23rd Annual Report of the

PACIFIC MARINE FISHERIES COMMISSION

FOR THE YEAR 1970

TO THE CONGRESS OF THE UNITED STATES AND TO THE GOVERNORS AND LEGISLATURES OF WASHINGTON, OREGON, CALIFORNIA, IDAHO, AND ALASKA

In Memoriam

Charles F. Henne

Wilbert McLeod Chapman

Milner B. Schaefer

Harry F. Linse

Errata for 22nd Annual Report of the Pacific Marine Fisheries Commission for the Year 1969

Please insert this sheet between pages 20 and 21 of your copy of the 1969 report. Figures 2 and 3 for troll-caught chinook and coho salmon have been corrected. The following corrected figures are from the 1970 Annual Report.

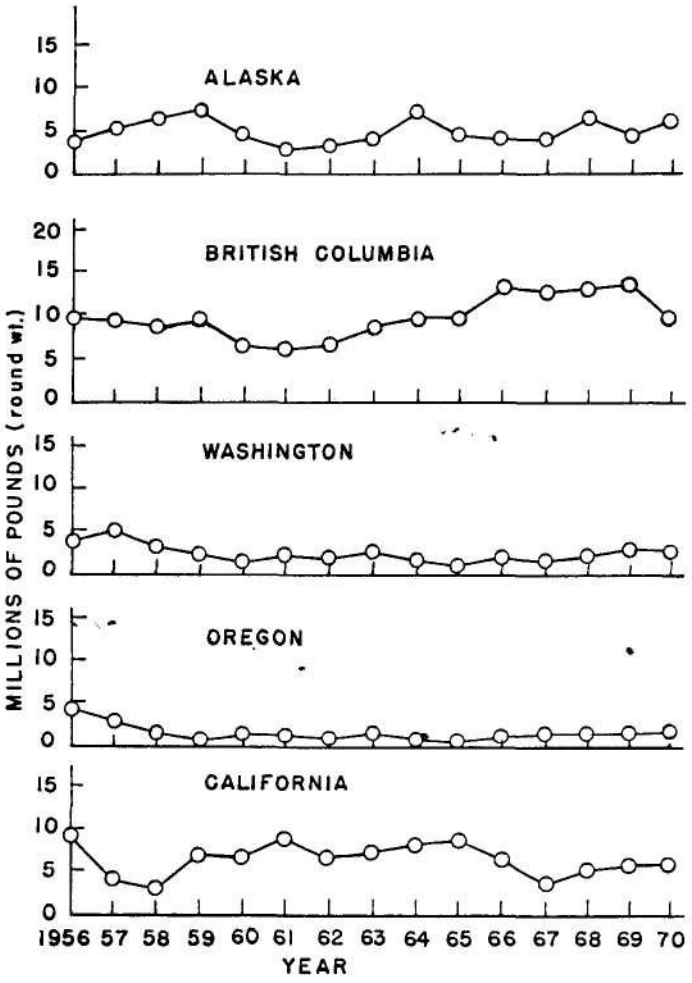

FIGURE 2. Pacific Coast annual troll chinook salmon landings by area, 1956-1970. (Figure 2 in last year's report indicated landings in British Columbia that were too high.)

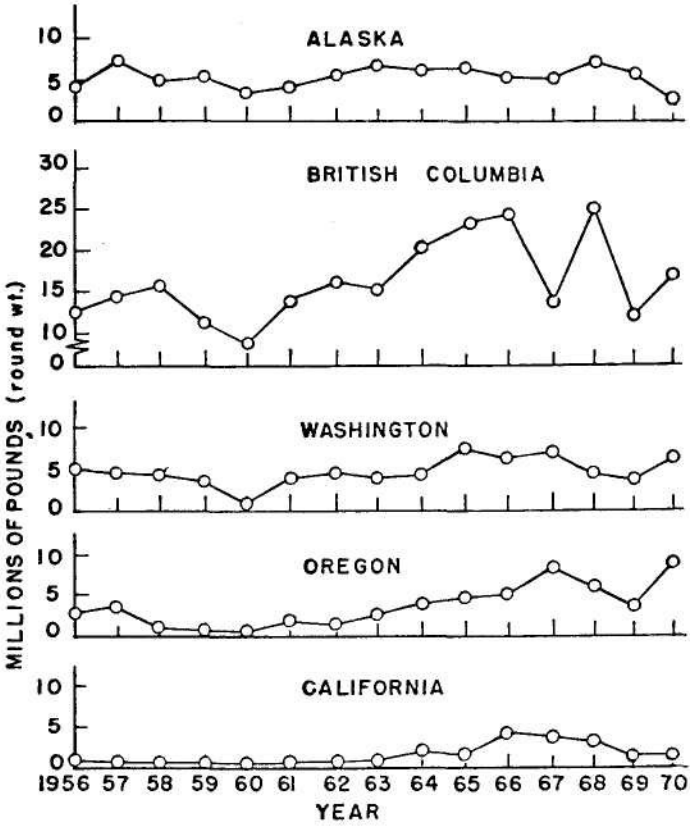

FIGURE 3. Pacific Coast annual troll coho landings by area 1956-1970. (Figure 3 in last year's report indicated landings in British Columbia that were too high.)

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INTRODUCTION

International

A number of important international actions relating to fisheries occurred in 1970. Nine Latin American nations, Argentina, Brazil, Chile, Ecuador, El Salvador, Nicaragua, Panama, Peru, and Uruguay, on May 8, at Montevideo, Uruguay affirmed the right of any coastal nation to extend its territorial limits to any distance desired—be it 200 miles or more; and to use freely and exclusively the natural resources of the seas and the sea beds within its claimed limits. This was followed in late May by President Richard M. Nixon's enunciation of a new Oceans Policy for the United States wherein he proposed that, "coastal nations act as trustees for the international community in an international trusteeship zone comprised of continental margins beyond a depth of 200 meters off their coasts." This is reminiscent of the resolution introduced by Malta in the United Nations several years ago. The United Nations General Assembly on December 18 called for a third Law of the Sea Conference to be held during 1973. The Conference will be preceded by two meetings of the United Nations Seabeds Committee in 1971 "to prepare for the Conference (of 1973) draft treaty articles embodying the international regime, including an international-machinery, for the area and resources of the seabed and ocean floor." The Conference of 1973 is to establish an equitable international regime to handle problems of "the continental shelf, the territorial sea (including the question of its breadth and the question of international straits) and contiguous zone, fishing and conservation of the living resources' of the high seas (including the question of the preferential rights of coastal states), the preservation of the marine environment (including, *inter alia,* the prevention of pollution), and scientific research." (See "Fisheries Loom Larger on the International Scene" by DeWitt Gilbert, National Fisherman Yearbook, Issue 1971.)

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Bilateral agreements among fishing nations were common in 1970 and included a number of agreements of interest to U. S. fishermen of the Pacific coast. Canada and the United States drafted an agreement on reciprocal fishing privileges applicable to both their Atlantic and Pacific coasts. Subsequently, Canada unilaterally indicated it could support extension of jurisdiction to the edge of the Continental Shelf; and drew fisheries "closing lines" to protect the fishery resources of large bodies of coastal waters, notably Hecate Strait and the Gulf of St. Lawrence. Canadian Minister of Fisheries and Forestry Jack Davis in late 1970 stated his belief that Canada, as well as other coastal states, "must be managers of the resources in waters over the Continental Shelf, and while others may be allowed to come in and fish, they have to fish under our routines and according to strict conservation." Canada and the United States of Soviet Republics entered into a bilateral agreement regarding fishing by Soviet vessels off the Pacific coast of Canada. Japan and the United States in Tokyo at the end of 1970 signed bilateral agreements for 1971 and 1972 which extend and revise previous agreements on fishing for king and. snow (tanner) crabs, groundfishes and saury off the Pacific coast of the United States.

Persistent attempts by the Republic of Korea to fish Pacific salmon on the high seas are of continuing concern to Canada and the United States and could lead to the termination of the International North Pacific Fisheries Convention wherein Japan agrees to abstain from fishing for salmon on the high seas east of 175° W. longitude. However, an important precedent regarding high seas fishing for salmon was established in 1970 when the International Commission for the Northwest Atlantic Fisheries (ICNAF) adopted a position limiting to 1969 levels the catch of Atlantic salmon and the salmon fishing efforts of member nations in the high seas of the ICNAF convention area.

National, Local and PMFC

The subjects of limiting entry to specific fisheries and the coordinated management of fisheries in the various jurisdictions (territorial waters, contiguous fishery zone, and high seas) were discussed frequently in 1970 both at the national and local level. A total of five proposals for extension of national fishing limits was received by PMFC and one of these. No. 13, "Extend Fishery Jurisdiction of the United States," (see page 18) was adopted as a Resolution at PMFC's Annual Meeting in Palo Alto, California, November 17-20. Resolutions dealing at the state or PMFC level with the coordinated regulation and harvesting of specific fishery resources were also adopted (see No. 4, "Uniform Opening for Dungeness Crab Fishery" and No. 17, "Trial Regulation of the Troll Fishery to Reduce the Catch of Coho Shaker," pp. 15 and 18).

The appointment in February of Philip M. Roedel, a long-time fishery scientist and administrator with the California Department of Fish and Game and an active participant in PMFC's affairs, to the directorship of the Bureau of Commercial Fisheries (Washington, D. C.) was one of the many changes affecting fisheries that occurred in the federal government during 1970. President Nixon's Reorganization Plan No. 4 on October 3 established the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce and brought together in one agency the governmental services concerned with the sea and air. This resulted in changing the name of the Bureau of Commercial Fisheries to the National Marine Fisheries Service (NMFS) and the transfer of the Service from the Department of Interior to NOAA in the Department of Commerce. NMFS was given responsibility for marine sport as well as commercial fisheries. The Bureau of Sport Fisheries and Wildlife remained in the Department of the Interior. On November 12 John S. Gottschalk resigned as

Director of the Bureau and was named Assistant to the Director of the National Marine Fisheries Service.

Walter J. Hickel, former governor of Alaska, resigned as Secretary of the Interior on November 2^5. He was succeeded as Secretary by Rogers C. B. Morton. Also leaving the Department of the Interior were Dr. Leslie L. Glasgow, Assistant Secretary for Fish, Wildlife and Parks; and Charles Meacham, Commissioner for Fish and Wildlife and Deputy Assistant Secretary for Fish, Wildlife and Parks.

Some other noteworthy fishery events in 1970 were: the merger of the Congress of American Fishermen with the National Fishermen and Wives in January under the name of the National Federation of Fishermen; the Fiftieth Anniversary Celebration Symposium of the College of Fisheries, University of Washington on April 2-7 in Seattle; and the Centennial Meeting of the American Fisheries Society on September 13-16 in New York.

The year 1970 might be referred to as the Year of the Environment. The National Environmental Policy Act of 1969 became law early in the year and gave rise to the establishment of a federal Council on Environmental Quality. "Earth Day" was observed nationally in many schools and universities on April 23. To the concern regarding oil pollution and persistent pesticides, such as DDT, was added concern about pollution and contamination of food chains by heavy metals. In line with concern about the environment, PMFC at its Annual Meeting adopted the following four Resolutions: No. 7, "Delta Facilities of the California Water Plan"; No. 10, "Urge Corps of Engineers and the Public Utility Districts to Take Necessary Steps to Reduce Nitrogen Supersaturation Levels in the Snake and Columbia Rivers"; No. 11, "Oppose Construction of Asotin Dam, Snake River"; and No. 12, Moratorium on Dam Construction, Middle Snake River""(see pages 16-18).

Due to deaths during the year, the PMFC and the fisheries of the Pacific Coast lost the following devoted fishery workers: Charles F. Henne, in March; Wilbert McLeod Chapman in June; Milner B. Schaefer, in July; and Harry F. Linse in September. PMFC at its Annual Meeting in November otisePved a moment of silence in honor of these departed men and adopted a Resolution in memory of each (see Resolutions 1, 8, 19, and 20 on pages 14, 17, 19 and 20).

The revision of the Pacific*Marine Fisheries Compact, particularly the new formula for membership contributions, became official when President Nixon on July 10, 1970, approved H. R. 13407, making that bill Public Law 91-315. This plus adoption by PMFC of a new "Goal and Objectives" (see page 9 for text) will facilitate administration of the Compact.

Pacific Coast Fisheries

The status of Pacific Coast fishery stocks[1] was mixed in 1970. Alaska's salmon pack, while below forecasts, was the second largest in 20 years, with the Bristol Bay red salmon catch of about 47 million fish producing a record canned pack for the Bay. The estimated troll catches in round weight of chinook and coho salmon for the entire coast, including the catch by Canadian trollers, were 26.1 million pounds of chinook and 36.1 million pounds of coho for a total of 62.2 million pounds, down 11.9 million pounds from the 74.1 million total for 1969. The 1970 chinook total was down from the 1969 total while the 1970 coho total was up. The estimated sport catches of these species plus steelhead trout were available for 1969. They indicated that the numbers of anglers continue to increase in most area, but that the 1969 total catches compared to 1968 were down for chinook, coho, and steelhead.

The 1970 estimated catches of shrimp (primarily *Pandalus jordani* and *P. borealis)* by Canadian and American fishermen off the West Coast totalled 95 million pounds, a new record for the 5th consecutive year. Approximately 74 million pounds of this total were caught by American fishermen off Alaska, mainly in the vicinity of Kodiak Island.

Pacific Coast trawl landings of bottomfish species by Canadian and American trawlers totalled about 139 million pounds in 1970. This is a 9% decrease from the 1969 total and a 6% decrease from the 10-year-mean total of 148 million pounds. Negotiations occurred for the export by Japan to the United States of pollock caught by Japanese vessels off Alaska. It is hoped that this event will encourage U. S. trawlers to exploit this huge resource which to date has been largely ignored by the domestic fishing industry. The intensive trawl fishing effort, especially that of foreign distant-water fleets, has depleted Pacific Ocean perch stocks off Oregon and Washington and appears to be a factor in the depressed yield of halibut to the American and Canadian longline fishery.

The States of Washington, Oregon and California reported combined estimated landings of Dungeness crab during their 1969—70 seasons of 47.2 million pounds, which is a record total. Alaska's and British Columbia's landings for the year 1970 were 9.7 and 2.5 million pounds, respectively, and were down from those of 1969.

The combined estimated landings of albacore in California, Oregon and Washington totalled over 56 million pounds, nearly 30 million of which were landed in California. However, 1970 marked the 5th consecutive year when a large portion of the annual albacore migration occurred off the Pacific Northwest. The domestic landings of other tunas which in general are caught in waters beyond the purview of PMFC were 234,000 tons, including landings in Puerto Rico and American Samoa, and were up 11% over the 1969 landings.

Prospects for increased landings or development of local fisheries on underutilized species are mixed. Landings in California of the very abundant anchovy resource continue to increase each year and during the August 1 to December 31, 1970 portion of the 1970-71 season they totalled about 118 million pounds. Hake off California, Oregon and Washington and pollock off Alaska continue to be only lightly exploited by American fishermen but continue to be heavily exploited

by foreign fishermen. The National Marine Fisheries Service is continuing exploratory fishing for Pacific saury and Japanese fleets are also attempting to harvest this unutilized West Coast resource which at times seems quite abundant.

ADMINISTRATION

Personnel

The following served as Commissioners during 1970:

Alaska

Wallace H. Noerenberg, Juneau
R. L. Rettig, Anchorage T. E.
Thompson, Petersburg

California

G. Ray Arnett, Sacramento, Chairman
Harold F. Cary, San Diego Vincent
Thomas, San Pedro

Idaho

R. J. Holmes, Twin Falls
Paul C. Keeton, Lewiston
John R. Woodworth, Boise, Third Vice-Chairman

Oregon

John P. Amacher, Winchester
John D. Callaghan, Salem
Joseph I. Eoff, Salem, Second Vice-Chairman
George L. Hibbard, Oregon City
Edward G. Huffschmidt, Portland
J. Pat Metke, Bend
McKee A. Smith, Portland
James Whittaker, Pilot Rock

Washington *•"■■«

Dwight S. Hawley, Seattle Harold E. Lokken, Seattle Thor C. Tollefson, Olympia, First Vice-Chairman

The Advisory Committee functioned under the "ADVI-SORY-RULES AND PROCEDURE" (Resolution #27, 1964; revised 1968) and consisted of the following members: *

Alaska

J. B. Cotant, Ketchikan, Section Chairman
Richard I. Eliason, Sitka
Ben Engdal, Wrangell
Charles A. Powell, Kodiak
Norman A. Riddell, Juneau
C. A. Weberg, Juneau
Charles Wells, Cordova

California*

Charles R. Carry, Terminal Island
Clifton D. Day, San Francisco, Over-all Chairman
Peter T. Fletcher, Rancho Santa Fe
John P. Gilchrist, San Francisco
Paul McKeehan, Santa Clara, Deputy Chairman
Anthony Nizetich, Terminal Island
Charles V. Williams, Crescent City

Idaho

John Eaton, Cascade
Robert G. Kalb, Sandpoint, Section Chairman
Glenn Stanger, Idaho Falls

Oregon

H. C. Buckingham, Newport
David B. Charlton, Portland, Section Chairman
Charles S. Collins, Roseburg
Harold C. Gramson, Warrenton
J. F. Hoagland, Astoria
Arthur Paquet, Astoria
Phillip W. Schneider, Portland

Washington

Jim Bolin, Seattle
Earl E. Engman, Tacoma
Warren H. Johnson, Arlington
Nick Mladinich, Tacoma, Section Chairman
Bjarne Nilsen, Westport
Jesse Orme, Seattle
John N. Plancich, Anacortes

Alternates were approved for those members who were unable to attend the annual meeting. These alternates serve only during the designated meeting.

The permanent staff comprised:

Leon A. Verhoeven, Executive Director
Gerald L. Fisher, Treasurer
Mrs. Evelyn Korn, Office Secretary

They were assisted for short periods by:

Alphonse Kemmerich, Consultant
W. Markham Morton, Consultant

Temporary clerical employees were utilized as needed.

Conferences and Meetings

Executive Director Leon Verhoeven represented the Pacific Marine Fisheries Commission at the following meetings and conferences during 1970:

Bureau of Commercial Fisheries special briefings: status of Master Plan for Fisheries, Seattle, January 7; analysis of the April 24, 1970, agreement between Canada and the United States regarding reciprocal fishing areas, and discussion of remaining Canada-U. S. fishery problems, Seattle, April 27.

American Fisheries Society, Oregon Chapter, Annual Meeting, Corvallis, January 16-17.

Fisheries and Wildlife Conservation Subcommittee of the House of Representatives Committee on Merchant Marine and Fisheries, hearings on fisheries legislation, Seattle, February 19.

Third Sea Grant Conference, Portland, March 5-6.

Bureau of Commercial Fisheries *ad hoc* Committee on Surveillance (of foreign fishing), Seattle, March 24.

Pacific Northwest River Basins Commission, Vancouver, Washington, March 27; review of Willamette Basin Comprehensive Study, Salem, Oregon, May 20; East Glacier, Montana, August 4-5; Boise, Idaho, December 2.

College of Fisheries 50th Anniversary, University of Washington, Seattle, April 2-7.

Pacific City Dorymen's Association, Pacific City, Oregon, May 16.

Columbia River Fishermen's Protective Union; discussion of salmon and steelhead in relation to pollution problems, Rainier, Oregon, June 25; nitrogen supersaturated water and other fishery problems, Vancouver, Washington, September 8.

Western Association of State Game and Fish Commissioners and Western Division, American Fisheries Society, Joint Annual Meeting, Victoria, British Columbia, July 13-16.

Conference on the Fishing Industry, sponsored by Congressmen John Dellenback and Don Clausen, North Bend, Oregon, August 18.

Dedication of Washington Department of Fisheries' salmon hatchery on Soleduck River, August 21.

Fish Expo '70 and Joint Meeting of Atlantic and Gulf States Marine Fisheries Commissions, Tampa, Florida, October 14-17.

Administrative and Service Activities

Executive Committee Actions: At its first meeting of the year on June 3 in Portland, the Executive Committee adopted or approved the following administrative actions:

1. -Plans for the Annual Meeting, November 17-20, 1970, at Palo Alto, California;
2. Operating budget for fiscal year July 1, 1970 to June 30, 1971;
3. Submission of the proposed budget for the biennium July 1, 1971 to June 30, 1973 for adoption by the Commission at the Annual Meeting;
4. Continuation of partial financial support for a technician on the federal-state unit for age determination of groundfish;
5. A policy that future Annual Meetings in the States of Alaska and California might be held anywhere within those States instead of being limited to sites in Southeastern Alaska or in San Francisco Bay and Northern California areas; and
6. Authorization by the Executive Director of additional meetings of committees of the Research Staff at PMFC's, expense, whenever he and the Research Directors agree a need exists.

At the June 3 meeting, the Executive Committee also took the following special actions:

1. Instructed the Executive Director to write Dana Wallace of the Maine Department of Sea and Shore Fisheries for information on the suggestion that the Atlantic States, Gulf States, and Pacific Marine Fisheries Commissions, plus the Great Lakes Fishery Commission, establish an office in Washington, D. C, to coordinate action and disseminate information on fishery legislation of interest to state conservation agencies, and also instructed the Executive Director to discuss the matter with personnel of the Atlantic and Gulf States Marine Fisheries Commissions when he attended their joint meeting on October 14-17, 1970. The Executive Director reported at PMFC's Annual Meeting that the instructions had been carried out but that the establishment of such a Washington, D. C. office did not seem practical at this time. If the Atlantic States Marine Fisheries Commission decides to move its office to Washington the suggested joint coordinating office might be reconsidered.
2. Instructed the Executive Director to ask the Canadian fishery agencies for a report on the results of the proposed cruise of the Canadian research trawler, 6. *B. REED* to simulate trawling by Soviet vessels, and to ask permission to put American scientists aboard the *REED* during the cruise. The cruise was made, American fishery agencies were furnished with a report on the results, and two American observers were generously taken aboard the *REED* on the cruise.
3. Instructed the Research Staff to prepare a proposal for a January 1 instead of a December 1 opening of the Dungeness crab season in all areas from Point Arena, California to but not including Puget Sound, and to prepare supporting arguments for the proposal for consideration at the Annual Meeting. (See Resolution No. 4, "Uniform Opening for Dungeness Crab Fishery," which was adopted at the Annual Meeting.).A one-page supporting report, prepared by the Research Staff accompanied the proposal. A detailed report "Condition, Yield, and Handling Mortality Studies on Dungeness Crabs During the 1969 and 1970 Seasons" by Herb C. Tegelberg was distributed and is reprinted herein (see Appendix 3—Special Reports).
4. Suggested the Research Staff members discuss with their respective administrative heads problems regarding lack of compliance with state laws concerning planting, transplanting and shipping shell fish and other aquatic organisms.
5. Asked the Director of the Fish Commission of Oregon to submit a proposal plus supporting arguments to PMFC, asking the State of Washington to consider adoption of a shrimp fishing season concurrent with Oregon's. Subsequently, this was made unnecessary by Washington's adoption of a regulation prohibiting the landing of shrimp

in Washington that were caught off Oregon during the latter State's closed season.

