DIGEST OF INTERIM REPORT

SKEENA RIVER SALMON INVESTIGATION

1944 to 1948

The present report briefly summarizes the findings of a five-year investigation of the salmon of the Skeena River system. The studies have covered nearly all phases of salmon production and propagation including the history and trends of the commercial fishery from early years up to 1948, the behaviour and movements of the adult salmon, the location and effect on migration of obstructions and hazards, the extent and influence of the Indian fishery, the size and distribution of the escapements, the condition of the spawning grounds, the conditions in the lake nursery areas, factors relating to predation and competition by other species of fish and the predation by other animals.

As a result of the analysis of the data collected, the following conclusions, suggestions and recommendations are offered:

(1) There has been over the period of the fishery an appreciable and fairly gradual decline in the sockeye salmon population of the Skeena system while the pink has suffered a more sudden drop in recent years. The spring, coho and, since 1935, the chum have maintained their abundance.

(2) The decline in the sockeye is attributed mainly to the commercial fishery which has increased in efficiency over the years. In the case of the pinks, major blame has been placed on weather conditions as they produce adverse effects on spawning, incubation and alevinage. In both instances, the decline, once started, has undoubtedly been furthered by many other factors, e.g. Indian fishery, predation, etc. Any corrective measures should, therefore, be designed to remedy all

and should be implemented concurrently.

(3) For sockeye salmon consideration should be given to building up all runs by increasing the escapement but more particular attention should be applied to the seasons of low productivity which recently have occurred twice in each five years. In 1949 and 1950, when the runs are expected to be high or medium, it is suggested that fishing open earlier, June 15 to June 19, and be definitely closed on August 10, that the northern ocean boundary of the Skeena gill-net area be drawn in to point Ryan where it was in 1935, and that twelve hours be added to the present weekly closed period making sixty hours in all. These changes should (a) permit more even exploitation of the populations in that the early lower-river runs and five-year-old males will be more heavily fished and the four-year-old fish going to upriver localities protected, (b) enable the separation of the Nass and Skeena fish in that there would be a distinct gap between the areas, and (c) increase the escapement with the additional protection. In 1951, when a low run is indicated, the river boundaries should be moved downstream and full-week closed periods judiciously implemented.

(4) Sufficient protection should be given the pink salmon by the sockeye regulations. No relaxation can be considered until the populations increase.

(5) The whole question of the Indian fishery should be reviewed in the light of the findings with a view to stating clearly and enforcing the regulations under which fishing is carried out. Injurious methods of catching, and the practices of bartering and sale must be more rigidly controlled.

(6) Another fishway should be installed at Moricetown falls to ease the

passage for all salmon and open a large expanse of spawning ground for the pinks. The Upper Bulkley should be cleared as the first step in re-establishing a run there. A thorough and continuous programme of stream improvement should be commenced to ameliorate the effects of weather conditions and remove all obstructions to migration. Engineering surveys should be made in certain areas, e.g. Babine, to determine the best methods of expanding the spawning beds.

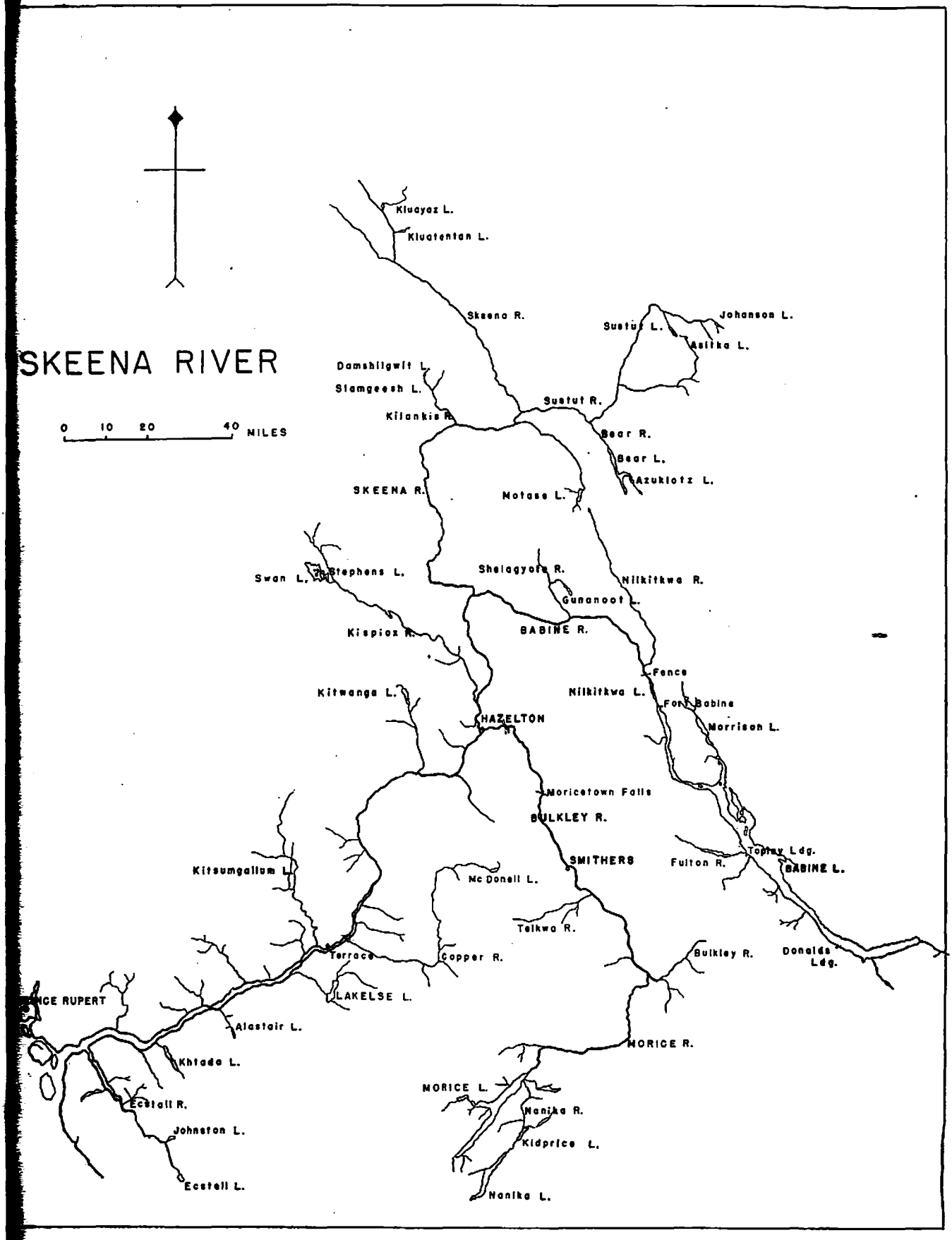
(7) The reduction in numbers or elimination of the harbour seal in the lower Skeena should be continued and encouraged. Further study is essential on the control of predator and competitor fish to increase the production of salmon.

(8) In addition to the Dominion Department of Fisheries and the Fisheries Research Board of Canada which are primarily responsible, the British Columbia Department of Fisheries, the British Columbia Game Commission, the Dominion Department of Indian Affairs, the fishing industry and the fishermen will be vitally concerned in the implementation of the recommendations and might profitably be allowed to discuss the problems as their interests appear. The actual application of regulation will no doubt be the responsibility of the Dominion Department of Fisheries through its Western and Inland Fisheries and Fish Culture Development branches. The Fisheries Research Board of Canada with this report has only discharged the first portion of its responsibility and should continue the following suggested two-phase programme:

(a) An <u>applied phase</u> in which its scientists, now familiar with the area and problems, advise as to the proper method of rehabilitation, generally supervise the work and check the results which accrue. Concurrently, they can attempt to obtain more accurate

statistics of catch and more accurate information on escapement.

(b) A research phase in which, working in a selected area such as Lakelse, they can investigate in more detail the questions of propagation, predation, competition and stream improvement. In another area, e.g. Babine, one or two tributaries might be selected for studies of spawning and incubation with a view to outlining methods of increasing the efficiency in these phases of the life history.


SKEENA RIVER
0 10 20 40 MILES
Kluayaz L.
Kluatantan L.
Skeena R.
Sustut L.
Johanson L.
Asitka L.
Damshilgwit L.
Slamgeesh L.
Sustut R.
Kitanki R.
Bear R.
Bear L.
Azuklotz L.
SKEENA R.
Motase L.
Swan L.
Stephens L.
Shelagyote R.
Nilkitkwa R.
Gunanoot L.
BABINE R.
Kispiox R.
Fence
Kitwanga L.
Nilkitkwa L.
Fort Babine
HAZELTON
Morrison L.
Moricetown Falls
BULKLEY R.
Topley Ldg.
SMITHERS
Fulton R.
BABINE L.
Kitsumgallum L.
Mc Donell L.
Telkwa R.
Terrace
Copper R.
Bulkley R.
Donalds Ldg.
LAKELSE L.
Alastair L.
MORICE R.
Khtada L.
MORICE L.
Ecstall R.
Nanika R.
Johnston L.
Kidprice L.
Ecstall L.
Nanika L.

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Skeena River Salmon Investigation

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ORIGIN

As early as 1937, preliminary examination of the salmon pack figures for the Skeena river indicated that at least in the case of the sockeye salmon, the most important species, a gradual decline was occurring. In that year and in 1938 and 1939, the Fisheries Research Board conducted general surveys of the area. At the time, however, it was felt that the restrictions on fishing then being imposed by the Department of Fisheries would rectify the situation and accordingly the investigation was discontinued. When the low catch of 1943, ca. 28,000 cases, followed that of 1942 which was almost as small, ca. 30,000 cases, extreme concern was felt in view of the fact that never had two successive catches been so far below 50,000 cases and in two years over 184,000 had been attained. As a result the Chief Supervisor, through the Deputy Minister, requested the Fisheries Research Board to examine the situation critically.

During the spring of 1944, a programme for that year was outlined at the Pacific Biological Station involving a general survey of the industry, the fishery, and the river system in order to familiarize the investigators with the drainage and the problems which might be encountered in the conservation of the salmon therein. When this was carried through in the summer, there was available a much better understanding of the situation as a basis for laying down the ultimate aims of the investigation. After complete and thorough discussion at the Annual Meeting of the Board in Ottawa at Christmas, the scope was broadened to include not only sockeye but all species of salmon and definite terms of reference were laid down as follows:

"1. The following apply to all species of salmon on the Skeena river, and, in particular, the sockeye.
2. The investigation is to be directed to ascertain whether there is or is not a true decline in the salmon population of the Skeena, and not a transient decline forming part of a natural cycle.
3. If there is such a decline, to what species does it apply?
4. If there is such a decline, does it apply to salmon throughout the whole river system or only to some part of the system?
5. If there is such a decline for any species, the investigation is to be directed toward determining its cause or causes, and whether these be natural such as, for example, silting up or other interference with the spawning beds; loss from predator birds, fish etc., or artificial, such as overfishing, either within the river system, or in the approaches to the Skeena, or through distant commercial fishing.
6. If there is a decline, specific recommendations should be formulated as to the best remedial measures.
7. If there is found to be no decline, such recommendations should be made as may seem feasible to increase the catch without producing a decline.

8. Every endeavour must be made so that the investigation can be completed by the end of the summer of 1948, and a report, covering the points in this directive, is to be made to the Annual Meeting of the Board in January, 1949, in such form that, if approved, it can immediately be transferred to the Department."

PROBLEMS

The general surveys of 1937, 1938 and 1939 coupled with the more intensive examination in 1944, definitely indicated that no evident single factor could without further investigation be charged with limiting the production of salmon on the Skeena. There was nothing which attracted attention like the obstruction at Hell's Gate on the Fraser. Accordingly the investigators gave serious consideration to all factors which might affect production of anadromous fish. Eventually the ideas in so far as sockeye were concerned were drawn together and illustrated in a diagram (Figure 1). This chart will apply in a general way equally as well for the other species if it is modified and simplified to cover the extent of penetration into fresh water and the time spent therein.

