PACIFIC MARINE FISHERIES COMMISSION

Bulletin 1

HISTORY AND DEVELOPMENT OF THE COMMISSION

COORDINATED PLANS FOR THE MANAGEMENT

OF THE

FISHERIES OF THE PACIFIC COAST

BY

THE RESEARCH STAFFS OF
CALIFORNIA, OREGON, WASHINGTON

Portland, Oregon
1948

COMMISSIONERS

PACIFIC MARINE FISHERIES COMMISSION

The commissioners, left to right, are: ROBERT L. JONES, Oregon; EARL H. HILL, Oregon; RICHARD S. CROKER, California; John C. VEATCH, Oregon; EUGENE D. BENNETT, California; MILO MOORE, Washington. Absent from picture: Senator JESSE M. MAYO, California.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

HISTORY AND DEVELOPMENT OF THE COMMISSION

The people of the North American continent have been fortunate and privileged beyond all other mankind in their enjoyment of the bountiful resources and conditions made available to them by nature. The civilization of America could not have expanded and prospered as it has without the wonderful fertility of its soil, streams, lakes, and marine waterways; the vast mineral wealth; the immense forests; and ideal climatic conditions.

One of the first natural resources to be utilized by the early European settlers was the fish, which were abundant in both salt and fresh water. Early records show that fish harvested from these waters were an important source of highly nutritious food for those pioneers.

The first Congress of the United States recognized the importance of this valuable resource to the wealth of the nation. After several years of continual negotiations with the maritime countries of Europe, a treaty was negotiated giving some protection to American fishermen operating off our coast line and in the vicinity of the Newfoundland Banks.

Upon the formation of our Federal Government certain powers were delegated to the new central authority and certain other powers were retained by the original thirteen states. Among the latter, each state reserved the right to control and manage its fishery resources. The Federal Government was given control in all territories and possessions, but as each new state was admitted to the Union the state assumed control of the fish and wildlife within its boundaries.

Because of this arrangement certain difficulties have arisen from time to time making proper management of our fishery resources a bit complex. These fishery rights are highly prized by the citizens of our coastal states, and they have been very loath about relinquishing any of this power to the Federal Government.

However, certain of these fisheries were being exploited by our own people and by citizens of other countries as well. In order to bring about a proper management plan for these particular fisheries, the states have, by virtue of Congressional acts, conceded limited authority and controls to International Commissions. The two best illustrations are on the Pacific Coast where we have the International Fisheries Commission regulating the halibut fishery of the Northeast Pacific Ocean and the International Pacific Salmon Fisheries Commission controlling the sockeye salmon fishery of the Fraser River. Both of these fisheries are being exploited by the citizens of Canada and the United States. These two commissions have had considerable initial success in their conservation and management programs.

Along our vast coastal areas are found many fisheries that overlap state boundaries and are, therefore, participated in by the citizens of two or more states. Proper management and uniformity of regulation have been a difficult problem. The states bordering the Atlantic seaboard recognized this problem and created, in 1942, the Atlantic States Marine Fisheries Commission. Since its inception, steady progress has been made toward the coordinated management of the Atlantic Coast fisheries.

As early as 1945 an attempt was made in Washington to provide by law some form of control for offshore fishery operations on the Pacific Coast for species other than halibut and sockeye salmon. On February 25 of that year, Senate Joint Memorial No. 8 was submitted to the Washington State Legislature. This memorial was, in effect, a resolution surrendering all interests that the State of Washington might have in offshore fisheries to the two present International Fish Commissions or to a third commission which would be created for the regulation of all the Pacific Coast offshore fisheries. This resolution was opposed and defeated when the administration of fisheries for the State of Washington expressed the belief that such an agency should be composed of members who also have the responsibility of managing the fisheries within the three Pacific Coast states.

Shortly thereafter, in September, 1945, the President of the United States issued a proclamation relating to the policy of this country with respect to our coastal fisheries in certain areas of the high seas. In addition an executive order was signed by President Truman providing for the establishment of fishery conservation zones.

Sparked by the action taken in Washington, members of the commercial fisheries departments of the three states held a meeting in Portland, Oregon, in December of 1945 to discuss the feasibility of forming a Pacific Marine Fisheries Commission. After a preliminary discussion of the aims and purposes, it was decided to exert every effort toward a speedy enactment of the necessary legislation to set up a Pacific Marine Fisheries Commission. Because of Canada's interest in coastwise fisheries problems, representatives were invited to attend the meeting. The delegates at this meeting, speaking for their respective agencies, were agreed that prompt action should be taken. The fishing industries of the Pacific Coast states, likewise interested in coastwise conservation and management of the fishery resources, gave added impetus to the formation of such a commission. A general outline of the plan was prepared and definite steps were taken for the drafting of a compact by the legal authorities of the three states.

On the Pacific Coast, one of the motivating forces in the creation of the Pacific Marine Fisheries Compact was the Council of State Governments through its Commission on Interstate Cooperation. Members of this commission from the three Pacific Coast states were asked to discuss the subject of a Pacific Marine Fisheries compact at the Commission's meeting at Salt Lake City, Utah, in February, 1946. The reaction of this group was very favorable and as a result the following resolution was adopted:

> *Whereas*, the conservation of Pacific offshore fisheries is the responsibility of each of the three states bordering the Pacific, namely, California, Oregon, and Washington; and
>
> *Whereas*, interstate cooperation is evidently necessary to agree upon uniform regulations to conserve the fisheries and for the uniform application of regulations, and of research relating to the fisheries development;
>
> *Now, Therefore, Be It Resolved* that each of the interested Commissions on Interstate Cooperation, namely, California, Oregon, and Washington, appoint two of their members to a committee to prepare immediately to develop means of such interstate cooperation to carry out the above responsibility, and that this committee, from among the membership of the three state Commissions on Interstate Cooperation, select one person to act as chairman of the committee;
>
> *And, Be It Further Resolved* that each state provide technical assistance to the committee;
>
> And be it recommended that in the event international treaties may become necessary the interested states must be concerned in their formulation from the time of their initiation.

The members of the committee appointed from the three states were as follows:

Washington:
H. N. Jackson, State Senator
Smith Troy, Attorney General

Oregon:
P. J. Stadelman, State Senator
Carl H. Francis, State Representative
George K. Aiken, State Budget Director, Chairman

California:
Warren T. Hannum, Director, Dept. Natural Resources
Harrison W. Call, State Assemblyman

The first meeting of the committee was held in Portland, Oregon, on April 19, 1946. After a discussion of matters relating to the compact, drafts of a tri-state compact, a state enabling act, and a bill to provide consent by Congress were read with a view for further consideration at the next meeting.

A second meeting was held in Portland on June 19, 1946, and the third meeting at the same place on August 13, 1946. The proposed tri-state compact was analyzed, discussed and revised at these meetings and finally adopted by the committee on offshore fisheries at their meeting in San Francisco, November 20, 1946.

The Compact was adopted in San Francisco at the Western Legislative Conference of the Council of State Governments on November 21, 1946.

The Compact provides for the establishment of a Pacific Marine Fisheries Commission composed of such representatives from each state joining the Compact in accordance with the statutes which

the respective states may adopt. It was modeled to some extent after that approved by Congress for the Atlantic Marine Fisheries Commission.

This Commission has no regulatory powers. It is essentially an investigating and research body with authority to submit specific recommendations to the respective states for adoption by the legislature or state agency having authority to act.

The Compact was enacted by California, Oregon, and Washington in their 1947 legislative sessions. The objectives of the compact and the duties of the Commission are well described in the compact itself as follows:

A COMPACT

Entered into by and between the States Signatory hereto, with the consent of the Congress of the United States of America by an Act approved July 24, 1947, granting the consent and approval of the Congress to an interstate compact relating to the better utilization of the fisheries, marine, shell and anadromous, of the Pacific Coast, and creating the Pacific Marine Fisheries Commission.

The contracting states do hereby agree as follows:

ARTICLE I

The purposes of this compact are and shall be to promote the better utilization of fisheries, marine, shell and anadromous, which are of mutual concern, and to develop a joint program of protection and prevention of physical waste of such fisheries in all of those areas of the Pacific Ocean over which the states of California, Oregon and Washington jointly or separately now have or may hereafter acquire jurisdiction.

Nothing herein contained shall be construed so as to authorize the aforesaid states or any of them to limit the production of fish or fish products for the purpose of establishing or fixing the prices thereof or creating and perpetuating a monopoly.

ARTICLE II

This agreement shall become operative immediately as to those states executing it whenever two or more of the states of California, Oregon and Washington have executed it in the form that is in accordance with the laws of the executing state and the Congress has given its consent.

ARTICLE III

Each state joining herein shall appoint, as determined by state statutes, one or more representatives to a Commission hereby constituted and designated as the Pacific Marine Fisheries Commission, of whom one shall be the administrative or other officer of the agency of such state charged with the conservation of the fisheries resources to which this compact pertains. This Commission shall be invested with the powers and duties set forth herein.

The term of each commissioner of the Pacific Marine Fisheries Commission shall be four years. A commissioner shall hold office until his successor shall be appointed and qualified but such successor's term shall expire four years from legal date of expiration of the term of his predecessor. Vacancies occurring in the office of such commissioner from any reason or cause shall be filled for the unexpired term, or a commissioner may be removed from office, as provided by the statutes of the state concerned. Each commissioner may delegate in writing from time to time, to a deputy, the power to be present and participate, including voting as his representative or substitute, at any meeting of or hearing by or other proceeding of the Commission.

Voting powers under this compact shall be limited to one vote for each state regardless of the number of representatives.

ARTICLE IV

The duty of the said Commission shall be to make inquiry and ascertain from time to time such methods, practices, circumstances and conditions as may be disclosed for bringing about the conservation and the prevention of the depletion and physical waste of the fisheries, marine, shell and anadromous, in all of those areas of the Pacific Ocean over which the states of California, Oregon and Washington jointly or separately now have or may hereafter acquire jurisdiction. The Commission shall have power to recommend the coordination of the exercise of the police powers of the several states within their respective jurisdictions and said conservation zones to promote the preservation of those fisheries and their protection against over-fishing, waste, depletion or any abuse whatsoever and to assure a continuing yield from the fisheries resources of the signatory parties hereto.

To that end the Commission shall draft and, after consultation with the Advisory Committee hereinafter authorized, recommend to the governors and legislative branches of the various signatory states

hereto legislation dealing with the conservation of the marine, shell and anadromous fisheries in all of those areas of the Pacific Ocean over which the states of California, Oregon and Washington jointly or separately now have or may hereafter acquire jurisdiction. The Commission shall, more than one month prior to any regular meeting of the legislative branch in any state signatory hereto, present to the governor of such state its recommendations relating to enactments by the legislative branch of that state in furthering the intents and purposes of this compact.

The Commission shall consult with and advise the pertinent administrative agencies in the signatory states with regard to problems connected with the fisheries and recommend the adoption of such regulations as it deems advisable and which lie within the jurisdiction of such agencies.

The Commission shall have power to recommend to the states signatory hereto the stocking of the waters of such states with marine, shell or anadromous fish and fish eggs or joint stocking by some or all of such states and when two or more of the said states shall jointly stock waters the Commission shall act as the coordinating agency for such stocking.

ARTICLE V

The Commission shall elect from its number a chairman and a vice chairman and shall appoint and at its pleasure remove or discharge such officers and employees as may be required to carry the provisions of this compact into effect and shall fix and determine their duties, qualifications and compensation. Said Commission shall adopt rules and regulations for the conduct of its business. It may establish and maintain one or more offices for the transaction of its business and may meet at any time or place within the territorial limits of the signatory states but must meet at least once a year.

ARTICLE VI

No action shall be taken by the Commission except by the affirmative vote of a majority of the whole number of compacting states represented at any meeting. No recommendation shall be made by the Commission in regard to any species of fish except by the vote of a majority of the compacting states which have an interest in such species.

ARTICLE VII

The fisheries research agencies of the signatory states shall act in collaboration as the official research agency of the Pacific Marine Fisheries Commission.

An Advisory Committee to be representative of the commercial fishermen, commercial fishing industry and such other interests of each state as the Commission deems advisable shall be established by the Commission as soon as practicable for the purpose of advising the Commission upon such recommendations as it may desire to make.

ARTICLE VIII

Nothing in this compact shall be construed to limit the powers of any state or to repeal or prevent the enactment of any legislation or the enforcement of any requirement by any state imposing additional conditions and restrictions to conserve its fisheries.

ARTICLE IX

Continued absence of representation or of any representative on the Commission from any state party hereto, shall be brought to the attention of the governor thereof.

ARTICLE X

The states agree to make available annual funds for the support of the Commission in proportion to primary market value of the products of their fisheries as recorded in the latest published reports (five year average), provided no state shall contribute less than two thousand dollars per annum and the annual contribution of each state above the minimum shall be figured to the nearest one hundred dollars.

The compacting states agree to make available initially the annual amounts scheduled below, which amounts are calculated in the manner set forth herein, on the basis of the latest five year catch records. Subsequent budgets shall be recommended by a majority of the Commission and the total amount thereof allocated equitably among the states in accordance with the above formula.

SCHEDULE OF INITIAL ANNUAL STATE CONTRIBUTIONS

California	$11,000
Oregon	$ 2,000
Washington	$ 2,000
Total	$15,000

ARTICLE XI

This compact shall continue in force and remain binding upon each state until renounced by it. Renunciation of this compact must be preceded by sending six months' notice in writing of intention to withdraw from the compact to the other parties hereto.

The Washington enabling act provides that the Director of Fisheries ex officio, shall be that state's representative on the Commission. The Oregon statute provides that the Fish Commission shall represent that state on the Commission. The California statute provides for three commissioners as follows:

> ". . . there shall be three members, hereinafter called commissioners, of the Pacific Marine Fisheries Commission, hereinafter called the commission, from the State of California, appointed by the Governor by and with the advice and consent of the Senate. One such commissioner shall be administrative or other officer of the department or agency of this State charged with the conservation of its marine fisheries resources; another commissioner shall be a member of the Legislature of this State who is a member of a committee on interstate cooperation of the said Legislature, and another member shall be a citizen of this State who shall have wide knowledge of and interest in the marine fisheries problem. The term of each commissioner shall be four years . . ."

The California statute also provides that "Participation of this state in such compact shall terminate upon January 1, 1950, unless prior to that time continued participation shall have been authorized by law."

House Resolution 3598, approving and consenting to the Compact was introduced into Congress by the Honorable John J. Allen, Jr., representative from the 7th Congressional District of California. The House added a proviso which would have changed the compact to the extent of providing for greater participation by the United States Fish and Wildlife Service; but this provision was deleted by the Senate. This resolution as originally submitted became Public Law 232 by action of the 80th Congress and was signed by the President July 24, 1947, and the Compact was duly signed by the governors of the three states.

An organizational meeting was held in Portland in November, 1947, with the following commissioners present:

California:
Eugene D. Bennett, Attorney-at-Law
Richard S. Croker, Chief, Bureau of Marine Fisheries
Jesse M. Mayo, State Senator

Oregon:
Earl H. Hill, Member Oregon Fish Commission
Robert L. Jones, Member Oregon Fish Commission
John C. Veatch, Member Oregon Fish Commission

Washington:
Milo Moore, Director Department of Fisheries

The following officers were selected to serve until December 31, 1948:
John C. Veatch, Chairman
Richard S. Croker, Vice-Chairman
Milo Moore, Secretary
H. F. Linse (Oregon Fish Commission), Treasurer
Arnie J. Suomela (Oregon Fish Commission), Executive Officer

Minor routine business was conducted and a committee appointed to formulate rules and regulations for the conduct of business. It was also decided to appoint an official advisory committee of fifteen, with five members from each state.

The second official meeting was held at Portland in January, 1948. At this meeting, a set of rules and regulations for the conduct of business was adopted as follows:

I.

The Pacific Marine Fisheries Commission is constituted pursuant to an act of Congress approving an interstate compact relating to the better utilization of the fisheries (marine, shell, anadromous) of the Pacific Coast, and ratified by the states of California, Oregon, and Washington.

II.

Membership shall be composed of three members from California, appointed by the Governor; three members from Oregon, who shall be members of the Oregon Fish Commission, and one member from Washington, who shall be the Director of Fisheries, said membership being designated by the laws of the signatory states.

III.

Voting powers shall be limited to one vote for each state regardless of the number of representatives.

IV.

The Commission may establish one or more offices for the transaction of its business.

V.

The officers of the Commission shall be a chairman, vice-chairman, secretary and treasurer, and such other officers as the Commission may appoint. The chairman and vice-chairman must be members of the Commission. The chairman shall be elected for a term of one year. The chairmanship shall rotate annually among the three states.

VI.

Duties of Chairman: The chairman shall preside at all meetings of the Commission. It shall be his duty to see that all orders and resolutions of the Commission are carried into effect. He shall have general supervision and direction of the other officers or appointees of the Commission and shall see that their duties are properly performed. He shall sign all contracts and other instruments of writing which shall have first been approved by the Commission, and shall countersign checks drawn by the treasurer.

VII.

Duties of Vice-Chairman: The vice-chairman shall be vested with all the powers and shall perform all the duties of the chairman in the absence or disability of the latter.

VIII.

Duties of Secretary: The secretary shall record all the proceedings of the meetings of the Commission and shall perform such other duties as may be assigned to him by the Commission or the chairman. He shall give, or cause to be given, notice of all meetings of the Commission.

IX.

Duties of Treasurer: The treasurer shall have custody of the funds of the Commission and shall deposit same in such bank or banks as may be designated by the Commission. He shall keep full and accurate accounts of receipts and disbursements. Funds shall be paid out only by check signed by the treasurer and countersigned by the chairman.

Time and Place of Meetings: At least one meeting shall be held every six months at a time and place designated at the preceding meeting, or at the call of the chairman.

XI.

Annual Reports: The Commission shall make annual reports and recommendations to the National Congress, and to the governor or legislatures of each of the three states on or before the date required by the laws of the respective federal and state governments.

XII.

All official Acts and/or policies recommended by the Commission must have the unanimous approval, by vote, of the Commission.

XIII.

Each Commissioner who is not also a state officer shall be paid $10.00 per day while on business of the Commission.

XIV.

All commissioners, employees, and others authorized to perform and performing services for the Commission shall receive reimbursement for their expenses not to exceed $10.00 per day plus transportation costs when away from their home station.

Claims for such expenses shall be submitted on the form prescribed and furnished by the Commission.

In case of travel by private vehicle, mileage shall be allowed at the rate of six (6c) cents per mile.

XV.

The Chairman may determine the necessity for hiring temporary employees in case of emergency to carry out the work of the Commission, and prescribe the rate of compensation therefor not to exceed a total sum of $500.00 unless otherwise authorized by the Commission.

XVI.

Copies of all important letters, reports, correspondence and data will be mailed by the Chairman or the Secretary to each of the Commissioners.

XVII.

Advisory Committee of five from each state shall be appointed by the Commission and vacancies filled as may be required upon the recommendation of the Commission members of each state. At least once each year the Commission shall hold a meeting with the advisory committee selected and discuss the proposed recommendations with said committee according to Article VII of the Compact. Said advisory committee of each state shall be appointed and serve at the pleasure of the Commission.

XVIII.

These rules and regulations may be revised or amended by the Commission at any regularly called meeting of the Commission.

Also, the names of the five men appointed as the Oregon members of the Advisory Board of the Pacific Marine Fisheries Commission were announced. After disposal of general routine business, the offshore fisheries and objectives of the Commission were discussed. The result of this discussion was the issuance of instructions to the biological staffs of the three states to meet in San Francisco in the near future to prepare a report on the status of the offshore fisheries for presentation at the next meeting of the Commission.

At the next regular meeting held in San Francisco in April, 1948, the names of members appointed to the Advisory Board from Washington and California were announced. The members of this board appointed to date include:

California:
T. J. Guaragnella
William D. Kay
Montgomery Phister
Donald T. Saxby

*Oregon:
John A. Graham
Leonard H. Hall
Andrew J. Naterlin
Arthur Paquet
Anton Sorensen

Washington:
Chas. D. Alhadeff
Bert G. Johnston
Nick P. Kuljis
Harold E. Lokken
J. L. Welsh
Fred Buhrman (Alternate)

After disposal of routine business. The following report of the biological staffs was presented for discussion.

PACIFIC MARINE FISHERIES COMMISSION

John C. Veatch, Chairman
Richard S. Croker, Vice-Chairman
Milo Moore, Secretary
Eugene D. Bennett
Earl H. Hill
Robert L. Jones
Jesse M. Mayo

* The advisory board for Oregon was selected from a committee of fifteen, including one member of the Senate and two members of the House of Representatives, appointed by the Oregon Fish Commission for the purpose of consultation on fisheries problems.

COORDINATED PLANS FOR MANAGEMENT OF THE FISHERIES OF THE PACIFIC COAST

Prepared by the Research Departments of
California, Washington, and Oregon

INTRODUCTION

Biologists, representing the staffs of the three Pacific Coast States, met in San Francisco on February 17, 18 and 19, 1948, for the purpose of preparing a report of the status of the offshore fisheries resources along the Pacific insofar as available scientific information would permit. Biological knowledge was interchanged; existing and proposed programs of study were discussed; present regulations were compared; and programs of research for coastwise cooperation were drawn up and are herewith presented in order to fulfill the directives from the Commission. With a few notable exceptions, sufficient knowledge is not available to warrant a change in existing regulations. Programs were drawn up with two views in mind. First, a complete program is presented of the necessary magnitude to rapidly and efficiently arrive at a practical management plan encompassing all phases of the fisheries. (It will be noted that on several of the fisheries no program is recommended.) It is the intent of the group to present the Commission with a clear and concise picture of the actual magnitude of the fisheries problems and the effort necessary to properly implement a coordinated plan of conservation. But, it is realized that for the present sufficient funds are not available to inaugurate large-scale studies of many of the fisheries. Second, the group recommended coordinated research studies on a much smaller scale possible with the present staffs and funds.

With certain of the fisheries—such as tuna—a greatly expanded program will be necessary if results are to be expected within a relatively short time. Unfortunately, most biological research of lasting value is based on relatively long periods of uninterrupted study.

It should be understood that the problem of properly regulating the harvest of any fisheries must be based on certain fundamental knowledge. It is necessary, when a coordinated conservation program for widely separate areas is considered, to not only thoroughly understand the interrelationships of the separate or contiguous fisheries, but to obtain basic knowledge necessary throughout the range of the fishery to properly regulate the yield. Before any fishery can be properly managed to obtain constantly the maximum yearly harvest, a number of fundamental concepts must be evaluated: 1) The life history of the fish including a knowledge of the growth, age, and maturity; 2) The habits of the fish, including the range of migration; 3) The effects of the existing fishery on the populations, which includes the loss due to fishing; and 4) The losses due to natural causes throughout the life of the fish. Woven into this pattern must be a knowledge of the rate of replacement by the young and the effects of environmental conditions such as ocean currents, foods, and temperatures on the migrations or availability of the fish. Many times levels of abundance most suitable from a scientific standpoint are not in harmony with the economic levels of harvest. Then, adjustments must be made to allow for the most economic utilization of the resource by diverting the catch into channels yielding the greatest benefit. Thus, it can be seen that for adequate control and fisheries conservation, considerable effort must be expended in order that management on a coastwise basis will be based on sound scientific information.

The various sections presented in this report were prepared by study groups of specialists from each state concerned in the research on these fisheries for their respective states. The report has been prepared in part by a large number of men stationed at widely separate parts of the coast, and it must be realized that the form and style of the sections vary to a considerable extent. For the purposes of acquainting the Commission with the fisheries problems, detailed analyses and specific data are omitted. The fisheries are discussed in general terms, including necessary statements to substantiate conclusions and recommendations. All fisheries are not inlcuded in the discussions. Problems of local importance alone are purposely omitted. Only those problems of concern to two or more of the three Pacific Coast states participating in the Compact were discussed and are reported. It is believed that all fisheries of important mutual concern are included.

SALMON FISHERIES

Introduction

The Pacific salmon fisheries extend from central California to Alaska and are the basis for the most valuable fishing industry on the west coast. The combined commercial catches of Washington, Oregon, and California are worth about 36 million dollars annually to the fishermen; this does not include the value to dependent businesses. The value of the sport fishery is difficult to assess but may be worth an additional nine million dollars.

Salmon create a complex research and management problem because every adult salmon is a product of both some stream and the ocean. It is evident, therefore, that the preservation of this important fishery depends upon the proper management of the salmon in both types of environment.

