered tank (20,000 gallon) was to be used as a storage tank and the metal head tank to heat the water necessary to maintain a sufficiently high temperature.

To remove as much organic material as possible a sand filter was built over the inlet valve of the small tank. It was felt that sand filtering the water would also remove predators and reduce the other bivalve competitors for food. During previous experiments both these handicaps had become serious problems.

To allow a change of water in the large tank filtros blocks were installed over one of the valves. These would prevent the egress of the larvae. The water thus removed (about 10,000 gallons daily) would be replaced by warmed and fresh sea water. Last year this change of water was found to be of value in speeding up growth and regulating pH.

The food problem had always been acute. Observation showed that the larvae ingested forms up to 10 microns and readily digested a small colorless flagellate, thought to be Monas sp. This flagellate may be obtained by coarsely filtering seawater collected among eel grass. Cultures of Monas sp. were begun and added (about four pailfuls) to the tank every second or third day. At this age the flagellates were about 5 microns.

In spite of a very ambitious programme very little could be accomplished. The large tank allowed water and larvae to leak out (filter closed) much faster than it could be heated and replaced. Weather conditions, during August were very unfavourable.

When it became evident that no results could possibly be obtained by using the large tank a number of experiments were carried on in the smaller one. Results were similar to those of former years since it was impossible to get filtered, heated water for the small tank. A few useful facts were noted.

1. During most of July, female oysters were quite immature. Though by subjecting them to a rise in temperature and stimulation, spawning would occur, the larvae were very poor and rarely lived more than three or four days.

2. The salinity was very low during the early part of the summer. Until the salinity reached 27.00% it was impossible to keep the larvae for more than 7 or 8 days.

3. A temperature of at least 22°C. for at least the first 10 days gives the best results. Observations taken this year of larvae under natural conditions show that after 10 or 12 days they were able to tolerate temperatures as low as 18°C. for short periods of time.

4. Artificial feeding, into filtered water, is necessary. The tiny flagellate is very easy to culture.

G.C. Pike

Appendix No. 90

Whale Investigation

With the opening of a shore whaling station at Coal harbour Vancouver Island, whaling operations were resumed in British Columbia during the summer of 1948 after a lapse of five years. In the interests of conservation, development and optimum utilization of whale resources a biologist was assigned to serve in the capacity of inspector in accordance with the terms of the International Whaling Agreement to which Canada has subscribed. The study and investigation was prompted by the recognition that the collection and analysis of biological data is indispensible to sound management of the whale fishery as with other fisheries resources. Sound management is a prerequisite to the realization of the ideal of maintaining or increasing the present whale stocks to permit an optimum sustained exploitation and to avoid the pitiful decline of various stocks that has occurred on this coast as in other parts of the world in the past.

In addition to the recording of statistical data, which included measurements of length, determination of species and sex determination of size and sex of foetuses when present, and position of capture; careful observations of the condition of the whales landed were made. The placing of specially prepared log-books aboard the whale catchers provided information as to the extent, movements and habits of whales sighted other than those captured. Note was made of the condition of the reproductive organs in each whale landed, and stomach contents enumerated.

Collections of a variety of specimens were made for future study. Some of the material has been dispensed to institutions or individuals prepared and equipped to make the best use of it. The bulk of the material consisted of the following preserved specimens:

1. Ovaries from twenty-seven individuals.
2. Six foetuses of various sizes less than three feet.
3. Specimens of various parasites.
4. Histological specimens of glands and tissues.
5. Sample of stomach contents.
6. Miscellaneous items such as foetal skull and brain, testes, etc.

In cooperation with the Pacific Experimental Station various glands were identified and collected for chemical analysis to determine their commercial value. These included pancreas and epinephrin glands. Samples of liver were submitted for tests of vitamin potency and oil content.

The past season's activities at Coal Harbour, coupled with the extensive knowledge gained in whaling operations and studies in other parts of the world, serve the purpose not only of providing a picture of the current condition of the whale stocks on this coast, but also of suggesting methods for future study and management in the pursuit of a sound exploitation policy.