In Figure 1 are shown graphically and proportionally the results of the studies on natural propagation obtained at Cultus lake on the Fraser river by Dr. R.E. Foerster. Comparative figures for Karluk, Alaska, obtained by Mr. J.T. Barnaby, are also recorded but not graphed proportionately. At each stage, therefore, is available the latest information on the percentage of sockeye of a given size which remain in relation to eggs deposited. Outside the semicircle are listed most of those factors which may limit the salmon at each stage of the life history while on the inside are printed the possible remedies which might be applied. The main point which should be stressed is that the natural relationships in the life cycle of the sockeye, and in fact all salmon, are complex and thus make conservation not simply a matter of adjusting one factor but that of establishing a sound balance between many.

PROGRAMME

With the full appreciation of the complexity of the situation, the expanse of the area, and with the knowledge that no one factor could be considered as definitely limiting the production, the Skeena river programme was organized to cover all the phases rather than to concentrate on localized specific problems. During 1945, the investigation was divided into the following sections: Migration Studies, Lake Surveys, Stream Surveys, Study of Obstructions, Statistics - commercial and Indian, Age Determinations and Study of Mammalian Predators, (harbour seals). In each of these subdivisions, a chosen investigator was free to organize and carry out more particular investigations so long as his work contributed to the final solution of the terms of reference. In some instances, e.g. the study of statistics, it was first necessary to assess the reliability of the information already available and then to set down and recommend a sounder method for future collections. In others, such as lake surveys where no data were

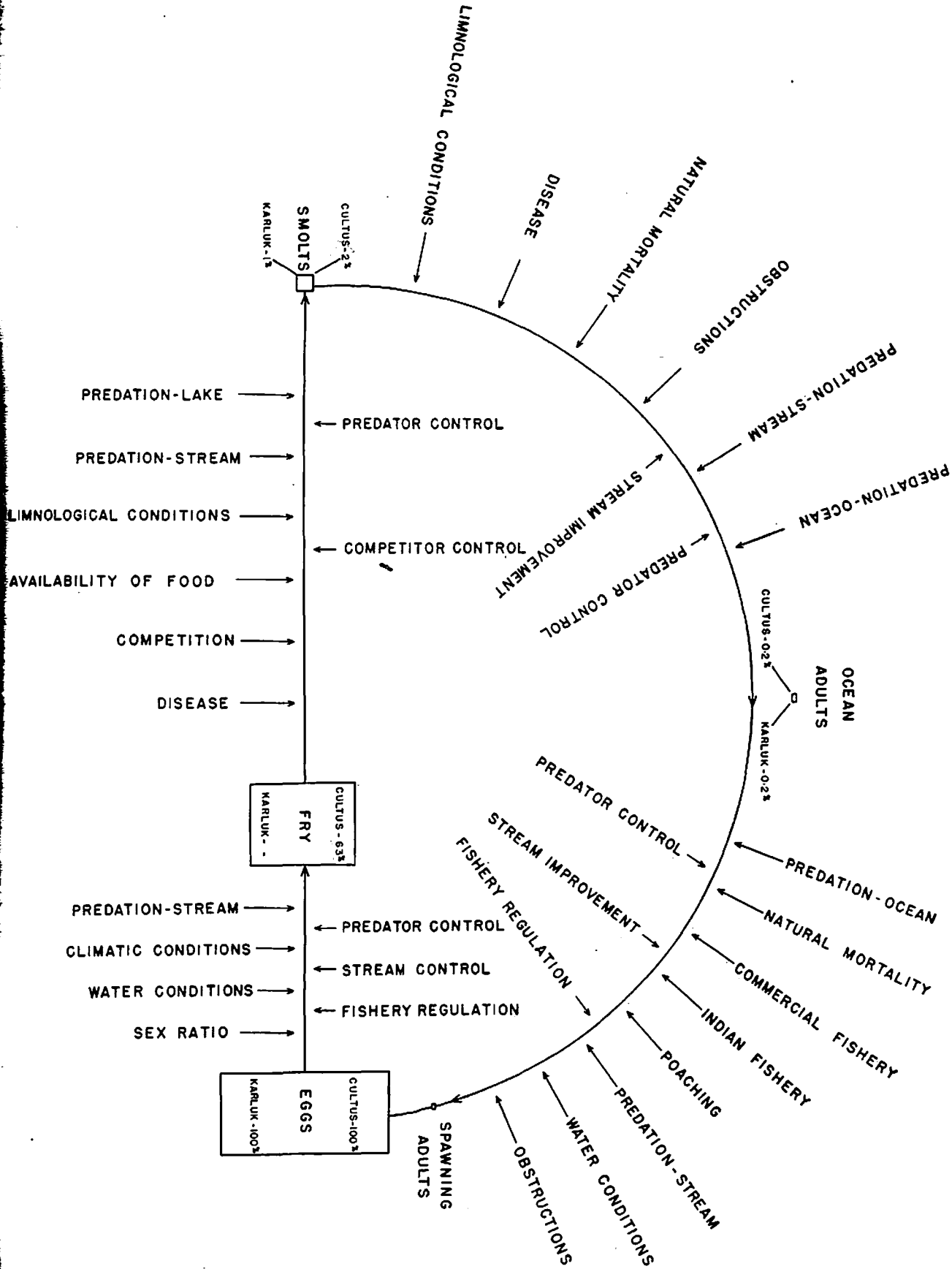
SMOLTS
KARLUK-1%
CULTUS-2%
LIMNOLOGICAL CONDITIONS
DISEASE
NATURAL MORTALITY
OBSTRUCTIONS
PREDATION-STREAM
PREDATION-OCEAN
PREDATOR CONTROL
STREAM IMPROVEMENT
PREDATION-LAKE
PREDATOR CONTROL
PREDATION-STREAM
LIMNOLOGICAL CONDITIONS
COMPETITOR CONTROL
AVAILABILITY OF FOOD
COMPETITION
DISEASE
OCEAN ADULTS
CULTUS-0.2%
KARLUK-0.2%
FRY
KARLUK--
CULTUS-63%
PREDATOR CONTROL
STREAM IMPROVEMENT
FISHERY REGULATION
PREDATION-OCEAN
NATURAL MORTALITY
COMMERCIAL FISHERY
INDIAN FISHERY
POACHING
PREDATION-STREAM
WATER CONDITIONS
OBSTRUCTIONS
PREDATION-STREAM
CLIMATIC CONDITIONS
PREDATOR CONTROL
STREAM CONTROL
WATER CONDITIONS
FISHERY REGULATION
SEX RATIO
EGGS
KARLUK-100%
CULTUS-100%
SPAWNING ADULTS

Fig. 1

accumulated, definite standard procedures had to be selected, adapted, and outlined from a knowledge of the field of limnology (fresh-water biology) in order that pertinent information might be gathered in a similar manner from each body of water and that the results obtained might be comparable from one to another.

In 1946 a modification was introduced in stressing the work at Lakelse lake, an area of reasonable size and accessibility, in the expectation that a more complete examination of conditions therein would serve to elucidate similar occurrences elsewhere. At the same time general surveys were continued in areas not previously inspected. Other refinements were attempted particularly in connection with the estimation of spawning escapements by such methods as more regular and definite stream examinations and the installation of counting fences like that on the Babine river.

With the commencement of the year 1947, it was realized that the programmes must be restricted, designed and directed mainly toward amplifying and elucidating the data already collected so that the general report, stipulated in the last term of reference, would be available at the end of 1948. The decision was therefore reached to carry on the essential general phases - marking, tagging, stream surveys, etc., to endeavour to reach and survey such areas as had not yet been visited, and otherwise to concentrate on detailed work in the Babine and Lakelse areas.

With the beginning of 1948, analyses of the data on file had indicated a number of problems which needed answering for complete interpretation of the full information. Sufficient general material was on record to make unnecessary further lake surveys. For these reasons, marking and tagging were continued and lake surveys were limited to filling in the data at Babine and further concentration at Lakelse. The statistical work resolved itself into an effort to outline the behaviour of the runs in the present season and summarize the essential phases for presentation. Stream surveys, including the operation of the Babine fence and the installation of a new structure at Lakelse, were stressed to round off the history of the escapement.

In short, the history of the investigation has been a general survey during 1944 to permit the outlining of a complete programme, expansion and wide examination of conditions in 1945 and 1946, restriction in 1947 to phases essential to the first general report in 1948 and further restriction and concentration in 1948. At all times, however, attention has been given to the possible continuance of the investigation to gather further data considered essential to the solution of salmon conservation problems generally. For this reason, in experimental areas apparatus of a more permanent nature has been installed.

RESULTS

Because in this particular case it is desired that certain questions set down in the terms of reference be answered at a stipulated time, and that recommendations be made for a definite purpose (Term of Reference #8), the present summary will be brief, containing merely terse statements of the findings and conclusions. The detail of the data on which the deductions are based, and the manner in which they have been derived, are described in the attached appendices to which frequent and appropriate reference is made.

Terms of Reference 2 & 3 (App. 1)

Is there or is there not a true decline in the salmon population of the Skeena and not a transient decline forming part of a natural cycle? If there is a decline, to what species does it apply?

In order to obtain a clear picture of what has happened or is happening to the salmon populations of the Skeena, it is necessary to study the history over all the period for which information is available. Since the total population is catch plus escapement, not only should a complete outline of commercial exploitation be drawn but the spawning records should also be examined. For instance, it is possible though perhaps not probable, that a rise in catch might be compensated by a fall in escapement and vice versa, with the result that the total population would remain the same. The study must also be extended over as long a period of years as possible so that the effect of long term natural fluctuations in abundance, if they occur as in the case of some other animals, e.g. lemmings, may be detected.

In Appendix No. 1, there is outlined the methods of approach toward gathering and summarizing the pertinent data, the difficulties encountered through inaccurate and incomplete statistics, and the conclusions which may be drawn after due allowance has been made for the shortcomings.

Sockeye Salmon:- The Skeena river sockeye salmon catch rose with the development of the fishery during the period from 1880 to 1900 to an average of over 100,000 cases (ca. 1,200,000 fish) annually. From 1904 to 1924, although the catch fluctuated around an average of 107,000 cases to a high of 187,000 in 1910 and a low of under 53,000 in 1913 the trend line indicates an over-all decrease of about 8,000 cases in the annual figure during the 21 years (Fig. 2). Similarly the catch from 1925 to 1945 fluctuated greatly and has been declining (ca. 12,000 cases for the period). For some reason, however, the trend line for the last period (1925-1945) is about 30,000 cases below that for 1904 to 1924. This sudden change could have been due to such occurrences as the decrease in Japanese fishing licences, the lowering of the river fishing boundaries, the revision in method of recording in an attempt to separate the sockeye actually caught on the Skeena from those packed there, etc., all of which events took place about the time specified.

Over the whole recent period, 1904 to 1945, a definite decline must be admitted amounting to approximately 50 per cent. or 59,000 cases in the average annual catch in 41 years. The main drop apparently occurred between 1915 and 1935 when the trend line indicated a decrease of 23,000 cases in 21 years.

Although the records of spawning escapements are very rough and at times inaccurate, it is nevertheless felt that they at least indicate any such large increase or decrease which would be necessary to balance small or large catches respectively if the total population remained unchanged. There is no indication whatsoever that this escapement consistently varies in an inverse manner to the catch. Although fluctuations are evident, there is no doubt that the escapement has gradually fallen and consequently with the drop in catch above indicated, the total population (catch plus escapement) has gone down.

