# SKEENA SALMON MANAGEMENT COMMITTEE

## ANNUAL REPORT 1957

Jan. 1, 1957 - Dec. 31, 1957



COMMITTEE MEMBERS

A.J. Whitmore

A.W.H. Needler

IN CHARGE OF INVESTIGATIONS

F.C. Withler

ADVISORY BOARD MEMBERS

S. Oddsun

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J.R. Daniels

R.E. Walker

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E. MacMillan

R. Bell-Irving

## Terms of Reference

In the fall of 1954, the Minister of Fisheries appointed Mr. A.J. Whitmore, Chief Supervisor of Fisheries for the Pacific Area (now Area Director of Fisheries) and Dr. A.W.H. Needler, Director of the Biological Station of the Fisheries Research Board at Nanaimo, as a Committee on Management for the Skeena River Salmon Fisheries. The Committee was directed to investigate thoroughly the condition of Skeena River salmon stocks toward improving the management of the runs and increasing the yields. It was noted particularly that the Babine Lake sockeye run, the Skeena's largest, had been seriously depressed by the 1951-52 Babine River rock slide and that special effort would be necessary to rebuild the returning runs.

The Committee, in achieving its objectives, was directed to make fullest use of the administrative and research staffs of the Federal Department of Fisheries, both of which had worked extensively on Skeena salmon stocks. The Committee was required to coordinate and extend these activities.

The Minister, after establishing the Committee, appointed an Advisory Board representing the various sections of the industry concerned with the Skeena salmon fishery. The Committee has met with its Advisory Board several times each year to discuss new developments arising from investigations and to discuss thoroughly the basis for recommendations for regulation of the Skeena fishery. Advisory Board members for 1957 are listed on the cover page of this report.

This report reviews the meetings concerning the 1957 fishery, the results of the 1957 regulations, and the progress of investigations.

## Record of Meetings

The Committee met in Vancouver on December 7, 1956, to review the results of investigations in 1956 and to review the performance of the salmon stocks under the regulations which had been proposed by the Committee. The Committee then examined the evidence concerning the likely abundance of Skeena sockeye and pinks in 1957.

It was noted that the sockeye run would be composed of $4_2$ fish from the 1953 seeding and $5_2$ fish from the 1952 seeding, and that these sockeye were produced predominantly in Babine Lake. The 1953 Babine spawning had been large (resulting in a seaward smolt run of some 30,000,000), suggesting that the 4-year-old component of the 1957 sockeye run would be large. The 5-year-olds, on the other hand, would arise from the slide-blocked 1952 Babine sockeye run, which had provided a small spawning and had produced a seaward smolt run of less than 3,000,000. The 1957 Skeena sockeye run was therefore expected to be moderate in size as a result of a combination of an anticipated good return from 1953 and a poor return from 1952.

The Committee noted also that the observations of distribution of young salmon in the Babine-Nilkitkwa watershed in 1956 were consistent with the preliminary observations made in 1955, viz. that the large southern portion of the lake was underutilized by the numbers of young sockeye being reared there, while the small northern portion of the lake was, in some years, sufficiently populated to cause diminution of the size of the young fish. Since the southern

portion of the lake is seeded by early running sockeye, the Committee agreed that regulations should be designed to rehabilitate the early Babine runs to better use the large nursery area of the southern basins.

The 1957 Skeena pink salmon run would arise from the 1955 spawning escapement of over 1,000,000, which was considered a large number in comparison with pink escapements in recent years. The production of fry from the major 1955 spawnings had been satisfactory. The best expectation for the 1957 pink run was therefore that it would be of about the same magnitude as the 1955 run, which had totalled slightly over 3,000,000. The Committee was concerned that the odd-year spawning escapement should be maintained at a good level, and agreed that, while the expected return should permit a considerable pink fishery in 1957, the 1957 regulations should be designed to assure continued good escapement.

With the above considerations in mind, the Committee released on January 7, 1957, a statement containing tentative regulations for the 1957 Skeena salmon fishery for consideration by the industry generally, in order that discussion and suggestions might be solicited at the forthcoming meetings of the Committee with its Advisory Board. The proposals for regulation for the Skeena Gillnet Area put forward in the release were as follows:

(1) That the upriver commercial fishing boundary for all salmon fishing in the Skeena Gillnet Area in 1957 be maintained at Mowitch - Veitch Point line.

(2) That prior to 6:00 p.m. Sunday, July 7, 1957, only gillnets having mesh not less than 8" linen, or 8 1/2" nylon, stretched measure, be permitted, and that prior to this date a 72-hour weekly closed period from 6:00 p.m. Thursday, until 6:00 p.m. Sunday be maintained.

(3) That fishing for salmon with gillnets of any mesh size be permitted after 6:00 p.m. July 7, 1957, until the end of the fishing season, as follows,--

(a) From July 7 to July 28 - 96 hour weekly close time, 6:00 p.m. Wednesday to 6:00 p.m. Sunday.

(b) From July 28 to August 11 - 72 hour weekly close time, 6:00 p.m. Thursday to 6:00 p.m. Sunday.

(c) From August 11 to September 1 - 96 hour weekly close time, 6:00 p.m. Wednesday to 6:00 p.m. Sunday.

(d) From September 1 to end of season - 72 hour weekly close time, 6:00 p.m. Thursday to 6:00 p.m. Sunday.

(4) Provise:- That the weekly closed times outlined above shall be extended in the event that for any week or series of weeks the proposed weekly closures, in the opinion of the Committee, are deemed insufficient to provide adequate escapement of salmon for reproduction purposes.

The Committee also proposed to make recommendation as follows relating to adjacent fishing areas in order to extend similar protection to Skeena-bound sockeye and pink salmon while passing through those areas:

Nass Gillnet Area - Sub Area 3X and 3Y only

Same weekly closed times from July 7th to September 1st, 1957.

Salmon Purse Seine Area No. 5 - Beaver Passage and Ogden Channel only.

Same weekly closed times from July 28th to September 1st, 1957.

The results of 1956 investigations, the performance of the 1956 salmon runs, and the evidence regarding the likely abundance of sockeye and pink salmon were reviewed at meetings of the Committee with its Advisory Board at Prince Rupert on January 19, 1957, and at Vancouver on January 24, 1957.

Advisory Board members present at the Prince Rupert meeting were O. Olafson, S. Oddsun, and K.F. Harding; other interested persons also were present. General agreement with the proposals for regulation was expressed, except that there was concern as to whether it was necessary to restrict fishing to 3 days per week during the period July 7 - 28, 1957.

At Vancouver, Advisory Board members present were R. Hager, R.E. Walker, R. Nelson, R. Bell-Irving and E. MacMillan. Some doubt as to the need for restriction of the fishery to 3 days during the period July 7 - 28 was expressed, and it was strongly contended that restriction to 3 days fishing would not permit an economically profitable fishing and canning operation. An alternative proposal - that the upriver commercial fishing boundary be moved seaward - was put forward for consideration.

The discussions and suggestions put forward at the Advisory Board meetings were reviewed at a meeting of the Committee only at Nanaimo on February 20, 1957. A statement dated March 5, 1957, was released subsequently recommending to the Department of Fisheries that regulation of the 1957 Skeena salmon fishery be carried out as had been proposed in the January 7 release, except that provision was made that weekend closed times would be shortened during the fishing season, if in the opinion of the Committee, the escapement in any week or series of weeks were sufficient for conservation needs to be met with shorter weekend closed times. Concerning its decision to increase weekly closed periods, rather than to move the upriver fishing boundary seaward, to effect necessary conservation of the runs, the Committee stated in its release of March 5, 1957:

"All groups agreed that the essential consideration in proposing the 1957 regulations was to conserve spawning stocks at a level which would assure better sustained yields in future years, in line with the Committee's objectives. The evidence concerning present-day efficiency of the Skeena fishing fleet is such that, with inside and outside boundary locations which have been in effect in recent years, the closed times proposed in the Committee's January 7 release could not be relaxed without endangering recovery of Skeena salmon stocks. Alternatively, movement of the inshore boundary a sufficient distance seaward to permit a 4-day fishing week from July 7 to July 28, bearing in mind the escapement necessary for conservation purposes, would bring about immediate serious dislocation of operations in the normal field of fishing activity. It is the Committee's concern, that,

in proposing regulations designed to rehabilitate those runs which are below maximum production, additional restrictions should involve least possible disruption of industry. To this end, restrictions based on lengths of closed times are deemed to provide most equitable imposition on all types of boats and fishermen."

The regulations, as proposed in the release of January 7, 1957, and recommended to the Department of Fisheries slightly amended as indicated above in the release of March 5, 1957, were accepted and applied to the 1957 Skeena salmon fishery and to the fisheries in Sub Areas 3X and 3Y and in Beaver Pass and Ogden Channel.

No further meetings were held until August 12, 1957, when available members of the Advisory Board were assembled in Prince Rupert to review the progress of the 1957 Skeena fishery for sockeye and pinks. It was noted that the 1957 sockeye run had been unexpectedly low, whereas the pink run had returned in relatively great abundance. Members and representatives of members of the Advisory Board strongly contended that the very large catches of pinks being made in the Skeena Gillnet Area pointed to a great abundance, and in view of the 3-day fishing week to be permitted by the regulations from August 11, 1957, to September 1, 1957, an extremely large and perhaps excessive escapement was likely. It was pointed out that, while the catch had been great, test fishing catches above the upriver fishing boundary were not greater than in the brood year 1955, indicating that the escapement of Skeena pinks was not excessive, and that it might be endangered by relaxation of the weekly closed periods originally laid down. In view of the evidence available, the Committee recommended against relaxation of the weekly closed time for the period August 1, 1957, to September 1, 1957, and no changes were effected by the Department.

At a meeting of the Committee only, on December 6, 1957, at Nanaimo, the performance of the 1957 Skeena runs was reviewed and the effect of regulations, as recommended by the Committee for the 1957 fishery, studied. It was noted that the total 1957 Skeena sockeye stock had amounted to approximately 765,000, of which 279,000 had been caught in the commercial fishery. Of the remainder, 433,000 had entered Babine Lake. The total run was lower than had been expected, due to the poor survival of the progeny of the good 1953 spawning. The late opening of sockeye fishing by regulation (July 7) and the further tie-up because of price negotiations (until July 13) had permitted a moderate escapement as compared to a poor catch.

