

**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**

---

**1940**

---

**COMMISSIONERS**

**EDWARD W. ALLEN**

**CHARLES E. JACKSON**

**B. M. BRENNAN**

**TOM REID**

**A. L. HAGER**

**A. J. WHITMORE**

---

**NEW WESTMINSTER, B. C.**

**CANADA**

**1943**



## REPORT OF THE INTERNATIONAL PACIFIC SALMON FISHERIES COMMISSION FOR THE YEAR 1940

The Convention under which the Commission was appointed in the fall of 1937, provided that "The Commission shall not promulgate or enforce regulations until the scientific investigations provided for in the Convention have been made, covering two cycles of sockeye salmon runs, or eight years."

The objective of these investigations is to determine the means whereby the former great runs to the Fraser River can be restored. The last of these, in 1913, would be worth in excess of \$35,000,000 at present prices. To do this the Commission is required to carry on investigations upon the natural history of the Fraser River sockeye salmon, hatchery methods, spawning ground conditions, and other related matters. It may conduct fish cultural operations, improve spawning grounds, stock the Fraser with sockeye by such methods as it may deem advisable, and recommend removal of obstructions to migration. At the end of two four-year periods, it will be empowered to limit or prohibit the taking of sockeye salmon in Convention waters and to regulate the sizes of mesh in fishing gear with certain stated limitations. It is required to divide the catch as equally as possible between the two nationalities.

The program for the necessary investigations was formulated, discussed, and approved in 1938. It was explained to the Advisory Board from the industry and discussed by the Director with the Scientific Council. It has been continued, since each year of the four-year cycle differs and must be investigated in a comparable way.

During 1940 the Commission held its first meeting January 30, 31, and February 1 in Washington, D. C. The Commission was welcomed by the Honorable Secretary of the Interior Harold Ickes, Under Secretary Alvin J. Wirtz, and Assistant Secretary and Budget Officer E. K. Burlew. It was received by President and Mrs. Roosevelt at the White House, and also at the Canadian Legation.

At this meeting Mr. A. L. Hager retired as Chairman and Mr. B. M. Brennan as Secretary. Mr. Brennan was elected Chairman and Mr. Tom Reid, Secretary.

The Commission met again September 4, 1940, in Vancouver, B. C., and on September 5, when it met with the Advisory Board. The program and its results were discussed at length with them.

During the year Mr. W. A. Found, one of the first members of the Commission, died in Ottawa, Canada.

In the accompanying report by the Director, the progress made in research is detailed. The time of passage and the behavior in salt and fresh water of the various races of migrating adults is shown by tagging and other studies. A statistical system is being organized to give a basis for division of the catch as provided by the Treaty, to aid in formulation of regulations, and to allow comparison of catch with escapement. The spawning grounds have been surveyed, and methods of

making annual estimates of escapement and observation of the spawning have been provided. Obstructions have been found and surveyed, their effect is being investigated, and engineering studies are under way looking toward their removal or toward remedial measures.

This year's report calls especial attention to the need for research to discover the most desirable ratio of catch to escapement. This ratio depends upon apparently elastic biological relationships during the life in fresh water, and is illustrated in concrete fashion by reference to the still continuing study of Cultus Lake.

The report of the Director follows.

#### INTERNATIONAL PACIFIC SALMON FISHERIES COMMISSION

B. M. BRENNAN, *Chairman*  
EDWARD W. ALLEN  
A. L. HAGER  
CHARLES E. JACKSON  
A. J. WHITMORE  
TOM REID, *Secretary*.

**REPORT ON THE  
INVESTIGATIONS OF THE INTERNATIONAL PACIFIC  
SALMON FISHERIES COMMISSION  
ON THE  
FRASER RIVER SOCKEYE FOR THE YEAR 1940**

W. F. THOMPSON, *Director*

The season of 1940 was the third since the first meeting of the Commission in the late fall of 1937. The first season, of 1938, was one of organization. Because of limited funds, the work done then was of an experimental and preliminary nature to establish facts upon which the program could be based. That which followed in the succeeding two years has been as nearly as possible the program approved by the Commission after discussion at that time with the Advisory Committee and the Scientific Council.

The members of the staff responsible for sections of the following reports are:

Statistics . . . . .	F. H. Bell
Tagging, Salt Water and Hell's Gate . . . . .	Dr. J. L. Kask
Stream Observers . . . . .	C. E. Atkinson
Experiments on Enumeration of Spawners in the Harrison-Birkenhead System . . . . .	M. B. Schaefer
Cultus Lake Experiment . . . . .	Dr. J. L. Kask

Tagging experiments were carried on at Sooke, in various localities in the Straits of Juan de Fuca, Puget Sound and the Gulf of Georgia, and at Hell's Gate.