The conclusion is obvious therefore that after an early rise in catch when the virgin fishery was being exploited up to 1904, there was gradual decline in the Skeena sockeye populations. Between 1915 and 1935 the drop

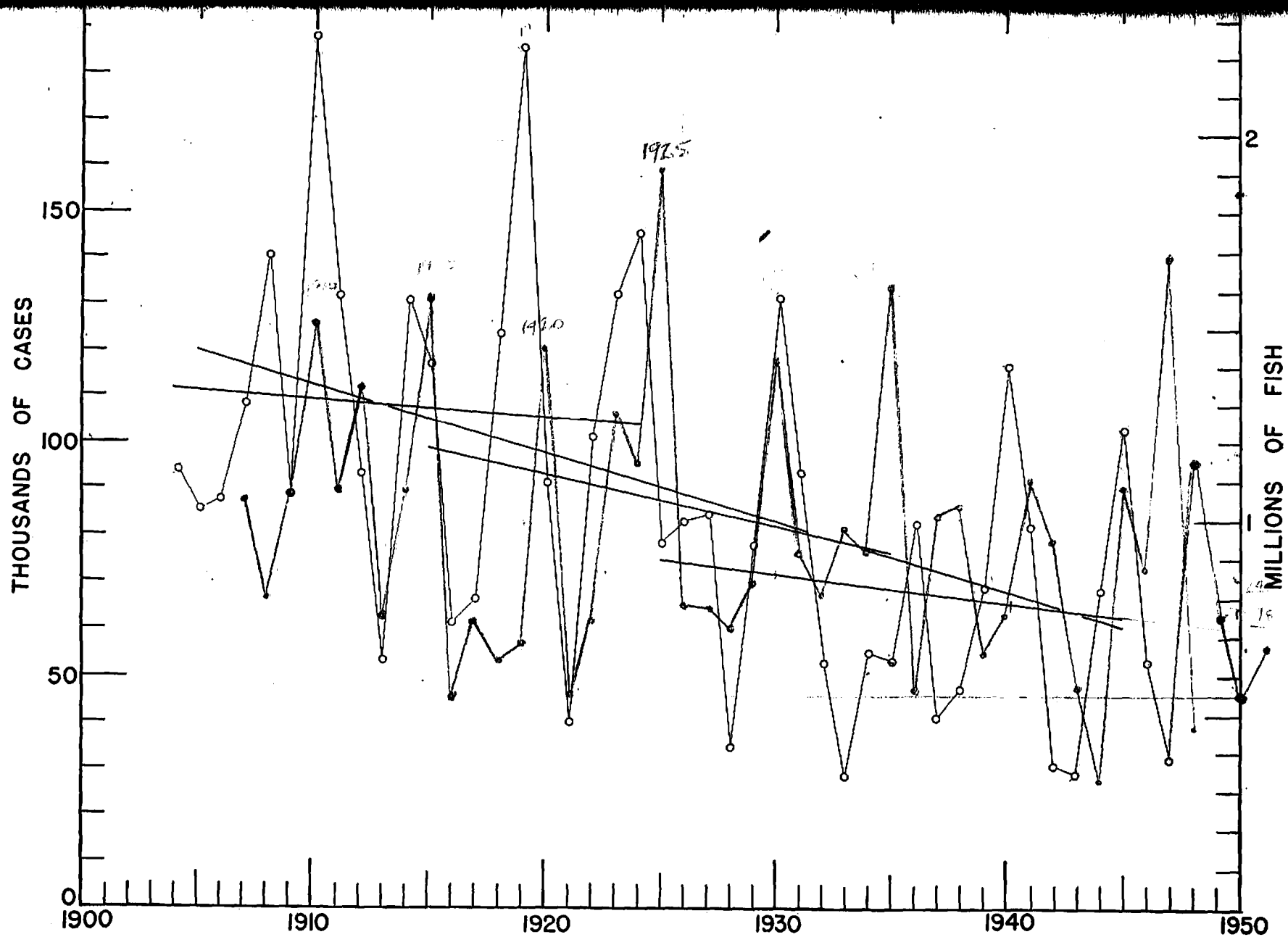
THOUSANDS OF CASES
150
100
50
0
1900
1910
1920
1930
1940
1950
MILLIONS OF FISH
2
1925
1940

FIGURE 2

was of the greatest magnitude when the effort was relatively heavy. Whether the lowest point has now been reached cannot at the present moment be definitely indicated since the result will depend on the effort expended and the regulatory action taken.

Pink Salmon:- The catch of pink salmon (Fig. 3) on the Skeena increased relatively steadily until 1930 as a possible result of the additional exploitation brought about by a more favourable economic demand. A drastic failure occurred in 1932 and since that time, the largest cycle (the even-numbered years) has never recovered. The odd-numbered years gradually became the largest up to the high pack of 1945. In both 1946 and 1947 the runs failed.

In considering the record for the escapement of pink salmon, it soon becomes apparent that the numbers which reach the spawning beds are no true indication of the size of run which may result in the cycle two years later. Certainly no compensation is evident for the severe drop in the even years since 1930 and no proven explanation is available for the failure in the two most recent years. The conclusion must be accepted that the pink salmon run (catch plus escapement) has declined very perceptibly.

Spring Salmon:- The average catch of spring salmon on the Skeena river proper from 1925 to 1945 was about 8,000 cases annually. During the past two years, it has amounted to more than twice that figure. In general, although there appears to have been a slight drop since 1920, this is not considered serious because of the difficulty of evaluating its true significance arising from the trouble encountered in outlining an accurate picture of the take by the fresh-fish industry to which 60 to 90 per cent. of the product is contributed.

The species spawns mainly in the larger swifter rivers such as the Morice and Bear where estimates of escapement have either been discontinuous or are difficult to reach. From records available, however, there is no real indication of a downward trend in the number of spawners.

The conclusion is sound that the spring salmon are at least maintaining themselves.

Coho Salmon:- The average annual catch of coho salmon in recent years on the Skeena (Fig. 3) has been about 27,000 cases (roughly 15 per cent. of the total for British Columbia). It has apparently increased steadily from 1905 until just recently to reach the largest catches on record in 1938 and 1941. Accurate estimates of escapements are difficult since the species spawns in almost all rivers often in fairly deep water and late in the autumn. There is, however, no reason to believe that the escapement has declined and, therefore, no true decline in the population has yet occurred.

Chum Salmon:- The Skeena river chum salmon catch (Fig. 3) has never been large by comparison with the others and it has fluctuated in a manner similar to that throughout the rest of British Columbia. From the start of the fishery about 1915 until 1932, the annual catch fluctuated greatly. Recently it has remained more uniform. The 1946 take was very large as was that for 1947. These facts coupled with the observations that the escapements were normal, would certainly show that the chum populations, though relatively small, have not decreased to any serious extent.

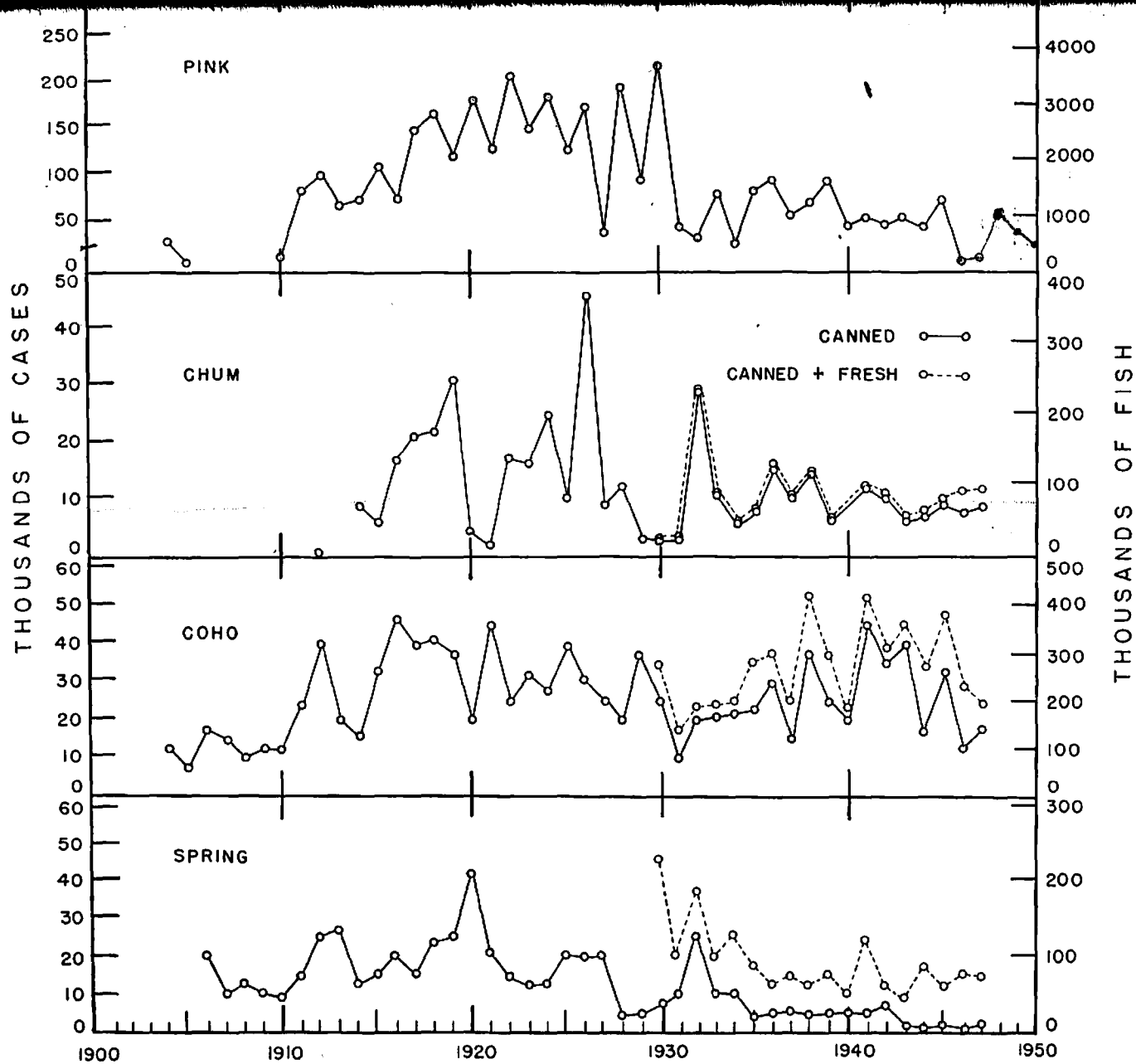
PINK
CHUM
COHO
SPRING
CANNED
CANNED + FRESH
THOUSANDS OF CASES
THOUSANDS OF FISH
1900
1910
1920
1930
1940
1950

FIGURE 3

In summary, therefore, it would appear that true and definite declines in population abundance are demonstrable for the sockeye and pink salmon, but that the spring, coho and possibly the chum have not yet suffered a similar fate. In the consideration which follows, the main emphasis will be placed on the sockeye and pink which have shown the drop, with only particular references to the others when necessary.

Term of Reference 4. (App. I & II)

Does the decline in salmon apply throughout the whole river system or only to some part of the system?

Sockeye Salmon:- One method of demonstrating the periods of decline of the sockeye salmon is to use the "Index of Success of Return" employed by Dr. W.F. Thompson in which years of "depletion" are considered as those in which the catch failed to repeat itself on the basis of age composition and the size of the catch in the parent year or years. From 1942 to the present, for instance, the decrease has been almost entirely due to the failure of the 4_2 group. Age composition studies have shown that most sockeye salmon of this age class spawn either in the Lower Skeena area (Lakelse, etc.) or in the Upper Skeena above Hazelton (Babine, etc.), but few appear in the Bulkley system. Since it is known that few early-running Lower Skeena sockeye are taken in the commercial catch and thus have little effect on the fishery, the particular "drop off" in question could be attributed to the failure of the Upper Skeena fish. Thus while the rule is that the decline is general throughout the system, the possibility is indicated that on occasion it can be limited to part of it.

Pink Salmon:- Since pink salmon all mature in the autumn of their second year, the even-numbered and odd-numbered seasons represent distinct populations. It is also true that in the earlier years of the fishery heavy runs appeared in different rivers in each of the two cycles, viz.- in Babine and Bear in the odd-numbered and in Lakelse, Kitwanga, Kispiox and other lower Skeena streams in the even.

Thus, when the large cycle of 1930 failed to repeat itself in 1932, the decline in large part must have been due to failure in the lower river districts. The cause, though unknown, must have been similar to that in other parts of British Columbia which experienced a comparable condition. Thereafter the odd-year cycle built up to a peak in 1945, a situation which was not only attributable to response in the Babine and Bear districts but also to increasing abundance in the lower river areas. The small catches of 1946 and 1947 coupled with small escapements indicate failure in both runs and over the whole river system.

It must be concluded, therefore, that in the case of pink salmon there have been true declines, but not such regular and perhaps predictable ones as in the case of sockeye. These declines up to the present have been mainly in one part of the system but recently the whole drainage seems to be affected.

