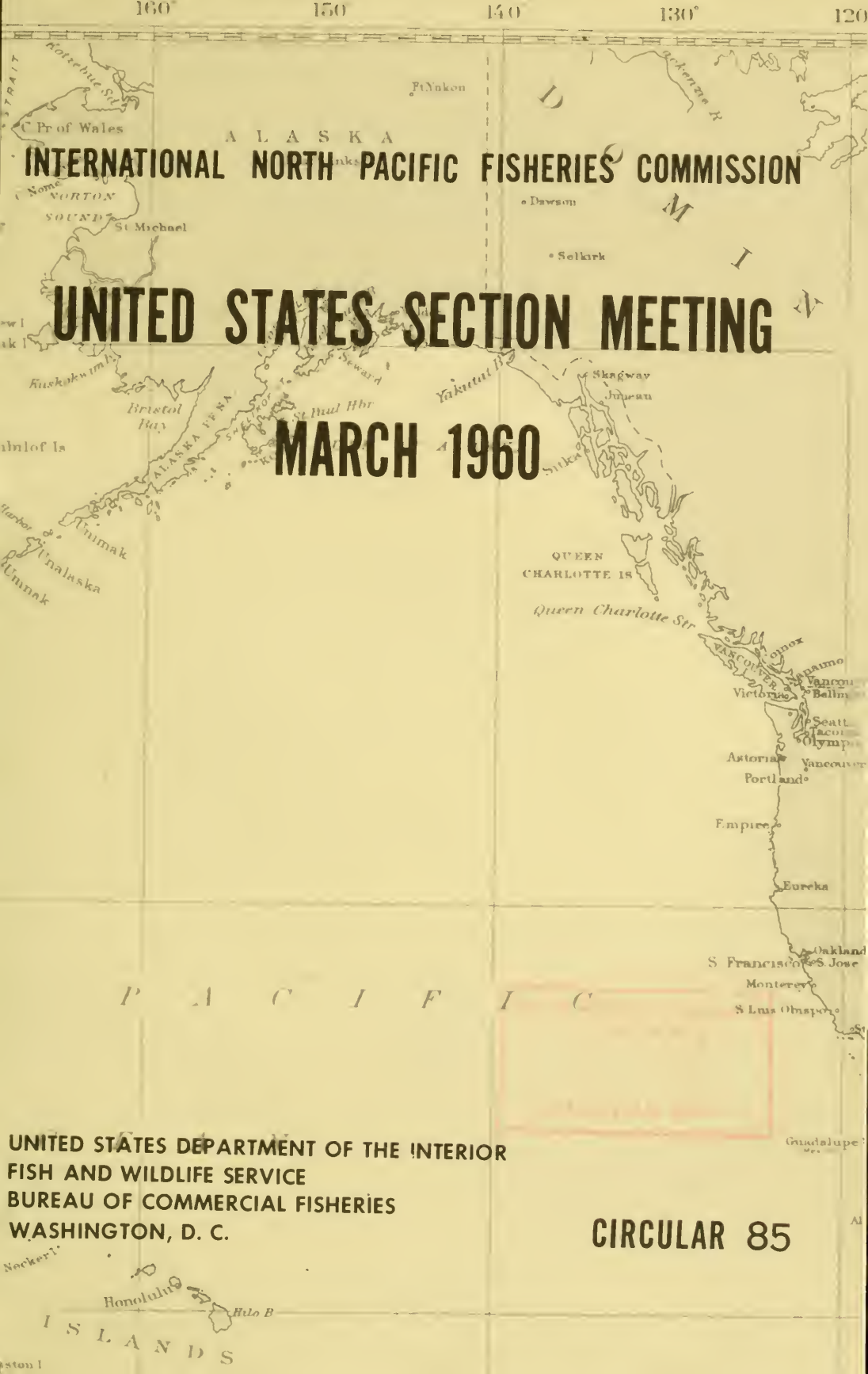

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

UNITED STATES SECTION MEETING

MARCH 1960

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES
WASHINGTON, D. C.

CIRCULAR 85

UNITED STATES DEPARTMENT OF THE INTERIOR
Fred A. Seaton, Secretary

FISH AND WILDLIFE SERVICE
Arnie J. Suomela, Commissioner

BUREAU OF COMMERCIAL FISHERIES
Donald L. McKernan, Director

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

UNITED STATES SECTION MEETING, MARCH 1960

PAPERS
Presented before a Joint Session
of the
Alaska Legislature
Juneau, Alaska

March 4, 1960

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UNITED STATES SECTION

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

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Members of the United States Section, International North Pacific Fisheries Commission, with Governor Egan of Alaska, March 3, 1960.

Left to right: Commissioners Edward W. Allen and John H. Clawson, Governor Egan, Commissioners Milton E. Brooding and Arnie J. Suomela, State Senator Alfred Owen, a member of the Advisory Committee.

THE INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION AND ITS WORK

Among the world's fisheries, those of the North Pacific Ocean are in many respects unique. Vast and valuable stocks of salmon spawn in fresh water, often hundreds of miles inland, in rivers that intersect thousands of miles of coastline, from Alaska to California and from Siberia to the islands of Japan. The young soon return to the sea and migrate over thousands of miles of ocean, feeding on rich oceanic pastures as they grow and develop to maturity. Tremendous stocks of halibut spend their entire life in the North Pacific in relatively shallow waters over the continental shelf, and the scientific research that led to management of these fisheries is a classic example of intelligent utilization of fishery resources.

The basic principle in management of salmon stocks is to determine the optimum numbers of fish that must be allowed to reach the spawning grounds, and to regulate the fishery so that these numbers, and no more, escape the fishermen's gear. Obviously, this control becomes more precise if regulations can be applied close to the spawning streams, and this is why the Pacific coastal states severely restrict salmon fishing on the high seas.

The prospective development of a large high-seas salmon fishery by foreign interests after World War II, therefore, threatened to interfere seriously with management of American stocks. Alaskan salmon fisheries were especially vulnerable, particularly the large and valuable red salmon stocks of Bristol Bay, in the Bering Sea. Entry into force of the International Convention for the High Seas Fisheries of the North Pacific Ocean between the United States, Canada, and Japan in 1953 demonstrated the importance that these three fishing nations placed upon conservation of high-seas fishery resources, and their recognition of the need for research and preservation of historic fishing rights.

Growth of the Japanese high-seas fishery has caused increasing concern in Alaska, and the responsibilities and activities of the International North Pacific Fisheries Commission with respect to this situation have not always been clearly understood. Accordingly, Governor Egan of Alaska issued an invitation to the United States Section of the Commission to hold its first meeting of 1960 in Juneau, so that the State Legislature and the public would have an opportunity to understand better the Convention and the activities that have taken place since it was ratified in 1953.

The United States Section promptly accepted the invitation and met in Juneau early in March 1960. The Section, with its Advisory Committee and scientists, met with the Natural Resources Committees of the Senate and House on March 3, and with the entire Legislature on March 4. In the evening of March 4 an open hearing was held, at which the Section and Advisors reviewed the Commission's work, heard statements and answered questions. This Circular contains the text of formal presentations before the Legislature.

Commissioner Brooding (center) addressing the Alaska Legislature.

STATEMENT OF THE UNITED STATES SECTION INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Presented by
Milton E. Brooding, Chairman

Mr. Chairman, Members of the Legislature, Ladies and Gentlemen:

It is a privilege for the United States Section of the International North Pacific Fisheries Commission to meet here for the second time. When we received the invitation from Governor Egan to hold our next meeting here in Juneau, we immediately took steps to do so. Being here is a most enjoyable experience and we deeply appreciate the courteous reception extended us. We have had an opportunity to become better acquainted with the Alaska viewpoint and it is our hope that we can impart to you a better understanding of the North Pacific Fisheries Convention--its problems, and some of the accomplishments of the Commission set up to administer its provisions.

It seems quite appropriate, in fact quite necessary, that this be done, for there can be no question that affairs of the International North Pacific Fisheries Commission impinge more directly upon the public welfare of the people of Alaska than those of any other of our coastal states, although all these states have a deep interest in the affairs of this Commission.