6 Agreed with the Research Staff's tentative conclusion regarding 1969's Resolution No. 9, "Uniform Opening Dates and Minimum-Size Limits in California, Oregon, Washington and Alaska Coho Troll Fisheries," that uniform salmon troll regulations for the entire coast are not necessarily the best means for optimum management of the salmon resources.

On November 17 the Executive Committee met again in preparation for the Annual Meeting at Palo Alto. The Committee approved as an emergency measure for consideration by the Commission Proposal No. 17, "Trial Regulation of Troll Fishery to Reduce the Catch of Coho Shakers," which was the only proposal received late. The Committee was advised that ratification of PMFC's revised membership contribution formula (ARTICLE X) was completed on July 1, 1970 when President Nixon signed Public Law 91-315 amending the Pacific Marine Fisheries compact. The reports of the Executive Director and Treasurer were reviewed, last minute details of the Annual Meeting were decided, a proposed site for the 1971 Annual Meeting in Seattle was accepted for recommendation to the Commission, and members of the Executive Committee for 1971 were nominated.

PMFC Standing Committees: The following committees of PMFC's Research Staff met in Portland on the dates listed: Groundfish, March 23-24; Shellfish, April 13-14; Salmon and Steelhead, April 20-21; and Research Directors, May 4-5. A meeting of the Albacore Committee was considered unnecessary. The Research Staff recommended that PMFC continue partial financial support of a technician working with the federal-state unit at the Bureau of-'Cornmercial Fisheries Seattle Laboratory to age groundfish. Standing committee members continued their vital contributions to PMFC's several data series (see Publications below).

The annual meeting to coordinate salmon and steelhead finmarking programs of Pacific Coast agencies was held in Portrand" on February 24 under the leadership of Executive Director Verhoeven. Requests and information from agencies that could not send representatives to the meeting were considered. Subsequently, PMFC's .office issued a 50-page 1970 Mark List, and during the remainder of the year distributed memoranda when necessary to advise the agencies of additions or revisions to that List.

Special Committee Responsibilities and Service Activities: Annual data on the propagation and conservation of salmon, on commercial fishing regulations concerning salmon and halibut, and on enforcement of those regulations in the States of California, Oregon and Washington were secured by PMFC's office and forwarded to the Office of International Relations, Bureau of Commercial Fisheries (subsequently National Marine Fisheries Service) in response to an annual request for these data which are compiled and forwarded via the U. S. Section of the International North Pacific Fisheries Commission to the Japanese Government.

The Executive Director served as liaison officer for the United States Section of the Trawl Fishery Committee of the Conference on Coordination of Fishery Regulations Between Canada and the United States. This Committee is more commonly referred to as the International Trawl Fishery Committee. On July 22-24, 1970, in San Francisco, he attended the Eleventh Annual Meeting of the Technical Subcommittee of this Committee. The statistics in the Bottom or Trawl Fish section of PMFC's Data Series are furnished by the member Canadian and American agencies represented on the Subcommittee. On November 18, in Palo Alto, the Executive Director served as Chairman of the Twelfth Annual Meeting of the International Trawl Fishery Committee.

The Executive Director continued to serve as one of the two United States members of the Informal Committee on Chinook and Coho. The Canadian and American Sections of the Committee did not meet together in 1970 but they corresponded frequently, and the Committee's Technical Working Group of Canadian and American fishery scientists met several times for purposes of drafting a joint or cooperative research program and exchanging information on Chinook and coho salmon.

The Pacific Salmon Inter-agency Council was inactive in 1970, but PMFC's Executive Director as ex officio secretary of the Council attended to administrative details concerning Phase 2 of the Salmon Compendium.

Publications in 1970: The 19th and 20th Annual Reports of the Pacific Marine Fisheries Commission for the Years 1966 and 1967 were published under one cover. (The 21st Annual Report for the Year 1968 had been published in 1969.)

Bulletin No. 7 (primarily concerned with biology of English Sole), was published.

Annual supplements containing 1969 catch and effort data to the (Dungeness) Crab and Shrimp section and the Bottom or Trawl Fish section of the Data Series were distributed to holders of copies of the sections.

COMMISSION ACTIONS

Action on 1969 Resolutions

Information on actions taken on resolutions adopted at the 1969 Annual Meeting was sent to all Commissioners, Advisors and Research Supervisors on November 5, 1970 as Appendix A to the "Report of the Executive Director, November 19, 1970." Additional copies of the Appendix and Report were available at the 1970 Annual Meeting.

All the 1969 resolutions, in addition to being sent to all attendants of the Annual Meeting in Sitka, were mailed or distributed as directed. The number and short title of each resolution, together with significant comments or actions taken on each, follow:

Resolution 1, Legal Status of Fish and Game: The United States Senate passed and forwarded to the House of Representatives, on December 8, 1969, S. 1232 "To declare and determine the policy of the Congress with respect to the

primary authority of the several States to control, regulate,, and manage fish and wildlife within their territorial boundaries; to confirm to the several States such primary authority and responsibility with respect to the management, regulation, and control of fish and wildlife on lands owned by the United States; and to specify the exceptions applicable thereto; and to provide procedure under which Federal agencies may otherwise regulate the taking of fish and game on such lands." The Senate-approved bill was assigned to the Subcommittee on Fisheries and Wildlife of the House Committee on Merchant Marine and Fisheries. Secretary of the Interior Hickel announced a policy of cooperation with state fish and game agencies, regarding fishing, hunting and management of fish and wildlife on federal lands. Subsequently, the Secretary, via a press release on September 16, announced publication of a new regulation for coordination of federal and state fish and game management. S. 1232 apparently died with adjournment of the 91st Congress.

Resolution 2, Delta Facilities of the California Water Plan: Governor Reagan, in an April 29, 1970 press statement, strongly supported early construction of a joint federal-state Peripheral Canal. Earlier, the California Assembly and Senate Water Committees favored the project, and sent endorsements to Secretary Hickel. The Pacific Marine Fisheries Commission is supporting the Delta Facilities in every way it can, since the far ranging king or Chinook salmon produced in the rivers of the Sacramento-San Joaquin area are important to fishermen and consumers beyond the boundaries of California's jurisdiction as well as to residents of that State.

Resolution 3, Opposition to Upper Columbia River Navigation Project and/or Ben Franklin Dam: Many Congressmen and Senators and the Bureau of the Budget replied to the resolution and its transmittal letter'of March 31, 1970, that they would keep PMFC's opposition in mind. On June 19, PMFC's office wrote Senator Stephen M. Young, Chairman, Subcommittee on Rivers and Harbors of the Committee on Public Works, with copies to other members of the Committee on Public Works, asking that the letter of March 31 and PMFCs resolution be considered at the Subcommittee's hearing on June 23, 1970. A September 11, 1970 release of the Department of the Interior stated that the Secretaries of the Departments of Interior and Agriculture had identified 27 streams for possible addition to the National Wild and Scenic Rivers System. Included in the 27 is the Columbia River from McNary to Priest Rapids. Mr. Lowell S. Johnson, representing the Washington State Sportsmen's Council, informed PMFC that the Corps of Engineers on October 6 advised the House Committee on Public Works that the navigation project was being submitted to Congress for information only, not authorization. The navigation proposal was not included by the Senate Committee on Public Works in the draft legislation of the Omnibus Rivers and Harbors bill. However, according to the *Wenatchee World* (Oct. 8, 1970), the proponents of the project are not giving up.

Resolution 4, Secure Agreement to Establish Offshore Conservation Zones Through Extension of Jurisdiction of Coastal State: Congressmen Dellenback, Dingell, Biaggi, and Senators Goodell and Packwood acknowledged receipt of copies of PMFC's transmittal letter of March 10, 1970 to President Nixon. Donald L. McKernan, Special Assistant for Fisheries and Wildlife to the Secretary of State, replied for President Nixon and also for Secretary of State Rogers. Enclosed with his reply was a copy of an address, by John R. Stevenson, Legal Adviser of the Department of State, regarding International Law and the Oceans. On March 10, 1970, Congressman Garmatz, *et. al.* introduced H. R. 16379, "To amend the Act entitled 'An Act to establish a contiguous fishery zone beyond the territorial sea of the United States,' approved October 14, 1966, to require that the method of straight baselines shall be employed for the purposes of determining the boundaries of such fishery zone, and for other purposes." On March 11, 1970, the Subcommittee on Seapower of the House of Representatives' Committee on Armed Services held an executive hearing on the territorial sea and continental shelf. The State of Rhode Island sent the United States Senate S. 204 memorializing Congress to adopt a substantial "offshore limit" of not less than 100 miles. "Limit" refers to fisheries. On April 27, the House of Representatives received H. Memorial 368 from the Legislature of the State of Alaska, relative to establishment of an exclusive fisheries zone for the United States; and Governor Miller of Alaska was quoted by the July 23, Portland *Oregonian* as calling for an immediate extension of the U. S. fishery zone to 200 miles offshore. On May 4, Congressman Clausen introduced H. R. 17426, to establish a continguous fishery zone (200-mile limit) beyond the territorial sea of the United States. The National Fisheries Institute at its Annual Convention, May 15-19, tabled a resolution urging a 200-mile or edge of continental shelf fishery limit. On November 20, 1970, PMFC adopted another resolution (No. 13, "Extend Fishery Jurisdiction of the United States") by a four to one vote.

Resolution 5, Study and Revise PMFC's Activities: Copies of this resolution plus copies of the September 1969 California draft of "THE OBJECTIVES AND GOALS OF THE PACIFIC MARINE FISHERIES COMMISSION" along with copies of the current "COMMISSION POLICY AND OBJECTIVES" from the Annual PMFC Report for 1962, were sent to 114 specific addressees with a request for comments and suggestions. Altogether, 31 replies (written and verbal) were received. These were summarized and listed and copies of the listing were sent to all respondents, plus other Commissioners, Advisors and Research Directors.

Subsequently the staff of the California Department of Fish and Game at the request of Chairman Ray Arnett prepared a second draft of "THE OBJECTIVES AND GOALS OF THE PACIFIC MARINE FISHERIES COMMISSION," which draft was referred by PMFC's Executive Committee to an Ad Hoc Committee with instructions to revise and to separate out those parts that belonged under rules and regulations. The Ad Hoc Committee submitted to the Executive Committee a third draft, with the title changed to "GOAL AND OBJECTIVES OF THE PACIFIC MARINE FISHERIES

COMMISSION" plus a draft of rules and regulations. Chairman Arnett appointed Robert W. Schoning to lead a discussion of these drafts at the 1970 Annual Meeting for purposes of securing their adoption. The following is the text of the goal and objectives that were adopted on November 20, 1970:

"GOAL AND OBJECTIVES OF THE PACIFIC MARINE FISHERIES COMMISSION

"Mutual problems of management of marine, shell, and anadromous fishes led the Pacific Coast states to form the Pacific Marine Fisheries Commission in 1947. By 1970 these problems had increased in number and complexity, and membership in the Commission had expanded numerically and geographically. Consequently, urgent need exists for solution of the economic, social, political, legal, and biological problems confronting fishery management, development, and utilization. The Commission, in light of present conditions, recognizes a need to reaffirm the goal of PMFC and to establish objectives to guide its future activities.

"GOAL

"The goal of PMFC is to promote the wise management, development and utilization of marine, shell and anadromous fisheries which are of mutual concern, and to develop a joint program of protection, enhancement and prevention of physical waste of such fisheries.

"OBJECTIVES AND ACTION PROGRAMS

"In order to accomplish the goal of PMFC*, the following pbjectives are established. Priority actions to accomplish these objectives are listed.

Objective I. Provide energetic leadership in recognizing and resolving fishery problems.

Action:

A. Establish an adequate secretariat.

B. Invite *all* federal and Canadian agencies concerned with fishery matters to participate in PMFC affairs in a nonvoting capacity.

C. Seek additional sources of funding tq carry out PMFG's programs and research.

D. Assist the federal government in inter national negotiations?

Objective II. Coordinate research and management projects relating to fisheries of concern to two or more states.

Action:

A. Publish data reports, mark lists, scientific papers, and administrative documents on a current basis.

B. Develop a coordinated plan to assess scientific knowledge as to the magnitude, distribution, and availability of unexploited or underexploited fishery resources, and to determine what additional inquiry is needed.

C. Develop a coordinated plan to monitor and assess the effects of foreign fishing on West Coast fishery resources.

D. Provide a mechanism for the collection and dissemination of information on the fishery resources, such as: life histories, ecology, management, and propagation. This would include, for example, cataloging and dissemin ating information on salmon research, man agement, and protection currently being done on the Pacific Coast, or encouraging studies leading to the identification of various subpopulations of marine and anadromous fishes.

E. Determine the division of responsibility for research and management projects of PMFC, as represented by the Secretariat, the member states, and the federal government.

Objective III. Develop PMFC positions and communicate them to the legislatures of the respective states, the Congress, the concerned agencies of federal, state, or local government, and to the private sector.

Action:

A. Monitor the opinions and activities of member states on environmental changes and water quality and propose appropriate action.

B. Poll member states on all important issues to coordinate state positions and develop, when appropriate, a single PMFC position.

C. Determine appropriate and definite ways and means to effectuate each PMFC position.

Objective IV. Propose compatible fishery regulations based on scientific evidence and with full consideration of ecological, biological, recreational, aesthetic, social, economic, and political matters.

Action:

A. Evaluate fishing regulations for compatibil ity and effectiveness on a coast-wide basis.

B. Evaluate the effectiveness of fishing agree ments with foreign nations.

C. Develop recommendations for regulations necessary to prevent overharvest.

Adoption of revised or updated rules and regulations was not completed at the 1970 Annual Meeting, however, their revision was subsequently agreed upon and their text will appear in the Annual Report for 1971.

* References to the PMFC throughout is to its member states and not to its Secretariat.

Resolution 6, Compile North Pacific Domestic Laws and Regulations Affecting Large U. S. Stern Trawlers and Request Scientific Observers: Commissioner Charles H. Meacham, U. S. Fish and Wildlife Service, replied to PMFC's request of October 31, 1969 that the Service would be glad to cooperate in the compilation of information on treaties, governmental agreements, laws and regulations affecting the operations of the *Seafreeze Pacific,* and he directed the Pacific Northwest Regional Office of the Bureau of Commercial Fisheries to collaborate with PMFC in the preparation of the compilation and in arranging for the placement of scientific observers aboard the vessel. U. S. Representatives Wendell Wyatt and Edith Green and Senator Robert Packwood offered assistance in expediting this matter. PMFC via an office memorandum of March 10, 1970, relayed to all its participants quotations and paraphrased excerpts from a compilation by the Regional Office of BCF, and advised the participants that the Executive Committee considered the request in Resolution No. 6 for information had been satisfied. Commissioner Meacham was thanked for his assistance.

Information on observers and cruises of the *Seafreeze Pacific* is as follows:

Cruise #1 November 14 to December 14, 1969, primarily off British Columbia and Washington-BCF's observers Charles R. Hitz and Richard W. Nelson;

Cruise #2 March 27 to April 7, 1970, primarily off British Columbia and Washington—International Pacific Halibut Commission's observer Ian R. McGregor;

Cruise #3 May 28 to July 13, primarily off British Columbia and Southeastern Alaska—BCF's observer Herbert H. Shippen;

Cruise #4 July 27 to October 14, primarily off British Columbia and Southeastern Alaska—BCF's observer Steven H. Rogers, until September 2, no scientific observer after September 2;

Cruise #5 October 25 to December 23,* 1970-primarily off Vancouver Island and northern Washington—without a scientific observer.

The *Seafreeze Pacific* because of its unprofitable operation was offered for sale and did not fish in 1971. The *Seafreeze Atlantic* is also for sale.

Resolution 7, Designate Authority to Deal with Oil and Chemicals Spills on Navigable Waters: On May 20, 1970, President Nixon proposed to Congress a "Ports and Waterways Safety Act of 1970" and asked for ratification of two new international conventions (1. preventative action against vessels on the high seas which pose an imminent pollution threat to national coastlines, 2. impose civil liability upon owners of vessels causing coastal pollution) and of amendments to the 1954 Convention for the Prevention of Pollution of the Sea by Oil. The President said he will ask Congress for $35 million to. set up a revolving fund to finance the clean-up of oil spills. The Secretary of Transportation has been directed to establish the Harbor Advisory Radar System in ports with much oil carrying traffic and to evaluate and promote recent tests of plastic bags for collection of oil from damaged vessels. The Coast Guard was directed to increase surveillance for oil spills. Local public and private authorities are asked to improve facilities for the disposal of oil wastes from ships. *(Congressional Record,* May 20, 1970, pages H 4571 and 4572).

Secretary of the Interior Hickel subsequently replied for President Nixon to PMFC's resolution by enclosing a copy of the "Water Quality Improvement Act of 1970" (Public Law 91-224 of April 3, 1970). According to Secretary Hickel, P.L. 91-224,

> "authorizes the President to remove or arrange for the removal of oil or hazardous substances discharged in navigable waters of the United States. It provides in addition for the development of a National Contingency Plan which is a policy guideline as well as an outline for action in the event of an oil spill. The Plan serves as a guide for the formation of strike forces capable of rapid response to oil spill situations. Federal manpower, material and methodology consonant with the Plan support and/or Supplement private, local and State cleanup activities, or perform independent cleanup activities in situations where others are not available or capable of providing adequate response.
>
> "The Plan also provides a schedule for chemical use by private. State and Federal authorities. This schedule sets conditions and limitations for use of chemicals in cleaning up oil spills. Except for fire hazard, or serious danger to human life or property, the use of chemicals to control oil must be approved by environmental control agencies."

The National Canners Association via its *Fishery Information Bulletin* of August 7, 1970 supplied the following:

> "Notice has been given that the Secretary of the Interior proposes to adopt a new part to the Water Quality Improvement Act of 1970, being administered by the Federal Water Quality Administration to prohibit the discharge of oil in U. S. waters that may be harmful to the public health and welfare.
>
> "The Water Quality Improvement Act of 1970 amended the Federal Water Pollution Control Act to add a new section to that act which provides in a subsection that 'The President shall, by regulation, to be issued as soon as possible after the date of enactment of this paragraph, determine for the purposes of this section, those quantities of oil the discharge of which, at such times, locations, circumstances, and conditions, will be harmful to the public health or welfare of the United States, including but not limited to, fish, shellfish, wildlife, and public and private property, shorelines, and beaches, except that in the case of the discharge of oil into or upon the waters of the contiguous zone, only those discharges which threaten the fishery threaten to pollute or contribute to the pollution of the territory or the

territorial sea of the United States, may be determined to be harmful.' The President by Executive Order of July 20, 1970 has delegated his authority under the new section to the Secretary of the Interior, who has determined the quantities, times, locations, circumstances and conditions under which the discharge of oil into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone is harmful to the public health and welfare of the United States as indicated in the proposed regulations published in the 'Federal Register,' July 24, 1970."

Subsequently representatives of petroleum companies and associations, such as the American Petroleum Institute, have contacted PMFC's office and members of the fishing industry for purposes of promoting informal discussions of mutual petroleum and fishing industry problems.

Resolution 8, March 15 Opening for the Chinook Salmon Troll Fishery: This proposal was rejected.

Resolution 9, Uniform Opening Dates and Minimum-Size Limits in California, Oregon, Washington and Alaska Coho Troll Fisheries: The Salmon and Steelhead Committee of PMFC's Research Staff discussed this resolution at its 1970 spring meeting and recommended to the Research Directors that a report on the resolution be made at the 1970 Annual PIVIFC Meeting and that a discussion of the salmon troll fishery be included on the Annual Meeting agenda. The "Review of Ocean Salmon Regulations Along the Pacific Coast," which was distributed at Sitka in 1969, and three recently prepared written reports, plus verbal reports on the preliminary results from the use of logbooks by the troll fleets of California, Oregon and Washington served as the basis for the discussion. The three recent written reports were:

"A Review of the Subject of Hooking Mortalities in Pacific Salmon *(Oncorhynchus),"* by Sam Wright, Washington Department of Fisheries,

"A Review of Trolling Gear Studies on Chinook and Coho Salmon," by Paul H. Reed, Fish Commission of Oregon,

"A Review of Chinook and Coho Shaker Catches in the Pacific Coast Troll "Fishery," by Patrick O'Brien, Steven N. Taylor, and Paul T. Jensen, California Department of Fish and Game. *

They are reprinted in Appendix 3 of this report.

Resolution 10, Retain Existing Fishery Attache Posts and Establish One in Peru: In late November 1969, the Department of State announced that the existing fishery attache posts were being retained. The National Fisheries Institute at its Annual Convention (April 15-19, 1970) adopted a resolution urging strengthening and expanding the Fishery Attache program. Additional fishery attache" posts have not been established to date because of budgetary limitations.

Resolution 11, Oppose Construction of Asotin Dam, Snake River: The Bureau of the Budget informed PMFC that no funds were currently in the President's budget for Asotin Dam, and that PMFC's opposition would be kept in mind. Senator Randolph, Chairman, Committee on Public Works, promised to keep PMFC's views in mind. Congressman Rhodes, a member of the House Appropriations Committee, stated that Asotin Dam was not a budgeted item and that it was unlikely the dam would be included in the 1971 budget bill. S. 3329 which was introduced by Senator Packwood to establish the Hells Canyon-Snake National River would prohibit construction of Asotin Dam.

