INTERNATIONAL PACIFIC SALMON FISHERIES COMMISSION

APPOINTED UNDER A CONVENTION
BETWEEN CANADA AND THE UNITED STATES FOR THE
PROTECTION, PRESERVATION AND EXTENSION OF
THE SOCKEYE SALMON FISHERIES IN
THE FRASER RIVER SYSTEM

ANNUAL REPORT
1950

COMMISSIONERS

SENATOR THOMAS REID	ALBERT M. DAY
EDWARD W. ALLEN	OLOF HANSON
ALVIN ANDERSON	A. J. WHITMORE

NEW WESTMINSTER
CANADA
1951

INTERNATIONAL PACIFIC SALMON FISHERIES COMMISSION

MEMBERS

AND PERIOD OF SERVICE

SINCE THE INCEPTION OF THE COMMISSION

IN 1937

CANADA		UNITED STATES	
WILLIAM A. FOUND	1937-1939	EDWARD W. ALLEN	1937-
A. L. HAGER	1937-1948	B. M. BRENNAN	1937-1942
SENATOR THOMAS REID	1937-	CHARLES E. JACKSON	1937-1946
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OLOF HANSON	1948-	MILO MOORE	1946-1949
		ALBERT M. DAY	1947-
		ALVIN ANDERSON	1949-1950

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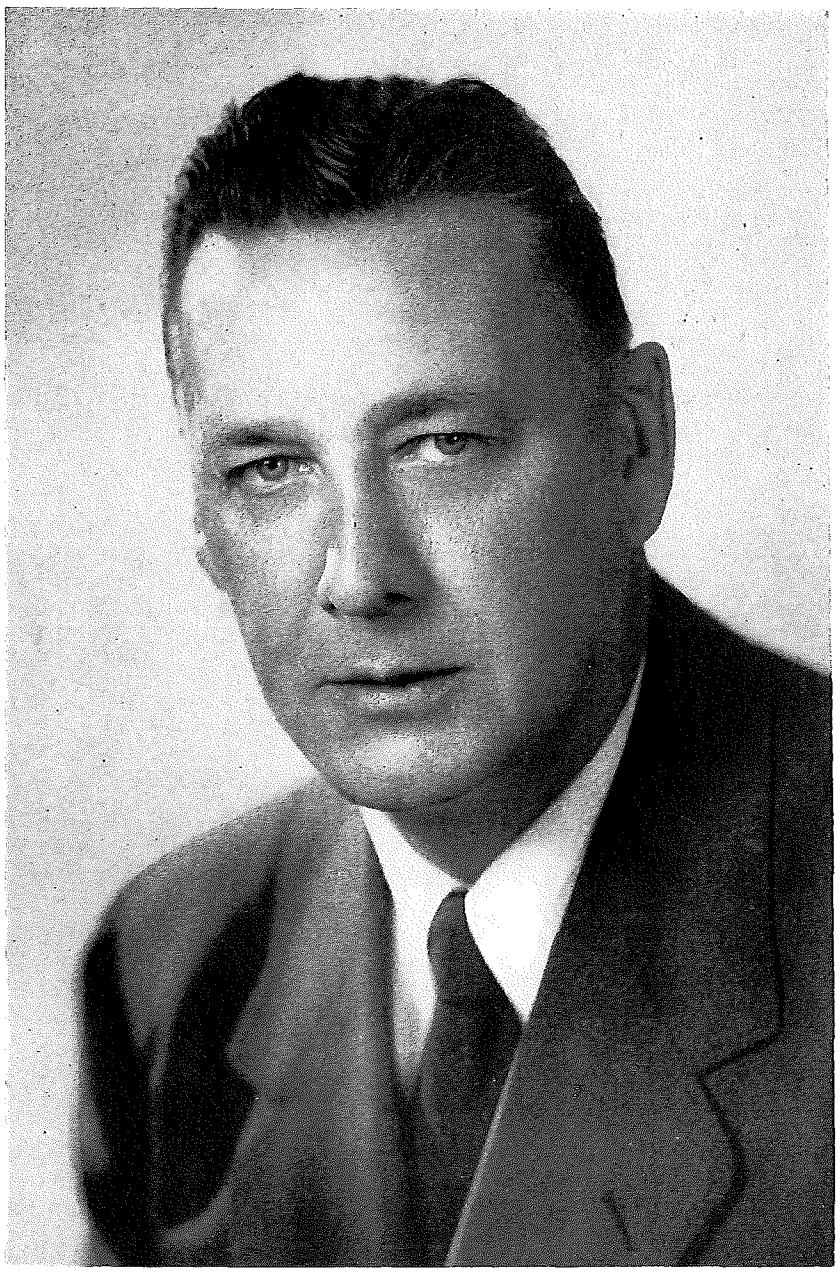
EDWARD W. ALLEN	OLOF HANSON
ALVIN ANDERSON (January to October)	A. J. WHITMORE

OFFICERS

LOYD A. ROYAL Director	MILO C. BELL Chief Engineer

NEW WESTMINSTER
CANADA
1951



ALVIN ANDERSON

Secretary of the International Pacific Salmon Fisheries Commission who passed away on October 8, 1950. Special tribute is due him for his unselfish, untiring and ardent devotion to the cause of Fisheries Conservation.

REPORT OF THE
INTERNATIONAL PACIFIC SALMON FISHERIES COMMISSION
FOR THE YEAR 1950

A Convention was ratified between Canada and the United States on July 28, 1937, to protect, preserve and extend the sockeye salmon fishery of the Fraser River System. Under the provisions of this Convention, the International Pacific Salmon Fisheries Commission was created and charged with the responsibility of fulfilling the terms of the Convention.

All of the problems relating to the serious decline and rehabilitation of the Fraser River sockeye could not be solved in the earlier years of the Commission's operation. Neither will they necessarily be solved in the immediate future. One principal cause for the decline and continued low level of abundance of the Fraser River sockeye has been determined and the major controlling factors have been eliminated by the construction of the Hell's Gate, Bridge River Rapids and the Farwell Canyon Fishways. No longer are hundreds of thousands of sockeye periodically found accumulated below these points of difficult passage where they eventually perished without spawning or were so seriously delayed that they became ineffectual spawners. The Adams River splash dam which, combined with the Hell's Gate obstruction, exterminated the large early run to Upper Adams River has been removed. Facilities have been constructed and are now in operation which may bring about the creation of new runs to now barren areas.

Regulation of the fishery to prevent overfishing and allow for rehabilitation was inaugurated in 1946 in accordance with the provisions of the Treaty. During the four-year period from 1946 to 1949, inclusive, stringent restrictions were placed on the fishermen to permit increased escapement to those spawning areas most seriously affected by the block at Hell's Gate. In spite of these regulatory restrictions, the total catch for the period increased almost a half million fish over the preceding four-year period unregulated by the Commission. The sockeye migrations in 1949 were the first returning progeny of fish using the Hell's Gate fishways. Exceptional increases were noted in almost all the populations produced above Hell's Gate. The total catch for 1949, in spite of additional restrictions on the fishery, increased 23 per cent over the cycle year, 1945. Escapements to some areas increased more than twenty-fold. The Early Stuart population was apparently larger than for any other known year on record even prior to 1913. The rapid rehabilitation of the Fraser River sockeye thus appears assured.

Scientific evidence collected by the Commission staff indicates that the future problem of management might be a complex one to solve. It is believed that, with increasing escapements, individual dominant cycles of reproduction will reappear perhaps with a different annual relationship than that which existed prior to the Hell's Gate catastrophe. All of these things were incorporated into the 1949 Annual Report as a discussion of the needs of scientific management under the terms of reference to the Commission.

The total population of sockeye in 1950 was approximately one-third that of the previous cyclic years 1946 and 1942. This reduction in the total population caused by the serious decline of the sockeye run to the South Thompson River necessitated emergency closures in the fishery of both the United States and Canada. It upset the economy of the industry, and made it impossible to obtain equal division of the catch between the two countries. The seriousness of the reduction in the 1950 catch necessitates special consideration by the Commission in its report to the two governments.

An inspection of the 1950 escapement by watersheds (Table VI) indicates that the decline was not general but was limited to three areas, Chilko, Stellako and the South Thompson. Actually the run to Chilko did not decline since the 1946 run to this area was not fished so intensively as it was in 1950. The Chilko area is once again producing on dominant years only, as it did in the early years. The 1950 Chilko production is considered normal. Likewise the Stellako population was fished more intensively in 1950 than in 1946. This area may be creating a dominant year on the 1949-1953 cycle, hence any decline to this area in 1950 is not believed to be unusual. The decline in the population produced by the 1946 escapement in the South Thompson area appears to be the only abnormal one. Because of emergency closures in both the United States and Canadian fishing waters, this decline is much greater than is indicated by the comparative cyclic escapements.

The South Thompson population spawns principally in the Lower Adams River and in Little River. The young fry spend their first year of life in Shuswap Lake. The decimation of the original population was apparently caused by the Adams River splash dam aided perhaps by other causes including the Hell's Gate block particularly in 1913, the year of the original dominant cycle. The Adams River splash dam ceased operations in 1922 at which time 20,000 spawners were reported by Dominion Fishery observers. By 1930 the total population including the catch had increased to several million fish and from that year on until 1950 this cycle has been referred to by the industry as the year of the great Adams River run. That the population may have approached its maximum size in 1942, because of either spawning limitations or the food limitation of Shuswap Lake, may be indicated by the slight decline in the 1946 population. This occurred in spite of a very large spawning escapement in 1942. It is important to note, however, that the decline was negligible and the escapement in 1946 approached equality with that of 1942. Nevertheless the 1950 run "failed" even though an earlier run to Seymour River, tributary to the same lake, increased substantially as indicated in Table VI. The young of both populations are known to live in the same lake.

Tagging records obtained over a ten-year period and statistical analyses of the catch indicate that all races of sockeye spawning above Hell's Gate are fast moving races with the exception of the Adams River population. Because of this comparatively rapid rate of migration, the weekly closed season as established tends to retain in the escapement the original character of the migration before it enters the fishery. The Adams River population, while maintaining approximately

the same rate of migration as that of the other races when approaching the mouth of the Fraser River, suddenly becomes "dormant" at this point. The arriving fish school off the mouth of the Fraser River for two weeks or more where they are subject to an intense fishery. Logically, the first to arrive are thus subjected to the heaviest fishing mortality and the last arriving fish to the least fishing mortality before the upriver migration actually starts. To obtain what is believed to be an adequate escapement, an extended closure has been placed in effect either before or during the time the fish were migrating upstream. This closure became effective on September 10 in 1938, before the fish entered the river, and extended to October 3. An excessive catch and a strike created an effective closure in 1942 on September 16 *the day upon which this population has normally entered the river fishery in any volume since the beginning of the records in 1901.* This closure extended to October 1 when fishing was resumed. In both years the peak of the upstream movement was allowed to escape and the end of the run was fished intensively.

The 1946 run appeared in large numbers in the United States fishery and no restrictions other than the usual weekend closed season of 36 hours were placed on the United States fishermen. Because of the abundance of the fish escaping the United States fishery, and the known limited capacity of the spawning grounds, the Fraser River fishery was not closed until September 25. The river then remained closed until October 14 after the migration of Adams River fish had practically ended in the lower river. Although the river did not close until September 25, a large number of fish escaped during the extended weekend closure of 72 hours on September 20, 21 and 22. The main escapement started upriver about 5 or 6 days later than had been the case in at least the two previous cycles. This delay was evident at Hell's Gate where studies on the passage of fish were being conducted as they were in 1942 and 1938. Here the fish encountered their first unusual obstacle. The level of the river had dropped to a 20-year low and a minor delay of a day or two occurred. This was not serious in itself but was additive to the delay already accrued as a result of the extended fishery. Additional delays occurred at Scuzzy Rapids, China Bar and in the Thompson Canyon about 10 miles upstream from the confluence of the Thompson River with the Fraser. All of these additional delays were caused by extreme low water conditions not normally expected. By the time the peak escapement had reached the Adams River spawning grounds it was approximately 15 days later than normal (Figure 1). The arrival date of the greatest number of spawners was October 26 in 1946, while on the same date in 1950 and in 1942 spawning was practically over, the peak of spawning being recorded between October 16 and 20 in 1950 (Table VI). In spite of the large spawning escapement of 2,400,000 fish in 1946, observers along the Fraser and South Thompson Rivers reported large schools of sockeye below points of difficult passage in late October. These sockeye were never observed arriving on the spawning grounds. They apparently perished enroute.