It would be appropriate at this point to introduce my colleagues on the U. S. Section: Commissioners Edward W. Allen, Seattle, Secretary of the Commission; John H. Clawson, Anchorage; and Arnie J. Suomela, Washington, D. C. We also have with us several members of our Advisory Committee as well as scientists and other experts from your own Department of Fish and Game and from the U. S. Bureau of Commercial Fisheries in Juneau, Seattle, and Washington, D. C.

In order to understand the origins of the International North Pacific Fisheries Commission, the treaty under which we operate, it is desirable to review some of the circumstances of relatively recent history. Prior to World War II, the interested public of the Pacific coast of the United States realized that great Japanese high-seas fisheries were expanding into the North Pacific. Their research vessels were searching towards the Equator and towards the Bering Sea for stocks of fish of all varieties. We know from the incident in the Bering Sea in 1937 that the Japanese were searching then for salmon in the eastern North Pacific. It appears that only prompt diplomatic action by our Government at that early date prevented exploitation on the high seas of salmon stocks of North American origin.

Many of us, in and out of Government, realized that expansion of fishing by the Japanese after the war, and the change in control in some of the land areas of the western North Pacific, would bring about an inevitable conflict of interest. Some orderly procedure was needed to protect the interests of the United States, yet not interfere with the recognized right under international law of a country to enjoy the freedom of the high seas.

All of you know something about the International North Pacific Fisheries Commission. Some of you, I know, understand it quite well. The Convention deals with highly complex problems, difficult and sometimes conflicting international interests, and relatively new and not widely understood biological and conservation concepts. I believe it will facilitate our discussions if I first attempt to explain why the Convention was drafted in its present form.

What is the International Convention for the High Seas Fisheries of the North Pacific Ocean?

The Convention is an agreement negotiated between the United States, Canada, and Japan, chiefly concerned with conservation principles and procedures to promote the maximum sustainable yield of North Pacific stocks of fish of "joint interest". The Convention runs for a minimum of ten years from June 1953 and will continue thereafter until one year after notice of intention to terminate is given by one of the parties to the Convention.

The principal provisions of the Convention are:

1. It provides for establishment of a North Pacific Fisheries Commission, composed of three national sections, each with four members appointed by the governments of the respective parties to the Convention. It also authorizes establishment of an Advisory Committee to each national section, composed of persons well informed on North Pacific fishery problems.

2. The Convention requires that the appropriate parties to the Convention will abstain from fishing stocks of fish which meet specified criteria, as follows:

a. the stocks are being fully utilized, so that more intensive fishing will not provide a substantial increase in yield which can be sustained;

b. fishing is controlled by legal measures in accordance with conservation programs based on scientific research; and

c. the stocks are under extensive scientific study designed to discover whether they are being fully utilized and to determine the conditions necessary to obtain maximum sustainable yield.

3. The Annex to the Convention specifies certain stocks of fish, which, at the time the Convention was negotiated, were found to satisfy these criteria for abstention.

4. It requires the Commission to study the stocks of fish specified in the Annex to determine whether they continue to qualify.

5. It provides that on request by any of the three countries, the Commission shall study any other stock of fish in the North Pacific to determine whether it qualifies for abstention.

6. It provides that the countries fishing the stocks from which certain other countries agree to abstain shall continue to carry out necessary conservation measures for these stocks.

7. It provides that, on request of any of the three governments, the Commission shall study any other fish stock under substantial exploitation by two or more countries to determine the need for joint conservation measures.

8. The Convention provides that, if nationals or vessels of a country not a party to the Convention adversely affect the operations of the Commission, on request of any of the three countries which are parties to the Convention, all the contracting governments will confer to determine steps necessary to obviate these adverse effects.

9. It spells out provisions for enforcing the Convention and the various rules under which the Commission shall operate.

10. The Protocol to the Convention specifies a provisional line, east of which the Japanese will not fish anywhere for salmon, and east of which the Canadians will not fish in the Bering Sea for salmon. It further provides that the Commission shall expeditiously investigate the area to determine whether there are areas where stocks of salmon

of North American origin intermingle with stocks of Asian origin. If such areas are found, then the Commission shall determine a line or lines which best divide salmon of Asian and North American origins and whether such line or lines more equitably divide such salmon than the provisional lines specified in the Protocol.

At the time the Convention was negotiated, the United States had little factual knowledge on high-seas migrations and distribution of salmon. It was generally believed that salmon spent their marine existence in waters overlying the continental shelf. This scarcity of information made agreement on the location of a line defining the eastern limit of Japanese salmon fishing very difficult. At one point the conference came very close to breakdown because views regarding location of such a line were widely different. The Protocol represents a compromise which saved the conference from failure. At the time the compromise was agreed upon, we had no information concerning the extensive intermingling of Asian and North American salmon. It was thought that if any movement of North American salmon across the provisional line did occur, it was not substantial. Our present knowledge is derived entirely from the Commission's research program of the last few years.

Why was the Convention Drafted in Its Present Form?

I believe almost any of us could propose changes in the Convention which would make it much more to our liking. In fact, I have heard or read many proposals for such changes from sincere and well-intentioned people. Some of these proposals appear so reasonable and simple that the proposer finds it difficult to understand why they were not included in the first place and, failing that, why they should not be adopted now. Perhaps I can help to make clear why this is not so simple as it looks. These are some of the considerations:

1. Agreements between sovereign powers are based on mutual interests and persuasion, not dictation. A country's representatives sign and ratify a treaty only when they consider that it is in their country's interest to do so.

2. In endeavoring to give protection to our North Pacific fisheries, it was necessary to reconcile our claim to special interest in these fisheries with the general international legal concept of freedom of the seas. To meet the special situation prevailing in this area, the principle known as abstention avoided any assertion of ownership or jurisdiction over any area of the high seas, at the same time that it did assert that nationals of other countries should abstain from catching these special stocks which came within the scope of the principle.

Our salmon and halibut fisheries were developed exclusively by our own and Canadian fishermen. Huge sums were

invested in research and regulation of these stocks, and we had reason to believe they were being fully utilized; that is, additional fishing by other nations would not increase total production, but would simply replace present fishermen and discourage continuation of extensive conservation programs necessary for obtaining the maximum sustainable yield from these stocks. It was the incentive of increased and sustained production for their benefit which persuaded our fishermen to submit to the rigid regulation essential to effective conservation of these fisheries. Thus, the principle of abstention was necessary as a companion measure to the general principle of freedom of the seas, in order to preserve valuable fishery resources that we were maintaining at great effort.

3. We must bear in mind that Japan is a great fishing nation whose fishing activities are heavily dependent on the principle of freedom of fishing. Consequently, Japan cannot support or accept principles or procedures which seriously endanger this freedom. To minimize Japanese sensitivity to this problem, our proposals had to be related closely to the characteristics of the fisheries which I have referred to above and make clear the unique conservation considerations and scientific requirements involved.

4. When studying the Convention wording, all of these points should be kept in mind. The Convention refers to stocks of fish, and therefore does not involve areas of jurisdiction. It specifies full utilization, management measures in accordance with conservation programs, and the basic requirement that all must be supported by reasonable conclusions derived from scientific findings.

I will readily agree that the Convention is not in the precise form, or perhaps even in the approximate form, in which you or I would wish to draft it if we had complete freedom to do so, for it includes compromises necessary for agreement. However, if you will study it closely, I think you will find that it covers those stocks of fish of primary interest to Alaska. There is one major exception, the stock of Bristol Bay red salmon, which we now know migrate far to the west to areas much closer to the Asian mainland than to the mainland of Alaska. The results of recent research have demonstrated that red salmon from Bristol Bay mingle over a wide area with salmon of Asian origin. The problem that develops from this is extraordinarily complex, a complexity that derives from the extent and areas of migration, extensive intermingling, and world politics.