Term of Reference 5 (App. 1 to 12)

Possible Causes of Declines in Population

In view of the fact that the investigation was to be directed toward determining the causes of such drops in population as were found, or, in the event that there were no declines, toward increasing the numbers to increase the catch without producing a decline, many factors were examined to determine their relationship to the condition. In the present section, these are briefly discussed for purposes of information and record. Later under "Discussion and Recommendations" priority in blame and responsibility is assigned to those deemed important.

Natural Causes

(1) Climatic Conditions (App. 7B)

The climate of the Skeena drainage varies from the coast inland from moderate temperatures and heavy precipitation near the ocean to more extreme temperatures and low precipitation as the eastern side of the Coast range is passed beyond Terrace. One hundred miles or more from the sea the rainfall rarely exceeds an average of two inches per month, and, although high temperatures are infrequent, extremes of low temperature do occur.

In the available series of weather records, occasional exceptional variations are recognizable, e.g. the extremely heavy rainfall over the whole drainage in 1939, but these exceptional changes have not occurred with sufficient regularity to produce a definite cyclic or rhythmic variation. Over the whole period of the fishery there is not evident above and below the annual means of temperature and precipitation any great variation. Climate is therefore relatively constant and could not be considered as having caused the decline over the long-term period.

While the climate generally may have had little effect on the salmon runs, adversities in weather can and have been serious when they occurred at critical stages of development. A lowering of propagation efficiency has certainly resulted when there was not sufficient water to permit the fish to reach the spawning areas. Extreme temperatures and drought have on occasion caused losses both at spawning time and during incubation. The area of spawning ground available for use has been limited when the rivers were low through lack of rainfall. Sudden freshets have washed out developing eggs. Reduced flow coupled with heavy frost and lack of snow cover has resulted in freezing of eggs. Low water in the spring has made it impossible for the fry to move out of the high gravel bars.

In the case of the sockeye salmon in the Skeena, there are factors which compensate for the adverse effects of weather. The species spawns over the whole system and is unlikely to encounter bad conditions throughout in any one year. On the average the weather may be said to be favourable for the production of the species and its adverse effects are noticeable only in occasional and localized catastrophes.

For the pink salmon which spawn in the larger rivers in the interior, e.g. Babine and Bear, extremes of drought have little effect since sufficient water is always present to cover the eggs. Serious scouring freshets are infrequent. In the Lower Skeena near the coast, heavy rainfall just after spawning, e.g. 1945, has had disastrous results. Unfortunately for

the pink and the chum which frequent these districts, such adverse conditions, unavoidable but perhaps semi-controllable, do occur sufficiently often to seriously reduce the stock.

In summary, while the general climate of the Skeena drainage is suitable for salmon propagation, extremes in weather can be destructive for any species in accordance with the frequency of their incidence at or near a critical period in the life history. Climate is certainly not responsible for the steady long-term decline of the sockeye, but weather conditions could certainly have produced the great variation in production noted for the pink salmon.

(2) The Effects of Settlement on the Drainage in so far as its Suitability as a Salmon Habitat is Concerned.

Settlement in the Skeena river area is comparatively recent in origin. By the turn of the century, practically no white men had entered the region. First the prospectors and traders arrived. Development speeded up with the completion of the Canadian National Railway from Jasper to Prince Rupert. Roads were improved, farm lands cleared and small mines and lumber mills were developed. With the extension of the highway from Hazelton to Prince Rupert in 1944, increased activity took place. The valley is, however, still sparsely settled and the population is mainly confined along the main Skeena to Hazelton and along the Bulkley to Bulkley lake.

Until relatively recently, therefore, the whole drainage area was in its natural state showing on the coast the heavy coniferous temperate rain forest with thick underbrush and the smaller yet plentiful interior forms in the drier area. Only in the last few years have these forests been disturbed to any extent and up to the present no adverse effects in lack of water control are evident. The salmon were able to reach the spawning grounds comparatively unmolested and even now are protected by the fact that the main human population is along the deeper larger branches where interference is difficult. The Indian population which has increased slightly in numbers, has of course, taken a toll throughout but probably at a relatively constant level.

While conditions in this regard have thus far been favourable, and apparently not responsible for the over-all declines, it should be stressed that with the greater and more complex expansion now mooted and occurring in lumbering, pulp manufacture, etc., the fish will undoubtedly be faced with a more difficult situation and will have to be carefully protected therefrom.

(3) Obstructions (See App. 4 & 5)

In a summary such as this, listing of all obstructions which might retard or prevent migration of the adult salmon to the spawning areas or which might impede or block the egress of the young to sea, would be impractical and confusing. In most cases detailed records are available at the Pacific Biological Station.

Many of the smaller obstructions may be of some benefit in affording protection from predators for both young and adults and in causing the formation of deep pools where the fish can rest in safety. Others cause the

stream to spread into side channels and open areas where, even if the bed is good, water conditions are uncertain. Still others, e.g. in the Lakelse river, in forming pools, set up conditions favourable to such predators as harbour seals. In some cases, one channel may be completely blocked, forcing the migrants into another arm, e.g. Beaver river, Kitsumgallum lake. Log jams have reached their most serious proportions in the Upper Bulkley from Knockholt to Bulkley lake. Here during high water in the spring, the river spreads far and wide damaging farms and endangering the railroad. Later in the summer with low water, the fish cannot get through. Added to these partial blockades, beaver dams in a number of tributaries, viz. Seccontine, Upper Bulkley, may stop the salmon entirely.

Amongst what might be considered major obstructions, Moricetown falls at the head of the Bulkley canyon about 24 miles east of Hazelton, appeared to have the greatest potentialities for trouble. Close examination during the runs in the three years 1945, 1946 and 1947, during which periods almost the extremes of high and low discharge were encountered, clearly demonstrated that at certain stages of low water, the fish are held up in their migration to the large spawning areas upstream. The effect varied with the time of incidence of the adverse conditions in relation to the time of arrival at the falls and the characteristics of the species. Springs which are large and strong, were able to surmount the most difficult conditions. Cohoes and sockeyes, though less rugged, could overcome great difficulties. The pinks rarely were able to ascend even under most favourable circumstances. As far as could be discovered, there was no mortality below the falls as a result of the "hold-up." It is evident, however, that one species, the pink, is denied the use of the large expanse of spawning area above, and that all are made vulnerable to the heavy Indian fishery and to some extent to the sport fishery as they lie in the pools and fight the falls in large numbers.

Father Morice in his history of northern British Columbia reports that at one time the entrance to the Bulkley canyon at Hagwilget, two miles above Hazelton, was blocked by a rock slide so that the Moricetown Indians had to move west to catch their fish. At the present time there is seldom any arresting effect except very occasionally when pink salmon arrive there at very low water.

Because most of the obstructions were present under primitive conditions and have not been progressively increasing in seriousness, they cannot be held responsible for the declines in salmon populations. On the other hand, they have set up conditions which tend to keep the runs from building up again.

(4) Conditions on the Spawning Beds (App. 4)

Thus far no mention has been made of such factors as silting which may cause losses during incubation because of lack of aeration or water supply. Certain tributaries of the Skeena, e.g. Kitsumgallum, Morice, Kluayaz and Motase are glacier-fed. The water is therefore grey and almost opaque from silt in suspension. This material undoubtedly settles on the bottom and shuts off the circulation of water in the gravel beds. In non-glacial areas, a similar effect is obtained when heavy freshets scour out the banks and bottoms of the streams. Such a condition is fairly prevalent in the coastal district where high precipitation occurs.

Silting in the over-all consideration has undoubtedly remained approximately similar over the years since, lacking any extended removal of forest cover, it is dependent upon climate already shown to be relatively constant. While it thus maintains a generally depressive effect and on occasion may result in a sudden downward trend, it cannot be held responsible for progressive declines.

(5) Physico-chemical Conditions in Lake Nursery Areas (App. 7A)

Since the sockeye salmon young remain one or more years in lakes before migrating to sea, it was essential to discover whether conditions therein were limiting production and whether changes in such conditions were more and more reducing the productivity.

During the survey records were maintained for each lake of transparency, hydrogen-ion concentration or pH, temperatures, and oxygen content of the waters. Transparency is considered the most important limiting factor to production in many glacier-fed lakes but in the others light penetration is ample. The hydrogen-ion concentration or pH varies from lake to lake and from surface to bottom in the same lake but the differences are so small that they do not raise or lower the final reading above or below the wide range which salmonid fish are known to be able to withstand. In all lakes the temperatures are well within the range of tolerance although the differences may have the effect of slowing or increasing the growth rate. The oxygen contents of all waters with one exception are well above the minimum demand. In the extreme case - that of a deep section in Kitwanga lake - the area affected was of such limited size that there could have been no general harm.

Analysis of the data permits the division of the lakes into two main categories, viz. (1) deep, cold bodies of water almost opaque and grey from glacial silt, containing relatively little plant or animal life and (2) rather shallow bodies of water, clear, of moderate temperature with comparatively abundant plant and amimal life. In Kitsumgallum, the most extreme example of the first group which has been encountered, it is evident that production of life including sockeye is limited by the physical conditions, of which probably the most important is the lack of light penetration. In such instances, it must be accepted that the populations will always be limited. Lakelse lake is an example of the second group where good conditions for growth and production are in evidence. On the basis of the available data, the following classification has been made: Group 1 - Johnston, Kitsumgallum, Morice, Motase, Kluayaz lakes, Group 2 - Lakelse, Kitwanga, Stephens, Nilkitkwa, Morrison, Azuklotz, Sustut, Asitka, Damshilgwit, Slamgeesh and Kluatantan lakes, and Group 3 -(intermediate, embodying some characteristics of each of the above but more closely related to Group 2) - Alastair, Swan, Babine, Bear and Johanson lakes.

In summary, the nursery lakes of the Skeena drainage do not appear to have any physical or chemical characteristics which would not permit organisms to reproduce. Some bodies of water are limited in their productive capacities because of their physical attributes. There is no reason to believe that conditions have changed radically in this respect over the period of the fishery.

(6) Basic Food Supply as indicated by Plankton (App. 8)

The basic food supply available in any body of water is mainly dependent upon the physical and chemical conditions which exist therein. These include amongst others, depth, shore development, bottom configuration, mineral content, conditions for photosynthesis, etc. In general samples indicate that there is throughout the system plenty to satisfy the needs of the present fish population and even accommodate a much larger one.

Certain exceptions do appear in some of the lakes. The heavily silted waters of Kitsumgallum, Morice, Kluayaz and Motase, are low in production of plant and animal life due mainly to the lack of light penetration. The actual availability of smaller food organisms to young sockeye may be low in lakes such as Morrison where a large population of whitefish act as competitors.

The production of bottom organisms appears to follow the plankton in those lakes where sufficient samples were taken to demonstrate the relationship. While not over-abundant, it would still appear to be in sufficient supply generally to maintain the bottom feeders such as whitefish and suckers. In Morrison lake where bottom organisms are scarce, the whitefish has turned to a purely plankton diet as an alternative.

(7) Predation (App. 6 & 9)

Predation by other animals at various stages in the life history of the salmon has come to be considered as a prime factor, if not the most serious, in causing the heavy losses which are known to occur. For that reason a full investigation of the problem was essential for the Skeena river where an attempt was being made to stop declines in population and build up the runs.

Predation by other fish. It is now established that there are seven noteworthy predators on young sockeye in the nursery lakes, viz. squawfish, lake trout, cutthroat trout, rainbow trout, dolly varden char, burbot (ling), and sculpin. All these do not necessarily occur together in every lake. For instance, the squawfish has not been reported from Alastair, Morice, Stephens and Swan and the lake trout and burbot are limited to certain northern lakes not being found in Alastair, Lakelse, Kitsumgallum, Kitwanga, Stephens and Swan. (See App. 6).

To assess quantitatively the damage done to sockeye by these fish, it is essential to know their food habits, the rates of digestion of each species under different conditions of temperature, and the total number of individuals. Such absolute information is still not procurable in spite of the advances made in fisheries research. Accordingly, the best approach was to compare the effect from lake to lake and with other areas by using comparable methods of netting with standard gear and similar methods of food examination. From the results a catch per net per night figure was obtained which gives the best available representation of the relative abundance. From analysis of stomach contents, the average volume of prey devoured is established and by combining this with the catch per net-night, a "predation index" - a necessarily rough assessment of the effect of predation - has been set up.