Landings

There are five species of salmon contributing to the catch: chinook (king), *Oncorhynchus tschawytacha;* silver (coho), *O. kisutch;* sockeye (blueback), *O. nerka;* pink (humpback), *O. gorbuscha;* and chum (dog), *O. keta.* All of these are taken by the "inside" (bay and river) fisheries while only the silvers and chinooks are taken by the ocean troll and the sport fishery to any degree.

Commercial Catches

Each state requires from the industry a record of each landing by boat or fisherman. This record includes the date and place of landing, poundage, and gear used to make the catch. From these records are determined the total catches for each state as shown in Tables 1, 2, and 3. The California landings started to decline after 1920. By 1939 they had reached an all-time low level of about two and three-quarter million pounds. Following 1939 they have increased until at present the landings are of equal magnitude of those of 1916-20, (Figure 1). In Washington and Oregon, while the fishery has more or less stabilized throughout the last twenty years, the trend of the catches is still downward.

Table 1. California Total Commercial Salmon Landings[1]
Calendar Year, Pounds

Year	Ocean	Sacramento-San Joaquin Rivers	Other Rivers[2]	Total California Commercial Catch
1916	5,592,216	3,450,787	1,896,591	10,939,594
1917	6,085,997	3,975,487	999,097	11,060,581
1918	5,933,346	5,938,029	1,221,813	13,093,188
1919	7,208,382	4,529,222	1,408,123	13,145,727
1920	6,066,190	3,860,312	1,207,317	11,133,819
1921	4,483,105	2,511,127	996,700	7,990,932
1922	4,338,317	1,765,066	1,131,741	7,235,124
1923	3,736,924	2,243,945	1,109,391	7,090,260
1924	6,374,573	2,640,110	1,000,586	10,015,269
1925	5,481,536	2,778,846	1,265,371	9,525,753
1926	3,863,677	1,261,776	958,626	6,084,079
1927	4,921,600	920,786	669,543	6,511,929
1928	3,444,306	553,777	480,483	4,478,566
1929	4,033,660	581,497	429,714	5,044,871
1930	4,085,650	1,213,698	703,546	6,002,894
1931	3,666,841	941,605	686,065	5,294,511
1932	2,649,194	1,264,987	703,990	4,618,171
1933	3,657,661	454,253	446,520	4,558,434
1934	3,921,530	397,572		4,319,102
1935	4,773,112	888,868		5,661,980
1936	4,093,475	949,179		5,042,654
1937	5,934,996	974,871		6,909,867
1938	2,170,921	1,668,376		3,839,297
1939	2,238,755	496,933	Closed to	2,735,688
1940	5,160,403	1,515,588	commercial	6,675,991
1941	2,945,994	844,963	fishery.	3,790,957
1942	4,063,272	2,552,944		6,616,216
1943	5,285,510	1,295,424		6,580,934
1944	7,021,848	3,265,143		10,286,991
1945	7,912,754	5,467,960		13,380,714
1946	7,134,472	6,524,991		13,659,463
1947	8,080,780	3,403,808		11,484,588

[1] The Commercial catch of California has not been separated into the two species present. Occasional samples and partial separation for a few areas are available for a few years. The recent samples indicate that the silver salmon constituted about nine percent by weight of the ocean catch in 1939–42. Silver salmon are not taken by the Sacramento-San Joaquin fishery.

[2] Smith, Klamath, Mad, and Eel Rivers.

TABLE 2. OREGON TOTAL COMMERCIAL LANDINGS
FISCAL YEAR, POUNDS

Date	Chinook	Silver	Sockeye	Chum
1929	10,979,116	6,868,500	356,303	2,426,171
1930	11,615,077	8,298,473	259,807	666,443
1931	13,515,243	4,933,832	106,124	1,717,228
1932	9,679,251	7,780,230	24,795	817,552
1933	12,186,821	4,948,143	83,188	1,235,043
1934	11,990,021	7,042,797	211,370	1,058,924
1935	12,239,967	13,243,891	38,012	1,202,640
1936	14,598,429	4,892,547	169,498	1,872,885
1937	15,929,555	7,165,342	246,066	1,568,386
1938	10,915,015	7,476,873	289,690	1,989,074
1939	11,115,953	7,352,382	199,020	1,249,801
1940	11,882,845	6,106,756	243,371	1,302,850
1941	18,785,169	4,351,277	348,461	4,587,521
1942	14,105,054	2,647,808	138,430	5,908,988
1943	9,584,515	1,870,816	115,625	940,247
1944	11,292,357	4,697,512	44,587	530,295
1945	11,333,574	4,975,854	5,766	1,166,662
1946	12,754,950	3,498,933	102,675	1,075,115
1947	14,933,422	4,239,537	547,011	727,021

TABLE 3. WASHINGTON TOTAL COMMERCIAL LANDINGS
CALENDAR YEAR, POUNDS

Date	Chinook	Silver	Sockeye	Chum	Pink
1935	11,001,443	16,639,528	4,667,709	8,428,755	33,491,709
1936	11,986,116	9,483,520	3,230,235	10,432,940	141,916
1937	12,670,583	9,145,837	6,594,800	9,755,057	29,245,541
1938	8,627,258	8,030,148	10,452,628	10,082,315	45,385
1939	9,360,000	10,897,955	3,979,385	4,395,302	23,384,353
1940	11,858,807	9,420,882	5,622,254	8,004,136	149,081
1941	13,690,358	10,172,652	12,446,253	11,883,161	11,620,796
1942	11,675,272	5,038,932	20,554,254	11,958,947	82,092
1943	9,351,996	7,126,012	1,763,208	5,664,102	5,594,399
1944	9,966,273	6,672,036	2,118,419	3,992,444	24,650
1945	10,967,943	10,065,078	4,651,110	5,226,518	33,894,732
1946	12,475,082	5,674,723	21,986,603	15,243,490	1,265

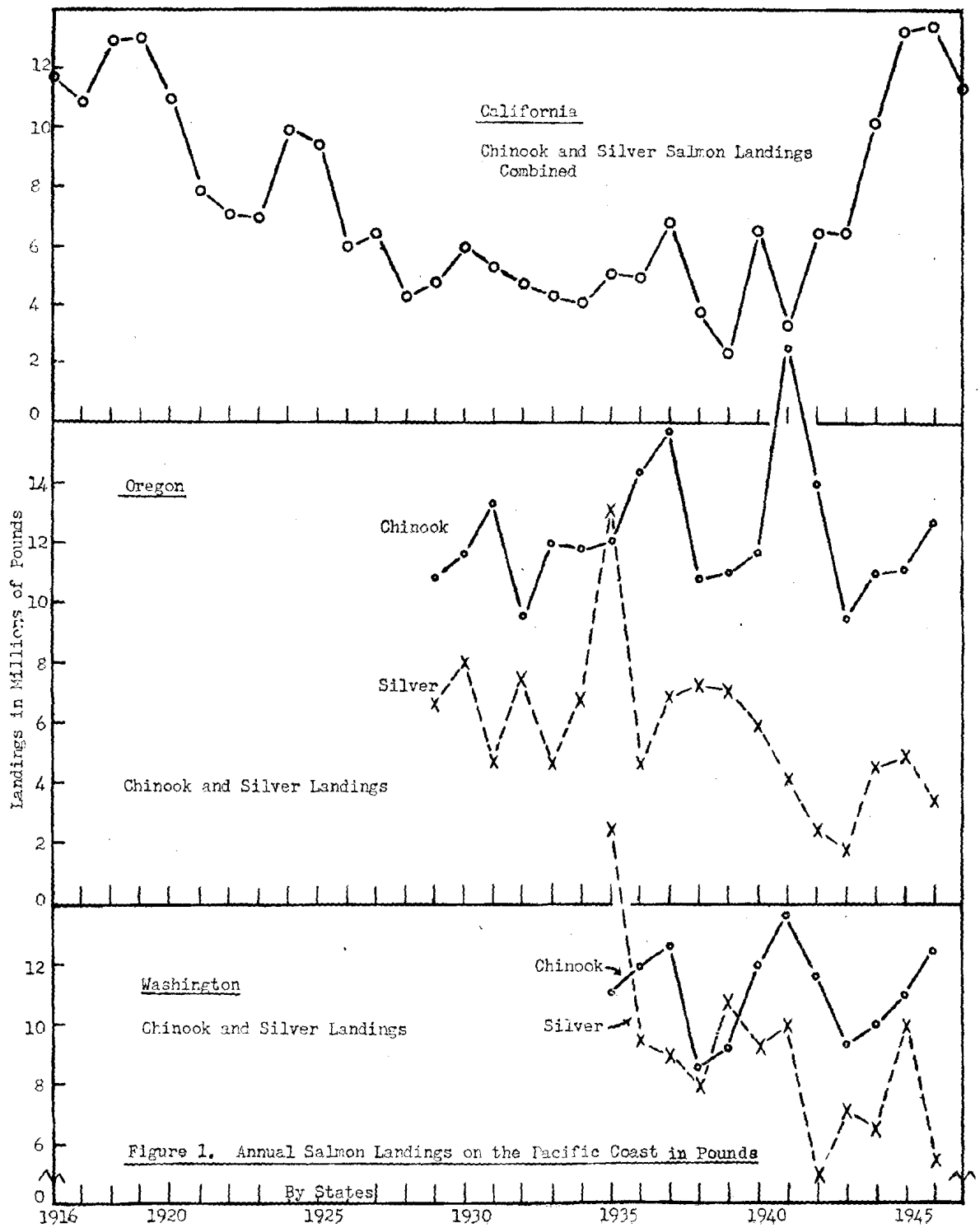


Figure 1. Annual Salmon Landings on the Pacific Coast in Pounds By States

For many years the salmon fishery along the Pacific Coast operated solely in inside waters by means of gillnets, seines, traps, etc. Following its inception around 1912, the offshore troll fishery has been expanded until in 1946 the trollers caught 33.4 per cent (by weight) of the total chinooks and silvers landed in the Pacific Coast states (Table 4). Inasmuch as the average size of troll fish is generally smaller than river fish the percentage of individual fish taken on troll is much higher.

From Table 4, it is seen that of the five species of salmon, only the chinooks and silvers are landed in all three states. Therefore, it is these species that are primarily of tri-state importance.

There are some problems arising from the sockeye and pink salmon fisheries between Washington and British Columbia. These sockeye problems are being studied by the International Pacific Salmon Fisheries Commission and the pink salmon problems by a cooperative investigation of Washington and British Columbia.

The Columbia River fishery is of great interest to both Washington and Oregon and joint studies of this fishery were begun in 1947. The states have concerned themselves primarily with the Indian fishery, statistical studies, investigation of the sport fishery, studies of the spawning grounds, and a tagging program with all its ramifications.

TABLE 4. INSIDE AND TROLL LANDINGS OF CHINOOK AND SILVERS—1946
POUNDS

	Inside Catch	Troll Catch	Total	Per cent Troll
Washington	13,301,430	4,760,869	18,062,299	26.4
Oregon	12,410,767	3,843,116	16,253,883	23.6
California	6,524,991	7,134,472	13,659,463	52.2
TOTAL	32,237,188	15,738,457	47,975,645	32.8

SPORT CATCH

The sport fishery for salmon has increased rapidly in recent years. In Table 5 is shown estimates of the sport catches in California from 1936 to 1946.

TABLE 5. ESTIMATED TOTAL SPORT CATCH OF SALMON IN CALIFORNIA
NUMBERS

	1936	1937	1938	1939	1941	1942	1943	1946
Catch	196,000	160,000	178,000	215,000	253,000	180,000	274,000	306,000

While the records for Washington and Oregon are not complete for this period of time, observations indicate that such an increase has occurred also in these states. Table 6 shows the estimate of the sport catches in each state for 1946 in numbers of fish.

TABLE 6. ESTIMATED SPORT CATCH IN NUMBERS OF SALMON, 1946

	Washington	Oregon	California[1]
Chinook	83,000	43,000	.....
Silver	142,000	21,000	.....
Total	225,000	64,000	306,000

[1] Not broken down by species.

One of the weaknesses in the array of factual material for the management of the salmon fishery consists of the absence of adequate statistics on the sport catch. The accuracy of the present estimate is problematical although it does indicate the general magnitude of the catches.

The present size of the sport catch as shown by the 1946 estimates and its potential magnitude as indicated by the trends of recent years makes it imperative that this fishery be incorporated into any management program developed for the conservation of the salmon. As part of such a

program, better methods must be devised to obtain more accurate and comprehensive estimates of the sport catch of salmon. Plans for such a program in California during 1948 are now being made. If it is carried out and proves feasible, it could be utilized by the other states.

Ocean Research

Very little study has been made of the ocean phase of the life history of the salmon. Preliminary tagging experiments have been carried out on the troll fishery by the State of California and by Canadian fisheries workers. These experiments indicate a mixing of fish from the different rivers in the ocean. Salmon tagged off California were caught in Oregon and Washington, and salmon tagged off British Columbia were caught as far south as the Sacramento River. Marked silvers released from hatcheries in Oregon were recovered in the troll fishery as far south as Crescent City.

Many of these experiments did not give any idea of the actual number of tagged fish that were caught or that entered the rivers. They do show, however, that salmon originating in one state migrate long distances in the ocean and are taken by the fishermen of all three states. Hence, what one state does to protect the salmon in its rivers is of great importance to the other two and, similarly, ocean management by one state may affect the runs in rivers of another state. The mortalities of salmon from natural causes at various ages and sizes are not known and consequently the best age and size for harvesting has not been determined. Well-directed, carefully planned studies of the salmon in the ocean will establish these facts which are necessary for the proper management of the ocean troll fisheries. The importance of knowledge relating to the migrations of salmon at sea is ably discussed in a symposium, "The Migration and Conservation of Salmon," The Science Press, 1939.

River Research

From the early days of the salmon industry on the coast, it was known that the salmon ascended the rivers to spawn. It is inconceivable that it was not realized that, unless enough adults spawned each year, the runs would decline. Yet no heed was taken. Fishermen took all the fish they could catch; dams were built which prevented the fish from reaching the spawning grounds; spawning areas were destroyed by mining and logging operations; and streams were dried up because of the diversion of water for irrigation and power generation. These developments and their effects on salmon runs proceeded gradually and the runs were in many cases reduced to very low levels before the dangers were realized.

Most of the research on salmon to date has dealt with the fresh water phases of its life history. There are many reasons for this. What happens to the salmon in a river is much more obvious than that which happens in the ocean. Salmon blocked by a dam, killed by pollution, or stranded in an irrgation ditch are seen and reported by many people while few people realize that the majority of the life of the salmon is spent in the ocean. Inasmuch as the major changes to the environment of the salmon have occurred in freshwater it is logical the early studies have been on the rivers. With the changes in environment in the ocean less recognizable it is likewise logical that consistent research work now be carried out at sea.

Much general knowledge has been gradually obtained which is applicable to the rehabilitation and management of salmon runs in all of the rivers. However, since conditions vary from river to river, specific problems must be studied by concentrated investigations of each. Salmon research in the rivers can roughly be divided into studies of: (1) the adult migration from sea to spawning grounds; (2) the fish on the spawning grounds; and (3) the migration of the young to the ocean.

ADULT MIGRATION

The objectives of this study are the determinations of the size of the runs entering the rivers, and the percentage successfully reaching the spawning areas. This information leads to measures which assure a sufficient seeding of the spawning beds. From recent experiments using tagged adult salmon in the rivers as a basis for estimating the size of the runs and the escapement, it appears that this method is an economical way of making such estimates. Certain technical difficulties and statistical problems of analyses must be corrected by experimental work, however, before the

method can be used universally. Results of such experiments as have been completed to date indicate that in some of the northern rivers only fifteen to thirty per cent of the runs entering the river reach the spawning grounds. There is evidence that the Sacramento-San Joaquin runs are under-utilized and can withstand a heavier fishery. It is pertinent here to mention that there is now before California voters a bill to eliminate all gillnetting in inland waters.[1] This would needlessly destroy California gillnet fishery and would reduce the value of the salmon industry. The Sacramento-San Joaquin runs are not in need of such ill-advised restriction, and, furthermore, the elimination of that group of the industry will reduce opposition to dams. The net result may be to increase the probability of the construction of dams and reduce the probability of construction of adequate fish protective devices.

Such factors as a heavy river fishery, pollution, and barriers such as dams and log jams reduce the escapement. Once such factors are detected, they are subject to correction. Some work along these lines has been done and the program is being continued at present. Antiquated river fishery regulations are gradually being revised as studies progress on the different rivers. Through programs of stream improvement, barriers are gradually being removed or fish ladders constructed over them. Much of this work is costly, so progress along these lines has been slow.

Spawning Ground Studies

In order to obtain the maximum production of salmon the spawning areas must be properly utilized. The amount of these areas available is one of the factors that determines at what levels of abundance the salmon runs can be maintained. Constant vigilance must be kept to prevent the further destruction of the limited remaining spawning grounds. On a few rivers additional spawning area is being made available by constructing fishways by which salmon can pass over natural falls into areas that were previously inaccessible. Experiments are now being conducted on the feasibility of transplanting runs into such areas or other areas in which the runs have been exterminated. However, the expansion of spawning area by this means is limited and such work has not kept pace with the present rate of destruction of spawning grounds.

A few experiments on some species of salmon indicate that there is an optimum number of spawners that each stream can accommodate. More than that number over-populates the spawning beds and the resultant production of young fish is reduced. Less than this number results in an under utilization of the spawning areas, producing also a reduced number of young fish. Surveys indicate that most of the spawning areas of our coastal rivers are under utilized although a few are in danger of over-population.

Downstream Migration

In order to perpetuate the runs, the adult salmon not only must reach the spawning grounds and spawn successfully but also the resulting young must reach the ocean and survive to maturity. Studies have revealed many obstacles to the safe downstream migration of young salmon. The age and size of young salmon at the time of downstream migration has been ascertained, in general, for the different species. The migrating habits may be summarized as follows:

Chinook—

Upper Columber River (Spring run)—migrate to sea in spring and summer of first year to spring of second year.

Columbia and tributaries (Fall run)—migrate to sea in spring of first year.

Willamette River (Spring run)—migrate to sea in spring of first year and winter and spring of second year. (Returning adults are largely from the latter group.)

Sacramento-San Joaquin (Spring and fall runs)—migrate to sea in spring of first year. Some springs in the spring of second year.

Silver—

All areas—migrate to sea in spring of second year.

Blueback—

All areas—migrate to sea in spring of second year. (There are a few exceptions.)

[1] Since writing this manuscript, the voters in a general election defeated the bill.

Chums—
All areas—migrate to sea in winter and spring of first year.

Pinks—
All areas—migrate to sea in winter and spring of first year.

With this information it has been possible in some areas to develop sport fishing regulations to protect these young fish, and to determine the proper time of release of the young fish from the hatcheries.

Artificial Propagation

Hatcheries have been used as an aid in the maintenance of salmon runs for many years. It was not, however, until recently that their efficiency was questioned. Various experiments have been and are being conducted on the efficiency of artificial propagation with the different species of salmon. These experiments are concerned with two questions. First, from equal numbers of eggs, which yields the greatest number of returning adults, artificial or natural propagation? Second, do hatcheries efficiently and economically produce adult salmon?

From what little work that has been completed on these problems, it appears that there is a considerable variation among species. It was found that the artificial propagation of sockeye salmon in British Columbia was only slightly more efficient than natural propagation. However, considering the cost of artificial propagation, hatcheries were not found to be economically feasible for supplanting natural propagation when good natural spawning grounds existed.[1]

A few experiments with silver salmon have shown that the value of returning hatchery-reared fish was many times greater than the cost of producing them. These experiments do not, however, demonstrate the relative value of natural and artificial propagation for this species.

The efficiency of hatchery propagation of chinook salmon is now being studied. Spring chinook salmon have been marked on the Willamette River in Oregon in 1946 and 1948 to assess the success of planting fish at various ages. Fall chinook will be similarly marked in 1948. Similar work is under way in the State of Washington. The Fish and Wildlife Service is likewise conducting large numbers of marking experiments on both the Columbia and Sacramento Rivers.

Hatcheries, at their present levels of efficiency, are with few exceptions only supplements to natural propagation. They serve also as a source of fish with which depleted streams may be restocked. At present, considerable research is being directed toward the improvement of hatchery techniques. It is realized that with the further reduction of available spawning grounds resulting from the building of high dams, hatcheries will have to replace natural spawning in many areas if the salmon runs are to be maintained.

Much is being accomplished in this field. Better diets are being formulated for young fish and substitutes are being found to take the place of the limited supply of foods being used at present. The proper times for the release of young fish into the rivers are being determined for the various species, and methods of treating diseases which are a menace in hatcheries are being developed. These studies are gradually increasing the efficiency of the hatcheries.

Problems Arising From the Multiple Uses of Water

With the continuing advance of industrialization and agriculture and the increase of population on the West Coast the problems arising from the various uses of water are becoming more and more acute. The major uses of water are as follows: domestic water supplies, irrigation, power, navigation, mining, waste disposal, fish life, and recreation. Involved in many of these uses is the related problem of flood control. The legal aspects of the problem from a fisheries standpoint are not clearly defined in any of the Pacific Coast States. Apparently fish have virtually no "rights" except in a few specific instances.

The major competition with salmon and other anadromous fishes for water arises from irrigation and power uses. Irrigation demand becomes severe in the early summer and continues into the fall.

[1] Foerster, R. E., An investigation of the life history and propagation of the sockeye salmon (*Oncorhynchus nerka*) at Cultus Lake, British Columbia, No. 1–5 (Canada Biol. Bd. contr. to Can. Bio. and Fish, n.s. V. 5, No. 1–3, 82 p.; V. 8, No. 27, p. 345–55; Jour., V. 2, No. 3, Toronto.)

Major losses to salmon occur through lessened stream flow, higher temperatures, and the diversion of downstream migrants into irrigation lateral canals. Losses have been severe from the latter cause on tributaries of the Columbia River east of the Cascade Mountains. Young salmon in the Central Valley of California usually migrate down into the main Sacramento and San Joaquin early in their first year before irrigation diversions take large quantities of water and, consequently, some losses are thereby prevented. Fish screens have been installed in numerous places in California and Washington and to a lesser extent in Oregon, but the overwhelming majority of diversions in all three states are either unscreened or not satisfactorily screened. Adequate supervision of the operation of screens has often been lacking and they have, consequently, often been ineffective. The extent of loss of young salmon that pass through power turbines is virtually unknown and may be severe in places. Because of the large flows and high velocities involved it has often been impossible to screen such channels with mechanical screens. California has been experimenting with electrical screens but has as yet failed to make this type of equipment do a satisfactory job of diverting downstream migrants.

The dams associated with flood control, power, and irrigation projects have eliminated much of the spawning areas available to salmon. For example, it has been estimated that seventy per cent of the original total stream mileage of the Columbia River watershed has been lost to anadromous fish as a result of dam construction. The majority of California dams requiring fishways are provided with them. There are many small dams and several large irrigations dams in Oregon lacking fishways entirely and many additional that do not have adequate ladders. Washington is faced with a similar situation. Many ladders are poorly designed and improperly operated. Corrective measures are being undertaken continually.

Mining problems are most acute in localized areas of Idaho and eastern Oregon and in the Central Valley of California. Gold dredging and pollution from copper mines appear to be most serious.

Use of streams as a vehicle for waste disposal has been associated with not only the mining mentioned above but also with a great variety of industries, canneries, and municipalities. An acute pollution problem exists in the Willamette Valley in Oregon and in the Central Valley of California. Steps are being taken to solve the problem in Oregon, and it should be considerably mitigated in the next decade.

At present there is a large federally-sponsored program under way in the Willamette Valley designed to provide flood control, irrigation, navigation, power, pollution dilution, recreation, and fish-life benefits. This program is, in many respects, new to the west coast and may set the pattern for future programs. It involves many high dams on the lower reaches of tributary salmon streams and there will be major changes in the run-off below such structures. High temperatures may be a serious problem, and the alteration of flows may adversely affect the upstream and downstream migration of salmon in the tributaries below and in the main rivers. Violent fluctuations of flow below the dams will be deleterious to fish life.

In general, if the presently proposed multiple-use water projects are carried to completion, the salmon resources of the three Pacific Coast states cannot be maintained at present levels unless considerably greater success is experienced in artificial propagation.

Commercial Fishery Regulations

Troll Fishery

The regulations for the ocean troll fisheries of the three states are shown in Table 7. These regulations are designed primarily to protect the small fish which have not passed their most rapid period of growth.