Problems and Accomplishments of the Commission

We have reviewed the nature and origins of the North Pacific Convention and the make-up and terms of reference of the Commission appointed under its provisions. What are the problems of this Commission and what has it accomplished?

The Commission operates under the terms of reference provided by the Convention. It has no authority to make decisions or recommendations except as provided by the Convention's terms. This frame of reference cannot be changed by the Commission but only by agreement among the three countries party to the Convention. The United States Section, as part of the Commission, cannot change the basic rules under which it works. It must rely upon the establishment of a solid scientific basis for the principles under which the Convention was negotiated.

Operating in this manner, the Commission, and the United States Section, have been engaged in a number of research programs which have yielded extremely valuable results. One of the most important, of course, is the program of research relating to abstention. Unless the applicability of the abstention requirement can be demonstrated clearly by scientific research, the whole basis for the principle is jeopardized, and abstention as a method of fishery management cannot survive.

A review of the principal research projects will be undertaken in greater detail later. However, it may be useful at this time to summarize what the United States Section has been doing in this regard. First, with respect to salmon and halibut, the analysis carried out by United States scientists has added substantially to our knowledge and has greatly strengthened out abstention case in the Commission. We feel that we have made a strong case for our salmon and halibut stocks. Work in this field continues in order that our case regarding all requirements for abstention with respect to these stocks may be clearly demonstrated.

An extensive analysis of the data on herring stocks has clearly shown a decrease in the utilization of herring in recent years. It has shown further that increased fishing would result in a substantial and sustainable increase in yield. Since the herring stocks of Alaska thus fail to meet one of the primary requirements for abstention; i. e., full utilization, the United States Section and the Commission had no choice but to recommend that they be removed from the abstention list. A failure so to act would have undermined the whole basis of the abstention principle.

Another important line of research is providing a basis for interpretation of the Protocol to the Convention and the question of possible relocation of the provisional line for abstention by other countries from fishing American salmon. The Protocol requires the Commission to investigate the distribution of salmon of North American and Asian origin to determine the area and extent of intermingling. Acting under this requirement, the Commission, and particularly the United States Section, has sponsored the most intensive and extensive high-seas fishery research program ever conducted.

This program has developed a surprising picture of the distribution of salmon. They are found in large numbers ranging completely across the ocean from North America

to Asia. New and ingenious methods to determine the origin of salmon caught on the high seas have been devised.

With these new methods it has been found that Asian red, chum, and pink salmon, especially chums and pinks, come almost as far east as the tip of the Alaska Peninsula. Conversely, American salmon are found far to sea, moving thousands of miles during their ocean life. Some Bristol Bay red salmon are found far west in waters near Kamchatka.

The general outlines of the areas and extent of intermingling have been determined. However, variations in numbers of the various species in various parts of the ocean and at various seasons require more investigation.

The Protocol provides that the question of possible relocation of the provisional abstention line shall be referred to a neutral committee of scientists if the Commission fails within a reasonable time to make a unanimous recommendation. At present, however, there is disagreement within the Commission as to interpretation of certain language of the Protocol, specifically as to whether the words "best divide" and "equitably divide" mean "divide" in the sense of "to separate" or in the sense of "to apportion".

It is the Japanese contention that the line should divide the salmon of the area, including all species, in such a way that the number of North American salmon found west of the line is equal to the number of Asian salmon found east of the line. This would, of course, permit them to catch the large numbers of Bristol Bay reds which cross the line and would not interfere seriously with their ability to catch salmon of Asian origin which move east of the line, for these salmon eventually must return to Asian shores to spawn. Moreover, Asian salmon would not be vulnerable to capture by American fishermen east of the line, for we prohibit salmon fishing with nets on the high seas.

It is the contention of the United States Section that the Protocol should be interpreted in the light of the primary objective of the treaty, which is to apply the principle of abstention to the entire stock of salmon coming within its purview, and therefore the line should be so located that the Japanese will abstain from catching American salmon. We recognize, of course, that the abstention principle should not be interpreted so rigidly that Japan will be prevented from continuing her historical fishery for Asian salmon.

Despite the increasing volume of scientific knowledge on intermingling of North American and Asian salmon, it will not be possible to refer the data to a neutral committee for decision until the disagreement over interpretation is resolved. The meaning of the language is fundamental to the decision a neutral committee would be asked to make. Because this disagreement involves the basic terms of reference of the Commission, the question of interpretation of the Protocol has been referred to the three Governments for clarification.

Thus, the Commission is not in a position at present to come to a decision regarding relocation of the abstention

line. Nevertheless, the scientific work which has been done and which continues on this subject has yielded substantial benefits. Can anyone doubt that the facts which have been brought to light have had a very considerable effect in the past two years on Japanese high-seas operations west of the provisional line? Furthermore, we are in a position to proceed on what we consider to be a basis of solid scientific knowledge once interpretation of the Protocol is settled.

To sum up, few international agreements which involve conflicting national interests are perfect documents in the sense of giving complete satisfaction to all parties. The North Pacific Fisheries Convention is no exception. The Convention has not afforded complete protection to all stocks of interest to Alaskan fishermen, for Bristol Bay reds are not adequately covered. However, the Convention has provided practically full protection for all other salmon stocks of Alaska and the rest of the Pacific coast and for halibut as well.

SCIENTIFIC RESEARCH BY THE UNITED STATES

by Dr. J. L. McHugh
Chief, Division of Biological Research
Bureau of Commercial Fisheries
Washington, D. C.

Research conducted by the Bureau of Commercial Fisheries for the Commission has two major purposes, to provide scientific knowledge necessary to determine whether the stocks of fish specified in the Annex to the Convention qualify for abstention, and to study the distribution of salmon on the high seas to provide knowledge required for proper interpretation of the provisions of the Protocol. The first objective, you will remember, is to show: (1) whether or not more intensive exploitation of the stocks of salmon, halibut, and herring will yield substantial increases in yield that can be sustained year after year; (2) that this exploitation is regulated by legal measures to maintain or increase the maximum sustained yield in accordance with scientific knowledge; and (3) that extensive scientific study is in progress to discover whether the stocks are being fully utilized and determine the conditions necessary to maintain maximum sustained yields. The second objective is to determine if there are areas in which salmon of North American and Asian origin intermingle, and if so, to determine a line or lines which best divide salmon from these two sources, and to show beyond reasonable doubt that this line or lines more equitably divide such salmon than the present provisional line at 175° West longitude.

Information bearing on the abstention question has been provided by several agencies. We have received, and are pleased to acknowledge, the assistance of the Alaska Department of Fish and Game on many occasions. The relationship between numbers of spawners and the success of fishing when their progeny return from the ocean has been determined from information provided by the scientific staff of Bureau of Commercial Fisheries Region 5, based in Juneau. The staffs of the International Pacific Halibut and Salmon Commissions have given us much useful information, also, as have the Washington, Oregon, and California State fishery agencies. Investigations of high-seas distribution of salmon have been made by the staffs of our Seattle Biological Laboratory and the Fisheries Research Institute of the University of Washington.

Continued exploitation of a fishery resource is possible because nature makes adjustments to offset the catch that is made by man. If this were not true, and the numbers of fish in the sea were always directly in simple proportion to the numbers that spawned, then continued fishing would lead to complete extinction of the resource, at a rate proportional

to the rate of fishing. With no fishing, of course, there is no catch, and the potential yield is wasted insofar as man is concerned. On the other hand, it is obvious that at some very high rate of fishing it would be impossible for the survivors to produce enough spawn to maintain equally large catches in later years. But judicious thinning can produce a steady yield year after year, somewhat as a row of carrots, or an apple tree, will produce the greatest weight of crop if thinned or pruned carefully. It is the purpose of scientific fishery research to determine the relationship between numbers of spawners and the size of the commercially-valuable crop they will produce, so that the best sustained yield can be known and can be maintained by regulating fishing and other controllable sources of mortality.

Mr. Fredin, of our Seattle Laboratory, in charge of scientific investigations bearing on the abstention case, will report to you first. He will be followed by Mr. Atkinson, Director of our Seattle Laboratory, who will describe studies of high-seas distribution of salmon, and Dr. Royce, Director of the Fisheries Research Institute, who will discuss distribution and movements of salmon as revealed by tagging.