As in the previous years, the tags used were celluloid disks 13.5 mm. in diameter, with a red spot on one side 7 mm. in diameter. The disks were attached on either side of the body immediately below the dorsal fin by means of a nickel pin run through from disk to disk. Upon one of the two disks a number was printed with the address of the Commission and an offer of reward. The red spot of each tag was turned outward when attached, to make the tag vivid and easily seen.

The experiments are discussed according to locality, under the following three headings:

1. The tagging of sockeye at the Sooke traps at the southern end of Vancouver Island was carried on under the same arrangements as in 1938 and 1939, with the cooperation of the Canadian Department of Fisheries and the trap operators.

The number of fish tagged and recovered from this experiment for the three years tagging is as follows:

<i>Year</i>	<i>Tagged</i>	<i>Recovered*</i>	<i>% Recovered</i>
1938 . . . . .	980	432	44.1
1939 . . . . .	1051	535	50.9
1940 . . . . .	930	415	44.6

The fish tagged in June and early in July were again returned in large part from streams and areas other than the Fraser. They formed 18% of the total returns of tags placed at Sooke. Those fish tagged on or before July 11 were recovered as follows:

Skagit Bay . . . . .	16
Issaquah Creek . . . . .	16
Pender Harbour . . . . .	16
Baker River . . . . .	8
Nitinat . . . . .	7
Swinomish Creek . . . . .	5
Barkley Sound . . . . .	4
Quinault River . . . . .	2
Grandy Creek . . . . .	1
Cedar River . . . . .	1
Cowichan River . . . . .	1
Rivers Inlet . . . . .	1
	78

Only in rare cases were fish tagged after this date taken anywhere but in the Fraser, or presumably en route to it. Two fish tagged at Sooke were recovered in Johnstone Straits.

Of all tags placed at the Sooke traps in 1940, 262 or 63.2% were taken by Canadian vessels; 130 or 31.3% by United States vessels; 16 or 3.9% by the Indian fishery in the Fraser River; and 7 or 1.7% were recovered on the spawning grounds.

2. In 1940 two boats were again employed, one a small seine boat, and the other a small troller. The seine boat operated for a period of three months, purchasing fish for tagging from fishermen in the vicinity of the San Juan Islands, and catching fish for tagging with a small seine in the Fraser estuary. The trolling vessel operated for approximately a month, purchasing fish for tagging in the Johnstone Straits area. In addition to this, a shore crew operated for a brief period from Lummi Island, purchasing fish from the reef netters. Altogether 3279 fish were tagged. Compared to former years the numbers tagged and recovered were as follows:

<i>Year</i>	<i>Tagged</i>	<i>Recovered</i>	<i>% Recovered</i>
1938 . . . . .	2587	1231	47.6
1939 . . . . .	6152	3990	64.9
1940 . . . . .	3279	1614	49.2

Recoveries from the various experiments are shown in the following tables:

\*All recoveries as of March 15, 1941.

SALMON BANKS. Total tagged 929; total recovered 491 or 52.9%.

<i>Recovered from</i>	<i>No.</i>	<i>%</i>
Canadian commercial fishery . . . . .	275	56.0
United States commercial fishery . . . . .	180	36.7
Indian fishery (Fraser) . . . . .	21	4.3
Spawning grounds . . . . .	15	3.1

FRASER ESTUARY. Total tagged 79; total recovered 45, or 57%.

<i>Recovered from</i>	<i>No.</i>	<i>%</i>
Canadian commercial fishery . . . . .	38	84.4
United States commercial fishery . . . . .	0	0
Indian fishery (Fraser) . . . . .	4	8.9
Spawning grounds . . . . .	3	6.7

LUMMI ISLAND. Number tagged 716; total number recovered 322, or 45%.

<i>Recovered from</i>	<i>No.</i>	<i>%</i>
Canadian commercial fishery . . . . .	199	61.8
United States commercial fishery . . . . .	97	30.1
Indian fishery (Fraser) . . . . .	21	6.5
Spawning grounds . . . . .	5	1.6

JOHNSTONE STRAITS. Number tagged 1555; total number recovered 756, or 48.6%.

<i>Recovered from</i>	<i>No.</i>	<i>%</i>
Canadian commercial fishery . . . . .	693	91.7
United States commercial fishery . . . . .	5	.7
Indian fishery (Fraser) . . . . .	50	6.6
Spawning grounds . . . . .	8	1.1

Of the above recoveries of Johnstone Straits tags 276, or 36.5%, were retaken in Johnstone Straits or in channels along the route to the Fraser River itself or near its mouth, and the remainder were taken in the river above the commercial fishery.