Table 7. Troll Fishery Regulations, Washington, Oregon, and California

	Minimum Total Length (inches)		Open Season	
	Chinook	Silver	Chinook	Silver
Washington	27	18	All year	July 1–Nov. 15
Oregon	27	None	All year	July 1–Nov. 15
California	25	25	April 1–Sept. 15	April 1–Sept. 15

The regulations for Washington and Oregon have just recently been adopted after a year's study of the seasonal changes in the sizes of the fish in the troll landings.[1] By prohibiting the landing of silvers before July 1, at which time they average about six pounds dressed (26 inches); no minimum size is necessary. The minimum size for silvers prescribed by Washington applies to the purse seine catches. The season for this fishery conforms with the troll season. The silvers do not start to leave the ocean until the latter part of August, so are yet available to the troll fishery after July 1. By that time they have almost doubled their April weight so the fishery profits by this additional growth by waiting until July to catch them. Practically all of the mature silvers have entered the rivers by November 1. Only small immature fish are available in the ocean in any quantities after that time.

With the chinooks, however, the problem is not as simple. Different races of chinooks leave the ocean to enter the rivers from early spring to late fall. Should seasons be set for chinooks, it would permit some races to escape the troll fishery entirely and throw the brunt of the fishery on the other races. (This may prove of value in affording protection to over-fished runs when their distribution in the ocean is more definitely established.) For the present, a 27-inch minimum size (7 pounds dressed) limit has been adopted in order to give the smaller fish a chance to grow before they are taken for the market.

California's troll regulations, although differing somewhat from those of Washington and Oregon, accomplish practically the same end. Some friction has developed in the fishing areas near the California-Oregon border through these differences in regulations. Immediate study should be made to determine the feasibility of adjusting these differences in that area. The present troll regulations can only be regarded as preliminary measures leading toward the proper management of the troll fisheries.

Inside Fishery

The inside fisheries have borne the brunt of conservation measures for the salmon runs in past years. Some of the regulations on these fisheries and chiefly those concerning river fisheries have been formulated with very little consideration of the basic principles of fisheries management. Other regulations have been honest attempts to preserve the salmon runs.

In Oregon salmon are permitted to be taken only by drift nets in the rivers south of the Columbia. (Setnets are permitted in the Tillamook area for chums.) The driftnet fishery is regulated by seasons, mesh-size limits, and dead-lines above which no fishing is permitted. Some rivers have been closed entirely to commercial fishing with disappointing results to the proponents of such measures. In the Columbia River salmon are taken by gillnets, dipnets, seines, and traps.[2] These are regulated by season and dead-lines. Purse seining for salmon is prohibited in Oregon.

Salmon are taken in Washington by purse seines, gillnets, reefnets and dipnets. The use of traps, beach seines, and setnets is illegal in Washington waters, including the Washington side of the Columbia River. Washington gear is regulated by seasons and areas. Both in Washington and Oregon there are Indian fisheries over which the states have only limited jurisdiction.

Commercial salmon fishing is illegal in California in all rivers except those of the Sacramento-San Joaquin systems. Fish may be taken in this area with driftnets only. This fishery is regulated by seasons, zones, and mesh-size limits.

Sport Fishery Regulations

Salmon sport fisheries in the three states are regulated chiefly by bag limits, seasons, and closed areas. The regulations vary from river to river depending upon the time and general abundance of the runs in each river. The take of young salmon is restricted by opening the fishing season after they have left the rivers and by minimum size regulations.

[1] Since this report was written, the Pacific Marine Fisheries Commission has recommended salmon troll regulations to the various states. Briefly, they include a 26 inch total length limit on chinook salmon; a March 15 to November 1 open season for chinooks; and a June 15 to November 1 open season for silver salmon.

[2] All fixed gear was eliminated as legal fishing gear on the Columbia River by an initiative passed by the voters of Oregon, November general election, 1948.

Washington

No more than six salmon over twelve inches of which only three may be over 24 inches can be possessed from any waters of the state now open to sport fishing.

Oregon

Only two salmon twenty inches in length or over may be taken in any one day. Only four such fish may be taken in any seven consecutive days or had in possession and not more than twenty such salmon in a year. Salmon under twenty inches are classified as jack salmon and the bag limit on these is ten in one day, but not more than twenty in possession.

California

Depending on the river or area fished, the bag limits are two to three salmon with no minimum size limits except in the bays and ocean where the minimum size is 25 inches.

Proposed Program

In order to develop a comprehensive management program for the salmon fisheries, existing knowledge of the life history of the salmon and the effects of the various fisheries on the runs must be supplemented by additional data.[1]

The greatest lack of data is that of the ocean life of the salmon. To obtain this information, an extensive coastwise program of research is necessary. This should encompass the waters off the three states and include British Columbia and possibly Alaska. Such a program to give good quantitative results should entail:

1. Tagging offshore of approximately 10,000 salmon per year. These should be distributed all along the coast and throughout the entire season.
2. A thorough coverage of all the sport and commercial fisheries along the coast, inside and outside, and spawning areas of all the rivers to assure, insofar as possible, a complete recovery of all tagged fish.
3. A log book system to be kept by trollers in order that measures of abundance, origin of the catches, and intensities of the fisheries may be determined.
4. Sampling of the troll landings along the coast to determine seasonal variations in sizes, age composition, and percentage of each species in the catch.
5. Marking of large numbers of young salmon before going to sea.

In addition to this but in conjunction with some of the above work the following should be undertaken:

1. Estimates on the size of the runs that enter the various rivers and the percentage escapement to the spawning areas.
2. Good estimates of the salmon sport catches from the ocean and each river.
3. Large scale stream improvements and improved conditions be maintained by continual engineering operations coordinated with adequate surveys of rivers and streams.
4. Better methods of evaluating sport and commercial fisheries and the fish populations be devised, perhaps under the direction of an economist, and made uniform along the Pacific Coast and consistent with other water-use values.
5. The legal status of fish life in inland waters be adequately determined and, where advisable, provision be made for reserving specific water flows for fish maintenance.

Much of this program would work in with some of the present research which is now being carried on and should be continued. Such a research program as outlined above would be rather expensive and should be carried on each year for a period of five years. Following that time, the

[1] For further discussion of proposed salmon investigations see: Van Cleve, R., "Program of the Bureau of Marine Fisheries", California Fish and Game, Vol. 31, No. 3, 1945.

scope of the program could be reduced but some studies of the fishery would have to be maintained as long as a management program is continued.

At present the research staffs of California, Oregon, and Washington are involved in studies of the rivers. A large portion of this work involves studies of the effects of the proposed multiple uses of the water on the salmon runs. Some of this work would have to be neglected should an offshore tagging program be undertaken without an increase in the present research personnel.

A limited program that can be initiated by the present staffs is contemplated. The research staffs of the three states plan to tag troll salmon at sea insofar as funds and manpower permit. Tagging of silvers prior to July first in Washington and Oregon waters should be economical, as that species cannot be landed during that period. Likewise, tagging of silvers under 25 inches (in California) and chinooks of under 25 inches (under 27 inches in Washington and Oregon) should be relatively inexpensive as these sizes may not be landed at any time. A good tagging program should, of course, involve tagging adults and not merely undersized fish. However, much good information can be gathered from even the limited operations possible this coming season. Useful information can be obtained regarding the following matters:

(1) The movements of silver and chinook salmon at sea.

(2) The river of origin of silver and chinook salmon found at various places in the sea during the season. (This will have limitations depending on the scope of the river studies.)

(3) The natural mortality of silver and chinook salmon at sea at various ages and sizes. This involves use of the analysis techniques of Michael Graham and W. F. Thompson which have been applied successfully on halibut, razor clams, and elsewhere, and will lead to more specific information regarding the optimum size and age to harvest salmon.

(4) Possibly the approximate numbers of salmon present in areas of the sea at various times. When related to the fishery this will provide information on fishing intensity.

(5) A better understanding of the troll fishery and the men and gear involved will accrue from work at sea. Inevitably this should be conducive to intelligent regulation of the fishery.

Summary and Recommendations

Investigations on the ocean troll fishery to date have been limited in scope and have not yielded sufficient data for the complete management of this fishery. An extensive offshore tagging program and associated studies are necessary in order to secure adequate data.

The troll fishery off the Oregon-California boundary area must be studied and adjustments made in the conflicts of the troll regulations of the two states as they affect this area.

The present methods of determining the salmon sport fishery catches are not exact enough for management purposes. Better methods must be devised.

In the catch statistics of California, the salmon landings must be broken down into landings by species.

The specific effect of various pollutants should be studied in order that corrective measures can be applied to alleviate present and prevent future stream pollution affecting fish life.

More efficient fish facilities must be developed to protect salmon runs at barriers and diversions.

Because of the various factors of great importance affecting the survival of salmon in the three Pacific Coast states, both in fresh water and in the sea, the elimination of commercial fishing on inland waters will not have the desired effect of insuring the rehabilitation and perpetuation of the salmon resources.

Cooperative studies of the ocean salmon fishery among the three Pacific Coast states will begin immediately.

STEELHEAD INDUSTRY

Introduction

The steelhead of the Pacific Coast belong to one species, *Salmo gairdnerii*. It is possible that several subspecies or races are in existence, but if such is the case, their similarity as regards life history and habits overshadows any systematic dissimilarities. This fish is the most widely distributed of our anadromous salmonids, spawning in practically every coastal stream, small or large, that has not been rendered unfit by man, from the Mexican border on north.

It is important at the start to emphasize that no evidence is at hand to indicate that intermingling of stocks takes place between the states of Washington, Oregon, and California, except in the Columbia River system. However, the steelhead fishery of the Pacific Coast presents problems of common interest to the three states from two main viewpoints, outlined herewith.

In the first place, the steelhead are generally similar to the Pacific salmons in their life history and habits, except for the fact that they are physiologically able to spawn more than once, while the salmon all die after their first spawning. In general, the two also inhabit the same streams. Thus, problems in fresh water which are of concern to the salmon—dams, diversions, multiple-water use, pollution, and food supply—are also of intimate concern to the steelhead.

At one time both salmon and steelhead were taken commercially in California, Oregon and Washington. At the present time salmon are still of commercial importance in all three states, but steelhead may be taken commercially only in Oregon. This change has resulted from a series of laws and regulations, backed by sportsmen's organizations, which have gradually turned the steelhead almost exclusively into a sport fish. Such legislation had both an economic and a biological background. From the viewpoint of economics, it is clear that the pioneers in the West were limited in their food supply, and so sought food from every source. As the West grew and life became more stable, more and more people turned to the pursuit of fish and game as a recreation. Concurrently, the once seemingly endless stocks of fish and game had diminished because of the early unlimited exploitation, and so were protected by increasingly restrictive legislation. From the biological viewpoint, the steelhead was selected as one of the game species because of the fact that it takes flies and artificial lures in fresh water much more readily than do the salmons, and so possesses a strong appeal to sportsmen.

From the above, we see that the trend toward making the steelhead exclusively a game fish is one that is the expected result of the development of the West and its society. It is difficult to forsee any reversal of this trend in the near future.

The sport fishery for steelhead is tremendously valuable along the entire Pacific Coast. The fish are taken both as adults and juveniles. The adults are caught principally in fresh and brackish water, but are also taken to some extent at sea, but close to shore, in certain areas. They are rarely taken in the offshore waters, either by commercial fishermen or anglers, and their life and migrations at sea remain a mystery.

Juvenile steelhead are caught in fresh and brackish water, often under the name of rainbow trout. It is possible that there also exist non-migratory populations of rainbow trout in various coastal streams. However, such populations are not readily distinguished from young steelhead, either by biologists or anglers.

Catch Statistics

Sport Fishery

One of the greatest weaknesses in the protection of the steelhead of the Pacific Coast lies in the absence of over-all catch statistics for the great sport fishery. State-wide statistics for the sport catch of steelhead as such are lacking in all three states.

California maintains a system for making estimates of the sport catch of the State, but this system has no provision for separating steelhead from non-migratory trout, or adult steelhead from juveniles. Furthermore, a weak point in the system is that the catch estimates are based on political sub-divisions (counties), instead of drainage basins.

To obtain a proper basis for management and for evaluation of the fisheries, the three states should install systems for making accurate estimates of the catches of both adult and juvenile steelhead by river basins, and of the numbers of anglers involved. They should in addition attempt to devise methods for estimating the runs in all streams.

California is now contemplating the institution of a personal interview poll on a contract basis. Such a canvass may prove to be the best means for obtaining the indicated catch data. If the poll yields the desired results, Oregon and Washington may wish to try similar methods. In any case, exchange of information between the three states should lead to adoption of some system for securing adequate catch data.

Estimates of the sport catch in some individual streams, based mainly on creel censuses, are available in the case of all three states. For example, in 1946-47 an extensive survey of the Umpqua River steelhead by a cooperative investigation of the Fish Commission and the Game Commission of Oregon led to an estimate of 4,100 fish for the sport catch. (The commercial catch consisted of 1,244 fish and the total run was estimated to be 41,000; thus, the escapement was approximately 88 per cent.) Some phases of this program are being continued by the Oregon Game Commission, which is also making limited studies on some of the other coastal rivers. At present, the Oregon Fish Commission is conducting but little study of steelhead in streams outside the Columbia River system.

There is a considerable sport fishery on the Columbia River, from its lower tributaries on both the Oregon and Washington sides to the Salmon River in Idaho. There are also flourishing sport fisheries on such up-river tributaries as the Deschutes, Klickitat, Grand Ronde, and Idaho tributaries such as the Salmon, Clearwater, Weiser, and others. On the main Columbia and Snake large numbers of steelhead are taken near Bonneville Dam and at the mouth of the White Salmon River, Celilo Falls, the mouth of the Snake, and along the Snake in the vicinity of Lewiston, Idaho. Current studies indicate that steelhead passing through the lower Columbia in the summer spawn largely in Idaho streams, whereas those entering the Columbia in the winter and spring spawn largely in tributaries below Bonneville Dam. The total sport catch of Columbia River steelhead is not known.

Commercial Fishery

As noted in the introduction, the commercial fishery for steelhead is now limited to Oregon. Even there, many of the coastal rivers have been closed entirely to commercial fishing. On those open to commercial fishing, the seasons gradually have been adjusted so that at present there is no distinct net fishery for steelhead on any of them. The commercial landings from the coast streams of Oregon exclusive of the Columbia River, in pounds round weight, are shown in Table 8.

Table 8. Commercial Steelhead Landings, Oregon Rivers Exclusive of the Columbia River, 1928–1947

Season	Catch in Pounds	Season	Catch in Pounds
1928	592,601	1938	248,255
1929	219,164	1939	201,598
1930	411,910	1940	256,720
1931	346,219	1941	141,001
1932	170,447	1942	178,473
1933	288,967	1943	73,041
1934	282,455	1944	145,380
1935	293,507	1945	82,864
1936	337,274	1946	135,595
1937	110,617	1947	120,457

In Table 8, each season consists of the winter beginning in the year listed; e.g., 1928 consists roughly of the period November, 1928, through February, 1929. These landings show a downward trend which does not reflect the abundance of steelhead. This downward trend is occasioned by the closure of some streams to commercial fishing during this period and also to the gradual restriction of the river net fishery for steelhead. There is also a large commercial catch of steelhead from the

Columbia River. This catch is landed chiefly in Oregon. As noted previously, the steelhead is classified as a commercial fish in Oregon, but in recent years has been classified as a game fish in Washington. However, until 1947 steelhead caught commercially in the Columbia were allowed to be landed on the Washington side of the river, provided that they were delivered immediately to Oregon. Table 9 shows the seasonal landings of steelhead from the Columbia.

TABLE 9. COLUMBIA RIVER COMMERCIAL STEELHEAD CATCH, 1928–1947
CATCH IN POUNDS

Season	Oregon	Washington	Total
1928	1,129,192	1,460,987	2,590,179
1929	1,351,877	1,484,248	2,836,125
1930	1,444,383	1,912,587	3,356,970
1931	1,474,499	1,501,471	2,975,970
1932	1,033,539	1,067,144	2,100,683
1933	1,113,222	1,181,203	2,294,425
1934	1,296,244	1,187,756	2,484,000
1935	1,299,684	418,468	1,718,152
1936	1,901,164	394,786	2,295,950
1937	1,552,878	409,172	1,962,050
1938	1,600,266	345,040	1,945,306
1939	1,307,909	319,536	1,627,445
1940	2,380,493	497,546	2,878,039
1941	2,145,568	467,147	2,612,715
1942	1,435,500	391,599	1,827,099
1943	1,170,095	327,952	1,498,047
1944	1,422,394	379,706	1,802,100
1945	1,484,960	366,962	1,851,922
1946	1,396,535	359,780	1,756,315
1947	1,462,737	283,370	1,746,107

Steelhead are taken in the Columbia throughout the year, but the bulk of the catch is taken during July, August, and September from a stock of fish that spawns primarily in the headwaters of the Columbia. This race is not fished by recreational fishermen in Oregon and Washington to any great extent, but a considerable fishery exists in Idaho. As yet there is but little conflict between sport and commercial fishermen in regard to the summer steelhead runs of the Columbia.

There is a minor peak of commercial steelhead landings in February. The sport fishery interests of the State of Washington are concerned with this catch. They have asked that this fishery be curtailed, in the hope that the sport catch of steelhead from this run may be increased in the Washington lower Columbia River tributaries. However, the steelhead runs in the Columbia, as measured by the commercial catches, seem to be maintaining themselves.

The steelhead fishery is governed by salmon fishing regulations (see section on existing regulations), so that the steelhead catches are more or less incidental to the salmon catches. Gillnets of various sized mesh in the same net are used to fish salmon, so that fish of all sizes are caught. The peak of the steelhead landings corresponds with the peak of the fall king salmon (chinook) fishery and not, according to counts over Bonneville Dam, with the peak of occurrence of this run in the river. The seasonal landings in Oregon during 1943, in pounds round weight, are shown in Table 10.

TABLE 10. COLUMBIA RIVER COMMERCIAL STEELHEAD LANDINGS IN OREGON, 1943

Month	Catch in Pounds	Month	Catch in Pounds
January	6,825	July	230,537
February	63,632	August	254,316
March	None	September	527,504
April	1,937	October	46,770
May	22,617	November	9,700
June	22,843	December	1,294

Existing Regulations

SPORT FISHERY

The Washington Game Commission, the Oregon Game Commission, and the California Fish and Game Commission all have the power to promulgate regulations governing game fish. Such

regulations are formulated annually. Additional laws and regulations concerning game fish are effected by the state legislatures.

The take is variously regulated by means of bag limits, size limits, season limits, closed areas, and restrictions on angling gear and methods. One rather startling fact which emerges when the regulation of steelhead and other game fish is considered is that it is only the take of the individual angler which is restricted and that the total annual take of game fish from any body of water is not directly limited.

Since steelhead are taken by anglers both as sea-run adults and as fish which have not yet migrated to salt water, and since the latter are very difficult to distinguish from resident rainbows, it is inevitable that the river regulations governing the species are quite complex. Comparatively little fishing for steelhead exists in offshore waters, and so regulations governing such angling are relatively simple.

Commercial Fishery

In Oregon coastal streams exclusive of the Columbia River, the commercial gillnet seasons vary from river to river, but in general very little net fishing is permitted between November 30 and May. This adequately protects the steelhead from the commercial fishery and what few are taken in nets are those caught incidentally during the latter part of the salmon gillnet fishery.

On the Columbia River little commercial fishing is allowed during December and January. February is open while March and April are closed. This appears to allow adequate escapement of the winter steelhead at the present time.

The summer steelhead are protected by a weekly closed period of thirty hours during the early summer and 24 hours in August. An entire river closure from August 26 to September 10 helps to protect the peak of the summer steelhead runs.

Extent of Past Studies

Extensive river studies on steelhead have been made in each of the three states, but comparatively little of the available information has been published. California and Washington in particular possess much unpublished experimental information which should be brought to light. These data were gathered in large part at the experimental stations at Waddell Creek in California and Minter Creek in Washington and consist largely of returns from marking and tagging experiments and other life history information. Also, counts of adult steelhead have been made on a number of streams in all three states.

The studies which have been conducted have changed many of our concepts regarding the management of steelhead. For example, while at one time it was thought that natural propagation was rather ineffective, we now know that it can be remarkably efficient; that if stream conditions are suitable, spawning is complete, and that the percentage of eggs fertilized and of fry emerging from the gravel is very high.

At Waddell Creek in California, steelhead were studied under natural conditions. Over a nine-year period, counts of both upstream and downstream migrants were obtained at a dam and two-way fish trap, and were complemented by observations made on fish in the stream. At nearby Scott Creek, data which could not be secured at Waddell Creek, such as egg counts, were obtained in connection with regular spawning operations. In both streams, extensive marking and tagging programs were carried out.

The marking experiments at Waddell and Scott creeks showed that over 97 per cent of the steelhead returned to the home stream and less than three per cent strayed to the other stream. Experiments on the Klamath River indicated that within a large river system the amount of straying of sea-run steelhead is not much greater. Therefore, each steelhead stream must be treated as a separate unit, insofar as replenishment of stock by means of either natural or artificial propagation is concerned.

The finding that May is one of the principal seaward migration months for yearling steelhead (and silver salmon) resulted in the closure of many coastal streams until the end of that month,

thus increasing the potential number of adult fish returning from such migrants. Data in regard to the time of seaward migration and the size at time of such migration provide criteria by which to govern planting of hatchery fish. Data on survival of naturally-spawned seaward migrant steelhead of different sizes provide criteria by which to evaluate survivals of comparable fish liberated from hatcheries.

Discovery that many yearling steelhead which migrate downstream in the spring remain through the summer in the tidal lagoons resulted in the closure to summer fishing of the lagoons of a number of coastal streams.

The Waddell Creek studies also revealed that fish with certain life histories predominate during one time of the steelhead spawning run, while fish with quite different life histories predominate during other times of the run. If heredity plays an important role in determining life history, exposure of one portion of a run to fishing and protection of another portion may gradually change the composition of the run as a whole in an undesirable direction.

No offshore studies of consequence have been made regarding steelhead. As noted previously, steelhead are rarely taken in offshore waters.

Present Investigations and Programs

Since in recent years the steelhead has been classified as a game fish in Washington, the Department of Game is now studying that species there. In Oregon, work on steelhead is being done by both the Fish Commission and the Game Commission, and in California by the Division of Fish and Game.

Applied Programs

Steelhead are propagated in a number of hatcheries in all three states. These hatcheries are operated by both state and federal agencies.

California also maintains an extensive program of steelhead (and salmon) rescue, in which the fingerling fish are taken from drying stream beds and stocked in live waters.

The applied management programs of the state agencies concerned also include stream improvement in the broad sense of the term. The improvement work consists largely of the removal of log jams, unused dams, and some natural barriers and the construction of fishways over dams and falls. Such work makes available additional spawning areas for steelhead.

Considerable screening of water diversions is being carried on in Oregon and Washington. Mortality among downstream migrants is reduced in this way. In California, screening of diversions on a large scale will be possible only when the present inadequate screen laws are revised.

Investigations and Research

As opportunity permits, in all three states the agencies concerned are carrying on the physical inventory of steelhead waters. This is a continuing job which will never be completed because of the changes which are constantly taking place.

In addition to carrying on the routine surveys, the state agencies are called upon with increasing frequency to concentrate their efforts upon steelhead waters which will be affected by the construction of large-scale multiple water use projects. In order to make proper recommendations for the protection of the steelhead runs it is necessary to study each of the proposed projects in detail and frequently the problems are so complex that the studies extend over a considerable period of time. It has been found that it is possible to make many adjustments in the construction and operation of the projects which make them less damaging to fish life.

Work in all three states is being done to improve methods and techniques at steelhead hatcheries. Creel censuses are also carried on in various waters, to determine the quality and amount of angling. In addition to the above types of studies, common to all three states, various investigations are being made by the agencies concerned.

In California, studies are being conducted on the efficiency of fish screens and the effects of fluctuating water from a power dam in the Klamath River basin. Continuing counts of sea-run

steelhead are being made on the Mad River, the upper Eel River and one of its tributaries, and the upper Klamath River and two of its tributaries. Results from past experiments are being prepared for publication and for issuance in the form of typewritten administrative reports. No tagging or marking programs are now under way.

The Oregon Game Commission is making counts of sea-run steelhead on several streams. By combining these counts with the commercial catch and the estimated sport catch, the latter obtained by creel census, it has in some instances been possible to estimate the total run and the escapement in such streams. At a trapping weir on Sand Creek, Tillamook County, the Game Commission is making counts of both upstream and downstream migrant steelhead, in conjunction with studies on the cutthroat trout.