G.C. Pike

Appendix No. 91

Inspection of Whales Landed

From catch statistics of the 1948 whaling operation of the Western Whaling Corporation at Coal Harbour Quatsino Sound, North end of westcoast of Vancouver Island, certain facts may be taken as representative of the current condition of the whale stock and certain trends may be anticipated by comparison with similar operations elsewhere. Comparison of this year's record with those of past years does not lend itself to the establishment of general trends in the condition of the stock because of the different localities in which whaling was centred. Sperm whales constituted the bulk of the catch at the two stations operating at the South end of the Queen Charlotte islands because of a predominance of this species in this particular locality. Records of catches at Cachelot Station on Kyuquot Sound, west coast of Vancouver Island, are available only for five seasons up until 1926 when whaling was discontinued. It is notable there that Finbacks constituted the greatest part of the catch with a proportionately greater number of Sei and Sperm whales, and a total of one hundred and fifty-one Blue whales during these years. This year's catch consisted largely of Humpbacks, and no Blue whales were caught.

Composition of catch from May 31st to September 24th 1948:

Species	Female		Male		Total
	No.	Ave. Size	No.	Ave Size	
Humpback	64	40.3 ft.	49	39.9 ft.	113
Finback	20	58.1 ft.	19	58.3 ft.	39
Sei	1	47.0 ft.	1	46.0 ft.	2
Sperm	-	--	28	45.3 ft.	28
					182

The above table shows a predominance of Humpbacks in the catch, a characteristic common to the first few year's operations in many different areas. This early predominance has always been followed by a marked decline in the numbers of Humpbacks caught. A notable feature of the Humpback catch was the large number of pregnant females landed. Thirty-eight of the females were found to be carrying young. Of the total number of females many were immature.

Finbacks showed fewer pregnancies--only thirteen percent of the females as compared with twentyeight per cent in the Humpbacks. This was in part due to the large proportion of small immature individuals taken. Extensive exploitation of Finbacks represented by a composition of this sort would certainly have an adverse effect on the stock.

The catch of Sperm whales presents no cause for concern because on this part of the coast they consist almost exclusively of the large bulls, the females it is said, frequenting more remote waters. Apart from this consideration, the small size of the females renders them relatively free from commercial exploitation.

Knowledge of the true condition of the whale stocks on this coast as determined by the analysis of records from this one small area during a period of just four months is incomplete. Statistical and biological data over a period of years are required. Such thorough biological knowledge should ultimately provide a basis for an acceptable policy for taking whales.

T.H. Butler Appendix No. 92

Observations on shrimping grounds

During the summer opportunities were taken to make trips on local shrimp boats. These trips were made on the "Yuri M" and "Valdim" to the English Bay grounds, and one trip made on the "Gil" to Burrard Inlet. Qualitative observations were made on the species of fish and crustacea associated with the shrimps. On one trip stomach contents of associated fish species were examined.

In the following lists for the two areas attention is given only to the more numerous species or to those which evidently are related to shrimps.

Burrard Inlet

Fish:
Lemon, sand and rock soles -- not plentiful -- to 8".
Rockfish -- mostly Sebastodes caurinus -- numerous, small size.
Midshipmen (Porichthys notatus) -- numerous.
Whiting (Theragra chalcogramma) -- plentiful to 6".

Crustacea:
Crabs (Cancer magister) -- numerous mostly under 6½".
Munida quadrispina -- numerous.
Crago alaskensis -- fairly numerous.
Spirontocaris brevirostris -- few.
Spirontocaris suckleyi -- few

English Bay

The loads studied here were taken from Point Grey to Jericho Beach. The bulk of the commercial catch is made up of the "pink" (Pandalus borealis) with lesser amounts of "side stripe" (Pandalopsis dispar), "humpback" (Pandalus hypsinotus), "prawn" (Pandalus platyceros), and "coon stripe" (Pandalus danae), in that order.

Fish:
Stomach contents were examined from a load here and the species that contained shrimp are noted.
Eel pouts (Family Zoarcidae) -- great numbers.
Lemon, dover, slender, rex soles -- not plentiful.
Flathead soles -- fairly numerous -- one stomach contained 2 pinks.
Midshipmen -- great numbers -- 1 pink in one stomach.
Skates (mostly Raja binoculata) -- common
Hake (Merluccius productus) -- numerous, pink shrimps found in five stomachs.
Lingcod (Ophiodon elongatus) -- not common, one pink shrimp found in one stomach.
Whiting (Theragra chalcogramma) -- fairly common, small size -- three small pinks found in one stomach.
Dogfish -- not always in nets -- pinks found in two stomachs.