3. In 1940 sockeye were again tagged at a point just below Hell's Gate as in 1938 and 1939.

The numbers tagged and recovered for these years were as follows:

<i>Year</i>	<i>Tagged</i>	<i>Recovered*</i>	<i>% Recovered</i>
1938 . . . . .	2128	632	29.7
1939 . . . . .	4344	2328	53.6
1940 . . . . .	5194	1762	33.9

A considerable number of tags was recovered in eddies immediately above Hell's Gate in spite of the fact that rigorous attempts were made to curtail Indian fishing for tags at these points.

Fishing operations were initiated at Hell's Gate on June 22 this year and continued until November 7. Fish were present in varying numbers in the eddies during the whole of that time.

Gill-nets were again used to catch fish for tagging during the first part of the season. During the latter part sockeye caught with gill-nets and fish caught with

\*Recoveries as of March 15, 1941.

dip-nets were tagged on alternate days. The dip-nets have the advantage over the gill-nets in that they do not select fish according to size and the fish appear to be more vigorous when tagged.

Recoveries from the spawning grounds indicate a distribution of the runs as they pass Hell's Gate as follows:

Stuart Lake . . . . .	Before July 27
Bowron . . . . .	July 15 - August 10
Chilko . . . . .	July 22 - September 28
Nechako . . . . .	July 22 - September 14
Shuswap . . . . .	September 9 - November 2
Seton-Anderson . . . . .	August 26 - September 28
Raft River . . . . .	July 22 - August 17
Canyon Streams . . . . .	July 22 - September 28

This is a preliminary listing only. Final proof must await a thorough analysis of the data on hand. Evidence of a blockade and of delay in migration at Hell's Gate was found, and indicated strongly the necessity of an especially thorough investigation of mortalities.

4. During 1940 the statistical activities of the four regular cannery observers engaged in the recovery of tags and sampling of the catch were continued. They were stationed at Steveston, Bellingham, and Anacortes. They recovered tagged fish, took representative samples of sockeye throughout the season, and collected statistics. The services of F. H. Bell were secured for four months through a joint arrangement with the International Fisheries Commission, to assist in the organization of a statistical system for the fishery. After the end of the fishing season services of two of the observers were utilized in compiling some of the statistical material. Mr. Bell's report follows:

Attention was directed to developing an effective, comprehensive, and economical system of statistics that would be elastic enough to satisfy both the present and future requirements of the Commission for investigations of life history, regulation, and division of the catch according to Treaty terms.

A short outline of what is deemed necessary is: The total catch of Fraser River sockeye; locality of catches; their amount by vessel according to the type of gear and nationality, with samples of their catch and recovery of tags taken.

To determine the locality of capture several alternative measures were tested. These were: A canvass of the seine fleet; the actual observation of its operations on the fishing grounds; and a system of records, or logs, kept by the fishermen. The trial of these three methods indicated that the log book system offers most promise and should be tried, possibly supplemented by direct observation for a few years by staff members on the fishing grounds until the log book system is firmly established. As many as possible of the daily catch samples will, by this method, be secured on the grounds so that their origin and the size of mesh in the gear used can be more accurately determined.

Similar procedures were tested with the gill-net fleets, and this year's experience shows the desirability of using a simplified fishing record kept by the boats themselves, for as large a part of that fleet as will cooperate. It is anticipated that both the log books and fishing records will have to be supplemented by a



continuous daily survey of the fishing grounds for several years, if possible, by Commission boats.

This approach will be direct and will give authentic information at first hand, despite the mass of detail which must be handled. Experience has shown that dependence upon second, and often third-hand information when this is collected from the canneries to give the origin and amount of the catches and the gear used by individual boats, will lead to serious errors.

While certain figures of total catch and individual boat catches can be secured from the canneries and numerous independent buyers, practices in the industry make these existing totals unsatisfactory for determining any measures of abundance by means of catch per unit of effort and in some cases even for total catch purposes. Despite the excellent records kept in some quarters, there are great deficiencies in others. It has been found that there are at present too many of these deficiencies in the data to proceed with any analysis of the catch figures as they have come from cannery and other sources. By securing the complete cooperation of all handlers of the fish in the proposed work, many of these difficulties will be overcome.

A method of photographing the catch records of the various canneries has been developed. It promises to be a most inexpensive method of providing the Commission with an accurate and permanent file of all available statistical data. Considerable historical material has been so copied by courtesy of the United States Fish and Wildlife Service from their records.