RESEARCH RELATED TO THE CASE FOR ABSTENTION

By R. A. Fredin
Fishery Research Biologist
Bureau of Commercial Fisheries
Biological Laboratory
Seattle, Washington

I shall review the abstention provisions of the North Pacific Treaty, including their purpose, the stocks of fish concerned, the conditions under which a stock qualifies for abstention, and the scientific studies required.

The purpose of the Treaty is to ensure maximum sustained productivity of the fishery resources of the North Pacific Ocean. To this end, Canada and Japan agreed, in 1953, to abstain from fishing certain stocks of fish in certain waters, and Canada and the United States agreed to carry out necessary conservation measures.

Japan agreed to abstain from fishing the following stocks in certain waters: (1) halibut (*Hippoglossus stenolepis*) originating along the coast of North America and which occur off the coasts of Canada and the United States; (2) herring (*Clupea pallasii*) of North American origin occurring off the coasts of Canada and the United States, exclusive of the Bering Sea and waters of the North Pacific Ocean west of the meridian passing through the western extremity of the Alaskan Peninsula; and (3) the five species of salmon (*Oncorhynchus spp.*) originating in the rivers of Canada and the United States. Because the range of the salmon was unknown, a provisional line was specified in the Protocol. Japan and Canada agreed to abstain from fishing these stocks because, at the time the Treaty was negotiated, it was concluded that each fulfilled the three conditions for abstention, (1) full utilization, (2) regulated exploitation, and (3) extensive scientific study.

At the time the Treaty was negotiated it was recognized that errors in classification might be possible or that changes in a stock and its fishery might take place. Hence, the Treaty required that each year, beginning in 1958, the Commission should determine whether the stocks of halibut, salmon, and herring continue to qualify for abstention in the three conditions given above.

In order for the Commission to make the required study, it has been necessary to assemble scientific data and other information relating to the three conditions for abstention for each stock on the abstention list. The task has been and is a difficult one, particularly with respect to the first condition for abstention. For a salmon stock, for example, the scientific evidence relating to the first condition for abstention includes an assessment of the current condition of the stock, a measure of the intensity of the fishery and the

interrelationships of fishing intensity, stock size, and yield.

To demonstrate how this evidence is used to study the qualification of a salmon stock for abstention, let us suppose that the relationship between number of spawners and the number of adult fish they produce resembles the hypothetical examples in the following table:

Example	Number of spawners	Run of adult fish they produce	Permissible catch for sustained yield
1	500	1500	1000
2	1000	2500	1500
3	1500	2000	500

If, from the 1500 adult fish in (1) we catch 1000 fish, we leave 500 spawners to perpetuate the run at an average of 1500 fish. If, from the 2500 adult fish in (2) we catch 1500 fish, we leave 1000 spawners to perpetuate the run at an average of 2500 fish. If, from the 2000 adult fish in (3) we catch 500 fish, we leave 1500 spawners to perpetuate the run at an average of 2000 fish. We can say that these catches of 1000, 1500, and 500 fish represent the average sustained yield at the three levels of escapement. In this case the maximum average yield is 1500 fish, and the optimum escapement is 1000 spawners.

Suppose that we have a run of 2500 fish annually. If we catch 1500 and leave 1000 for spawning, we would be fully utilizing the stock while maintaining the escapement at the level which, on the average, will provide the maximum sustained yield. It would be concluded that more intensive fishing would not provide a substantial increase in the sustained yield. However, take a case where we have a run of 2000 fish annually, out of which we have always caught only 500 fish and have left 1500 for spawning. These 1500 spawners provide a long-term yield of 500 fish. By increasing the fishing intensity to catch 1000 fish instead of 500, the escapement would be reduced from 1500 spawners to 1000 spawners. These 1000 spawners would provide a long-term yield of 1500 fish. Here, then, is a case where more intensive fishing would provide a substantial increase in the sustained yield.

For a halibut or herring stock, the scientific evidence required to determine whether the first condition for abstention is satisfied includes additional data on growth rates, rates of mortality from natural causes, the age at which the fish enter the fishery, and the number of years they remain available to the fishery.

The following example illustrates how growth and natural mortality rates affect the yield to be obtained from a given number of fish. Suppose we have a group of 1000 fish which is going to be available to us for one year, and that we could catch any or all of them at any one time during the year. Let us say that, at the start of the year, each fish weighs 5

pounds. Thus, if we harvest them all at the start of the year, our yield would be 5000 pounds. Suppose that we let the fish remain for the year, that none of them dies from natural causes during the year, and that each fish gains one pound in weight. At the end of the year, the available catch is 6000 pounds. Therefore, catching the fish at the end of the year rather than at the start, our yield increased by 1000 pounds, because the gain in weight exceeded the loss due to natural mortality.

On the other hand, suppose that during the year we let the fish remain, 500 of them died from natural causes, leaving only 500 for harvesting at the end of the year. The yield at the end of the year would be 500 times 6 pounds, or 3000 pounds. The yield would be 2000 pounds less than it would have been had we harvested at the start of the year, because the loss due to natural mortality exceeded the gain in weight by the survivors. Similar knowledge of the growth and natural mortality of halibut and herring enable us to estimate when and how much fishing should be employed to obtain the maximum yield from a given number of fish entering the fishery. If the current fishing intensity is lower than that which provides the estimated maximum yield, we would conclude that an increase in fishing would provide an increase in yield. If the current fishing intensity is at or above that which provides the estimated maximum yield, we would conclude that more intensive fishing would not provide an increase in yield.

Another type of evidence can be used to study the qualification of a stock for abstention. It consists of the historical changes or trends in catch, fishing effort and relative abundance of a stock. The conclusions to be drawn from this type of evidence are usually rather general. Nevertheless, they are, if logically, drawn, based on the same biological principles and concepts as those drawn from the more rigorous analytical treatment of return-escapement data or growth and natural mortality data.

With regard to the second condition for abstention, it is necessary to demonstrate that our regulatory measures are designed for the purpose of achieving maximum sustained yield, and that they are based on the findings of scientific research.

For the third condition for abstention, it is necessary to explain the scope and objectives of our research programs. It should be emphasized that, unless the third condition for abstention has been and is reasonably satisfied, we lack the scientific evidence required to study the qualification of a stock under the first condition for abstention and to serve as a basis for regulatory measures. Clearly, the three conditions for abstention are closely related.

During the past three years, we have assembled various types of scientific data concerning utilization of our stocks and other information relating to regulation of and research studies on the stocks. These data and information represent a body of knowledge on our salmon, halibut and herring

stocks which had not been gathered together prior to the negotiation of the treaty, and they constitute a significant advance in the science of fishery conservation. This has been presented to the Commission in the form of seven major technical documents and about twenty other supporting documents, which have been our cases for abstention to date. Without a doubt, additional documents will be required, for while our cases for abstention are for all reasonable purposes conclusive, they are not, and never can be expected to be, entirely perfect.

For salmon, we have presented evidence which shows that, for several years following World War II, a greatly intensified United States fishery failed to provide an increase in yield. We have also shown, for most of our major red (*O. nerka*) and pink (*O. gorbuscha*) salmon-producing areas, that recent spawning escapements have been lower than those escapements associated with the larger average yields. We have concluded from this that more intensive fishing would further reduce escapements and probably would result in a decrease, not an increase, in the sustained yield. Indeed, with regard to Bristol Bay red salmon, which Canada abstains from fishing, the Canadian Section agreed with this conclusion at the last annual meeting of the Commission.

However, the Japanese Section of the Commission has stated that we have not yet demonstrated that more intensive exploitation of our salmon stocks would <u>not</u> provide a substantial increase in yield which could be sustained. Their scientific arguments have been based on the hypothesis that the long-term average yield from a salmon stock is primarily controlled by natural factors, and that fishing plays a relatively minor role. This problem of separating the effects of a fishery from those of the environment is a difficult one, and it will be necessary to examine the logic of Japanese scientific arguments regarding the effects of fishing on salmon stocks and to demonstrate, with supporting data, the weaknesses of their logic. In addition, it is important that we gather the scientific evidence required to determine whether or not a high-seas salmon fishery results in a waste of the salmon resources.