T.H. Butler Appendix No. 92

Crustacea and others:
Crago communis -- most common of all other varieties.
Spirontocaris lamellicornis -- common.
Paracrangon echivata -- few.
Crago franciscorum -- not as numerous as others.
Pandalus goniurus -- not common, smaller than commercial pandalids.

It is noted that the name Crago communis is new to British Columbia check lists. Full consideration of the factors influencing distribution must await studies of conditions on various grounds and examination of additional areas.

T.H. Butler Appendix No. 93

An Additional Species in Commercial Shrimp Landings on July 9, 1948.

The shrimper "Seven Seas II", fishing between Sangster and Lasqueti Islands from 25-70 fathoms, caught about 100 pounds of an unrecognized species of shrimp. The shrimps were sold to a fish dealer in Vancouver. Through the co-operation of the skipper, Mr. Frank Cobb, a sample was saved, and the species was identified as Pandalus montagui tridens Rathbun. The specimens examined appeared to be larger than the more common "pink" shrimp (Pandalus borealis). The fact that these shrimps were handled through the local fish market without complaints speaks for their palatable qualities. Perhaps this species will appear in greater amounts in commercial landings in the future caught from the area named or elsewhere in coastwise waters.

R.E. Foerster Appendix No. 94

A Study of the Queen Charlotte Island Crab Fishery

In continuing the investigation of the crab fishery along the north coast of Graham island, Queen Charlotte islands, which was commenced last year by Mr. R.G. McMynn, it was decided to limit the field work this season to additional tagging experiments and a collection of the pertinent catch statistics. Mr. R.O. Palmer was engaged to conduct the work.

Three well-separated crab grounds occur at the north end of Graham island, namely, Naden Harbour, along the north coast and along the east coast. It was believed that liberation of tagged crabs would give information not only on migration, but also on degree of exploitation by the fishery. For Naden Harbour, where an extensive fishery has recently developed, 508 crabs were tagged during August and September. Only one tag had been recovered by September 15th. For the 1947 season, 358 tags had been used and 121 recovered, indicating a minimum fishing intensity of 34%. Along the north coast in 1948, 815 crabs were tagged between June 5 and September 3 of which 21 or 2.58% had been retaken to September 7th. In the 1947 experiment only 5% were recovered. For the east coast area, 1213 tags were used between June 11 and August 10, of which 28 or 2.3% were recovered, as compared with 4% in the 1947 test.

R.E. Foerster Appendix No. 94

During the 1948 season a number of tags used in the 1947 experiments were recovered. The 1947 data have not yet been reanalyzed to show the significance of these additional recaptures.

J.R. Adams Appendix No. 95

Studies on the Lobster Population Introduced into Lasqueti Island Lagoon in 1946

Systematic trapping of lobsters was begun in Lasqueti Lagoon about the middle of May, 1948. Only 12 traps were in good repair at that time. These were used on the east and south sides of the lagoon and on both sides of the entrance to it. By July 15th, sixteen additional traps had been rebuilt and were put into use. Considering the poor results obtained in the lagoon, this group of traps was used in False bay in an attempt to find out if lobsters had left the lagoon. Traps were moved every week to new location so as to cover the whole bay.

Only four lobsters were caught during the period from May 1st to October 15th, as follows:

May 7th - Lasqueti lagoon - 24 cm. female with eggs
July 3rd - " " - 31 cm. female
" " - 30 cm. male, last from pond on June 13th
Aug. 13th - False bay entrance - 30 cm. female
north side

The 16 lobsters present in the floating pond at Lasqueti island continued to do well. Only one death occurred following a local shipwreck and the contamination of the lagoon water with fuel oil. Most of the captive lobsters moulted during July and August showing gains of 2 to 3 cm in length.

Comparison of the size and weight of lobsters in 1948 with that at the time of planting indicates good growth on the part of surviving individuals.

