

SALMON OF THE NORTH PACIFIC OCEAN—PART I

INTRODUCTION

by Roy I. Jackson¹

In 1955, when the International North Pacific Fisheries Commission began its research on salmon in the North Pacific Ocean, almost nothing was known of the salmon in this vast region, one of the least known of the oceans. Now, eight years later, as a result of what may be the world's greatest cooperative fisheries research program, the situation is remarkably different. The North Pacific Ocean has become one of the best known oceans and a very great amount of information has been accumulated on the salmon which spend their marine life there.

In order to make this information available, the Commission has undertaken the preparation of a comprehensive report on the origin, distribution, abundance and intermingling of continental stocks of Pacific salmon in the North Pacific Ocean and a description of their oceanic environment. The complete report will be published in a number of issues of the Commission's bulletin series, of which this is the first. It is a great honour and pleasure to introduce these outstanding cooperative contributions from a number of fishery scientists in Canada, Japan and the United States. As a prelude to their reports I intend to describe briefly the salmon and the salmon fisheries of the North Pacific, to describe the organization and execution of the high seas salmon research program of the Commission, to explain the reasons for preparing the report as a whole and to indicate the title and contents of each of its parts.

Pacific salmon (genus *Oncorhynchus*) spend the marine years of their lives in a wide area of the North Pacific Ocean. Their general oceanic distribution extends from the shores of Asia to the shores of North America and from approximately 40° North latitude through the Bering Strait and into the Arctic Ocean. There are six anadromous species in the genus, five of which reproduce on both continents; the sixth (*Oncorhynchus masou*) originates only in Asia. The scientific names and usual common names of the various species of Pacific salmon are:

Oncorhynchus nerka (Walbaum)—sockeye, red

Oncorhynchus gorbuscha (Walbaum)—pink, hump-back

Oncorhynchus keta (Walbaum)—chum, keta, dog

Oncorhynchus kisutch (Walbaum)—coho, silver

Oncorhynchus tshawytscha (Walbaum)—chinook, spring, king

Oncorhynchus masou (Brevoort)—masu salmon, sakura masu.

The average size and weight of mature salmon varies considerably both between the various species and for the same species in different regions. As an example, mature sockeye taken in Alaska in 1961 in different regions varied in average weight from 5.5 to 7.9 pounds. Similar figures for the other species in Alaska in 1961 were as follows: pink salmon, 4.1 to 6.0 pounds; chum salmon, 6.6 to 10.3 pounds; coho salmon, 5.3 to 12.5 pounds; chinook salmon, 10.8 to 22.5 pounds.

Pacific salmon hatch from eggs laid in the gravel beds of freshwater streams and lakes. Their spawning grounds are found from the northern part of the Japanese island of Honshu northward into the Arctic Ocean and southward to San Francisco Bay. Without any known exception in nature, Pacific salmon die after spawning once. After hatching of the egg and absorption of the yolk sac are completed, usually in the spring following spawning, the young salmon (fry) emerge from their gravel beds. The length of their subsequent period of residence in fresh water is subject to wide variations both between and within species. All pink salmon and most chum salmon migrate directly to the sea after emergence. In some of the other species, individuals may live for as much as three years or more in fresh water before descending to the sea.

After entering the sea, many young salmon remain for some weeks or even months in coastal waters before moving offshore; however, the timing of major movements from coastal areas to the high seas needs more investigation. The offshore distribution of salmon is, of course, a subject of major investigation by the Commission and one which will be dealt with extensively throughout the reports. It is sufficient to state here that salmon are pelagic, are found far offshore and that their distribution across the width of the North Pacific is continuous.

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The length of life in the sea also varies both between and within each species. Pink salmon spend only one year in the sea, as do practically all coho salmon, before returning to their home or parent streams to spawn and die. The other species spend longer and more variable lengths of time in the sea. Two, three and four years in the sea are most common. Thus, the total length of life of a single generation varies from two years for pink salmon to as much as eight years, and possibly longer, for some sockeye and chinook salmon.