At present the work of the Oregon Fish Commission and the Washington Department of Fisheries on the Columbia River steelhead is incorporated in their Columbia River Basin fisheries studies. This study is designed in part to determine the effect on fish runs of the many proposed dams and to study remedial measures. Steelhead (and salmon) are being tagged as they enter the Columbia in order to study the upstream migration of the various races to their respective spawning grounds. Also, it is planned to determine the magnitude of the fishing intensity on these fish through this tagging program. This Columbia River Basin study is to be continued and expanded by the interested states chiefly in the interests of salmon, but the steelhead will also be studied at the same time.

The Washington Department of Game also has several marking experiments with steelhead under way in the Columbia River drainage, and is conducting management studies on certain Columbia River tributaries as well as in Puget Sound.

Discussion

Biological experiments of the type which have been discussed above are rather costly and usually must encompass a series of consecutive years to produce reliable data. Therefore, the experiments which are set up and the results obtained from them should serve as guides for all of the regulations and other management measures adopted up and down the Pacific Coast, wherever steelhead occur. In areas away from the experimental district, it is often necessary only to conduct spot checks, in order to make sure that the findings are applicable.

The problems of steelhead connected with fishways, fish screens, stream improvement, pollution, and multiple water use are quite similar to those of salmon. Since a full discussion of them has been included in the report on salmon, it will not be repeated in the present report. However, several points should be emphasized.

Steelhead, like salmon, spend a part of their life at sea and a part in fresh water. Man has little control over the physical environment of the fish at sea. But he has a large degree of control of such environment in fresh water He is largely responsible for the adverse conditions for steelhead which exist in many streams today, and it is within his ability to remedy such conditions. Exchange of information between the fishery biologists and administrators of the three states would greatly assist them in obtaining the knowledge of the measures which would be most effective in improving stream conditions for steelhead.

Since steelhead inhabit the same waters as salmon, they face similar problems regarding multiple uses of water. Adequate protection for one in connection with large-scale projects such as dams and diversions will usually result in adequate protection for the other. In some instances the value of the salmon runs or the steelhead runs considered individually is not sufficient to warrant a demand for adequate protective measures (fishways, release of water, etc.), but the value of the combined salmon and steelhead runs is great enough to obtain needed protective measures. Thus, it is to the advantage of the fishery interests, salmon and steelhead, commercial and sport, to work together and present a united front. As the first step in this direction, uniform methods of evaluation should be worked out and adopted. The fishery interests should seriously consider hiring a good economist to aid them in doing this.

Much still needs to be learned regarding the effectiveness of artificial propagation in maintaining

steelhead runs. Some steelhead streams are heavily stocked, while others maintain considerable runs without any stocking.

Recommendations

No evidence is at hand to indicate that intermingling of steelhead stocks takes place between the states of Washington, Oregon, and California, except in the Columbia River system, and therefore, it does not appear necessary to coordinate the regulations governing the fisheries in the three states. However, since the biological and economic problems affecting steelhead are much the same in the three states, it is logical to assume that fuller knowledge of conservation principles will lead to greater uniformity in the approach to management in every form, including regulations. Exchange of information and ideas between the three states will hasten this process. The following recommendations are presented from this viewpoint.

(1) Accurate estimates should be obtained of the spawning runs, catch, and escapement by river basins. This would be the first and basic step in determining the amount of fishing that should be permitted in order to obtain the maximum sustained yield.

(2) Uniform methods of evaluation of the runs and sport and commercial fisheries (the latter exist only in Oregon) should be adopted. Adoption of uniform methods would greatly strengthen the position of all fishery interests with respect to multiple use of water.

(3) The legal status of water for fish should be clarified and where possible strengthened.

(4) Whenever possible, information regarding available data and proposed studies and programs should be exchanged, to avoid needless duplication of effort. This applies to biological data, management methods, and information pertaining to fish screens, fishways, and pollution and the regulations governing them.

OTTER TRAWL FISHERIES

Introduction

The otter trawl fisheries of the Pacific Coast extend from Santa Barbara, California, to Hecate Strait, British Columbia and Alaska. Of the commercial fishing methods used on the Coast, dragging is one of the oldest, drag gear first being used about 1870. Modern dragging is carried out by means of the otter trawl; this net is built like an elongated conical sack with an enlarged mouth and wings extending out from two sides. These wings serve to lead the fish into the mouth of the net. The fish travel from the mouth into a blind sack. The sack, or "bag," is closed with a draw string. When the net is brought aboard the vessel, the draw string is loosened and the fish sluice out upon the deck. The net is held open on the bottom of the ocean by water pressure on "doors" attached to the ends of the wings. Each door is fastened to a cable which leads to a winch aboard the boat. The crew of a trawl boat usually numbers three to five men.

More than twenty species are included in the catch of the otter trawl fishery. The more important species are: the English, petrale, dover, and sand soles, the dogfish shark, several species of rockfish, black cod, ling cod, and flounders. Edible fish are usually processed into fillets for the domestic market. The vitamin rich livers of several species are taken, and constitute an important part of the economy of the fishery. The major trawl fishing ports along the coast are Puget Sound and Grays Harbor, Washington; Astoria and Newport, Oregon; and Eureka and San Francisco, California. There are over 300 drag boats in the coastal fleet. The bulk of the bottom fish landed in the Pacific states, with the exception of the northern halibut, is landed by trawl vessels. However, as there are hook and line and gillnet fisheries that operate on the same stocks, this report will deal with the bottom fisheries in their broader aspects. The value to the fishermen in 1944 for their catches was over twelve million dollars.

Regulations

The present regulations covering otter trawling on the Pacific Coast are:

	California	Oregon	Washington
Mesh	5″ min., inside knots.	None.	4¼″ min.
Closed ocean areas	Inside 3 mi., Northern California. Inside 25 f., Central California. All closed, Southern California.	Inside 3 miles closed. All bays closed.	Bays and certain areas of Puget Sound.
Size Limits	None.	None.	11½″ Soles. 14½″ Flounders.
Crabs	500 lbs. per boat.	Not allowed.	Not allowed.
Log Books	Required.	Optional.	Optional.

Management Studies

Bottom Fish

The fish catch on the coast has increased greatly in the past decade in all three states. The rise in catch is primarily due to several factors of which the existence of virgin stocks of fish and improved markets resulting from the recent war are the most important. The following tables and figures portray the history since 1935. (Figs. 2 and 3, Table 11.) The sudden rise in 1941 and 1942 was not produced with the same small fleet that operated prior to that time. In California the trawler fleet numbered about twenty vessels in 1935. There are over 100 at present. While the landings increased, it is known that the numbers of fish of certain species actually declined on some grounds. Although specific data are not available for all species, the soupfin shark, dogfish, and Washington petrale sole stocks declined greatly between 1942 and 1945. The sablefish stocks have declined over an even greater period according to Bell and Gharrett.[1] It is suspected that the stocks of rockfish and ling cod on some grounds have also decreased. However, this condition was masked by the continual spread of the fishery to new grounds which now provide the bulk of the catch in some cases. The fact that most of the Washington fleet have found it necessary to move to Hecate Strait (400-600 miles north) is a good example of this. The rockfish catch in all waters of California has shown a decline with the exception of the Eureka area. The catch of rockfish in this region skyrocketed during the war years when new grounds and markets were found.

Studies of the petrale sole off northern Washington in 1942-1945 have shown that this is a slow growing fish. The females mature at about six years and sixteen inches, the males at four years and thirteen inches. During the period studied the average age of the catch declined from 8.0 years to 6.3 years, and the average length of fish fell from 18.2 inches to 16.0 inches. Concurrently the catches of sole per trip on these grounds fell from about 9,000 to 4,000 pounds, and the days fished per trip increased from approximately four to six. Preliminary tagging experiments indicate that these sole may be relatively local in nature. Less than ten per cent were found over twenty miles away after a year of freedom.

Data on English sole indicate that they grow more rapidly and migrate more widely than do the petrale. They mature at two to four years of age and eight to twelve inches in length. The fact that these fish are fast growing is an important incentive for protecting the young from the fishery. Fifty-mile migrations are fairly common for these fish, and a few have been known to travel as far as 500 miles. Thus, the English sole population is definitely a matter of interstate concern.

In 1944 there were 131,200,000 pounds of dogfish "in the round" taken by California, Oregon, Washington, and British Columbia. These tremendous catches when combined with the knowledge that the dogfish is slow growing and reproduces only a small number of young, leave no doubt concerning the cause of decline. Dogfish grow less than an inch per year. They mature at twelve or thirteen years of age. The females produce only eight young every other year, the period of gestation being two years. Tagging experiments definitely demonstrate that dogfish migrate freely along the Pacific Coast, moving south to California in the winter and north to British Columbia in the summer months. The maximum migration recorded is 1,210 miles.

[1] The Pacific Coast Blackcod, *Anoplopoma fimbria*, F. Heward Bell and John T. Gharrett. Copeia, 1945, No. 2, June 30.

FIGURE 2

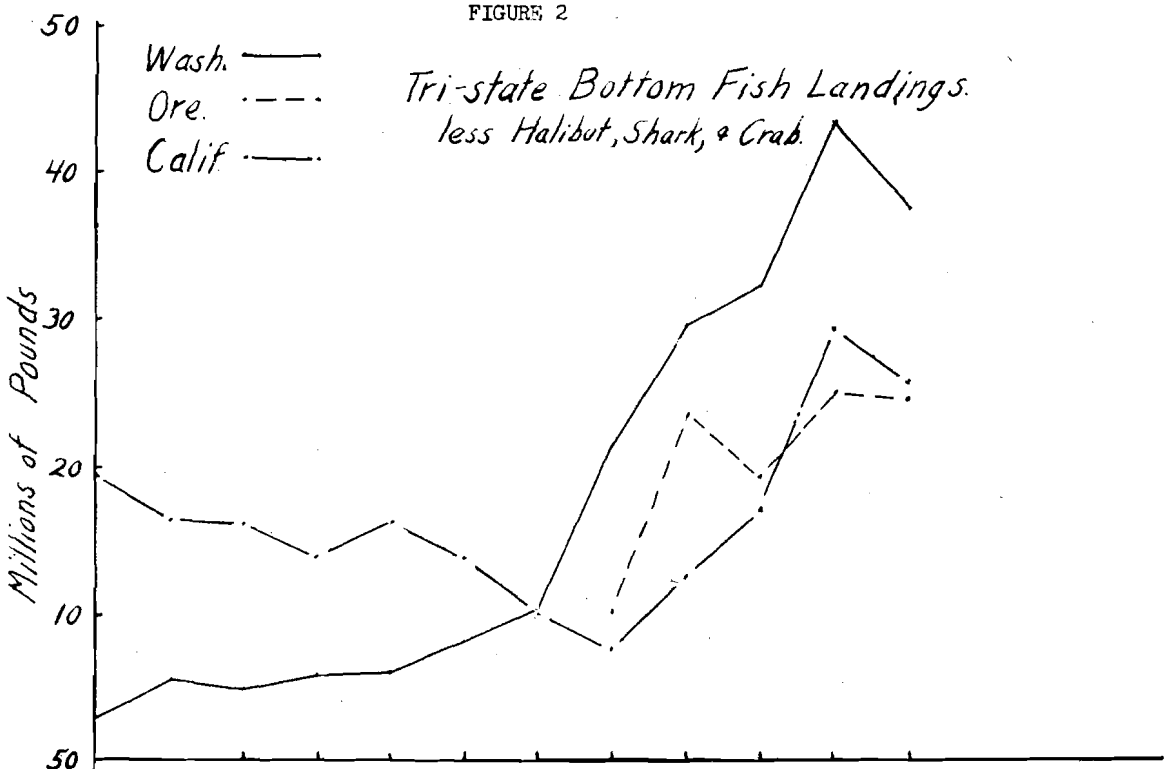
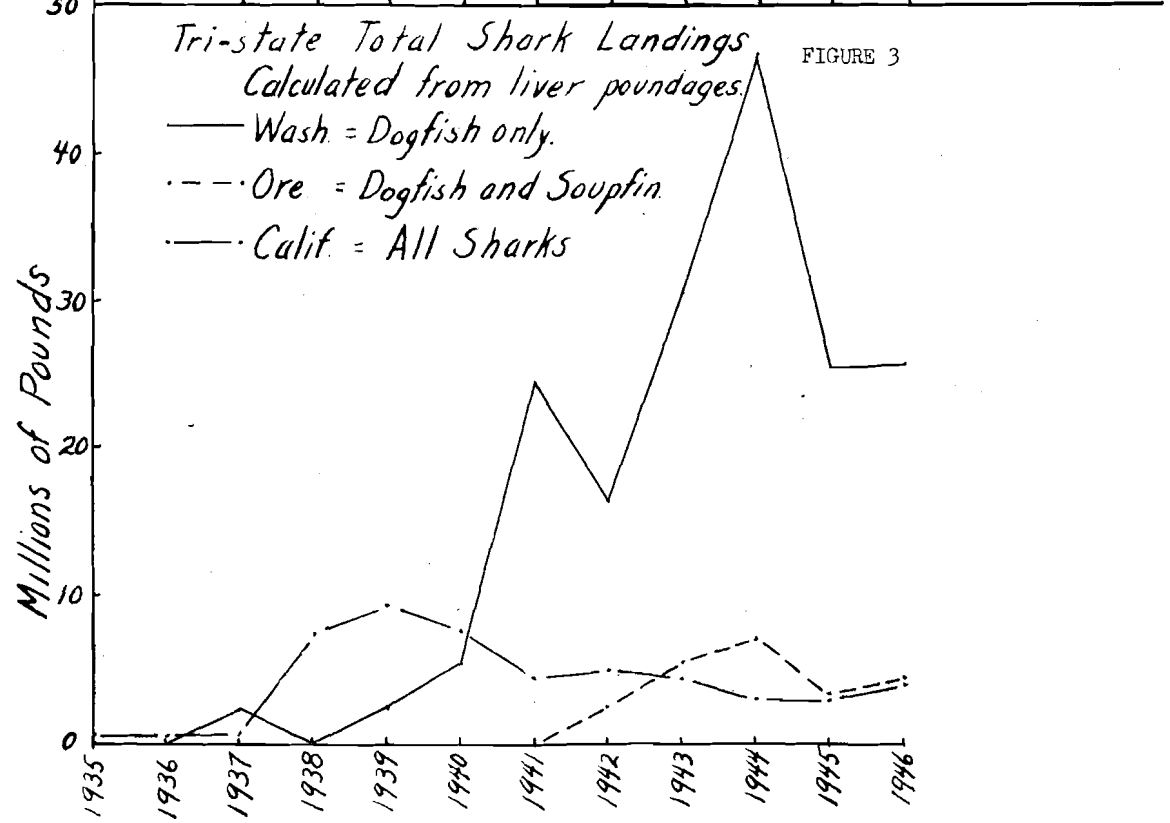


FIGURE 3



Soupfin Shark

The soupfin shark fishery reached a peak in about 1942. Since then it has suffered a serious decrease in total catch. During the same time the fishing effort increased over ninety per cent. On the average, soupfin produce 35 young per year with almost all females south of Pt. Conception pregnant and bearing young. Females produce a low potency vitamin A oil with a proportional value much less than the high potency oil of the males. All available evidence indicates that they are very migratory. Among the few recoveries of tagged fish, one traveled about 1,000 miles. Because virtually no young occur in the northern states, it seems evident that the pupping grounds of Southern California must support the fishery.

If this fishery is to be revived, the species must be given stringent protection. Because the catch has fallen until the species is facing commercial extinction[1] the only solution is a complete closure of the highly efficient net fishery until the stocks recover some of their former productivity. It is recommended that the long line fishery for this species be permitted to continue because it is necessary to have a contact with the stock of sharks in order to know the rate of recovery. (The intensity of this fishery is very low.) To be completely effective, British Columbia should cooperate in this program of restriction.[2]

Savings Gear

Existing experimental data on mesh sizes gathered in California and Washington show that an increase in the size of mesh commonly used would release large numbers of immature fish of commercial species. The great bulk of the average otter-trawl catch is unsaleable as human food and is returned to the water in dead or dying condition. Much of this fish consists of comparatively unutilized species such as arrowtooth halibut, skates, hake, etc. At the present time a portion of these species are landed in Oregon for use as mink feed. Unfortunately, many young food fish are included with this scrap. Parallel hauls with different sized trawls have indicated (Figures 4 and 5) that five-inch mesh will effect considerable savings of immature bottom fish. Flounders will not be greatly affected by this sized mesh, but as these species are extremely hardy they may be released in a viable condition.

It is not probable that other fish will escape in such numbers as to harm the catch. The rockfishes are too large and rough to pass through such a mesh. The small ling cod that may escape should be released. In some areas the draggers capture many small ling cod that dress out less than three pounds. Any release of these fish will be beneficial. Moreover, there is reason to believe that many black cod of sizes now caught and killed may pass through the meshes undamaged. Several draggers who have used larger mesh of their own volition have reported this. Results of experiments on the East Coast and Europe demonstrated that larger mesh nets fished better, took smaller quantities of trash per drag, and over a period of time the total catch of the large mesh net was greater than that of the small mesh net. The three states are cooperatively studying this problem further before definitely arriving at a suitable minimum mesh size to be recommended for use along the Pacific Coast.

Coordinated Studies

To obtain the most efficient use of the available and potential facilities of the three states, the following objectives are to be attained.

Tri-state management of the otter-trawl fishery will involve the regulation and control of over twenty different species of fish. These species are fished upon disproportionately in the three states owing to the difference in their relative abundance along the coast. The picture is further confused by differences in biology. For instance, in one area, a closed season to allow the spawning of an important species may not protect another species which spawns at a different time of the year. When other biological differences such as growth rates, size at maturity, strength of populations, seasonal abundance, migrations, and the ability to reproduce, are considered, the problem of assessing the

[1] Ripley, W. E., The Soupfin Shark and the Fishery. California Fish and Game, Fish Bulletin, No. 64: 1–37.

[2] At the December, 1948 meeting of the Pacific Marine Fisheries Commission, it was recommended in general that all fishing for females be prohibited and a 9½ inch minimum mesh size be established. All vessels to be licensed to fish soupfin shark and the licenses subject to revocation if convicted of a violation.

relative importance of the various components and integrating the parts into a unified management plan assumes difficult proportions. The future of the bottom fisheries depends upon the successful development of this management plan.

Congruity in the collection of statistical data is an important requisite in coordinated trawl fishery investigations. Basic information which must be contributed by the three states is: Catch by species by area and the amount of time spent fishing to make the catch.

A major tagging program should be carried out on a tri-state cooperative basis. Inasmuch as so many species are involved in trawl catches, tagging will give the relationship of the various groups to the whole and further clarify those groups which migrate and those that do not. Those species which need immediate attention are petrale, English and dover soles, black cod, ling cod and several species of rockfish. Tagging information will show how much movement occurs, the distance traveled and when and how often the movements take place. It will reveal the growth of the fish and the intensity of the fishing operations in relation to the abundance of the various stocks.

To understand properly the mechanics of these fisheries, it is necessary to know the age composition, rate of growth, and size at maturity for the various species, and whether or not the growth and size are the same throughout the range of the species. There is no assurance that the petrale sole grows at the same rate in California as it does in Washington or Oregon. For example, large differences in growth rates have been found to exist between English sole in northern and southern Puget Sound. There is some evidence to indicate that the growth rates of this sole are different in northern and southern California.

These biological data will give the level of population density and sizes (representing the optimum condition, age, and weight of the fish stocks) at which the various populations are most productive and can contribute the greatest amount to the fishery.

Although some work has been done relative to mesh size and the release and retention of fish, this phase needs further work to strengthen it for the present fishery. Figures 4 and 5 show the results of experiments designed to test the size of the fish caught by various mesh sizes. It may be observed that both in California and Washington the five-inch mesh net effected a considerable savings in the smaller fish. When the investigations were carried on in California, there was little or no dover or slime sole taken. Consequently this fish was given small consideration in the analysis. At present the catches of dover sole are an important segment of the trawl caught species in Oregon and northern California. At the time the investigations were carried on, the fishery was not conducted on such an intense level as it is at present. The results then indicated that the stocks in California were adequate to produce a suitable return to the fisherman with a specified corrected mesh size. However, it is possible that with the tremendously increased pressure and intensity to which the fishery was subjected from 1940 to the present, the existing stocks are in such a condition that the remedial measures may be severe until the populations have been built back to their formal level.

It is proposed that savings gear work be undertaken with the over-all complexity of the fishery in mind and that this work be carried on as rapidly as possible. However, to conduct this type of experiment in the most satisfactory manner (experimental fishing is not an economically profitable enterprise), a vessel should be at the disposal of those doing the experimentation. It is feasible, and in some respects desirable, to carry on gear and mesh size experiments on the commercial fleet. This approach has been used by Washington, and will be attempted further by Oregon and Washington. Inasmuch as the species composition varies in the three states and the various biological phenomena may not be proportional, it is very likely that the work will have to be conducted along the entire coast. Even though adequate funds are not now available, the work should not be neglected. As far as it is possible, friendly cooperation by fishermen should be utilized.

Facilities Required for Coordinated Studies

To pursue the major phases of the program outlined above, additional facilities and personnel would be necessary to supplement the present staffs of the three states now engaged in work on the trawl fisheries. At present California has two biologists, and Oregon and Washington have one each to devote to trawl investigations.

The statistical phases can be accomplished with the present personnel as can some of the biological work. However, more data are required for a comprehensive understanding of the factors

governing the dynamics of this fishery. To gather this information will necessitate additional personnel. Of the experimental investigation involved perhaps the two phases, tagging and savings gear studies, will give the most immediate concrete results. These studies would involve the efforts of a minimum of two biologists in each state, or a total of six, if the work were to be carried on simultaneously. Unless the tagging is carried on simultaneously along the entire coast, the greatest good cannot be obtained from the experiment.

Tagging can be accomplished aboard suitable commercial fishing vessels if necessary. Savings gear experiments, however, should be partially conducted in a manner comparable to but not in conjunction with commercial fishing operations. The time involved in making experimental hauls, changing nets, measuring fish and otherwise interfering with the commercial activities aboard the vessel would not enhance the continuity of the investigation or the results. Until a vessel is available for this work, many valuable observations may be made on experimental gear fished by the regular fleet. Some fishermen may not object to using a special net so that the effect of a larger mesh can be directly observed in the commercial fishery.

Immediate Plans of the Three States

Washington plans immediate work on the trawl fisheries in regard to log books and the rockfish fishery. The trawl program in this state will follow and depend upon the coordinated program set up by the commission. A particular effort will be made to tag bottom fish off southern Washington in conjunction with Oregon.

Oregon plans a tagging program in addition to a savings-gear study to determine the effects of various sized mesh on dover sole and other species. A log book system will also be started to obtain data from all fishing vessels.

California is reinaugurating a log book system on trawler vessels. Biological studies will be carried on as log book activities permit.

Recommendations

1. Because several of the bottom fish show evidence of over-fishing and because existing data show that a five-inch mesh (measured from *center* of *knot* to *center* of *knot*) will release many undersized food fishes while losing few desirable fish (figures 4 and 5), it is recommended that further study of proper mesh size be made in Washington and Oregon in order to adopt a proper minimum mesh size in these two states. California law now requires a five inch minimum *between knots*. If this proves more economical after further study it should be later adopted as a minimum size for both Washington and Oregon as well.

It is recommended further that:

2. Daily log books be kept by trawl vessels in the states of Washington, Oregon, and California. The data to be obtained from the log books should be comparable.

3. The type of gear be shown on all landing records.

4. Soupfin shark be taken by hook and line only. In order to prevent undue hardship on the fishery, this regulation should become effective eighteen months after enactment into law.

TABLE 11. TRI-STATE BOTTOM FISH LANDINGS[1]
POUNDS

Year	Washington		Oregon		California	
	Bottom Fish	Shark[2]	Bottom Fish	Shark[3]	Bottom Fish	Shark
1935	3,112,561	.....	.....	.....	19,387,158	545,761
1936	5,546,097	.....	.....	.....	16,383,150	457,530
1937	5,083,607	2,431,270	.....	.....	16,207,560	907,414
1938	5,960,424	.....	.....	.....	14,066,564	7,492,229
1939	6,011,813	2,465,342	.....	.....	16,205,402	9,224,155
1940	8,108,199	5,662,800	.....	.....	13,935,378	7,856,835
1941	10,242,972	24,677,980	.....	.....	10,107,854	7,591,603
1942	21,530,168	16,456,710	10,067,401	2,690,000	7,589,266	3,491,603
1943	29,709,700	30,444,270	23,669,439	5,484,000	12,376,102	3,680,481
1944	32,377,165	46,975,770	19,161,501	7,149,000	17,010,548	2,591,278
1945	43,330,323	25,454,700	25,005,260	3,370,000	29,178,094	2,418,289
1946	37,729,069	25,927,495	24,730,859	4,757,000	25,829,438	1,577,716

[1] Less halibut and crab. [2] Dogfish only (calculated). [3] Soupfin and dogfish (calculated).