On the basis of catch per net-night calculations, squawfish was found to be the most abundant but not the most widely distributed predator species. Next in order is the cutthroat which throughout the Skeena lakes totalled

with the squawfish 67 in every hundred predators. In the aggregate waiving consideration of species, predators are most abundant in the coastal areas varying in Kitsumgallum, Kitwanga and Lakelse from 1.4 to 4.7 per net-night. In upriver and interior areas the concentration is generally much less giving figures similar to Babine, viz.-0.2 to 0.9 per net-night. Thus the concentration in the lakes of the coastal district although similar to Cultus on the Fraser, is about five times or more greater than that for the interior. In neither case are these "coarse" fish as plentiful as in lakes where good commercial fisheries are existent, cf. 13.7 per net-night for Great Slave and 20 for Athabasca.

The "predation index" (catch per net-night X the average volume of prey in all stomachs) when closely analyzed, suggests the following classification of waters on the basis of predator effect: High: Lakelse, Stephens, Kitwanga and Morice, Low: Morrison, Babine and Alastair, and Intermediate: Nilkitkwa and Swan. Stephens lake, although in the interior, receives a high rating because of the presence of large numbers of dolly varden char - a voracious type. Similarly Morice is advanced because of the large lake trout population. In the overall picture, both the abundance calculation - catch per net-night - and the "predation index" give similar conclusions.

In addition to predation within the nursery lakes, there must be considered losses in the tributary rivers due to the destruction of eggs at spawning time. There is sufficient proof from this and other investigations that sculpins, rainbow trout, cutthroat trout, coho salmon yearlings and dolly varden char may do great damage in this phase. In the case of the pink salmon at McClinton creek, the loss from this source is estimated at 60 per cent. of the total during spawning, incubation and alevinage (W.M. Cameron Mss.). In the Skeena where the population of river predators is equally as large, we must assume similar proportions even though definite figures are not available. There is also no doubt that a reduction of yearlings takes place for the same reason in the main rivers each spring as the young make their way to sea.

Mammalian Predators. Of most importance in this connection is the harbour seal. While these animals do little damage to the gill-nets, they do cause considerable monetary loss to the fishermen by damaging or removing salmon from the nets especially during the spring and coho fishing season when few boats are in the river. During the sockeye season, the seals move upriver above the fishing boundary and there prey upon the salmon which have escaped the fishery. Considering a minimum estimate of 450 animals and an average diet requirement of 10 pounds of fish per day, the loss during the fishing season is sizeable. There is also the possibility that their influence on the salmon populations has become and is becoming progressively heavier. In the early days, it is reported that the Indian tribes hunted the seals for food and apparently kept the numbers low. At that time, even in years of heavy salmon runs, they were seldom seen as far upriver as Hazelton. With the acceptance of modernization, the Indians have ceased hunting. Without the limitation the seal population appears to be on the increase.

Bears - both black and grizzly - are present in the Skeena area in moderate numbers. While evidences of their depredations are found in most rivers, they tend to be more concentrated in some areas than in others. In the Lakelse and lower Skeena drainage, the black bear drags many spawning fish out on the banks. In Falls creek, tributary to Swan lake on the Kispiox, grizzlies are very abundant. Examination of the kill reveals that in most cases the destruction is not as serious as might be reckoned since most of the salmon are partially spawned males or spawned-out females.

Bird Predators. The effect of this group is difficult to assess unless large numbers of samples are taken throughout the year and the absolute numbers can be determined. To date there are no records of extraordinarily heavy concentrations of mergansers, loons, eagles, etc. so that, by comparison with other areas, it must be accepted that losses from this source are normal but not heavy.

Ocean Predation. There is relatively little information on the effect of predation during the salmon's ocean life. From the analyses of harbour seal stomachs, it is evident that salmon form a smaller proportion of their diet in the offshore areas where their place is taken by such things as flatfish. It must be recognized that sea lions, sharks, etc. may also take a toll.

In summary the coarse fish population in the nursery lakes in the Skeena drainage is not heavy. On the coast it is similar to that in bodies of water such as Cultus on the Fraser yet much lighter than in large producers such as Great Slave and Athabasca, while in the interior where the major spawning grounds are located, it is much lighter. Thus, lake fish predation must be relatively light. Losses due to consumption of eggs and fry in spawning rivers and of the young going to sea also occurs but, though serious, must be gradually lessening in their effect with the heavy increase of sport fishing. Predation by harbour seals in the lower river is considerable and it is suggested that it may be becoming progressively heavier with the lack of control on the population which resulted from the cessation of Indian hunting. Bears, both black and grizzly, haul out salmon but these are mainly partially spawned males or spawned-out females. Predatory birds are not particularly concentrated and thus are no more serious than elsewhere. Ocean predation has not been assessed. While the losses due to these animals are evident, since generally with the exception of harbour seals their effect must be decreasing, they cannot be blamed for the progressive declines, which have been noted for certain of the salmon populations.

(6) Competition (App. 6 & 8)

The factor of competition of other fish with young sockeye for the food present in the lake nursery areas, is very complicated and difficult to reduce to simple terms. Netting indicates that there are populations which could compete either in their young stages or as adults. Stomach analyses reveal, however, that the effect is lessening owing to the fact that certain species turn to other food in the adult stages. Plankton studies show that at present sufficient basic food is available to take care of both the coarse fish and salmon. No critical limit is evident in most lakes and the possibility of its existence is merely indicated in such peculiar conditions as exist in Morrison where the eastern whitefish, usually

a bottom feeder, subsists throughout its life on plankton. By no stretch of the imagination, could the progressive decline in the sockeye catches or the sudden lowering of the pink salmon populations be ascribed to competition for food.

Artificial Causes

(9) The Indian Fishery Relative to the Declines (App. 3).

For a full appreciation of the relationship of the Indian food fishery to the conservation of the salmon runs in the Skeena river, it is essential to review its history briefly. At the turn of the century the only residents of the area were the native Indians (about 1,900 in all) who took salmon for food without restraint but for whom there was no opportunity of selling. When the white civilization advanced, the value of the salmon was enhanced both for fresh food and the canned product. As a result of pressure, the Indians finally agreed to remove their barricades in return for the promise that they would always be allowed to take salmon for food, a right which they considered inherently theirs. Whether the methods of fishing were definitely stipulated, is not now clear. It seems that the Indians can take as many fish as are needed so long as they do not use fences, waste the product or use it for sale or barter.

For a long period when salmon were plentiful, little attention was given the agreement or the fish which were captured under it. In recent years a much closer check has been maintained. This has brought to light the fact that no set numbers of one species or other are taken. The various types are used in accordance with their desirability, their time of migration and ease of capture. Sockeye, with their bright red colouring and oily flesh, are preferred, but, if weather conditions are bad during the run, the natives may not be able to fish them effectively and be forced to turn to the later-running species. If the Indians have lucrative work at the canneries, in the woods or elsewhere, they do not fish at certain periods. For these reasons there is a great variation in the seasonal take by those tribes easily visible on the main river, e.g. at Hazelton, Hagwilget and Moricetown. This difference, however, is minimized to some extent by the consistent behaviour of those tribes which still live in a more or less primitive manner, viz. at Babine and Bear lakes.

The average for the ten year period from 1935 to 1945 indicates the amount of annual exploitation as follows: Sockeye - 72,000, Spring - 6,100, Coho - 15,000, Pink - 11,000 and Chum - 130, or a total of 104,230. These are recognized as minimal estimates since they are procured at the main fishing stations and do not take account of incidental captures by nomadic bands, hunters and trappers. For the present Indian population of approximately 2,100 persons, the consumption would be about 50 fish apiece or a minimum of 250 pounds per year per individual. This consumption, although admittedly high by comparison with the general average, must be considered in the light of the fact that fish is the main meat diet of the Indians and is one without which they cannot exist in a healthy condition.

There are definite indications from tag recoveries that the Indian catches may be considerably higher than those reported even though due allowance is made for the fact that in some cases definite efforts are made to catch the tagged individuals and obtain the reward. In fact, it appears that the number may be almost twice what is recorded. Such an observation merely serves

to accentuate the possible seriousness of the drain.

It should be mentioned here that for many years, the natives from the Stuart lake district on the Fraser river watershed have migrated to Babine lake to take their food supply. Recently with the increase in the upper Fraser escapement, this drain has been relieved to some extent.

Of particular importance also in connection with conservation is the fact that the Indian catch is relatively steady from year to year. This situation, though capable of logical explanation in that the same number of individuals must be fed each season, leads to the result that the take is proportionately much greater in years of small runs and thus could have a critical effect on the maintenance of the population.

Without true realization of the fact, the Indians are doing great damage to the runs by employing certain methods of fishing. The outstanding example is the gaffing at Moricetown falls. If an inefficient operator is in action, many salmon will flop off the long hook and often escape with a hole through the body cavity. If the fish lives, water thus let into contact with the eggs will "water harden" them so that as a result they cannot be shed. On the average at this location about 30 to 35 per cent. of those hooked are injured in some manner and escape - a serious drain on any run especially at the high level of exploitation now in existence.

To summarize, there is no doubt that the Indians must have fish for food if they are to survive. There is also no mistaking the fact that they tend to take more than are absolutely necessary, and that in some areas wastage occurs due to the methods of capture used. In spite of this, one could not definitely assign to the natives the blame for a progressive or sudden decline in salmon populations. Even though their numbers have risen slightly over the years, many individuals have now turned to the white man's diet and other foods such as moose are available so that it is problematical whether they now catch as many fish as formerly. On the other hand, it is certain that if a decline were once started, the Indian fishery would accentuate it with its proportionately heavy exploitation in low years, with its inefficient methods, and with its relatively rare but still well-recognized illegal practices.

(10) The Commercial Fishery Relative to the Declines (App. 1)

(a) Sockeye Salmon

The Skeena river sockeye salmon fishery commenced at the end of the last century in a small way with the exploitation of a virgin population. With the increase in demand for the product, greater and greater effort was expended and for a while larger catches resulted. The time arrived, however, when the addition of further effort was not repaid in extra catch. In spite of this, the established desire for canned sockeye and the capital already invested, seemed to make it impossible for the industry to ease the strain by limiting fishing of their own volition and still heavier exertion was applied to maintain the supply. At this point the Government entered the picture as a restricting agency with the definite purpose of maintaining the run for perpetuity. The limitation of the river fishing area, the shortening of the season and the implementation of weekly closed periods had the effect of causing the fishermen to expand to districts farther seaward off the river mouth.

The first canning establishment on the Skeena was built in 1887 and by 1906 there were fourteen in operation. Since 1925, the number has steadily decreased to the seven now operating. Although there are now fewer canneries, their capacity has increased greatly with the installation of more lines and retorts so that now the number of cases packed at each is almost twice as great as formerly yet many are not operating to full capacity. In addition the first fresh fish house was established in 1914 and today there are ten, three of which have freezing and storage facilities.

From 269 in 1890, the number of gill nets increased to 850 in 1911 and to 1,335 in 1924. From 1924 on it has dropped in an irregular manner to about 800. As in the case of the processing plants, the decrease in numbers was compensated by other changes in so far as exploitation was concerned. In 1924 the gasoline-powered boat was introduced and by 1940, the original sail boats had completely disappeared. The mechanical net drum made its appearance in 1942 and is now in general use. In addition, trolling and purse-seine vessels operating in the ocean areas increased their efficiency and range through the introduction of better power, gurdies (1920), live rollers (1922), power winches, etc.

Since 1925 there is evidence that a factor more economic than biological may have been making itself felt as indicated by the fact that the effort has declined at a more rapid rate than the catch except in 1925 when the number of Japanese fishermen was curtailed and again in 1942 when they were eliminated entirely. It is true that fishing is prosecuted economically only when the fishermen are taking a certain number of fish. When the number is low they move out and a compromise results with the catch regulating the effort to a noticeable degree.

In addition to exploitation in Canadian waters, there should also be considered the drain on the sockeye population by the Alaskan fishery particularly in the vicinity of Cape Fox, Cape Muzon and Cape Chacon where the runs are tapped as they move southward through the inside channels. Tagging experiments conducted throughout the season by American biologists in a number of years between 1922 and 1926 indicated that as high as 18 per cent. of the sockeye salmon were returned from British Columbia. Of these most were from the Nass area and only a few (about 2 per cent.) for the Skeena. In recent seasons the traps have not been allowed to fish until late July and early August after which time the sockeye catch is relatively light. Even if 50 per cent. of the total take were Skeena-bound, the numbers would represent only a few hundred cases.