Two characteristics of the life history of salmon are of fundamental importance to their exploitation and conservation. These are, first, that salmon, to a very great extent, return to their home or parent streams to spawn and die. Second, that the timing of the shoreward migration of each population unit is consistent from year to year, within narrow limits. These two attributes make it possible to study the life history and population dynamics of separate population units and, in many cases, to manage the fishing on population units in accordance with their individual conservation requirements.

Fishermen of Canada, Japan, the United States and the Union of Soviet Socialist Republics operate commercial fisheries for salmon. The fishery is of major importance. In 1961 the catch by species by country was as follows (in thousands of pounds):

Country	All species	Sockeye	Pink	Chum	Coho	Chinook
All four countries	964,554	228,833	394,295	234,354	67,513	39,559
Canada	125,112	26,622	50,059	14,609	24,729	9,093
Japan	349,036	80,903	167,295	90,375	9,433	1,030
U.S.A.	314,749	104,051	110,226	49,079	23,389	28,004
U.S.S.R.	175,657	17,257	66,715	80,291	9,962	1,432

The gear and vessels used vary to some extent. Most salmon are caught by nets, particularly by floating gillnets and purse seines. Many are taken by traps and other forms of fixed gear. Floating longlines carrying baited hooks are also employed, as are hooked lures towed behind moving boats (trolling). Japanese fishermen take salmon on the high seas as well as close to shore. The Japanese mother-ships are accompanied by catcher boats which employ drifting surface gillnets for capturing salmon. This fishery, which began in 1952, has developed rapidly. Land-based salmon fishing vessels, working out of ports in northern Japan, employ either drift gillnets or floating longlines. Japanese coastal salmon fishermen use traps and fixed gear.

Fishermen of the U.S.S.R. take salmon only in

coastal waters. They employ traps, beach seines and weirs to capture maturing salmon from schools en route to the spawning grounds. In Canada and the United States, including Alaska, salmon fishing by nets may not legally be carried on at any distance from the outer coast. In other words, offshore or high seas salmon fishing with nets is prohibited. Traps are also prohibited, with minor exceptions. Thus, except for salmon caught by trolled hooks, principally coho and chinook, most salmon caught in North America are taken by purse seines and gill-nets, in inshore waters. Throughout all the countries most salmon are preserved by canning. Lesser amounts are frozen, salted, iced or smoked. The form of preservation varies somewhat with the species.

Those salmon which survive the risks of hatching, the hazards of freshwater and marine life, the toll taken by fishermen and the risks of the final migration up the rivers, deposit their eggs and die, leaving the embryonic new generation in the gravel beds.

The prospect of increased development and expansion of fishing for various species, including salmon, in distant offshore waters, which had begun on an exploratory basis before the second world war, led Canada, Japan and the United States to adopt a fishery treaty for the North Pacific Ocean. This treaty, known as the International Convention for the High Seas Fisheries of the North Pacific Ocean, came into force on June 12, 1953. It will continue in force for ten years and thereafter until one year from the day on which any Contracting Party gives notice of termination. The Convention applies to all waters of the North Pacific Ocean and its adjacent seas, other than territorial waters.

The general objectives of the Convention, as stated in its opening paragraphs, are:

“ Believing that it will best serve the common interest of mankind, as well as the interests of the Contracting Parties, to ensure the maximum sustained productivity of the fishery resources of the North Pacific Ocean, and that each of the Parties should assume an obligation, on a free and equal footing, to encourage the conservation of such resources, and

“ Recognizing that in view of these considerations it is highly desirable (1) to establish an International Commission, representing the three Parties hereto, to promote and coordinate the scientific studies necessary to ascertain the conservation measures required to secure the maximum sustained productivity of fisheries of joint interest to the Contracting Parties and to recommend such measures to

such Parties and (2) that each Party carry out such conservation recommendations, and provide for necessary restraints on its own nationals and fishing vessels, . . . ”

Although the terms of the Convention encompass any “ fisheries of joint interest ”, most of the Commission’s research efforts to date have been devoted to the fulfillment of the requirements of those provisions of the Convention which relate to salmon. Under the terms of the Convention Japan agrees to abstain from fishing for salmon east of a line which was provisionally placed at or near the meridian of 175° West longitude in the Bering Sea and the North Pacific Ocean¹. Canada agrees to abstain from fishing for salmon east of the same line in the Bering Sea.