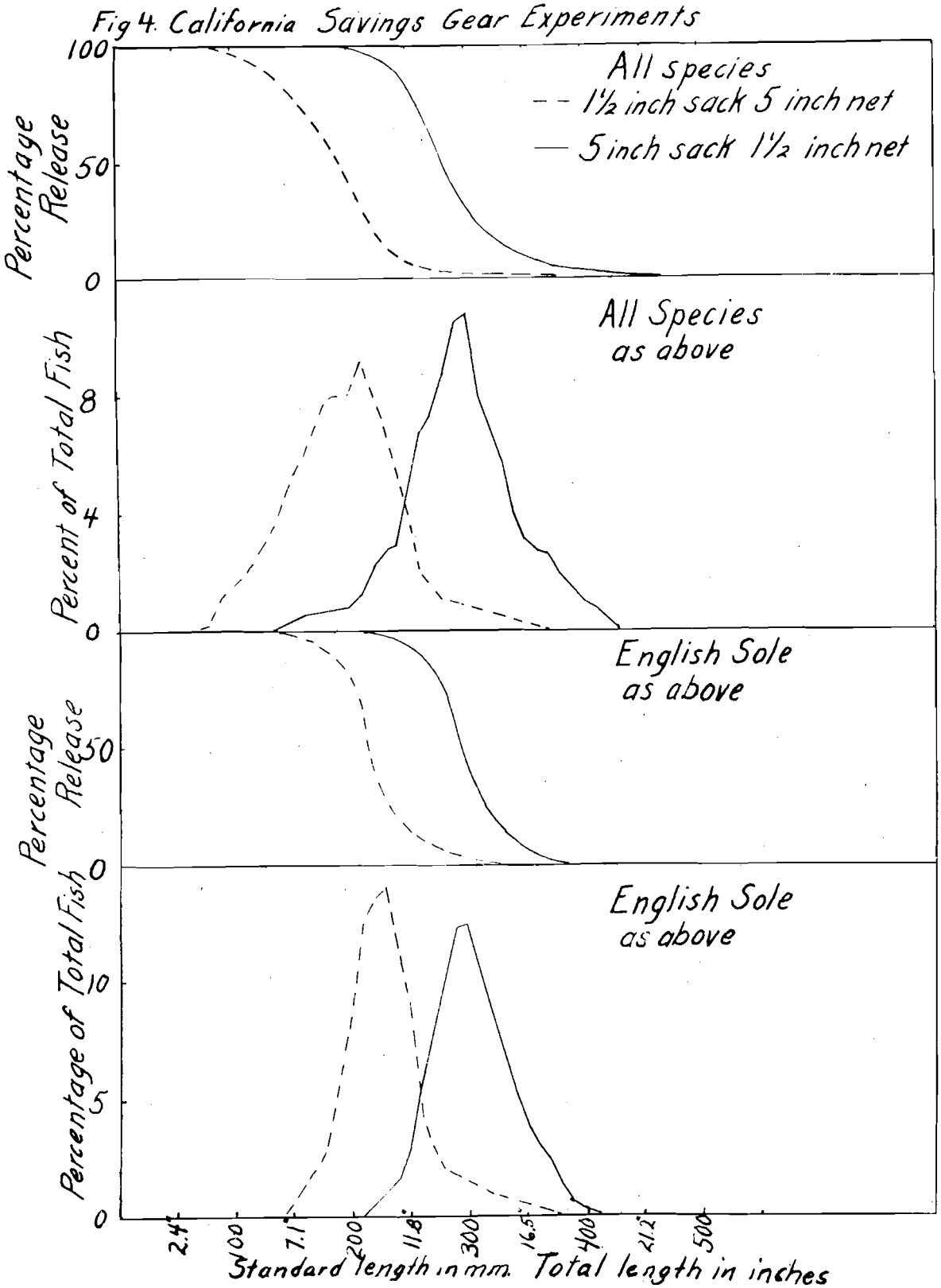
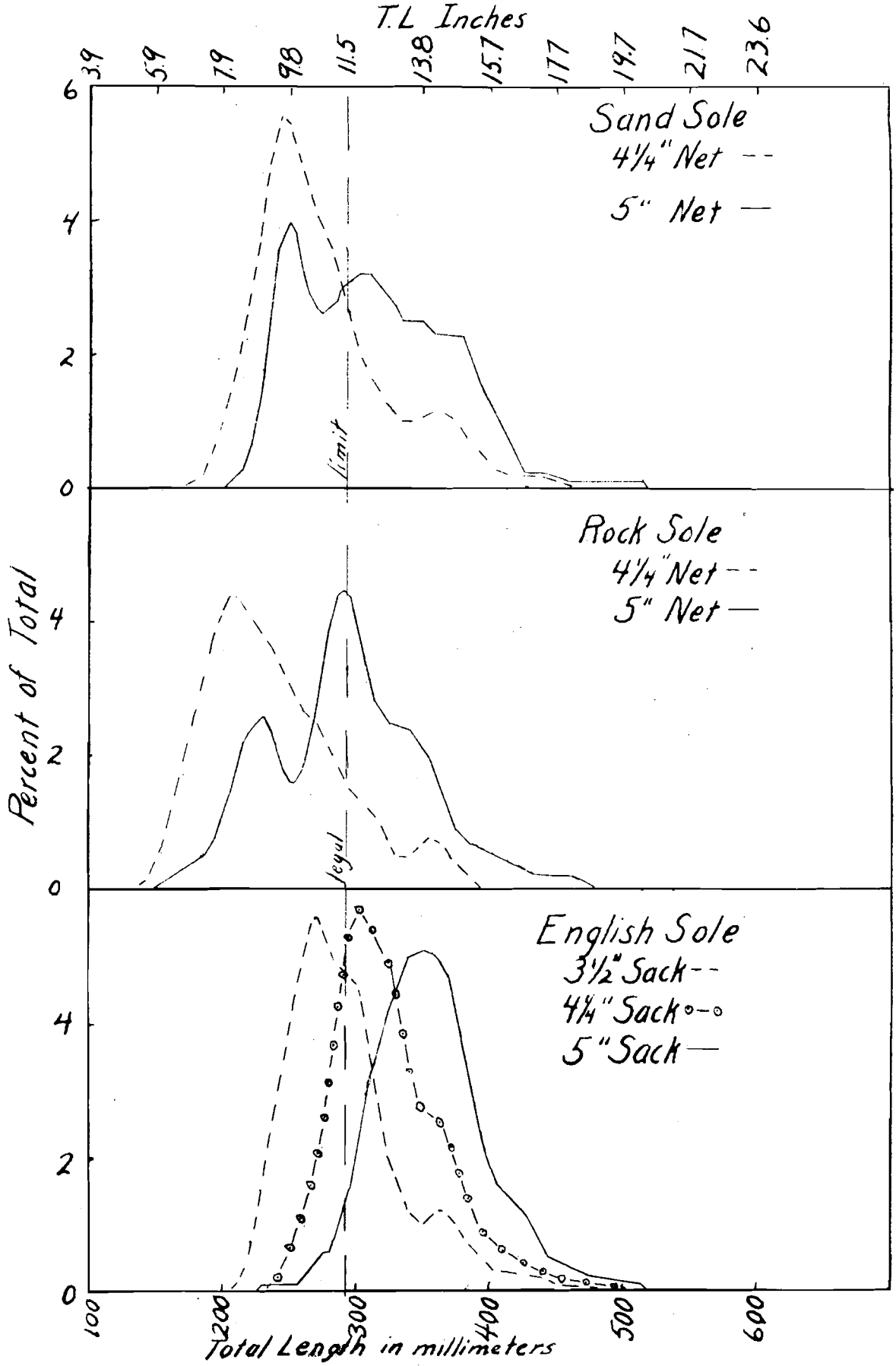


Fig 4. California Savings Gear Experiments
All species
-- 1½ inch sack 5 inch net
— 5 inch sack 1½ inch net
Percentage Release
100
50
0
All Species as above
Percent of Total Fish
8
4
0
English Sole as above
Percentage Release
50
0
English Sole as above
Percentage of Total Fish
10
5
0
2.4"
100
7.1"
200
11.8"
300
16.5"
400
21.2"
500
Standard length in mm.
Total length in inches

Fig. 5 Washington Savings Gear Experiments.



TUNA FISHERIES

Introduction

The following report has been prepared according to instructions on the status of and plans for a cooperative tuna investigation. Inasmuch as the albacore is the only species jointly exploited by the three Pacific Coast states the entire report will deal exclusively with this species.

The total catch of albacore is plotted in Figure 6 for the years 1916 to 1947, inclusive. The graph reveals that the fishery is and has been characterized by extreme fluctuations of an erratic nature. With such wide fluctuations it is impossible to establish any regular trend and all that can be said is that the catch declined from a high in 1917 to nothing in 1928, and rose again from 1935 to a peak about 1944. In the intervening years, from 1928 to 1935, the fishery was practically non-existent. Beginning about 1937 the fishery was extended to the coasts of Oregon and Washington. Although the catch was thus materially increased, the general picture was not fundamentally changed and the same major fluctuations are apparent. Furthermore, the season of the annual fishery is essentially the same in both regions. In the Northwest (Oregon and Washington) approximately 92 per cent of the catch was landed in the three-month period July-August-September (1941 to 1947 both inclusive), while in California approximately 85 per cent was landed in the same interval (1940 to 1946 both inclusive). Figure 7 shows the average monthly landings in California throughout the year for the period 1940 to 1946, which is fairly typical for both regions and all seasons.

The foregoing summary suggests that the albacore population is only partially exploited. Seasonally, this is unquestionably true, for outside the three-month period the landings are as a rule negligible. If such is the case (as a more extensive review of all available data indicates) then no restrictive regulatory measures are needed at this time. The problem, on the contrary, may be one of developing a valuable and as yet incompletely exploited resource. Specifically this involves exploratory fishing on-and-offshore and at various depths in order to locate the albacore in those seasons when they are not at present available to the fishermen.

A Summary of Available Knowledge

The seasonal nature of the fishery and the extreme fluctuations in the catch have been discussed. As yet no satisfactory correlations have been established between the success of a seasonal run and environmental conditions, and therefore no predictions as to the size of the catch can be made. Also, because the fishing is seasonal and because the portion of the stock being exploited is not known, insufficient data are available to determine the proper rate of exploitation. It is conceivable that the fishery is actually yielding a maximum tonnage now, and that exploration might result in over-fishing. If the stock should prove to be small this result is probable. Nevertheless, exploration is still necessary from a management standpoint in order to determine the potential of the fishery and to bring about relative stabilization in the annual catch. Within the northern Pacific, albacore occur within various areas between Asia and the American mainland. There is, besides our local fishery, a thriving albacore fishery in Japan and a lesser one at the Hawaiian Islands. No albacore occur within the tropics of the eastern Pacific. A detailed comparison of albacore from Japan and the Hawaiian Islands with local specimens, made in 1941, demonstrated that all specimens must be considered as of the same species, for it was impossible to distinguish individual fish from any locality. However, a more detailed statistical analysis of fourteen body proportions made upon nine Japanese, three Hawaiian, and 108 local albacore indicate that the Japanese and American fish may constitute separate populations. Measurements from the three Hawaiian albacore indicated that these fish resemble the Japanese more than the local fish. Unfortunately the numbers in the foreign samples were too small to warrant positive conclusions, and it is planned to duplicate this study upon larger numbers of fish as soon as possible. Nevertheless, the preliminary study affords the only basis for judgment to date, and leads to the tentative assumption that the albacore supporting our American fishery may constitute a separate reservoir of fish.

The albacore is a surface fishery in this country and one in which the fish are caught exclusively on hook and line, either trolled or with live bait. The run of albacore is associated with the warm,

Figure 6 Pacific Coast Albacore Landings by State

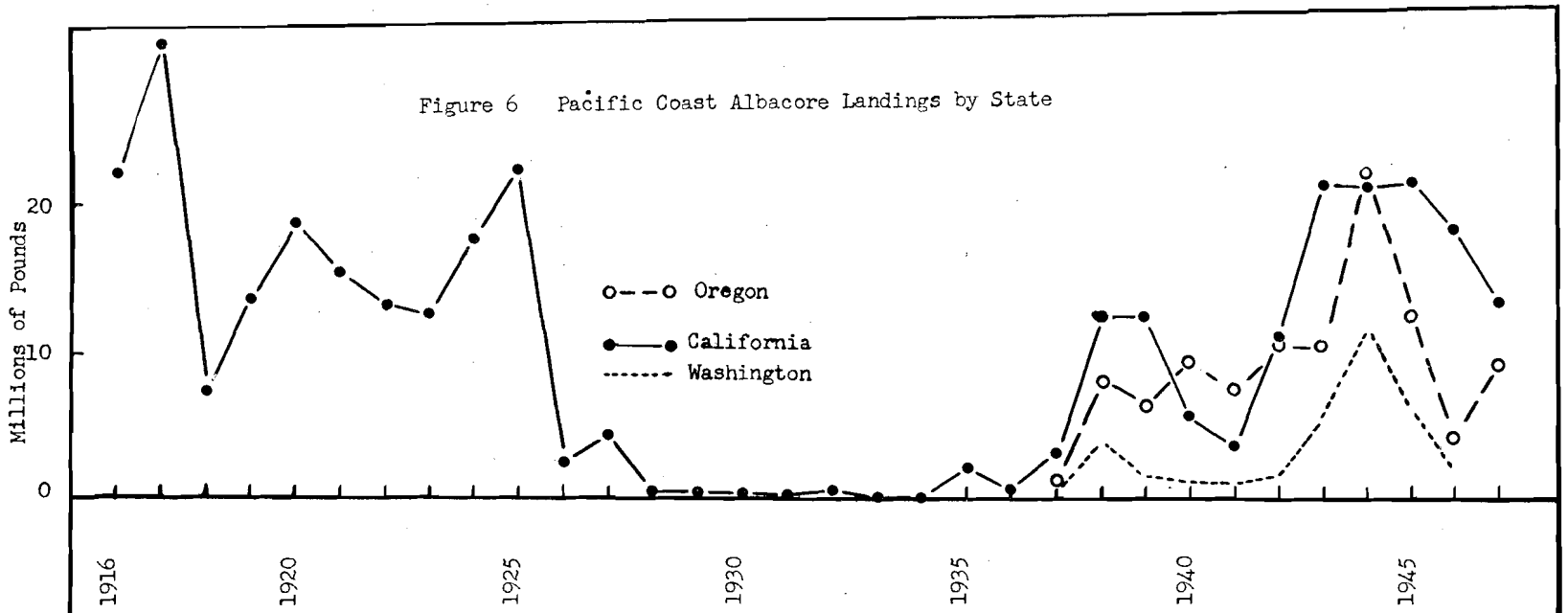
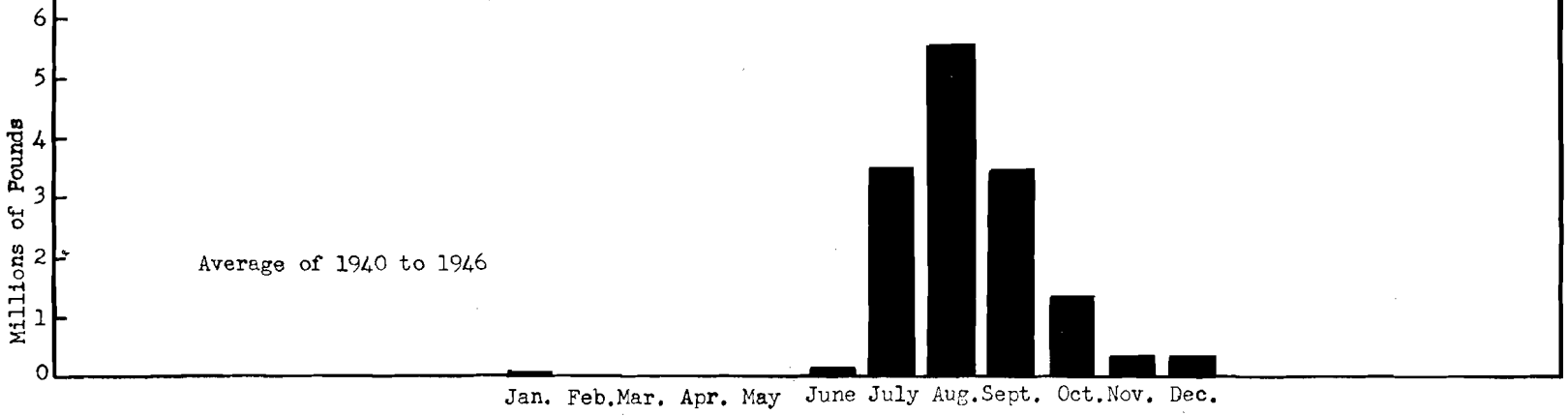


Figure 7 California Average Monthly Landings



blue oceanic water which—with variations—prevails along this coast through the summer months. In consequence, fishermen seeking albacore generally watch for warm or blue water, and frequently follow the approximate boundary between the green coastal and the blue oceanic water. Working on this theory, members of the California State Fisheries Laboratory, aboard the "N. B. Scofield" found albacore in August-September, 1941, distributed from Southern California to Vancouver Island, in considerable abundance although the catch of that year was relatively small. An earlier trip in July-August, 1939, demonstrated that albacore were present in fair abundance at distances of about 400 miles offshore, due west of the Southern California coast. Although these locations are beyond the range of the small vessels engaged in the albacore fishery, the observations will, nevertheless, furnish a starting point for future explorations.

The fishery usually starts in May or June in California, and July in Washington and Oregon, with small, occasional catches. The run of fish continues through September. In October there is generally a sharp drop in catch and the fishery usually terminates in that month or in November. However, in exceptional years some catches are made in California in December and even into January. Throughout the remainder of the year albacore are never seen at the surface and are rarely taken.

The food of the albacore consists of any actively swimming organisms abundant in the area. Squid and small and larval fish were frequently noted in the albacore stomachs on the exploratory trips.

A large proportion of the California catch is caught on live bait. In this method of fishing the albacore, when encountered, are attracted around the vessel by throwing out the living bait fishes, confined in running sea-water within a deck-tank, and then catching the attracted albacore on a feathered hook, or with a live bait-fish impaled upon a barbless hook which is suspended by a short line from a bamboo pole. Bait, throughout the years, has not as a rule been a limiting factor in California where small sardines or anchovies have been used. In Oregon however, bait is not as abundant and the industry there depends almost exclusively upon anchovies. During the first few weeks of the albacore season in Oregon most of the fish are caught by trolling boats using jigs. As the season progresses the emphasis shifts to the bait boats. These bait boats have the problem of obtaining bait to be kept alive in the bait tanks. The anchovy is the favored bait in Oregon. It is obtained mainly at or near the mouth of the Columbia River, in Yaquina Bay, and in Coos Bay. The bait fish are caught with a lampara net.

During the 1947 season a trip was made aboard a bait boat, in part to determine whether any great number of salmonoids were being caught. Three sets of the net were observed, two in the Columbia River near the north jetty and one off North Head. Five chinook salmon fingerlings were seen in approximately 35,000 fish. The great majority were anchovies, with a few smelt, tom-cod, herring, and other fish of no commercial importance.

Sampling of the California catch of albacore was started in 1917 and continued until about 1928 when the fishery failed. Although samples have been taken spasmodically since then, the routine was not resumed and no comparable records are available for the period 1929 to the present. Sampling will, however, be resumed in the summer of this year. The earlier material has not been adequately studied although data for some years has been reviewed by Oregon workers. The material should be studied and evaluated.

In 1937 albacore were first found in large numbers off the Oregon coast. The fishery quickly developed; canneries were built, boats equipped, and a new industry was born. In 1938 the Oregon Fish Commission began a biological study of the albacore. Much of the data collected consisted of market measurements. The lengths were taken on a measuring board from the tip of the snout to the ends of the middle caudal rays. In 1938 only one sample was taken which was not enough for significant comparisons with data collected in later years. In the following years up to 1943 more adequate samples were taken. In 1943 the albacore work was suspended and was not resumed until 1947.

In Figure 8, the length-frequencies are depicted by year for Oregon. From these graphs it is evident that the albacore fall into two distinct size groups which will hereinafter be designated the "small" fish and the "large" fish. Furthermore, these two distinct size groups may be successive

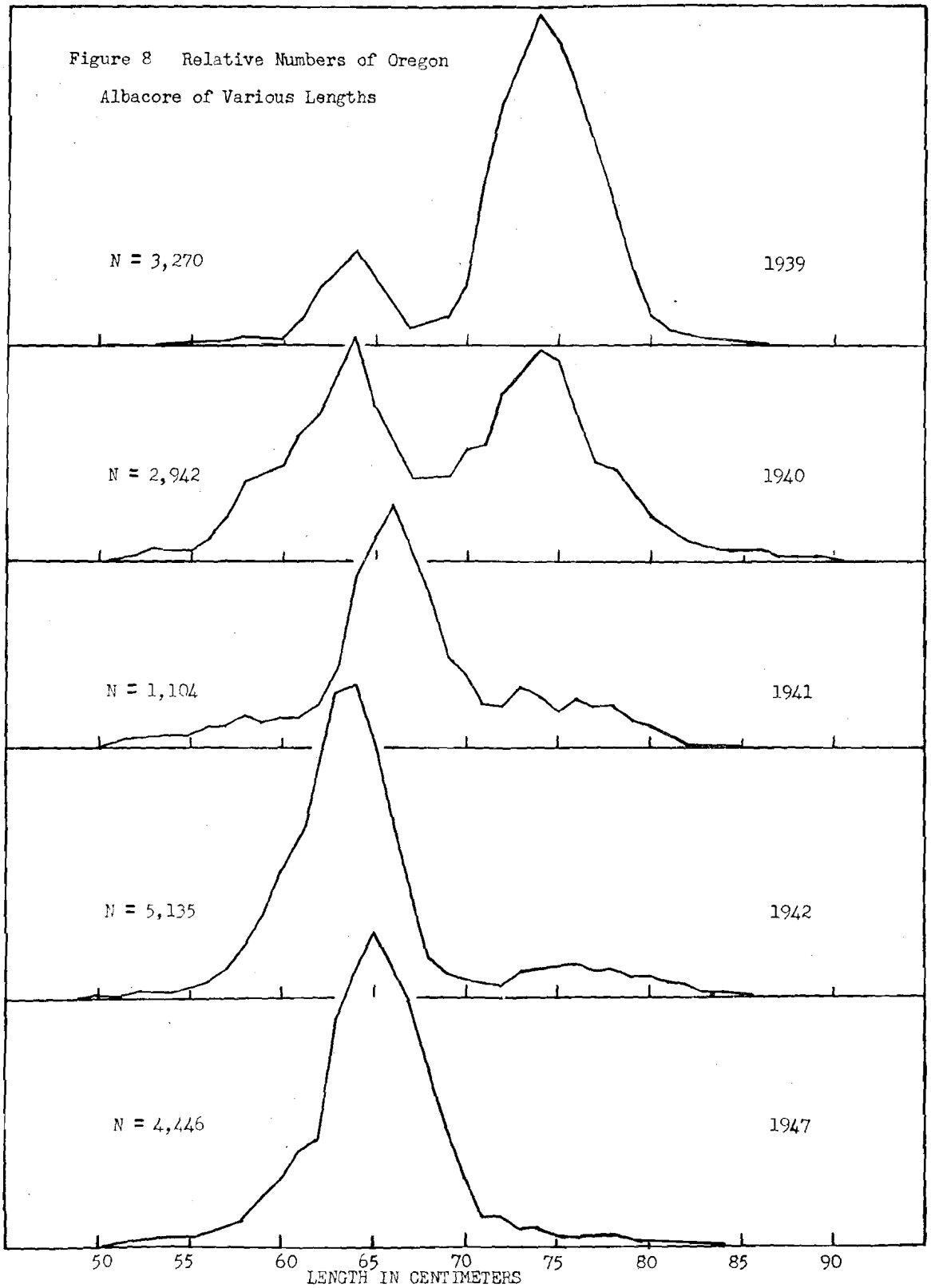


Figure 8 Relative Numbers of Oregon Albacore of Various Lengths

year classes. This has not yet been proven because no method has been perfected for determining the age of the albacore.