Data regarding the types of vessels and their gear are being accumulated, such being essential to the proper analysis of the statistics as well as to an understanding of the economic relationships in the industry.

The whole system is designed to provide on as current a basis as possible, information on such matters as the total catch, the gear and catch by each nationality, and identification and magnitude of the runs as they pass through the commercial fishery. The results are also designed to aid in the interpretation of the various experiments of the Commission, such as tagging and spawning ground surveys.

5. The spawning grounds were again surveyed and estimates made of the number of spawners returning to each, as in 1938 and 1939. Because of the distribution of the spawning population in the 1940 cycle, it was necessary to divide the Fraser River watershed somewhat differently than in the previous two years, the areas being designated as the Stuart Lake, Nechako-Quesnel-Bowron, Chilcotin, Thompson-Seton-Anderson, Harrison-Lillooet, and the Canyon-Lower Fraser districts. Every known sockeye stream was visited during the season and those containing sockeye salmon were patrolled frequently. It was the purpose of each observer to recover all tags possible, to estimate as accurately as was feasible all sockeye present in the spawning areas, to record the extent of spawning areas, and to record the progress of the run throughout the season. Obstructions were observed and stream conditions recorded. Dead fish were recovered for information as to size, sex ratio, and the completeness of spawning, and samples were collected for racial studies. As in previous years close cooperation was maintained with the officers of the Canadian Department of Fisheries who are stationed in the Fraser watershed.

It is felt that the estimate of the number of sockeye on the various spawning

areas is more accurate than those of the previous years, but there are still difficulties found under the most ideal situations which tend to make some errors in the counts. The chief difficulty at present is to estimate properly the replacement in the counted population and to evaluate lake spawning. It will be necessary to conduct experiments on counts and estimations in various sections of the Fraser before a completely satisfactory and accurate account of the sockeye escapement can be made.

The proportion of the total run in the river which passed through the commercial fishery was higher than in 1939, but it is still believed that considerable numbers escaped observation.

From the estimate of escapement the percentage of the sockeye going to each of the important spawning areas is given to show the relative distribution of the runs in the river in 1940.

Chilko River and Lake . . . . .	71.4%
Cultus Lake . . . . .	9.7%
Harrison "late run" . . . . .	8.0%
Birkenhead River . . . . .	3.6%
All other streams . . . . .	7.3%

It should be pointed out that these estimates are the best figures which can be given now, and are subject to errors which later may be corrected as the estimates are revised.

The Chilko run for 1940 was a definite increase over the cycle year of 1936. Parts of the river were used for spawning which, so far as is known, had not been used before. In addition, dead sockeye were recovered over half-way up the lake, apparently an indication of a considerable lake spawning.

Incidental to the spawning ground survey in the Chilcotin district, a limited tagging program was carried on, securing fish by dip-nets from the Indians at the major fishing stations. A total of 393 tagged sockeye were released in lower Chilcotin River, of which 7.8% were returned from the Indian fishery and 16.3% were recovered from sockeye on the spawning area. From the results of this experiment it was possible to obtain experimental data on the rate of migration and to assist in reaching an estimate of the total number of sockeye present in this area.

The observers made frequent visits to the various Indian fishing stations to redeem tags, as well as to note the location of stations, height of water, and other characteristics. No complete estimate of the Indian catch was made by our observers. These statistics were gathered by the Dominion Fisheries officers and on numerous occasions were supplemented by our own observers.

Information from the spawning stream survey for the past three years has become increasingly complete, and has been systematically recorded. It has been utilized in the drawing of detailed maps of each spawning stream, with references to the current, bottom, trails, land marks, etc. These will be of great value for our own future reference.

6. The experience of the field observers has shown the need for special methods to determine more accurately the numbers of fish spawning and to show the presence of bodies of fish not accessible to observation.

As has been reported before, experiments have been conducted at Cultus Lake

with a view to establishing a system by which the number of fish on a spawning ground could be calculated indirectly by tagging a part of the run. These calculations at Cultus Lake could be checked, as the number of fish in this area was known by actual count through a weir. In 1938 a proportion of the run was tagged; and the calculated number of fish arrived at from the proportion of tagged to untagged carcasses found on the spawning grounds, was remarkably near the known figure. This is more encouraging, as in this area only a very small fraction of the fish known to be present can actually be seen.

In 1939 this experiment was repeated, on a much larger run of fish with equally satisfactory results.