For North American halibut stocks, we have presented one document on the history of the changes in the stock and the fishery, and another on the yield to be expected at various levels of fishing intensity under present-day conditions of growth and natural mortality. This latter document is a significant contribution to our knowledge of the halibut stocks. The scientific data indicate, for halibut stocks outside the Bering Sea, that present-day fishery is taking almost the maximum yield from the stocks, and that greatly intensified fishing would provide only a relatively small increase in yield. Canadian scientific reports on halibut have reached essentially the same conclusions.

Japan has stated that we have not yet demonstrated that more intensive fishing of the halibut stocks would <u>not</u> provide a substantial increase in yield which could be sustained.

Their principal scientific argument has been that we do not know the relation between stock size and production of new halibut of commercial size. It will be necessary for us to study the logic of this argument that such information is necessary to the management of a marine species such as halibut.

The third species of fish of United States origin on the abstention list in 1953 was Alaska herring. Within the past year, some important new scientific evidence was assembled for Alaska herring, and this was reviewed at the last annual meeting of the Commission.

The new scientific evidence consisted of information on levels of fishing intensity during the past five or six years, natural mortality, and growth rates. These data showed that after herring are three or four years old, natural losses in numbers of fish far exceed the weight increases of the survivors. The data also showed that present-day fishing intensity is low, much lower than during the years preceding negotiation of the Treaty, and considerably below the levels which would provide higher sustained yields.

The conclusion drawn from the scientific evidence was that more intensive fishing of Alaska herring would, with reasonable certainty, provide a substantial increase in yield which could be sustained. This conclusion was agreed upon by scientists of Japan, Canada, and the United States.

DISTRIBUTION AND RACIAL COMPOSITION OF SALMON ON THE HIGH SEAS

By Clinton E. Atkinson
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Bureau of Commercial Fisheries
Seattle, Washington

The Protocol to the International Convention for the High Seas Fisheries of the North Pacific Ocean directs 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", and to "conduct suitable studies to determine a line or lines which best divide salmon of Asiatic origin, and salmon of Canadian and United States of American origin". Since its organization the United States Section of the Commission has conducted extensive investigations on the problems of the Protocol to determine whether or not the present provisional line at 175° W. (fig. 1) adequately protects North American runs of salmon from exploitation by the Japanese fisheries. The results of research to date show that the provisional line protects most North American runs of salmon with the exception of Bristol Bay red salmon which range far to the westward and into the area of high seas fishing.

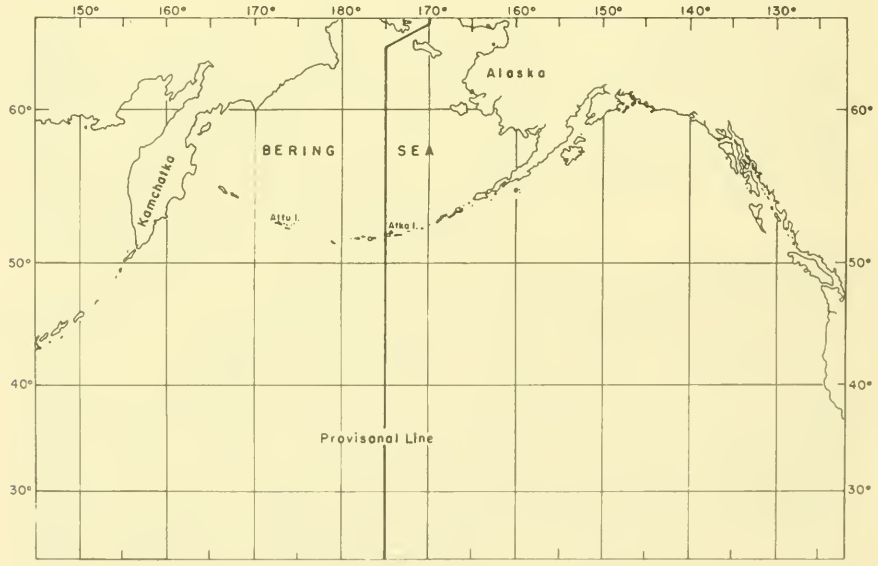

Figure 1.--North Pacific Ocean and Bering Sea, showing position of Provisional Abstention Line.

At the time the treaty was signed, almost no information was available on distribution of Asian or North American salmon on the high seas. It is true that the Japanese in the 1930's had undertaken a detailed survey of the Bering Sea west of 180°, but the main purpose of their survey was to determine where salmon were most abundant for purposes of establishing a commercial fishery, and no attention was given to whether the fish taken were of Asian or North American origin. The limited research of the United States in 1937 and 1938 in eastern Bering Sea indicated that salmon were probably confined to the continental shelf.

After entry into force of the Treaty on June 12, 1953, the Commission was organized in February of 1954 and its program of research was approved in the fall of that same year. The first explorations to determine distribution of salmon were made in the spring of 1955 when the U. S. Fish and Wildlife Service vessel John N. Cobb was sent out along the west coast of North America, across the Gulf of Alaska, and along the Alaskan Peninsula. Wherever the Cobb set its nets, salmon were taken.

Based upon this information, two halibut schooners were chartered in July 1955 to investigate the critical waters between 175° E. and 165° W. lying on both sides of the provisional line. Again, they took salmon all along the Aleutian Islands north of about 48° N. But when the boats passed into more southern waters, salmon disappeared from their catches and instead, quantities of albacore were taken. It was now obvious that two separate environments had been found. This was most important to us because it meant that we had found the southern range of salmon distribution (fig. 2).

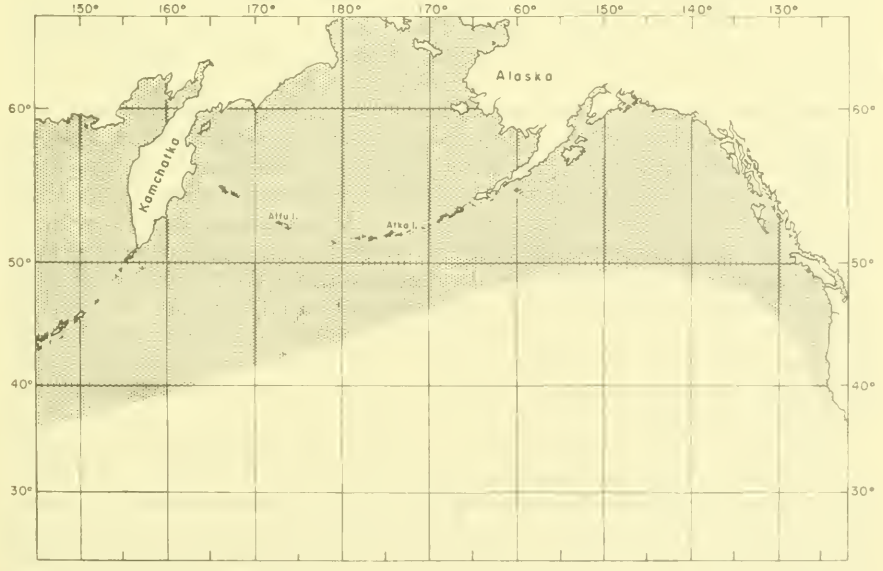

Figure 2.--North Pacific Ocean and Bering Sea showing area inhabited by salmon in May - June.

However, further evidence was required on distribution of salmon in spring (winter in the sea) when the colder water of the North Pacific extends as far south as about 40° N. Arrangements, therefore, were made for vessels from the laboratory of the Bureau of Commercial Fisheries at Honolulu to extend their spring cruise for tuna into waters north of 40° N. and, as predicted, salmon were found in these waters. It was evident that the distribution of salmon was intimately associated with conditions in the ocean, varying from season to season and, of course, from year to year.