It will be noted that in some years small fish predominate and in other years large fish are more numerous. Only in 1940 are the two size groups nearly equal. Assuming that the two size groups are year classes, one is led to the conclusion that the fishery depends mainly on only two successive year classes. The explanation for one or the other of the year classes being partially or almost completely absent in certain years might be poor spawning conditions or could be one of the size groups not migrating into the fishery. There is evidence that the two size groups school in part at least separately. The extreme fluctuations in the catch might be due to the fact that there are

TABLE 12. LANDINGS OF ALBACORE IN CALIFORNIA, OREGON AND WASHINGTON, IMPORTS FROM JAPAN AND HAWAII EXCEPTED

POUNDS

Year	California	Oregon	Washington	Total
1916	22,899,309	.....	.....	22,899,309
1917	30,556,242	.....	.....	30,556,242
1918	7,265,422	.....	.....	7,265,422
1919	13,630,899	.....	.....	13,630,899
1920	18,876,647	.....	.....	18,876,647
1921	15,276,727	.....	.....	15,276,727
1922	13,231,823	.....	.....	13,231,823
1923	12,514,833	.....	.....	12,514,833
1924	17,695,362	.....	.....	17,695,362
1925	22,206,923	.....	.....	22,206,923
1926	2,469,921	.....	.....	2,469,921
1927	4,579,367	.....	.....	4,579,367
1928	283,321	.....	.....	283,321
1929	269,101	.....	.....	269,101
1930	283,117	.....	.....	283,117
1931	37,322	.....	.....	37,322
1932	619,694	.....	.....	619,694
1933	487	.....	.....	487
1934	93,929	.....	.....	93,929
1935	2,447,528	.....	.....	2,447,528
1936	945,595	11,176	.....	956,771
1937	2,020,016	1,353,522	332,299	3,705,837
1938	6,814,900	8,000,000	4,132,328	18,947,228
1939	10,000,362	6,484,795	2,444,399	18,929,556
1940	3,940,638	9,286,261	1,330,266	14,557,165
1941	3,341,209	7,545,131	1,045,364	11,931,704
1942	10,621,360	10,942,956	1,975,888	23,540,204
1943	21,384,864	10,385,956	5,754,914	37,525,734
1944	18,433,574	22,418,704	11,869,555	52,721,833
1945	21,275,300	12,178,371	6,029,708	39,483,379
1946	18,069,274	3,950,804	2,122,539	24,142,617
1947	13,171,751	9,556,587	4,243,191	26,971,529

only two year classes entering the fishery. If there is a failure of one or both of the year classes to enter the fishery, there is no buffering effect of other year classes to ease the shock.

The California length-frequencies for the seasons 1924 to 1928 inclusive are shown in Figure 9. It will be noted that again there are two distinct size groups, indicating two successive year classes. The modes of these groups, however, are at a somewhat greater length than the modes of the Oregon albacore. This is due mostly to the fact that the California albacore were measured with a tape stretched over the side of the body, while the Oregon albacore were measured on a measuring board. However, even after converting the California data by means of a suitable factor to measuring board lengths, the large group of California albacore is a little longer than the comparable Oregon group.

NOTES ON THE JAPANESE ALBACORE FISHERY

The Japanese have conducted an albacore fishery for many years. There are two distinct fishing seasons, each in a distinct area. The so-called summer fishery, which begins in late April, reaches

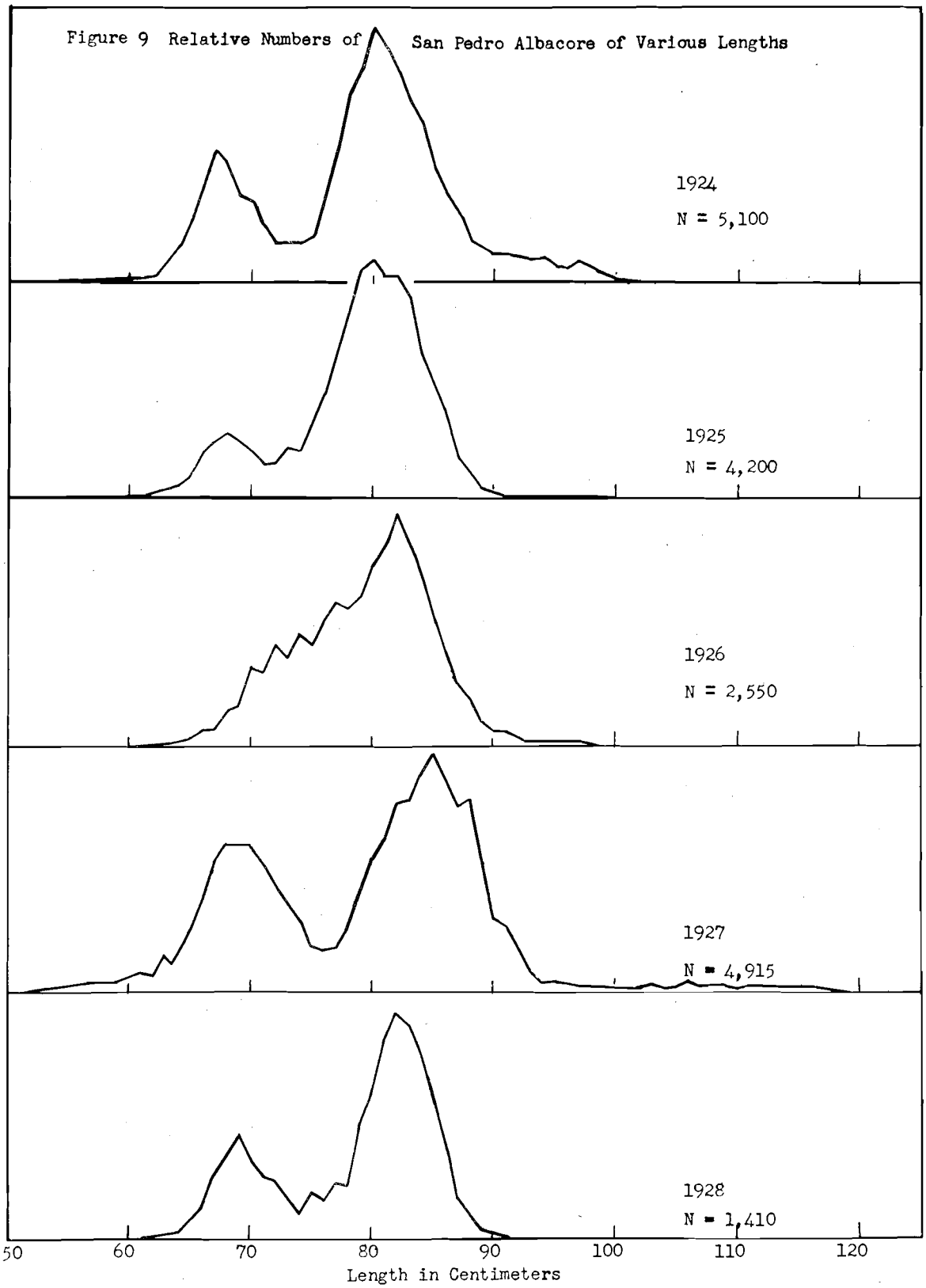


Figure 9 Relative Numbers of San Pedro Albacore of Various Lengths

a peak between the middle of May and the middle of June and ends in July. It occurs along the mainland coast of Japan, and is comparable with our fishery. The catch of this fishery has steadily declined each year. Prior to 1934 it exceeded that of the winter fishery, but the latter has been the more important since 1936.

The winter fishery was at first located roughly 200 miles east of the Japanese mainland, but has been progressively extended over the years. In 1931 the heaviest fishing occurred in an area bounded by the parallels 36° and 38° north latitude and between 146° and 148° east longitude, but by 1936 the area had shifted to that bounded by 27° and 35° north latitude and 161° and 176° east longitude. This is almost as far as the island of Midway, over 2,000 miles from Japan.

The winter season begins in October, reaches its peak between December and February, and ends in the middle of April. This schedule shows almost no variation from year to year, and the catch has tended to increase steadily. The water temperature in the period of heaviest winter fishing is between 63° and 66°F, while in the summer, coastal fishery most albacore are taken in water of 64° to 70°F.

The Japanese have divided the albacore into three size groups: large, 41.3 pounds and over; medium, 25 to 41 pounds; and small, under 25 pounds. They report that the fish taken from coastal waters—in the summer fishery—are smaller (from 8 to 33 pounds) than those taken on the deep-sea grounds, which include a fairly large number of large fish. In comparison with these figures the Oregon albacore in the 1947 season weighed between 6.3 and 33.5 pounds. The small fish at the modal length of 65 centimeters weighed 12.4 pounds, while the few large fish present, at an assumed modal length of 74 centimeters, weighed about 18 pounds.

The Japanese believe that the coastal albacore and the deep-sea albacore form two imperfectly connected groups from each of which schools migrate into the other. They believe that over-fishing has occurred in the coastal waters and that their coastal populations have become greatly reduced, large individuals particularly having almost disappeared from the fishery. There are no marked indications of depletion in the Japanese deep-sea albacore fishery.

The Japanese employ principally the long-line method in the albacore fishery. The average number in a crew engaged in the coastal fishery is forty. Tuna long-lines are measured in units of baskets, each unit being 350 meters long. Each unit has seven branched hook lines or ganging. On board the fishing boat the lines are kept in bamboo baskets with the hooks stuck into straw rope attached to the rim.

Summary

As a starting point for a planned investigation, the available knowledge concerning the albacore is summarized as follows:

1. The total catch of albacore is subject to extreme annual fluctuations, and is as yet unpredictable.

2. Between the years 1928 and 1935 the catch was negligible.

3. The coastal fishery is seasonal. About ninety per cent of the total catch is landed in July, August, and September.

4. Albacore are known to occur across the width of the north Pacific. There are important albacore fisheries in Japan and around the islands to the east; in the Hawaiian Islands and off the American coast. Albacore are not found in the tropical eastern Pacific.

5. The albacore of Japan, Hawaii and America are of the same species, *Thunnus germo*, and cannot be individually told apart.

6. Preliminary racial studies indicate, however, that the American albacore may be a distinct population which does not intermingle with those of Japan. The Hawaiian albacore appear to resemble the Japanese fish more than the American albacore.

7. If such is the case our industry is dependent upon a stock which may be confined to the eastern Pacific, and one not exploited by other nationals.

8. Albacore are caught on this coast only in surface waters on trolled lures or by chumming.

9. The fishery extends from the coast to considerable distances offshore.

10. Albacore are generally found in the warm, blue oceanic water, or on the boundary between the blue ocean water and the green coastal water.

11. There appear to be but two general size groups of albacore entering the commercial fishery on the Pacific Coast, one of which may be absent in the catch of particular years.

12. Pacific coast albacore have never been found in a spawning condition.

13. There is considerable information concerning the Japanese albacore fishery.

Proposed Program

The albacore fishery needs development. This, however, must be accompanied by the collection of those biological facts and fishery statistics which are essential to intelligent management of any fishery. The albacore population when fully exploited will yield to the industry an annual tonnage in proportion to the size of the stock and to the annual spawning increment. The determination of this tonnage, i.e., the proper rate of exploitation, is the ultimate goal of all fisheries research, and although the immediate problem is one of development, the final goal must be kept constantly in view and the necessary data progressively accumulated.

The development of the fishery involves exploratory fishing, both vertically from the surface down to practical depths and horizontally from the coastline offshore. The extent of the coastline and the water area involved are extensive and the time required to explore this region will depend upon the boat facilities available, but the work should be continued until the whereabouts of albacore throughout the year is known.

When the exploratory work is completed the location of the rearing grounds should next be investigated because an appraisal of the abundance of each incoming year group will ultimately afford a basis for the prediction of the relative success of each subsequent seasonal catch.

In connection with the search for rearing grounds preliminary hydrographic observations should be made in order to test the correlation between various oceanographical factors and the movements of the adult fish.

A concerted effort should be made immediately and continued until successful to duplicate and check the preliminary population (racial) study completed by California. This project is of major importance because it is essential to know with a degree of certainty whether the stock of albacore which we exploit is confined to this coast or is shared by the fisheries of Japan and Hawaii. The answer to this question will be available as soon as specimens or comparable measurements are secured from Hawaii and Japan. Negotiations are now under way to obtain this material.

The determination of age, rate of growth, and size at maturity must be undertaken. These data are essential to the proper management of the fishery.

Studies should be started, or continued as the case may be, based on existing information, of the fundamental relationships existing between:

(a) Catch and effort, which are necessary to determine the proper rate of exploitation.

(b) Catch and environmental factors, with the view of ultimately predicting if possible the relative success of the summer run.

(c) The size composition of the commercial catch and the tonnage landed, in an attempt to correlate the contribution of a given size (or age) group with the tonnage landed in succeeding seasons. For this purpose regular sampling of the commercial catch should be continued in the three states.

A study should be started, based on existing records and continued as more accumulate, of the apparent movements of albacore along the coast in the course of the summer season. Casual inspection of the catch statistics offers little hope of deciphering any pattern of migrations.

Nevertheless a careful study of such records may reveal a clue to the onshore and offshore or coastwise movements of albacore which would be invaluable in connection with the exploratory work.

Continuous efforts should be made to improve the methods of collecting accurate and detailed

statistics in regard to the catch of albacore and the fleet engaged in this fishery. It is important to know the exact catch in pounds of individual boats per trip; the size of boats; the type of gear used, and the general location where the catch was made. Although other information is desirable, such as the number of men in the crew, the length of trip, etc., the foregoing items are those of primary importance.

In connection with statistics, it is also desirable to collect log-books from representative vessels in the fleet. The value of this lies in the fact that such log-books, properly kept, serve to give a general seasonal picture of the prevailing conditions (in regard to weather, behavior of fish, bait, conditions, etc.), affecting the entire fleet within an area.

Although the program outlined applies exclusively to albacore, it is very probable that much will be learned incidentally concerning the bluefin tuna, *Thunnus thynnus*. The latter, like the albacore, is temperate in distribution, and there is a general similarity in the behavior and seasonal occurrence of the two species. There are indications that bluefin also occur in the Pacific Northwest in commercial quantities, and the possibility of discovering the whereabouts of bluefin tuna at various seasons should be emphasized in the exploratory work.

Modifications of this program would necessarily be made as the work progressed, but if it were properly and vigorously carried out, it would afford in time the information needed for intelligent management of the fishery.

Immediate Program

Reference to the time required suggests a review of necessary facilities to expedite the work. The time needed to complete the outlined program is purely a function of the size of the staff engaged and the facilities at their disposal. At present, Washington will assign one man part-time to the albacore work. Oregon has assigned to this fishery as much of one man's time as facilities and circumstances warrant. California has two men working on the tunas, and in all probability one of these two men will devote his full time to albacore. In regard to facilities, only California has an ocean-going research vessel suitably designed and equipped for the albacore work. With the one vessel (or such of her time as can be spent on albacore) and the foregoing staff the following projects are now under way or will be started in the current year.

1. The exploratory work, which will be conducted from California to British Columbia onshore and offshore, using drift gillnets of varying mesh-size to locate the fish, will start as soon as the necessary nets are delivered.

2. Arrangements have been completed to secure measurements of Japanese albacore, and the data will be analyzed as soon as it comes to hand. Attempts will be made this summer to obtain similar measurements from Hawaii and it is hoped that the population (racial) study can be brought to completion this year. In the meantime the preliminary population study by California at the outbreak of the war will be released and published immediately.

3. Preliminary age determinations may possibly be attempted this year. An analysis of the size composition of the catch is being undertaken. Sampling the commercial catch in Oregon will continue and will be resumed in California this summer.

4. The collection of statistics in the three states is already a part of the permanent program.

5. The issuance and collection of log-books will be initiated this summer by the three states.

Such are the plans of the Tri-State staffs for the current year. No phenomenal progress should be anticipated because each staff member has other responsibilities and a vast amount of time-consuming clerical and routine work is involved. Furthermore, the availability of a research vessel is a primary limiting factor, and California's vessel has much else to do in other major fisheries. If more rapid progress is desired it will be essential to provide at least one vessel for full time work on albacore, with two biologists to work aboard; clerical help will also be required to handle the accumulated mass of statistical data collected since 1916. If the states of Oregon and Washington could each provide a research vessel—even though a small one—the allocation of vessel-time to the several important fisheries could be more adequately coordinated.

In the event that it is possible to launch a large-scale, intensive investigation of the albacore, a

committee of the Tri-State staffs has drawn up for consideration an outline of the staff and facilities needed for such a project, with (roughly) estimated costs.

SUGGESTED STAFF AND BOAT FACILITIES NEEDED FOR INTENSIVE ALBACORE INVESTIGATION

BOATS:		
1 Approximately 115′ ocean-going research vessel, equipped for tuna work	$300,000	
1 Approximately 70′ research vessel for coastal work, equipped for tuna work	180,000	
		$480,000
UP-KEEP OF VESSELS:		
On 115′ Vessel—		
Salaries for nine-man crew, per year	$32,640	
Operation and maintenance, per year	25,000	
	$57,640	
On 70′ Vessel—		
Salaries for six-man crew, per year	$23,160	
Operation and maintenance, per year	18,000	
	$41,160	
STAFF:		
1 Senior Biologist, in charge, @ $450	$ 5,400	
2 Assistant Biologists, to handle major biological problems, @ $375	9,000	
6 Junior Biologists, to do field and boat work, @ $275	19,800	
6 Clerical and Stenographical Assistants, @ $180	12,960	
	$47,160	
Total annual regular expenditures		$145,960

CRAB FISHERY

Introduction

The past ten years have seen huge increases in the numbers of Dungeness crabs landed in California, Oregon, and Washington. The catch figures show a consistently rising production for all areas, with no striking evidence of a tendency to decline as yet, with the possible exception of Oregon. The annual catches in dozens of crabs are shown in the following table.

TABLE 13. CATCH OF CRABS IN CALIFORNIA, OREGON AND WASHINGTON, IN DOZENS OF CRABS

Year	California[1]	Oregon[2]	Washington[1]	Year	California[1]	Oregon[2]	Washington[1]
1935	153,341	85,365	49,104	1942	100,588	311,494	228,193
1936	96,325	95,339	74,964	1943	96,472	438,333	215,285
1937	67,823	196,466	109,230	1944	122,305	320,729	254,349
1938	161,254	239,788	116,167	1945	180,579	383,776	279,250
1939	248,043	231,153	135,614	1946	401,401	303,612	341,211
1940	214,539	268,640	205,953	1947	446,582	371,038	476,000*
1941	177,498	276,755	242,596				

Figure 10 contains these catches and trends in a graphic manner which shows the situation more clearly.

Existing Regulations

The existing regulations governing crab fishing vary considerably between the States. The more important laws are included in the table below.

TABLE 14. COMMERCIAL CRAB LAWS IN THE THREE STATES

	California	Oregon[4]	Washington
Size Limit[3]	6⅝ inches.	5⅝ inches.	6¼ inches.
Sex	Males only.	Males and females.	Males only.
Open Season	Dec. 15–Aug. 30 (Northern area). Nov. 1–Aug. 15 (Southern area).	12 months.	Oct. 1–June 1 (Puget Sound). Jan. 1–Sept. 30 (Coast).
Trawl Caught	Not over 500 lbs. per landing.	Not allowed.	Not allowed.

* Estimate.

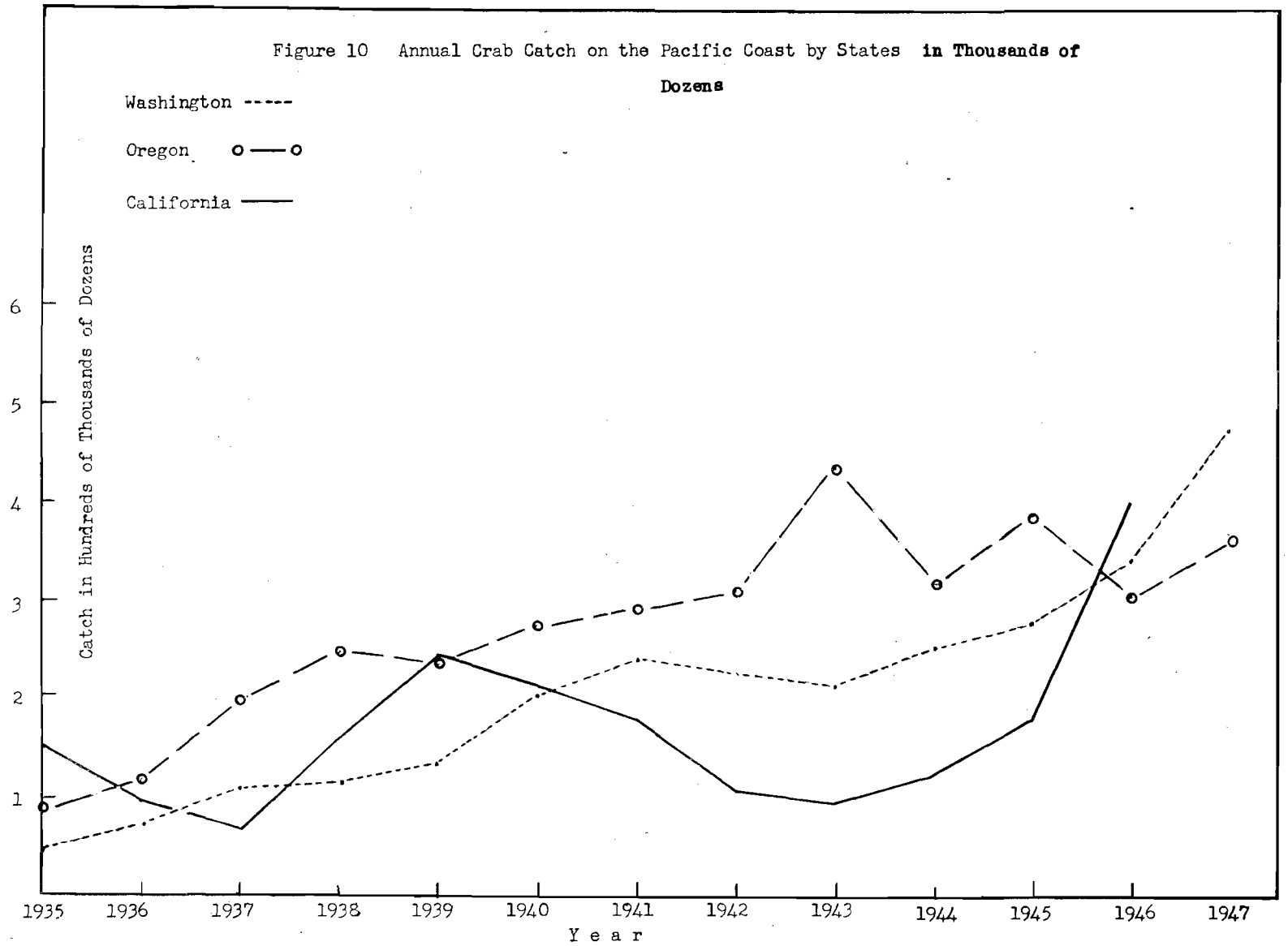
[1] Statistics on a calendar year basis, January through December.

[2] Statistics on a fiscal year basis, April 1 through March 31.

[3] "Shoulder to shoulder" measurement—i.e., excluding lateral spines.

[4] Oregon has adopted regulations which include a minimum size of ocean crabs of 6¼ inches across the back, a controlled closed season during soft-shell season, and a prohibition against the landing of female crabs.

Figure 10 Annual Crab Catch on the Pacific Coast by States **in Thousands of Dozens**



The major differences lie in size limits and closed seasons. While some crabs may be landed by otter trawl in California, this fishery is strictly limited to a low level.

Present Knowledge

From all appearances, a uniform coastwise closed season for moulting is neither practical nor desirable. Existing information in California and Washington shows that the present protective seasons are well adjusted to the moulting habits of the crabs. The earliest coastal shedding occurs in the San Francisco area, where the season closes on August 15 for a period of two and one-half months. Along the Washington coast, fishing is not allowed after September 30 for a three-month period. Oregon will presumably fall somewhere between these two periods. The closure there will be invoked as soon as the 1948 softshell season occurs.

The matter of size limits is a little more difficult to evaluate. To date, California has done little work in recent years to establish growth rates for the crabs in that area. The present limit of 6⅝ inches across the back inside the points appears to provide for the maintenance of the populations at high levels of abundance.