The total 1957 Skeena pink stock had amounted to some 3,700,000. Of these 2,300,000 had been caught in the Skeena Gillnet Area and 500,000 in the Nass Gillnet Area, providing the largest Skeena pink catch since 1930. The escapement amounted to about 900,000 which was less than the brood year 1955. The average rate of exploitation was 75%, in spite of the unexpected big run and the relatively stringent regulations which had been imposed (3 or 4 days fishing only per week).

The 1957 Skeena gillnet catches of springs, coho, and chums had been below average and the escapement of these species had been moderate to poor.

## The 1957 Skeena Salmon Catch and Escapement

The following table summarizes the weekly catches by gillnet for all species in the 1957 season (as reported in the B.C. Catch Statistics of the Department of Fisheries) for Statistical Area 4:

| WEEK ENDING | SOCKEYE | PINK | SPRINGS & JACKS | COHO | CHUM |
|---|---|---|---|---|---|
| April | | | 2 | | |
| May 11 | | | 13 | | |
| 18 | | | 66 | | |
| 25 | | | 22 | | |
| June 1 | | | 124 | | |
| 8 | 49 | | 517 | | |
| 15 | 126 | | 667 | | 1 |
| 22 | 197 | | 2,070 | | 2 |
| 29 | | | | | |
| July 6 | 6 | | 592 | | |
| 13 | 983 | 42 | 297 | 4 | 8 |
| 20 | 48,175 | 29,051 | 4,447 | 1,215 | 986 |
| 27 | 49,434 | 182,687 | 1,739 | 1,876 | 873 |
| Aug. 3 | 75,256 | 741,540 | 2,038 | 12,340 | 2,924 |
| 10 | 60,776 | 784,864 | 372 | 7,562 | 6,048 |
| 17 | 35,594 | 502,178 | 252 | 10,465 | 8,012 |
| 24 | 7,767 | 74,453 | 65 | 5,585 | 6,825 |
| 31 | 1,177 | 12,141 | 43 | 5,115 | 4,673 |
| Sept. 7 | 296 | 1,777 | 14 | 3,013 | 2,946 |
| 14 | 87 | 518 | 48 | 3,696 | 1,589 |
| 21 | 11 | 65 | 42 | 1,272 | 502 |
| 28 | | | | | |
| TOTAL 1957 | 279,934 | 2,329,316 | 13,430 | 52,143 | 35,389 |
| AVERAGE 1950-56 | 578,981 | 725,629 | 23,619 | 71,348 | 62,976 |

The estimated total stock of Skeena sockeye in 1957 was 765,000, not including "jacks" (precocious males). Of this total, the Skeena gillnet fishery removed 280,000, leaving an escapement past the upriver commercial fishing boundary of some 485,000. Of this total escapement, 433,000 entered the Babine Lake watershed, where another 20,000 were caught in the Indian food fishery. Of the remaining 50,000+ sockeye entering other watersheds, probably 10,000 more were caught by Indians, leaving a total spawning escapement of 455,000.

The low 1957 sockeye catch was brought about in two ways. First, sockeye fishing began after a good portion of the run had passed, because the

opening date had been delayed until July 7 by regulation, and further delayed in practice by a fishing tie-up pending fish price negotiations. Second, the sockeye run itself was low, being the result of a moderate-sized return of 4-year-olds coupled with a poor return of 5-year-olds.

The escapement, on the other hand, was about average as compared to those prior to the Babine River slide. In proposing the 1957 Skeena regulations to permit the desired sockeye escapement, the Skeena Salmon Management Committee had been guided by two important considerations, viz., that the anticipated total run would be moderate in number, and that the early sockeye runs to Babine Lake were depressed. The late opening of fishing permitted the early Babine sockeye to escape. This early escapement offset the reduction in total escapement which would have resulted had the smaller-than-expected run been fished heavily throughout the season. As a result, about 63% of the total run escaped the fishery and, as in 1956, a higher than usual proportion of the spawners entering Babine Lake spawned in early-run streams adjacent to the main basin.

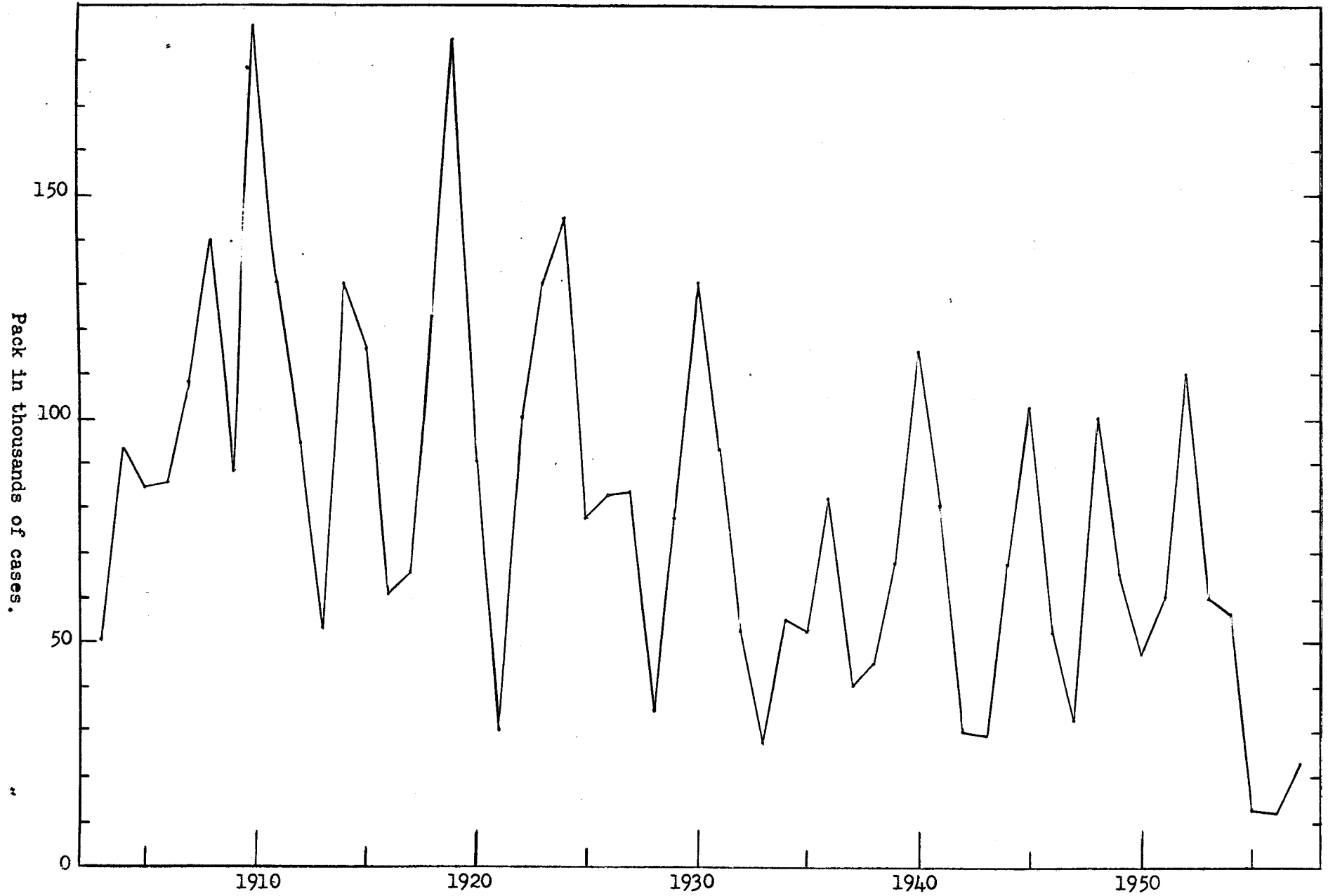
In sharp contrast to the sockeye run, the 1957 Skeena pink run exceeded expectations. The 1955 pink escapement had been slightly over 1,000,000 after a catch of about 2,000,000. The best expectation of return in 1957 was that the run would be as large as in the parent year, 1955. In fact, the total run was approximately 3,700,000, of which 2,800,000 or 75% were caught (2,300,000 in the Skeena Gillnet Area, 500,000 in the outside Nass Sub Areas). Thus, in spite of shortened weekly fishing times as compared to 1955, the catch was much larger, and the escapement was reduced slightly from just over 1,000,000 in 1955 to just over 900,000 in 1957. Since the ratio of return to escapement for the 1955 brood appears to have been higher than for most years in the past, the large 1957 return can be attributed to an exceptionally high survival of young from a better-than-average escapement.

The 1957 Skeena gillnet catch of spring salmon was 13,430, which is below average for the period since 1950. Although the total run was small (since the escapement was also only moderate), the lowered catch was largely due to the delayed opening of salmon fishing to July 13, brought about by the fishing tie-up mentioned above.