Coupled with this knowledge of the southern limit of salmon distribution, subsequent studies have shown that the northern limit lies at a temperature of about 3° C., and here again the temperature pattern varies markedly between seasons and years.

Yearly changes in abundance of salmon have been followed closely since 1955 by fishing the same stations on the high seas. In this work we discovered that the numbers, kinds, and sizes of salmon on the high seas vary from time to time and place to place. For example, we have found the ocean near the central Aleutian area to be heavily populated with pink salmon (*Oncorhynchus gorbuscha*) during odd-numbered years, and we have found that these are Asian fish. In marked contrast, very few pink salmon are present in the even-numbered years, and these fish are predominantly of North American origin. Pink salmon invariably return to spawn at the end of their second year of life, hence these patterns are not surprising.

The distribution of salmon within this area varies as the season progresses. In 1959 pink salmon were first observed in large numbers about 200 miles south of the Aleutian chain. As the summer progressed, pink salmon became more and more abundant near and north of the Aleutian chain in the Bering Sea, but by mid-July they could be found only in the westernmost part of the ocean, near the Asian continent.

Similar changes have been found for red salmon (*O. nerka*). In May and June of 1959, the central area just north of the Aleutians was heavily populated with adult red salmon almost certainly of Bristol Bay origin, and red salmon remained abundant here until about the end of June. In July, the larger, more mature red salmon became scarce but we began to catch large numbers of immature red salmon. In 1959 these immature red salmon were about 10 times more abundant than in previous years and were certainly part of the very large outmigration of small fish from Bristol Bay in 1958.

These initial explorations were sufficient to give us an answer to the first question posed by the Protocol, that is, did Asian and North American salmon intermingle on the high seas? There is no question but that large numbers of salmon from Asia and North America intermingle in the mid-Pacific and the Bering Sea. We also found that the amount of mixing and the actual distribution of the salmon was related to the abundance of fish from certain mainland

rearing areas and to the configuration of the hydrography of the sea.

Our next problem was to define this area of mixing for the three important species of salmon: red, pink and chum (*O. keta*) salmon. Tagging experiments provided the best way to define these areas, and such investigations were arranged by contract with the Fisheries Research Institute of the University of Washington.

Finally, to answer the problem set forth in the Protocol, we must know not only where salmon are, but also the relative abundance of North American salmon at any point on the high seas. The answer to this question required the development of new methods for identifying Asian and North American fish. In effect, we must examine a salmon, and by certain differences, such as variations in size, shape, or numbers of parts in various sections of the body, be able to say that this fish is from Asia or from North America. Three successful methods for identifying stocks of salmon are now being used.

These areas of the North Pacific Ocean mentioned above were all fished by our research vessels for the purpose of securing samples to determine where fish in the high seas originated. In studying these fish samples, examination of the structure of scales of individual fish was the first approach followed. It has been found that salmon tend to deposit rings (or circuli) on their scales in patterns characteristic for each area. A careful study of these characters of red salmon scales demonstrated by 1957 that Bristol Bay red salmon were found far to the west in the central Pacific. Subsequently, we have devised means of making quantitative separations into continent of origin of scale samples taken on the high seas.

Similarly, we have experienced considerable success in the study of the counts of body structures of salmon. This different approach makes use of variations in the number of scales on the fish, bones in the backbone, bones in the gill arches, and fin rays, as well as a number of other readily-examined portions of the fish which tend to show differences. This method has been particularly useful to us in developing quantitative separation of red salmon on the high seas. We have been able to determine with reasonable precision what portion of the salmon in a sample taken in the middle of the ocean came from North America and what portion came from Asia.

One of the newer and more fascinating approaches, or techniques, applied is that of serological or blood chemistry differences between Asian and North American fish. It has been necessary to develop this research from a rather scanty basis of knowledge of blood types in fish. However, it has been found that salmon and other fishes do indeed have blood types. It has been possible to produce antisera which will react with the blood of North American red salmon but will not react with the blood of Asian red salmon. By this means it is possible to collect samples of blood on the high

seas and, subsequently to determine whether the blood was from Asian or North American fish, although the fish may have been taken thousands of miles from its point of origin.

To summarize briefly the results and progress at this point, we have worked out, for the years during which research has been possible, a picture of the distribution of North American red, pink, and chum salmon on the high seas.

For red salmon it has been found that Bristol Bay fish are dominant in the Aleutian area as far west as 175° E. longitude; that is, a matter of about three-fourths of the distance from Bristol Bay to Kamchatka (fig. 3). Asian fish in smaller numbers are found as far east as the eastern Aleutian Islands.

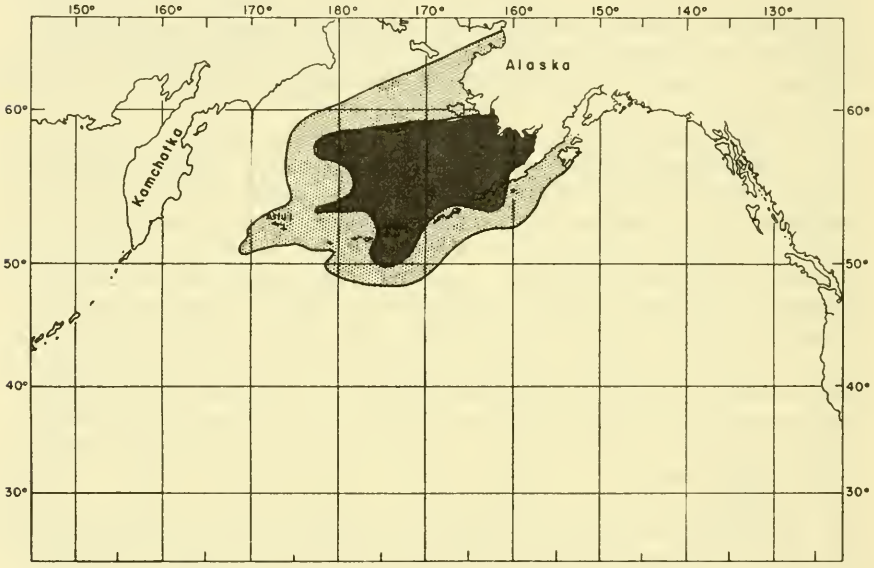

Figure 3.--Distribution of western Alaska red salmon in 1957. In the shaded areas, western Alaska-type red salmon were dominant, and their relative abundance was proportional to the depth of the shading.

Pink salmon from the Bering Sea coast of North America were found very nearly as far west as Bristol Bay red salmon; however, not nearly so abundantly. Conversely, Asian pink salmon in 1957, and apparently also in 1959, were found as far east as the tip of the Alaska Peninsula in very considerable numbers. It seems that in these odd-numbered years Kamchatka fish overwhelmingly dominated the entire mid-Aleutian pink salmon population.

Chum salmon were distributed in approximately the same manner as pink salmon. Asian chums have been caught near the Shumagin Islands, and North American chums, while they go far to the west, do not appear actually to reach the Asian mainland. Again, the numbers of Asian chum salmon in mid-ocean appear to far outnumber those from North America.

The results of racial studies provide two important answers related to problems of the Protocol. First, information on the extent of mixing of the salmon on the high seas is further strengthened. The east-west extent of the mixing area is shown in figure 4. North American red salmon, the species of greatest concern, have been recognized by the Commission to predominate in catches as far west as 175° E; these red salmon originated in the Bristol Bay region.