With the facilities at hand there was no way to assess the effect of this abnormal spawning migration. Observations were made of spawning, of the fry emergence and of the seaward migration of the yearlings. Actual enumeration

of the hatch or of the seaward migration was impossible, so any doubts of the success of spawning were tabled for further study. Information directly and indirectly related to this problem has been collected since 1946 and especially in 1949 and 1950 when additional funds were made available. The information was not sufficiently conclusive to make a public statement other than that appearing on Page 29 of the Annual Report for 1949, as follows:

> "The history of the Adams River run indicates that the nature of any restrictive regulation to obtain escapement may have an effect on the character of the spawning run, particularly as to time of arrival on the spawning beds. Observations are being made to determine the change if any in the normal character of the escapement and the influence of such a change on the productivity of the spawning populations."

We now proceed with our philosophy of the cause of the serious decline in the 1950 Adams River run and a statement of the facts collected which appear to substantiate it.

Each race of Fraser River sockeye, including the Adams River race, leaves its ocean feeding grounds and enters the United States fishery and the Canadian fishery at approximately the same time, each year and each cycle. The migration is characterized by a slow but gradual increase in numbers, a mass movement of the bulk of the population in a few days, then a long extended period of a small and declining number of fish. A graph of the available numbers migrating past a given point in relation to time can be crudely referred to as a "Sombrero" curve. This consistency of timing under natural conditions is maintained throughout the migration to the spawning grounds and for the spawning act itself. Since sockeye are cold-blooded animals the consistency in the timing of the spawning act sets the stage for a consistency, within the limits of environmental variation, in the time of hatch and entrance of the fry into their lake residence. Thus we logically assume that this consistency in the time of migration and the character of the migration itself must be related to the requirements for reproduction and freshwater survival. If this were not true, why should there not be runs of sockeye to each individual area over longer periods of time or at different seasons of the year. The very *rigidity* in the timing of the environmental cycles in the spawning areas of the Fraser River almost arbitrarily indicates a close relationship of these cycles to successful reproduction.

A great volume of temperature data collected over several years during the spawning time of each race of Fraser River sockeye reveals that spawning almost always takes place at a water temperature between 55° and 45° Fahrenheit, with peak spawning tending to occur at 50° Fahrenheit. This happens whether the distance of migration to the spawning grounds is 30 or 730 miles from the sea. In fact the availability by time of each race to the fishery appears to be related to the speed of migration, the distance of the spawning ground from the sea and the normal timing of the water temperature cycle on the spawning ground. Perhaps the long and slow beginning and end of a run are abnormal migrants not properly timed to the environmental cycle as the mass movement of the peak

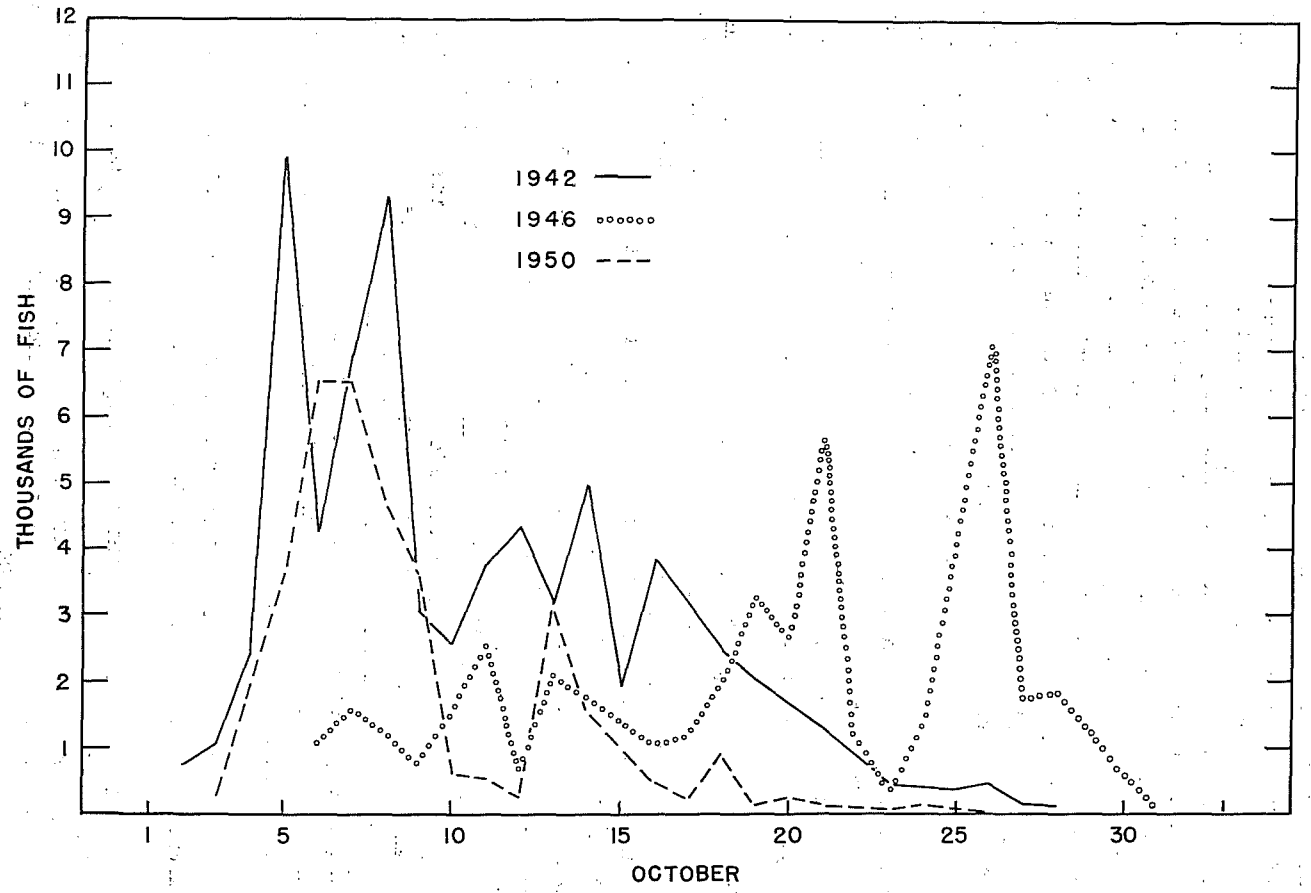


FIG. 1.—Daily Movement of Sockeye up Adams River as Measured by the Number of Fish Passing the Lower Adams River Bridge Per Hour.

migration apparently is. Inspection of the spawning grounds reveals that early arrivals tend to die without spawning, especially when prevailing water temperatures are near 60° Fahrenheit. This may be one of the important environmental limitations which prevents the expansion of spawning to an earlier date. It is known that sockeye spawn successfully in a water temperature of 45° Fahrenheit and below, but since they do not normally do so in the Fraser River watershed, some environmental limitation to reproduction may exist at or below this temperature. In 1949 and 1950, controlled experiments conducted on the effect of water having a temperature of 45° Fahrenheit on the natural spawn of sockeye, indicated three times the normal mortality to hatching, a weak hatch and a delayed hatch. In these experiments the water temperature after fertilization was changed daily to duplicate the temperature conditions during the incubation period on the upriver spawning grounds. While these experiments are not conclusive, they indicate a possible reason for the failure of any race of Fraser River sockeye to return in expected numbers when it was spawned in water having a temperature of 45° Fahrenheit or below. A "late" spawning may start a schedule of development which is not synchronized with the environmental cycle throughout its fresh water existence, or even perhaps with the cycle affecting the entrance of the young into the sea. The greatest proportion of the 1946 escapment to Adams River spawned in water having a temperature near or below 45° Fahrenheit.

In addition to the possible adverse effect of below normal water temperature at the time of spawning there is also the probability of a lowered viability of the eggs caused by prolonged egg retention. It is commonly known that abnormal egg retention lowers the viability of the eggs at a rapid rate. An examination of Figure 1 shows the peak arrival of spawners in Adams River between October 6 and October 10 for the years 1942 and 1950. Records of actual spawning show that in both years the peak of spawning was prior to October 20. In contrast to 1942 and 1950, the peak of arrival of the 1946 Adams River spawners was not until October 21 to October 26, considerably later than the peak of spawning in 1942 and 1950. Since the 1946 migration entered the Fraser River on the same day as in previous years there is reason to believe that arrival and spawning time would have been more nearly normal for a majority of the escapement if the delays because of abnormal physical hazards had not occurred. Thus it appears that the peak of spawning was artificially delayed in 1946 by the delay in arrival on the spawning grounds.

Summarizing the variations from normal in the character of the 1946 escapement to the Adams River area we find that:

1. The escapement consisted of a large portion of the end of the run. The beginning and end of a run, in spite of a limited amount of individual dispersion during the migration, might be classed as abnormalities not properly synchronized with the normal environmental cycles to permit a maximum rate of reproduction.

2. The peak escapement was delayed approximately 15 days later than normal in arriving on the spawning grounds. This delay may have had two effects. These are:

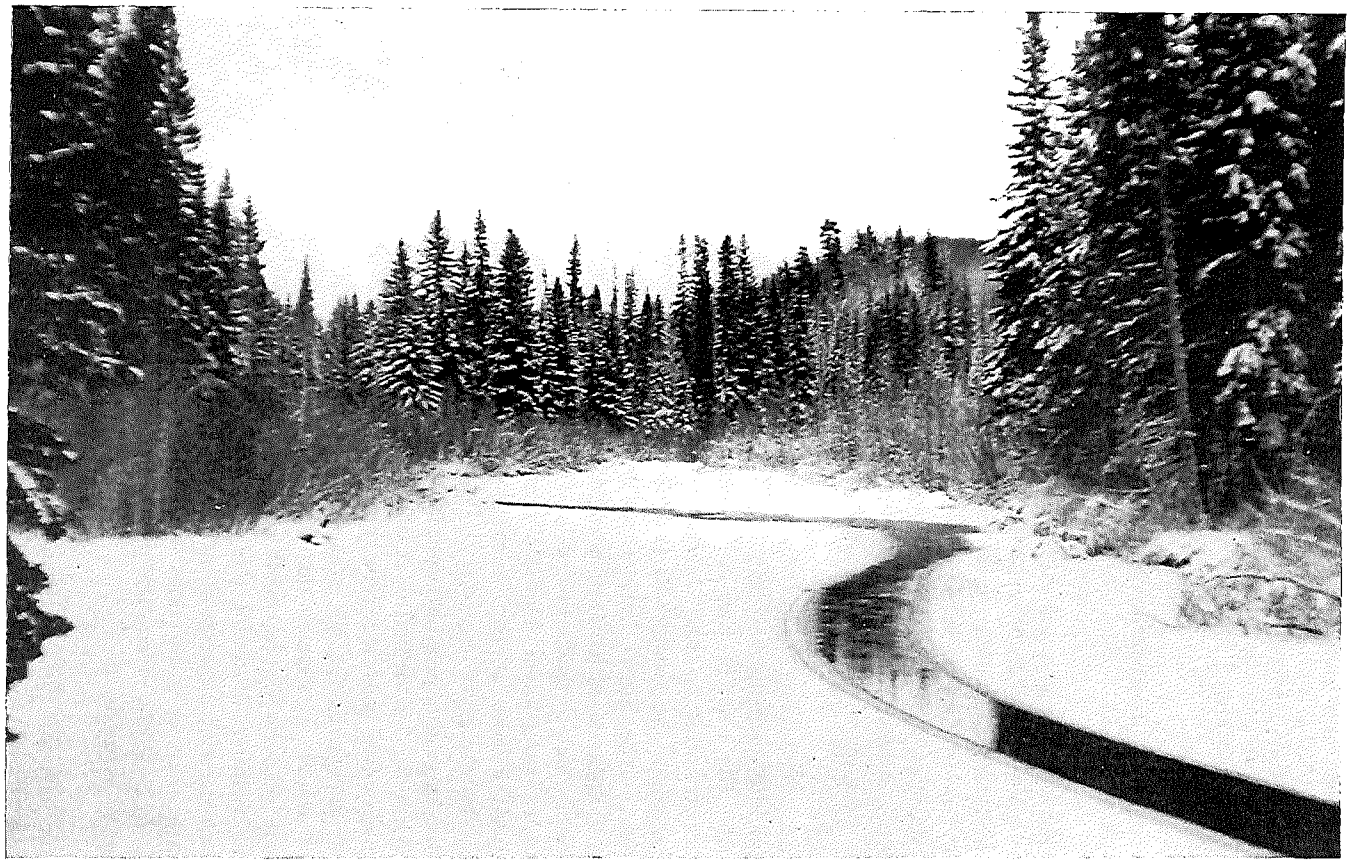


FIG. 2.—An early winter scene of the sockeye spawning grounds in the Horsefly River 1950. Prevailing "Forty below" weather caused the exposed surface of the river to freeze completely over soon after this picture was taken.

a. Spawning in water having a temperature near or below 45° Fahrenheit may have increased the mortality prior to hatching, caused a delayed emergence from the gravel not properly timed for normal entrance into Lake Shuswap, and may have resulted in a hatch poorly fitted from a physiological standpoint to meet the competition of its early life. Perhaps the normal time of seaward migration and of the entrance of the migrants into the sea may have been changed, but no evidence on this point has been obtained.

b. A lowered viability of otherwise normal eggs because of prolonged egg retention.