Secretary of Interior Hickel and Secretary of Agriculture Harding, via Department of the Interior news release of September 11, 1970, announced the inclusion of 47 additional rivers or portions of rivers in the study category for possible addition to the National Wild and Scenic Rivers System. Among these 47 is the Middle Snake from Hells Canyon Dam downstream to Lewiston, Idaho, including the tributary Imnaha. The Secretaries warned,

"Selection of these rivers in no way prohibits planning, contruction, or programs to change existing uses in the river areas; however, such programs must proceed on the basis of a complete understanding of how existing values in the river areas would be altered."

The Idaho Fish and Game Department submitted a proposal for reaffirmation of Resolution No. 11, at the 1970 Annual PMFC Meeting.

Resolution 12, Moratorium on Dam Construction, Middle Snake River: The Federal Power Commission informed the Executive Director that his letter of January 6, 1970 and PMFC's resolution would be made part of the record of the FPC's hearings on the Snake River. According to the October 25, 1970 issue of the Portland *Oregonian,* Federal Power Commission attorneys have recommended against construction of High Mountain Sheep Dam or its two chief alternates (Pleasant Valley-Mountain Sheep and Appaloosa-Mountain Sheep).

The Senate on May 15, 1970 amended and passed S. 940, whfch had been introduced by Senators Church and Jordan in 1969. The amendment changed the 10-year moratorium provision of the bill to an 8-year moratorium on construction of additional dams on the Middle Snake River. The amended bill was forwarded to the House. The October 25 *Oregonian* also said that Senators Church and Jordan had introduced a second bill to "authorize a $347 million Southwest Idaho water development project that would provide water for the irrigation of about 500,000 acres, plus electric power generation." These two bills plus Senator Packwood's S. 3329, to establish the Hells Canyon-Snake National River were not passed by the 91st Congress.

The Middle Snake River from Hells Canyon Dam to Lewiston, Idaho, including the Imnaha in Oregon and the Grande Ronde in Oregon and Washington, was one of the streams included in the list of 47 streams identified for possible addition to the National Wild and Scenic Rivers System per the Department of the Interior's news release of September 11, 1970.

The Idaho Fish and Game Department submitted a proposal for reaffirmation of Resolution No. 12 at the 1970 Annual Meeting.

Resolution 13, Multi-Level Water Outlets in Dworshak Dam: The U. S. Army Corps of Engineers replied to the Resolution that the dam was being provided with multi-gated outlets.

Resolution 14, Oppose Construction of Dams on Main Stem of Clearwater River: Congressman McClure replied that the Corps' budget for FY 1970 included $37,000 for study of practicality of increasing power output of the Dworshak Dam, but that the Corps has no authority to plan or build the Lenore Dam. He also stated that he is opposed to Lenore and to Penny Cliffs dams and to any other additional structures on the Clearwater.

The Corps of Engineers replied that preliminary studies on the lower Clearwater River were initiated in FY 1969 to determine possible effects of various operating schemes of the Dworshak Reservoir project on best overall use of the water resources of this reach of the river, with full consideration being given to the environmental and ecological aspects. The outcome of these studies will determine whether further detailed studies are necessary. "If the study indicates the need and desirability of a reregulation dam when, and if, the future power units at Dworshak are installed. Congressional authority will be required before further action can be taken."

The Corps subsequently held a meeting at Lewiston, Idaho on the evening of November 19 to discuss the Lower Clearwater River. The Executive Director notified the Corps that he was unable to attend because of PMFC's Annual Meeting on the same date, but he submitted a written statement. Representatives of member state agencies of PMFC attended the Lewiston Meeting.

Resolution 15, Urge Extension of Anadromous Fish Conservation Act: Between October 17, 1969 and March 6, 1970, PMFC's office wrote three letters to various members of Congress sending them copies of the resolution and submitted ^ for. hearings two statements supporting H.R. 1049 as amended. Congressmen Dingell, Wyatt, Dellenback, GarTnatz, Don Clausen, and Harold Johnson; and Senators Gravel, Stevens, Goodell, Hartke, and Magnuson acknowledged PMFC's position and promised to support Extension of the Anadromous Fish Conservation Act. H.R. 1049, as amended, was passed by Congress and on May 14, 1970 the President signed the bill (P.L. 91-249), extending the Act for 4 years from June 30, 1970 and authorizing $32 million for the extended period.

Resolution 16, Surveillance of Pacific Coast Foreign Fishing Fleet Activity: Various members of Congress acknowledged the resolution and promised to support requests of enforcement agencies for enhancement of surveillance and enforcement capabilities.

William Hill, Executive Secretary, Humboldt Fishermen's Marketing Association, Inc., in testimony before the House of Representatives' Subcommittee on Fisheries and Wildlife Conservation on February 19, 1970, included part of PMFC's resolution in his statement. Mr. Hill wrote PMFC that the National Wildlife Federation (at the request of Salmon Unlimited and the California Wildlife Federation) would consider Resolution 16 at its convention in Chicago during March 1970.

Senator Packwood advised PMFC's office that Congress passed and forwarded to the President, on October 14, 1970, H.R. 14678 to strengthen the penalties for illegal fishing in the territorial waters and the contiguous fishery zone of the United States ... He also sent PMFC a copy of Senate Report No. 91-1320, "Penalties for Illegal Fishing in Fishery Zone," and said he would devote attention to the next problem of securing adequate funding of the Coast Guard to enable it to increase surveillance. On October 27, 1970 the President signed the bill into law (P.L. 91-514).

Resolution 17, Extend U. S. Fishing Limits: This proposal was tabled at the 1969 Annual Meeting.

Resolution 18, Requesting the Congress of the United States of America to Promptly Enact Legislation Providing for a Fair and Equitable Solution to the Alaska Native Land Claim Problem: Various addressees acknowledged receipt of this resolution. The Department of the Interior said PMFC's position would be made a matter of record. Senator Cranston mentioned that the Committee on Interior and Insular Affairs was holding executive hearings on S. 1830 and S. 3041 and thanked PMFC's office for its views. Senator Packwood replied that Congress was committed to determination of whether Alaskan natives should be given ownership of land and how much land.

The news media in 1970 carried numerous articles about Indian or native problems. According to the September 24, 1970 Portland *Oregonian,* a House subcommittee endorsed a bill to give Alaska's natives 40 million acres, which is far more generous than a reparation bill passed by the Senate in July. Fishing was not mentioned in the article.

Resolution 19, Commend Government of Canada and Urge Continuation of Mark Recovery Effort: Canadian Minister of Fisheries and Forestry, Jack Davis, replied that the resolution's request would be drawn to the attention of persons within his Ministry, who are directly concerned. Deputy Minister, Dr. A. W. H. Needier replied subsequently on December 30, 1969 that it was unlikely that Canadian agencies would be financially able to participate in the present continuing U. S. mark recovery programs. This information was relayed to the U. S. sections of the Informal Committee on Chinook and Coho and of the Committee's Technical Working Group.

Resolution 20, Limit Imports of Groundfish: Congressman Harrington and Senator Kennedy each replied with information on their respective identical bills, H.R. 15155 and S. 2825, "To provide certain essential assistance to the United States fishing industry." The Subcommittee on Energy, Natural Resources and the Environment of the Senate Committee on Commerce held hearings on S. 2825 in late 1969 and March 1970, but neither of these bills was passed by the 91st Congress.

Congressman Burke (Massachusetts), Member of the House Committee on Ways and Means said he would make PMFC's views known to the Committee which was presently (June 8, 1970) holding hearings on trade matters.

Congressmen Wyatt, Ullman and Keith on January 13, 1969 introduced H.R. 3139 and Senator Hatfield on June 5, 1969 introduced S. 2313. Both bills would establish quotas on imported groundfish. Some other bills on trade were H.R. 14870, 15028, 15338 and 18970.

Senator Javits on August 21, 1970 spoke against H.R. 18970. He was opposed to quotas and made specific mention of petroleum, textiles, steel and agriculture, but made no mention of fish. *(Congressional Record,* pages S 13902—13904).

During 1970, there was much mention in the "press" of tariffs and trade, but little or no mention of fish in this regard. PMFC received Proposal No. 16 on this subject for consideration as a Resolution at its 1970 Annual Meeting.

Resolution 21, In Memory of Thomas R. Gardiner: A copy of the resolution was sent to Mrs. Gardiner and family via a letter expressing PMFC's sympathy and its appreciation for Mr. Gardiner's participation in PMFC.

Resolution 22, Appreciation for Meeting Arrangements: Copies of this resolution, via a letter of thanks, were sent to the Governor of Alaska, Alaska Airlines, Sitka Sportsmen's Association, Sitka Cold Storage, Wakefield Fisheries, Sitka Sentinel, Greater Sitka Chamber of Commerce and the Alaska Department of Fish and Game.

General Actions at the 1970 Annual Meeting

The 23rd annual meeting of the Commission was held at Palo Alto, California on November T9 and 20, preceded by two days of committee meetings. At the annual meeting, the Commission took the following administrative and internal management actions:

1. Accepted the appointment by Joseph I. Eoff, who was ^ unable to attend, of Robert W. Schoning as his alternate on the Commission and as Oregon's representative on the Executive Committee. Other alternate Commissioners were Robert G. Kalb for Paul C. Keeton (Idaho) and John W. McKean for George L. Hibbard (Oregon).
2. Confirmed the appointments of Peter T. Fletcher (Califor nia), H. C. Buckingham (Oregon), Jim Bolin (Washington) and Warren H. Johnson (Washington) to the Advisory Committee. Approved alternates for four Advisors from California who could not attend: M. S. Ballo for Clifton D. Day, James Barr for Charles R. Carry, William Hill for Anthony Nizetich, and Fred L. Phebus for Charles V. Williams.
3. Reviewed and approved of actions by the Executive Committee during the year.
4. Received and approved reports by the Executive Director and Treasurer. The financial report for the year 1970 is presented on page 21 of this report.
5. Accepted the resignation of Leon A. Verhoeven as Executive Director, effective upon appointment of his successor.
6. Distributed written annual status reports on albacore, Dungeness crab, salmon commercial troll, salmon and steelhead sport, shrimp, and trawl fisheries. Verbal sum maries were omitted to free time for discussion of revised Goal and Objectives. The fishery status reports are printed in Appendix 1 as updated at the end of the year.
7. Adopted *Goal and Objectives of the Pacific Marine Fisheries Commission* (see p. 9 for text) superceding the Commission Policy and Objectives as published in the Fifteenth Annual Report of the Pacific Marine Fisheries Commission for the Year 1962, pp. 10-12.
8. Participated in a panel discussion of the U. S. troll fishery for salmon, moderated by James C. Simpson, Chief, Fisheries Division, Idaho Fish and Game Department. Panelists and the titles of their papers were:

   Patrick O'Brien, California Department of Fish and Game: "A Review of Chinook and Coho Shaker Catches in the Pacific Coast Troll Fishery."

   Paul H. Reed, Fish Commission of Oregon: "A Review of Trolling Gear Studies on Chinook and Coho Salmon."

   Sam Wright, Washington Department of Fisheries: "A Review of the Subject of Hooking Mortalities in Pacific Salmon *(Oncorhynchus)."*

   Panelists Reed and Wright also reported on the status of log-book programs in the Oregon and Washington troll fisheries, and Steven N. Taylor of the California Department of Fish and Game reported on a similar program in the California troll fishery. Copies of panelists' papers were distributed at the meeting and have been reprinted in Appendix 3 of this report. Notes on the panel discussion were included in the minutes of the meeting which were » mailed to all registered attendants.
9. Participated in a discussion, moderated by Robert W. Schoning, Director, Fish Commission of Oregon and a member of PMFC's Executive Committee, of international fishing subjects. The principal speakers and their subjects were:

   Philip M. Roedel, Director, National Marine Fisheries Service, Washington, D. C, described the Service's organizational structure for dealing with international fishing problems; and recent international devel-opments including a proposed Law of the Sea Conference, probably in 1973.

   Al Pruter, Acting Base Director, Exploratory Fishing and Gear Research, National Marine Fisheries Service, Seattle, discussed fishing by Japanese, Soviet and South Korean fleets since 1967 off Alaska, Wash-ington, and Oregon. (A thorough discussion of this subject occurred at the Annual PMFC Meeting in 1967. See p. 24 of the combined 19th and 20th

Annual Reports of PMFC for the Years 1966 and 1967.)

M. P. Houghton, Chief of Conservation and Protection, Pacific Region, Canadian Department of Fisheries and Forestry, Vancouver, B. C, discussed Canadian concern for and reaction to Japanese and Soviet fishing off British Columbia.

C. R. Forrester, Fishery Scientist, Fisheries Research Board of Canada, Nanaimo, B. C, summarized Technical Report No. 210 by Jergen Westrheim, et al, of the Nanaimo Laboratory, on the results of the August 1970 cruise of the research trawler *G. B. REED* to simulate and monitor Soviet trawling off the west coast of Vancouver Island.

John L. Baxter, Chief, Marine Resources Branch, California Department of Fish and Game, discussed Japanese and Soviet fishing off California.

None of these discussions was accompanied by formal written papers. However, the discussions as well as comments and questions from the audience were summarized and included in the minutes of the meeting.

10. Discussed revision of PMFC's Rules and Regulations and referred them to the Executive Committee for final drafting, acceptance and ultimate publication in the 1971 Annual Report.

1970 Resolutions

A total of 21 proposals for adoption as resolutions was considered at the Annual Meeting. Sixteen or these which were received fifteen or more days priox to the meeting had been duplicated and distributed in advance to all Commissioners, Advisors and Researchers. One (No. 17) which was received just before the meeting was accepted as an emergency by the Executive Committee, which directed that copies be made and distributed to all PMFC participants prior to consideration of pjORpsals. Four (Nos. 18 through 21) were drafted during the course of the meeting. ♦

The pre-meeting distribution of most of the proposals and the convening of the Executive Committee, Steering Group of the Advisory Committee, and the Research Directors on November 17, and of the Advisory Committee and Research Staff on November 18, resulted in careful screening of the proposals and in advice to the Commission on each.

Subsequently on November 20, the Commission adopted as resolutions 16 of the 21 proposals, tabled 4 and rejected 1. The following 16 resolutions are cited verbatim as they were adopted; missing numbers are those of proposals that were not adopted.

1. In Memory of Charles F. Henne

WHEREAS, Charles F. Henne, an Advisor from Oregon to the Pacific Marine Fisheries Commission for many years, died on March 14, 1970, and

WHEREAS, This gentleman devoted the greater part of his life to the good of fishery resources, to the protection of the environment so necessary to their perpetuation, and to sound management practices, and

WHEREAS, his honesty and candor always placed his views on any issue squarely on the side representing the best interests of the resource,

NOW, THEREFORE, BE IT RESOLVED, that this Commission, its advisors and staff, in regular session at Palo Alto, California, having observed a moment of silence on November 20, 1970 in his memory, now instruct the Executive Director to convey their sentiments of appreciation and respect to his brother and sister of San Francisco.

2. 30-Day Deadline for Submission of Proposals

WHEREAS, Resolution No. 21 of 1963 provides, "Resolutions must be submitted fifteen (15) days before the first day of the annual meeting. However, emergency resolutions may be submitted to the Advisory Committee with the concurrence of a majority of the State Advisory Committees", and

WHEREAS, the Commission, on November 16, 1966, charged the Executive Committee instead of the Advisory Committee with the responsibility of ruling whether late proposals qualify as emergency proposals, and

WHEREAS, the present 15-day deadline for submission of proposals to the Commission for its consideration as resolutions does not afford the Commission, its Advisory Committee and Research Staff sufficient time to consider the proposals,

NOW, THEREFORE, BE IT RESOLVED, that proposals for consideration by the Pacific Marine Fisheries Commission as resolutions must be submitted to the Commission thirty (30) days before the first day of the annual meeting, and in the event of an emergency the Executive Committee shall rule on whether the late proposal is truly an emergency and should t»fi considered by the Commission at the current Annual Meeting. The first day of the Annual Meeting shall be defined as the day on which the Executive Committee and Steering Group meet independently prior to the convening of the Advisory Committee at the Annual Meeting.

3. Salmon Compendium

WHEREAS, The National Marine Fisheries Service began a compilation of scientific literature on salmon from the year 1900 on, and

WHEREAS, the Service for budgetary reasons suspended work on the compilation, which is referred to as the "Salmon Compendium," after completion of Phase 1, "Pacific Salmon Literature Compilation-1900-1959," and

WHEREAS, the 108 volumes or 42,341 pages of Phase 1, covering 1,406 reports, were put on 645 microfiche cards, which could be purchased at a nominal charge of $185.00 per set, thereby making 60 years of salmon literature conveniently

available for laboratories and field stations that lacked comprehensive fishery libraries, and

WHEREAS, in an effort to continue this important work, the Pacific Salmon Interagency Council entered into a contract with the University of Washington to perform Phase 2, the compilation of the salmon literature from 1960 through 1964. This contract, until its expiration on December 31, 1969, was financed via Anadromous Fish Conservation Act funds and matching expenditures of the Pacific Salmon Interagency Council. During the contract, the University prepared 42,483 pages of salmon literature, covering the years 1960 through 1964, which pages are being put on microfiche cards for sale in sets, and

WHEREAS, the Pacific Salmon Interagency Council is financially unable to enter into a contract for the conduct of Phase 3, covering the literature for 1965 through 1968, and

WHEREAS, the termination of the Salmon Compendium project will adversely affect the efficiency of the various agencies in the proper management, preservation and enhancement of salmon resources,

BE IT THEREFORE RESOLVED, that the Pacific Marine Fisheries Commission urges the National Marine Fisheries Service to undertake Phase 3 of the Salmon Compendium and to continue the Compendium on a current basis.

4. Uniform Opening for Dungeness Crab Fishery

WHEREAS, a high incidence of soft-shelled and poor quality Dungeness or market crabs prevailed in December 1969 in most crab fishing areas between Point Arena and Cape Flattery, and this problem also has occurred in December of some other years, and

WHEREAS, an economic loss 'to the fishing industry results from the processing of poor quality crabs, a decrease in total potential resource yield results from mortality caused by handling and discarding soft-shelled crabs on the fishing grounds, and a decrease in consumer esteem results from failure to receive prime quality crabs in fish markets, and

WHEREAS, the production capability of the crab indus try has greatly increased, thereby assuring that a high percentage of the catch will be taken in a short time in average years, and

WHEREAS, in January of most years a higher percentage of legal-size crabs would be in prime condition, thereby resulting in greater poundage yield and economic return from the crab stocks than if they were harvested earlier,

BE IT THEREFORE RESOLVED, that the Pacific Marine Fisheries Commission recommends that the States of California, Oregon, and Washington adopt January 1 as the opening date for the Dungeness or market crab season from Cape Flattery, Washington to Point Arena, California,

BE IT FURTHER RESOLVED, that copies of this resolution be forwarded to appropriate authorities in Oregon, California, and Washington.

The following two statements are part of the record concerning this resolution:

STATEMENT ON DUNGENESS CRAB SEASON PROPOSAL

by PMFC's Shellfish Research Staff
September 28, 1970

At the spring staff meeting, biologists from Alaska, Washington, Oregon, and California discussed crab condition in relation to the opening date of the season. Presently, the Dungeness crab season opens December 1 off Oregon and California (north of Point Arena). Regular opening date for the Washington coast is January 1, but the season has usually been opened on December 1 by emergency order to coincide with the opening in other States.

Preseason sampling in November 1969 revealed that crabs were not in good condition in most fishing areas off Northern California, Oregon and Washington, and were particularly poor off Washington and Northern Oregon where approximately 90% were "soft-shells." Fishing, during periods when "soft-shells" are numerous, causes direct loss because of discard handling, and results in processing and marketing of some poor quality crabs. Please refer to the special PMFC report on crab condition during the 1969 and 1970 season, which will be distributed by mail prior to the November 17-20, 1970 Annual PMFC Meeting.

Record or near-record landings were made off each State in 1970 despite general delays in the beginning of fishing. There is no evidence that delaying the season-opening would decrease the total yield in any season.

We recognize that January 1 is not a magic date for crabs to reach overall marketable condition. A flexible, uniform opening date, however, is ruled out by the facts that California's seasons are determined by legislative action and that considerable time also is required to revise regulations in the other States. With these in mind, the Research Staff believes that the recommended January 1 uniform date will proyide a long-term economic gain to the coastal crab fishery.

MINORITY REPORT ON PROPOSAL #4

by Bill Hill and Fred Phebus
November 20, 1970

The California Advisory Committee is opposed to Proposal #4, titled, "Uniform Opening for Dungeness Crab Fishery" for the following reasons:

(a) The State of California would have only a partial opening on January 1 as no change of opening date is anticipated or required in the area south of Point Arena which season would still open on the second Tuesday of November. The longer period of up to seven weeks between the openings of the two seasons would create an even greater influx of crab boats from northern California ports into the southern area, creating additional economic problems for the southern portion of the fishery.

(b) Northern California fishermen quite often experience a very profitable portion of their total season during December

in those years when the crabs are in excellent shape. As much as 15% of the total seasonal yield is harvested during the month. More than one million pounds of crab were marketed during the month of December, 1968.

(c) The opening and closing dates of the crab season in California can only be changed or established by an act of the state Legislature. The States of Oregon and Washington can change their seasons through action by the state fisheries agencies on comparatively short notice, thus manipulating the opening and closing dates at their convenience. Even though the States of Oregon and Washington might adhere to an opening date of January 1 religiously, nothing within Proposal # 4 would prevent them from extending the season to a much later date than the California closing which is fixed by legislative act.

(d) Although the northern California crab season now opens on December 1, the northern California crab fishermen have proved that they have the ability and integrity to police their own fishery by their action during the 1969-70 season. By their own volition, they refrained from fishing until January 1 when the crabs were in a more marketable condition. They have profited by this experience and will continue to harvest the local crab crop when the better yield of meat is apparent.

Consequently, they feel that any change in the season at this time is unwarranted and detrimental.

5. Information Retrieval System for Reports on Projects Partially Financed by Federal Acts

WHEREAS, the Pacific Marine Fisheries Commission is interested in fishery research, development and management, and recognizes the value of effective dissemination of information, and

WHEREAS, the Commercial Fisheries Research and Development Act (P.L. 88-309), the Anadromous Fish Act (P.L. 89-304) and the Jellyfish Act (P.L. 89-720) have provided aid to the several States for increased research and development programs, and

WHEREAS, the_ results of progress and completion of research, development, and management programs are required reports under these Acts,

BE IT THEREFORE RESOLVED, in the interest of fishery science, management, and economy, and for the benefit of the U. S. fishing industry, the Pacific Marine . Fisheries Commission strongly recommends that the National Marine Fisheries Service, with the concurrence of the several States participating in the aforementioned Acts, consider developing and funding an information retrieval system for the benefit of fishery researchers throughout the Nation.