Oregon is now in the process of evaluating the effect of the fishery on her crab stocks. As yet the investigation has not been in operation for a sufficiently long time to yield conclusive information on growth, migration, or the mechanics of the fishery. However, work had begun in time last year to observe a portion of the softshell season in the vicinity of Newport, where it begins in late August or early September.

Washington has had the benefit of two years' observations, during which the life history and fishery for the crabs have been closely watched. The salient facts revealed by this investigation are:

1. Some of the crabs are large enough to catch (6¼ inches wide) when three years old, but the bulk of an age group do not enter into the fishery until they are four years old.
2. Although under natural conditions, many lived to be five or more years old, the growth rate slows greatly after four years. The crabs were no larger thirty years ago than they are under the present intensive fishery.
3. The fishery is very intense. During the 1947 season, approximately eighty per cent of the legal-sized crabs in the ocean off southern Washington were taken.
4. This did not decrease the size of the crabs in the catches. During the first two months of 1948, the individual crabs were larger than for the same period in 1947. The total stocks between Point Grenville and the Columbia River are somewhat smaller than in 1947. Last year, there were approximately six million legal-sized crabs on these grounds, but the best estimate for 1948 is about five and one-fourth millions.
5. The decrease in abundance seems largely the result of a smaller incoming year class in 1948. Estimates of the relative abundance of three year old crabs in 1946 and 1947—the year before they entered the fishery in full strength—were of the nature of 1.0:0.75.
6. Crabs are migratory to a surprising degree. After six months of freedom, the average distance traveled was fifteen miles. The smaller crabs tagged (5 inches—6½ inches) traveled further than did the larger. Between January and June, northward migrations predominated. Crabs tagged from trawl catches in 45 fathoms entered the commercial fishery to the same degree as those tagged in six fathoms.
7. Crabs are polygamous. Several individual crabs were observed to mate successfully with five females in a single week. The males mature sexually a year before reaching legal size. Generally over ninety per cent of the mature females carry fertile eggs during the winter months.

Future Plans

The plans for future studies include cooperative tagging plans on a coastwise basis for the purpose of defining the separate crab populations and evaluating the fishing mortality with its effect on the stocks. Wise interstate regulation will be impossible until the extent of interstate migration is known. During 1948, Washington and Oregon will tag and recover tags in a uniform manner both north and south of the Columbia River, which will eliminate any uncertainty concerning the extent of the north-south migration which was observed last year. Growth studies are underway in Oregon, which will result in the establishment of an effective size limit. California

will employ a man who will study these problems in conjunction with the Oregon staff. This combined operation will permit the maximum uniformity of regulation consistent with good management of the separate groups of crabs on the Pacific coast.

Recommendations

It is recommended that the closed season for softshelled crabs be invoked in Oregon in the late summer or fall of 1948. The actual period to be closed to be set by the Oregon Fish Commission when the crabs begin to shed. The present size limits in California and Washington afford effective protection for the crabs in both those areas. The majority of the three-year-old crabs are fully protected. Between the third and fourth year, the gain in weight of an individual crab is about 65 per cent, which more than compensates for any loss to predators. Because of this, it is inadvisable to take them at a smaller size. Since the growth of the population declines after the fourth year, it is not economical to increase the minimum size to afford further protection. Oregon will evaluate the rate of growth for their coastal crabs in the coming growth season, and if the rates appear similar to that in Washington, a common minimum size will be agreed upon.[1]

The tagging work should be extended down the coast to determine to what degree the stocks of crabs utilized in the various fisheries are independent.

The catch reports in California and Oregon should be changed to include the type of gear used in making the catch. This will make it possible to compare catches (and efficiency of regulation) in a coastwise manner.

ANCHOVY FISHERY

Introduction

The anchovy fishery along the coasts of Washington, Oregon, and California is still a minor fishery but it is gaining in importance. In former years anchovies were used mainly as bait in the pursuit of certain other fisheries. This is still the case, but in addition, since the fall of 1946 the canning of anchovies on a fairly regular basis has been done in California. This is a plain or tomato sauce pack in four-ounce and eight-ounce cans. In 1947, in California, about nineteen million pounds of anchovies were taken for canning and another five million pounds were used for bait. In Washington and Oregon the main importance of the anchovy is still as a source of bait for other fisheries, but recently there has been some experimental canning and preservation of this product.

The most important species taken is the northern anchovy, *Engraulis mordax*, which is found along the coasts of all three states. This is one of the larger anchovies found along the American coast, attaining a total length of 8½ inches. At least three other species of anchovies are found in Southern California but these are of smaller size and less abundant than the northern anchovy.

Existing Laws

There are very few restrictions that apply to the taking of anchovies along our coasts. There are no size limit, season, or gear limitations in the three states, except general regulations that apply to other fisheries as well, such as certain limited closed areas.

The existing laws of all three states permit the canning, or other forms of preservation as food of anchovies, as well as utilization in the fresh form as food or as bait for the capture of other fish. Reduction of loads of whole fish into oil and meal is not permitted under the wording of the present law in California and Washington, and is under Fish Commission jurisdiction in Oregon.

Although the canning of anchovies is permitted, none of the states have a minimum required case pack. If and when the consumer demand becomes satisfied in the future the tendency may be to pack less and run more whole fish through the straight reduction process. This would be particularly true when large loads of soft fish or of small fish came in and, perhaps were accepted under discount terms. An adequate minimum case pack requirement would compel packers to discourage very large loads and also loads of small fish not suitable for canning.

[1] Both a closed season for soft-shelled crabs and an increased size limit were placed into effect during the summer of 1948 in Oregon.

Past and Present Biological Studies

There has been little biological work done on the anchovy in the past because of the relative unimportance of the fishery from the commercial standpoint. The activities of the various staff members have been concerned with fisheries of greater importance.

A paper describing the eggs and the early larval stages of the Northern anchovy was published in 1936.[1] This work was done for Monterey Bay and the author mentions that anchovy eggs were taken in the south portion of the bay each month of the year, although a larger proportion of eggs were taken during the period December-June. The anchovy egg floats free in the ocean and hatches in about 62 hours.

Since September, 1946, when the canning of the anchovy started in California on a fairly permanent basis, samples of the commercial catch have been taken periodically for the purpose of ascertaining the sizes, ages, and size at maturity of the fish. The age of this fish can be ascertained from an examination of the scales. However, since the scales come off the fish readily, the collections must be watched so that too many regenerated scales are not included.

All the scale collections on hand have not been read yet but now that this fishery is one of mutual concern, activities along this line will be increased so that more definite information on the rate of growth and age at maturity of this species may be gathered.

Some preliminary scale examinations indicate that this is not a long-lived fish. It may attain a maximum age of only five or six years. Gonad examinations indicate that there is some spawning throughout the year even though there may be a period within which a large proportion of the fish spawn.

J. L. McHugh, working for his doctorate at the Scripps Institution of Oceanography, La Jolla, California, is making racial studies of the anchovies in California. At the completion of this work in the near future, it can be decided what is necessary to determine whether there is a homogeneous stock along the entire coast, or whether there are a number of somewhat independent races that may entail more detailed management.

There is a need for accurate records of the amount of this as well as other species taken for bait and other incidental uses. The marine sport catch statistical system in Southern California will continue to provide an estimate of the amount of bait used by marine sports fishermen in that region. This is the only region at present along the coast where there is a sports fishery using a significant amount of this type of bait. Also, the states will strive to obtain records of the approximate amount of anchovies or other bait used by tuna boats. If these vessels are provided with log books, the number of scoops and kind of bait required to make a catch could be entered there. Records should be demanded of bait dealers even though they deliver to tuna boats.

Recommendations

California should continue to obtain records of the amounts used for bait in the marine sport catch. California, Oregon, and Washington should attempt to obtain the amounts used as bait by tuna boats. Records by bait dealers should be demanded even though they deliver to tuna boats.

Anchovies should be reserved for bait and canning and other forms of preservation wherein the product is used directly as food. No permits should be granted for the reduction of whole fish into oil and meal. In connection with canning, a minimum case pack requirement should be set up to discourage excessive reduction of whole fish.

The maximum commercial utilization of this resource should not be hurried because along with the herring, and pilchard (sardine) found along our coasts, the anchovy is an important forage fish that feeds on the plankton in the ocean and in turn furnishes food for countless predatory fishes.

[1] "Embryonic and early larval stages of California anchovy, *Engraulis mordax*," By Rolf L. Bolin, California Fish and Game, vol. 22, no. 4, Oct., 1936.

SARDINE OR PILCHARD FISHERIES

The Fishery

The sardine or pilchard is fished from British Columbia to Mexico with the heaviest exploitation occurring off the west coast of Vancouver Island southward to the Columbia River and in California from Point Reyes south to the Mexican Border. The greatest catch occurred in 1936–37 when 790,000 tons were taken. In the succeeding seasons the catch fluctuated around five to six hundred thousand tons. In 1946–47 it dropped to 250,000 tons and will not be much greater than 100,000 tons in 1947–48.

Fishing is done with roundhaul nets, chiefly purse seines, operated from boats ranging from sixty to one-hundred feet in length and with a capacity of sixty to two-hundred-fifty tons. In the Canadian fishery two boats work together but on the Washington, Oregon, and California fishing grounds boats work independently. In the northwest, as a general rule, catches are made during daylight, whereas in California fishing is almost entirely at night, either before moonrise or after moonset. Throughout the history of the industry the California catch has comprised seventy per cent or more of the total and in many seasons more than ninety per cent.

Biological Information

Studies of size and age composition in the catch, meristic counts, and an extensive tagging program have demonstrated that all fisheries draw from the same population and that the fisheries on the various grounds place a drain on the common supply.

The population follows a general migratory pattern which is northward during the late spring and summer and southward in the fall and winter. Spawning takes place from February to July well offshore centering outside the Channel Islands in Southern California. Some spawning occurs both to the north and south of this region and in some seasons, when conditions are unusually favorable, heavy spawning may occur in the northwest or in Mexican waters.

The nursery grounds are along the sandy beaches, chiefly in northern Lower California and in Southern California. From these grounds the sardines gradually disperse throughout the range. The northwest fishery draws from the largest and oldest fish and the California fishery from all ages and sizes.

The rate of growth is relatively slow. Sardines mature at two to four years and live to fifteen or more. From the time they are a few months old until about a year and a half they are exploited by the live-bait fisheries in California and to a limited extent in Oregon and Washington. Fish two to eight years old furnish the main supply of sardines for the canning and reduction plants along the entire coast.

The survival from each year's spawning is variable. Some year classes have been outstandingly abundant and others very sparse. This variation in spawn survival plays an important role in governing the size of the population which supports the intensive fishery off the Pacific Coast.

Statistical Information

Records of individual boat catches are gathered by the British Columbia, Washington, Oregon, and California agencies. From these records statistical analyses have been made and measures of the return per-unit-of-effort and total effort expended have been calculated. Studies for Canada, Washington, and Oregon are not completed, those for California have been published for the period 1932–33 through 1941–42 and completed through 1946–47.

Coordination of Research

The Canadian and California authorities have carried on extensive biological investigations of the sardine. The U. S. Fish and Wildlife Service has contributed considerable time and effort to such studies and Washington and Oregon a more limited amount. All of the investigations are coordinated through an annual conference attended by the biologists working on these studies. At these meetings the previous year's work is reviewed, new lines of investigation discussed and the next year's program outlined.

Future Research

In addition to the routine investigations now being carried out, which comprise studies of the size and age composition of the catch from all fishing grounds and statistical analyses of the return per-unit-of-effort, certain additional investigations should be undertaken. For a comprehensive management program the most outstanding need is an early measure of the abundance of each new year-class and of the oceanographic factors which produce good or bad spawn survival. Also needed is a measure of the influence of oceanographic factors on the availability of fish on the fishing grounds. This varying availability may materially affect the measures of return-per-unit-of-effort.

To obtain this basic oceanographic information requires ships and equipment and personnel beyond the facilities of any of the organizations now studying the sardine along the Pacific Coast. California has taken the first steps to initiate oceanographic studies by providing funds to Scripps Institution of Oceanography to acquire and operate three vessels, and the California sardine processors have added fifty cents per ton to their tax to provide additional funds for such studies. The small catch of 1947–48 will unfortunately not furnish a very large sum for this work but the oceanographic program is gradually getting underway.

Recommendations for Legislation

The almost complete failure of the sardine fishery in the northwest and in Northern California in 1946–47 and 1947–48 and the very poor fishing conditions in Southern California in 1947–48 has thrown the industry into a serious financial crisis. Two schools of thought prevail concerning the causes of the present situation. The first is that, due to changing oceanographic conditions, the sardines have not been available on the usual fishing grounds. We have no information about possible changes in oceanographic conditions and do not know whether or not such changes have occurred. The biologists of the U. S. Fish and Wildlife Service, however, tend to consider the possible changing availability an important factor in producing the present poor fishing. If such is true presumably the sardines will return to the usual fishing grounds and no immediate plans for management would be necessary.

The second explanation is that an intense fishery coupled with several years in which spawning success has been below average has reduced the population to a low level of abundance. If this conclusion is correct, a management program should be considered. Biological information has established that spawn survival has been poor since 1939. The larger and older fish have largely disappeared from the catch and the fishery is mainly dependent on younger year-classes. If good spawn survival does occur presumably good fishing will result but continue only as long as recruitment of younger year-classes remains good. The fishery would thus be subject to fluctuations which at times might cause serious economic loss. The biologists of the three states agree in the interpretation that heavy fishing intensity and poor spawn survival have reduced the population to a dangerously low level and that management of the fishery should not be postponed.

If attempts at management are to be considered they should be based on an overall control of the annual catch. The usual management procedures such as closed seasons, closed areas and size limits are not practical in the sardine fishery. Closed seasons merely concentrate the fishery into a shorter time interval but do not decrease the total effort expended. Since the sardines are continually moving from area to area a closed area will offer no protection. Size limits are not feasible due to the nature of the fishery. With roundhaul nets it is not possible for fishermen to catch certain sized sardines and avoid smaller sizes. This is especially true for fish of seven inches or greater. With the exception of the smallest sardines, fishes of all sizes intermingle on the fishing grounds.

Should it be possible to set up regulations in California for an overall control of the annual catch, the Pacific Marine Fisheries Commission could aid materially in getting corresponding controls in Washington and Oregon. Since California takes the major part of the catch the first constructive moves should come from California and the Commission could urge the initiation of such measures.[1]

[1] An annual bag limit of sardines, initially of not more than 100,000 tons and preferably of 50,000 tons, was recommended by the research staffs of California, Oregon and Washington at the August, 1948, meeting of the Pacific Marine Fisheries Commission. This catch would be allotted to the entire Pacific Coast until an increase in the stocks would warrant an increase in limit.

TABLE 15. SEASONAL CATCH IN TONS OF SARDINES ALONG THE PACIFIC COAST. EACH SEASON INCLUDES JUNE THROUGH THE FOLLOWING MAY

	British Columbia	Washington	Oregon	Total Pacific Northwest	California						Grand Total	California Percent of Total
					Floating Plants	San Francisco	Monterey	San Pedro	San Diego	Total California		
1916–17	.....	.....	.....	.....	.....	.....	7,710	17,380	2,440	27,530	27,530	100
1917–18	80	.....	.....	80	.....	70	23,810	41,340	7,360	72,580	72,660	100
1918–19	3,640	.....	.....	3,640	.....	450	35,750	32,530	6,810	75,540	79,180	95
1919–20	3,280	.....	.....	3,280	.....	1,000	43,040	16,580	6,410	67,030	70,310	95
1920–21	4,400	.....	.....	4,400	.....	230	24,960	11,740	1,520	38,450	42,850	90
1921–22	990	.....	.....	990	.....	80	16,290	19,220	910	36,500	37,490	97
1922–23	1,020	.....	.....	1,020	.....	110	29,210	33,170	2,620	65,110	66,130	98
1923–24	970	.....	.....	970	.....	190	45,920	35,040	2,780	83,930	84,900	99
1924–25	1,370	.....	.....	1,370	.....	560	67,310	96,330	8,820	173,020	174,390	99
1925–26	15,950	.....	.....	15,950	.....	560	69,010	61,990	5,710	137,270	153,220	90
1926–27	48,500	.....	.....	48,500	.....	3,520	81,860	64,720	2,110	152,210	200,710	76
1927–28	68,430	.....	.....	68,430	.....	16,690	98,020	67,900	4,650	187,260	255,690	73
1928–29	80,510	.....	.....	80,510	.....	13,520	120,294	119,250	1,420	254,484	334,994	76
1929–30	86,340	.....	.....	86,340	.....	21,960	160,050	140,540	2,620	325,170	411,510	79
1930–31	75,070	.....	.....	75,070	10,960	25,970	109,620	38,490	80	185,120	260,190	71
1931–32	73,600	.....	.....	73,600	31,040	21,610	69,080	42,660	260	164,650	238,250	69
1932–33	44,350	.....	.....	44,350	58,790	18,630	89,600	83,600	60	250,680	295,030	85
1933–34	4,050	.....	.....	4,050	67,820	36,340	152,480	125,050	1,750	383,440	387,490	99
1934–35	43,000	.....	.....	43,000	116,480	69,000	230,860	178,820	4,860	600,020	643,020	93
1935–36	45,320	10	26,230	71,560	150,830	76,150	184,470	138,400	10,650	560,500	632,060	89
1936–37	44,450	6,560	14,200	65,210	235,590	141,100	206,710	138,110	4,590	726,100	791,310	92
1937–38	48,080	17,100	16,660	81,840	67,550	133,720	104,930	109,950	380	416,530	498,370	84
1938–39	51,770	26,480	17,020	95,270	43,890	201,200	180,990	146,400	2,780	575,260	670,530	86
1939–40	5,520	17,760	22,330	45,610	.....	212,450	227,870	101,820	110	542,250	587,860	92
1940–41	28,770	810	3,160	32,740	.....	118,090	165,700	175,590	1,200	460,580	493,320	93
1941–42	60,050	17,100	15,850	93,000	.....	186,590	250,290	148,910	1,580	587,370	680,370	86
1942–43	65,880	580	1,950	68,410	.....	115,880	184,400	201,510	2,870	504,660	573,070	88
1943–44	88,740	10,440	1,820	101,000	.....	126,510	213,620	135,310	2,690	478,130	579,130	83
1944–45	59,120	20	.....	59,140	.....	136,600	237,250	178,290	2,770	554,910	614,050	90
1945–46	34,300	2,310	90	36,700	.....	84,100	145,520	173,110	950	403,680	440,380	92
1946–47	3,990	6,140	3,960	14,090	.....	2,870	31,240	194,720	4,770	233,600	247,690	94

These records have been supplied by the governments of Canada, Washington, Oregon, California, and the U. S. Fish and Wildlife Service.

SHAD FISHERIES

Introduction

The shad fisheries of Washington, Oregon, and California produce annually over three million pounds of fish valued at approximately 800,000 dollars. Seth Green introduced the shad to the Pacific Coast in 1871 when he planted 10,000 in the Sacramento River. This plant was followed by many others. The first plants were successful and in 1879 several thousand were marketed in San Francisco. The first shad seen in the Columbia River were caught in 1880. These fish must have been among those planted in the Sacramento River in 1871 and 1873 or their progeny. The first plant in the Columbia River was made in 1886. The market for shad on the West Coast has never been large enough to cause an unlimited demand consistent with the available quantity of this fish.

Sport Fisheries

Minor fisheries are supported by the shad wherever they occur in abundance. In Oregon and Washington the sportsman is unrestricted. In California there is no closed season, but there is a possession limit of five between June 10 and March 14.

Commercial Fisheries

Shad are taken commercially only by gill-netting in the larger rivers and bays.

The restrictions are imposed primarily to protect the salmon and steelhead in Oregon and the striped bass in California. Because shad are valued principally for their roe, the seasons are usually confined to the time of the spawning migration. In some Oregon rivers the spring run salmon are protected from incidental capture by a late opening of the shad season. The maximum mesh sizes

protect salmon from gilling, and the minimum restrictions are for the protection of trout and striped bass.

On the Columbia there is a weekly closed period from 6 p.m. Saturday to 6 p.m. Sunday. On the Sacramento the weekly closed period is from sunrise Saturday to sunset Sunday.

SEASONS AND MESH LIMITS

River	Open Season	Mesh Limit	
		Minimum	Maximum
Columbia	Entire year	5½	6½[1]
Siuslaw	May 15–July 1	5	6¼
Coos Bay	April 1–June 30	4½	6½
Coquille	April 1–June 30	4½	6½
Umpqua	May 10–July 1	6	6½
Sacramento-San Joaquin	March 15–June 1	5½	None

The fluctuations in the catch reflect economic conditions and to some extent the relative abundance of salmon at the time of the shad season. Therefore, they cannot be used to gauge the size of the shad population.

The commercial shad fishery of California will cease to exist if an initiative petition being circulated now is approved by the voters in November.[2]

TABLE 16. SHAD CATCH OF WASHINGTON, OREGON, AND CALIFORNIA, IN 1,000'S OF POUNDS

	Columbia River			Other Rivers Oregon	Total Oregon	California	Tri-State Total
	Washington	Oregon	Total Columbia River				
1928	576	636	1,212	647	1,283	2,089	3,948
1929	598	778	1,376	300	1,078	1,603	3,279
1930	582	783	1,365	497	1,280	1,199	3,061
1931	341	517	858	795	1,312	852	2,505
1932	89	229	318	397	626	1,173	1,888
1933	87	127	214	233	360	1,158	1,605
1934	167	492	659	417	909	873	1,949
1935	66	355	421	391	746	1,602	2,414
1936	57	249	306	417	666	2,273	2,996
1937	38	242	280	281	523	653	1,214
1938	53	117	170	288	405	1,339	1,797
1939	87	264	351	709	973	1,317	2,377
1940	111	253	364	537	790	1,764	2,665
1941	103	278	381	582	860	113	1,076
1942	195	325	520	656	981	2,572	3,748
1943	85	257	342	428	685	2,348	3,118
1944	228	380	608	598	978	2,689	3,895
1945	423	522	945	1,013	1,535	1,484	3,442
1946	788	658	1,446	1,428	2,086	771	3,645
1947	897	600	1,497	976	1,576	306	2,779

Since 1943 there has been a small fishery in Puget Sound that is not included in this table.

Biology

The adult fish enter fresh water to spawn in spring and return to the ocean in early summer. The young of the year go down to salt water in the fall. Shad are generally believed to return to the parent stream. The percentage of fish which may stray is unknown.

Because the salmon is preferred in the markets, shad are likely to be in danger of overfishing only on those rivers where there is a closed salmon season or poor salmon fishing at the time of the shad run.

For the past two years the Oregon Fish Commission has conducted a comprehensive study of the Umpqua River shad. The age and rate-of-growth have been studied and estimates of the escapement

[1] Mesh regulation applies only during periods closed to commercial fishery for other species.
[2] This initiative was defeated by the voters of California in November, 1948.

have been made. It was found that, under present regulations and fishing intensity, about fifty per cent of the total commercial-sized fish in the run escape the fishery. It is planned to continue this work in order to observe how these fish stand up under this fishing pressure. Such information is necessary in order to properly regulate the fishery. It is not planned to expand this investigation on a coastwise basis, except to freely exchange current investigational results.

Recommendation

It is recommended that until more evidence of need is available, interstate regulation of the shad fisheries should not be considered as necessary.

STRIPED BASS

Introduction

The striped bass has been included in this report because it supports important fisheries in both California and Oregon and because it migrates to a certain extent along the Pacific Coast. The discussion is purposely brief, because, generally speaking, information at hand indicates that striped bass problems will usually be local in nature. A possibility nevertheless exists that major interchanges of population between Oregon and California may occur, and this possibility cannot be ignored.

Striped bass do not occur in significant numbers along the Washington Coast.

History of the Pacific Coast Striped Bass Fishery

Striped bass were introduced into California in 1879; 132 were brought out from New Jersey in that year. In 1882 an additional 300 were brought west. Our present large population sprang from this small nucleus of less than 500 fish. The success of the introduction was phenomenal. In only twenty years the California commercial catch reached well over a million pounds a year. The species spread along the coast fairly rapidly. It appears to have been first noted in the coastal rivers of Oregon about 1900, and a few individuals were taken at the mouth of the Columbia River in 1906.

The California fishery is localized in the San Francisco Bay area where striped bass are caught throughout the year; only negligible numbers are caught elsewhere in the state. Extensive life history studies of striped bass have been made in California and in the east, in which connection reports by Scofield (California Division of Fish & Game, Fish Bulletin No. 29, 1-82), Pearson (Bull. U. S. Bureau Fisheries, Vol. XLIX, 825-851) and Merriman (Fishery Bulletin of the Fish & Wildlife Service, Vol. 50, 1-77) should be consulted.