It should be noted that the line delimiting salmon fishing is provisional in location. The Protocol to the Convention instructed the Commission to:

“ . . . investigate the waters of the Convention area to determine if there are areas in which salmon originating in the rivers of Canada and of the United States of America intermingle with salmon originating in the rivers of Asia. If such areas are found the Commission shall conduct suitable studies to determine a line or lines which best divide salmon of Asiatic origin and salmon of Canadian and United States of America origin, from which certain Contracting Parties have agreed to abstain in accordance with the provisions of Article V, Section 2, and whether it can be shown beyond a reasonable doubt that this line or lines more equitably divide such salmon than the provisional lines specified in sections 1(c) and 2 of the Annex. In accordance with these determinations the Commission shall recommend that such provisional lines be confirmed or that they be changed in accordance with these results, giving due consideration to adjustments required to simplify administration.”

It is worthwhile, I believe, to describe the way in which the Commission conducts its research program. In February, 1954, the newly-appointed members of the Commission, four from each country, held their first meeting, in Washington, D.C. They established a Standing Committee on Biology and Research consisting of one Commissioner and two scientists from each member country. The Director and Assistant Director of the Commission’s Secretariat were later made members of the Committee, *ex officio*, without vote.

The Committee on Biology and Research was directed to study a number of subjects, the first being

the investigations required by the Protocol to the Convention; that is, the determination of the origin and distribution of the stocks of Pacific salmon on the high seas. If it was found that stocks of salmon from the two continents intermingled on the high seas, the Protocol required studies to determine a line or lines which would best divide the continental stocks. In planning and conducting research to meet these requirements, the Commission utilizes the technical and scientific services of official agencies of the Contracting Parties, rather than organizing its own research staff. This procedure is required by the Convention insofar as it is feasible.

The program of research established by the Commission has been described in detail in many of its annual reports and research bulletins. It is accurate to say that when the Commission began its investigations in 1955, knowledge of the distribution, abundance, origin and movements of salmon on the high seas was almost non-existent. It was known, of course, that juvenile salmon went to sea and that the maturing survivors returned later for spawning. Fishing, almost without exception, was conducted on salmon during their pre-spawning migration. The extent of knowledge of the sea life of salmon prior to 1955 has been summarized in previous Commission bulletins and will be discussed again in various parts of the forthcoming joint report. The Commission’s research program devoted itself first to studies of the offshore distribution of salmon. Records of offshore commercial catches were collected and analyzed. In addition to the studies of commercial catch records, the Commission organized special fishing by research vessels for the purpose of determining salmon distribution and collecting samples for analysis. Much attention was given to developing and applying techniques for identification of the continent of origin of salmon on the high seas. These studies included morphological and meristic studies, bio-chemical and physiological investigations, scale studies and studies of the parasites of the salmon. Techniques for direct study of the movements of salmon on the high seas, using tagging, were developed and applied. Finally, the oceanic environment of the salmon was studied extensively to provide a background for understanding of the characteristics and variations of salmon distribution on the high seas.

The work of the Commission has been on a large scale. As many as fifteen or sixteen research vessels have operated on the high seas in most years. Because the Commission’s research program is executed by the research agencies of the various countries, it is difficult to make a precise assessment of its total cost.

¹ Details of the abstention provisions may be obtained from the text of the Convention, which was printed most recently in the Annual Report of the Commission for 1959.

However, it may be estimated that approximately \$2,000,000 per year has been spent on this investigation by the three countries combined. By far the major portion of this amount has been required for the operation of research vessels on the high seas.