During the period from 1920 to 1935 when approximately 1,200 gill net boats operated in the Skeena, there is a sudden drop in the catch trend line. Investigation shows that this is not due in any large measure to such things as constantly poor weather conditions, although the reduction of Japanese licences, the change in reporting methods to separate more accurately the fish originating in and belonging to the Skeena, the change in fishing boundaries and other variants had some effect. All things considered, however, this is believed to be the period when noticeable overfishing occurred.

The discussion thus far can, in the opinion of the investigators, lead to no other conclusion than that the commercial fishery must be held mainly responsible for the decline in the sockeye salmon populations. Other factors even though their effect is recognized, could not have caused the progressive reduction over the years. On the other hand, as the effort and efficiency of the industry has increased, the populations have decreased.

While the fishery may be held responsible in large measure for the "over-all" decline, it is certainly not entirely to blame for the large fluctuations which occur from year to year. These are felt to be due largely to variations in such things as weather and spawning conditions (environmental effects) which are of major importance in producing either a favourable or unfavourable return from a given seeding and thus setting up the cycles of abundance. The fishery has its influence in reducing the abundant population and in lowering the less abundant to a critical level.

It is maintained by some that commercial exploitation, which according to tag returns varies from 18.6 to 40.1 per cent., is relatively low compared with other areas and cannot do further harm controlled as it is by the economic factor of poor runs attracting few fishermen and limited as it is by restrictive measures such as reduced fishing seasons, abbreviated fishing areas, and closed periods not to mention adverse weather conditions in causing decreased catches, but the facts indicate otherwise. It must be admitted that all these things have not been effective in stopping the downward trend and some of them have introduced other difficulties which may have serious implications. As examples, under the present reduced season, fishing commences on the last Sunday in June and continues until about August 20. This permits much of the run to the lower river areas, e.g. Lakelse and Gitnadoix, to escape, and allows many males of the five-year-old group, which run prior to the females, to migrate through to other rivers. To have the populations of one section of the drainage or one sex and age group making little contribution is unwise since more weight is thrown on the others. Perhaps because more females are caught in the gill nets late in the season, the early selection is more or less balanced and no drastic influence of inequality on production has been felt. Lowered river fishing boundaries have undoubtedly helped but their effect has been counteracted to some extent by fishing farther offshore in the approaches to the river. The short closed periods in vogue at present, viz. 6.00 p.m. Friday to 6.00 p.m. Sunday, are of relatively little consequence since the fish take an average of about five days to move from the river mouth to the fishing boundary. By Friday night the whole river area is well fished. On Sunday night the fishermen first start upriver thus exploiting most of the salmon which are often considered to have escaped. Bad weather conditions do not occur often enough or with sufficient regularity to lower the total exploitation any considerable amount.

(b) Pink Salmon

From the records available, it would appear that the Skeena river pink salmon fishery must at present be considered to be in an earlier stage of development than that for sockeye. Although some of the species were taken incidental to the sockeye catches late in the last century, it was not until about the period of the first great war, 1914-1918, that a real demand was built up. At that time the even numbered years constituted the largest population and the catch therefrom increased to the extreme of 1930. A similar rise was evident in the odd-year run. After 1930, however, the pinks never seem to have recovered from what is now called the "calamity" of 1932. The odd year run did not fall as low and thus gained ascendancy over that of the even. Finally, however, both cycles dropped suddenly as evidenced by the catches and escapements of 1946 and 1947.

Concurrent with these developments in the catch and escapements, there do not appear to have been changes in the effort which would explain the variation. The fishery is still not a "primary" one for gill nets but is prosecuted more or less as a lucrative side issue. The general practice of most canneries is to consider the sockeye fishery the major endeavour which should pay the operating costs and to consider the catch of others such as pinks as profit.

Admittedly some of the drop within the last few years could have been due to the moving of the boundary downriver, thus eliminating one of the best areas for pink fishing, yet the added escapement has not appreciably built up the run. The final sudden decline in which both catch and escapement were involved, was probably due to weather conditions affecting hatching. This assumption is supported by the fact that the drop in numbers was similar throughout the region where similar climate obtains, e.g. southeastern Alaska. It thus seems unreasonable and unsound to blame the fishery for the major changes which have occurred.

(c) Other Species

The fact has already been recorded that two remaining species of salmon, the spring and coho, have as yet shown no signs of depletion and are apparently maintaining themselves if not increasing. The chum population has been more or less similar since 1932. Any effect of the commercial fishery in causing a decline is thus certainly not evident.

The reason for lack of influence appears to be in the fact that because of the very nature and behaviour of the fishery and the species, additional protection has been afforded. In the case of the spring salmon which are large fish and run early in the season, large-meshed nets are employed. Fishing is limited in April until the ice is all out of the river and the fresh fish plants are in complete operation. In late June, when the sockeye arrive in large numbers, the majority of the fishermen turn to them in preference. The coho migrate in the late summer and autumn and many of the gill-netters may continue sockeye fishing during the first of the run and stop fishing later when the weather becomes bad. The chum which is not present in the Skeena in large quantities, is apparently not heavily exploited by gill nets for the reason that the effort will not be adequately repaid.

DISCUSSION AND RECOMMENDATIONS

Since, as already indicated, there have been declines in the populations of the sockeye and pink salmon in the Skeena river while those of the spring, coho and probably the chum have maintained themselves, recommendations should be forthcoming under both Term of Reference No. 6 and Term of Reference No. 7. In the discussion which follows, no attempt is made to separate the idea of remedying a drop in numbers from that of building up an already good run to allow an increase in catch. The ultimate goal is accepted as being an attempt to get "maximum production for use yet guarantee the runs for perpetuity."

Close study of the problems and their interrelations has made it clear that no single remedial measure can be expected to quickly and efficiently accomplish the above aim. The declines and the limitations to production result from the effect of many factors all of which must be adjusted or corrected within the same period to produce the results desired. For this reason, it

is not reasonable, wise or perhaps fair to select one to the exclusion of the others. Each possibility is discussed in moderate detail as a basis for the final summary and review of the most important items submitted in the abstract at the beginning of this report.

(1) The Control of the Commercial Fishery

The commercial fishery, the artificial agency handling the largest numbers of salmon, has been designated the most important factor in reducing the sockeye populations although it has not been held responsible in the case of pinks. There is no doubt that the peculiarities in behaviour of the species mentioned have given rise to differences in the fisheries dependent upon them and thus to the effects of these fisheries. Because similar situations obtain for the spring, coho, and chum, it seems best to treat each species separately and to modify the specific recommendations in such a way as to bring about the best general reaction for all.

A. Sockeye Salmon

The history of the Skeena river sockeye fishery shows that low catches occur at intervals but not at particularly regular ones. Low productions are in one or two instances three years apart, more often four years, most frequently five and very occasionally six. Likewise peaks in production occur. Other runs are intermediate in size. Since compensatory opposite changes in escapement have not been noticeable, it appears that the whole population has varied in a manner similar to the catches due undoubtedly to the variation in age composition and the success of the different broods. Whatever the cause, any control of the populations should be directed toward building up all the runs but more particularly toward raising the lowest to well above the point where a minor catastrophe might wipe them out.

At the outset several facts of conviction on the part of the investigators should be recorded as a background for understanding their reasons for supporting certain types of remedial action to attain the above goal. In the first place, it is fully realized that demonstrations have shown that a large escapement is not necessarily followed by a large return in the succeeding cycle. In fact, it has been indicated in many instances that small spawnings give a higher percentage return presumably as a result of better conditions. A conservative attitude must, however, be adopted with the full realization that there is a lower limit in numbers where a small escapement cannot maintain a population, and that, on the average, although there may be proportionately more wastage, the larger escapements give the larger absolute returns. In the second place, the runs of sockeye salmon to the various tributaries of the Skeena river are thoroughly mixed as they pass through the fishery with the possible exception of a few bound for Lakelse and Gitnadoix which migrate early and are little exploited. It is therefore practically impossible to make even a rough segregation in point of time. In the third place, the decline has not reached such an extreme that any area which originally produced sockeye, is now completely denuded of them. Finally, there can be only one objective, namely, that of building the population to give maximum production for use.

If the escapement is to be protected and raised appreciably in years of low runs, it is essential to be able to predict when such low runs will occur. This is a manifestly difficult task for the Skeena in view of the changes which take place in age composition and in the environmental conditions affecting the runs. It can be accomplished only if close studies are maintained of both these conditions as well as of the statistics of the catch for which it is hoped the figures will be more accurate when the suggested system of collection is implemented. Even now it can be stated

with moderate reliability that the 1949 run should be at or near the peak while that in 1950 should be medium in size. The population in 1951, which will probably be small, will have to be closely protected. Regulations should be left as flexible as possible in the event that these predictions are upset occasionally by unforeseen circumstances.

There are several means of raising the escapement which differ mainly in degree of limitation.

(1) Use of a flexible system of restrictions on and adjustments in exploitation.
(A relatively slow method but one which would allow production to continue and enable quick action to be taken in case of adverse or favourable unpredicted abundances).

(2) Complete closure of the fishery.
(More drastic from the production viewpoint but perhaps the quickest method).

(3) Imposition of a quota system.
(The ultimate goal in regulation but one which should not be attempted until more information is available on all phases).

(1) Restriction on and adjustments in exploitation can be attained without stopping production completely by reducing the amount of fishing through shortening the season or lengthening the closed periods, by limiting the number of boats, and by restricting the area in which nets may be set.

Over the years the period of fishing has been reduced in a more or less haphazard manner from slightly over fifty to approximately thirty days. Usually the starting date is set (up to 1934 as of June 20 and thereafter as of the last Sunday in June). The closing date is dictated by the lack of catch. This manipulation of the season has had many unexpected effects. The early runs such as those to the Gitnadoix and Lakelse now suffer practically no exploitation. Because the older fish move into the river first and the males usually arrive before the females, many five year old males are untouched. The main weight is thrown upon the five year old females and the four year old group. The latter is particularly vulnerable since it is fished until netting is unprofitable before the season is closed. Such heavy drain on one run or portion thereof with none on another, is highly undesirable. For that reason, it is suggested on the basis of present data, that the season should be opened earlier and closed earlier to equalize exploitation on the groups and on the sexes within them. When the change is made, the results should be closely checked to determine whether the regulations are having the desired effect.

The weekly closed period is now regulated according to the number of boats fishing. Up until 1946 if less than 850 were present, no netting was allowed between 6.00 p.m. Friday and 6.00 p.m. Sunday. If there were over 850, an additional twelve hours was added. In 1947 and 1948, the dividing line was 1,000 with an additional closure of twenty-four hours if it was exceeded. Unfortunately the effect of such closed periods have been because they were set without full knowledge of the migratory behaviour of the salmon and becuase they were not adjusted in accordance with the changes in operational activity of the fishermen. It is now known from tagging that the time taken for sockeye to move from the mouth of the Skeena to the vicinity of Point Lambert where the present boundary is located, varies from a part of a day to forty or fifty. Usually by the end of five days after tagging over seventy per cent. have accomplished the journey. The

week-end closed season thus cannot allow many of the fish which are off the river on Friday night to escape. In addition, the fishermen have further limited the effectiveness by a discreet change in fishing procedure. By Friday night, they are spread over the whole river and are no doubt catching the fish as they come in. On Sunday night, they commence their netting at the boundary to catch off the concentration and then move downstream.

To be really effective, therefore, the length of any closed period should be increased to at least a week, and these weeks could be set in general to protect the peak runs to desired tributaries, even though they could not be determined in such a way as to protect one run to the exclusion of all others, e.g., the Babine population is usually in greatest concentration in the fishery just after July 15 and that for the Bulkley in early July.