7. Delta Facilities of the California Water Plan

WHEREAS, the State of California and the Federal Government have selected the Peripheral Canal as the engineering facility in the Sacramento-San Joaquin Delta to carry out the California Water Plan and to further develop the Central Valley Project, and

WHEREAS, the State of California is faced with a deficit in the financing of the State Water Project and the Bureau of Reclamation has suffered some unfortunate delays in preparation of the Feasibility Report for Congress, and

WHEREAS, the Secretary of Interior approved the Feasibility Report on July 10, 1969 and the State of California approved it by letter of April 28, 1970, and

WHEREAS, the California Department of Fish and Game has predicted increasing dangers to the anadromous fish resources in the years between the start of state pumping operations (now operating), increased pumping by the Bureau of Reclamation, and the completion of the Peripheral Canal, and

WHEREAS, the anadromous fish resources of the Central Valley of California must pass successfully through the Sacramento-San Joaquin Delta, and

WHEREAS, man's activities including dam construction, water diversion, pollution, dredging and filling have already done considerable damage to the anadromous fish resources, and there is great need to protect and rebuild these resources, and

WHEREAS, these anadromous fish runs are of major importance to the salmon fisheries in the ocean off California and also contribute to ocean fisheries off Oregon and Washington, and

WHEREAS, the Peripheral Canal Plan is the only known engineering plan which will protect existing anadromous fish resources passing through the Sacramento-San Joaquin Delta and will provide opportunities for passage through the Delta of increased king salmon runs, thereby allowing enhancement of said salmon runs, and

WHEREAS, existing conditions in the Delta are detrimental to the San Joaquin River anadromous fish runs and may "become so to the Sacramento River and the American River anadromous fish runs before completion of the Peripheral Canal, and

WHEREAS, operation of the Peripheral Canal, after its completion, may well be the most critical factor in the protection and enhancement of the Central Valley anadromous fish runs,

NOW, THEREFORE, BE IT RESOLVED, that the Pacific Marine Fisheries Commission reaffirms its support of the Peripheral Canal Plan and urges all appropriate agencies to start and complete this project at the earliest possible date to protect and enhance the anadromous fish resources of the Central Valley of California, and

BE IT FURTHER RESOLVED, that the Pacific Marine Fisheries Commission urges that the operation of the Peripheral Canal to maintain a Delta environment compatible with anadromous fish runs be an objective of the project.

8. In Memory of Harry F. Linse

WHEREAS, with the death of Harry F. Linse on September 8, 1970, fisheries lost a dedicated friend and former fellow worker, and

WHEREAS, Harry had served as Treasurer of the Pacific Marine Fisheries Commission from the time of the Commission's formation in 1947 until poor health caused him to resign on October 31, 1963, and

WHEREAS, his pleasing and industrious personality helped in the carrying out of PMFC's many activities,

NOW, THEREFORE, BE IT RESOLVED, that the Pacific Marine Fisheries Commission, its advisors and staff, in regular session at Palo Alto, California having observed a moment of silence on November 20, 1970 in his memory, now instruct the Executive Director to convey their sympathy, appreciation and respect to his widow and family.

10. Urge Corps of Engineers and Public Utility Districts to Take Necessary Steps to Reduce Nitrogen Supersaturation Levels in Snake and Columbia Rivers

WHEREAS, both upstream and downstream anadromous fish migrants passing through the Columbia and Snake Rivers have been subject to extremely high nitrogen supersaturation levels, and

WHEREAS, studies indicate that large mortalities have resulted to both upstream and downstream migrants as a result of nitrogen disease, and

WHEREAS, the high nitrogen supersaturation levels result directly from Snake and Columbia River dam construction,

NOW, THEREFORE, BE IT RESOLVED, that the Pacific Marine Fisheries Commission goes on'reCord as urging the U. S. Army Corps of Engineers and the public utility districts to take the following steps to reduce the existing nitrogen supersaturation threat:

1. Install the full complement of six turbines in each of the lower three Snake River dams on an emergency basis. Accelerate installation of the full complement of turbines on the Columbia River mainstream dams including Chief Joseph Dam. Based on present knowledge, this is the only approach which would*be immediately effective in reducing nitrogen supersaturation.
2. Modify the design of Lower Granite Dam spillway and stilling basin to reduce nitrogen entrapment or, as an alternative, defer further construction of Lower Granite Dam.
3. If Lower Granite Dam is constructed, six turbine units should be ready for immediate operation prior to the filling of the pool.
4. Investigate the feasibility of modifying the spillways and stilling basins of existing dams to reduce nitrogen entrapment. If this is found to be feasible, spillway modifications should be pursued on an emergency basis with emphasis on the Snake River initially. From a fishery standpoint, such modifications would provide the most desirable solution to the problem of nitrogen supersaturation.
5. Investigate the feasibility of reducing nitrogen entrapment through adjustment of spillway operations and through the use of turbine skeleton units for passage of water or any other structural or operational solutions which the Corps' staff may be able to develop.
6. Conduct and implement the results of an in-depth study of flow control to maximize water quantity and quality for fish and wildlife purposes. Such a study should take into account the effects of peaking operations as well as means of reducing nitrogen supersaturation.
7. Proceed on an emergency basis with design studies for self-contained fish screens for turbine intakes. This would be important from the standpoint of either a capture and transportation system or a fingerling bypass system.
8. Vigorously pursue the research effort directed towards refining techniques for capturing downstream migrants in the Columbia and lower Snake Rivers.
9. Compensate for fishery losses incurred in the Columbia and lower Snake Rivers as a result of loss of habitat, loss of fishing opportunities, and fish passage losses, and

BE IT FURTHER RESOLVED, that copies of this resolution be sent to all federal agencies, public utility districts and private utility companies who have hydroelectric projects on the Columbia River system and to members of appropriate Congressional Committees and the Congressional Delegations from member States of the Pacific Marine Fisheries Commissions

11. Oppose Construction of Asotin Dam, Snake River

WHEREAS, the U.S. Army Corps of Engineers has indicated it will request pre-construction funds for Asotin Dam, and

WHEREAS, Asotin Dam will adversely affect runs of anadromous fish to the Snake River drainage, and

WHEREAS, power and other benefits produced by this project will be relatively insignificant,

NOW, THEREFORE, BE IT RESOLVED, that the Pacific Marine Fisheries Commission goes on record as being opposed to the construction of Asotin Dam and urges Congress not to appropriate funds for the project, and

BE IT FURTHER RESOLVED, that copies of this resolution be sent to the Congressional Delegates from the Pacific Coast States, to the U..S. Army Corps of Engineers and to other interested parties.

12. Moratorium on Dam Construction, Middle Snake River

WHEREAS, the anadromous and resident fish of the Snake River have been progressively and seriously reduced by existing dams, and

WHEREAS, the issue of further dam construction on the Middle Snake River is now under consideration by the Federal Power Commission, and

WHEREAS, the construction of any of the proposed alternative projects for the Middle Snake River would have serious adverse effects on major Snake River runs into the Salmon and Imnaha Rivers, and

WHEREAS, Senators Church and Jordan of Idaho have introduced legislation to establish a 10-year moratorium on construction of additional dams on the Middle Snake River,

NOW, THEREFORE, BE IT RESOLVED, that the Pacific Marine Fisheries Commission urges Congress to enact legislation providing for a 10-year moratorium on dam construction in the Middle Snake River,

BE IT FURTHER RESOLVED, that copies of this resolution be sent to the Congressional Delegates and Governors of the Pacific Coast States and to other interested parties.

13. Extend Fishery Jurisdiction of the United States

WHEREAS, the living marine resources found in the waters adjacent to and associated with the United States continental shelf and slope provide an important part of the seafood needs of the Country, and

WHEREAS, these living marine resources are particularly vulnerable to damage from unrestrained fishing, and

WHEREAS, the United States is handicapped in providing proper protection and management for these living marine resources by lack of adequate jurisdiction over all fishing in the areas in which these resources are found, and

WHEREAS, the harvesting of these marine resources on a sustained basis can be effective only if a greater measure of jurisdiction is given to coastal authorities,

BE IT THEREFORE RESOLVED, that the United States of America by appropriate means secure fishery jurisdiction off it coastline to the outer edge of the continental slope or to such additional distance as will allow adequate protection and management to fishery resources emanating from or adjacent to the United States with such fishery jurisdiction being qualified to permit fishing by foreign vessels inside the United States fishery zone through negotiated agreements with foreign governments.

17. Trial Regulation of the Troll Fishery to Reduce the Catch of Coho Shakers*

WHEREAS, the States of Alaska, Washington, and Oregon and the Province of British Columbia presently have a June 15 opening for troll-coho salmon fisheries, and

WHEREAS, only the State of California permits the capture and retention of coho salmon beginning on April 15 if they are 25 inches or more in total length, and

WHEREAS, the California fishery is selective of the larger members of the available coho population, which selectivity results in significant numbers of coho being caught and discarded and in creation of a disorderly coastal fishery, and

WHEREAS, biologically and economically, the only form of rational size-limit stipulation during an open troll-coho fishery in Oregon and Washington is a 15-inch total length minimum to protect small, immature coho during the fall months, and

WHEREAS, protection can be achieved in California with a 22-inch-total-length minimum, and

WHEREAS, some dead and badly injured coho will always be encountered during the spring troll fishery for Chinook regardless of the selective practices and care exhibited by fishermen, and

WHEREAS, in one major Pacific Coast trolling area, off the lower west coast of Vancouver Island, losses resulting from "shaker" coho prior to the June 15 opening are too great to permit continuance of the troll fishery as it presently exists, and

WHEREAS, research by Canada has demonstrated the losses can be drastically reduced in this area through the exclusive use of large trolling plugs instead of spoon and flasher gear,

NOW, THEREFORE, BE IT RESOLVED, that a uniform June 15 opening date be adopted on a 1-year trial basis by all Pacific coast States for the troll-coho fishery with a 22-inch-minimum-size limit in California and no minimum-size limit until August 1 with a 15-inch-total-length minimum thereafter in Oregon and Washington, and

BE IT FURTHER RESOLVED, in order to reduce wastage of dead and seriously injured coho, troll fishermen be allowed to land an incidental poundage of coho prior to June 15 not to exceed 5% of their chinook poundage during any individual delivery, and

BE IT FURTHER RESOLVED, that the Federal Government be requested by the Pacific Marine Fisheries Commission to open negotiations with Canada relative to reducing the catch of coho shakers by American and Canadian fishermen fishing off the lower west coast of Vancouver Island prior to June 15.

*A "shaker" coho is one that is less than the minimum-size regulation or one that can not be retained prior to a specified date.

The following statement is part of the record concerning this resolution.

MINORITY REPORT ON EMERGENCY PROPOSAL #17

by Fred Phebus and John Gilchrist,
November 20, 1970

1. While we offer no criticism per se, attention is called to the fact that the vote taken by Section "A" on Resolution No. 17 was irregular in that advisors who were not ap pointed to Section "A" voted upon the resolution.

2. The California delegation of advisors unanimously opposed the resolution. The California research delegation supported an amended version of Proposal No. 17.

3. California's advisory group opposed Proposal No. 17 for the following reasons:

   a. During early California open season (April 15) stocks of king salmon are intermingled with stocks of silver (coho) salmon of mature (25" or more) size.

   b. To release mature silver salmon during this period would contribute to an unnecessary waste of the resource by probably increasing mortality.

   c. California commercial fishing interests are unanimously of the opinion that the great bulk of the silver salmon resource begins to move into the Oregon coastal area during the month of June.

   d. Assuming that contention *"c"* above is accurate, closing the California silver salmon season until June 15 would deny California fishermen a just right to take "legal" fish thereby contributing to economic losses for both fisher men and processors.

   e. In asking that Proposal No. 17 be rejected by the Commission the California advisory delegation recog nizes the need for further study of this particular problem and pledges its full cooperation in seeking an equitable solution toward proper management of this valuable resource. ♦

18. Commendation to State of California and Its Fish and Game Commission

WHEREAS, the 1970 annual meeting of the Pacific Marine Fisheries Commission, held in Palo Alto, California, has been a most constructive and successful deliberation, and

WHEREAS, the California Fish and Game Commission, celebrating its 100th Anniversary, and the California Advisors to Pacific Marine Fisheries Commission have acted as official hosts in an outstanding and cordial manner thereby contributing to the success of the discussions, and

WHEREAS, the cordiality of the meeting was further heightened by the social occasion hosted by the Fish and Game Commission and various groups* within the commercial and sport fishing industries of the State of California,

NOW, THEREFORE, BE IT RESOLVED, that the Pacific Marine Fisheries Commission hereby expresses its sincere appreciation for the assistance and hospitality tendered so graciously during the course of the meeting and the stay of its participants in Palo Alto, and

BE IT FURTHER RESOLVED, that the Pacific Marine Fisheries Commission records its gratitude to the ladies who worked long and faithfully in the Steno Pool, and the Staff of the California Department of Fish and Game, and its Director Ray Arnett, all of whom contributed so much to the meeting's success.

'Included among the various groups were:

Fishermen & Allied Workers Division
Local 33, I.L.W.U. San Pedro, California

American Tunaboat Association
San Diego, California

Tuna Research Foundation
Terminal Island, California

California Wildlife Federation
San Francisco, California

Westgate-California Food, Inc.
San Diego, California

United Cannery & Industrial Workers
of the Pacific (AFL-CIO)
Terminal Island, California

California Seafood Institute
San Francisco, California

Salmon, Unlimited
Fort Bragg, California

Del Monte Corporation
San Francisco, California

Star-Kist Foods, Inc. *
Terminal Island, California

Washington Fish & Oyster Co. of California
San Francisco, California

Bumble Bee Sea Foods, Inc.
Astoria, Oregon

California Fish and Game Commission
Sacramento, California

Fishermen's Wharf Merchants Ass'n.
San Francisco, California

19. In Memory of Wilbert M. Chapman

WHEREAS, in the passing of Wilbert M. Chapman on June 25 of this year, the fisheries community of the West Coast lost one of its greatest friends and most articulate spokesmen, and

WHEREAS, his work on behalf of fisheries reached into and affected every level of local, regional, national and international fishery activities, and

WHEREAS, his life work had profound influence in the areas of fishery science, education, diplomacy, government service, and industry, and

WHEREAS, he devoted much effort over the life of the Pacific Marine Fisheries Commission to the support of its work,

NOW, THEREFORE, BE IT RESOLVED, that this Commission, its advisors and staff, in regular session at Palo Alto, California, having observed a moment of silence on November 20, 1970 in his memory, now convey their deepest sympathy, appreciation and respect to his widow and family.

20. In Memory of Milner B. Schaefer

WHEREAS, in the passing of Milner B. Schaefer on July 26 of this year, the fishery community of the West Coast lost one of its greatest friends and keenest minds, and

WHEREAS, his work on behalf of fisheries reached into and affected every level of local, regional, national and international fishery activities, and

WHEREAS, his life work had profound influence in the areas of fishery science, education, international service, government service, and industry, and

WHEREAS, he devoted much effort over the life of the Pacific Marine Fisheries Commission to the support of its work, ■

NOW, THEREFORE, BE IT RESOLVED, that this Commission, its advisors and staff, in* regular session at Palo Alto, California, having observed a moment of silence on November 20, 1970 in his memory, now convey their deepest sympathy, appreciation and respect to his widow and family.

21. Appreciation andThanks to Leon Verhoeven

WHEREAS, Leon Verhoeven has served as Executive Director of the Pacific Marine Fisheries Commission since July 1963 and has tendered his resignation to be effective upon appointment of a successor, and

WHEREAS, he has served diligently with keen interest and dedication in promoting the objectives of PMFC throughout this period, and

WHEREAS, Leon's work in the role of Executive Director has been carried on under varied and sometimes difficult circumstances, and

WHEREAS, he has maintained a professional and dignified image in his many opportunities to represent PMFC throughout the Country, and

WHEREAS, he has.been singular in his faithful dispatch of his duties to PMFC,

THEREFORE, BE IT RESOLVED, that PMFC in annual session at Palo Alto, California, on November 19 and 20, 1970 expresses its unanimous appreciation and thanks for Leon's years of faithful service.

Election of Officers; 1971 Meeting Location

The following were elected officers for 1971:

Executive Committee:

Chairman	Thor C. Tollefson, Director, Washington Department of Fisheries
1st Vice-Chairman	Robert W. Schoning, Director, Fish Commission of Oregon
2nd Vice-Chairman	John R. Woodworth, Director, Idaho Fish and Game Department
3rd Vice-Chairman	Wallace H. Noerenberg, Commissioner, Alaska Department of Fish and Game
Secretary	G. Ray Arnett, Director, California Department of Fish and Game

Steering Group of Advisory Committee:

Overall Chairman	Earl E. Engman, Washington
Deputy Chairman	Jim Bolin, Washington
Sectional Chairman	David B. Charlton, Oregon
Sectional Chairman	Robert G. Kalb, Idaho
Sectional Chairman	J. B. Cotant, Alaska Sectional
Chairman	Paul McKeehan, California
Advisor Emeritus	Andrew J. Naterlin of Newport, Oregon who had served the Commission as an Advisor with great diligence from January 1948 to October 1970 was appointed an Advisor Emeritus.

The Commission voted to hold the 1971 Annual Meeting in Seattle at the Washington Plaza Hotel, November 16-19.

Financial and Audit Reports

Financial Support, 1970

The Commission receives its financial support from legislative appropriations made in accordance with Article X of the interstate Compact in which the signatory states have agreed to make available annual funds for the support of the Commission as follows: eighty percent (80%) of the annual budget is shared equally by those member states having as a boundary the Pacific Ocean; and five per cent (5%) of the annual budget is contributed by each other member State; the balance of the annual budget is shared by those member States, having as a boundary the Pacific Ocean, in proportion to the primary market value of the products of their commercial fisheries on the basis of the latest five-year catch records.

STATEMENT OF RECEIPTS AND DISBURSEMENTS
January 1, 1970 to December 31, 1970

CASH BALANCE December 31, 1969 (Ending Balance 22nd Annual Report)		$ 45,837.06
RECEIPTS:		
Contributions by Member States		
Alaska	$ 16,000.00	
California	15,300.00	
Idaho	3,000.00	
Oregon	12,600.00	
Washington	13,300.00	60,200.00
REFUNDS:		
US Postmaster	2.86	
US Gov. Printing Office	1.65	
Superintendent of Documents	1.00	5.51
INCOME:		
Interest from Savings Certificates		1,815.55
DISBURSEMENTS:		
Salaries and Wages: Executive Director, Consultants, Treasurer, Office Secretary and Temporary	28,205.60	
Office Supplies	1,240.48	
Telephone and Telegraph	388.32	
Postage, Freight, Express	1,043.94	
Printing of Publications	7,287.16	
Rents, Office	1,342.00	
Premiums: Bonds, Insurance	284.62	
Audit Fees	375.00	
Private Car Mileage	291.41	
Fares: Plane, Railroad, Bus	1,040.63	
Meals and Lodging	569.42	
Medical Insurance	120.00	
Library Supplies	60.00	
Retirement Annuity	2,161.60	
Social Security	988.56	
Annual and Research Meetings:		
Advisory Com. $5,033.65		
Commissioners 2,153.82		
Admin. & Research Staff 5,778.75		
Meeting Rooms, etc. 270.00	13,236.22	
Cooperative Research	883.54	
All Other	80.50	
Total Disbursements	$ 59,599.00	
Cash on Deposit in the US National Bank of Portland, Ore., Dec. 31, 1970	48,295.12	
	$107,858.12	$107,858.12

Biennial Budget, 1971-73

The Executive Committee, acting for the Commission and in accordance with guidelines established at the 1969 annual meeting, approved a budget of $139,866 for the 1971-1973 biennium. An anticipated surplus of $20,066 from the previous biennium, plus interest income of $3,800, reduced the amount to be raised by membership contributions to $116,000 for the new biennium or $58,000 per year.

PACIFIC MARINE FISHERIES COMMISSION
Biennial Budget, July 1, 1971 to June 30, 1973

ALASKA, CALIFORNIA, IDAHO, OREGON & WASHINGTON

Salaries and Wages:	
Executive Director	$ 36,832
Office Secretary	15,276

Part-Time and Temporary	12,700
General Operations and Maintenance:	
Office Supplies	3,700
Telephone and Telegraph	1,200
Postage, Freight, Express	2,900
Rent, Office	4,100
Premiums, Bonds, Insurance	551
Audit Fees	680
Private Car Mileage	600
Fares, Plane, R.R., Bus	2,400
Meals and Lodging	1,700
Library Supplies	100
Social Security	2,391
Retirement Annuity	4,364
Medical Insurance	480
Annual, Research and Executive Committee Meetings:	
Meeting Rooms	300
Advisory Committee, Travel; etc	12,158
Commissioners, Travel, etc	6,085
Administrative and Research Staff	10,795
Sound and Recording	500
Spring Research Meetings	6,800
Executive Committee Meeting	900
Publications:	
Annual Reports Nos. 24 and 25	5,200
Data Series	900
Cooperative Research	5,000
Capital Outlay:	
Office Furniture and Equipment	1,690
Miscellaneous	164
Total Estimate	$139,866
Surplus from Previous Biennium	20,066
Interest Income	3,800
	$116,000

PROPORTIONATE CONTRIBUTIONS BASED ON TOTAL ANNUAL CONTRIBUTIONS OF $58,000

Member	**5-Year Average***	**% of Contribution**	**Annual Contribution**
Alaska	$ 67,501,072	27	$ 15,500
California	51,967,199	25	14,600
Washington	20,084,264	22	12,700
Oregon	12,130,600	21	12,300
Idaho	Insignificant	5	2.900
		100	$ 58,000

*Annual value of catch, 1964-1968 inclusive.