The basic purpose of the investigations was and continues to be to provide the Commission with detailed scientific knowledge of the distribution, abundance and migrations of the continental stocks of Pacific salmon on the high seas, and the environmental conditions which influence variations therein.

The pages of the book dealing with the sea life of salmon, which were largely blank, are now rapidly being filled with facts and interpretations. Many of the results of the Commission's work have already been presented in its annual reports and research bulletins and in the journals of other research organizations. It became obvious, however, that there was need for a comprehensive report on Pacific salmon on the high seas. This bulletin contains the first part of that report. Others will follow as soon as they can be prepared. All manuscripts are expected to be in the Commission's hands by November of 1963. There will be nine major divisions to the report. Several of the parts, containing information of a background nature, are being prepared by separate authors in each country, working independently. Most of the parts, however, are being prepared by joint teams of scientists, each team having representatives from each of the three cooperating countries. In these jointly-written contributions, when agreement on the interpretation of data cannot be reached, the authors are free to express their separate views.

The separate parts of the joint report are briefly described below.

PART I. *Introduction and Catch Statistics for North Pacific Salmon.* Information on the organization and background of the Commission's research program and a compilation of historical salmon catch statistics for all regions. Prepared by the INPFC Secretariat.

PART II. *Review of Oceanography of the Subarctic Pacific Region.* This volume, which has already been published by the Commission, contains information on the oceanography of the Subarctic waters of the North Pacific Ocean in terms suitable for fisheries interpretation. It has been prepared by a team of oceanographers from the three countries.

PART III. *A Review of the Life History of North Pacific Salmon.* Background information, by geographical regions, on the reproduction, freshwater and marine

life history of salmon. Separate authors assigned for Asia, British Columbia and the United States. Primarily concerned with sockeye, pink and chum salmon.

PART IV. *Spawning Populations of North Pacific Salmon.* Descriptions of the geographic distribution of the spawning grounds for each species, abundance records, timing and numerical information on escape-ments. Also to serve as background for the studies of the distribution, origin, abundance and intermingling of each species of salmon that will be dealt with in subsequent parts of the joint report. Separate authors for Asia, British Columbia and the United States.

PART V. *Offshore Distribution of North Pacific Salmon.* This volume will contain information on the distribution of salmon on the high seas as determined from information obtained from research vessels and commercial fishing records. This volume is being written jointly by a team of scientists from the three member countries.

PART VI. *Sockeye Salmon in Offshore Waters.* This volume, which is being jointly written by a team of scientists from the three countries, will contain information on the oceanic distribution of specific stocks of sockeye salmon on the high seas and the intermingling of these stocks.

PART VII. *Pink Salmon in Offshore Waters.* Same basic contents as Part VI; also jointly written.

PART VIII. *Chum Salmon in Offshore Waters.* Same basic contents as Parts VI and VII; also jointly written.

PART IX. *Coho, Chinook and Masu Salmon in Offshore Waters.* Same basic contents as Parts VI, VII and VIII, except that it will also contain information on the life history of these species. Separate authors for each species.

As has been said previously, the Commission hopes to have all of the parts of this report completed in manuscript form by November of 1963. Parts will be published as they become available, without regard to order. The basic responsibility for promoting and coordinating this unique and monumental assignment in coordinated fishery research and reporting falls on the Commission's Editorial Referees. The Editorial Referees, Dr. A.W.H. Needler for Canada, Dr. Tasuku Hanaoka for Japan and Mr. D.L. McKernan for the United States, assisted by the Secretariat of the Commission, have taken the initiative in planning of the joint report.

All manuscripts submitted to the Commission for publication in its bulletin series must first receive the approval of the Editorial Referees. Following their approval, papers must receive approval for publication by the Commission. All publications of the

Commission are issued separately in English and in Japanese. The original language of each paper is indicated and the accuracy of translation is the responsibility of the Secretariat.

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