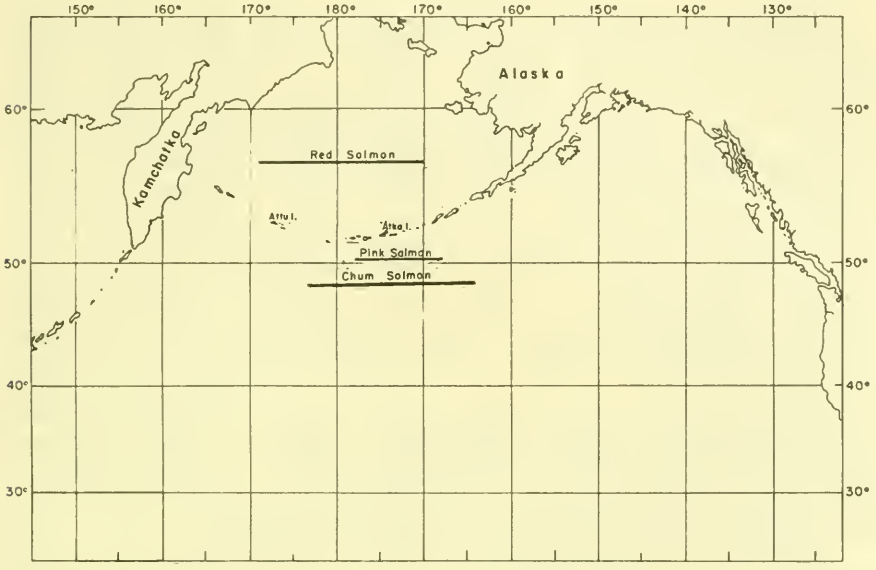

Figure 4.--East-west extent of high seas mixing between American and Asian salmon. The area observed was near the Aleutians. The bars indicate for each species the range of latitude over which American and Asian fish are commonly found in the same waters.

But the most important problem at this time is raised by the information on proportions of Bristol Bay red salmon found in various areas of the high seas (fig. 1). Even though the data presented here are only of the most general nature, the chart does show the extent of the Bristol Bay red salmon runs which migrate beyond the provisional line and are subject to capture by the Japanese fishery. This is the problem of the Protocol now before the Commission.

PACIFIC SALMON IN INTERNATIONAL WATERS[1]

Presented by
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Intensive research in the past several years has shown that the five species of Pacific salmon (genus *Oncorhynchus*) and steelhead trout (*Salmo gairdneri*) travel tremendous distances in their ocean migrations. American salmon travel so far west, and Asian salmon so far east, that stocks from both continents are found mixed throughout a large part of the central North Pacific Ocean and Bering Sea. Some king or chinook salmon (*O. tshawytscha*) born in the gravels of the Salmon River in the State of Idaho range at least as far as the central Aleutian Islands before maturing and returning again 2,500 miles to ascend the Columbia River enroute home. Occasional red or sockeye salmon (*O. nerka*) from lakes in British Columbia swim westward at least to 177° E. longitude, well over halfway to Asia, in their ocean travels. Chum salmon (*O. keta*) from southeastern Alaska may make a round trip of 3,500 miles to the central Aleutians in their quest for food at sea. Steelhead trout from rivers of the State of Washington and Oregon also may wander at least to the central Aleutians in their seaward journeys.

Likewise chum salmon and pink salmon (*O. gorbuscha*) from many Asian spawning areas are found feeding along the Aleutian chain as far eastward as the Alaska Peninsula, a distance of 1,000 to 1,500 miles from their natal streams. Chums in the rich ocean feeding areas at the base of the Alaska Peninsula often are a mixture originating from such diverse spawning grounds as the Anadyr River in the Siberian Arctic, various rivers tributary to the Sea of Okhotsk, streams on the island of Hokkaido, Japan, and, as already mentioned, streams in many parts of Alaska. Silver or coho salmon (*O. kisutch*) from east Kamchatka range seaward to the central Aleutians (175° W.) a distance of at least 1,000 miles.

High-seas salmon tagging has been conducted since 1955 by the Fisheries Research Institute of the College of Fisheries of the University of Washington under contract to the United States Bureau of Commercial Fisheries. Tagging is also being done on a smaller scale by the Canadian and Japanese sections of the Commission, and the three programs have been integrated as far as practicable.

Tagging salmon on the high seas has proved much more difficult than tagging in coastal areas. Large specially-designed

[1] Prepared by Allan C. Hartt, Fishery Research Institute, University of Washington for presentation at the North American Wildlife Conference, Dallas, Texas, March 7-9, 1960.

purse seines were developed for capturing salmon in the open sea in good condition for tagging. Brailing nets and holding tanks were designed for handling salmon with minimum injury. Experiments were needed to find tags that would give maximum returns after 1 or 2 years on rapidly-growing fish. Identification of the several species of salmon, not normally a problem in coastal areas where fish are mature, was a problem at sea. Catches often included all five species and many age groups. Rapid identification of the younger fish sometimes only 8 to 10 inches long required practice. Scale samples were taken from all fish tagged for later positive identification. A total of 48,296 salmon and steelhead have been tagged over the 5 years, and 1,128 have been returned to date. The overall rate of return (2.3 percent) is based on all salmon tagged, including immatures, which of course yield fewer returns than matures. Returns of mature salmon, those destined to spawn in the year of tagging, average nearly 10 percent. Immatures may spawn 1, 2, or 3 years later, and some of those still at liberty will be recovered in 1960 and 1961. Returns from central Pacific experiments have come from Japan, the U.S.S.R., Alaska, Canada, Washington, Oregon, and Idaho, and from the Japanese high seas gill net fishery in the North Pacific Ocean and Bering Sea.

Each year, results of tagging have disclosed new and valuable data on ocean habits and movements of salmon. The abundance and migration patterns of the several species have been found to vary tremendously from year to year, so that continued observations are needed to answer fully the questions implicit in the North Pacific Treaty.

A summary of results to date for all species is presented in figures 5 to 8. Tagging areas are shown by circles, and recovery locations by arrowheads. The thickness of lines indicates approximate relative numbers of fish to a given destination. Lines are not intended to show exact routes, but are drawn diagrammatically for simplicity. Fish are shown moving westward prior to going through Aleutian passes because purse-seine catches indicated a positive westward movement through tagging areas south of the Aleutians. In evaluating the four figures, it must be borne in mind that most tagging was in the areas along the Aleutians from 160° West to 170° East longitude. Mature salmon, of course, are recovered only in the year of tagging, while immatures are recovered 1 or 2 years later (except for some few immatures which were taken by the Japanese high seas gear in the year of tagging). Since tagging was conducted at numerous locations each year from May to September, returns may be considered representative of summer stocks in the Aleutian area.

Red salmon returns (fig. 5) indicate the overwhelming predominance of American red salmon along the entire Aleutian Chain in the North Pacific and Bering Sea. A total of 215 was returned from Bristol Bay, but only one from Asia. The destingation of a few others is uncertain. The

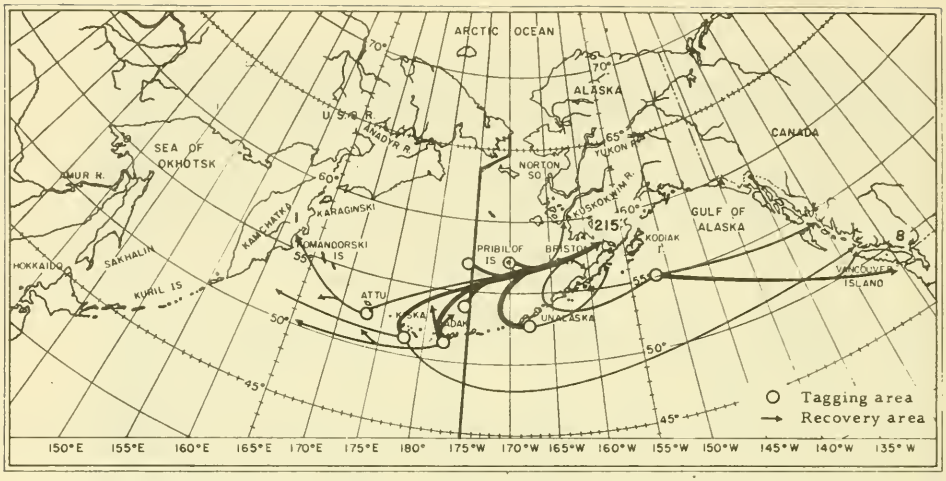

Figure 5.--Generalized distribution pattern of tag returns from red salmon tagged at sea from 1956 to 1959.

distribution of returns is in keeping with what we know about relative production in Asia and America; red salmon production in Bristol Bay alone is probably greater than that of Asia.