Balance Sheet, June 30, 1970

ASSETS:	Total	General Fund	Property Fund
Cash in Bank	$ 3,669.18	$ 3.669.18	$ —
Certificate of Deposit	18,500.00	18,500.00	—
Office Furniture & Equipment	4,256.79	—	4,256.79
Total Assets . . .	$26,425.97	$22,169.18	$ 4,256.79
LIABILITIES:			
Accounts Payable . .	$ 497.96	$ 497.96	
RESERVES:			
Reserve for Allocation— Co-op Research .	1,494.45	1,494.45 (1)	
Reserve for Allocation— Printing	5,945.20	5,945.20 (2)	
Total Reserves . .	$ 7,439.65	7,439.65	
FUND BALANCES:			
Investment in Fixed Assets	4,256.79	—	4,256.79
Unappropriated Surplus	14,231.57	14,231.57	—
Total Fund Balances . . .	18,488.36	14,231.57	4,256.79
Total Liabilities, Reserves, and Fund Balances	$26,425.97	$22,169.18	$ 4,256.79

Note # 1: At year end, $1,494.45 was allocated for cooperative research, all of which was unpaid balance on the Otolith Reader cooperative research project with the Washington Department of Fisheries.

Note # 2: Purchase orders currently outstanding for printing are:

Project	Amount
19th Annual Report	$2,082.00
20th Annual Report	1,368.00
21st Annual Report	2,495.20
	$5,945.20

Audit Report

ALLEN H. ADAMS
Certified Public Accountant
Portland, Oregon

September 4, 1970

The Board of Commissioners Pacific Marine Fisheries Commission State Office Building Portland, Oregon 97201

Gentlemen:

I have examined the books and records of the Pacific Marine Fisheries Commission for the fiscal year ending June 30, 1970. The examination was made in accordance with generally accepted auditing standards and, accordingly, included such procedures as were considered necessary in the circumstances.

The accounting procedures of the Commission reflect revenue in the accounts when it is received rather than at that date when appropriated by member states to the Commission and reflect expenditures in the fiscal period in which they arise irrespective of when paid, i.e., the accrual basis.

The following exhibits are submitted:*

A. ComDined Balance Sheet, as at June 30, 1970, of the General Fund and the Property Fund, and Notes to Balance Sheet.

B. Statement of Revenue and Expenditures, with Budg etary comparisons, for the period July 1, 1969, to June 30, 1970.

C. Analysis of changes in Unappropriated Surplus and in the Property Fund for the period July 1, 1969, to June 30, 1970.

D. Reconciliation of changes in the cash balance with Revenues and Expenditures for the period July 1, 1969, to June 30, 1970.

E. Audit Comments.

F. Scope of the Audit.

In my opinion, the accompanying statements present fairly the financial position of the Pacific Marine Fisheries Commission at June 30, 1970, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Yours very truly, ALLEN H. ADAMS Certified Public Accountant

* Exhibit A is the Balance Sheet which appears in the left-hand column. It is the only exhibit reprinted for this report. A complete audit report with exhibits was sent each Commissioner.

Appendix 1 —Status Reports

Status of the 1970 Pacific Coast Albacore Fishery

An early season projection for the 1970 aibacore season would have indicated a continuing trend toward heaviest landings in Oregon and Washington. Landings in both states truly were well above average; however, a sudden change in the fishery favored California ports and landings there eventually exceeded those in the Pacific Northwest. Though catch statistics are preliminary, Pacific Coast landings in 1970 will exceed 56 million pounds. This is above last year's 48 million pounds and well above the 25-year average of 43 million.

California

The first evidence that the 1970 albacore migration was underway came from preseason scouting of the National Marine Fisheries Service's research vessel *David Starr Jordan.* During the last week in June, the *Jordan* caught 100 albacore offshore between San Diego and Cape Mendocino.

Anticipating a continuation of the northern fishery trend, most of the California fleet sailed to strategic ports to await the outcome of price negotiations. On July 15, a cannery-delivered price of $550 per ton was agreed upon by the fishermen and processors. Fortuitously, the best fishing developed between Eureka and the Columbia River. High catch rates and heavy landings were typical of the seasons's first two weeks. However, by August 1, the troll catch had declined from several hundred fish per day to less than 100. When no fish were located to the north as far as Vancouver Island, an area that had produced well in* 1969, mostjigboats returned to northern California waters. The weather here was not favorable, but fishing was steady between storms.

The small, southern California fleet which character-istically remains south of San Francisco, experienced good fisrring'between Ensenada (Baja California) and Point Arguello during July, August, and part of September. Later, by the end of September and throughout October, the entire Pacific Coast fishery was located off central California.

Due to the short time spent fishing in July, only 30 tons of albacore were landed in California. This was far below the pre-1965 average and only about one-fifth of the landings for July 1969. During August, landings reached 3,500 tons. Although this is below the average it is still the best for any August in the past 5 years. September landings were about average at 4,000 tons, while those for October reached a record 6,300 tons. Total California landings this year reached 15,000 tons for the first time since 1964.

Southern California's sportfishery contributed another 2 to 3 million pounds to the Northwestern Pacific harvest this year. Partyboat records show that anglers landed over 112,000 albacore at ports from San Diego to Morro Bay. This is well above last year's 49,000 fish and nearly 20 percent above the 20-year average.

Oregon

The Fish Commission of Oregon's chartered vessel *Sunrise* found suitable water conditions but no albacore during a preseason scouting cruise from June 30 to July 10. Based upon this information and the catches of the *David Starr Jordan* in late June, some 200 miles farther offshore and south of the area scouted by the *Sunrise,* we surmised that albacore had not yet reached the Oregon coast and that they would arrive about mid-July.

Many boats put to sea immediately after the price was established on July 15. On the 16th, catches up to 300 fish were reported off northern California with smaller catches off southern and central Oregon. The weather became rough off California shortly thereafter, and most of the fleet sailed north to the Coos Bay area where catches up to 1,200 fish per day were reported. The entire fishery moved northward rapidly and by month's end it was centered 60 to 100 miles off the Columbia River. Daily catches averaged about 400 to 600 fish per boat. July landings in Oregon reached 7.6 million pounds.

The fishery off Oregon collapsed on August 1, as catch rates dropped suddenly to around 50 fish per day. The fleet scouted considerable distances in all directions but did not find concentrations of fish until the second week in August off northern California. By August 20, live-bait fishing improved and high catches of 20 tons per day were reported about 50 miles offshore between Newport, Oregon and Grays Harbor, Washington. Approximately 7.1 million pounds of albacore were landed in August; however, about one-third of these had been caught in July.

Jig fishing did not improve during September, but the baitboats continued to do well when they could find biting schools. Catches per boat of 20 tons per day were common but the average was about 3 to 5 tons per day of large 19- to 20-pound fish. September landings reached about 5.7 million pounds.

By mid-October most of the baitboats had returned to California and the only fish landed thereafter were caught by trollers, on the way home.

Albacore landings in Oregon during 1970 totaled 21,779,234 pounds.

Washington

Soon after a price settlement on July 15, the fishery began with excellent fishing 100 to 125 miles off the Columbia River. Jigboats checked during this period averaged 186 fish per day, with some reporting the highest daily scores in recent history.

Early in August, weather conditions caused the ocean's mixed layer to deepen; these conditions persisted through early September. At the same time, the albacore dispersed and as a result the jigboats averaged only 44 fish per day. Many albacore fishermen returned to fishing for coho salmon which had increased in abundance during this period.

Baitboat fishing, although slow initially, eventually dominated the fishery off Washington. Good catches were made within 60 miles of Grays Harbor in late August and about 35 miles off the Columbia River in September.

Washington landings for 1970 totalled 4.4 million pounds, the highest since 1950 and a sizeable increase over the excellent catch of 3.6 million pounds in 1969. Of the total, 2.7 million pounds were caught by jigboats and 1.7 million pounds by baitboats. Prices paid to fishermen ranged from $525 to $540 per ton.

TABLE 1

Pacific Coast Albacore Landings (in 1,000's lbs.)

Year	California	Oregon	Washington	Total
1945	21,225	12,178	6,030	39,433
1946	18,078	3,951	2,123	24,152
1947	13,172	9,558	4,243	26,973
1948	36,456	8,004	4,917	49,377
1949	44,006	6,457	4,434	54,897
1950	61,745	5,386	5,035	72,166
1951	30,915	2,917	625	34,457
1952	49,804	2,586	177	52,567
1953	33,836	776	89	34,701
1954	26,107	469	421	26,997
1955	29,002	503	233	29,738
1956	37,055	3,654	630	41,339
1957	43,525	2,702	433	46,660
1958	27,188	9,754	1,503	38,445
1959	32,740	10,582	2,961	46,283
1960	35,113	4,563	526	40,202
1961	29,123	3,251	456	32,830
1962	36,622	8,936	365	45,923
1963	48,860	11,413	527	60,800
1964	42,551	4,452	1,055	48,058
1965	23,218	12,122	2,048	37,388
1966	18,189	18,041	1,101	37,331
1967	17,858	29,243	1,240	48,341
1968	15,077	37,752	3,050	55,879
1969	14,722	29,828	3,561	48,111
Average	31,447	9,563	1,911	42,922
1970 Preliminary	29,880	21,779	4,400	56,059

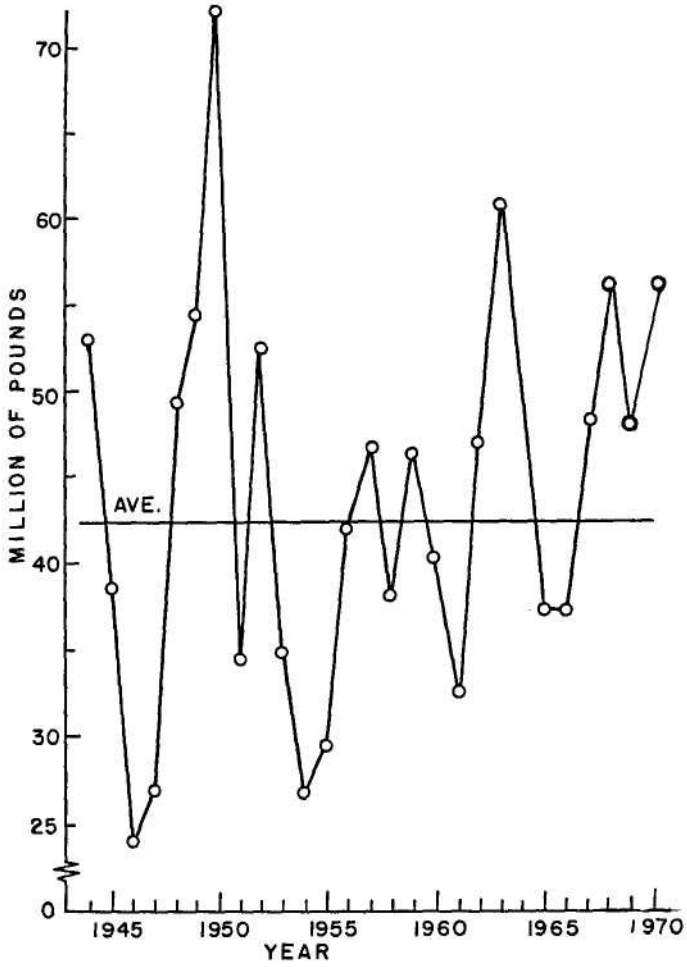

FIGURE 1. Pacific Coast albacore landings through 1970 and 25-year average (1945–1969, incl.).

Summary

» For the fifth consecutive year, a large portion of the albacore migration took place off the Pacific Northwest. However, this year differed from others in that California ports received a greater portion of the catch. Most baitboats fished off Oregon and Washington, while the trollers generally were more successful off California after the first fortnight.

Albacore landings in California approached 30 million pounds. This is below average but it is a significant increase over 1969. Oregon landings continued well above average but they were considerably below 1969. In Washington, landings were double the average and were 20 percent above those of 1969. For the entire Pacific Coast, landings exceeded last year's 48 million pounds by 8 million pounds. Thus, 1970 was the fourth, consecutive season during which albacore landings were well above the 25-year average of 43 million pounds.

The fishery depends upon an annual migration and therefore it is subject to wide fluctuations in albacore abundance and availability. However, present evidence indicates that the Northeastern Pacific fishery continues healthy.

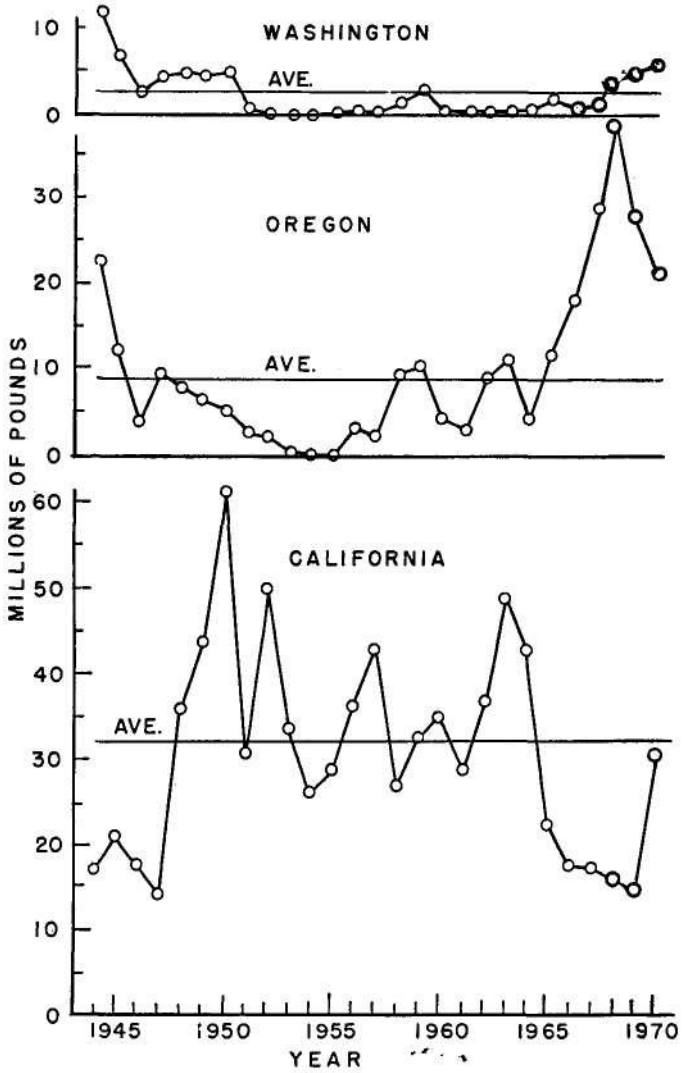

FIGURE 2. Annual albacore landings by State through 1970 and 25-year average (1945—1969, incl.).

Compiled by: William L. Craig, California Dept. of Fish and Game

Other Contributors: Larry H. Hreha, Fish Commission of Oregon and Sam Wright, Washington Dept. of Fisheries

Status of the 1969-70 Pacific Coast Dungeness Crab Fishery

The preliminary 1969-70 season total of 47.2 million pounds of Dungeness crab for trie combined landings of Washington, Oregon, and California is the highest ever recorded for the 3 contiguous states and is 3.1 million pounds higher than the previous record season of 1968-69. The catch for the West Coast, excluding Canada, was 56.9 million pounds (Figure 1), exceeding the 15-year mean of 34.1 million pounds by 22.8 million pounds, and is 3.2 million pounds greater than the previous record of 1968-69.

Alaska[1]

Landings in Alaska totalled 9.7 million pounds or 1.6 million pounds less than for the same period in 1969 (Figure 2). In the Kodiak area the catch per unit of effort in 1970 was much lower than in either of the two preceding years.

British Columbia

Total Dungeness crab landings in British Columbia were 2.5 million pounds, a reduction of 1.2 million pounds compared to the 3.7 million pounds landed in 1969. Reduced landings reflected crab scarcity in 1970.

Washington

Coastal crab landings in Washington totalled 17.7 million pounds (Figure 2). This is 0.7 million pounds less than last season's all time record. Due to the extraordinarily poor condition of the crabs, the 1969-70 season was delayed until

' Alaska and British Columbia data are summarized by calendar year.

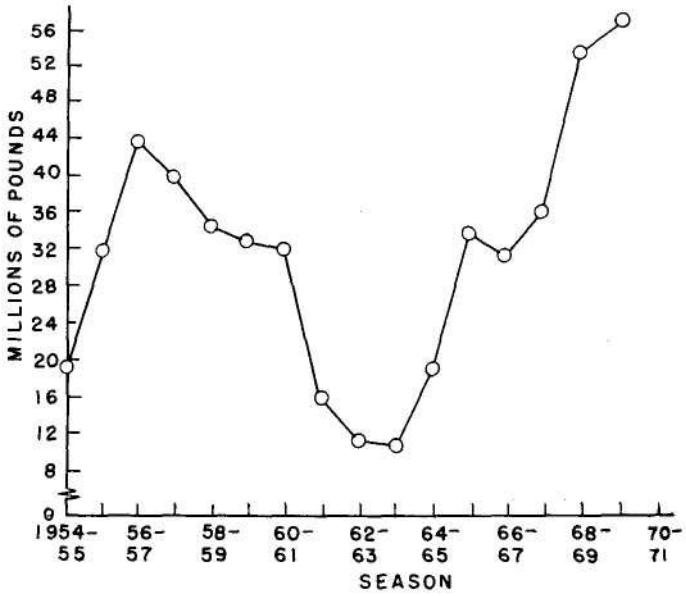

FIGURE 1. Combined Dungeness crab landings for the Pacific Coast except British Columbia.

January 1, 1970. However, all but two processors refused to buy crabs until late January. The crab fleet was the largest in recent seasons with 108 boats fishing an estimated 30,000 pots in the ocean and 30 boats fishing an estimated 4,000 pots inside of Willapa Bay and Grays Harbor. The Puget Sound landings from October 1969 through 1970 totalled 932,615 pounds. This is the highest landing from Puget Sound since the 1965-66 season when the total was nearly 1.5 million pounds.

Oregon

Oregon crab landings for the 1969-70 season totalled 14.0 million pounds (Figure 2). This represents the fifth season in a row when 10 million or more pounds were landed and the best season ever recorded. The catch, as reflected by landings, was uniformly distributed along the coast and was made by 141 boats fishing an estimated 33,000 pots.

California

Statewide landings totalled 15.5 million pounds (Figure 2), the highest in 10 years, and 1.8 million pounds greater than the 1968-69 landings. Landings in excess of 14 million pounds in northern California represent a new record for that area, exceeding the previous high by 1.8 million pounds. The San Francisco area also showed an increase over the previous season. The 1969-70 season total of 1.5 million pounds was an increase of 0.6 million pounds over the 1968-69 season. This was the highest total in the San Francisco area since the 1960-61 season.

Compiled by C. Dale Snow, Fish Commission of Oregon.

Other Contributors: Peter Jackson, Alaska Dept. of Fish & Game; Terry Butler, Fisheries Research Board of Canada; Doug Magoon, Washington Dept. of Fisheries; Walter Dahlstrom, California Dept. of Fish & Game.

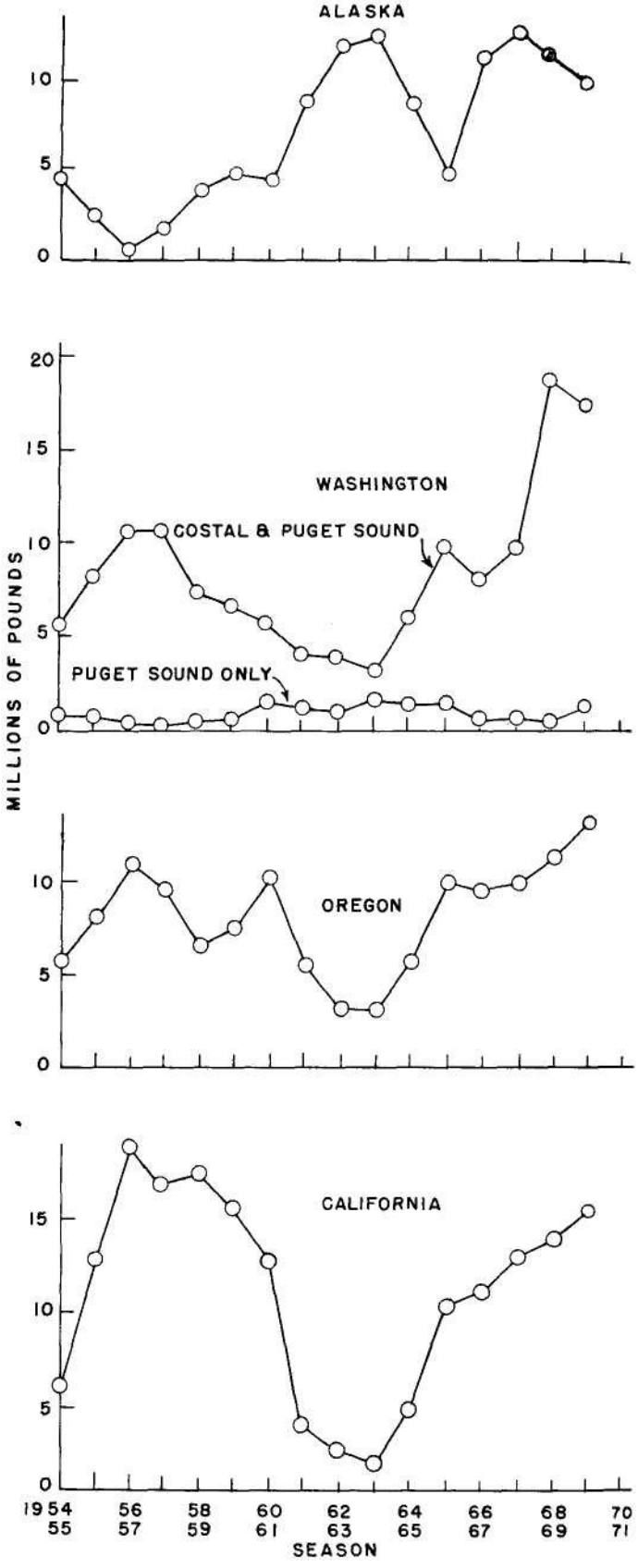

FIGURE 2. Dungeness crab landings by season, 1954-55 through 1969-70, except Alaskan seasons are on calendar year basis, i.e., 1954-55= 1955.

Status of the 1970 Pacific Coast Trawl Fishery

Pacific Coast trawl landings of bottomfish species by the United States and Canada totalled 139 million pounds in 1970 (Figure 1). This amount is down 9% from 1969 landings of 153 million pounds and 6% below the past 10-year mean of 148 million pounds. The decline in production which began during 1967 and 1968 was interrupted briefly in 1969 but was resumed in 1970.