The problem of limitation of gear or the number of boats fishing is very complicated since it involves not only scientific factors but economic influences. The justice of the claim that the size of the run will inevitably control the amount of fishing is recognized since everyone desires their share of big catches and no one wishes to operate at a loss. On the other hand, it is known that in years of large runs perhaps too many flock to the area while in years of small runs fishermen will continue even for a low recompense in the hope of better returns at any time. The basic fact is that a limited population is being exploited. From the economic viewpoint, therefore, there is a point in number of boats above which it is foolish to operate since the individual's catch as part of a limited whole, becomes too small to pay expenses. There is also a stage where there are just too many gill nets in a restricted area to allow the sockeye to escape in sufficient numbers for satisfactory spawning. Considering these factors, the present estimated numbers in the populations, and the increased efficiency of the modern gill net boat with gasoline power and mechanical drum, it is suggested that the reasonable number of boat licenses for the Skeena area should be about 700 but always below a maximum of 800.

The area of fishing within the river has already been cut down considerably. Since these restrictions coupled with others have not stopped the decline, it will be necessary to go even farther in the cycles of low runs. At such times if the sockeye fishing boundary were lowered to a line across the river at the eastern end of deHorsey island, much greater escapement would result. In the first place, the weekly closed period would be more effective since the escape time would be lessened. In the second place, when, due to flow and water conditions downriver, e.g., Standard bar, fishing failed, the boats would not be able to move upstream to the section between Veitch point and the eastern end of deHorsey island, to catch the same individuals. It is admitted that such a regulation would tend to increase offshore fishing but the nets would not be nearly so effective in the less confined areas.

If and when such regulations are put into effect, careful records should be maintained of the catches in order to discover what is the result. Modifications could then be made as seemed desirable on the basis of the experiment. In connection with the collection of the statistics for the analysis, it will be necessary to have the most accurate figures but it is also suggested that the ocean boundary in the area be retracted to Point Ryan as it was in 1935, to provide a gap between the Nass and Skeena areas

and permit the catches to be more accurately reported.

(2) Complete closure of the sockeye fishery. There is no denying the fact that the quickest way to increase the escapement of sockeye is to permit the run to pass without fishing it. If the sockeye fishing season were closed, only a few individuals of the species would be taken during the spring and autumn in the larger meshed nets used for spring and coho salmon. Virtually all the others would reach the spawning grounds to augment the existing spawning population. At the present time there seems no necessity to apply such a stringent remedy until less extreme methods of cure have been tried. Complete closure would perhaps be bearable by the larger companies which have revenue-producing operations elsewhere but it would impose a distinct and perhaps insurmountable hardship on smaller operators which have only a single location and that on the Skeena river.

(3) Imposition of a quota system. Under a quota system, the industry would be notified in advance of the number of salmon which could be taken during the next year. Certain restrictions in time might be imposed in order that each population and sex be evenly exploited. Such a procedure would find favour with the industry since it would have a sound basis on which to plan. The Department of Fisheries, on the other hand, would be relieved of many of the difficulties of policing and protection.

To set for each year a catch figure which would allow maximum production yet guarantee sufficient escapement, requires accurate and definite prediction. There are not yet available for this purpose enough reliable catch and escapement data or enough details concerning the causes of fluctuations in abundance from year to year. Granted that a sound "guess" might now be made, there would still remain the necessity of a control authority on the spot in case an unheralded high run or an unexpected low occurred. For these reasons the practice is not recommended at present but further investigation is urged to clarify and explain the problems toward final implementation of such a procedure.

In summary, it would seem on the basis of data now available that the sockeye salmon runs to the Skeena in 1949 and 1950 will be relatively high or medium. For those two years, therefore, consideration should be given to building them up further by increasing the escapement above the usual. It is suggested in these instances that the season be opened sooner, viz. - June 15 to June 19, to permit further exploitation of the early lower-river runs and the five-year-old males, and that it should be definitely closed on August 10 to allow the late four-year-olds to escape to upriver areas. The river boundaries should remain the same but the ocean limits should be drawn in on the northern end of the area to Point Ryan where they were in 1935. This will afford some slight additional protection and will serve to separate the catches of the Nass and Skeena areas. An extra twelve hours on the present weekly closed period (60 hours in all) would certainly raise the escapement to some extent throughout the season.

The data now at hand suggest that a small run will occur in 1951. Further restriction should then be imposed in the form of lowered river boundaries and full-week closed periods judiciously placed. If these efforts coupled with adjustments in upriver districts fail, complete closure should be contemplated.

Because of the fact that sudden changes can and do take place in propagation efficiency with the result that an expected medium run such as that in 1948, may be much larger, a continuing close check of catch and escapement must be maintained so that, if favourable conditions do occur, they may be recognized long enough in advance to permit modification of policy.

B. Pink Salmon

The decline of the pink salmon populations in the Skeena river cannot be attributed to commercial fishing. The blame has been laid upon weather as it has affected conditions for spawning, incubation and alevinage. Owing to the fact that the populations in both cycles are now low, no relaxation in restriction such as opening better fishing bars, e.g., Aberdeen, should be considered. The further limitations suggested for sockeye should be helpful. In the meantime close examination of catch and escapement should be continued.

C. Spring Salmon

Since this species is apparently maintaining itself well under existing fishing conditions, there would seem no reason to suggest a change. Because the large-meshed nets used in the fishery appear to take a large percentage of big male sockeye, it might be well to examine the problem carefully through the operation of a graded series of nets throughout the season.

D. Coho Salmon.

The coho salmon population within the river is maintaining itself. In view of the fact, however, that catches dropped in outside areas in 1948 where other populations are being exploited and that an earlier closure of the sockeye fishery may put additional pressure on the species, the situation should be carefully watched.

E. Chum Salmon

The chum salmon which is taken only in small quantities, after a preliminary drop in numbers, has been relatively constant since 1935. To build up the population it is suggested that the season be shortened slightly within the river and outside. This will preclude the capture when the fish are in such ripe condition that they cannot be canned but are of use for frozen bait only.

F. All Species

Certain recommendations such as that concerning the minimum legal weight of three pounds, will apply to several or all of the species. For gill net fisheries, it has long been realized that a minimum weight cannot be maintained without wastage. Once a fish is gilled, it is usually injured so that it will not recover when released. The proper procedure is to set the minimum mesh size and allow the fishermen to keep all fish captured therein.

(2) The Control of the Indian Fishery

Undoubtedly the whole question of the Indian fishery on the Skeena is now, by accident or design, rather clouded and indefinite. The oft-mentioned treaty under which the natives gave up certain privileges and practices in return for other privileges does not seem to be available. From the present uncertainty, it would appear that it must have contained many very loose promises for which local interpretations have been given throughout the system. These rulings have come to be accepted as law through application. The resulting confusion leaves no alternative but to recommend a complete and thorough re-examination and revision of the plan by representatives of the Dominion Department of Indian Affairs, the Dominion Department of Fisheries and the Fisheries Research Board of Canada to solve the difficulties and evolve a new design more favourable to salmon conservation.

In the negotiations and discussions it should be stressed that no attempt is being made to eliminate fish as a free item of diet for the natives. Because it is known that their catch as recorded is sizeable and since it may be even greater than reported, it must be considered in the light of conservation of the salmon. The main purpose is to draw up an agreement on a sound, fair and clearly understandable basis so that wastage and confusion will be removed. Living conditions have changed and still are changing. Many of the Indians have now taken their place in the white man's economy and are earning high wages in mills, on the railway, etc. Such individuals are really not entitled to further food concessions although they are in many instances the persons who cause most trouble. On the other hand, there are still whole tribes which still pursue the aboriginal life and must be given full consideration.

Destructive methods of fishing should definitely be removed. As an example, in gaffing at Moricetown falls up to 30 per cent. of the salmon hooked break away. Undoubtedly many of these will not be able to spawn because of the injury. Up until 1935 a basket was operated here from which many families could get their supply. It was abandoned apparently because of quarrels over its ownership and the division of the catch. This or some other method such as the use of dip nets might be implemented to protect the run more fully.

In other areas the Indians still carry out such practices as fencing the streams, e.g., Kitwanga, or gaffing on the spawning grounds. If properly controlled, these methods may not be more injurious than others but lack of attention and care would certainly lead to trouble. Under the present agreement, however, it would seem that this behaviour should not be permitted. If the practices are not deemed injurious, they should be legalized. Half-way measures in enforcement have a tendency to build up at least a disrespect for, if not a complete disregard of, responsibility and discipline.

When the revised terms become law, they should be publicized and explained in complete detail both to the Indians and within the protective agency. The penalties for bartering, selling and illegal catching should be made perfectly clear. Only after this understanding, will it be possible to enforce anything approaching sound regulation.

(3) Stream Improvement

For purposes of clear discussion, the question of stream improvement may be arbitrarily broken into three sections: (a) amelioration or removal of hazards and obstructions to migration of the adult fish moving upstream to the spawning tributaries, and of the young on their way to sea, (b) modifications in the physical conditions of the spawning grounds now available to ensure proper and efficient spawning, incubation and alevinage, and (c) extension of such beds into sections not now used.

(a) Amelioration and Removal of Hazards

In general the Skeena river system may be said to be relatively clear of serious obstructions. There are, of course, hazards such as the jam on Beaver river, Kitsumgallum lake, which cause the fish to use another channel. Some streams are blocked by beaver dams at certain seasons of the year. Such difficulties will be easily overcome under the coordinated programme of stream improvement recommended in section (b). Two major problems are further considered herein, viz. Moricetown falls and the Upper Bulkley.

Moricetown falls, at the head of the Bulkley canyon about twenty-four miles east of Hazelton, has been shown at certain stages of water level to retard sockeye, coho and spring salmon on their upstream migration, the length of the delay depending on weather conditions. Pink salmon seldom surmount the falls. Thus the fish are concentrated below the obstruction where they become easier prey to the Indian and sport fishery and the pinks are denied a large area of spawning bed where relatively stable water conditions exist. Therefore, not only to increase the over-all escapement but also in the hope of enlarging and stabilizing the returns from a given seeding of pink salmon, it is recommended that another fishway be constructed on the western side to ease the passage. No final estimates of cost have been struck but preliminary surveys indicate that they would be relatively small.

A major river clearance project should be undertaken on the Upper Bulkley between Knockholt and Bulkley lake with attention to Topley falls. This will involve chiefly the removal of numerous tight log jams and the opening of beaver dams. Burning, dismembering or blasting may be indicated but the work should be completed at such a time that the debris will go out on the freshets in the spring. Cooperation in this effort will certainly be available from the residents whose lands are now often flooded, from the Provincial Department of Public Works since the roads are often damaged, and from the Canadian National Railways which yearly has trouble with water on the right of way. This is the first essential step to rehabilitation of a run. When the river is clear, other fish cultural procedures may have to be invoked to aid in the rebuilding.

(b) Improvements to Spawning Rivers

Stream improvement after the preliminary examinations, becomes an engineering problem, the chief aim of which should be to provide more stable water conditions over the gravel bars. It is not essential to remove every log and twig but some action should be taken with those which are either creating a barrier to migration or diverting the stream into side channels which may later dry and leave the alevins stranded. On this basis each

tributary presents its own special problem even though the general remedies may be somewhat similar.

For the Skeena, it is recommended that a complete and coordinated programme be laid out so that eventually the whole area will be covered. In this work it is suggested that a party of men with an engineer in charge be assigned to a definite district. They then become part of a fish cultural service. The beginning should be made in the most productive area - Babine lake - and the work continued down the scale to the streams with smaller runs. In some tributaries, there will be little or no effort needed, but in others there are fairly large log jams, the removal of which might be assigned to special crews. In the end, even though it is years after the commencement of the project, there will at least be some assurance that conditions are favourable and not limiting production.

It is assumed that before actual operations of such crews begin, every person with pertinent information will be consulted, that the sketch maps and records of conditions on file at the Pacific Biological Station and in the Dominion Department of Fisheries will be examined, that reference will be made to practices in other areas and finally, most important of all, that the attack will be definite, and the programme continuous and thorough. Concurrent with this plan of implementing the stream improvements now recognized as helpful, the Fisheries Research Board should continue its studies of spawning conditions in the hope of obtaining further beneficial methods.