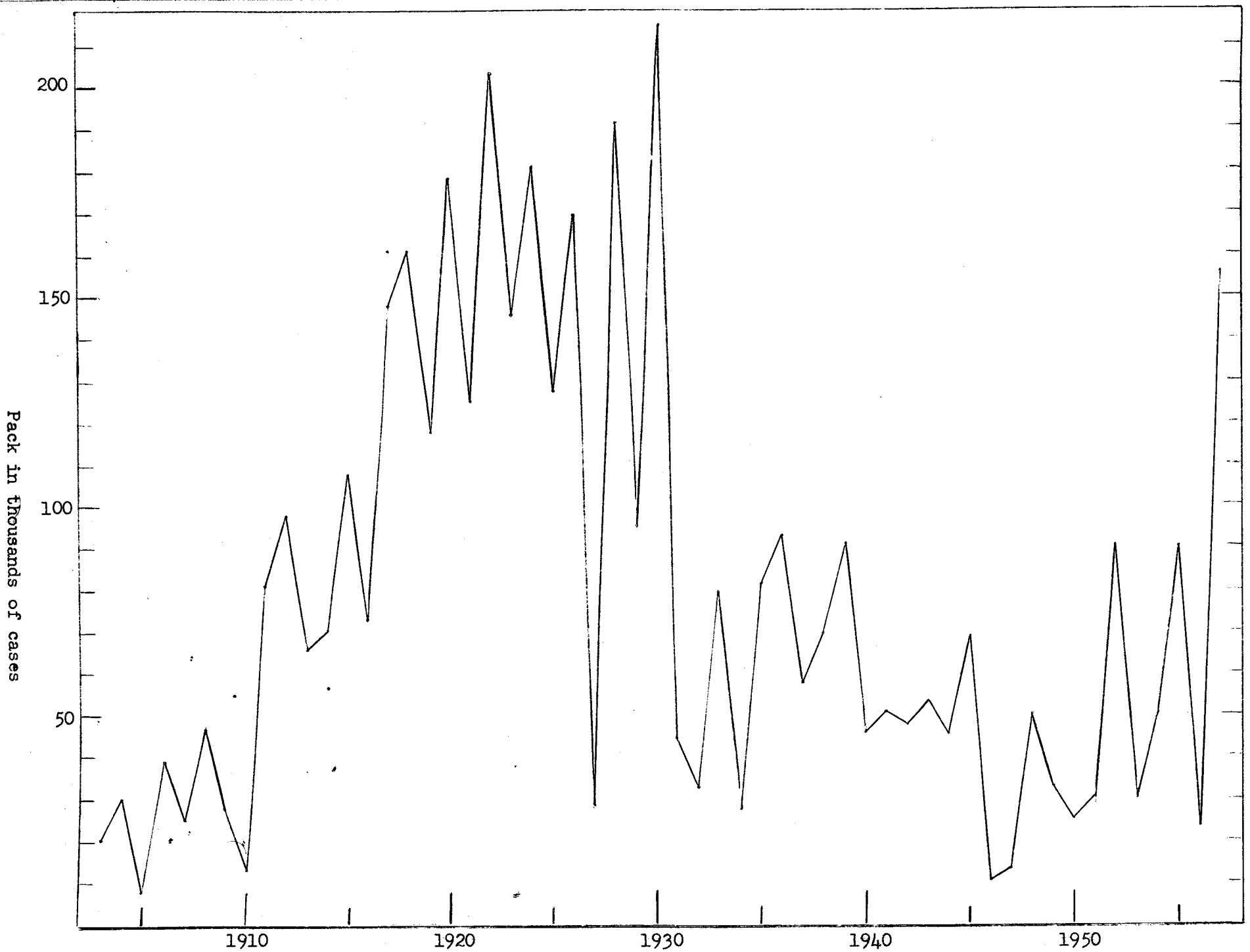
The 1957 gillnet catch of coho salmon in the Skeena Area was 52,143, which is below the average for the years since 1950. The escapement was judged by Department of Fisheries officers to have been moderate. Some extra protection for the coho run, which is most abundant in the Skeena fishing area during August, was provided by the 4-day weekly close periods from August 11 to September 1, which were proposed primarily to provide an adequate pink escapement.

The 1957 Skeena chum catch was 35,389, which is well below average. The escapement was also poor.

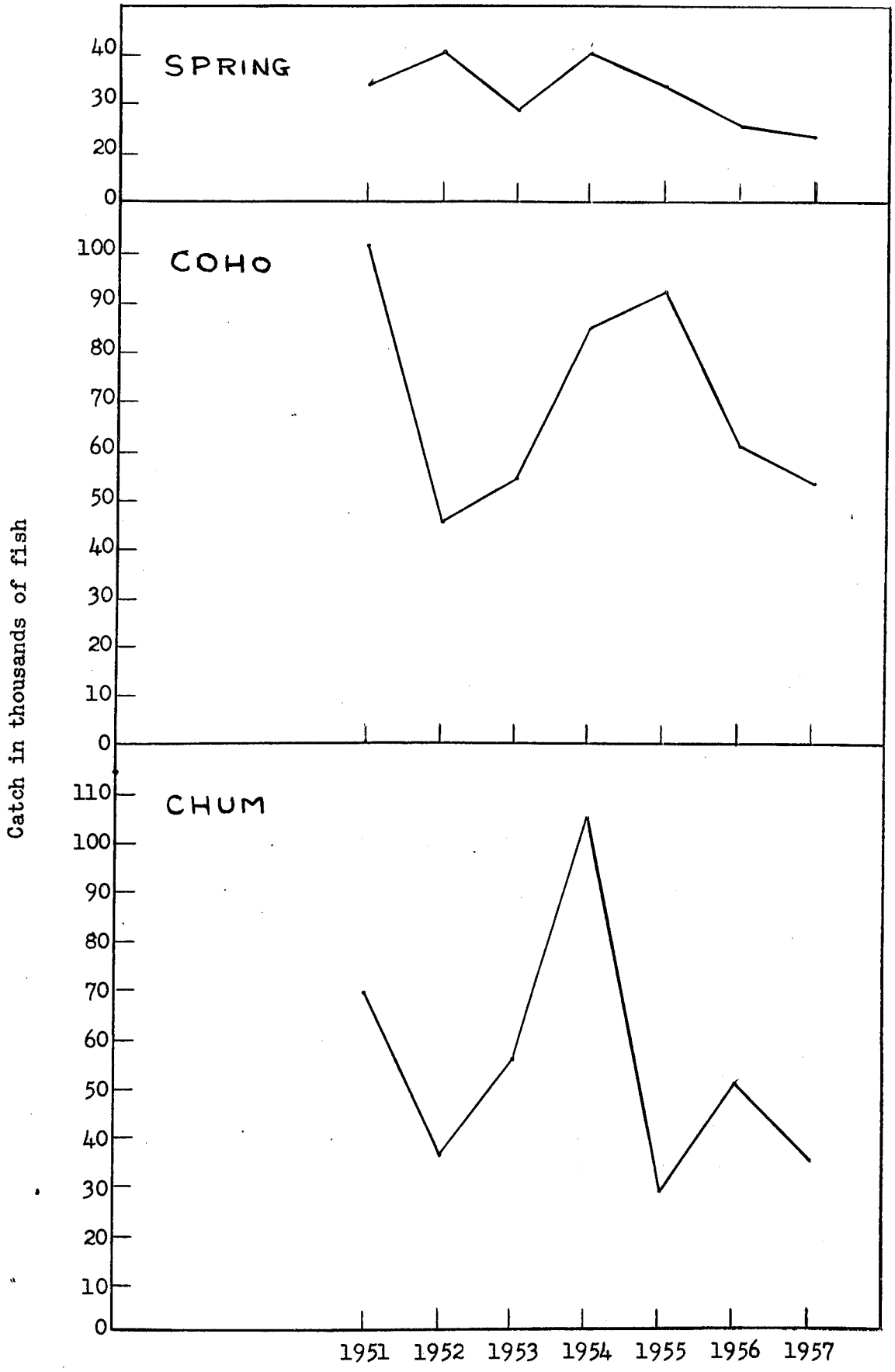
The 1957 catches of each species of salmon in the Skeena Gillnet Area are compared with previous years' catch in the following figures.




Annual packs of sockeye salmon caught in the Skeena Gillnet Area (from "The Commercial Salmon Fisheries of British Columbia", Statistical Basebook, No. 3, and B.C. Catch Statistics of the Department of Fisheries).




Annual packs of pink salmon caught in the Skeena Gillnet Area (from "The Commercial Salmon Fisheries of British Columbia", Statistical Basebook, No. 3, and B.C. Catch Statistics of the Department of Fisheries).




Annual catches of spring, coho, and chum salmon in the Skeena Gillnet Area (from the B.C. Catch Statistics of the Department of Fisheries).

## Investigations

Investigations are carried out to provide the biological background necessary for management of Skeena salmon stocks. Currently, attention is focussed on sockeye and pinks, which form the bulk of the commercial catch in the Skeena Gillnet Area.

While it is true that variations in both the freshwater and marine environment exert important effects on survival, there is an increasing body of evidence indicating that the abundance of the Skeena stocks is largely dependent on the size and distribution of the spawning escapements. In general, for Skeena sockeye and pinks, small escapements have tended to provide small returns and large escapements to provide larger returns. It is recognized that the freshwater environment must eventually limit production when the capacity of either the spawning or the nursery areas is approached. Indeed, in certain parts of the Skeena system, there are indications that spawning populations have approached this limiting level in recent years. But it is the general case that present Skeena spawning stocks are below the size necessary to tax the capacity of the freshwater environment, and hence it is probable that substantial increases in the long-term yield can be achieved by providing larger escapements.

Much of the work of the Skeena salmon investigation is directed toward determining the likely size of escapements to each of the major production areas which will provide the greatest sustainable yield to fishing. This work involves enumeration of spawners using each of these areas and the estimation of the numbers of progeny resulting from these spawnings, both as young fish going to sea and as returning adults.

For sockeye salmon, the Babine-Nilkitkwa watershed is the major producing area of the Skeena system, accommodating over 75% of the annual spawning escapement. This area is essentially divided into two parts. One part, the area adjacent to the outlet, is characterized by having a large run of late-running fish with a relatively restricted lake nursery area (about 10% of the total lake surface area); the other part, the area remote from the outlet, has earlier runs of fish of about the same magnitude but with a relatively vast lake nursery area (about 90% of the lake surface). Studies of the growth and distribution of young sockeye during their year of lake residence and estimations of the number of seaward-migrating smolts indicate that in recent years neither the spawning grounds nor the nursery area of the main lake basin has been fully used. On the other hand, as indicated by depressed growth in some years, sufficient fry have been produced from spawnings in the outlet area to tax the capacity of the small nursery area there. For the past two years, regulations of the fishery therefore have been directed toward increasing the escapements to the main basin area. As a consequence of the increased spawnings provided by these regulations, the production of young fish in the main basin has been raised markedly, without any evidence of depressed growth. Whether or not this encouraging increase in production of young fish will result in a corresponding increase in adult production must await the return of these fish 2 to 4 years hence.

For pink salmon, spawning is concentrated mainly in three large tributaries of the Skeena--the Kispiox, accommodating an early run; the

Lakelse, a late run; and the Kitwanga, an intermediate run.