Date	No.	Mean Length	Range
June 1946 planting	631	21.0 cm., 8½"	18 - 23 cm., 7-9"
July 1948 (newly moulted)	6	28.2 cm., 11"	24 - 31 cm., 9½ - 12"

Three 24 cm. male lobsters moulting in the pond grew an average of 11% in length. This compares favourably with a 9% gain reported by Templeman, 1936, for nine 23 cm. males moulting in captivity at Point du Chene on the Atlantic coast.

The mean weight of 7 freshly moulted lobsters was 1 lb. 14 2/3 oz. (870 gr.) on July 13, 1948. On the same date 9 old shelled lobsters averaged 1 lb. 7½ oz. (665 gr.) The largest individual weighed 2 lbs. 8 oz. Mean weight at the time of planting was 12 oz. (340 gr.)

J.R. Adams Appendix No. 95

Freshly moulted female lobsters were separately caged with hard shelled males of the same size. By August 30th, six of the captive females were carrying eggs.

A review of all the data on this and previous introductions of lobsters into Canadian Pacific waters was made. A detailed report has been prepared and submitted with recommendations.

On the suggestion of this investigator the experiment at Lasqueti was terminated in the fall and the lobsters moved to the tanks at the Pacific Biological Station.

J.R. Adams Appendix No. 96

Experiments on the Rearing of Lobster Larvae at the Biological Station

As a part of the general study of the introduction of lobsters into Pacific waters, attempts to hatch and rear larvae were made in the summer of 1948. The eggs carried by two females were available for experimentation in May.

A rearing box of the type employed at Boothbay Harbour, Maine, was constructed. A pressure-operated electrical pump and storage tank were set up to produce the necessary flow of 100 gallons per hour through the rearing box. The water was pumped from a 15,000 gallon concrete tank which could be filled at high tide from the sea. This equipment was not ready until June 9th.

On May 31st one lobster, whose eggs appeared to be on the point of hatching, was placed in an improvised tub to which air was supplied by a small air-pump. The larvae on hatching were transferred to culture jars similarly supplied with air.

In the meantime, the Fraser river flood had caused a drop in the salinity of Departure bay water to 13.82%. An attempt was made to raise the salinity of the culture water by the addition of sea salt. Salinities ranging from 25 to 27% were used during the next few days.

No normal larvae were hatched. None of them showed any ability to swim or survive more than three days.

The second female was left in the outside tank subject to the influence of the low salinity water during this period. One June 9th, when the installation of the rearing tank was completed, she was moved into it. The lobster and her eggs were apparently normal. Examination one week later revealed that all of the eggs had disappeared. No larvae had been hatched. The eggs may have rotted or been eaten.

The failure to obtain any normal larvae for experimentation is attributed to the influence of unsatisfactory salinity conditions on the eggs. No other explanation has been suggested.

A repetition of the attempt should be possible next year since a number of "berried" female lobsters are on hand.

J.P. Tully — Appendix No. 97

Lighthouse Project

A program of daily observations of sea water temperatures and salinities was initiated on the Pacific Coast in 1914 with one station. This has been increased at intervals, until the present total of eleven stations was reached in 1939. Most of the observations are made from coastal lightstations which explains the project designation.

These data serve to identify the duration, and frequency of repetition of the coastal oceanographic conditions, which are being investigated in oceanographic surveys.

It is the purpose of this investigation to accumulate these records as reference data for all other investigations in the Canadian coastal seas, to determine their significance as submarine climatological indices, to determine their relation, if any, with the success of coast fisheries, to evaluate annual cycles and trends, and geographical differences. Studies based on these data may be anticipated.

The data are being published in mimeographed volumes, which may be obtained on application to the Director, Pacific Biological Station.

Observations of Sea Water Temperature, Salinity and Density on the Pacific Coast of Canada

Volume	I	1914 to 1934 inclusive	now available
"	II	1935 to 1937 "	" "
"	III	1938 to 1939 "	" "
"	IV	1940 and 1941	" "
"	V	1942 " 1943	" "
"	VI	1944 " 1945	in preparation
"	VII	1946 " 1947	" "
"	VIII	1948 and thereafter to be issued in annual volumes	

J.P. Tully — Appendix No. 98

Alberni Project

From 1939 to 1943 an exhaustive investigation was undertaken to predict the state of pollution that would result in Alberni Inlet from a proposed 135 ton sulphite pulp mill to be erected by Bloedel, Stewart and Welch Ltd., at Port Alberni. This research concluded that pollution from the mill would not be tolerable when the discharge of the Somass river was less than 1600 cubic feet per second. This implied that amelioration measures would be required for about two months every year. To obviate this the industry proposed and built a sulphate mill which could be tolerated under the most adverse conditions.