Chum salmon (fig. 6) show quite a different picture, for those tagged in the Aleutians yielded 146 returns from Asia, and 52 from Alaska. Nearly all Alaskan returns were from releases in the eastern Aleutians. Again results are in harmony with relative production in the pertinent recovery areas; Asian chum salmon production is much greater than that of northwest Alaska. Alaskan chums are present at least to 177° West. The lone return to southeast Alaska indicates that few chums from this source travel as far as the central Aleutians.

Pink salmon returns (fig. 7) show a still different picture. It should be noted here that pink salmon have a very uniform 2-year life history, and in many areas throughout their range, runs have a pronounced cyclic abundance in odd or even years. In odd years (1957 and 1959), pinks were abundant in the Aleutian tagging areas, and tag returns came only from east Kamchatka or were intercepted at intermediate points on the high seas by the Japanese fleet. (In 1955, tagging consisted of small-scale preliminary experiments only as far west as Kodiak Island.) In even years (1956 and 1958), pinks were present in relatively small numbers, but all coastal returns were from Alaska. Those taken on the high seas, as shown, had an uncertain destination, but it is noteworthy that runs to east Kamchatka were large in 1957 and 1959, and small in 1956 and 1958. Although other Asian production areas (west Kamchatka, for example) have very large runs in even and odd years, these areas have yielded no pink salmon returns to date. East Kamchatkan pink runs are many times larger than those to northwest Alaska, at least in odd years. The few pinks tagged in the Gulf of Alaska

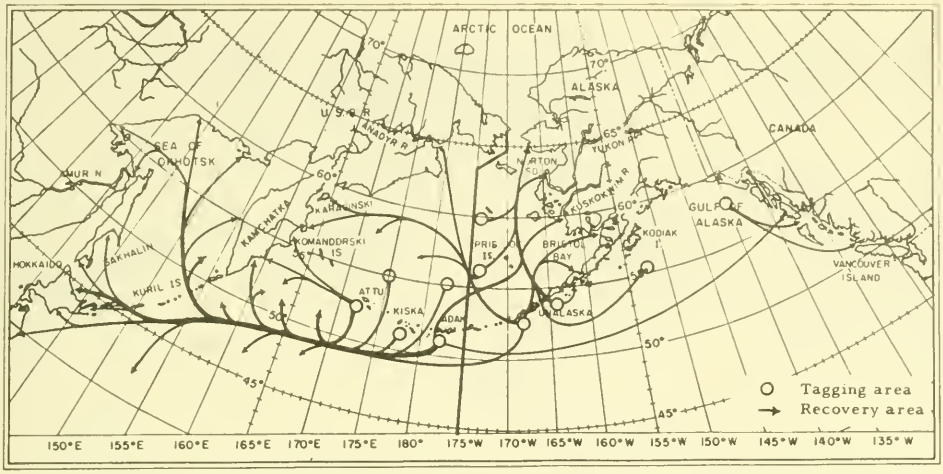

Figure 6.--Generalized distribution pattern of tag returns from chum salmon tagged at sea from 1956 to 1959.

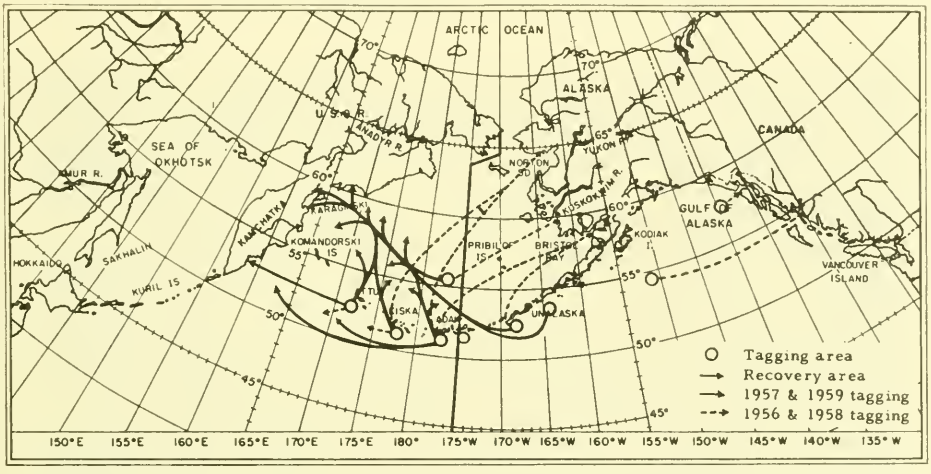

Figure 7.--Generalized distribution pattern of tag returns from pink salmon tagged at sea from 1956 to 1959.

indicate that some of this species cross the Gulf from southeastern Alaska.

Results of tagging king and silver salmon and steelhead trout, as mentioned previously, have demonstrated that these species travel spectacular distances at sea, but numbers tagged and recovered have been too small for conclusions as to relative importance of Asian and American stocks in the areas of intermingling. In figure 8 each arrow indicates only one tag return. To date, returns of kings and steelhead have come only from America, but silvers have come from both continents. American production of kings and steelhead is far greater than Asian.

Thus, tagging to date has shown a mixture of American and Asian salmon in ocean areas fished by the Japanese

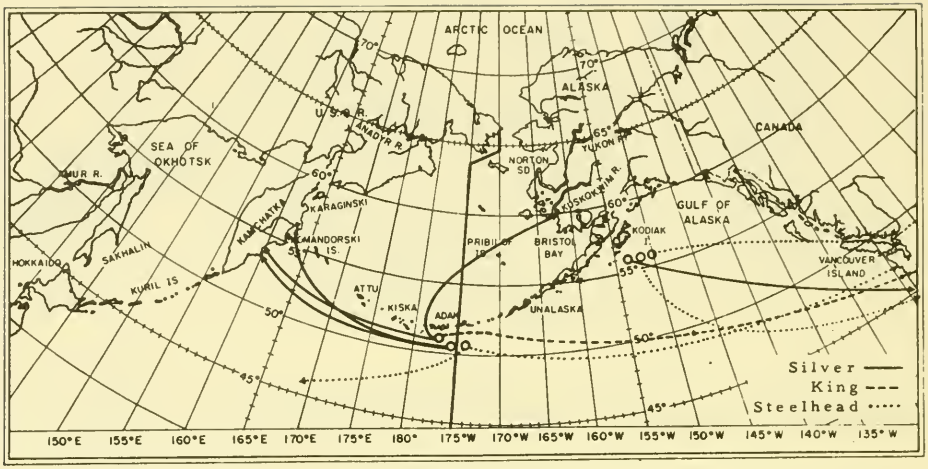

Figure 8.--Generalized distribution pattern of tag returns from king and silver salmon and steelhead trout tagged at sea from 1956 to 1959.

high seas fleet. Red salmon are overwhelmingly American (Bristol Bay) across the full length of the Aleutians. Chums are a mixture, and Asian fish probably predominate in areas west of 170° West longitude. Pinks are abundant and overwhelmingly Asian in odd years, whereas in even years this species is scarce, but principally American in origin.

The problem of boundaries of distribution of Asian and American salmon is thus made more complex by the dissimilar distribution of the several species. These distributions can be expected to vary annually in accordance with relative abundance and perhaps according to varying migration patterns, oceanographic conditions, and the like.

Canadian and United States regulations prohibit all salmon fishing, except some trolling, on the high seas. This permits much more effective regulation since intensity of fishing upon runs to individual rivers may be regulated according to size of runs. Depleted stocks may be protected, and healthy runs fished more. High seas harvesting permits no such individual controls and also takes many immature salmon.

This paper presents a brief outline of results to date of one phase of a large research program on Pacific salmon at sea. In addition to providing data for the purposes of the International North Pacific Fisheries Commission, the research is providing a wealth of new information on the ocean biology of salmon. The saltwater life-history of salmon and steelhead is proving no less remarkable than their much-studied yet little-understood freshwater life-history.

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