(c) Expansion of Spawning Areas

It may be contended that the expansion of spawning areas should not be considered until there is complete utilization of all those now available. On the other hand, some vision should be shown in procuring information in case the need for action should arise. The present survey indicates that the chief district where expansion could be implemented involves the streams on the south shore of Babine lake. Fifteen Mile or Anderson creek now has limited spawning ground and upstream migration is blocked by Quartette falls. Above these, however, is a large chain of lakes with a fair expanse of gravel in the tributaries. A means of circumventing these falls should be investigated from the engineering viewpoint. Fulton river at Topley Landing is also blocked by a falls about four and one-half miles from the mouth. This barrier is so high that it is doubtful whether an efficient fishway could be built. The falls should be considered from the point of view of power development since it might be recommended as an alternative to other sites where great damage might be done to the salmon runs, e.g. Moricetown falls on the Bulkley. The falls on Twin and Pierre creeks are high but they should perhaps be surveyed further.

(4) Predator Control

The reduction or elimination of species predatory on salmon must be approached with great caution not only because of the multiplicity of interests involved but also because there is a chance of upsetting the "biological balance" and producing conditions worse than those which now exist. Removal or limitation of one species may release the control on another with disadvantageous effects. These possibilities have been kept in mind in the discussion which follows.

Amongst the mammalian predators the harbour seals apparently do the most damage. It is therefore recommended that the work of reduction commenced in

an exploratory way in 1948, be continued at the proper and most convenient time in the spring to reduce the population as far as possible. With each attempt more efficient methods will be devised. There is at present too little information on the habits and effect of bears to suggest action.

To date the predatory birds have not been shown to be present in sufficiently large numbers to merit a premeditated attack. Close observation and examination should be made as a basis for future plans.

Even though the general survey indicates that fish predators of sockeye and other salmon are present in the coastal areas in normal abundance compared with similar districts elsewhere and are less abundant in the interior, the question of improving the runs through their reduction or elimination still remains important. The solution is very complex from the economic viewpoint since there are involved the various species of trout highly prized by sport fishermen. There is no doubt that the whole matter must be thoroughly discussed with the Provincial Fisheries Department and the British Columbia Game Commission. At present, however, after a close study of the data, it appears that there could be a division of the waters into three categories, (a) those in which salmon are scarce or absent, (b) those in which trout have almost equal importance to salmon, and (c) those which are essential to salmon production and survival. In the first, (a) including such lakes as Round, Kathryn, Fulton, Chapman, etc., efforts might be bent toward increasing game fish. In the second division (b), in such places as Lakelse, improvement of conditions for both populations might be sought but no more game fish should be planted. In the third group, (c), e.g., Babine, all work should be directed toward improving the situation for salmon propagation even to allowing reduction of trout.

In return for this segregation of responsibility over the area and in view of the lack of any astounding abundance of predator fish, the organizations interested in salmon should assume the long-term view with regard to game fish reduction in specific localities. In our opinion, the wisest course in the end would not involve such radical but really unproven methods as netting, blasting and poisoning, but rather a definite encouragement to sportsmen to fish more. Eventually, if the history of provinces like Ontario can be taken as any criterion, the "undesirable" trout populations will be radically reduced and with every season, conditions for salmon propagation should be improving.

In areas where equal rights are recognized, it might be possible to institute reduction of species which prey on both trout and salmon. It would appear that netting at spawning time of such fish as squawfish in lakes such as Lakelse and Kitwanga would help considerably. Perhaps subsidization of a commercial fishery in the larger northern lakes such as Babine, would lower the population of lake trout. It is essential that more investigation of the habits of the fish involved and the methods and effects of their reduction or elimination be carried out to provide a sound basis for prediction of future status.

(5) Control of Competitors

Since the matter of the competition of other fish with young sockeye for food is complex and because at present even in lakes where competitors are relatively abundant, there appears to be sufficient food to satisfy the demands of both groups, no general action is recommended. Investigation should be continued to clarify the relationships by selecting an area such

as Lakelse where more intensive examination is possible. Further work is indicated in localities such as Morrison lake where a specific competitor (the whitefish) has through a change in its feeding behaviour assumed such an important role.

(6) Miscellaneous Considerations

At this time comments should be made on other factors and difficulties which may arise in the long-term regulation of the Skeena river fishery. These cannot be construed as specific recommendations but should act as a guide if and when the suggested difficulties do arise.

It should not be assumed that many of the possible causes of decline, particularly those of the "sudden" type referable mainly to weather, are uncontrollable. Some methods of alleviating the adverse effects have been listed under "Stream Improvement" and more will be forthcoming as a result of further research on such things as stream control.

Fertilization has been suggested as a possible means of raising lake food productivity. The points should be clearly made that to date the widely publicized fertilization experiments have been carried out on relatively small bodies of water and the results which have been obtained, though encouraging, are not too positive. Before any general application is attempted, small trials should be carried out within the area.

Poisoning as at present applied in removing predator fish is a practical impossibility since there is no time during the year when salmon of one size or another are not present in the lakes or streams. Trout populations might also suffer. The only hope of this method lies in selective application which might be tested here as elsewhere.

The advance of civilization and the consequent industrialization will will undoubtedly make salmon conservation more difficult. In recent years, lumbering has increased greatly but fortunately this has been of the truck-logging type which did not necessitate the use of the rivers to any great extent for driving. No real effect detrimental to salmon is yet evident but indications of what might happen may be seen in Granite creek, Lakelse lake, where a sizeable run of sockeye is now virtually non-existent. Within a few years the situation may become serious with the development and expansion of large plants such as that at Prince Rupert. Machinery should now be set up to obtain data on water flow, etc. so that the Department may have concrete proof of the effects of deforestation. A basis of information should also be provided to decide how to clean tributary streams, when to drive logs, etc.

Thus far, due to the small population, little water power development has taken place. This will undoubtedly come and the Department should then be prepared to outline clearly the value of the runs which will be affected, methods of avoiding difficulties in migration and spawning, and perhaps even to suggest alternative sites which would be more mutually satisfactory.

(7) The Role of Various Organizations in the Conservation of the Skeena River Salmon Population.

Throughout this summary constant references have been made to the fact that organizations other than the Department of Fisheries and the Fisheries Research Board of Canada, which are immediately responsible, are vitally concerned with the Skeena river salmon populations. The fact cannot be too

strongly emphasized that these organizations should be consulted, made fully aware of the situation and asked for advice in the framing of policy. The British Columbia Game Commission should cooperate in making the plans which may affect the sport fish and game animals. The British Columbia Fisheries Department should know the details of the lake and stream work. The Department of Indian Affairs should take part in discussion of questions affecting the Indian population. The industry and fishermen should be informed of the progress so that they can support and help implement the cure.

The Dominion Department of Fisheries, as the instigator of the investigation, will no doubt now be concerned with the implementation of the recommendations. This responsibility will be assumed by several branches involving Western and Inland Fisheries and Fish Culture Development (including Engineering).

It seems unwise to assume that with the submission of this report, the Fisheries Research Board has discharged its complete responsibility. Its scientists should now be more familiar with the problems than any others. It is hoped that they will maintain a direct interest, advise as to the programme for rehabilitation of the runs, give the work general supervision and check the results accruing from the implementation of recommendations.

Throughout the investigation it has been essential in order to reach a solution quickly, to make use of data collected, conclusions reached and methods devised in other fisheries programmes. As would be expected, many problems have been encountered and many are still unsolved. It would appear that the Fisheries Research Board should initiate detailed experiments to obtain the solutions and thus provide a basis for future decisions in other areas. Thus, in addition to giving advice and checking the results of application, it should conduct further fundamental research along several lines. An experimental area such as Lakelse lake might be used for studying in detail the questions of propagation, predation, competition and stream improvement. In Babine lake, one or two tributaries might be selected for studies of spawning and incubation, and of the methods of bettering conditions in these phases of the life history.

ACKNOWLEDGEMENTS

The Skeena River Investigation has been carried out as part of the work of the Pacific Biological Station. Dr. R.E. Foerster in his capacity as Director of that institution, has maintained close and active interest in the work, and freely given advice and help from his long experience in salmon research.

The whole programme has been run and organized on a closely integrated and cooperative basis. While each of the senior scientists was responsible for a definite phase, all were involved in one way or another in the work reported in every appendix and in the general summary. The writer would express his sincere gratitude to Mr. J.R. Brett for his efficient organization and supervision of the lake and stream survey work and the construction and operation of the counting fences; to Mr. D.J. Milne for the laborious job of working up the statistics of the commercial and Indian fisheries, the study of Moricetown falls and the supervision of the tagging; to Mr. F.C. Withler for his administration of the Babine lake section and contributions to the work on predator fish; to Mr. V.H. McMahon for his plankton studies; to Mr. J.A. McConnell for his food analyses, drafting, and organization of the data files, and to Mr. D.R. Foskett for his studies of age composition and surveys of northern lakes.

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We have been exceedingly fortunate in being able to get such excellent artisans as Mr. O.A. Ragsdale and O.A. Schmidt for the construction work in isolated areas.

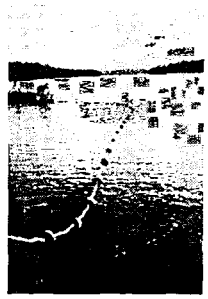
The membership of the Skeena River Advisory Committee has changed throughout the years but to the following we are indebted for advice, criticism and active help at one time or another in the period: Messrs. J. Boyd, I. Urseth, J.H. Deane, K.F. Harding, T. Wallace, C.E. Salter, W. Johnson and B. Kristmanson. It is a pleasure to record that cooperation with the officers of the Dominion Department of Fisheries, the industry and the fishermen has been almost perfect, thus easing the many difficulties and troubles.

December, 1948. A. L. Pritchard.

INVESTIGATION OF SKEENA RIVER

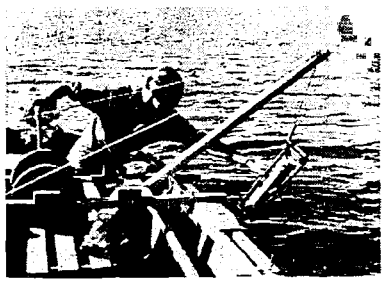
GILL NET LIFTED - KITWANGA LAKE

"SQUAWFISH EATS WHITEFISH"



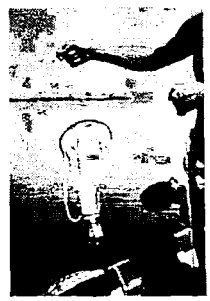
DRAG SEINE SET - STEPHENS LAKE

COLLECTING FISH IN SHALLOW WATER



WATER BOTTLE AND THERMOMETER

FOR TEMPERATURES, OXYGEN CONTENT, ETC.



SILK NET USED TO ASSESS

PLANKTON SUPPLIES IN LAKES

SAMPLING SALMON EGGS - FULTON RIVER,

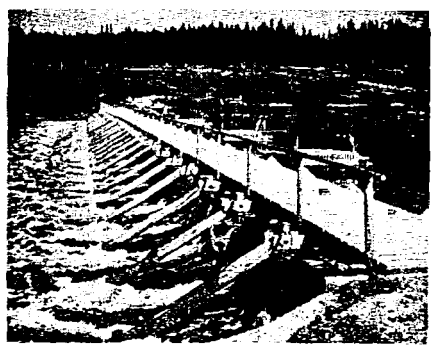
BABINE LAKE, IN WINTER

TEMPERATURES AT LAKELSE LAKE IN WINTER

WATER BOTTLE LOWERED THROUGH HOLE IN ICE

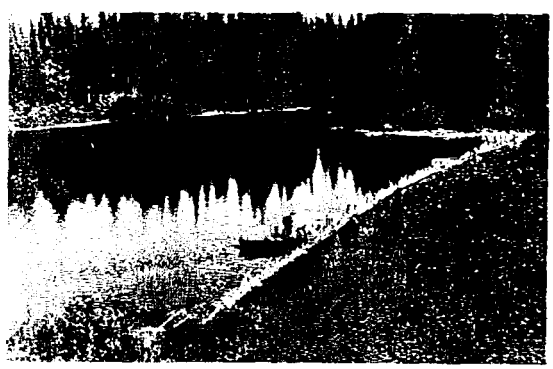
MORICETOWN FALLS

INDIAN FISHING - MORICETOWN FALLS



BABINE RIVER, COUNTING FENCE

LAKELSE RIVER "NETTING FENCE"



BEAR RIVER COUNTING FENCE