The mill came into operation in the spring, and in mid-summer the pollution potential and the state of the water in the inlet was examined. It was observed that the biochemical oxygen demand of the mill sewage was greater, but the mill losses were considerably less than anticipated. There was no evidence of depletion of oxygen, or any other form of pollution from the mill.

J.P. Tully Appendix No. 98

The concentration of mill sewage, the oxygen demand, and the estimated degree of pollution due to this mill are shown in the following table.

Estimated Oxygen Demand in the Upper Zone of Alberni Harbor During the Low River Levels, Due to Sewage from the Existing (1948) Sulphate Pulp Mill.

Discharge Somass R. (c.f/s.)	Concentration of Sewage Upper Zone (p.p.m.)	Mean Oxygen Demand in Upper Zone (p.p.m.)	Dissolved Oxygen Concentration (p.p.m.)	Estimated degree of Pollution (P_{max}) (%)
153	15,000	2.1	8.5	60
200	12,000	1.7	8.5	48
300	9,400	1.3	8.5	37
500	7,000	1.0	8.5	28
700	6,200	0.9	8.5	25
1,000	5,100	0.7	8.5	20

153 cubic feet per second is the minimum recorded discharge of the Somass river.

1.0 These small oxygen demands are within the natural limits of variation of Dissolved oxygen, and would not be noticed in test of the water in Alberni Harbour.

(P_{max}) The degree of pollution (P) is the ratio of the oxygen demand of the pulp mill sewage to the dissolved oxygen available, in excess of the amount required for the fish. When the maximum pollution occuring anywhere in the Inlet is 100% or less, there will be 5 parts per million, or more, of dissolved oxygen everywhere in the upper zone.

W.M. Cameron Appendix No. 99

Oceanography of Chatham Sound

An oceanographic investigation of the approaches to the Skeena river was carried out from May 19 to September 10. Its object was to describe the behaviour of the water discharged from the Skeena river in Chatham sound during maximum and normal runoff, and to relate that behaviour to daily observations of river discharge, weather, and surface sea water observations at the monitoring lighthouse (Triple island). A description of conditions in the Sound during the adult sockeye salmon migration will be available to the Skeena river salmon investigation.

The organization and direction of the project was undertaken by the Senior Oceanographer, Dr. J.P. Tully, until mid-July, at which time the writer assumed this responsibility. Dr. G.L. Pickard, Oceanographer, and Messrs. A.J. Dodimead and R.H. Herlinveaux, Assistant Technicians, completed the complement of scientific personnel. The oceanographic survey vessel "H.M.C.S. Ehkoli" was under the command of Lieut. R.B. Hayward, R.C.N. and was manned by naval personnel.

E. and C. Berkeley — Appendix No. 100

Polychaete Studies

Final proofs of Part 1. (Errantia) of our contribution to the Canadian Pacific Fauna series have now been passed and this publication should appear shortly. Meanwhile we are preparing a paper on the Sedentaria of the coast bringing knowledge of that division of the Polychaeta up to date. This is a necessary preliminary to completion of Part 2 (Sedentaria) of the Canadian Pacific Fauna publication. The latter is now well under way.

J.R. Adams — Appendix No. 101

Preliminary Studies on British Columbia Fish Parasites

During July and August collections of parasites were made from marine fish caught in the vicinity of the Biological Station. Additional specimens were obtained from field workers on other projects and a collection of endoparasitic worms from fish in the Skeena river system was made available for study. Identification of the parasites is far from complete but there do not appear to be any species new to science.

A survey of available published records and of manuscript reports on the parasites of marine fish in this area was made and a host-parasite list has been compiled. This will serve the purpose of defining the present knowledge in the field and form a basis for the selection of future problems for study. The survey indicates that an extension of the descriptive work begun by Wardle and others is desirable, only the more common fishes having been studied. Life history and distributional studies have been largely neglected. The protozoan parasites of local fish have apparently not been studied at all.