Many observations will have to be made and much experimentation must be carried on before sufficient scientific evidence will be available to completely substantiate the logic and philosophy detailed above. However, the reasoning is simple and direct and based on certain scientific evidence. The Adams River run "declined", the others did not. The summarized variations are the only measured ones and they have not been previously noted, either in the case of other observed Adams River runs or in the case of those runs destined for and spawning in other areas.

In spite of the lack of conclusive scientific evidence on the effect of the known variations from normal in the character of the 1946 Adams River spawning escapement, the danger of contributing to these variations through regulation of the fishery is great. Fortunately the Adams River race of sockeye appears to be the only important one in the Fraser system particularly susceptible to having the character of its migration seriously disturbed by regulation. The dormant stage in its migration which extends for perhaps two weeks or more, while it is off the mouth of the Fraser River, tends to increase fishing mortality to a point where an extended closure appears necessary to obtain adequate escapement. The season must be closed, if necessary to obtain adequate escapement, at the beginning of the upstream peak in migration and the last of the migration fished intensively. Only by this method of regulation can the escapement be expected to arrive on the spawning beds at a time when the same stage in the environmental cycle exists as it does during the spawning of all other races of sockeye in the Fraser River system. It appears that if a maximum catch is to be maintained from this race of sockeye, the quality of part of the catch by Canadian fishermen may have to suffer. Assuming that the variations from normal in the character of the 1946 escapement are responsible for the decline in the 1950 run, the only way to guarantee that regulation does not contribute to any future situation of similar nature is to close the river fishery on or about September 15 until an adequate escapement is assured.

The recommended regulations for 1950 included a special provision for an extended weekend closure beginning September 15. The serious decline in the run actually necessitated an emergency closure of Canadian waters on September 7. The planned division of the catch between Canada and the United States failed by a deficit of 347,000 sockeye on the part of Canadian

fishermen although the total catch by Canadian fishermen for the five years of regulation by the Commission still exceeds that of the United States fishermen by 232,000 sockeye.

The first Commission meeting in the year 1950 was held at Vancouver, B. C., on February 6 and 7. Recommendations to the two governments for regulatory control over the 1950 fishing season were considered and presented to the Advisory Committee in final form. An agreement was reached by the Commission on the proposed regulatory recommendations on February 7.

A unanimous decision was made by the Commission at this meeting to close the High Seas embraced in Paragraph Number 1 of Article I of the Convention to the taking of sockeye from July 1, through August 31, 1950. Action was delayed until July 20 on recommendations for weekly closed periods in United States waters and in those Canadian waters lying in the Straits of Juan de Fuca.

Members of the Advisory Board which met with the Commission on February 6 were Peter Jenewein, gill net fishermen; Harry Martinick, purse seine fishermen; M. W. Black, sport fishermen; and Richard Nelson, salmon packers; representing Canada, and Frank Scott, alternate, gill net fishermen; Nick Mladinich, purse seine fishermen; John R. Brown, troll fishermen; and J. N. Plancich, salmon packers; representing the United States.

On June 19 and 20, the Commission met with representatives of the Department of State in Washington, D.C. Administrative details involving the United States government were discussed. Official correspondence from the fishing industry of both the United States and Canada relative to the 1950 regulations was considered and a decision was reached and appropriate answers given. The Biological and Engineering programs of investigations for the year were presented by the staff and approved. On June 22 the meeting was reconvened at Ottawa, Canada. Administrative problems were discussed with representatives of the Canadian Government. A policy regarding flood control and power developments on the Fraser was considered relating particularly to those projects being proposed on the Nechako and Quesnel Rivers. The proposed budget for the 1951 fiscal year was examined and approved. Instructions were given to the officers of the Commission relative to the completion of the tentative equipment inventory submitted for examination by the Commissioners.

The third meeting of the year was held at Bellingham, Washington, on July 20. All members of the Advisory Board of both Canada and the United States were present, the United States gill net fishermen being represented by Louis Bretvic, alternate. The recommendations for regulation of the fishery, not decided upon at the Vancouver meeting, were discussed with the Advisory Committee and final action was taken. Procedure for legally changing the approved regulations to meet unforeseen emergencies without a formal session of the Commission was unanimously approved. The building of a high level fishway at Hell's Gate was authorized.

At the fourth meeting held in Kamloops, B. C., on October 12, special tribute was paid to the memory of Commissioner Alvin Anderson. The staff presented a review of the 1950 fishing season and special reports on some of its current investigations. A general report on the fishing season and on the problems relating to proposed water use projects was presented to the Advisory Committee. A mutual inspection of the Adams River and Little River spawning populations was made by the Commission and the Advisory Committee. Messrs. M. W. Black, R. Nelson, A. E. Carr and P. Jenewein represented Canada and J. Plancich, C. Karlson and J. Brown represented the United States on the Advisory Committee.

The final meeting of the year was convened in Seattle, Washington, on December 8, when tentative proposals for the 1951 regulations were submitted to the Advisory Committee together with brief reports on the Commission's research. William Pitre was chosen by unanimous vote of the Commission to fill the vacancy on the Canadian Advisory Committee created by the unfortunate death of Harry Martinick. Although Mr. Martinick had served only a year with the Commission his advice was always found to be conservative and sound.

Canada was represented on the Advisory Committee by A. E. Carr, R. Nelson, P. Jenewein, and W. Pitre. The United States was represented by K. McLeod, J. Plancich, C. Karlson, J. Brown and N. Mladinich.

1950 REGULATIONS

Recommendations for regulations governing the management of the sockeye fishery in 1950 were considered during 1949 and 1950 at meetings held in Bellingham, Washington, Vancouver, B. C., and Washington, D. C. In general they were adopted at a meeting in Vancouver, B. C., on February 7, 1950, on which occasion it was decided to approve a closure pertaining to the High Seas section of the Convention waters. It was likewise decided to issue at once those recommendations dealing with the opening dates in all waters and all recommendations dealing with Canadian waters other than the Straits of Juan de Fuca. At a meeting in Washington, D. C., the regulation regarding the High Seas was officially promulgated and at a meeting held in Bellingham, Washington, on July 20, 1950, the remaining recommendations relating to control of fishing in United States Waters and the Straits of Juan de Fuca in Canada were approved.

These recommendations for regulations as approved were transmitted to the Departments of Fisheries of Canada and the State of Washington. They were accepted in substance for Canadian waters by an Order-in-Council adopted on July 12, 1950, and for United States waters by an order of the Director of the Washington State Department of Fisheries promulgated June 13, 1950.

The recommendations of the Commission were as follows:

Canadian Waters

The International Pacific Salmon Fisheries Commission appointed pursuant to the Convention relating to the protection, preservation and extension of the

Sockeye Salmon Fisheries between the United States and Canada signed at Washington on the twenty-sixth day of May, 1930, hereby recommends to the Honourable the Minister of Fisheries that regulations to the following effect, in the interests of such fisheries be adopted by Order-in-Council as amendments to the Special Fishery Regulations under authority of the Fisheries Act, namely:

1. That in the waters of Canada embraced in Paragraphs 2 and 3 of Article I of the Convention relating to the protection, preservation and extension of the Sockeye Salmon Fisheries between the United States and Canada and signed at Washington on the twenty-sixth day of May, 1930, in order to secure a proper escapement of sockeye salmon, no one shall fish for or take any sockeye salmon by any gear whatever between 12:01 a.m. the first day of July, 1950, and 8:00 a.m. the thirty-first day of July, 1950.

2. That in the waters of Canada embraced in Paragraphs 2 and 3 of Article I of the said Convention, during the Spring or Chinook salmon fishing season, commencing at 12:01 a.m. the first day of July, 1950, and ending at 8:00 a.m. the thirty-first day of July, 1950, no one shall fish for any kind of salmon with a gill net having a mesh of less than eight inches extension measure when wet, and further that this provision shall also apply whenever those waters or any part thereof shall be closed pursuant to a recommendation of the Commission.

3. That in those waters of Canada embraced in Paragraphs 2 and 3 of Article I of the said Convention known as Fisheries District 1 and Areas 17 and 18 of Fisheries District 3 commencing on the thirty-first day of July, 1950, and continuing until the fifteenth day of September, 1950, there shall be weekly closed periods of seventy-two hours at the weekend, and further that in these same waters commencing on the fifteenth day of September, 1950, and continuing until the twenty-sixth day of September, 1950, there shall be weekly closed periods of ninety-six hours duration.

4. That in those waters of Canada embraced in Paragraph 2 of Article I of the said Convention and known as Areas 19 and 20 of Fisheries District 3 the desired weekly closed time shall be as determined at a later meeting of the Commission.

5. That in those waters of Canada embraced in Paragraphs 2 and 3 of Article I of the said Convention the weekly closed periods may be extended or reduced on further decisions by the Commission and communicated by the Commission through its Chairman to the Chief Supervisor of Fisheries for British Columbia.

6. That whenever, in the waters of Canada embraced in Paragraphs 2 and 3 of Article I of the said Convention, it shall become necessary to announce closures, additional closures, or other amendments to the regulations, the posting of notices twenty-four hours in advance of the effective time of such change of fishing regulations shall be considered sufficient notice.

7. That in the waters of Canada embraced in Article I of the said Convention no one shall buy, sell or have in his possession any sockeye taken in those waters or any part thereof between July 1, 1950, and July 31, 1950, or at any other time when fishing for or taking sockeye salmon shall be prohibited in such waters, or part thereof, on recommendation by the Commission.

8. That in the waters of Canada embraced in Paragraph 1 of Article I of the said Convention no one shall fish for or take sockeye salmon from the first day of July to the thirty-first day of August, both dates inclusive for the year 1950.

9. Nothing contained in any Regulations made pursuant to the Fisheries Act shall apply to the taking of sockeye salmon within the waters of Canada embraced in Article I of the said Convention by the International Pacific Salmon Fisheries Commission, or its servants, or agents acting pursuant to its direction, for the purpose of exercising its objects under the said Convention.

The weekly closed season for purse seines in the waters of Canada embraced in Paragraph 2 of Article I of the Convention and known as Areas 19 and 20 of Fisheries District 3 was recommended by the Commission in session on July 20, 1950, to be from midnight Thursday to midnight Saturday of each week from July 31, 1950, to and including August 12, 1950. Beginning on August 19 the recommended weekly closed season for purse seining in these waters was to be from midnight Friday to midnight Saturday and from midnight Monday to midnight Tuesday of each week through September 12, 1950. The 1950 weekly closed season for gill nets and traps was recommended to be as aforesaid for purse seines except that in each instance the closed season should begin and terminate six hours earlier. These recommendations were officially accepted by the two governments.

During the fishing season it was deemed necessary in order to insure an adequate escapement of sockeye to add one additional 24-hour closure in the waters of Areas 19 and 20 by closing the fishery on August 18. The regular weekly closed period for District Number 1 and Areas 17 and 18 was extended 24 hours at its normal ending.

When it became apparent that the numbers of sockeye destined for spawning in the South Thompson watershed had declined considerably from the abundance of former years and that adequate escapement would be seriously endangered by equal division of catch between Canada and the United States, a closure was recommended by the Commission on September 5 including all the Canadian Convention waters lying in Area 17 and District Number 1 commencing at 8:00 a.m. Thursday, September 7 and continuing until 8:00 a.m. October 2. An extension of this closure to include Area 18 was recommended on September 7 to become effective at midnight Saturday, September 9. These recommendations were accepted by the Canadian Government. Because of the magnitude of the Spring salmon run at the time of the above emergency closures no restriction was placed on the use of gill nets having a stretched mesh of 8″ or over, but the taking or possession of sockeye was prohibited. By September 16, the snagging of sockeye in the spring salmon nets had reached such proportions that a great economic waste was occurring and escapement was again endangered. Fishing by any size net was prohibited in the waters of District Number 1 and Areas 17 and 18 beginning at 8:00 a.m. September 18.

Observations on the upstream passage of sockeye indicated that adequate escapement had been obtained on September 22 and the Commission relinquished all control of fishing in Canadian waters effective at midnight September 23.