A more detailed look at the 1970 total catch levels by State and the Province of British Columbia reveals the following patterns (Table 1). In Alaska, annual trawl landings which are usually less than 100,000-pounds were negligible. The Washington trawl catch totalled 49 million pounds—down 15% from 1969. This decline is partly the result of a vessel tie-up in January and February, and of market limits on some species. Oregon trawl landings of 20 million pounds are slightly (4%) under those for 1969. A decline in animal food rockfish landings in Oregon more than offset the increased catches of other species. The California catch of 39 million pounds was a record high. During the first half of 1970 market demand was high in California ports but it declined subsequently. The combined catch of all 4 Pacific Coast states totalled about 109 million pounds in 1970—down 6% from the 116 million pounds landed in 1969.

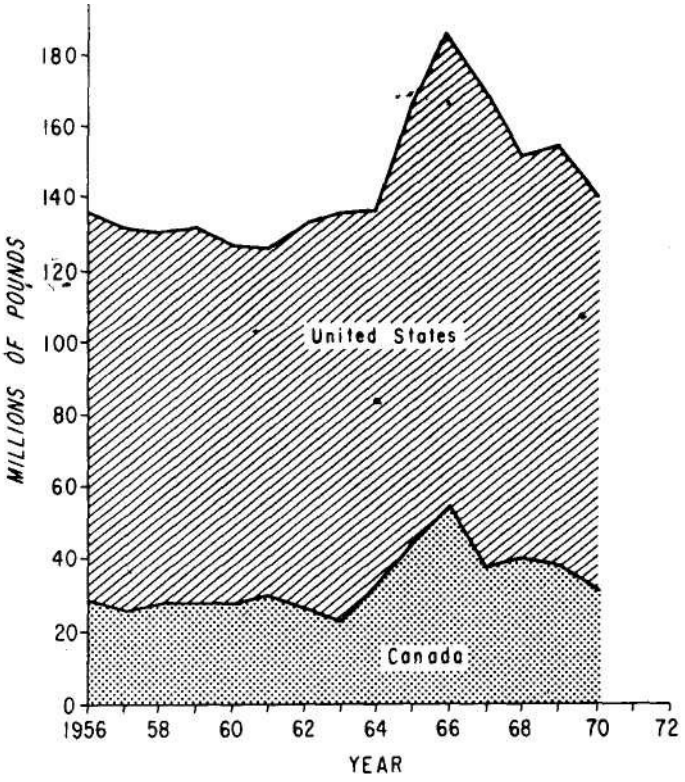

FIGURE 1. Pacific Coast trawl landings of the United States and Canada, 1956–70.

TABLE 1

Trawl Landings (1969 & 1970 in 1,000's of lbs.)

Region	1969	1970	% Change
Alaska	negligible	negligible	—
Washington	58,110	49,368	-15.0
Oregon	21,025	20,044	- 4.3
California	36,533	39,372	+ 7.8
Total U.S.	115,668	108,784	- 6.0
British Columbia	37,827	30,701	-18.8
Total (U.S.–Can.)	153,495	139,485	- 9.1

In British Columbia, trawl landings of bottomfish amounted to about 31 million pounds—down 19% from the 1969 production of 38 million pounds. This decline has been due primarily to a continuing decrease in catches of Pacific cod which is the most important species in the British Columbia trawl landings.

Two exceptions to the general decline in 1970 are substantial increases in Dover sole and Pacific ocean perch landings. About 75% of the food fish species are comprised of 8 main species or groups. What follows is an examination of trends in the landings of these by region (Figure 2 and Tables 2-9).

- FIGURE 2. United States and Canada Pacific Coast trawl landings of major species or groups, 1956—70.

Petrale Sole *(Eopsetta jordani)*

Petrale sole landings (Figure 2) of 7 million pounds in 1970 were up 2% from the 1969 catch and 18% below the past 10-year average. Examination by area shows that Washington landings took the brunt of the decline (Table 2). A vessel tie-up and bad weather were important factors here. Increased Oregon catches were due to a strong 1964-year class moving into the fishery. The petrale sole landings in California, Oregon and Washington combined totalled 6 million pounds—about even with 1969 landings. The British Columbia landings of petrale sole were up slightly from a low in 1969, due primarily to a relatively new deep-water, late-winter fishery.

TABLE 2

Petrale Sole Trawl Landings (1969 & 1970 in 1,000's of lbs. Foodfish Only)

Region	1969	1970	% Change
Alaska	—	—	—
Washington	1,608	796	-50.5
Oregon	1,835	2,141	+16.7
California	2,867	3,415	+19.1
Total U.S.	6,310	6,352	+ 0.7
British Columbia	351	464	+32.2
Total (U.S.-Can.)	6,661	6,816	+ 2.3

English Sole *(Parophrys vetulusj*

Production of English sole by Canadian and American trawl fleets (Table 3) during 1970 was down 11% from 1969. The 1970 catch was about 9 million pounds which is 21% below the past 10-year average.

TABLE 3

English Sole Trawl Landings (1969 & 1970 in 1,000's of lbs. Foodfish Only)

Region	1969	1970	% Change
Alaska	—	—	—
Washington	2,989	1,721	-42.4
Oregon	1,716	1,884	+ 9.8
California	3,803	3,279	-13.8
Total U.S.	8,508	6,884	-19.1
British Columbia	2.196	2,613	+19.0
Total (U.S.-Can.)	10,704	9,497	-11.3

Declines occurred in catches landed in Washington and California. Based on the catch per unit of fishing effort (pounds caught per hour of trawling), it a.ppears that the abundance of this species is down from past years in the major fishing areas off the Washington and California coasts. In addition, the vessel tie-up in Washington affected landings there. A 10% increase in the Oregon catch is noted, however. Combined catches of all 3 States equalled 7 million pounds which is down 19% from 1969. British Columbia landings of English sole, however, have a continuing upward trend. Landings amounted to 2.6 million pounds—up 19% from 1969. The bulk of the Canadian catch was taken from grounds in northern Hecate Strait.

Dover Sole *(Microstomus pacificus)*

Dover sole trawl catches continued upward as 26 million Rourjds were landed by American and Canadian trawl fleets in 1970 (Table 4). This catch is up 23% from 1969 and.59% over the past 10-year average.

TABLP4

Dover Sole Trawl Landings (1969 & 1970 in 1,000's of lbs. Foodfish Only)

Region	1969	1970	% Change
Alaska	–	–	–
Washington	1,850	2,230	+20.5
Oregon	5,554	5,538	- 0.3
California	12,919	15,144	+17.2
Total U.S.	20,323	22,912	+12.7
British Columbia	855	3,110	+263.7
Total (U.S.-Can.)	21,178	26,022	+22.9

Good market demand accounted for increased landings in Washington. Oregon landings remained unchanged. The 1970 California Dover sole catch of 15 million pounds exceeded the previous record high of 12 million pounds landed in 1969. Combined production of California, Oregon and Washington totalled 23 million pounds—up 13% over 1969. Increased deep-water fishing in northern Hecate Strait gave a 1970 Canadian catch of 3 million pounds, a substantial increase over previous years' landings.

Rock Sole *(Lepidopsetta bilineata)*

Rock sole landings were increasing in Canadian and American ports through 1969 (Figure 2). However, total American and Canadian trawl landings of this species during 1970 were only slightly over 4 million pounds, down 44% from 1969 and 21% from the past 10-year mean.

The American catch of rock sole is landed almost entirely in Washington ports (Table 5). Washington landings of this species were 451,000 pounds in 1970, down 61% from 1969. Most of the rock sole catch is made by the British Columbia trawl fleet. The 1970 Canadian catch was nearly 4 million pounds, off 41% from the 1969 catch.

TABLE 5

Rock Sole Trawl Landings (1969 & 1970 in 1,000's of lbs. Foodfish Only)

Region	1969	1970	% Change
Alaska	—	—	—
Washington	1,148	451	-60.7
Oregon	25	5	-80.0
California	3	0	—
Total U.S.	1,176	456	-61.2
British Columbia	6,653	3,906	-41.3
Total (U.S.-Can.)	7,829	4,362	-44.3

Pacific Cod *(Gadus macrocephalus)*

The 1970 landings of Pacific cod by American and Canadian trawl fishermen was 9 million pounds (Figure 2), which is 33% below the 13.5 million pounds landed in 1969 and 54% below the past 10-year average. Landings of Pacific cod fluctuate widely since the fishery is primarily supported by only 2 or 3 year-classes and year-class strength varies considerably. The present decline is attributed to a reduction in recruitment of young fish to the fishery, i.e., weak year-classes entering the fishery.

The American landings of Pacific cod occur primarily in Washington as this region approximates the southern end of the range of Pacific cod in commercial quantities. Washington landings in 1970 totalled 2.7 million pounds, down 29% from 1969 (Table 6). British Columbia landings were just over 6 million pounds in 1970 which is 35% below the nearly 10 million pounds landed in 1969.

TABLE 6

Pacific Cod Trawl Landings (1969 & 1970 in 1,000's of lbs. Foodfish Only)

Region	1969	1970	% Change
Alaska	---	---	---
Washington	3,767	2,660	-29.4
Oregon	47	78	+66.0
California	0	0	---
Total U.S.	3,814	2,738	-28.2
British Columbia	9,686	6,339	-34.6
Total (U.S.-Can.)	13,500	9,007	-33.3

Lingcod *(Ophiodon elongatus)*

The American and Canadian catches of lingcod in 1970 were 8 million pounds (Figure 2). This amount is 16% below the 1969 total and 17% below the past 10-year average.

The trawl catch of lingcod was down in all areas except California (Table 7). Washington, which is the primary U.S. area for lingcod trawl landings, showed a 27% decrease from 1969. Combined landings of lingcod for California, Oregon and Washington totalled 4.8 million pounds, down 11% from 1969. It appears that the rate of decline exhibited in the 1969 catches may be lessening somewhat.

TABLE 7

Lingcod Trawl Landings (1969 & 1970 in 1,000's of lbs. Foodfish Only)

Region	1969	1970	% Change
Alaska	---	---	---
Washington	3,465	2,541	-26.7
Oregon	1,048	945	- 9.8
California	836	1,300	+55.5
Total U.S.	5,385	4,786	-11.1
British Columbia	4,022	3,166	-21.3
Total (U.S.-Can.)	9,407	7,952	-15.5

Pacific Ocean Perch *(Sebastes alutus)*

Pacific ocean perch landings in 1970 totalled 19.5 million pounds (Figure 2), which is up 18% from 1969 and even with the past 10-year average.

Landings of Pacific ocean perch in the United States occur mainly in Washington and Oregon as this species is not present in commercial abundance in California coastal waters. Oregon landings of 1.6 million pounds were up 70% over the 1969 level (Table 8). This increase in catch reflects an expansion of the Oregon fleet to grounds off northern Washington and southern Vancouver Island. Washington landings of 13.3 million pounds were up 8% from 1969. Queen Charlotte Sound, British Columbia, accounted for the bulk of the 1970 Pacific ocean perch catch landed in Washington; and the annual catch-per-trawling hour, which had been declining in this area, was also up slightly. Apparently, diminished populations off Washington and southern British Columbia (west Vancouver Island) did not attract sustained fishing pressure from the Washington trawl fleet in 1970. British Columbia landings of 4.6 million pounds were 40% higher than in 1969. Canadian production of Pacific ocean perch is also centered in Queen Charlotte Sound.

TABLE 8

Pacific Ocean Perch Trawl Landings (1969 & 1970 in 1,000's of lbs. Foodfish Only)

Region	1969	1970	% Change
Alaska	---	---	---
Washington	12,269	13,254	+ 8.0
Oregon	940	1,595	+69.7
California	45	57	+26.7
Total U.S.	13,254	14,906	+12.5
British Columbia	3,316	4,626	+39.5
Total (U.S.-Can.)	16,570	19,532	+17.9

Other Rockfish *(Sebastes* and *Sebastolobus)*

The "other rockfish" category comprises all rockfish *(Sebastes* and *Sebastolobus)* species other than Pacific ocean perch *(Sebastes alutus).* The landings of "other rockfish" are made up of numerous species and an evaluation.of these stocks is therefore extremely difficult. Another complication is that rockfish landings are dependent primarily on market conditions. The 1970 landings of "other rockfish" (Figure 2) was 26 million pounds—down 15% from the 1969 catch and up 7% over the past 10-year average. Declines in abundance of other foodfish species has accounted for the relatively high production in 1970.

American trawlers caught 25 million pounds of "other rockfish" in 1970. Washington landings of 12 million pounds were down 29% from the 17 million pounds landed in 1969 (Table 9). This occurred primarily because of the vessel tie-up in January and February and the imposition of some market limits. Oregon landings of 3.5 million pounds were down 31% from 1969 catches while California landings of 9 million pounds were 20% over 1969. British Columbia landings of 1.5 million pounds were up 52% over 1969.

TABLE 9

"Other Rockfish" Trawl Landings
(1969 & 1970 in 1,000's of lbs. Foodfish Only)

Region	1969	1970	% Change
Alaska	---	---	---
Washington	17,141	12,196	-28.9
Oregon	5,101	3,515	-31.1
California	7,571	9,059	+19.7
Total U.S.	29,813	24,770	-16.9
British Columbia	1,003	1,528	+52.3
Total (U.S.-Can.)	30,815	26,298	-14.7

Compiled by J. E. Reeves, Washington Department of Fisheries

Other Contributors:
C. R. Forrester, Fisheries Research Board of Canada
J. Meehan, Fish Commission of Oregon
T. Jow, California Department of Fish and Game

Status of the 1970 Pacific Coast Troll Salmon Fishery

The estimated troll salmon catch for British Columbia, Alaska, Washington, Oregon, and California for 1970 was 62.2 million pounds (round weight). This catch is considerably below the 74.1 million pounds that were taken in 1969. Total landings by species were 26.1 million pounds of chinook and 36.1 million pounds of coho. Good coho catches in Oregon and Washington put the total for this species slightly above the **1969 total.**

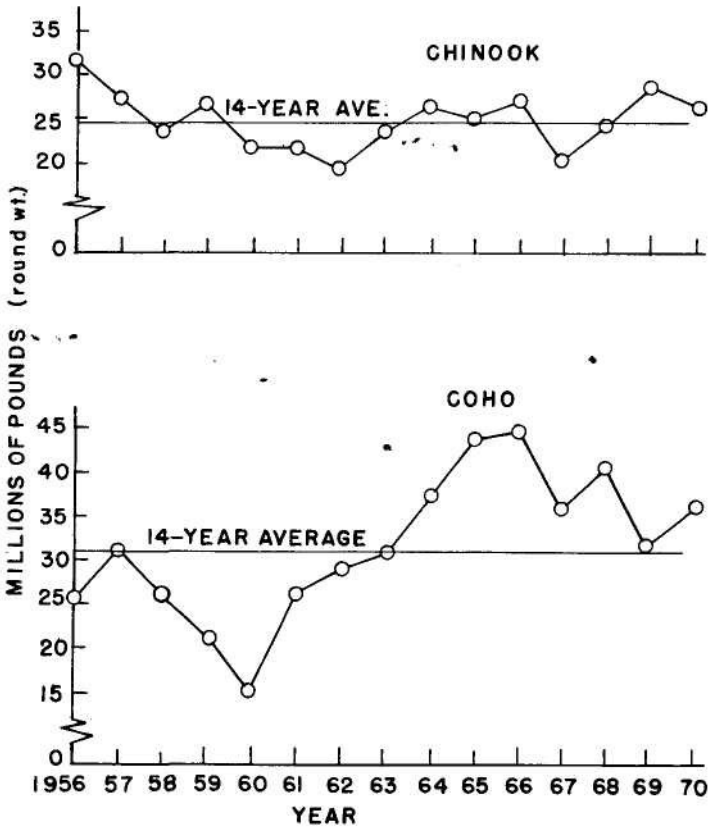

FIGURE 1. Total Pacific Coast annual landings of troll-caught salmon vs. average for 14 years (1956-1969, incl.).

Troll Chinook Fishery

Oregon troll chinook landings for 1970 were 1.9 million pounds, round weight, the best since 1957. Columbia River area catches were fair through June, but were subsequently poor. Newport area fishing was poor most of the year with the exception of August when the best catches since 1960 were landed. Early Coos Bay landings were only fair, but record catches occurred in September and October. Brookings landings were good all season and probably rank third highest on record.

In 1970, 2.5 million pounds of troll-caught chinook were landed in Washington on a round weight basis. At this level, 1970 ranked as the best since 1963 and continued the improving trend of recent years. Highlight of the fishery was an excellent abundance of fish off Grays Harbor (Area 11) during April and May. This was followed by good fishing off Split Rock (Area 10) and the Columbia River (Area 12) in late May and early June. Chinook from both the 1966- and 1967-brood years, as 3- and 4-year-olds, respectively, contributed well.

Alaska preliminary troll chinook statistics indicated a total landing of 5.8 million pounds (round weight). Chinook catches approximated the 10-year average.

The estimated 1970 troll chinook harvest in California was 6.0 million pounds (round weight). In 1969, a total of 5.6 million pounds of troll-caught chinook were landed.

The 1970 Chinook troll catch for British Columbia totalled 9.9 million pounds (round weight). This will be the lowest harvest since 1965 but 10 percent above the 10-year average.

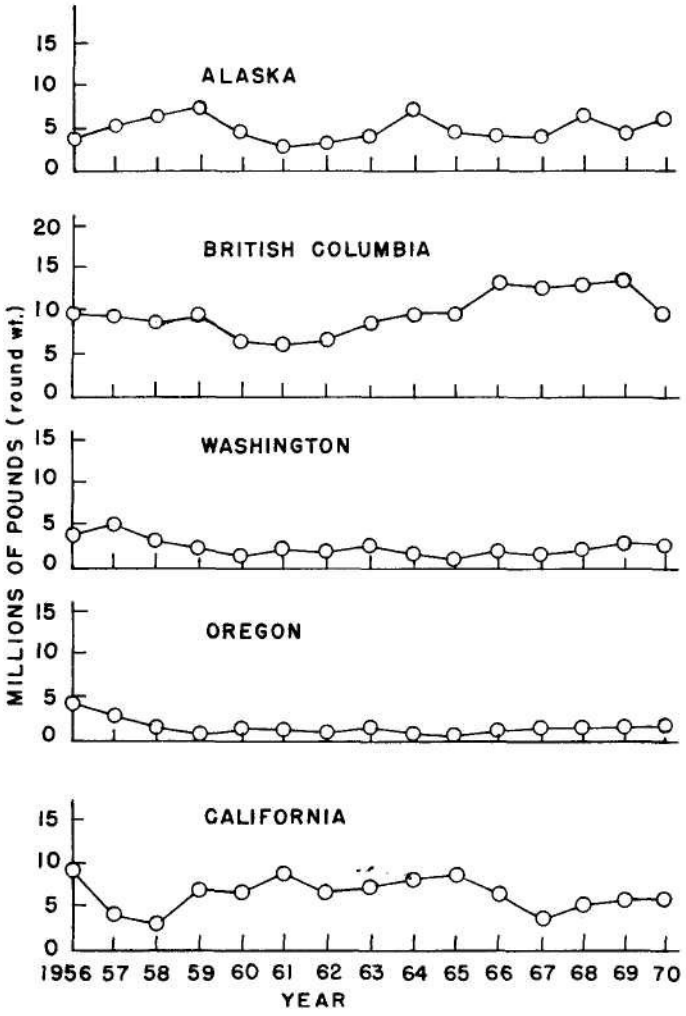

FIGURE 2. Pacific Coast annual troll chinook salmon landings by area, 1956-1970. (Figure 2 in last year's report indicated landings in British Columbia that were too high.)

TABLE 1

Pacific Coast Estimated Troll Salmon Landings (pounds round), 1970

Region	Chinook	Coho	Total
British Columbia	9,900,000	17,300,000	27,200,000
Alaska	5,800,000	2,500,000	8,300,000
California	6,000,000	1,500,000	7,500,000
Washington	2,500,000	6,100,000	8,600,000
Oregon	1,900,000	8,700,000	10,600,000
Total	26,100,000	36,100,000	62,200,000

Troll Coho Fishery

Oregon troll coho landings were fantastic in 1970 and hit 8.7 million pounds (round weight) compared to 3.6 million pounds in 1969. This exceeds the previous Oregon record of 8.3 million pounds in 1967. The Columbia River and Coos Bay troll fisheries were only fair in 1970 although the Coos Bay fishery in August was excellent. The Newport area had an exceptional August fishery when almost 3 million pounds were landed. Brookings had excellent June and August fishing. July was poor in many areas as bad weather prevented fishing during much of the month.

The total 1970 Washington troll coho catch was 6.1 million pounds (round weight). At this level, the 1970 fishery represents an encouraging come back from the poor season of 1969 when only 3.3 million pounds of coho were taken. The mean size of fish landed was also good, running more than one pound above normal expectations. Top production zones were Quillayute (Area 9) followed by Columbia River (Area 12) and Split Rock (Area 10).

The preliminary troll coho data for Alaska indicated that both the inside and outside catches were down and the troll catch of coho was 2.5 million pounds.