Since intensive study of the pink salmon stocks began only in 1956 (sockeye studies began in 1944), less is known concerning the capacities of Skeena pink spawning systems than of the major sockeye areas. However, analysis of past catch statistics suggests that, as with sockeye, spawnings in years of abundance more often resulted in large returns than did spawnings in years of scarcity. It was encouraging to note that the 1957 pink run, which provided the greatest catch since 1930, was produced by one of the largest pink spawning escapements of recent years. Even this large catch, however, was much less than those which were sustained over more than a decade prior to 1931 and at a time when both the demand for pink salmon and the ability of the fleet to capture them were much less than now. This evidence, added to the fact that recent spawning densities have in general not appeared excessive, indicates that the only hope for restoring the catches to their former high levels rests on the provision of substantially greater escapements. This is especially true of the Kispiox River whose runs appear to be more depressed than those of the other two. With this background, regulations for the past three years have been directed toward allowing more spawners to escape the fishery.

The information required for management of the Skeena sockeye and pink fisheries involves intensive study of the stocks from the time the adults first enter the fishery until the progeny of the survivors return to the sea. The projects involved in this program include:

(1) Tagging of the adult fish as they approach and pass through the fishing area. Recoveries of tags in the fishery and on the spawning grounds provide information on the timing of runs to the various spawning areas. These data are necessary to permit proper harvesting of individual runs.

(2) Analysis of the commercial catch records. The Department of Fisheries collects records of the daily landings of salmon in the Skeena and also from adjacent fishing areas through which Skeena salmon pass. The records are used in conjunction with escapement statistics to estimate the contribution of the various runs to the fishery.

(3) Sampling of the commercial catch. Samples are obtained to determine the age, size and sex composition of the commercial catch so that the contributions to the catch by each brood year will be known for sockeye.

(4) Test fishing above the commercial fishing boundary. The catches of standardized fishing operations are used to estimate the numbers of fish escaping the fishery. Such estimates provide measures of the effectiveness of different regulations in controlling the exploitation of the stocks by the fishing fleet, and hence during the season, permit adjustment of the regulations to offset unexpected fluctuations in abundance of fish or fishing efficiency.

(5) Estimation of Indian food catches. Department of Fisheries officers collect statistics on the numbers of salmon taken by natives in the area between the commercial fishing boundary and the spawning grounds.

(6) Estimation of spawning escapements. These critical data are obtained by foot and aircraft surveys by Department officers and Fisheries Research Board personnel and, for the important Babine sockeye stocks, by an actual count through a weir. Considerable work is currently devoted to developing more accurate, yet economical, methods of assessing spawning runs. Attempts are made to determine the age composition of the sockeye escapement (through length-frequency analyses) so that, in conjunction with comparable data from the commercial catches, the total return from a given year's spawning may be estimated.

(7) Estimates of pink fry production. On the three major pink rivers, small trap-nets are operated each spring to provide indices of fry output from observed spawnings. Such observations of production over a series of years in which different-sized spawnings occur will demonstrate the size of spawning which is likely to provide the greatest return to fishing.

(8) Observations of growth and distribution of young sockeye in lakes. Sampling young sockeye in the Babine-Nilkitkwa nursery areas has provided information about the consequences of varying the size of spawning escapements to the different parts of the watershed. These studies are providing estimates of the capacity of the nursery areas to support young sockeye, and permit estimation of the size and distribution of spawning stocks required for most effective use of these rearing areas. Important fundamental studies on the relationship between the growth and distribution of young sockeye and their plankton food and other factors are also being conducted.

(9) Estimation of sockeye smolt runs. Estimates of the total sockeye smolt run from the Babine-Nilkitkwa area each spring, by mark and recapture techniques, provide measures of the freshwater production resulting from different-sized spawnings. These estimates provide preliminary indications of the return of adults from Babine spawnings, and in so doing aid in interpreting fluctuations in abundance brought about by environmental factors both in freshwater and in the sea.

## Details of Investigations

Salmon tagging in and around the Skeena Gillnet Area in 1957. Following the success of the preliminary tagging carried out in 1956 in the waters adjacent to the Skeena Gillnet Area, a more extensive tagging program was embarked upon in 1957. The purposes of this tagging were to determine the times, speeds, and routes of migration of the various species of Skeena salmon and also to determine whether significant numbers of Skeena-bound salmon are present at any time during the fishing season in the adjacent Nass and Ogden Channel fishing areas.

The tagging, in which conventional Peterson-type disc tags fastened with nickel pins were used, was carried out from the chartered drum-seiner Cape Blanco during the period from June 5 to August 22. Tagging was carried out in the following seven general areas:

(1) in Ogden Channel, Beaver Pass, and at the northern end of Principe Channel;

(2) near Grace Island at the northern tip of Porcher Island, and around Stephens Island;

(3) near Kinahan Island;

(4) near Green Island, Bristol Rock, and in Hudson Bay Passage;

(5) around Arniston and Whitly Points, Holliday Island, and the Gnarled Islands, all at the northern end of Dundas Island, and in Caamaño Passage;

(6) in the southwestern half of Portland Inlet;

(7) around Birnie and Finlayson Islands.

The numbers of salmon of the different species tagged in each of these seven areas are listed in the following table:

| Species | Ogden Channel | Grace Island | Kinahan Island | Green Island | Arniston Point | Portland Inlet | Birnie-Finlayson | Total |
|---|---|---|---|---|---|---|---|---|
| Sockeye | 36 | 17 | ... | 36 | 926 | 392 | 127 | 1,534 |
| Spring | 1 | ... | ... | 3 | 36 | 85 | 5 | 130 |
| Pink | 1,398 | 482 | 380 | 32 | 3,076 | 916 | 630 | 6,914 |
| Coho | 25 | 4 | 1 | 5 | 222 | 34 | 15 | 306 |
| Chum | 164 | 8 | ... | 5 | 127 | 835 | 5 | 1,144 |
| Steelhead | 2 | ... | ... | 1 | 19 | ... | 1 | 23 |
| TOTAL | 1,626 | 511 | 381 | 82 | 4,406 | 2,262 | 783 | 10,051 |

Tags were recovered later from the commercial, Indian, and sports fisheries, from fish-wheels and fish-weirs operated by the Department of Fisheries and by the Fisheries Research Board, and from spawning streams by Departmental and Board personnel. A total of 3,822 tags were recovered from the commercial fishery and 543 tags from freshwater areas. This return, which is slightly in excess of 43%, is the highest recovery from any tagging carried out in the vicinity of the Skeena River. The distribution of the tag returns by statistical area is indicated in the accompanying table.

The tagging data indicates that in 1957 most of the Skeena salmon entered the Skeena Gillnet Area from the north around the tip of Dundas Island. The remainder of the salmon entered the area through the passages to the west and from the south through Ogden Channel. Skeena fish were present in varying amounts throughout the season in these adjacent areas.

| | | Sockeye | Spring | Pink | Coho | Chum | Steelhead | Total |
|---|---|---|---|---|---|---|---|---|
| Alaska | Marine | 10 | 1 | 105 | 3 | 77 | 1 | 197 |
| | Stream | ... | .. | 2 | 1 | ... | .. | 3 |
| Area 3 | Marine | 131 | 18 | 494 | 30 | 166 | .. | 839 |
| | Stream | 52 | 2 | 1 | .. | 1 | .. | 56 |
| Area 4 | Marine | 276 | 8 | 1,935 | 41 | 51 | 4 | 2,315 |
| | Stream | 286 | 5 | 153 | 17 | 5 | 4 | 470 |
| Area 5 | Marine | 20 | .. | 283 | 6 | 6 | .. | 315 |
| | Stream | 4 | .. | 9 | .. | 1 | .. | 14 |
| Area 6 | Marine | 2 | .. | 23 | 2 | 2 | .. | 29 |
| 7 | " | 2 | .. | 19 | 3 | .. | .. | 24 |
| 8 | " | .. | .. | 9 | 1 | .. | .. | 10 |
| 9 | " | .. | .. | 4 | 1 | .. | .. | 5 |
| 10 | " | .. | .. | 2 | .. | .. | .. | 2 |
| 11 | " | 4 | .. | 11 | .. | .. | .. | 15 |
| 13 | " | .. | .. | 2 | .. | .. | .. | 2 |
| 20-27 | " | 1 | .. | 1 | .. | .. | .. | 2 |
| 29 | " | 1 | .. | 2 | 1 | .. | .. | 4 |
| Unknown | " | 7 | .. | 44 | .. | 12 | .. | 63 |
| TOTAL | | 796 | 34 | 3,099 | 106 | 321 | 9 | 4,365 |

Test fishing and tagging in the Skeena estuary. Two chartered gillnet boats were employed again in 1957 to carry out test fishing immediately above the Skeena River fishing boundary in order to obtain information concerning the size and composition of the daily escapement of salmon. Information concerning the time of passage of sockeye and pink runs to different spawning areas was obtained by tagging those fish which were in suitable condition.

Fishing was carried out for one-hour periods over the slack tides with a 200-fathom net composed of 10 panels of different-sized web, from 3 1/2" to 8" stretched measure in 1/2" intervals. A total of 270 sets were made from June 3 to September 8.

The number of salmon caught, the number tagged, and the number of tags recovered in 1957 are shown in the following table with the comparable figures for 1955 and 1956:

| Species | Year | Number Caught | Number Tagged | Tags Recovered | |
|---|---|---|---|---|---|
| | | | | From Fishery | From upriver |
| Sockeye | 1955 | 1,173 | 822 | 113 | 69 |
| | 1956 | 2,344 | 1,386 | 39 | 203 |
| | 1957 | 2,351 | 1,234 | 150 | 197 |
| Spring | 1955 | 782 | 376 | 48 | 22 |
| | 1956 | 696 | 439 | 26 | 28 |
| | 1957 | 924 | 514 | 77 | 42 |
| Pink | 1955 | 3,590 | 1,488 | 28 | 34 |
| | 1956 | 1,408 | 974 | 24 | 8 |
| | 1957 | 5,734 | 3,321 | 215 | 102 |
| Coho | 1955 | 483 | 233 | 27 | 2 |
| | 1956 | 422 | 265 | 17 | 1 |
| | 1957 | 315 | 158 | 39 | 3 |
| Chum | 1955 | 124 | 45 | 1 | 0 |
| | 1956 | 151 | 79 | 12 | 1 |
| | 1957 | 283 | 89 | 8 | 0 |
| Steelhead | 1955 | inadequate record | | | |
| | 1956 | 310 | 199 | 10 | 5 |
| | 1957 | 137 | 54 | 8 | 2 |
| TOTAL | 1955 | 6,152 | 2,964 | 217 | 127 |
| | 1956 | 5,231 | 3,342 | 128 | 246 |
| | 1957 | 9,744 | 5,370 | 497 | 346 |

Seasonal variations in exploitation of the 1957 Skeena sockeye and pink runs. Catches of salmon made by the test-fishing boats are studied to provide information on the variation in escapement from the commercial fishery. These estimates of escapement in conjunction with catch statistics permit determination of the seasonal changes in rate of exploitation.