United States Waters

The International Pacific Salmon Fisheries Commission appointed pursuant to the Convention relating to the protection, preservation and extension of the Sockeye Salmon Fisheries between the United States and Canada and signed at Washington on the twenty-sixth day of May, 1930, hereby recommends to the Director of Fisheries of the State of Washington that regulations to the following effect, in the interests of such fisheries, be adopted by him by virtue of authority in him vested by Section 6 of Chapter 112 of the laws of the State of Washington of 1949, namely:

1. That in the waters of the United States of America embraced in Paragraph 2 of Article I of the Convention relating to the protection, preservation and extension of the Sockeye Salmon Fisheries between the United States of America and Canada signed at Washington on the twenty-sixth day of May, 1930, no one shall fish for or take sockeye salmon commercially between June 30, 1950, and 8:00 a.m. on the thirty-first day of July, 1950.

2. That in the waters of the United States of America embraced in Paragraph 2 of Article I of the said Convention there shall be a weekly closed period, the nature of which shall be determined at a meeting of the Commissioners to be held on the twentieth day of July, 1950. The recommendation concerning this closure will be communicated by the Commission through its Chairman to the Director of Fisheries of the State of Washington at the time of its adoption.

3. That in the waters of the United States of America embraced in Paragraph 2 of Article I of the said Convention, from time to time the Commission may prepare further recommendations concerning additional closed time for fishing for sockeye salmon, which recommendations will be communicated by the Commission through its Chairman to the Director of Fisheries for the State of Washington.

4. That in the waters of the United States of America embraced in Paragraph 2 of Article I of the said Convention, in order to ensure a proper escapement of sockeye salmon, no one shall fish for or take any kind of salmon by any gill net having a mesh of less than 8″ extension measure when wet during the period in the Spring or Chinook salmon fishing season, commencing on the first day of July, 1950, and extending up to 8:00 a.m. on the thirty-first day of July, 1950.

5. That in the waters of the United States of America embraced in Paragraph 1 of Article I of the said Convention, no one shall fish for or take sockeye salmon by any gear whatsoever unless permitted by the regulations of the International Pacific Salmon Fisheries Commission promulgated for the purpose of governing the times when sockeye may be taken in the waters embraced in Paragraph 1 of Article I of the said Convention.

6. That in the waters of the United States of America embraced in Article I of the said Convention it shall be unlawful to possess, sell or purchase sockeye salmon during the time that fishing for such salmon is prohibited therein.

7. Nothing contained in any rules or regulations relating to fishing for or taking sockeye salmon shall apply to the taking of sockeye salmon within the waters of the United States of America embraced in Article I of the said Convention by the International Pacific Salmon Fisheries Com-

mission or its servants, or agents acting pursuant to its directions for the purpose of exercising its objects under the said Convention.

The Commission in session on July 20 recommended that the weekly closed period in United States Convention waters should coincide with the weekly closure in Areas 19 and 20 of Canadian Convention waters, the closing and opening hours for purse seines and reef nets to be midnight to midnight on the respective days and for gill nets six hours earlier in each case. One additional 24-hour closure was recommended on August 18 to obtain proper escapement.

Because of the serious decline in the late run of sockeye destined for the South Thompson watershed an emergency closure of United States Convention waters was recommended effective from 9:00 p.m. August 30 until 6:00 p.m. September 6. It was further recommended that the waters north of a line from Birch Point to Patos Island remain closed until midnight September 15 and those waters lying west of a line from Point Roberts Lighthouse to the Patos Island Lighthouse remain closed until midnight September 30. These recommendations were accepted by the State of Washington.

High Seas

"Under the authority of the Convention hereinafter mentioned, the International Pacific Salmon Fisheries Commission at its meeting at Washington, D. C., on the 19th day of June, 1950, hereby made and adopted the following order and regulation, namely:

> taking Sockeye Salmon on the High Seas described in paragraph numbered 1 of ARTICLE I of the Convention between the United States of America and the Dominion of Canada for the protection, preservation and extension of the Sockeye Salmon Fisheries in the Fraser River System, signed at Washington on the 26th day of May, 1930, is hereby prohibited from July 1, 1950, through August 31, 1950; provided that this Order and Regulation shall apply only to nationals and inhabitants and vessels and boats of the United States of America and the Dominion of Canada: this Order and Regulation being affirmatively voted for by three of the Commissioners of the United States of America and three of the Commissioners of the Dominion of Canada."

The units of fishing gear in United States waters had increased substantially in recent years (Table II). The Canadian fishery operating on Fraser River sockeye had indicated a tendency to expand to new fishing areas. A large Canadian purse seine fleet was already operating in the Straits of Juan de Fuca in 1949 and showed intentions to expand its operation along the West Coast of Vancouver Island during 1950 as it did on pink salmon in 1949 when an estimated 1,800,000 fish of that species were taken by this gear in the Straits of Juan de Fuca and in the coastal area westerly and northerly of Bonilla Point.

The approved extension of an efficient purse seine fishery in Canadian waters to the Straits of Juan de Fuca and the rapidly increasing intensity of fishing in United States waters created a new and difficult problem for the

Commission to solve. The expansion of fishing on the part of either or both countries to the area west and north of Bonilla Point in 1950 would have in the opinion of the Commission endangered its whole program of management. There were many reasons for this. Among them are the following:

1. The Commission had no information on how to assess the racial catch in the area. Any attempt to establish racial catch-escapment ratios would have been impossible.
2. The taking of large and unequal catches of unknown races by the fishermen of the two countries would have rendered valueless any established method for predicting the size of the run and for obtaining equal division of the catch.

These reasons in themselves were considered to be sufficient justification for closing the offshore area during the 1950 sockeye run. If the 1950 South Thompson run of sockeye had been normal, its characteristic of schooling at the surface in the offshore and Straits area would have resulted in a large catch. It should be pointed out that more than the allowable share of the sockeye catch can be taken by the fishermen of either country operating in the traditional fishing areas. An expansion of effective fishing to the offshore area cannot result in an increased catch but merely in the redistribution of the allowable catch by fishing areas.

The 1950 closure on the High Seas did not result in any economic loss or discomfort to either country. The opposite was probably true because of the serious decline in the run which was not anticipated by the industry of either country. Since the fishing industry of both countries has indicated its desire to fish sockeye in Convention waters westerly and northerly of the line from Bonilla Point to Tatoosh Island, the effect of such a fishery can eventually be assessed and methods established for its control if such methods are found to be possible and practical. The proper time to study such a fishery is during an "off" year when many races of sockeye are present in the area but no one of which is available in sufficient numbers to attract a large fleet of fishing boats. The current year was not considered satisfactory as a year for this type of study and as previously stated the danger of an intensive fishery to the proper management of the 1950 run was great. It is not the present intention of the Commission to arbitrarily regulate the "offshore" waters, merely to control the expansion of fishing to this area within the needs of good management. It seems important to note however that coincidental with the increased size of the racial populations returning to the Fraser River this expansion must be controlled as a necessity for proper management.

THE UNITED STATES FISHERY

The rapid increase in the units of gear fishing in United States waters was again evident in 1950. An estimated fleet of 220 purse seine boats started fishing on July 31, the opening date. This fleet increased as the season progressed until 303 individual boats were recorded as having taken Fraser

River sockeye. The number of gill net and reef net fishermen also increased substantially over the number fishing the previous cycle years of 1946 and 1942 (Table II).

The pattern of the daily catch record was not similar to that of the preceding cyclic years. Prior to August 10, the total production was greater than for the same period in 1946, 1942 and in 1938. Except for minor exceptions a larger catch was taken each day than was taken on the same days for the three previous cycles (Table III). The year 1938 showed the greatest degree of similarity with 1950 and throughout the season the production of both years was quite comparable. The equal numbers of sockeye taken in 1938 and 1950 do not however indicate equality in the size of the total run for the two years. The 1950 catch was taken by a fishing fleet considerably larger in size than that operating in 1938.

The collective population of the early races of sockeye fished between July 31 and August 15 appeared in strength as anticipated and was responsible for the comparatively good catches during this period. The main body of the South Thompson population started showing on August 17 and continued its migration through the fishery until August 26 after which date the only good catches were made near the International Boundary. The peak migration appeared a full week earlier than in 1946, a few days earlier than in 1942 and at about the same time as in 1938. The fears of the Commission that a decline might occur in the size of the 1950 run to the South Thompson River were more than justified for by August 27 it was known that the run had declined beyond all expectations. The emergency closures to protect the run against excessive fishing mortality are detailed elsewhere but it is important to note a lower efficiency of the United States gear in catching fish of this race than is the case when fishing on the earlier races. This had been demonstrated on other cycles but little was known of the effect of such increased fishing intensity as prevailed during the 1950 season.

Total landings and pack in United States and Canada for the period of Commission regulation beginning in 1946 and extending up to date are shown in Table I. Cyclic comparison of the total landings and pack of the two countries are recorded also. Daily catch figures in United States waters for 1950, 1946 and 1942 are detailed in Table III.

THE CANADIAN FISHERY

Fishing effort by all gear in Canadian Convention waters was less than in the previous cyclic years. The customary number of five traps operated at Sooke during the sockeye run. There were 147 purse seine boats active in the Straits of Juan de Fuca, easterly of Bonilla Point of which a maximum of 91 boats landed sockeye on any one day. When Area 17 opened only a part of the fleet attempted to operate in this area whereas in 1946 as many as 180 purse seines were recorded fishing for sockeye.

TABLE I

LANDINGS AND PACK OF SOCKEYE, 1946 TO 1950

1946 - 1950 (5 year totals)	*United States*	*Canada*	*Total*
Total Landings (No. sockeye)	7,008,104	7,262,313	14,270,417
Share in Fish	49.1%	50.9%	
Total Pack (48 lb. cases)	574,224	584,251	1,158,475
Share in Pack	49.6%	50.4%	
1946			
Total Landings (No. sockeye)	3,551,773	4,240,198	7,791,971
Share in Fish	45.6%	54.4%	
Total Pack (48 lb. cases)	280,018	331,292	611,310
Share in Pack	45.8%	54.2%	
*1950			
Total Landings (No. sockeye)	1,220,935	894,469	2,115,404
Share in Fish	57.7%	42.3%	
Total Pack (48 lb. cases)	116,458	81,510	197,968
Share in Pack	58.8%	41.2%	

* Twenty canneries in the United States and thirteen canneries in Canada received the sockeye caught in Convention waters.

TABLE II

LICENSED GEAR TAKING SOCKEYE IN UNITED STATES CONVENTION WATERS

	Purse Seines	*Gill Nets*	*Reef Nets*
1942	135	75	63
1946	167	72	64
1950	303	332	126

It is natural when operating on a run of the type found in this cycle, for the gill net fleet in District 1 to increase in size during the latter part of the sockeye season. In 1942 the gill net fleet reached a total of approximately 2,500 boats, while in 1946 the fleet included an estimated 3,000 boats. This seasonal increase in the number of boats did not occur in 1950 because of the small late run and the emergency closure of District 1 to sockeye fishing from September 7 to September 23. The maximum fleet was estimated at 1,700 boats.

THE INDIAN FISHERY

The estimated number of sockeye taken by Indians in the various accustomed fishing grounds in the Fraser River watershed for the year 1950 are recorded in Table V. These records are partially compiled by the District Inspectors of the Dominion Department of Fisheries and are released here through the courtesy of that Department.

The total catch increased substantially over that of the previous cycle and represents the fifth continuous annual increase since the Hell's Gate Fishways were constructed in 1945. The larger number of sockeye escaping to the northern areas is providing subsistence to the Indian population in the upper watershed that has not been enjoyed since prior to 1913.

Restricted fishing was permitted in the Chilcotin River by the Department of Fisheries with the approval of the Commission. The annual runs of sockeye to this watershed are now believed to be of sufficient size each year to permit a controlled Indian fishery for needed winter food supplies.