In 1939 experiments were instituted in the Harrison-Lillooet River system with the object of applying the methods developed at Cultus Lake to a determination of the sizes of salmon populations in a large river system by means of marking. During the 1940 season these studies were continued and modified on the basis of the results of the 1939 researches.

The pile-driven trap near the mouth of the Harrison River was again operated. It should have been re-driven and altered, but funds were lacking. Yet in view of the value of the information obtained, it was operated as well as was possible. It was determined that sockeye first appear at this place in early August. A total of 280 sockeye were tagged here during the 1940 season. It was found that, as in 1939, the sockeye passing before a date, about September 20, went to the tributaries of the Lillooet River and to tributaries of upper Harrison Lake (Douglas Creek and Silver Creek) while those passing after that date spawned in the lower part of the system, in such localities as Weaver Creek, Hatchery Creek, and Harrison Rapids.

In order to evaluate separately the runs to the upper Lillooet River areas, sockeye caught by Indian dip-netters were tagged at Skookumchuck Rapids throughout the season, August 20 to October 7. A total of 2146 sockeye were tagged at this locality. The large bulk of the run arrived at Skookumchuck during a short period in the latter part of August. From the data of the recaptures of tagged fish at Skookumchuck it has been found these rapids form a distinct barrier to upstream migrants at certain water levels, but apparently allow easy passage at others.

A cheaply constructed wire fence trap, developed in 1939, was erected near the mouth of the Birkenhead in the 1940 season and was used for the capture of fish for tagging, and for sampling the run to determine the time of passage and the ratio of tagged to untagged fish. 439 fish were tagged from this trap during the 1940 run. It was found that such a fence is also an excellent means of obtaining a uniform and unbiased sample of the dead sockeye drifting down the river. 3379 dead fish, over 10% of the entire Birkenhead run, were recovered as dead against the fence.

Extensive studies of sampling methods for both live and dead sockeye on the spawning grounds were also carried out in the Birkenhead River.

The Birkenhead River and Skookumchuck studies show that during the 1940 season the majority of sockeye passing the Skookumchuck spawned in the Birkenhead River, but that a significant number cannot be directly enumerated by ordinary methods of observation.

A standard design of picket weir was erected at the mouth of Weaver Creek

in order to carry out experiments paralleling those of Cultus Lake, using tagged samples to aid enumeration of the adult migrants in a stream where the population can be kept under good direct observation, and also to determine the number of tagged fish entering the stream from the Harrison trap. A total of 1689 sockeye were marked at this weir. Detailed and extensive sampling on the spawning grounds was also carried out in Weaver Creek; about half the sockeye migrants to Weaver Creek were individually examined as dead fish.

Extensive observation and sampling were done on the spawning grounds in the tributaries to Harrison Lake, in some of which sizable runs of sockeye occurred during the 1940 season.

The tagging experiments and the spawning ground observation and sampling showed that a large share of the late run into the Harrison River, part of which spawns in Weaver Creek and Hatchery Creek, spawns elsewhere than in those streams. A large number of these were probably on the Harrison Rapids where they could not be enumerated by direct methods. The determination of the numbers made by the tagging experiment is not as yet perfected for release.

In general, during the 1940 season, the techniques of estimating salmon populations by tagging experiments were further studied and developed to a point where they show promise of being of real value. It has also been shown that for the system as a whole, as well as for its several parts, there is probably a considerable number of sockeye which do not spawn on the known spawning grounds or in places where they can be directly enumerated, and a good estimate has been made of the numbers of spawners in this area which could not be included in the estimates based on the ordinary spawning ground observations.

7. The collection and study of the voluminous records of all kinds which have to do with the Fraser River run of sockeye are proceeding as outlined in the Report for 1939. It is an extensive task, but is proving well worth while. It cannot be completed for several years, as it can be carried on only while other duties of the staff permit. As pointed out in the first part of this report, this is one of the projects which it is most necessary to complete.

8. The capture of predator fish, the counting into the lake of the adult spawning sockeye and the counting out of the resulting fry were continued at Cultus Lake in 1940.

The gill-nets used for the capture of predator fish were worked continuously from February 5 to June 30, during which time 4292 coarse fish were removed from the lake.

The first adult sockeye of the Cultus Lake run arrived at the counting weir on September 1. The run continued in varying numbers until January 3, 1941, when the last sockeye entered the lake. Altogether the run numbered 74,121 fish.

The number of first and second age group seaward migrants counted out of the lake in the spring of 1940 was 1,374,928.

9. An experiment was conducted on the value of the various types of marks on fingerling sockeye. Groups of year-old sockeye were marked on January 11, 1940, by the use of an electric cauterizing needle. They are being held in tanks at the University of Washington.