Test-fishing catches as indices of escapement. As outlined in these reports for 1956-57, comparisons of the seasonal patterns of test-fishing catches with those of the escapements reaching the spawning grounds suggested that the test-fishing catches were, within each season, proportional to the daily escapements.

To investigate the sources of error inherent in deriving escapement estimates from test-fishing catches, a factorial analysis was made of the effects of changes in fishermen, nets, boats, cloud cover, wind force and direction, rainfall, time of day, tides and presence of debris and of seals, on test catches of sockeye. To avoid the masking effects of the fishery on the size of test catches, these analyses were restricted to those of the period June 8 to July 31, 1956, when there was a complete closure of the Skeena fishery. The analyses showed that only two factors exerted demonstrable effects on the magnitude of the test-fishing catches: one fisherman caught consistently more fish than did the other, and catches made at very low tides tended to be proportionately higher. In the following analyses involving test-fishing catches, the data have been adjusted to compensate for differences

in efficiency of the fishermen. No correction was made for tidal effects because it is impossible to determine whether the observed differences were caused by changes in catchability, or real changes in the abundance of fish passing the test-fishing site. Comparable analyses of pink salmon catch data fail to demonstrate any effects of the factors studied.

Assuming that the test-fishing catch/hour is roughly proportional to the number of fish migrating upstream, indices converting catch/hour to annual spawning escapement of both pinks and sockeye are provided through stream surveys and fence counts. By summing the daily catch/hour figures and dividing this number into the total estimated escapement to areas upstream from the test-fishing site, the estimated daily escapement indicated by a catch of one fish/hour is obtained. The data are summarized in the table below:

| Year | Sum daily catch/hour | | Total escapement** (1,000's fish) | | Escapement per daily catch of 1 fish/hour | |
|---|---|---|---|---|---|---|
| | Sockeye | Pink | Sockeye | Pink | Sockeye | Pink |
| 1955 | 377 | 1,672 | 125 | 1,058 | 333 | 630 |
| 1956 | 834* | 522 | 441 | 260 | 530 | 498 |
| 1957 | 769* | 1,929 | 485 | 910 | 632 | 472 |

* Adjusted to correct for differences in efficiency of boat skippers.
** Upstream from test-fishing site.

As noted in last year's reports, there was a relatively large difference between the escapement indices derived from the 1955 and 1956 data. At that time the discrepancy was largely attributed to differences in the nets used in the two years. The fishing procedure in 1956 and 1957 was essentially identical, and as a consequence, the indices are much more similar. The pink indices in these latter two years differ by only 5%; the sockeye indices by 16%.

Seasonal changes in exploitation in 1957. Using the escapement indices described above to estimate the weekly escapement from the fishery, and the weekly catch figures provided by the Department of Fisheries, the weekly rates of exploitation in the Skeena Area were derived. These figures are summarized in the table below:

| Week Ending | Sockeye | | | Pink | | | Days Fishing | Deliveries |
|---|---|---|---|---|---|---|---|---|
| | Comm. catch | Estim. escap. | Rate of expl. | Comm. catch | Estim. escap. | Rate of expl. | | |
| | 1,000's fish | | % | 1,000's fish | | % | | |
| July 21 | 48.2 | 64.6 | 42.7 | 29.0 | 51.2 | 36.2 | 3 | 1,293 |
| 28 | 49.4 | 67.9 | 42.0 | 182.7 | 126.1 | 59.1 | 3 | 1,485 |
| Aug. 4 | 75.3 | 35.4 | 68.0 | 741.5 | 139.3 | 84.1 | 4 | 3,161 |
| 11 | 60.8 | 41.5 | 59.4 | 784.9 | 206.5 | 79.2 | 4 | 2,862 |
| 18 | 35.6 | 24.4 | 59.2 | 502.2 | 286.2 | 63.7 | 3 | 2,102 |
| 25 | 7.8 | 10.7 | 42.1 | 74.5 | 81.1 | 47.8 | 3 | 1,091 |
| Sept. 1 | 1.2 | 1.0 | 54.5 | 12.0 | 13.4 | 47.2 | 4 | 522 |

In 1957 the weekly rate of exploitation for sockeye varied between 42 and 68%, and for pinks between 36 and 84%. The data indicate in two ways that the percentage removal is closely related to the amount of effort expended in catching the fish. On the average a substantially greater proportion of the stock escaped during 3-day fishing weeks than in 4-day weeks (an average of 46% of the sockeye and 51% of the pinks were caught during 3-day weeks, whereas 58% of the sockeye and 70% of the pinks were removed during 4-day weeks). Also, for weeks in which fishing time was comparable, there tended to be a higher rate of exploitation when the greatest number of boats (as reflected by the number of deliveries) was fishing. For example, the greatest rate of exploitation for both sockeye and pinks was achieved in the 4-day week ending August 4, in which there was the greatest number of deliveries.

A point of special interest in these data is the extremely high rate of exploitation of the 1957 pink run. At the time of the run, the test-fishing catches indicated that the escapement past the fishing boundary was no better than in 1955. Had it not been for the evidence, the remarkable effectiveness of the fishing fleet would not have been known, with the result that serious reduction of the spawning run would have been caused by extension of fishing time.

Salmon enumeration in 1957 at the Babine fence. In 1957, as in all years since 1946 (except in 1948 when floods damaged the weir), the salmon runs to the Babine Lake watershed were counted at the Babine River weir. Since the sockeye escapement to Babine Lake usually constitutes about 70% of the total escapement to the Skeena River, the weir count provides the best index of the Skeena sockeye escapement. The counts have been particularly valuable since 1951 in determining the effect of the partial block of the Babine River to salmon by the rock slide.

The counts of the five species of salmon which passed the counting fence in 1957 are compared in the following table with the counts obtained in other years:

| Year | Sockeye | | Spring | Pink | Coho | Chum |
|---|---|---|---|---|---|---|
| | Large | Jack | | | | |
| 1946 | 417,841 | 57,864 | 10,528 | 28,161 | 12,489 | 18 |
| 1947 | 261,460 | 261,101 | 15,614 | 55,421 | 10,252 | 7 |
| 1948* | 650,000 | | | | | |
| 1949 | 461,139 | 47,993 | 7,433 | 13,663 | 11,938 | 5 |
| 1950 | 364,356 | 179,302 | 6,838 | 38,728 | 11,654 | 7 |
| 1951 | 141,415 | 11,042 | 2,778 | 50 | 2,122 | 0 |
| 1952 | 349,011 | 27,936 | 5,915 | 2,706 | 10,554 | 1 |
| 1953 | 686,586 | 28,028 | 8,353 | 1,108 | 7,648 | 17 |
| 1954 | 493,677 | 9,745 | 5,925 | 4,604 | 3,094 | 66 |
| 1955 | 71,352 | 30,624 | 3,528 | 2,151 | 8,947 | 3 |
| 1956 | 355,345 | 18,164 | 4,345 | 2,691 | 9,250 | 3 |
| 1957 | 433,149 | 50,162 | 7,509 | 25,865 | 4,421 | 15 |

*Total sockeye estimated from comparison with stream surveys and fence counts of other years.

The run of sockeye salmon in 1957 was close to the pre-slide average. It began with a single fish on July 6, followed the usual pattern attaining an early peak of 15,486 fish on July 27 and a main peak of 18,058 sockeye on August 31. Counting was discontinued on October 29, on which day only 4 sockeye passed the fence.

In 1957, as in 1956, a proportionately greater number of sockeye spawned in the streams tributary to the southern and central portions of the lake than in most recent years. Most of the larger streams in these areas had larger spawning populations than in the past eleven years.

The spring salmon run in 1957 was average in number. However a larger proportion of the fish were jacks. The count of spring salmon provides only an index of the run since springs spawn below the fence as well as above it.

The pink salmon run was the third cycle following 1951, the year when the run of pink salmon through the Babine fence was reduced to 50 fish by the rock slide. The 1957 run was of comparable size to some of the pre-slide runs. As with springs, some pinks spawn below the fence.

The run of coho salmon in 1957 was the second cycle to the 1951 run which also was reduced in size by the rock slide. The 1954 and 1957 runs of coho have indicated a gradual recovery so that the 1957 run was twice that of 1951.

A few chum salmon again reached the Babine fence.

Sockeye sampling at the Babine fence. In order to describe the composition of the 1957 run, 1% of the previous half-day's run was sampled twice daily for length and sex, and a "jack count" was carried out for an hour daily.

In 1957 jack and large sockeye were counted separately in the daily counts rather than together, giving a total count of 433,149 large and 50,162 jack sockeye. The percentage and number of jacks in the sockeye run was greater in 1957 than in most years. The jack count showed also that 8.8% of the large sockeye had net marks, 1.6% had other injuries, and 89.6% had no injuries. The percentages of fish with net marks was higher, and with other injuries, lower, than in most other years.

As in all other years except in the two slide-affected years, the female sockeye in 1957 outnumbered the large male sockeye, the 1% sample indicated that 49% of the large sockeye were males and 51% females. The 1% sample also indicated that the jacks, large males, and females were smaller than average.

The average egg content in 1957 was calculated to be 3,063 eggs per female. Since the number of female sockeye estimated to have survived the Indian fishery was 212,804, the potential egg deposition would be in the vicinity of 652 million. This is close to the average of pre-slide years.