TABLE III

DAILY LANDINGS OF SOCKEYE, 1942-1946-1950 FROM UNITED STATES TREATY WATERS SHOWING NUMBER OF SOCKEYE TAKEN DAILY AND CUMULATIVE PER CENT OF SEASON TOTAL AS OF EACH DATE

	AUGUST						SEPTEMBER					
	1942		1946		1950		1942		1946		1950	
Date	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*
1	7,264	4.72	10,851	.47	15,403	2.43	180,185	91.66	53,804	75.77	343	99.40
2	11,097	5.09	8,879	.72	20,880	4.14	118,421	95.70	131,749	79.48	42	99.41
3	7,799	5.36	51	.72	25,058	6.19	10,618	96.06	92,579	82.09	16	99.41
4	12,749	5.79	12,163	1.06			906	96.09	71,241	84.09	3	99.41
5	14,735	6.30	7,745	1.28					62,452	85.85	18	99.41
6	21,761	7.04	15,543	1.72	16,961	7.58	378	96.10	79,725	88.09		
7	24,290	7.86	34,751	2.70	34,588	10.42	7,262	96.35			968	99.49
8			47,971	4.05	48,134	14.36	589	96.37	41,085	89.25	713	99.55
9	20,550	8.56	38,902	5.14	41,470	17.75	794	96.40	94,111	91.90		
10	23,806	9.38			36,990	20.78	4,455	96.55	103,522	94.82	207	99.57
11	32,832	10.49	23,838	5.81			4,070	96.69	92,895	97.43	393	99.60
12	36,892	11.75	23,799	6.49					13,347	97.81	297	99.62
13	46,307	13.33	29,522	7.32	55,865	25.36	33	96.69	7,562	98.02	56	99.63
14	40,801	14.69	35,193	8.31	26,563	27.53	13	96.69			62	99.63
15	8	14.69	34,903	9.29	18,115	29.02	13	96.69	8,342	98.25	46	99.64
16	17,408	15.29	43,047	10.50	36,042	31.97	20	96.69	8,598	98.50		
17	24,080	16.11			52,889	36.30	144	96.70	21,893	99.11	898	99.71
18	52,395	17.89	27,381	11.27			124	96.70	9,173	99.37	483	99.75
19	74,633	20.43	43,713	12.50					11,005	99.68	2,427	99.95
20	88,366	23.44	63,070	14.28	138,217	47.62	77	96.70	705	99.70	365	99.98
21	162,510	28.98	64,503	16.10	153,568	60.20	250	96.71			124	99.99
22	446	29.00	55,089	17.65			106	96.72	4,882	99.84	67	99.99
23	263,166	37.96	54,416	19.18	100,173	68.41	130	96.72	2,197	99.90		
24	251,749	46.54			131,748	79.20	3,002	96.82	1,696	99.95	12	99.99
25	192,015	53.08	89,452	21.70	107,788	88.03	773	96.85	1,846	99.99	21	99.99
26	159,915	58.53	134,956	25.50							14	99.99
27	302,628	68.83	290,642	33.68	83,504	94.86	1,350	96.89			17	99.99
28	150,202	73.95	542,836	48.96	38,212	97.99	15,418	97.42			18	99.99
29	1,089	73.99	366,879	59.29			16,468	97.98			11	100.00
30	58,271	75.97	531,426	74.25	16,860	99.38	26,608	98.89				
31	280,408	85.53										
Month Total	2,380,172		2,631,521		1,199,028		392,207		914,409		7,621	
To August 1	131,164	4.47	5,839	.16	14,286	1.17						
October 1-30							32,680	100.00	4	100.00		
Season Total							2,936,223	100.00	3,551,773	100.00	1,220,935	100.00

TABLE IV

DAILY LANDINGS OF SOCKEYE, 1942-1946-1950 FROM CANADIAN TREATY WATERS SHOWING NUMBER OF SOCKEYE TAKEN DAILY AND CUMULATIVE PER CENT OF SEASON TOTAL AS OF EACH DATE

	AUGUST						SEPTEMBER					
	1942		1946		1950		1942		1946		1950	
Date	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*
1	13,576	3.39	807	.06	25,874	6.66	70,126	20.24			312	85.82
2			212	.06	26,390	9.61	105,974	22.34	27,736	23.66		
3	5,231	3.49	278	.07	30,775	13.05	168,433	25.68	132,495	26.79	120	85.83
4	15,863	3.81					201,686	29.68	195,535	31.40	19,760	88.04
5	7,478	3.96	1,979	.11			162,469	32.90	144,446	34.81	12,062	89.39
6	8,812	4.13	333	.12	11,031	14.29			72,977	36.53	26,320	92.33
7	3,173	4.19	132	.12	53,074	20.22	24,692	33.38	70,348	38.19	978	92.44
8	10,235	4.40	5,823	.26	31,653	23.76	107,007	35.50			150	92.46
9			7,759	.45	20,121	26.01	263,636	40.73	33,030	39.97		
10	11,632	4.63	5,277	.57	21,189	28.38	430,156	49.25	89,516	41.08	307	92.49
11	27,324	5.17			296	28.41	283,396	54.86	586,175	54.91	50	92.50
12	15,721	5.48	26,515	1.20			304,744	60.90	94,753	57.14	50	92.50
13	20,064	5.88	36,177	2.05	14,679	30.05			313,429	64.53	58	92.51
14	10,834	6.09	27,586	2.70	49,953	35.64	366,669	68.17	80,770	66.44	16	92.51
15	13,336	6.36	23,584	3.26	29,973	38.99	458,173	77.24			16	92.51
16			16,146	3.64	32,366	42.61	285,102	82.89	163,566	70.30		
17	29,803	6.95	18,174	4.06	38,300	46.89	155,886	85.98	210,664	75.27	16	92.52
18	34,928	7.64					48,240	86.94	207,573	80.16	15	92.52
19	18,090	8.00	24,430	4.64			19,173	87.31	139,073	83.44	15	92.52
20	47,292	8.93	34,148	5.45	71,775	54.91			139,638	86.74	15	92.52
21	22,101	9.37	18,118	5.87	42,085	59.62					10	92.52
22	33,916	10.04	27,241	6.52	29,217	62.88	373	87.32			8	92.52
23			22,697	7.05	45,742	68.00	203	87.33	154,779	90.39		
24	45,423	10.94	30,670	7.78	52,525	73.87	1,631	87.36	218,304	95.54	2	92.52
25	63,395	12.20			21,972	76.33			178,218	99.74	29,233	95.79
26	113,004	14.44	132,590	10.90			1,287	87.38	646	99.76	10,835	97.00
27	64,912	15.72	339,263	18.90	3,118	76.67			3,588	99.84	10,663	98.19
28	58,421	16.88	91,937	21.07	40,252	81.17	3,775	87.46	2,921	99.91	4,980	98.75
29	74,221	18.35	26,199	21.69	19,577	83.36						
30			28,957	22.37	13,918	84.92			135	99.91		
31	25,415	18.86	26,964	23.01	7,737	85.78						
Month Total	794,200		973,996		733,592							
To August 1	157,549	3.12	2,152	.04	33,721	3.77	3,462,831		3,260,315		115,991	
October 1 - November 30							633,019	100.00	3,735	100.00	11,165	100.00
Season Total							5,047,599	100.00	4,240,198	100.00	894,469	100.00

TABLE V

THE INDIAN CATCHES OF SOCKEYE SALMON BY DISTRICTS AND THE AREAS WITHIN THESE DISTRICTS, 1946, 1950

	1946		1950	
District and Areas	*Catch*	*No. of Fishermen*	*Catch*	*No. of Fishermen*
HARRISON-BIRKENHEAD				
Skookumchuck	—	—	846	9
Lillooet Lake	400	2	—	—
Birkenhead River	2,875	10	5,992	22
TOTALS	3,275	12	6,838	31*
LOWER FRASER				
Seabird Island	532	5	—	—
Katz and Ruby Creek	380	7	—	—
TOTALS	912	12	—	—
CANYON				
Union and American Bars	953	8	896	16
Yale	3,181	15	4,366	19
Spuzzum	226	4	1,632	14
Lower Gorge	212	4	—	—
Upper Gorge	782	8	—	—
Boston Bar	108	4	766	14
Boothroyd	3,480	13	834	23
Cisco	3,354	16	3,153	62
TOTALS	12,296	72	11,647	148*
LYTTON-LILLOOET	5,996	17	6,285	—
BRIDGE RIVER RAPIDS				
Lillooet	3,267	40	3,770	—
Rapids	3,777	34	8,685	—
Pavillion	1,658	23	985	—
TOTALS	8,702	97	13,440	152*
CHILCOTIN				
Farwell Canyon			15	—
Hance's Canyon			111	—
Martins			37	—
Anahim	No		—	—
Alexis Creek	Fishing		150	—
Siwash Bridge			470	—
Keighley Holes			250	—
Henry's Crossing			—	—
TOTALS			1,033	59*
UPPER FRASER				
Alkali Lake	486	5	300	23
Chimney Creek	398	2	2,110	33
Soda Creek	1,275	8	513	17
Alexandria	686	7	251	5
Quesnel	608	3	525	5
TOTALS	3,453	25	3,699	83*
NECHAKO				
Nautley Reserve	2,660	10	3,205	17
Stella Reserve	1,217	8	2,569	21
TOTALS	3,877	18	5,774	38*
STUART LAKE				
Fort St. James	775	16	2,688	48
Tachie Reserve	624	11	2,863	35
Trembleur and Takla Lake	132	9		5
TOTALS	1,531	36	5,551	88*
THOMPSON				
Nicomen Creek	3,556	—	—	—
Ashcroft	363	—	—	—
Deadman's Creek	850	17	—	—
North Thompson River	3	1	—	—
South Thompson River	5,313	31	16,528	42
TOTALS	10,085	49	16,528	42
GRAND TOTALS	50,127		70,795	

* Number of permits issued to Indians in District.

TABLE VI

SUMMARY OF THE SOCKEYE ESCAPEMENT TO THE FRASER RIVER SPAWNING AREAS, 1938, 1942, 1946, 1950

District and Streams	Period of Peak Spawning	Estimated Number of Sockeye				Sex Ratio		
		1938	1942	1946	1950	3 yr. Jacks	Males 4-5 yr.	Females 4-5 yr.
LOWER FRASER								
Cultus Lake	Nov. 23 - 30	13,342	37,305	33,284	30,595	667	10,027	19,901
Upper Pitt	Sept. 11 - 14			1945—36,000	42,800		23,369	19,431
Widgeon Slough	Nov. 3	400	529	1,404	600		349	251
HARRISON								
Big Silver Creek		—	7+	—	25	—	—	—
Douglas Creek		—	67	—	100	—	—	—
East Creek		104+	—	200	100	—	—	—
Harrison River	Nov. 6 - 10	0	112	15,631	33,860	819	14,711	18,330
Hatchery Creek		1,950	875	1,000	150	—	—	—
Weaver Creek	Oct. 16 - 18	21,500	19,000	36,000	30,700	190	13,720	16,790
LILLOOET								
Birkenhead River	Oct. 3	11,000	87,000	90,000	72,567	8,128	19,956	44,483
Upper Lillooet Streams		—	—	—	200	—	—	—
SOUTH THOMPSON								
Seymour River	Aug. 24 - Sept. 5	—	1,950	2,600	12,000	1,368	5,772	4,860
Scotch Creek		—	—	—	0	—	—	—
Adams Lake and tributaries	Oct. 16 - 20	—	200,000	6,000	2,000	—	—	—
Adams River	Oct. 16 - 20	600,000	1,968,000	1,835,000	848,500	19,515	430,190	398,795
Little River	Oct. 16 - 20	175,000	400,000	419,000	376,900	15,830	182,535	178,535
Shuswap Lake	Oct. 16 - 20	1,130	Present	36,000	29,100	—	—	—
South Thompson River	Oct. 16 - 20	—	Present	92,000	41,500	—	—	—
NORTH THOMPSON								
Raft River	Aug. 25 - Sept. 5	500	450	3,000	6,400	—	2,989	3,411
CHILCOTIN								
Chilko River	Sept. 20	6,000	34,100	58,600	29,800	8,677	9,223	11,900
Chilko Lake		—	—	350	Present	—	—	—
Taseko River		—	—	—	500	—	—	—
QUESNEL								
Horsefly River	Aug. 25 - 27	0	0	58	400	—	119	281
Little Horsefly River	Oct. 10	—	0	—	6	—	—	—
Mitchell River		0	0	2	0	—	—	—
NECHAKO								
Endako River	Sept. 1	65	309	368	900	8	412	480
Nadina River	Aug. 23	30	62	66	1,950	—	995	955
Nithi River	Aug. 16	50	1	4	125	—	47	78
Ormonde Creek	Aug. 19	8	54	193	732	3	346	383
Stellako River	Sept. 30 - Oct. 1	3,077	48,064	245,200	145,100	87	58,954	86,059
STUART								
Ankwil Creek	Aug. 16	—	—	—	67	—	—	—
Bivouac Creek	Aug. 8 - 12	—	—	—	2,320	—	—	—
Driftwood River	Aug. 23	0	—	5	144	—	—	—
Dust Creek	Aug. 16	—	—	—	1,125	—	—	—
Twenty-Five Mile Creek	Aug. 16	—	—	—	521	—	—	—
Fifteen Mile Creek	Aug. 16	—	—	—	54	—	—	—
Five Mile Creek	Aug. 16	—	—	—	162	—	—	—
Fleming Creek		3	—	—	—	—	—	—
Forfar Creek	Aug. 8 - 12	2,608	3,244	1,822	10,259	33	4,981	5,245
Forsythe Creek		—	—	—	2	—	—	—
Frypan Creek	Aug. 16	—	—	—	69	—	—	—
Gluske Creek	Aug. 8 - 12	—	1,734	2,905	11,007	15	4,466	6,526
Kazcheck Creek		2	1	60	243	—	—	—
Kynoch Creek	Aug. 8 - 12	1,575	1,949	1,843	24,644	192	12,534	11,918
Leo Creek	Aug. 16	—	—	—	97	—	—	—
Middle River	Sept. 14 - 15	31	Present	488	2,600	—	1,368	1,23
Narrows Creek	Aug. 16	64	100	277	2,265	—	—	—
Point Creek	Aug. 16	—	—	—	42	—	—	—
Rossette Creek	Aug. 8 - 12	10	929	2,641	6,260	40	2,903	3,31
Sakeniche Creek	Aug. 16	—	—	—	234	—	—	—
Shale Creek	Aug. 16	—	50	61	628	—	—	—
Tachie River		—	—	14	200	—	—	—
NORTHEAST								
Bowron River		1,305	1,826	6,951	16,266	—	7,938	8,32
TOTAL		839,754	2,807,718	2,893,027	1,786,819			

ESCAPEMENT

One of the Commission's primary objectives, beginning in 1946, when the power to regulate became operative, has been to increase the escapement to the badly depleted spawning areas. This has been done by seasonal restrictions of the fishery of the two countries. Escapements to many areas have increased phenomenally almost every year.