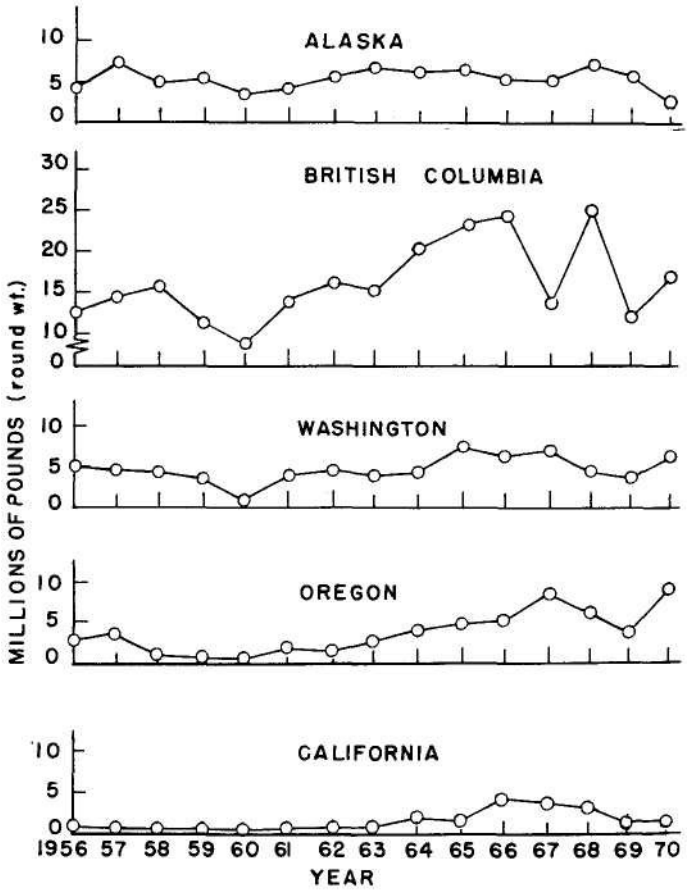

FIGURE 3. Pacific Coast annual troll coho landings by area, 1956-1970. (Figure 3 in last year's report indicated landings in British Columbia that were too high.)

The preliminary landing estimate for 1970 troll-caught coho in California was 1.5 million pounds (round weight), the same as 1969, but well under the 1966 record of 4.1 million.

The 1970 coho troll catch for British Columbia totalled 17.3 million pounds (round weight). It was up considerably from 1969 but about 5 percent below the 10-year average.

Compiled by Jerry Mallet, Idaho Fish and Game Department

Contributors:

Carl Rosier, Alaska Department of Fish and Game Patrick O'Brien, California Department of Fish and Game Robert McQueen, Fish Commission of Oregon Sam Wright, Washington Department of Fisheries Blake A. Campbell, Department of Environment, Fisheries Service, Canada

Status of the 1970 Pacific Coast Shrimp Fishery

The estimated 1970 landings of shrimp for the West Coast of the United States and Canada have established a new record for the fifth consecutive year. The catches for the first 8 months of 1970 equalled the total of 1969 landings. The 1969 catch of 64.8 million pounds was exceeded in 1970 by a total catch of 94.6 million pounds. Increases in catches were recorded for California, Oregon and Alaska. Landings in Washington and British Columbia were below average.

California

Ocean shrimp *(Panda/us jordani)* fishermen set a new record for California with landings of 4,044,640 pounds. The 1970 landings exceeded last year's record of 3,092,220 pounds.

Another new record was set by northern California (Eureka-Crescent City) shrimp fishermen for the Area A bed during the 1970 season when landings reached 3,638,851 pounds. The previous record was from the 1969 season when 3,092,220 pounds were landed. The 1970 quota of 3,400,000 pounds, set by the California Fish and Game Commission, was increased by 400,000 pounds over the 1969 quota. The quota is based on a generalized production model.

The Area A season ran from May 1 through Atigust 4. Fishing extended from off Redding Rock north to the Oregon-California border; however, the best catches came from the area south of Crescent City in 60 to 80 fathoms. Twenty-three vessels participated in the fishery. Average monthly catch rates for May, June, July, and August were 519, 763, 882 and 1,062 pounds per hour, respectively. The average for the season was 788 pounds per hour.

Area B-2 (Bodega Bay) fishermen caught 298,869 pounds. This was the highest total since 1957. A record catch per hour of 1,192 pounds was also established for the area. The quota of 250,000 pounds was reached in just 6 weeks of fishing and the area was closed on June 6. Year-class composition was 18% one-year-old, 79% two-year-old, and 3% three-year-old shrimp. Heads-on counts per pound averaged 98 for the season.

No effort was reported in Area B-1 (Fort Bragg) for 1970 and small landings totalling 66,695 pounds were made from Area C (Morro Bay-Avila). This is the first successful fishing in Area C since 1960, when 74,756 pounds were landed.

The status of the resource appears to be good in Area A. Observations of the incoming 1970-year class indicate that it is relatively strong, and looks like it will be able to support the 1971 and 1972 fisheries. In other areas of California, the status is indefinite and will not be known until observations are made of relative strength of the 1970-year class.

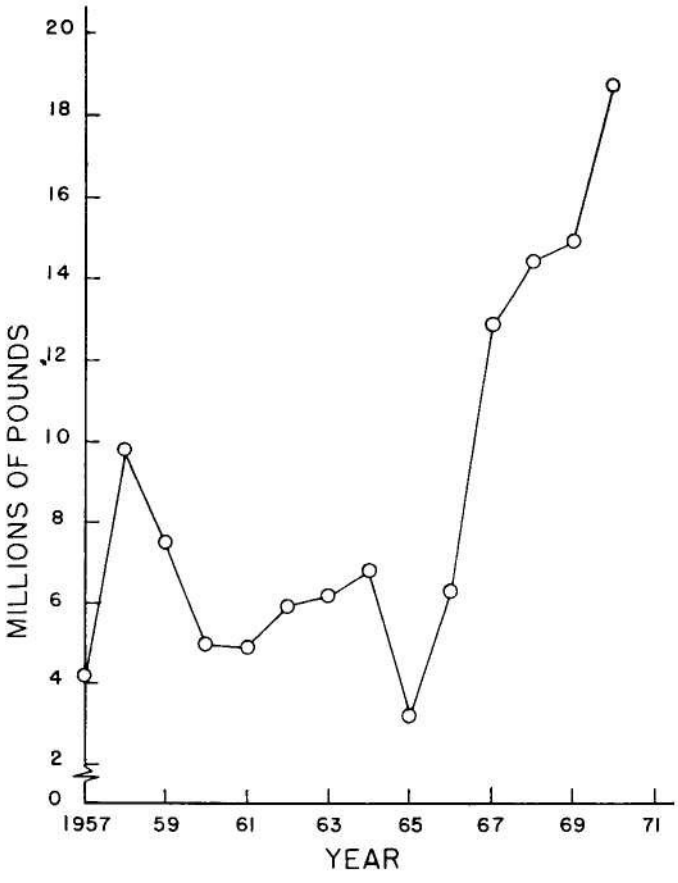

FIGURE 1. Annual combined shrimp landings for Washington, Oregon and California, from 1958-1970.

Oregon

A record of 13,735,000 pounds (610 pounds/hour tow) was delivered by 59 vessels in 1970. This exceeded the 1969 landings of 10.5 million pounds by 31%. A record market and ex-vessel price (14tf and 12d/lb. depending on market) in March and April spurred record effort and catch during that period. PMFC Shrimp Area 86 (Coos Bay) received most of the effort during this period. A slump in market occurred in May and Coos Bay effort and catch declined quickly as a result, until recovery occurred in August. Newport and Astoria boats, less affected by the market slump, found fishing very good off Cape Lookout in May and off Cape Foulweather in June, July and August, and off Washington in June and July. Excellent fishing off Port Orford as well as good fishing elsewhere and market improvement during August and September made these months the best of the year for shrimpers.

Astoria area shrimpers delivered 1.25 million pounds from off Washington in 1970, nearly the same as in 1969. Of that, 475,000 pounds (770 pounds/hour) and 778,000 pounds (540 pounds/hour) came from areas 72 and 74, respectively. Most of the 1969 catch came from area 74, Grays Harbor, while only 166,400 pounds came from off Destruction Island, area 72. Most of the 1970 catch, as in 1969, was produced during June and July.

The area off northern California (area 92) was largely unutilized by Oregon vessels in May and June, due to poor market conditions. Most of the 1970 catch (168,024 pounds at 715 pounds/hour) was landed during July. No fishing was done off California after August 20, when an Oregon Fish Commission closure on landings of shrimp captured south of the California-Oregon border became effective. Fishing off southern Oregon yielded 142,000 pounds (420 pounds/hour), most of it during August after the California season ended.

The brightest happening of 1970 occurred off Port Orford (area 88) in late August. The shrimp bed there, which produced only 2,100 pounds (58 pounds/hour) in all of 1969 after a record 1.3 million pounds (1,087 pounds/hour) in 1968, suddenly became a bonanza fishery. Initially the area yielded little or -no shrimp during 1970 and as late as mid-August exploratory fishing in the area failed to find shrimp. Between August 2Q, and 31, however, 13 vessels produced 407,000 pounds at record catch rates (1,735 pounds/hour) for August. After a momentary slump in early September, the area continued to support excellent fishing (953,000 pounds; 1,240 pounds/hour) during September and (176,000 pounds; 760 pounds/hour) during October. The total catch for 1970 in this area was a record 1,540,000 pounds.

Age composition in the area appeared to be similar to that of other areas, with a very strong 1968-year class and a strong 1969-year class. Many 0-age (1970-year class) shrimp were also evident in catches, indicating this year class is the strongest since 1966. Evidently the scarcity of shrimp in the area during 1969 and 1970 was due to unavailability rather than absence.

Area 86 (Coos Bay) produced a record 4.9 million pounds (560 pounds/hour) during 1970, 29% more than the 1969 total (3.8 million pounds at 430 pounds/hour). This area consistently has produced 3-4 million pounds of shrimp annually. This is the fourth consecutive year in which landings have exceeded 3 million pounds. Along with market problems, following excellent fishing in March and April, fishing was poor during midsummer. This pattern of good to poor fishing (followed by recovery usually in August and September) is an annual occurrence. Fishing in 1970 improved in August, along with market conditions. Excessive jellyfish populations also hindered fishing in June and July. The 1968-year class was

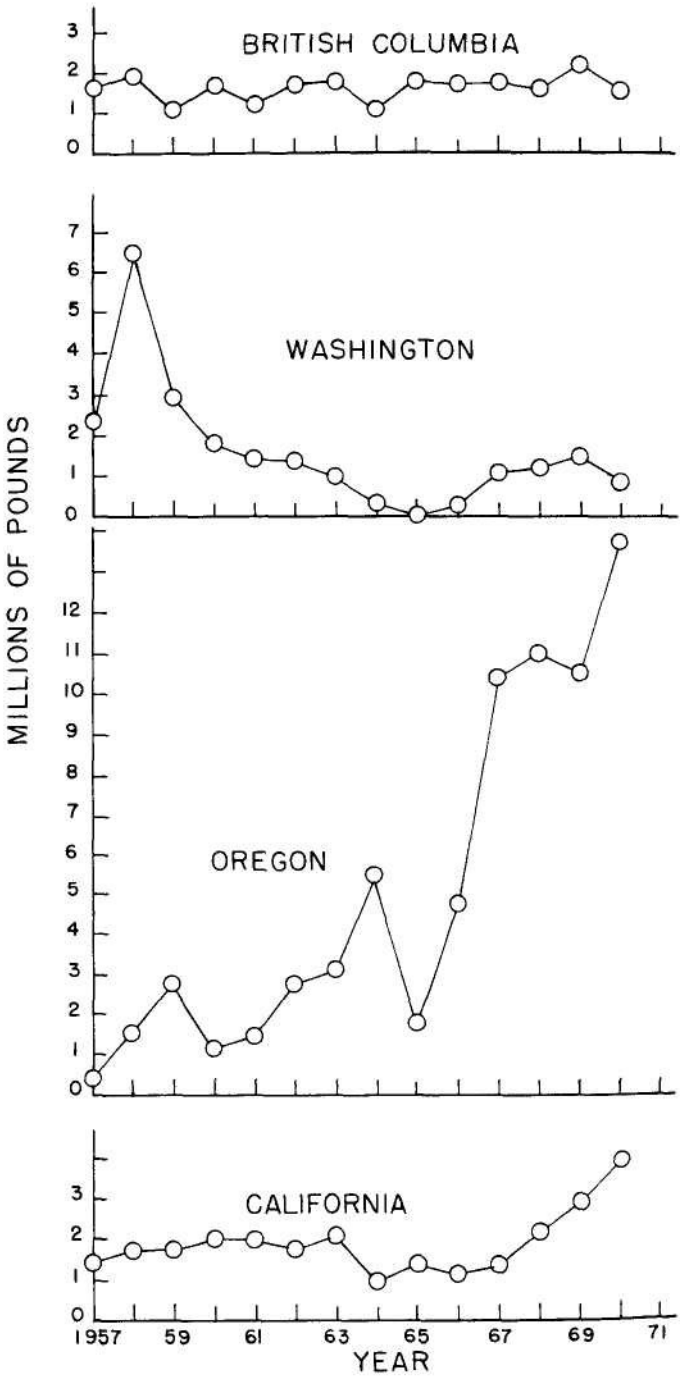

FIGURE 2. Annual shrimp landings in British Columbia, Washington, Oregon, and California, 1958–1970.

TABLE 1

Shrimp Landings for Alaska, British Columbia, Oregon, Washington and California from 1957–1970 (in pounds).

Year	Alaska	British Columbia	Washington	Oregon	California	Total
1957	2,380,154	1,597,000	2,383,854	403,600	1,425,631	8,190,239
1958	7,862,366	1,908,000	6,531,239	1,522,200	1,730,222	19,554,027
1959	13,052,320	1,043,000	2,942,557	2,764,100	1,785,228	21,587,205
1960	7,436,206	1,678,000	1,780,718	1,132,500	2,026,787	14,054,211
1961	15,980,550	1,206,000	1,436,599	1,455,900	2,006,274	22,085,323
1962	16,943,120	1,663,000	1,367,441	2,750,400	1,786,289	24,510,250
1963	15,126,950	1,788,000	956,105	3,114,700	2,095,278	23,081,033
1964	7,726,750	1,052,000	314,130	5,477,400	980,608	15,550,888
1965	16,818,941	1,755,000	23,468	1,748,000	1,425,875	21,771,284
1966	28,192,621	1,682,000	282,947	4,751,300	1,213,959	36,122,827
1967	41,812,552	1,696,000	1,028,744	10,373,956	1,404,821	56,316,073
1968	42,077,104	1,568,000	1,163,864	10,976,258	2,223,205	58,008,431
1969	47,850,524	2,118,700	1,425,286	10,477,945	2,951,800	64,824,255
1970	74,346,063	1,537,800	925,000	13,735,000	4,044,640	94,588,503

dominant (up to 90% of landings) with a fair 1969-year class becoming apparent by August. Appearance of 0-age shrimp in September landings indicated the 1970-year class might be very abundant on the grounds. For the third consecutive year, most of the catch came from the area northwest of Coos Bay. Good fishing was experienced intermittently off the Umpqua River also. The area off the Coquille River produced poorly (200,000 pounds, 495 pounds/hour) this year.

Fishing off Cape Foulweather (area 84) became very good in June and continued excellent throughout the summer. The area produced 2.2 million pounds at an excellent 675 pounds/hour, mostly in July and August, while other areas off Oregon were relatively unproductive. Excessive jellyfish and hake in catches, however, were an intermittent nuisance to fishermen and caused some catches to be dumped at sea during Jujy ,£nd August as in other areas. This area produced only 215,000 pounds irv 1969 and 325,000 pounds in 196a

The area off Cape Lookout-Cascade Head (also in area 84), just north of Cape Foulweather, yielded 3.0 million pounds (560 pounds/hour) in 1970, including approximately 100,000 pounds landed in Washington during February before the Oregon season opened. This was 21% lower than the 1969 total of 3.8 million pounds (570 pounds/hour). The respective differences in yield of these two sub-areas in 1969 and 1970 were probably due to a southward shift of the shrimp within area 84. The shift probably occurred between May and mid-June of 1970. Catch rates declined off Cape Lookout nearly simultaneously with increases to the south, and did so in a progressive manner during the period. The overall area catch (84) was 5.1 million pounds, much better than in 1969 (3.9 million pounds) and was a record.

Area 82 (Tillamook Head-Columbia River) produced only 610,000 pounds in 1970 (495 pounds/hour), 50% less than the 1969 total of 1.2 million pounds (660 pounds/hour). Fishing was spotty in the area all season, with best fishing during August (180,000 pounds, 635 pounds/hour). Probably the population level in area 82 is down, especially from the record levels of 1967-1968. The decline may be related to shifts of the population out of the area or into relatively hard-to-fish areas offshore in the vicinity of the Nehalem Banks. Age composition was dominated by the 1969-year class with a fair showing of the 1968-year class (reversed from most areas). The 1970-year class was seen in landings here also, indicating a strong year class.

Prospects for 1971 appear bright in all areas off Oregon. The strong 1968- and 1969-year classes should contribute to excellent size shrimp (3- and 2-year-olds in 1971) in most areas. The signs of a strong 1970-year class may, however, pose a problem for processors unable to utilize "pinhead" size shrimp in 1971.

The trend to increasingly heavy effort in area 86 during March may test the capacity of populations there to support established levels of production. Many females are still carrying eggs during this period when shrimp are usually concentrated and particularly vulnerable to fishing.

Washington

The year's first shrimp landings were made in February by Oregon vessels who landed nearly 100,000 pounds in llwaco to circumvent the Oregon closure. No further landings were made until late April when three Washington-based vessels began fishing off Grays Harbor. The Washington shrimp fleet, which did not exceed four vessels at any one time, made 55 landings totalling 645,000 pounds in May, June, and July. With only one vessel fishing in August, September, and October, the total 1970 landings of 925,000 pounds were the lowest since 1966. Landings in 1969 totalled 1,425,000 pounds.

For Washington vessels, the Grays Harbor area produced 549,000 pounds through July at an average of 536 pounds per-hour-drag. Shrimping was considerably poorer than in 1969 when the catch-per-hour was 806 pounds for the same time period. The Grays Harbor area produced a total of 668,000 pounds for Washington vessels in 1970 compared to 1,263,000 pounds in 1969. The Destruction Island area provided some excellent fishing during June and July, and Washington vessels caught 122,000 pounds at an average catch rate of 845 pounds per hour. No catches were reported from the Willapa area by Washington vessels.

The Oregon fleet was active off Washington beginning in June, and landed in Oregon approximately 774,000 pounds caught off Grays Harbor, 475,000 pounds caught off Destruction Island, and 8,000 pounds off Willapa Harbor. Combined Oregon-Washington fleet catches were 1,442,000 pounds off Grays Harbor (down 857,000 from 1969) and 598,000 pounds off Destruction Island (up 370,000 pounds from 1969 and highest since 1958).

Four-year-old shrimp (1966-year class) made a stronger contribution than expected. Usually, natural mortality after the spring larval release reduces the 4-year-olds to a minor role in the fishery. Both the 1968-year class (2-year-olds) and the 1969-year class (1-year-olds) showed well in biological samples of the 1970 catch. As a result, average size was smaller (110 shrimp per pound) than in 1969 (95 per pound) and we are optimistic about the shrimp population for 1971.

British Columbia

Shrimp landings in British Columbia for 1970 totalled 1,537,800 pounds, a reduction of 581,000 pounds from the 1969 record catch of 2,119,300 pounds. Lower production was due to a scarcity of shrimp in BaYkley Sound and Strait of Georgia areas.

Since 1965 the British Columbia shrimp fishery has been fairly stable, averaging 1.6 million pounds. Trawl ground adjacent to Vancouver Island, where *Pandalus jordani* occur, yield the greater part of the catch. The long established pot fishery for "prawn" or "spot shrimp" *(Pandalus platyceros)* reached a record pToduction of 251,100 pounds; it accounts for about 19.5% of the total catch.

Alaska

Approximately 45 vessels engaged in the Alaska shrimp fishery in 1970. The total number of landings in 1970 increased slightly over 1969 and there was a substantial increase in the average number of pounds per landing. The total shrimp catch for Alaska was 74.35 million pounds.

The shrimp fishery of western Alaska has experienced continuous growth since 1965. Vessel size ranges from 49-100 feet, using trawls with 70- to 125-foot ground lines. Trawling is done between 40-100 fathoms with an average depth of 65 fathoms. Duration of drags is from one to three hours. All nets, except one with bobbin gear, utilize a tickler chain and are fished just off the bottom.

Initially in 1970, the number of shrimp vessels engaged in the fishery in the Kodiak area remained the same as in 1969 and then increased from 18 to 22 vessels during the last quarter of the year. Continued expansion of the existing processing facilities and the addition of other processors will increase effort and fleet size in 1971. Shrimp production in Kodiak has increased steadily from 2.9 million pounds in 1959 to 62.4 million pounds in 1970. The 1970 catch increased 21.6 million pounds over the 1969 catch.

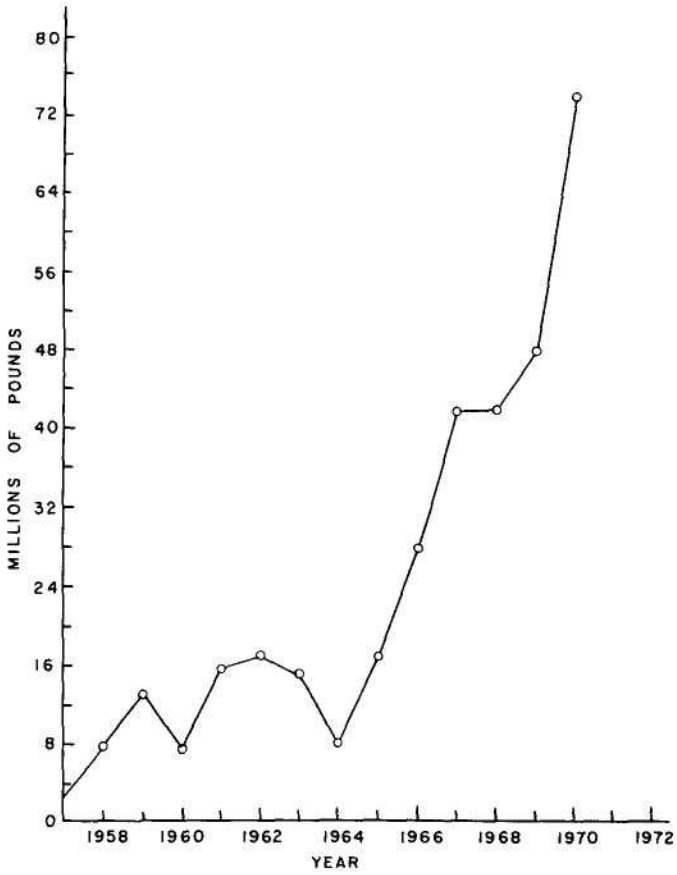

FIGURE 3. Annual shrimp landings in Alaska, 1957-1970.