The 1957 Skeena pink salmon escapement. The table below shows the estimated escapement to the Skeena and its major tributaries in 1955 and 1957. The estimates are based on inspections of the streams by Fishery Officers. Since 1955 their observations have been supplemented by those made by Research Board personnel.

Some of the figures given in last year's report have been revised in the light of more recent information.

| Place | 1955 | 1957 |
|---|---|---|
| Kispiox River | 540,000 | 360,000 |
| Kitwanga River | 125,000 | 160,000 |
| Lakelse River | 175,000 | 140,000 |
| Babine River | 5,000 | 27,500 |
| Bear River | 6,000 | 15,000 |
| Coastal Streams | 78,000 | 45,000 |
| Others | 129,000 | 163,000 |
| TOTAL | 1,058,000 | 910,000 |

The escapement in 1957 was slightly less than that in the parent year. There occurred decreases in the runs to the Lakelse and Kispiox Rivers. This was partly compensated for by an increased number of spawners to some of the other grounds. Both the Bear and Babine River runs, although still very small, showed a substantial increase over 1955. The number of spawners passed through the Babine fence in 1957 was over five times the number in the parent year. This shows good progress in the recovery of the odd-year cycle following the devastating effect on that cycle by the Babine River slide of 1951.

The 1957 escapement followed much the same pattern of distribution as was recorded in past years. The bulk of the spawning occurred in the Lakelse, Kispiox and Kitwanga Rivers. Of considerable interest and promise was the greater incidence of pink spawning in the Skeena River itself. Very light and scattered spawning has been noted here in the past. Observations by ground and air this year showed pinks had spawned on numerous bars and in side channels from Terrace downstream to the tidal zone. The surveys did not indicate that this spawning was intensive in relation to that which occurred elsewhere, but it could be considerably greater than that noted in the Skeena in past years.

Considerable effort is being put toward improving methods of estimating the sizes of spawning runs. Aerial photography has been used to locate and enumerate both spawners and spawning redds. This technique is especially useful in larger tributary streams, where great numbers of fish are involved and where spawning extends over long distances.

Migration times of major Skeena pink runs. One of the objectives of the research on Skeena salmon stocks is to obtain information which will permit, as far as possible, individual management of each major "run" or "race" so that optimum escapements may be achieved. In this regard, knowledge of migration times of the runs through the fishery is of paramount importance.

In 1956 and again in 1957 pink salmon were tagged at several points along the migration routes leading to the Skeena fishing area. Additional fish were tagged at the test fishing site which is immediately upstream of the Skeena River boundary.

The 1956 tagging program was largely exploratory and only a few pinks were tagged. In 1957, however, intensive pink tagging was carried out mainly in the vicinity of Dundas Island in the Nass River fishing area and in Ogden Channel in the Grenville-Principe area. A considerable number were also tagged at the test-fishing site.

Special crews were organized to recover tags on the spawning grounds. Spawned-out fish on the major grounds were examined throughout the spawning period. A total of 229 tags was recovered (or about one tag in every 1,000 fish examined).

The accompanying diagram shows the estimated time of arrival at the Upper Skeena River boundary of tagged fish which were later recovered on the various tributary rivers. Each tagged fish is represented by a black dot. The time of arrival at the boundary was determined from the date tagged and the mean length of time tagged fish required to proceed from the place tagged through the fishery to the upper boundary.

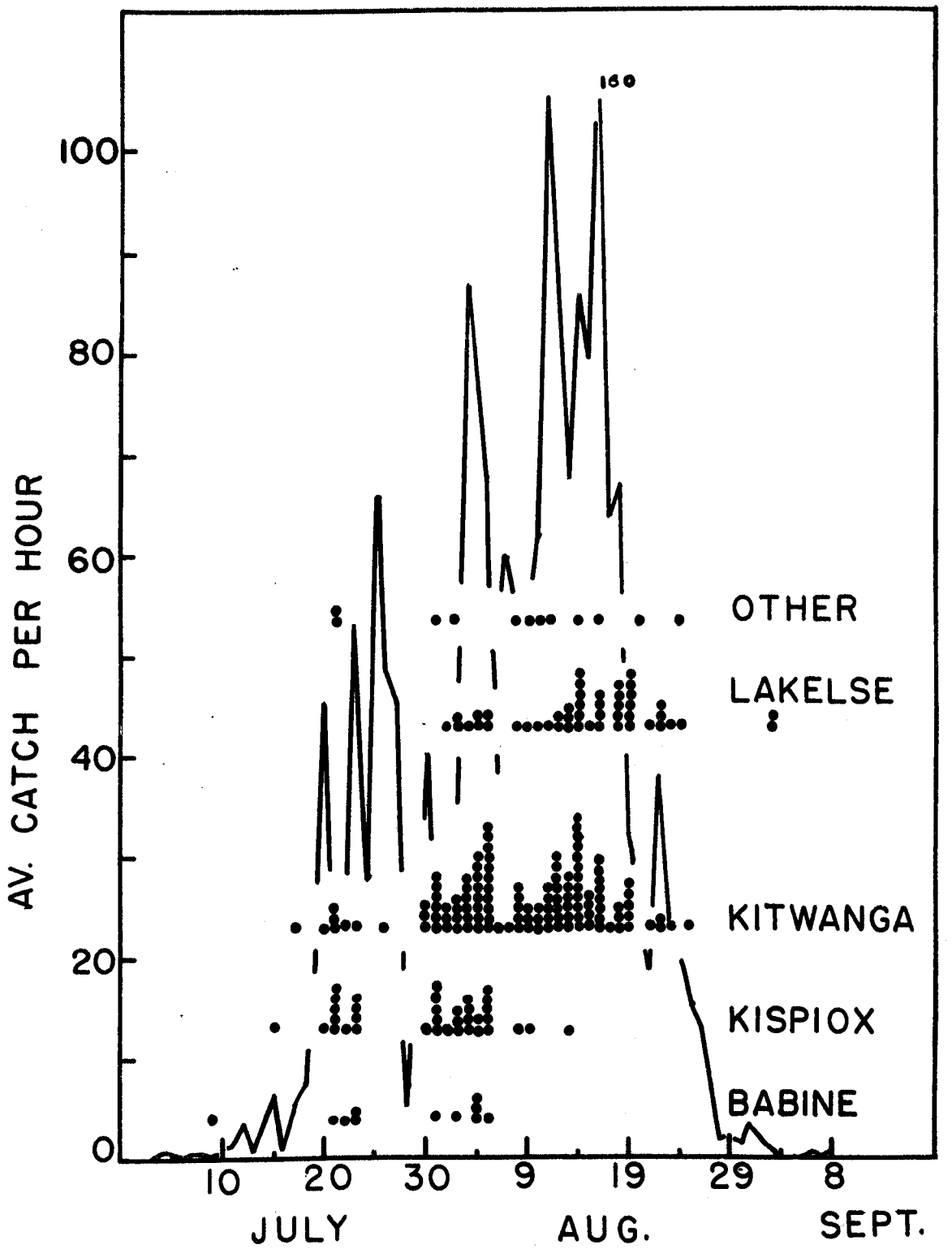
Also shown in the chart is the daily average catch per hour of pink salmon at the test fishing. These catches provide a relative picture of the progress of the runs above the boundary.

A general progression in the timing of the runs to the major spawning areas is apparent. The pinks proceeding to the Babine and Kispiox Rivers were early and contributed to the fishery from its beginning in July until approximately the middle of August. The Kitwanga River run was present in the fishery throughout most of the season and at its peak in the first three weeks in August. Pinks proceeding to the Lakelse River appeared to be the latest run to a major spawning area; they contributed to the catch mainly after the 10th of August.

The fence count at Babine and stream surveys elsewhere showed that the relative timing of the runs through the fishery was maintained onto the spawning grounds.

The 1957 data have confirmed observations made as a result of the less extensive program in 1956. There occurs, in general, a progression in the migration and spawning times of the various pink runs which is apparently related to the distance of the spawning ground from salt water. The runs proceeding furthest upstream (the Babine and Kispiox weirs) are followed by that to the Kitwanga River which is about central in the system. The last major run to ascend to the spawning grounds is that to the Lakelse River which is relatively near to the sea.

# THE TIMING OF THE 1957 PINK RUNS FROM TAG RECOVERIES




The estimated time of arrival at the upriver Skeena fishing boundary of individual tagged pinks later recovered on the indicated major spawning grounds is shown by black dots. The solid line indicates the seasonal abundance of pinks at the boundary according to test fishing catches.

Pink fry output from major Skeena spawning areas, 1957. Standard trap-netting at the mouths of major pink-producing tributaries was carried out in the springs of 1956 and 1957. The method involved fishing a small-meshed trap-net at frequent intervals during the time that fry migrate from the spawning grounds to the sea. The total catch of fry per unit effort provides a relative index of the fry output from these tributaries each year.

Trap-netting was carried out on the Lakelse, Kispiox and Kalum Rivers in 1956. This year the work was repeated on the Lakelse and Kispiox Rivers but the Kalum, found to be a relatively small pink producer, was dropped in favor of the more productive Kitwanga River.

Indices of the total fry output have been calculated on the basis of the average catch per hour adjusted by the relative efficiency of the trap. The latter was determined by the proportion of the stream width covered by the trap at each tributary.

The indices are given below with the estimated number of spawners which produced each fry run.

| Area | Parent year | Escapement | Index of total fry output |
|---|---|---|---|
| Lakelse | 1955 | 175,000 | 3.2 |
| | 1956 | 55,000 | 1.9 |
| Kispiox | 1955 | 540,000 | 10.6 |
| | 1956 | 75,000 | 1.4 |
| Kitwanga | 1955 | 125,000 | ... |
| | 1956 | 35,000 | 3.7 |

Catches of pink fry were considerably lower in 1957 than in 1956. The 1957 fry output from the Lakelse River was approximately 60% of that in 1956. The 1957 index for the Kispiox was only 13% of that of 1956.

The relatively large escapement to the Kispiox River in 1955 and the small escapement the year following produced proportionately as many fry. In other words, the percentage survivals from the larger and smaller seedings were about the same: the 1956 seeding was approximately 1/7 that of the previous year and produced about 1/7 as many fry.