The greatest producer of them all, the historic Quesnel system has shown definite signs of recovery in at least two years out of four. Unfortunately the Quesnel run is most difficult to regulate for the purpose of permitting the greater share of the run to escape the fishery. It passes through the fishing areas at approximately the same time as other runs which are sufficiently large to withstand a heavy catch. Fishing is allowed on the latter runs to help maintain the economy of the industry during the period of rehabilitation but the failure to control the catch of Quesnel fish completely should not prevent eventual recovery of the population. It merely retards the rate of recovery by the removal of part of the run in the fishery.

With the increasing escapements each year, many problems of management present themselves. The original production of sockeye in 1913 and prior thereto was extremely high every fourth year in most of the large producing areas of the Fraser system. The rate of reproduction was fairly high in one other year and usually was very low the other two years of the four-year cycle. This annual relationship in the productivity rate of sockeye for each area appeared to be quite consistent during the early development of the fishery and maintained itself until the dominant year of production was destroyed by the Hell's Gate block in 1913. Just how stable this annual relationship was within succeeding quadrennial periods prior to the development of the fishery is not yet known but failures in individual runs were recorded as early as 1823. This annual relationship of productivity, regardless of its degree of stability, apparently resulted from natural causes and may be expected to re-establish itself once sufficient numbers of sockeye reach the spawning grounds to absorb the reproductive potential of an area.

The present and coming period will be one of natural adjustment and comparatively large escapements to specific spawning grounds may produce at widely different rates, creating phenomenal returns in some instances and relative failures in others. The Chilko and Stellako runs both appear to be undergoing this readjustment.

Fortunate natural circumstances in 1936 and 1937 permitted the escapements to Chilko to produce at an extremely high rate. A substantial increase in the run occurred in both 1940 and 1941 with the run in 1941, the original dominant cyclic year, being the larger of the runs for the two years. The escapement in 1940 was estimated at 300,000 fish, over four times the escapement in 1936. Unlike the sockeye of 1940, the Chilko race in 1941 encountered continuing adverse water levels at Hell's Gate. Many thousands of sockeye

including fish destined to the Chilko area were permanently blocked by the obstruction. The escapement of 280,000 fish which did reach the spawning beds were seriously delayed and arrived in very poor physical condition. A comparison of the returning cycles revealed that the run in 1944 assumed the role of the dominant cycle while the 1945 run declined in numbers. This reverse trend was in greater evidence in 1948 and 1949.

In spite of the Hell's Gate obstruction the same annual relationship of the productivity within a four-year cycle maintained itself at Chilko until the block of 1941. The 1941 run, the same as the 1913 cycle, consistently maintained its superiority in numbers since early days regardless of the state of depletion. The 1940 run was the sub-dominant annual cycle and the 1938 and 1939 cycles were the poor years. The 1945 cycle returning in 1949 was sufficiently small, because of a low rate of reproduction, that it now can be classed as a year of "failure." The dominant year of productivity presently occurs on the 1940-1944-1948 cycle. Whether or not the 1939-1943-1947 annual cycle, originally a cycle having a low rate of reproduction will develop into the sub-dominant year of productivity in order to completely re-establish the original annual relationship of productivity within the quadrennial cycle but in a different cyclic sequence is yet a matter for conjecture.

It was not surprising that the 1950 escapement to Chilko dropped to 21,123 normal adults from a previous cyclic escapement of 59,000, especially since the 1950 run was more intensively fished than that of 1946. The rate of reproduction of this particular cycle has never been high according to known records and there is no reason at the present time to expect a significant change.

In the Stellako River, two annual populations are increasing rapidly. The 1946 escapement was 245,000 fish but this large population reproduced in an area where the offspring of 21,000 spawners in 1945 survived at an extremely high rate as indicated by the returning adult run of about 500,000 in 1949. The rate of reproduction of the 1946 escapement accordingly dropped so low that few, if any, more fish were produced in 1950 from 245,000 in 1946 than were produced from 21,000 spawners in 1945. With an intense commercial fishery and a declining rate of productivity on this cycle the escapement to the Stellako area could not be expected to maintain its previous numerical size.

The early unfished run to the Nadina River showed a substantial increase over the negligible number recorded the previous cyclic year. The young of this race apparently spend their lake life in Francois Lake while the majority of those produced in the Stellako River live in Fraser Lake, much the smaller of the two lakes.

All other races of sockeye throughout the Fraser River system except the Adams River population had increased or nearly equivalent escapements compared with those recorded in 1946. The sizeable Birkenhead escapement declined slightly for the second consecutive year. The fishery was definitely more intense than on the preceding cycle as was the case in 1949.

The run to Lower Adams River was originally dominant in the 1909 cycle but it was decimated in the years following. In 1922 the logging splash dam at the outlet of Adams Lake ceased operations. By 1930, eight years later, the estimated spawning population of twenty thousand fish in 1922 had increased to a total population of over five million. Thus, the dominant year now occurs on another annual cycle followed the next year by a sub-dominant run and then by two years of "failure". This makes up the original annual relationship in productivity but in a different cyclic sequence. The 1950 run was the return of the present dominant cycle. The serious decline in its numbers has been discussed earlier and will not be considered here. Emergency closures at the expense of an anticipated equal division in the catch between United States and Canada permitted an apparently adequate and well-timed escapement to the spawning grounds.

THE 1951 CYCLE

The daily sockeye landings in Treaty Waters for 1939, 1943 and 1947 are listed in Tables VII and VIII. These landings are presented again for the convenience of the industry in following the comparative seasonal trends of the 1951 run as it becomes available to the fishermen of the two countries. The cyclic escapement figures are shown in Table IX.

Production on this cycle has always been low with the total cyclic pack of the United States and Canada varying between 36,000 and 186,000 cases since 1903. The combination of an above-normal escapement in 1947 because of a severely restricted fishery, an early opening of the 1951 fishing season, and an expected increase in the intensity of the fishery should result in a catch somewhat greater than that of the past two years of this cycle.

Available scientific information is not yet sufficient for an accurate prediction of the numerical size of surviving populations in advance of their appearance in the fishery but intensive studies are being directed to this end. Since the rate of reproduction of each annual cycle to Chilko appears to be undergoing readjustment the rate of reproduction of the previous cycle in 1947 might be subject to change. The decline in the rate of reproduction of the 1946 run to Adams River could upset the expected rate of reproduction of the 1947 cycle. A change in the rate of reproduction in either case would add greatly to the knowledge of the forces controlling the annual variation in the racial productivity within a quadrennial cycle.

TABLE VII

DAILY LANDINGS OF SOCKEYE, 1939-1943-1947 FROM UNITED STATES TREATY WATERS SHOWING NUMBER OF SOCKEYE TAKEN DAILY AND CUMULATIVE PER CENT OF SEASON TOTAL AS OF EACH DATE

	JULY						AUGUST					
	1939		1943		1947		1939		1943		1947	
Date	Daily Sockeye	Cum. % Total	Daily Sockeye	Cum. % Total	Daily Sockeye	Cum. % Total	Daily Sockeye	Cum. % Total	Daily Sockeye	Cum. % Total	Daily Sockeye	Cum. % Total
1	155	0.22	4	0.06			8,042	12.31	5,690	22.52	9	0.08
2			56	0.09			5,817	13.35	8,916	26.21	10	0.09
3	161	0.25	3	0.09			5,650	14.37	14,001	31.99	4	0.09
4	3	0.25					2,209	14.76	14,738	38.08	6	0.10
5	4	0.25					199	14.80	7,784	41.29	47	0.15
6			129	0.14			9,709	16.54	6,684	44.05	147	0.32
7	73	0.26	23	0.15			6,394	17.69	9,361	47.92	826	1.25
8			11	0.16			7,980	19.12	3,655	49.43	46	1.31
9	31	0.27	39	0.17			10,582	21.02	4,286	51.20	352	1.71
10			27	0.18			9,643	22.76	5,582	53.50	1,100	2.95
11	77	0.28	16	0.19			4,758	23.61	10,511	57.84	526	3.55
12	83	0.30	99	0.23			762	23.75	10,439	62.15	559	4.18
13	21	0.30	180	0.30			12,888	26.06	5,392	64.38	5	4.19
14	21	0.30	418	0.48			14,150	28.60	95	64.42	37	4.23
15	191	0.34	452	0.66			15,361	31.36	8,398	67.89	45	4.28
16	741	0.47	1,319	1.21			13,024	33.70	4,918	69.92	710	5.09
17	389	0.54	520	1.42			12,935	36.02	4,952	71.96	3	5.09
18	530	0.64	2,025	2.26			9,759	37.78	5,914	74.41	4,376	10.05
19	2,186	1.03	1,969	3.07			824	37.92	4,554	76.29	8,743	19.96
20	2,656	1.51	4,337	4.86			18,494	41.25	1,265	76.81	8,431	29.52
21	4,305	2.28	2,335	5.83	6	0.01	32,831	47.14	66	76.84	7,839	38.40
22	65	2.29	1,917	6.62	21	0.03	30,121	52.55	6,037	79.33	3,944	42.87
23	3,633	2.94	1,723	7.33	9	0.04	39,538	59.65	7,700	82.51	79	42.96
24	6,950	4.19	2,428	8.33			44,963	67.73	6,251	85.09	8,119	52.17
25	7,187	5.48	5,548	10.63			17,350	70.84	7,425	88.16	4,953	57.78
26	6,814	6.71	5,248	12.79	8	0.05	537	70.94	5,017	90.23	5,894	64.46
27	7,532	8.06	3,241	14.13	14	0.07	25,856	75.58	2,277	91.17	6,234	71.53
28	5,890	9.12	4,051	15.80			21,301	79.41	6	91.17	5,536	77.80
29	2	9.12	5,903	18.24			17,624	82.58	3,869	92.77	3,097	81.31
30	2,858	9.63	4,523	20.11			16,380	85.52	2,911	93.97	7	81.32
31	6,857	10.86	157	20.17			10,239	87.36	1,499	94.59	3,314	85.08
Month Total	59,415		48,701		58		425,920		180,193		74,998	
June Total	1,066	0.19	150	0.06								

TABLE VII (Continued)

DAILY LANDINGS OF SOCKEYE, 1939-1943-1947 FROM UNITED STATES TREATY WATERS SHOWING NUMBER OF SOCKEYE TAKEN DAILY AND CUMULATIVE PER CENT OF SEASON TOTAL AS OF EACH DATE