The striped bass is one of the most highly esteemed sport fish in California, and it is estimated that over 100,000 individual anglers have fished for them annually during recent years.

Coos Bay supports the main population of striped bass in Oregon. The first one was taken there around 1920 but it was not until 1931 that the population had reached commercial proportions. In that year 18,000 pounds were landed. Since that time a large sport fishery for this species has developed in Coos Bay and the commercial catch increased to as high as 250,000 pounds in 1945. A few are also taken commercially in the Coquille River just south of Coos Bay.

The Umpqua River, about thirty miles north of Coos Bay, has a smaller run of these fish. They are present in the river from May to November and support a limited sport and commercial fishery. This is as far north as striped bass appear in any numbers although an occasional one is taken in the Columbia River. These fish are taken by the sport and commercial fishermen from the rivers and bays. Very few, if any, are caught offshore.

The striped bass in Oregon is not, in general, esteemed as highly as a game fish as are salmon and trout.

Preliminary studies on age, weight, and length indicate that these relationships closely approximate those found for California striped bass. Stomach analyses of Umpqua River bass show no salmonoids. Their diet consists of small crabs and flounders, shrimps, smelt, cottoids, and pilchards. The peak of seaward migration of young silver salmon is past before the bass appear in the river. The chinook migrants are in the river at the same time as the bass but are so few in number that the bulk of the bass diet consists of the more abundant species of forage fish. It has been reported

by Coos Bay fishermen that small salmonoids have been found in the stomachs of striped bass caught there. That such is the case seems likely since bass are taken there throughout the entire year and, therefore, would be present when the downstream migration of young silver salmon occurs.

Pacific Coast Striped Bass Catch

Available information on this subject is given in the tables which follow. Commercial catches in California are not included, because they are of historic value only. The commercial fishery in California was legislated out of existence in 1935.

Table 17 outlines the commercial catch for the State of Oregon. Although some of the fluctuations are due to economic factors, the trend reflects the increase in abundance of striped bass in Oregon during recent years.

TABLE 17. TOTAL COMMERCIAL CATCHES OF STRIPED BASS FOR THE STATE OF OREGON, 1931 THROUGH 1946

Year	Pounds Round Weight	Year	Pounds Round Weight
1931	18,050	1939	65,238
1932	17,594	1940	75,390
1933	21,198	1941	73,919
1934	25,774	1942	54,427
1935	27,598	1943	64,041
1936	29,254	1944	94,623
1937	32,832	1945	250,573
1938	42,501	1946	172,437
		1947	80,423

No satisfactory estimates of the magnitude of the sport catch are available.

Current Regulations—California

No commercial fishing or sale is permitted. The angling bag and possession limit is 25 pounds and one fish, or five fish. The minimum length limit is twelve inches.

Current Regulations—Oregon

Commercial fishing regulations are too complex to be outlined here. They are designed to protect salmon and steelhead, and protect striped bass only incidentally. Anglers are limited to a daily catch of fifteen fish. There is no closed season for angling.

Current Investigations

At present, in Oregon, the only work being done on striped bass consists of studies of the food habits of the Umpqua River striped bass. This work is being done primarily to determine the effects, if any, of their predation on the salmon populations.

It is planned to extend this study to include Coos Bay striped bass. It is also planned, but not for the immediate future, to conduct a tagging program to study the migrations of these fish within and between the various rivers.

In California an intensive study of the striped bass is being carried on along broad lines at the present time. It is designed primarily to collect data which will permit evaluation of fluctuations in abundance. A major share of attention is also being given to problems arising in connection with the Central Valley Project. Mammoth diversions in the Sacramento-San Joaquin Delta will draw water from the striped bass spawning grounds. Studies of striped bass reproduction in the Delta are being carried on to provide information upon which to base protective measures.

Recommendations

At the present time uniform regulations for the striped bass fisheries of California and Oregon are neither possible nor desirable, because of differences of conditions which exist in the two states. Regulation of the Oregon and California fisheries should accordingly rest with the states themselves.

There are several lines of research in which interstate cooperation may be desirable in the future. This will be particularly true of any large scale tagging program, although no such program is contemplated by either Oregon or California in the immediate future. Probably the most fruitful immediate step in the direction of interstate coordination will be the development of a well-organized arrangement for the sharing of the results of research as they become available.

OYSTER INDUSTRY

Introduction

The oyster industry itself is primarily one of private enterprise and as such does not enter into the scope of this commission. However, there is considerable transfer of oysters and oyster seed between different areas, not only within each state, but interstate and international as well. In these matters the commission should play an active part in regulating such transfers to protect the industry and valuable oyster growing land.

For a number of years the oyster industry has been of major importance in Washington and very recently has been expanding to considerable magnitude in Oregon and to a proportional extent in California. In a 1945 publication, the U. S. Fish and Wildlife service reported the total oyster production on the West Coast to be ten million pounds of meats. Expressed in terms of value to the producers, this represents between four and five million dollars annual income. At the present the production is considerably more than this 1945 figure and properly managed should continue increasing to still higher proportions.

Problems

In the past, transfers of oysters and oyster seed from both Japan and the East Coast have resulted in the unintentional introduction of other forms of marine life, a fair number of which have now become established in some oyster areas here. Some of these are serious pests, the most noted example being the Japanese Oyster Drill, *Tritonalia japonica,* while others of less consequence still inconvenience the industry. In both Japan and on the Atlantic Coast there are additional forms, which in their respective areas are of more serious consequence than those that have been introduced here to date. Whether or not any of these forms would establish themselves in our waters are moot questions at the present. It is known, however, that many of them may be introduced by careless transfers of oyster seed, and they must be considered as potential pests.

Present Laws

Under California law any biological forms introduced into any waters of that state must be approved by the Bureau of Marine Fisheries before introduction. The success of this system is shown not only by the lack of oyster pests which have been introduced into other areas lacking such restrictions but also by the fact that on at least one occasion it is actually known that this prevented introduction of the Japanese Drill.

At the present, Washington also regulates all transfers of oysters and oyster seed involving that state (effective since 1946). This law is administered by the Washington Department of Fisheries using a system of permits required prior to movements. Since the inauguration of this law there has been no further known spread of any pests.

To date Oregon has no regulations of any sort governing transfers of any kind. This is particularly unfortunate since the Oregon industry is now expanding, with a resultant great increase in the possibility of oyster pest introduction.

Although all three states are continuing to study and watch for pests as they may appear, no detailed investigations along these lines with the exception of one in Washington are being conducted or planned. It is felt that while more knowledge on this subject would be of value, the case is already proven as far as desirability of excluding certain forms. Furthermore, since this is an interstate problem, and the actions of any one state effect the industry in other states, it is believed that the matter should be considered by the Pacific Marine Fisheries Commission.

Recommendations

It is recommended that the following general regulations be inaugurated as soon as possible.

1. The State of Oregon should require inspection by the Oregon Fish Commission of any prospective transfers of oysters, oyster seed, or any material related thereof; all such transfers being subject to regulations promulgated by the Fish Commission.

2. Both Washington and Oregon should as soon as possible institute or revise their laws so as to cover all introductions of any exotic marine forms whatsoever, patterned after the law now in effect in California to assure that no forms are inadvertently introduced incidental to operations by other industrial operations.

3. While each state, being most aware of conditions within its own boundaries, should have its own regulations and inspections, the three states should cooperate and coordinate their programs to the mutual benefit of all areas and the entire industry. This is of utmost importance in the case of seed imports direct from Japan, in which particular case the Commission should issue a joint report to, and work with, representatives of the industry both here and in Japan, with regard to the quality of oysters transplanted.

DEVELOPMENT OF LATENT FISHERIES

The coastal fishing grounds off Washington, Oregon, and California are intensively fished and the populations thereon heavily exploited. Demands for additional supplies of presently utilized fish cannot be met from an increase in fishing intensity on the known grounds. To relieve this strain on the coastal areas and to increase production new grounds and species must be exploited and consideration should be given to the possibilities of such expansion.

Even the fisheries resources of the inshore waters are incompletely utilized. There are indications of virgin stocks of shrimp and scallops in relatively shallow waters along the coast. Only recently have a few fishermen become even mildly interested in developing these possible fisheries. Scad, hake, tomcod, anchovies, several species of bottom fish, and certain rockfishes are as yet either entirely overlooked or only landed incidentally to more sought after species by the industry along the Pacific Coast.

There are some indications that virgin populations of fish may exist well off the coast over and in deeper waters than are now fished. Reports of large schools of fish well offshore are not uncommon. In addition there are indications that our offshore waters contain populations of tuna and other large fish. Fur seals, inhabiting the offshore waters, must obtain food and such forage may comprise fish of commercial value.

The extent of the latent resources well off our coast can thoroughly be investigated only by experimental fishing. Small beginnings along these lines might be coordinated with tuna and oceanographic investigations as soon as provision can be made for offshore vessels to carry out these studies. Food studies of fishes taken in the present offshore tuna and salmon fisheries would also contribute information about the kinds of fish which might be available beyond our presently exploited grounds. Food studies of seals would also give some useful information. Such investigations should be set up and carried out when practical and possible with available equipment and personnel.

Dr. W. M. Chapman in the "Scientific Monthly," March, 1947, speaks at some lengths of the possible undeveloped fisheries beyond our present limited inshore fishing areas. He states: "The Pacific Ocean occupies about ten per cent more area than all the land in the world put together, and, while the land will produce only in its upper inches, the sea will produce in great variety to a depth of more than 1,000 feet."

There appears little doubt that, provided a proper exploratory as well as technological research program were instituted, the latent fisheries of the northeastern Pacific could become an active force in the expansion of the fishing industry of this section.

STATISTICS

It is agreed that detailed fish catch records are basic information needed in many of the investigations. The following points were discussed as general considerations applying to the three states. Special statistical requirements were discussed separately under each fishery investigation.

1. All three states have planned for and are collecting individual boat catch records so that catch can be analyzed as return per unit of fishing effort. The fact that the three forms of trip records differs is of minor consequence. Each gives catch per boat trip in pounds for each species.

2. Boat catch is affected by other factors than abundance of fish so supplemental data are needed. It is recommended that each state provide for its own system of recording improvements in fishing gear, developments in methods of fishing, changes in prices and market demand for certain species, use of new fishing grounds and similar data affecting catch.

3. It is recommended that each state provide that the fishing gear used and the locality of catch be recorded on the individual boat trip ticket. A system of serially numbered block areas in the ocean has been adopted by the three states.

4. In fisheries where duration of boat trip is commonly more than one day, it is recommended that trip records be supplemented, where needed, by daily pilothouse log books to show catch per set of gear. Daily logs for trawlers are now desired. The form of log may differ somewhat for each fishery but it is recommended that the form of log for any one fishery be standardized, where possible, between the three states by a free exchange of log forms before adoption by any one state.

5. Common names of fishes differ with locality and a uniform name for all states is not necessary. It is urged that each state adopt a list of official common names for that state with accompanying scientific names so that all may be sure what fish is referred to. It is recommended that these lists be exchanged before adoption so that uniformity in common names may be accomplished wherever possible.

6. The idea of one uniform boat number for the three states was discussed and abandoned as offering too many difficulties. For one thing, legislative changes would be necessary. It is recommended that each state provide its own boat numbering system and in those cases where a boat commonly fishes in two states it would carry two state numbers.

7. It is recommended that each state publish summaries of fish catch by calendar year and by monthly totals. Catch by fishing season will vary widely with locality and species but calendar year and monthly figures will be comparable. It is recommended that such publication of catch figures by each state be expedited as much as possible.

HYDROGRAPHIC STUDIES IN OCEANOGRAPHY

To collect adequate information for an intelligent management of Pacific Coast fisheries it will eventually be necessary to set up a program for the collection of data on changes in physical and chemical oceanography. Such environmental factors have direct bearing on the availability of fish on the fishing grounds. This in its turn influences our measures of the abundance of fish in the populations and on these measures are based the decisions about regulations and management programs. In addition oceanographic environmental factors influence the amount of survival from each year's spawning and the annual production of young fish constitutes the natural replacement to the stock on which the fisheries depend. We must know the factors which will lead to good or bad recruitment from year to year in order to set up intelligent management programs.

To obtain the necessary information about physical and chemical oceanography requires vessels working constantly at sea and an adequate staff of trained oceanographers to compile and analyze the data. Such a program is very expensive and cannot be undertaken immediately.

Preliminary plans for such work are being initiated in California with Scripps Institution of Oceanography arranging to operate three vessels and compile the data collected. These vessels will be able to run station lines from northern Lower California to central California, and Canada hopes to initiate similar work for the British Columbia area. Much valuable information will thus be collected which will be applicable to all fisheries.

A great deal more could be accomplished, however, if funds could be provided to operate one or two boats in the Washington, Oregon, and northern California areas. No provisions should be made for such vessels, however, unless funds are also set up for personnel and facilities to compile the data collected. Perhaps Scripps Institution of Oceanography could undertake the analysis of such data provided money was made available to hire the additional personnel required. This would aid in unifying the oceanographic work along the coast.

It is recommended that the Pacific Marine Fisheries Commission give thought to the expansion of oceanographic investigation on the Pacific Coast, based on the addition of one or two vessels to the present program plus additional trained personnel.

SUMMARY

Salmon

The salient features regarding each fishery have been summarized under each section and may be found at the end of the individual discussions. Only the more important phases are therefore gathered together here for consideration. Although a great many investigations have been made of the salmon inhabiting the rivers of the Pacific Coast, there is relatively little known of the ocean behavior of salmon and the factors at sea which affect their survival. Investigations of the ocean troll fishery

have been limited in scope, and until recently practically no restrictions were placed on the ocean salmon fisheries.

The basis for all management studies are adequate records from the fishery; with minor exceptions, these records are available for the commercial fishery, but as yet wholly inadequate for the sports fishery.

Gigantic water-development programs are proposed for all major river basins along the Pacific Coast. These pose tremendous obstacles in the maintenance of anadromous fish runs. In the case of the salmon resources, large hatcheries for artificial propagation are proposed to take the place of the natural rearing areas. Present hatchery methods have not proved successful enough to warrant optimism over this measure of amelioration. In general, unless artificial propagation increases greatly in efficiency and larger hatcheries become economically feasible the salmon resources cannot be maintained.

Moves are underway to eliminate the commercial fishing from the bays and river estuaries along the Pacific Coast. The salmon at maturity, when entering the rivers are at the prime marketable condition. Because of the many known factors adversely affecting salmon in fresh water and as yet uncorrected, and because of the many as yet unknown features of the ocean life of the salmon, it is believed that through an active coordinated management program the salmon runs can be maintained at high levels of productivity without the elimination of a valuable industry. The suggested closure of the California inland salmon fishery has no logical basis. The escapement into the Sacramento-San Joaquin River systems has been particularly heavy during recent years, and a heavier harvest, providing the populations remain at present high levels, of these stocks of salmon would be a sound conservation measure.

Cooperative studies of the ocean salmon fishery and the exchange of pertinent information on other phases of the salmon problems will begin immediately among the three Pacific Coast states.

Steelhead

The steelhead is the most widely distributed of the anadromous salmonids. Probably little intermingling of the stocks takes place between the three states, except in the Columbia River system.

Steelhead are similar to salmon except that they spawn more than once, and in general the problems involved in maintaining the steelhead runs are identical to those for salmon.

At the present time, steelhead are taken in large quantities by the recreational fishermen in California, Oregon, and Washington, but only in Oregon may they be taken commercially.

Although the steelhead sports regulations vary from state to state, in general, bag limits and seasons during the year are used to limit the take and protect the fish. No limit is placed on the total number of steelhead that can be taken, only the individual fisherman is limited. Ideally, only the annual production from a stream system should be taken.

Otter Trawl

More than twenty species of fish are included in otter trawl landings. The more important species are: the English, petrale, dover, and sand soles, the dogfish shark, several species of rockfish, black cod, ling cod, and flounders.

The soupfin shark fishery has been shown to be declining rapidly all along the coast until now it is hardly profitable. Since evidence is available that the soupfin migrate freely all along the Pacific Coast, coordinated regulations are necessary to rehabilitate the stocks.

Evidence is available that the populations of most of the valuable sole and flounders have been declining because of increased fishing intensity. Data is not yet available as to the intermingling of the stocks of bottom fish.

Otter trawl net mesh experiments in both California and Washington showed the advantages of using a five-inch mesh net over a smaller mesh in the added escapement of the younger immature fish. This corresponds with similar results on the east coast of the United States and in Europe.

A coordinated program designed to place into action a management plan along the entire coast is proposed as well as a suggested immediate cooperative program.

Tuna

Albacore fishing has violently fluctuated and suggests fishing is not fully exploiting stocks.

The American albacore may be a different stock from the Japanese and Hawaiian albacore.

In general the Pacific Coast fishery occurs on two size groups in most years, and the northern and southern fishery are fishing at about the same time of the year on the same size group. The fish are landed primarily in July, August, September, and October; the poor landings in some years appear to be due to the absence of one or the other or both size groups from the inshore fishing area.

The Japanese have two albacore fisheries, one occurring in inshore waters much as our present fishery; the other and larger Japanese fishery occurs about 2,000 miles offshore. The possibility comes to mind whether or not stocks do not occur in offshore waters of the Pacific Coast.

Coordinated studies on tuna will entail a large sum of money, considerable staff, and several years. Exploratory work offshore and experimental fishing as well as biological work is suggested. A tentative budget of $500,000 outlay and an annual operating budget of $150,000 for several years are suggested.

An immediate limited program for coordinated studies with the present limited staff is presented.

Crabs

A tremendous increase has occurred in the crab landings along the Pacific Coast in the past ten years. This fishery lands over one million dozens of crabs annually and the catch is still increasing.

The regulations vary all along the coast with Washington and California limiting both the season and size to a much greater extent than Oregon.

Crabs molt their shells to grow and during this soft-shelled condition are unfit for market. They are extremely vulnerable at this time and should be protected. The molting season varies all along the coast due to differences in the oceanographic conditions, and therefore, the season necessarily varies from state to state. The present size limit varies considerably between the three states with California's limit considerably greater than either of the other two states. Over two years of study have provided the State of Washington with adequate basis for regulation of the crabs. Both California and Oregon are beginning to evaluate the effects of the fishery on the crabs and will readjust their regulations after data are obtained. (See footnote 4, page 47.)

Anchovy

This fishing is still a minor fishery but promises to develop within the next few years. An expansion has already occurred in California, especially since the failure of the sardine catch.

The northern anchovies are being canned at the present time in California.

Few laws protect the anchovy at the present time; they may be used for food or for bait, but not for reduction.

Little biological work has been done on the northern anchovy, and the full extent of the available unexploited stocks are not known.

Preliminary scale examination in California indicates this fish is not a long-lived fish; probably living to a maximum of five or six years in California.

No good record is being kept of the catch along the coast; the portion of the catch used for bait for tuna boats is unknown at the present time.

This is a forage fish and is used extensively by other desirable species for food.

Sardines

This fishery extends from British Columbia to Mexico, and the fish are primarily reduced into oil and meal with substantial quantities canned.

The catch reached a peak in 1936-37 when 790,000 tons were taken and has declined to a probable catch of about 100,000 tons in 1947-48.

Studies have demonstrated that all fisheries along the Coast are derived from the same population, and fisheries on various grounds place a drain on the common supply.

The fish migrate north in the late spring and summer from California and south in the fall and winter to spawn mainly in southern California.

The Canadian and California fisheries agencies and the U. S. Fish and Wildlife Service have carried on extensive biological investigations of the sardine, and Oregon and Washington to a lesser degree. All investigations are coordinated at the present time.

The complete failure of the fishery during the past two years has caused a serious crisis in the industry, largely centered in California.

It is believed that heavy fishing intensity, coupled with a poor survival from spawning has reduced the populations to a dangerously low level. This may also be reflected in other fisheries using the sardines for food. Management of the fisheries should not be delayed and should be based on a control of the annual landings.

Shad

The shad fisheries of the three Pacific Coast states produce about three millions of pounds each year, valued at nearly one million dollars.

Present regulations on the fishery primarily protect salmon and steelhead in Washington and Oregon and the striped bass in California.

The fishery is confined to the time of the spawning migration.

Striped Bass

An important sports fishery for this introduced species exists in California and Oregon, with a commercial fishery landing about 200,000 pounds annually existing in Oregon.

Comprehensive studies are underway in California along broad management lines. Work in Oregon is being confined to food studies to determine whether this fish is a serious predator on young salmon.

Oysters

The oyster industry has expanded rapidly since the first introduction of Japanese oysters early after the turn of the century. The annual harvest is now valued at approximately five millions of dollars to the growers.

A problem of mutual concern is the danger of introducing serious oyster diseases and predators. These have already been introduced into Washington and have ruined much valuable land.

Present adequate laws are in effect in California and slightly less stringent regulations control the introduction and transfer of oysters in Washington. No restrictions limit the introduction or spread of diseases and pests in Oregon.

Latent Fisheries

Most biologists familiar with the Pacific fisheries agree that there are considerable undeveloped fisheries along the coast. To develop these resources will entail considerable exploratory research at a considerable expense.

Statistics

The basis for all fisheries management is comprehensive and accurate records of the fishery, both the landings of the various species and the amount of fishing necessary to make such catches.

It was agreed that certain basic data was necessary in order to have adequate statistical records for management. Certain phases of the necessary data are not uniformly available in all three states and recommendations for correcting this inadequacy were suggested.

Oceanography

Eventually a program of physical and chemical oceanography will be necessary to explain the occurrences and define the limits, availability, and movements of the fisheries resources of the Pacific Ocean. Maximum utilization of the resources of the sea will be possible only after an understanding of the environmental conditions.

RECOMMENDATIONS

General

While specific recommendations follow each section of the report, following are the salient features of the proposals suggested for cooperative studies and coordinated management of the Pacific Coast fisheries.

Long-term studies are recommended for *salmon, tuna, otter trawl* and *crab fisheries.* To accomplish these broad programs, encompassing all necessary aspects of fisheries management, within a reasonable span of time more funds for an expanded staff and additional equipment must be made available.

Cooperative programs are, however, recommended for all the above-mentioned fisheries, based on the limited funds and personnel now available to the three state agencies.

Our latent fisheries must be developed: first, by locating new methods of fishing and new locations where fish are found in commercial quantities; and second, by developing with the use of technological research methods of marketing little utilized species occurring in quantities in this section of the Pacific.

It is further recommended that studies of the ocean waters be carried out to determine the factors influencing the movements, occurrences, success of reproduction, and survival of fish in the ocean.

Specific

It is recommended that:

1. A more effective stream improvement plan be placed into effect on a coastwise basis, including improvement of spawning areas, removal of barriers, elimination of serious pollution blocks, effective laddering of natural and artificial obstructions, and the screening of diversions.
2. A study of methods of the evaluation of the fisheries resources, especially salmonoid fish, possibly with the aid of a competent economist be made.
3. An immediate study of the salmon troll fishery along the California-Oregon boundary be conducted with the objective of adjusting regulations to make them uniform in a single fishing area.
4. Regulated commercial and sport salmon fisheries be maintained on the inland waters of the Pacific Coast where studies indicate the resources can permit an annual harvest or where other controllable and correctable factors are the primary cause of the decline.
5. The legal status of the rights of the fisheries resources to an adequate water supply be ascertained.
6. Coordinated and uniform regulations of steelhead fisheries on the main stream of the Columbia River for both sports and commercial fisheries be formulated.
7. Free exchange of data being collected by each state on all fisheries will hasten conservation plans and prevent duplication of effort.
8. The tuna fishery not be curtailed now, but exploratory studies to further increase the range of the fishery and the yield be made.
9. The maximum utilization of the anchovy not be hurried because of the importance of this fish as food for other larger fish.

Improvements in Statistics

It is recommended that:

1. All three states inaugurate boat catch records and methods of measuring improvements in efficiency of fishing where not now in effect. Both are essential tools in analyzing catch records.
2. Each state provide a record of the gear used and the locality of catch on the individual boat trip ticket. The area caught be recorded by using the serially numbered block area system already accepted by the three states.
3. Each state adopt a list of official common names for that state of all fish caught with accompanying scientific names so all may know what fish is referred to. These lists be exchanged before adoption so that uniformity may be accomplished wherever possible.
4. Each state number its boats, licensed in that state, and each number remain with the boat indefinitely. Numbering systems between states would remain separate; boats fishing in two states would have two boat numbers. The boat numbers would accompany other information on each landing report.
5. Each state publish summaries of the fish catch by calendar year and by monthly figures.

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