The situation on the Lakelse River varied to some extent. The spawner-to-fry survival was higher in 1956-57 than in 1955-56. The 1956 escapement, which was less than 1/3 that of 1955, produced a fry output about 3/5 as large.

Since the escapement to the Lakelse and Kispiox Rivers in the past two years have comprised at least 1/2 of the total for the Skeena, their combined fry output may provide a general indication of that for the whole watershed. The total escapement in 1955 was estimated to be four times that of 1956. The data obtained from the fry trapping indicates that fry survival did not change to any considerable extent in the two years and that fry output has been roughly proportional to escapement size.

Ecology of young sockeye salmon during their lake life. This study is concentrated in the Babine-Nilkitkwa Lakes nursery area (see map) where intensive work began in 1956. Preliminary surveys of this area in the late summer and fall of 1955 indicated a total population of 50 to 60,000,000 age-0 sockeye salmon, at least 67% of which were concentrated in the 11% of the total lake area which lies north of Halifax Narrows (that is, in Nilkitkwa Lake and the North Arm of Babine Lake). Mean size of young sockeye in these regions of great concentration was much smaller than in the sparsely populated remainder of Babine Lake. It was concluded that the slow growth in areas of dense population was a result of crowding, and that the unequal distribution was a result of the unequal distribution of the spawning parent population and a limited dispersal of young from their points of lake entrance as fry--such limited dispersal being a result of the multibasin nature of this lake system.

These initial findings and conclusions were supported by the 1956 smolt estimate and the 1956 lake studies.

The seaward migration of the age-I sockeye smolts in 1956 was estimated as 20,000,000 (plus an unknown number, not likely exceeding 10,000,000 which migrated before the mark and recapture estimate went into operation). This would be of the general order of numbers one would expect from a lake population of 50,000,000 to 60,000,000 the previous fall. Also, of the 20,000,000 smolts estimated, roughly 1/2 (the earliest migrating) were very small in size (mean weight about 2 grams) as compared to the others (mean weight about 5 grams). The small smolts were believed to originate from lake regions north of Halifax Narrows and, because they were the earliest migrating, probably constituted considerably more than 50% of the run.

In 1956 the age-0 sockeye populations in Nilkitkwa Lake and the North Arm were sparse as compared to 1955 and growth was good, supporting the view that slow growth in 1955 was a result of crowding. In 1956 not one age-0 sockeye was taken in the entire lake region from 9-Mile Creek in the North Arm south to Bear Island. This lake region has only one tributary spawning ground, the Morrison River, and it had only 1,800 spawners in 1955. This result strongly supports the theory of limited distribution of young sockeye in this system from their points of entrance as fry.

A general summary of 1955 and 1956 age-0 sockeye abundance and distribution is given in the accompanying table along with the 1957 data.

Summary of 1955-57 estimated lake populations and estimates of related spawning and smolt populations

| | Number of adult sockeye spawning (thousands) | Number of age-0 sockeye in lake (millions) | Number of age-I smolts (millions) |
|---|---|---|---|
| | 1954 | 1955 | 1956 |
| North of Halifax Narrows | 261 | 35 to 45 | 10+ |
| South of Halifax Narrows | 189 | 10 to 20 | 10 |
| TOTAL | 450 | 45 to 60 | 20+ |
| | 1955 | 1956 | 1957 |
| North of Halifax Narrows | 30 | 2 to 3 | |
| South of Halifax Narrows | 31 | 3 to 5 (+6 to 9)* | |
| TOTAL | 61 | 5 to 8 (+6 to 9)* | 6 to 7 |
| | 1956 | 1957 | 1958 |
| North of Halifax Narrows | 125 | 26 | |
| South of Halifax Narrows | 163 | 31 (+26)* | |
| TOTAL | 288 | 58 (+26)* | |

* The figures in parenthesis are the additional millions estimated which were believed progeny of kokanee and residual types.

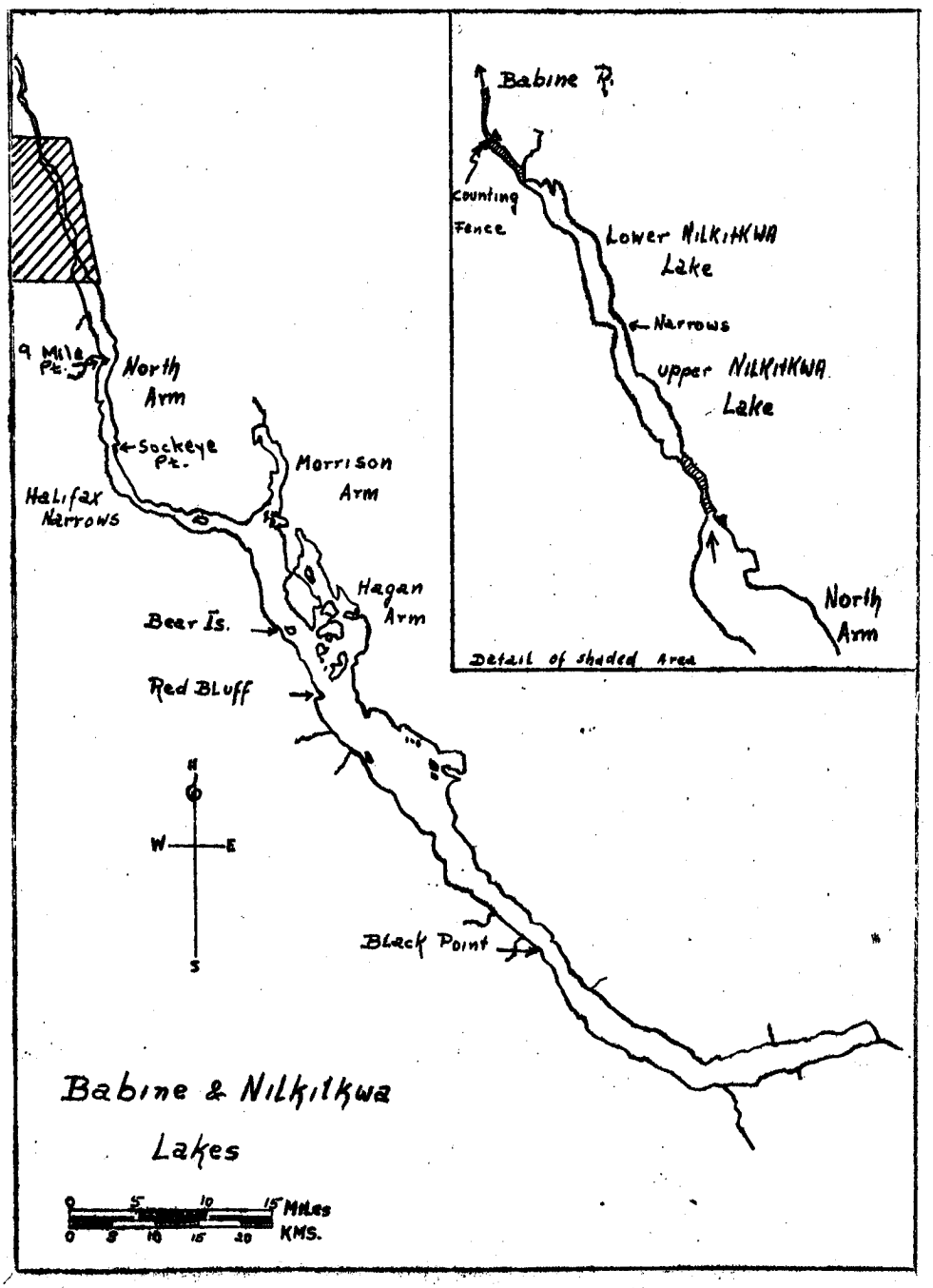
1957 Results: Babine Nilkitwa Lakes. The 1957 studies were far more intensive than any earlier.

Density and distribution of age-0 sockeye. In 1957, intensive sampling of young sockeye was carried on in five lake regions north of Halifax Narrows which are more or less discrete basins: the two halves of Nilkitkwa Lake, upper and lower (separated by a distinct narrows); and the three more or less distinct basins of the North Arm: north, central and southern. Limitation of available effort permitted only occasional sampling in regions south of Halifax Narrows. The following tabulation lists the estimated population densities and total populations of the different areas in late August, based on catch per unit of standard effort with tow-net gear:

| Lake region | Fish per acre | Total population (millions) |
|---|---|---|
| North of Halifax Narrows: | | |
| Lower Nilkitkwa | 4,860 | 2.9 |
| Upper Nilkitkwa | 5,750 | 3.5 |
| North Arm: north basin | 2,720 | 13.6 |
| North Arm: central basin | 2,050 | 5.7 |
| North Arm: south basin | 260 | 0.8 |
| TOTAL | | 26.5 |
| South of Halifax Narrows: | | |
| Halifax Narrows to Bear Is. | 50 | 0.6 |
| Morrison Arm | 90 | 0.4 |
| Hagan Arm | not sampled | ... |
| Red Bluff to Black Pt. | 680 | 31.3 |
| Black Pt. to south end | 890 | 24.9 |
| TOTAL | | 57.2* (31.5) |
| GRAND TOTAL | | 83.7* (58.0) |

* Based on plots on normal curve probability paper, the samples from regions south of Halifax Narrows appear to be composed of 2 widely overlapping size groups; the smaller, contributing an average of roughly 45% of the total, are believed to be the progeny of kokanee and/or residuals which spawned in great numbers in 1956. Thus the total estimates of sea-type progeny would be as shown in parentheses.

Growth rates of age-0 sockeye. Sampling in the five regions north of Halifax Narrows was sufficient to follow growth rates in detail. Distinctly different growth curves were shown by the fish in each of these five regions, substantiating the view that each region did have its own more or less discrete population. Expressed as the mean weight attained by mid-October, the following comparison of growth rates is presented:




Outline map of Babine and Nilkitkwa Lakes.

| Lake region | Mean weight in grams |
|---|---|
| Lower Nilkitkwa | 2.2 |
| Upper Nilkitkwa | 1.8 |
| North Arm: north basin | 3.5 |
| North Arm: central basin | 3.7 |
| North Arm: south basin | 5.+ |

Regarding growth rates south of Halifax Narrows: if the hypothesis that the populations there are composed of 2 groups holds true, fish of the larger group (progeny of sea-run sockeye) appear to have shown a growth rate most comparable to those in the south basin of the North Arm. That is, a mean weight of about 5 grams by mid-October.