	SEPTEMBER						OCTOBER					
	1939		1943		1947		1939		1943		1947	
Date	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*
1	10,693	89.28	1,859	95.36	2,952	88.43	229	99.94			3	99.99
2	548	89.37	2,085	96.22	1,587	90.22	104	99.96				
3	8,982	90.99	1,270	96.75	1,181	91.56	79	99.97			2	99.99
4	7,495	92.33	1	96.75	1,482	93.24	13	99.98				
5	6,353	93.47	1,057	97.18	984	94.36	2	99.98			2	99.99
6	11,806	95.60	932	97.57			4	99.98			1	100.00
7	6,230	96.71	914	97.95	714	95.17						
8	5,785	97.75	1,302	98.48	622	95.87	5	99.98				
9	4,331	98.53	1,022	98.91	246	96.15	4	99.98				
10	3,084	99.08	1,169	99.39	406	96.61	26	99.98				
11	1	99.08			316	96.97	4	99.98				
12	1	99.08	210	99.47	248	97.25	8	99.99				
13	26	99.09	357	99.62			4	99.99				
14	3	99.09	346	99.77	805	98.16						
15	3	99.09	232	99.86	107	98.28	28	99.99				
16	18	99.09	145	99.92	105	98.40	2	99.99				
17	89	99.11	45	99.94	443	98.91						
18	160	99.14			125	99.05						
19	128	99.16	18	99.95	240	99.32						
20	93	99.18	13	99.95								
21	92	99.20	27	99.96	69	99.40						
22	70	99.21	45	99.98	87	99.50						
23	1	99.21	20	99.99	272	99.81						
24	55	99.22	8	99.99	57	99.87						
25	2,476	99.66			36	99.91	43	100.00				
26	1,206	99.88	3	99.99	42	99.96						
27	40	99.89	8	99.99								
28	36	99.89			13	99.97						
29	43	99.90	3	99.99	6	99.98						
30			2	100.00	10	99.99						
31												
Month Total	69,848		13,093		13,155		555				8	
Season Total							556,804	100.00	242,137	100.00	88,219	100.00

TABLE VIII

DAILY LANDINGS OF SOCKEYE, 1939-1943-1947 FROM CANADIAN TREATY WATERS SHOWING NUMBER OF SOCKEYE TAKEN DAILY AND CUMULATIVE PER CENT OF SEASON TOTAL AS OF EACH DATE

	JULY						AUGUST					
	1939		1943		1947		1939		1943		1947	
Date	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*
1	2	.09	176	.20	23	.31	8,077	10.30			451	1.41
2			7	.20	6	.32	6,351	11.42	4,726	15.68	576	1.57
3	45	.10	14	.20	17	.32	4,858	12.27	10,868	18.80		
4	12	.10			3	.32	3,880	12.96	8,481	21.23	74	1.60
5	1	.10	134	.24	21	.33	3,850	13.63	7,593	23.40	220	1.66
6	160	.13	44	.25					4,129	24.59	191	1.71
7	3	.13	46	.27			4,972	14.51			612	1.88
8	120	.15	310	.36	13	.33	4,598	15.31			440	2.01
9			102	.39	2	.33	4,693	16.14	4,666	25.92	772	2.23
10	355	.22	224	.45	19	.34	5,119	17.04	8,840	28.46		
11	128	.24			24	.34	3,451	17.64	3,298	29.40	4	2.23
12	153	.27	255	.52	41	.36	4,738	18.48	6,542	31.28	512	2.37
13	655	.38	164	.57					6,204	33.05	406	2.48
14	774	.52	133	.61	28	.36	8,587	19.99			521	2.63
15	773	.65	781	.83	50	.38	14,670	22.56			104	2.66
16			447	.96	16	.38	7,993	23.97	3,279	33.99	185	2.71
17	1,474	.91	961	1.23	121	.42	6,229	25.07	9,811	36.80		
18	2,367	1.33			87	.44	3,686	25.71	9,894	39.64	441	2.84
19	2,483	1.76	1,900	1.78	51	.46	3,913	26.40	9,746	42.43	1,915	3.38
20	2,923	2.28	3,699	2.84					8,653	44.91	1,399	3.77
21	2,267	2.68	3,655	3.89			3,972	27.10			2,014	4.34
22	4,352	3.44	4,526	5.18	179	.51	16,695	30.03			90	4.36
23			3,494	6.18	157	.55	15,178	32.70	2,114	45.52	199	4.42
24	2,879	3.95	5,736	7.83	424	.67	14,624	35.27	6,947	47.51	15	4.42
25	6,007	5.00			176	.72	12,587	37.48	3,522	48.52	1,526	4.85
26	3,410	5.60	2,299	8.49	515	.86	19,821	40.97	5,804	50.18	989	5.13
27	4,666	6.42	5,413	10.04					5,962	51.89	382	5.24
28	3,250	6.99	4,828	11.42	67	.88	8,715	42.50			976	5.51
29	2,901	7.50	5,362	12.96	305	.97	25,703	47.02			824	5.75
30			4,794	14.33	315	1.06	11,796	49.09	1,544	52.33	877	5.99
31	7,851	8.88			809	1.29	15,629	51.84	8,444	54.75	101	6.02
Month Total	50,011		49,504		3,469		244,385		141,067		16,816	
May & June Total	534	.09	511	.15	1,095	.31						

TABLE VIII (Continued)

DAILY LANDINGS OF SOCKEYE, 1939-1943-1947 FROM CANADIAN TREATY WATERS SHOWING NUMBER OF SOCKEYE TAKEN DAILY AND CUMULATIVE PER CENT OF SEASON TOTAL AS OF EACH DATE

	SEPTEMBER						OCTOBER					
	1939		1943		1947		1939		1943		1947	
Date	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*	*Daily Sockeye*	*Cum. % Total*
1	11,507	53.86	4,361	56.00	190	6.08			3,308	98.81	861	98.21
2	12,681	56.09	6,534	57.87	570	6.24	4,552	89.92			2,127	98.81
3			7,556	60.04	135	6.27	12,861	92.18			1,515	99.24
4	2,483	56.52			351	6.37	3,951	92.87	676	99.00		
5	26,852	61.24	20	60.04	383	6.48	5,772	93.89	1,494	99.43		
6	30,325	66.57	3,532	61.05	281	6.56	2,868	94.39	774	99.65		
7	37,372	73.14	13,550	64.94	8	6.56	502	94.48	364	99.75		
8	16,198	75.99	3,150	65.84	4,907	7.94			363	99.86		
9	7,003	77.22	3,015	66.70	11,693	11.24	1,371	94.72				
10			2,317	67.37	9,611	13.94	6,115	95.80				
11	2,981	77.75			6,758	15.85	3,683	96.44	60	99.87		
12	8,431	79.23	10	67.37	4,258	17.05	3,367	97.04	150	99.92		
13	8,306	80.69	879	67.62	37	17.05	2,214	97.42	101	99.95	238	99.30
14	6,716	81.87	3,264	68.56	5	17.05	132	97.45	56	99.96	951	99.57
15	4,306	82.62	1,677	69.04	7,130	19.07			18	99.97	329	99.67
16	8,661	84.15	2,169	69.66	24,367	25.93	86	97.46			234	99.73
17			3,652	70.70	33,077	35.25	1,176	97.67			180	99.78
18					47,184	48.54	812	97.81				
19					27,377	56.25	361	97.88	26	99.98		
20			8,059	73.01			541	97.97	5	99.98	51	99.80
21			27,562	80.91			78	97.98	13	99.98	204	99.85
22			10,504	83.92	12,221	59.69			18	99.99	91	99.88
23	2	84.15	8,194	86.27	32,029	68.71	49	97.99			71	99.90
24			5,738	87.91	49,624	82.69	775	98.13			109	99.93
25	1,365	84.39			32,182	91.75	226	98.17	2	99.99		
26	10,878	86.30			15,632	96.16	304	98.22	20	99.99		
27	4,704	87.13	4,740	89.27	3	96.16	396	98.29	14	99.99		
28	4,669	87.95	17,769	94.36			22	98.30	4	99.99		
29	5,891	88.98	6,876	96.33	1,209	96.50			9	99.99		
30	779	89.12	5,325	97.86	5,224	97.97	12	98.30	1	100.00		
31							331	98.36				
Month Total	212,110		150,453		326,446		52,557		7,476		6,961	
November Total							9,346	100.00			247	100.00
Season Total							568,943	100.00	349,011	100.00	355,035	100.00

REHABILITATION OF BARREN AREAS

The basic program for rehabilitation of barren areas in the Fraser watershed was outlined briefly in the 1949 Annual Report and the activities of that year were recorded. Additional and more extensive experiments were conducted in 1950. Every effort is being made to measure the reproducing environment of both the parent and adopted stream. The history of sockeye transplants in this watershed does not provide any concrete evidence of a successful method of approach. It is essential that a variety of programs be carried out in order to determine at least one which will give sound biological results. When such a program is developed, a more intensive effort in restocking may be attempted.

The Quesnel Field Station operated throughout the 1949-50 season despite a very severe winter and spring including air temperatures at least 50 degrees below zero Fahrenheit. Two major rearing experiments were completed and new stocks of eggs brought in for 1951 plantings. The 1949 Horsefly sockeye eggs were hatched and reared to fingerling size and planted during November, 1950, in Quesnel Lake at the mouth of the Horsefly River. This plant comprised 94,000 fish, a portion of which were marked for future identification either in the fishery or on the spawning grounds. The purpose of this experiment is to determine if native fish will return to their native spawning area when artificially propagated. If the experiment is successful it will serve as a control over transplantations from one stream to another. The planting was delayed in the fall until the water temperature approached 40° Fahrenheit to avoid the existence of variable thermal layers which occur in the lake at higher water temperatures.

The second experiment was the rearing and planting of the Seymour River stock in an attempt to rehabilitate a sockeye run to the Upper Adams River and Adams Lake. This particular area, now completely barren, was formerly a major producer of sockeye. The fry and fingerlings should take up their lake residence in Adams Lake, which is approximately 50 miles long and potentially capable of sustaining a large number of young sockeye to migratory age. The choice of Seymour River stock for transplantation was very carefully considered. Biological and physical observations indicate that this stock should be adaptable to its new environment. Thus, in November of 1950, 84,000 fingerling sockeye, reared from the 1949 Seymour eggs, were taken by plane from the Quesnel Station and planted in the outlet of Upper Adams River at the head of Adams Lake. A portion of these fish were also marked by the removal of two fins, to assure positive identification of any surviving adults.

In addition to the transplant of hatchery-reared sockeye, a program of transplanting eyed eggs was initiated in 1950. A total of 667,000 Seymour eggs were "eyed" at a temporary station on the Seymour River and then transferred to the Upper Adams River. These eggs were planted in various gravel bars in a manner similar to the deposition of eggs by natural spawning. Control nests will be examined during the spring of 1951 to establish the success of survival throughout the winter.

FIG 3.—Planting Adams River "eyed eggs" in a scientifically selected area in Portage Creek, outlet channel between Anderson and Seton Lakes—January 1951.

A second experiment in the transfer of eyed eggs was performed using Lower Adams River stock and planting these eggs at Portage Creek in the Seton-Anderson watershed (Figure 3). Approximately 300,000 eggs were transported by plane from a temporary eyeing station on the Lower Adams River to this new area in January of 1951. The ultimate potential of this formerly productive area is not great in itself but the sum of several such small areas can contribute considerably to the commercial fishery once self-sustaining populations of sockeye are established.

Since transplants to Upper Adams River will be controlled by individual experiments each year, more than one method of transplantation is being tried with the same brood year in the case of restocking Portage Creek. A total of 400,000 "green" eggs taken from the Late Adams River race in 1950 were flown to the Quesnel Field Station. These eggs will be hatched, the fry reared, and the fingerlings planted in Anderson Lake just above the outlet of Portage Creek in a duplicate attempt to establish a run of sockeye in this area.

A dominant run is developing rapidly in the Quesnel system on the 1949 cycle and a nucleus of another native run apparently has been established on the 1950 cycle which should be aided in its development by the production of five-year-old fish from the preceding brood year. However, the late run to the Little Horsefly River outlet of Horsefly Lake has been completely exterminated. At present no existing races of sockeye elsewhere in the Fraser River watershed appear to be biologically suited for successful transfer to this original spawning area. Native kokanee which mature in Horsefly Lake use the Little Horsefly River for reproductive purposes and apparently react to the same environmental cycle as their probable sea-going ancestors.

A total of 177,000 kokanee eggs were secured from the outlet of Horsefly Lake in the fall of 1950 through the co-operation of the Provincial Game Commission and the Provincial Department of Fisheries. The growth of the resultant fry will be forced to the maximum in an attempt to stimulate a desire on the part of the year-old fingerlings for migration to the sea. A similar experiment on the Upper Columbia River by the U.S. Fish and Wildlife Service proved successful, with the return of several hundred marked and normal-sized sockeye from the sea to their native spawning grounds.