Factors determining growth rate of age-0 sockeye. Most of the age-0 sockeye in all regions of this nursery area appear to have entered the lake and taken up a pelagic, zooplankton-feeding existence by late June of both years thus far studied. Barring genetic differences, it is felt that their rate of growth is largely determined by three factors: (1) temperature, (2) food abundance, and (3) competition (population density). Regarding temperature: during the period from late June to October in both of the years (1956, 1957) and in all the various lake regions under consideration there have been only minor differences in the relatively near-surface waters inhabited by these fish. It is believed that differences in growth have been a result of differences in the other two factors. The accompanying tabulation presents information on growth and these two factors.

As can be readily seen, there is no simple relationship between growth and either of the two factors individually. Also, the two factors are not independent of each other--extreme high density of the fish population contributes to lower food abundance through cropping. However, certain conclusions seem justifiable. For Nilkitkwa Lake and the north and central basins of the North Arm it appears that growth is rather constant up to population densities somewhere beyond approximately 3,000 fish per acre above which there is an inverse relationship with density. At all the lower population densities the age-0 sockeye seem to attain a weight of roughly 3.5 grams by mid-October when the mean dry weight of zooplankton (0-10 m.) is in the range of 14 to 38 mg./cu.m. The higher growth (5. grams by mid-October) shown by the fish in the south region of the North Arm and, apparently, in all regions south of Halifax Narrows, seems clearly related to the much higher levels of zooplankton abundance in these areas.

Zooplankton studies. Sampling of zooplankton was carried out at 45 stations in Babine and 6 in Nilkitkwa Lake. Limitations of available effort restricted most frequent and thorough sampling to regions north of Halifax Narrows. As in 1956, zooplankton abundance in all regions increased greatly from time of ice breakup in mid-May to late June. Highest levels were attained in regions south of Halifax Narrows and in the south portion of the North Arm, and these high levels were maintained throughout the summer and fall period of observation. In the other regions zooplankton decreased considerably through July to lower levels which persisted throughout the period of observation. In these regions it was interesting to note a sharper decrease to lower levels in 1957 than did occur in 1956; this probably was a reflection of the much greater density of young sockeye in 1957 than in 1956.

| Lake region and year | Mean weight of age-0 sockeye in mid-October (in grams) | August Population density age-0 sockeye per acre | July-October Mean dry weight of zooplankton in surface 10 meters (mg./cu.m.) |
|---|---|---|---|
| Lower Nilkitkwa 1957 | 2.2 | 4,860 | 9 |
| Upper Nilkitkwa 1957 | 1.8 | 5,750 | 7 |
| North Arm: north basin 1957 | 3.5 | 2,720 | 22 |
| North Arm: central basin 1957 | 3.7 | 2,050 | 38 |
| Nilkitkwa 1956 | 3.7 | 1,420 | 14 |
| North Arm: north basin 1956 | 3.6 | 50 | 34 |
| North Arm: south basin 1957 | 5.+ | 26 | 60 |
| Babine: Black Pt. to south end 1957 | 5.+ | 890 | 65* |

* All other regions south of Halifax Narrows show comparably high plankton abundance.

Preliminary findings with sea-scanar echo-sounding gear. Preliminary observations with a sea-scanar were made at Babine Lake in 1957. This instrument was installed in a river-type boat, the unsuitability of which restricted observation largely to the more protected waters north of Halifax Narrows. The high sensitivity of this instrument proved sufficient for detection of age-0 sockeye. The most important findings concerned vertical and horizontal distribution.

(a) Vertical distribution. Observations to date indicate a daylight distribution of young sockeye throughout the surface 6 meters, with greatest concentration at about 3 meters depth. In the evening twilight there is a mass movement towards the surface with a maximum near-surface concentration occurring with the early moments of darkness. After dark there appears to occur a slow settling to greater depths which proceeds until the first moments of daylight. Then a few fish start appearing near the surface and soon after they have all taken up their typical daytime distribution in the surface 6 meters.

(b) Horizontal distribution. Observations to date indicate that young sockeye (and other pelagic fish) in any one basin frequently show an extremely non-uniform distribution. Horizontal concentration appears to be related to lake circulation.

Further observations will be necessary to evaluate the usefulness of scanar records in estimating numbers of young fish.

Size of Babine sockeye smolt runs, 1951-1957. Since 1951 the size of sockeye smolt runs out of the Babine watershed has been estimated by means of a marking and recovery technique using smolt traps at the outlets of Babine and Nilkitkwa Lakes. From the estimates so obtained and from estimates of potential egg depositions in the spawning years it has been possible to calculate the survival from egg to smolt.

The 1957 smolt run, using the technique used since 1951, was estimated to be 6.4 million. The method employed involves the capture and marking of portions of the run as it passes the outlet of Babine Lake, and the subsequent recovery of some of the marked fish in catches eight miles downstream at the outlet of Nilkitkwa Lake. Ratios of marked to unmarked smolts in the samples are used to estimate the size of the run.

The total numbers of smolts marked and released, the total numbers of marked fish recovered, and the total samples examined each year are given in the following table. Final estimates of the run for each year have been adjusted to conform with known changes in the mark/catch ratio at Fort Babine and to allow for late installation of trapping structures in years when portions of the run had passed before trapping began.

| Year | Number of smolts marked | Number of marked smolts recovered | Size of sample examined | Estimated size of run | 95% limits |
|---|---|---|---|---|---|
| 1951 | 34,689 | 200 | 21,855 | $4.2 \times 10^6$ | 3.7 to 4.8 $\times 10^6$ |
| 1952 | 33,880 | 646 | 86,391 | $4.5 \times 10^6$ | 4.2 to 4.9 $\times 10^6$ |
| 1953 | 61,950 | 2,498 | 124,396 | $3.1 \times 10^6$ | 3.0 to 3.2 $\times 10^6$ |
| 1954 | 42,631 | 1,156 | 81,082 | $2.8 \times 10^6$ | 2.7 to 3.0 $\times 10^6$ |
| 1955 | 113,931 | 1,287 | 270,546 | $30.9 \times 10^6$ | 28.6 to 32.6 $\times 10^6$ |
| 1956 | 72,707 | 1,802 | 649,588 | $21.1 \times 10^6$ | 18.5 to 22.9 $\times 10^6$ |
| 1957 | 68,666 | 1,496 | 170,772 | $6.4 \times 10^6$ | 6.0 to 6.8 $\times 10^6$ |

Certain errors associated with the possibility of increased mortality due to marking by fin-clipping and the likelihood of disproportionate intensities of marking with relation to the run passing Fort Babine each day cannot be assessed and have been assumed to be constant each year.

Assuming that all smolts are 1-year-olds, survivals from eggs potentially available (in spawners) to emigrating smolts are shown in the table below for the brood years from 1949 to 1954.

| Brood year | Eggs potentially available | Year smolts appear | Estimated number of smolts | Survival egg to smolt |
|---|---|---|---|---|
| 1949 | $853 \times 10^6$ | 1951 | $4.2 \times 10^6$ | 0.49% |
| 1950 | $591 \times 10^6$ | 1952 | $4.5 \times 10^6$ | 0.76% |
| 1951 | $194 \times 10^6$ | 1953 | $3.1 \times 10^6$ | 1.60% |
| 1952* | $409 \times 10^6$ | 1954 | $2.8 \times 10^6$ | 0.68% |
| 1953 | $1{,}241 \times 10^6$ | 1955 | $30.9 \times 10^6$ | 2.49% |
| 1954 | $1{,}020 \times 10^6$ | 1956 | $21.1 \times 10^6$ | 2.07% |
| 1955 | $105 \times 10^6$ | 1957 | $6.4 \times 10^6$ | 6.10% |

* Only about one-third of this run spawned successfully, thereby reducing the potential egg deposition and raising the estimate of smolt survival to about 2%.

Sampling of Babine sockeye smolts. Since 1950, samples of sockeye smolts have been collected at the outlets of Babine and Nilkitkwa Lakes. Examination of the smolts from 1950 to 1956 indicated that the sex ratio, though indicating slight variation from year to year, did not depart significantly from a 50:50 assumption. Scale examination has shown, as indicated in the following table, that the smolts are predominantly 1-year-old fish.

| Year | 1-year-old | 2-year-old |
|---|---|---|
| 1950 | 2,616 | 14 |
| 1951 | 2,795 | 10 |
| 1952 | 1,654 | 11 |
| 1953 | 1,234 | 22 |
| 1954 | 972 | 0 |
| 1955 | 1,944 | 2 |
| 1956 | 2,208 | 7 |
| 1957 | 1,657 | 53 |

Comparison of the average lengths and weights of 1-year-old smolts in the table below indicates differences in the average size from year to year:

| Year | No. in sample | Fork length (mm.) | | Weight (gm.) | |
|---|---|---|---|---|---|
| | | Range | Average | Range | Average |
| 1950 | 2,616 | 54-104 | 83.0 | 1.3-10.6 | 5.5 |
| 1951 | 2,795 | 58-111 | 82.4 | 1.6-12.8 | 5.6 |
| 1952 | 1,654 | 55-109 | 80.4 | 1.3-12.7 | 4.9 |
| 1953 | 1,234 | 70-111 | 86.0 | 2.4-13.5 | 6.2 |
| 1954 | 972 | 62-110 | 86.4 | 2.8-12.6 | 6.3 |
| 1955 | 1,944 | 56-105 | 81.4 | 1.6-11.0 | 5.4 |
| 1956 | 2,208 | 50- 99 | 77.8 | 1.1-10.1 | 4.7 |
| 1957 | 1,657 | 67-102 | 84.2 | 2.8-11.1 | 5.9 |

It has been demonstrated that sockeye smolts can vary considerably in size from one nursery area to another within Babine Lake and from Nilkitkwa Lake. The 1957 smolts were fairly uniform in size and on the average were larger than in most years.