TABLE IX

SUMMARY OF THE SOCKEYE ESCAPEMENT TO THE FRASER RIVER SPAWNING AREAS, 1939, 1943, 1947

District and Stream	*Estimated No. of Sockeye* 1939	1943	1947
LOWER FRASER			
Cultus Lake	73,189	11,875	8,898
Upper Pitt		1946—	18,520
Widgeon Slough	—	293	750
HARRISON			
Big Silver Creek	29	3+	—
Douglas Creek	156	—	—
East Creek	25	9	—
Harrison River	—	1,114+	16,000
Hatchery Creek	107	77	500
Weaver Creek	3,253	3,128	6,500
LILLOOET			
Birkenhead River	15,280	50,668	120,000
Upper Lillooet Streams	1,130	—	Present
SOUTH THOMPSON			
Seymour River	250	200+	10,000
Adams Lake and tributaries	—	—	0
Adams River	16,200	10,000	185,000
Little River	15,687	1,519+	15,000
Shuswap Lake	—	0	—
South Thompson River	—	—	100
NORTH THOMPSON			
Raft River	1,490	4,000	8,000
CHILCOTIN			
Chilko River	2,000	13,546	55,000
Chilko Lake	—	—	Present
QUESNEL			
Horsefly River	0	0	6
Mitchell River	0	0	0
NECHAKO			
Endako River	8	46	450
Francois Lake	—	—	Present
Nadina River	0	0	90
Nithi River	3	0	60
Ormonde Creek	0	0	40
Stellako River	1,446	9,142	55,000
Uncha Creek	0	—	2
STUART			
Driftwood River	—	0	0
Fleming Creek	—	—	0
Forfar Creek	89	400	1,500
Gluske Creek	—	0	200
Kazchek Creek	2	2	0
Kynoch Creek	458	2,150	10,000
Middle River	0	—	60
Narrows Creek	6	0	0
Rossette Creek	—	450	2,500
Shale Creek	—	—	0
Tachie River	—	—	0
NORTHEAST			
Bowron River	2,695	6,215	23,945

GENERAL INVESTIGATIONS

The Fishery

A tabulation of the daily catch data by gear and by area has been continued since the inception of the Commission's investigations. Preliminary tabulation of each day's catch now is made within twenty-four hours to permit a daily examination of the trend in the catch of the two countries to ascertain if the requirements for division are being fulfilled. This trend is compared with a daily check of the escapement at Hell's Gate to determine if a proper catch-escapement ration is being maintained. The methods used have proven fairly satisfactory but more detailed and exact information is needed in regard to the total catch and availability of individual races in relation to time.

A prediction of the size of the surviving population in advance of its entrance into the fishery must be possible before equal division of the allowable catch can be reasonably guaranteed. This was obvious in 1950 when the Adams River adult population showed a serious decline. Emergency closures were necessary to provide an adequate escapement and the Canadian catch failed to equal the catch of the United States fishermen. In 1949 the sizes of the runs appearing during the fishing season were within expected limits and an almost perfect division in the allowable catch was obtained.

A study of scale growth during the freshwater life of the sockeye fingerling indicates a possibility that the size of the surviving population may be related to the character of such scale growth. If this proves to be the case, at least a rough approximation of the incoming runs may be possible. This would prevent radical differences in the expected catch through the use of regulations scientifically formulated in advance of the migration. An identification of individual races in the catch may also be possible in certain instances. When such identification of a race is possible, an availability curve may be established for an individual race for that year. The fishing mortality on such an individual race as related to fishing intensity might also be determined. Intensive examination of all scales collected on individual spawning grounds and in the fishery over a thirteen-year period is now being undertaken to determine how useful a study of scale growth might be in predicting the size of runs in advance, determining racial fishing mortality, and the numerical availability of individual races in relation to time of passage through the fishery. Should a study of scale growth prove fruitful, the scales of downstream migrants can be secured two years in advance of the returning adult run and scales from three-year-old "jacks" can often be secured one year in advance of the normal run.

A study of the numerical relationship of the three-year-old jack population to the population of normal four-year-old adults the year following reveals a variable but still a definite relationship. This relationship may eventually provide another method of some value in predicting the racial survival of the larger populations of sockeye at least.

The tendency of regulation to change the character of the escapement from the original character of the incoming run and by so doing possibly lower the productive capacity of that escapement is being carefully observed. While regulation in 1946 may have partially contributed to a change in the character of the escapement and the major contributor may have been the extreme low water in the Fraser and the South Thompson Rivers, the possible adverse effects of such a change is emphasized in the serious decline of the size of the returning run in 1950. An understanding of the basic needs of the sockeye populations for maximum reproduction is perhaps the most important phase of the Commission's studies.

Reproductive Environment

There are variable natural factors which are known to affect the productivity of sockeye in fresh water. In the 1949 Annual Report it was stated that "Most, if not all of these, are not controllable but the tendency of the species to compensate for periodic mortalities tends to lessen any adverse effect within the maximum limits of productivity. A knowledge of these factors is essential, however, in recognizing the influence of any artificial change in the natural environment caused by man".

The adverse effect of Hell's Gate, an artificially created block was thoroughly studied and eliminated. Not, however, before hundreds of millions of dollars were lost to the fishing industry. The study of the Hell's Gate obstruction indicated the need of combining the abilities of both biologists and engineers if problems of this type were to be successfully solved or prevented in the future.

The scope of the engineering investigations has been greatly increased and more closely integrated with the biological investigations so that the physical requirements for successful reproduction may be adequately measured throughout the Fraser River Watershed.

The need for this information in advance of the planning and development of water use projects in the Fraser Basin cannot be over-emphasized if the Commission is to comply with its terms of reference to the two Governments under the Convention.

To extend the present fishery, or even maintain it, in the face of a rapid industrialization of the watershed will require more intensive effort than was needed to plan for Hell's Gate and Bridge River Rapids Fishways or the other efforts towards rehabilitation in operation to date.

The records of water use in the Fraser Basin indicate that many of the early developments had markedly adverse effects on individual populations of sockeye. Declines in the populations produced in certain tributary streams were obscured when the disaster at Hell's Gate in 1913-14 caused a spectacular decline in the entire sockeye fishery. These runs of sockeye were, in effect, twice destroyed. For example, long before the Hell's Gate blockade, the populations of sockeye

frequenting the Quesnel River system were temporarily depleted by stream alterations resulting from construction of an impoundment dam at Quesnel Lake outlet, the dumping of tailings from a huge placer mining operation into the South Fork, and gold mining operations in the spawning areas. The Quesnel races of sockeye are again increasing rapidly since stream conditions have approached normal and the block at Hell's Gate has been relieved. Recovery will continue unless upset again by adverse environmental changes arising from new water-use projects.

Similarly, sockeye runs to the Upper and Lower Adams River were either destroyed or seriously reduced in size partly by the operation of a splash dam at the outlet of Adams Lake which occasionally prevented access of spawners to the upper river and apparently made the spawning beds of the lower river unproductive. When the splash dam operations ceased, the run in the lower river recovered to become at present the largest in the Fraser Basin. In Upper Adams River, sockeye enroute to their spawning grounds found their access route obstructed or completely blocked by a dam. On the Lower Adams River, sockeye attempting to spawn were confronted with spawning beds alternately flash-flooded and later practically dried.

The development of the Fraser River Watershed for hydro-electric power has already started. A project, which will ultimately produce 1,600,000 horse power, is now being constructed in the Nechako Watershed by the Aluminum Company of Canada. The water licence as granted by the Provincial Government permits the diversion of the entire flow of the Upper Nechako River to the Kemano River on the Coast. The diversion dam as proposed by the licensee will not directly shut off any sockeye spawning grounds. Extensive observations by staff engineers and biologists show, however, that favorable environmental conditions for the upstream migration of sockeye to the Fraser-Francois system, tributary to the Lower Nechako, may no longer exist unless certain remedial measures are considered and placed in operation. These remedial measures appear to be biologically and economically sound and they have already been presented to the licensee through the Department of Fisheries of the Dominion of Canada.

A power project has also been proposed for the Quesnel River, a river system which apparently produced more sockeye prior to the adverse effects of the Hell's Gate block than any other in the Fraser River Watershed. Preliminary examination of the project indicates that if developed it might destroy all possibility of rehabilitating the historic sockeye runs to this area. Serious consideration is now being given to developing the power resources of the North Fork of the Quesnel, or elsewhere in an area where no sockeye were ever produced, as an alternate to a development on the main Quesnel River.

It is essential that all potential water use projects be thoroughly examined in regard to their possible effect on the sockeye resource of the Fraser River system in advance of their consideration for development. An exchange of accurate

information regarding the needs of the fishery and the needs of the region for water use projects should lead to wise development of the water resources for the greatest benefit to all.

A greatly expanded investigational program has been placed in operation during the past year to obtain the required information for the above purpose. Engineers are now collecting and analyzing river flow data (Figure 4), mapping the physical characteristics of river spawning and lake rearing areas, measuring and charting the hydraulic character of the flow over known spawning grounds and contouring stream areas in a study of their stability under changing flow. Biologists are likewise collecting data on water temperature during migration, spawning and the incubation period. They are investigating as rapidly as possible the effect of any variation from normal of all physical factors on the rate of reproduction. From this information the effect of a project may be understood and remedial modifications planned in advance of the actual project. If practical remedial measures are not possible, alternate projects which are less damaging in their effect on the fisheries can be considered in advance of any need for actual development.

HISTORICAL

Information on early history of the runs of sockeye to the various spawning areas of the Fraser River is being obtained through the courtesy of the Hudson's Bay Company. Daily catch records of the Indians were kept by the Factors of this Company starting as early as 1823 at Fort St. James on the Stuart system. A study of these records may reveal the natural stability of the annual relationship of productivity of sockeye within each four-year cycle. A knowledge of the degree of natural stability in productivity before the fishery started will be valuable in understanding the management needs for maintaining maximum productivity.

Additional knowledge concerning the original size of specific runs which is not available in later governmental reports likewise may be revealed. This information will be valuable in assessing when maximum rehabilitation has been obtained in the case of individual racial populations.

CONSTRUCTION AND MAINTENANCE

The operation, maintenance and improvement of existing river improvement works by the engineering division has continued. The major work items have been the Bridge River Rapids, Farwell Canyon and Hell's Gate Fishways.

Bridge River Rapids Fishways

The Bridge River Rapids Fishways operated without incident throughout the season. The principal maintenance difficulty was the clearing of slides on the access roads. When the water level dropped in August to the operating level of the fishways, the structures were cleaned of all debris and they operated satisfactorily during the balance of the sockeye migration season.

FIG. 4.—Engineers measuring the character of the cross-sectional flow over a spawning area of Lower Adams River, 1950.

Farwell Canyon Fishways

During the spring of 1950 the lower right bank fishway at Farwell Canyon was partially closed by a small slide of rock into the outlet tunnel and also into the fishway channel itself. This cleanup work was completed before the arrival of the first Chilko fish, and all five of the fishways remained operative throughout the season.

Hell's Gate Fishways

During the spring, deposited bed load was cleared from the fishways, minor repairs were made to the deck grills, and all metal work was painted. The river rose above the upper elevation of the fishways on the 6th of June and remained above the decks until the 21st of July. On June 20th the peak flow was reached which covered the fishway decks by 37 feet at the gauge level of 93 feet. The extended period of non-operation of the left bank fishway was sufficient to demonstrate an interference to the passage of the early runs of sockeye at these higher levels. This hazard to the increasing size of the early runs made it essential to begin construction of a high level fishway on the left bank. In August a crew was assembled to begin the construction of this fishway and by the close of the year, the exit end of the fishway had been completed.

The new structure is being built separately from the existing fishway structure and will extend the operating range on the left bank to elevation 70 on the Hell's Gate gauge, or 16 feet above the present upper limit of 54 feet on the gauge. Past records indicate that this fishway will not be needed every year, and when required to operate will only be needed to pass an early segment of the annual runs of sockeye. The size of this structure has therefore been reduced from the size of the original fishways which were built to accommodate the maximum peak of the collective runs.

To obtain efficient operation under changing conditions as the river discharge increases, the position of the fish entrance into the high level fishway must be placed some distance downstream from the entrance of the existing lower level fishway. It would not be practical to maintain a common entrance position for the two fishways as a major structure would have been required, the construction of which would have caused an undesirable change in the flow pattern of the river.

1950 PUBLICATIONS

1. Annual Report of the International Pacific Salmon Fisheries Commission for 1949.

2. Research Bulletin Number III.

   A Biological Study of the Effectiveness of the Hell's Gate Fishways, by G. B. Talbot, Associate Biologist.

   Variations in Flow Patterns at Hell's Gate and Their Relationships to the Migration of Sockeye Salmon, by R. I. Jackson, Associate Engineer.

3. Report on the Fisheries Problems Created by the Development of Power in the Nechako-Kemano-Nanika River Systems (mimeographed). Issued by the Department of Fisheries of Canada. Prepared by the technical staffs of the Department of Fisheries of Canada, the Fisheries Research Board of Canada, and the International Pacific Salmon Fisheries Commission. The data was collected and analyzed by mutual collaboration.