In the Kodiak area the status of the fishery is presently of concern. Early sampling indicated the 1968-year class was comparatively weaker than previous year classes. Recent catch sampling bore this out. The 1968-year class is contributing (in percent far less than did the previous two year classes to the fishery. Thus far the catch per unit of effort is little affected and the outcome will not be known until further fishing has occurred.

Recently, the Alaska Board of Fish and Game adopted a Kodiak area shrimp catch quota which will go into effect in April, 1971. The quota system delineates 12 "fishing districts," 4 of which have an open quota outside of an offshore base line, and 5 which have a quota applicable to the entire district. The quotas are based on past catches from each area, knowledge of areas of fishing concentration, and knowledge of stock delineation. The quota in each "fishing district" is

administered on a quarterly basis and is accumulative on an annual basis. An annual Kodiak area quota of 58 million pounds has been set for those "fishing districts" where quotas are applicable.

The Shumagin Island shrimp fishery has expanded from one processor and two vessels to two processors and three vessels, with additional processing facilities anticipated. The total 1970 catch was 5.3 million pounds (including the Chignik area).

Pink shrimp, *Pandalus borealis,* continues to be the most abundant species in the commercial catch. Other species in order of abundance in the commercial catch are humpy, *P. goniurus;* sidestripe, *Pandalopsis dispar;* and coonstripe, *Pandalus hypsinotus.* Spot shrimp, *Pandalus platyceros,* are taken in a small pot fishery with 9,832 pounds landed (head on) during March, April and May, 1970. Expansion of this fishery is expected to increase from one vessel to three or four vessels in the next year.

A new species, *Pandalus montagui tridens,* not previously seen in the commercial shrimp catch, was found off Afognak Island during the June 1970 tri-net sampling period, although it has been reported previously by foreign fleets fishing in offshore waters around Kodiak.

Russian fleets were observed catching shrimp in vicinity of the Kodiak and Shumagin Islands during the winter of 1969-70.

Catch per unit effort (CPUE) for the Kodiak area during 1970 ranged from a low of 2,188 pounds per hour in May to a high of 5,927 pounds per hour in August, for an average of 4,344 pounds per hour. The Shumagin Island area CPUE for the same period ranged from 2,038 pounds per hour in April to 6,714 pounds per hour in Febpuary, and averaged 3,348 pounds per hour.

In central Alaska a substantial increase in production occurred. This change reflects the installation of a new processing plant in the Cook Inlet area with 4 shrimp peelers with a capacity of 45,000 pounds daily. The 1970 catches for Cook Inlet total 5,724,688 pounds considerably over the previous year's total catch of 1,847,071 pounds. Three boats operate in the fishery. Prince William Sound catches are reported as only 9,882 pounds (head-off) of pot-caught "prawn" or "spot" shrimp with 3 vessels in the fishery.

The 1970 shrimp catch for the southeastern region totalled 951,011 pounds or about 750,000 pounds below the previous year's catch. The fishery continued to center in the inshore waters near Petersburg-Wrangell area with beam trawls. Because of the poor salmon season in 1969 some additional effort was made in the Ketchikan and Yakutat areas with pots for spot shrimp in 1970. The total pot-gear catch was about 34,000 pounds (head-on) during the winter and spring months. This figure is included in the total poundage for southeastern Alaska. Effort has remained constant with 11 vessels fishing beam trawls and 4 vessels fishing pot gear.

The total catch of pot and trawl caught shrimp in central and southeastern Alaska reached 6.7 million pounds in 1970. The domestic catch for Alaska totalled 74.3 million pounds of all species by all types of gear.

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Status of 1969 Salmon and Steelhead Sport Catches in the Pacific Coast States

Estimated total sport catch of salmon and steelhead during 1969 in the States of Washington, Oregon, California, Alaska, and Idaho was 1,899,200 fish. This catch was composed of 4% coho, 31% Chinook, 21% steelhead, and 8% other salmon species (Table 1), and represented about 11.4 pounds of salmon and 1.9 million pounds of steelhead for a combined total of 13.3 million pounds.

Washington

A total of 1,215,237 saltwater angler trips was taken in Washington during 1969 on which 796,743 salmon were harvested. On a statewide basis, saltwater anglers averaged 0.66 salmon per daily outing. In addition to the marine catch, freshwater anglers caught another 79,905 salmon to bring the recreational catch to 876,648.

A total of 232,400 steelhead was taken by 138,800 sport fishermen during 1969 in Washington. The 1968-1969 catch of winter-run steelhead was 207,250. This was an 8.3% decrease from the 1967-1968 winter catch. The catch of summer-run steelhead during 1969 was 65,300, a decrease of 20.2% from the 1968 catch.

Oregon

The Oregon sport catch in 1969 was estimated to be 479,000 fish of which 349,000 were salmon and 130,000 were steelhead. The number of salmon taken was virtually the same as in 1968, but the catch of steelhead had declined about 24,000 fish. A total of 327,000 anglers received Oregon's

TABLE 1

1969 Salmon and Steelhead Sport Catch

State	Anglers	Chinook	Coho	Red	Pink	Other salmon	Steelhead	Total catch
Washington	444,800[a] 1,215,500[b]	267,000	497,500	---	32,000	79,900[c]	232,400	1,108,900
Oregon	285,000	139,000	210,000	---	---	---	130,000	479,000
California[1]	unavailable	156,000	28,000	---	---	---	---	184,000
Alaska	99,300	12,900	30,400	24,600	27,100	800[d]	1,500	97,300
Idaho	47,300	13,000		---	---	---	17,000	30,000
TOTAL	---	587,900	765,900	24,600	59,100	80,700	380,900	1,899,200

[a]Total salmon punch card holders; [b]Number of marine salmon angler trips; [c]Freshwater catch of chinook and coho (no separation was made); [d]Chum salmon; [1]No freshwater data available.

salmon and steelhead license but only 167,000 (51%) made catches. Of the remainder, 42,000 (13%) were estimated as not having utilized their licenses while another 118,000 (36%) fished with no catch. When all anglers who fished were considered, the average catch per angler per year was 1.68 fish.

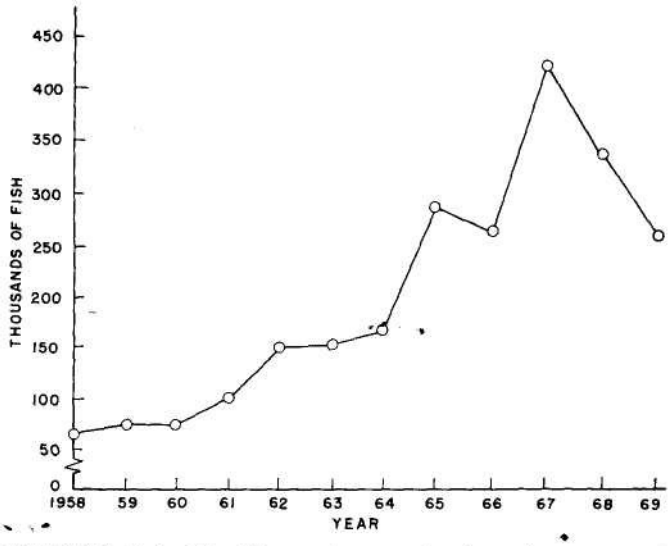

FIGURE 1. Columbia River estuary and adjacent ocean sport catch of salmon.

TABLE 2

Columbia River Estuary and Adjacent Ocean Catch, Oregon and Washington, 1969

	Angler trips	Chinook	Coho	Total*	Fish/ang. trip
Washington	115,139	33,490	165,193	193,683	1.72
Oregon	49,793	9,972	50,329	60,301	1.21
TOTAL	164,932	43,462	215,522	258,984	1.57

*Total does not include a combined catch of 2,547 pink salmon.

In the Columbia estuary, the 1969 sport catch of salmon was estimated from a catch-card system in Washington and from a separate catch sampling procedure in Oregon (Table 2). A slight decline from 1968 occurred in the estimated catches of chinook and coho. However, a lesser number of participating anglers kept the catch per angler trip comparable to 1968.

California

California enjoyed one of its better sport fishing years in 1969; however, the catch fell short of the 1968 record of 194,643 salmon (154,244 chinook and 40,399 coho). The 1969 estimate was 184,000 salmon (156,000 chinook and 28,000 coho) caught by ocean sport fishermen. The estimated chinook catch was the largest since 1956 when ocean anglers landed 163,000.

Alaska

Total poundage of salmon and steelhead landed in Alaska by sport fishermen was 823,080 pounds. Of the 97,300 salmon and steelhead caught, 30,400 (31%) were cohoes, 27,100 (28%) pinks, 24,600 (25%) reds, 12,900 (13%)chinooks, 1,500 (2%) steelheads, and 800 (1%) chums.

Idaho

An estimated 25,163 (45.8%) of 54,995 anglers who were issued salmon-steelhead permits fished for steelhead in Idaho during 1969. Of these, 6,585 anglers caught 17,000 steelhead, and 5,386 anglers caught 13,000 chinook.

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Appendix 2—Cooperative Research

Summary of Progress of Pacific Oyster Mass Mortality Investigations 1969-70

R. E. WESTLY
Washington Department of Fisheries

Mass mortality of adult Pacific oysters, *Crassostrea gigas,* has occurred each of the past several years in certain bays of Washington and California. Losses of 25% to 75% occur on the 2-year-plus-age oysters (in bad mortality years, 1-year-plus oysters also may be affected). Joint effort by the Pacific Coast Oyster Growers Association and the Pacific Marine Fisheries Commission in 1964 resulted in a yearly appropriation of $150,000 to the Bureau of Commercial Fisheries, predecessor of the National Marine Fisheries Service, to establish contracts with various state and other agencies to determine the causes of the mortality and to determine methods of minimizing, avoiding, or culturing around the mortality.

A Steering Committee set up by the Bureau of Commercial Fisheries conducts a review of progress and planned programs twice yearly to coordinate action and to take maximum advantage of information as it becomes available. Reports of the first four years of research have been given at previous annual meetings of the Pacific Marine Fisheries Commission.

Washington-R. E. Westley

Studies to date have led to the tentative conclusion that the oyster mortalities observed in Washington are similar to those observed in Japan on the same species, both being the result of physiological stress. Thus, during the 1969-70 study year, the work of the Washington Department of Fisheries shifted almost entirely to testing of various cultural techniques to avoid or minimize the oyster mortalities. Previous studies haci b'een set up to determine differences in mortaljty rates .from Pacific oyster seed-of various sources, and to determine if a delay in time of planting could reduce subsequent mortality. These studies are being continued. JMew experiments have been set up to test various methods of increasing survival of oyster seed, and to increase growth rate of oysters. Results of these studies, plus observations on the occurrence of mortality in 1970, are presented in Tables 1-3.

Table 1 indicates that oyster mortalities during the 1970 season in southern Puget Sound were generally moderate although localized instances of high mortality did occur.

Table 2 is relative to the seed source; it shows that based on a 3-year culture, no real consistent difference in adult mortality between oysters from the 5 different seed sources exists. However, on a 2-year culture there would have been a definite advantage in stocks from Dabob, Willapa, and Mango-ku-ura.

TABLE 1

Estimated Mortality by Area, in Percent

Area	1964	1965	1966	1967	1968	1969	1970
Quilcene Bay	13	7	6	10	6	4	9*
Oakland Bay	6	8	3	14	18	4	5*
Totten Inlet	12	29	14	48	26	9	19*
Case Inlet	16	25	12	48	57	19	7*
Eld Inlet	—	38	21	40	29	15	55**

(Case, Eld and Totten from commercial stock mortality estimates)

* To September 11.

** This is for the Brenner station, only 2% mortality was observed on commercial beds north of Flapjack Point.

TABLE 2

Seed Source Study

Area	May 1968 live + dead = total spat/shell	Surviving spat/shell Nov. 1968	Nov. 1969*	Oct. 1970*	% mortality Mar. 30, '70-Oct. 5, '70
Mangoku-ura	13	7	6	4	31.4
Pendrell Sound	39	18	14	8	43.9
Willapa Bay	19	5	5	3	29.6
Dabob Bay	80	20	18	12	35.7
Hojima	14	6	4	3	15.7

*Values calculated from percent cumulative mortality.

Table 3 presents results of a newer study which is intended to determine if manipulation of time of planting of oyster seed could make a difference in the subsequent adult mortality. As Table 3 indicates, plantings that were delayed until June suffered only about 1/3 the mortality of earlier plantings. However, the 2-month delay in planting has resulted in a somewhat smaller size oyster. Thus, mortality of this stock may increase next year.

TABLE 3

Seed Holding Experiment, Cumulative Mortality
from May 21, 1970 to October 5, 1970

Area	Time of planting	Percent mortality
Lot 1	April 1969	49.6
Lot 2	May 1969	38.6
Lot 3	June 1969	12.4

All lots were randomized from a common stock of Mangoku-ura seed.

During the spring of 1970 several additional experiments were set up to test seed survival of the two main Japanese seed sources in all major oyster areas of Washington, and to determine cultural techniques for increasing oyster seed survival.

University of Washington-Dr. A. K. Sparks

The University of Washington has continued to process and evaluate preserved histological material submitted by the Washington State Department of Fisheries and the Fish Commission of Oregon.

During the past year, a review of slides previously read has been undertaken, particularly those from the areas of high mortality such as Mud Bay. Pacific oysters from this area often present a similar pathological pattern. Considerable necrosis and hemocytic infiltration is present in the gonad, usually in the female, but also in some males. This is normally accompanied by numerous foci of bacteria in the gonads and at times in other areas of the oyster. Although at first the foci of bacteria appeared to be the, ..primary pathogen, recent examples of this pathological condition have been found in which no foci of bacteria were observed.

Oregon-C. Dale Snow

Oyster mortality information was collected in Tillamook, Coos, and Yaquina Bays. During the study year stations were rebuilt and restocked with oysters. Monthly sample* of Pacific and native oysters *fUstrea lurida)* and bay mussels *(Mytilus edulis)* were collected in Yaquina Bay and shipped live to the Oxford, Maryland Laboratory ftfr histological examination. In general. Pacific oyster mortalities in Oregon continue at a low level.

Califomia-Dr. S. C. Katkansky

The study program in California has been altered to provide greater emphasis on the major problem area of Humboldt Bay. To accomplish this, studies in Morro Bay and Elkhorn Slough have been de-emphasized and the phytoplankton study has been terminated.

During 1969 Pacific oyster mortalities in Tomales Bay were 8.8% for the 1967 seed planting, and 24% for the 1968 planting. In Drakes Estero, 1969 losses among the experimental oysters were less than 5%. In Humboldt Bay the experimental plantings of Pacific oysters continued the downward trend in mortality observed in 1967 and 1968. The 1969 losses were 9.6%.

California carries on a companion project to the Washington seed source study determining losses of Pacific oysters in Humboldt Bay from the same 5 seed source areas. The 1969 losses were as follows:

Mangoku-ura	9.0
Pendrell Sound	6.2
Willapa Bay	10.7
Dabob Bay	8.0
Hojima	14.2

The majority of these losses occurred from the middle of June through July. Statistical analysis of the data (analysis of variance, 95% level of significance) indicates that these differences are significant.

During 1970, heavy mortalities of Pacific oysters began in Humboldt Bay starting about June 1. The losses appeared to be generalized on the cultivated bars with little difference due to location or depth. Observations indicate that oysters of the same age and originating from the same area but cultivated by suspension from racks escaped the mortality until approximately July 1.

Mortalities among stocks of oysters cultured either on the ground or on suspended racks were notes to subside in August. Losses among ground-cultured oysters from the various culture areas in Humboldt Bay through the 1970 mortality period ranged from 20.9 to 38.9%. Analogous losses among rack-cultured oysters ranged from 10.8 to 17.3%.

Oyster losses (1969 seed planting) in Drakes Estero and Tomales Bay were 7.7 and 13.9% respectively for the 1970 mortality period.

Studies to determine cause of death of oysters in Humboldt Bay are still inconclusive. Histological examination 'shows inclusion cells persisting in most gapers and in a small proportion of the live oysters collected. The difference in mortality between the ground- and rack-cultured oysters seems to be an interesting clue.

Oxford Laboratory National Marine Fisheries Service—Dr. Aaron Rosenfield.

During the past study year the Oxford Laboratory has continued its program of histological evaluation of oysters received from the West Coast. Work of this laboratory is primarily directed toward assessment of the role of parasites and pathogens in oyster mortality. In addition to examination of histological samples, various experiments have been conducted in an effort to artifically infect healthy oysters with suspected pathogens.

Summary

The studies that have been carried out on Pacific oyster mass mortalities since 1965 can be summarized as follows. To

date no single clear-cut cause of mortality has been discovered. Various organisms, which may be related to mortality, are under investigation.

In Washington the consistent pattern of mortalities over the years and their similarity to mortalities observed on the same species in Japan has led to a tentative conclusion that the oyster mortality is a physiological stress resulting from an interrelationship of the fattening and spawning cycle of oysters. Based on this conclusion, work has shifted to development of cultural methods to avoid or reduce the extent of mortality.

Pacific oyster mortalities in Oregon continue at an extremely low level and the observations thus far provide a basis for comparisons with higher mortality areas.

In California, Pacific oyster mortality in Humboldt Bay was low in 1969, but became very severe in 1970. Cause of the mortality is still unknown. Difference in mortality rate between bottom and rack grown oysters is being investigated as a possible lead.

Appendix 3—Special Reports

Condition, Yield, and Handling Mortality Studies on Dungeness Crabs During the 1969 and 1970 Seasons*

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Dungeness crab season closures along the Pacific Coast are established to coincide generally with the principal molting and soft-shell period of males reaching legal size. Because of geographical differences and cyclic changes in the timing of the soft-shell period, the opening dates for crab seasons are frequently subject to controversy. The past two seasons have opened during periods of high incidence of soft-shells in certain areas along the coast due to a late conditioning cycle.

As background for a recommended January 1 uniform opening date from Pt. Arena to Cape Flattery, the shellfish research staff of PMFC, composed of biologists from coastal States, recognized the need for a special report on recent studies of crab condition by the States of California, Oregon, and Washington. The state research directors stipulated that this report pertain to the 1969 and 1970 seasons. Accordingly, the staffs of the three States pooled information for compilation of this report by the State of Washington.

Two general study categories are discussed:

(1) Crab condition, including shell condition and meat yield.
(2) Effects of fishing and discard handling on soft-shell crabs.

Washington's crab studies pertaining to these categories were expanded in 1969 in a program funded under PL 88-309, the Commercial Fisheries Research and Development Act.

CRAB CONDITION

Sampling Procedures

The coastal States have carried out port sampling programs of varying degree on Dungeness crabs for many years. In 1966-1968, PMFC furnished the matching funds *(25%) for cooperative port sampling in Crescent City, Port Orford, and Brookings under a PL 88-309 .contract that included crab condition samples (Gotshall and Hardy, 1969). For a number of years, California made pre-season cruises to estimate abundance and check condition. The California grading system included two categories—hard crabs and soft crabs. However, attempts to grade crabs by shell condition were discontinued in northern California at the end of the 1968-1969 season because it was felt the method was not reliable.

Although coastal sampling during the 1968-1969 and 1969-1970 seasons included some port sampling, increased emphasis was given to yield data from samples taken by experimental fishing. Thus, two basic sample sources are considered: (1) those termed port, dockside, or plant samples, and (2) those termed experimental, pot-run or non-selected samples. Port samples may be selective, depending upon the degree to which soft-shells are sorted by fishermen at sea. Yield or pick-out is the percentage of meat, either unbrined or brined, obtained by commercial procedures from a given weight of live crabs.

Beginning in October 1969, Washington expanded its crab condition studies under PL 88-309 funding in an effort to establish a standard method for determining crab condition. This program is being continued through the 1970-1971 season. Samples of approximately 150 crabs per area are taken at least monthly from 3 ocean areas and from Willapa Bay. These are pot-run samples of legal-size crabs taken by standard commercial fishing methods. In addition, occasional plant samples are taken for comparison. For each sample, crabs are measured, then graded into 3 categories according to shell hardness:

Grade I. shell hard, little or no flexibility in carapace.
Grade II. shell intermediate between I and **III.**
Grade **III** recently molted soft shells, carapace and legs flexible, easily cracked by finger pressure.

Weight and volume (water displacement) are obtained for each graded lot, then each lot is butchered, cooked, and picked separately. The picked meat is weighed, then sub-samples of body and leg meat are sealed in plastic bags for subsequent drying to constant weight in a drying oven. From these procedures, we expect to test the meaningfulness of the 3 grades by relating them to yield, and to obtain miscellaneous information on such relationships as crab weight to volume displacement, and loss of water in crab meat. Four indices of condition are derived from the present procedures:

1. Pickout or yield of unbrined meat related to green (live) weight (as %).
2. Pickout of unbrined meat related to green volume (lb/gallon).
3. Yield of dried meat related to green weight (as %).
4. Yield of dried meat related to green volume (lb/gallon).

1969 Season

The coastal crab season opened on December 1, 1968, off Oregon, Washington and northern California. Oregon reported 15—24% soft-shell crabs in port samples taken at the beginning

of the season. California reported approximately 20% soft-shell crabs in port samples at Eureka and 8% at Crescent City (Table 1). Soft crabs were scarce at Crescent City, but at Eureka continued to make up 20% of the dockside samples through February.

TABLE 1

Per Cent of Soft Crabs in Northern California Port Samples, 1968-1969 Season.

Month	Eureka	Crescent City
December 1968	21.0	7.8
January 1969	19.2	0.9
February 1969	21.1	0.6
March 1969	0.0	2.2
April 1969	0.0	3.8
May 1969	0.0	4.0

Early in December 1968, crab pot samples off Grays Harbor showed 40% hard-shells (Grade I) and 60% in Grades II and III. Because of the high incidence of soft shells, the season was closed December 11 and reopened January 1, 1969. Crab condition improved steadily, with hard-shells comprising 64% of plant samples in January, 82% in February, and 96% in March. Condition-wise, crabs were approximately 1 month later in 1969 than in 1968. Soft-shells were almost non-existent in April through July, then increased to 5% in August and 13% in September (season closed September 15). The September percentage is deceptively low because it includes plant samples biased by discard of soft-shells at sea. Pot-run samples in a September observation trip ran 12% and 64% Grade III in 2 strings of pots "hear Destruction Island, indicating the start of heavy molting.

1970 Season

A severe soft-shell problem was first indicated in samples taken off the Washington coast on October 31, 1969. As a result, the Washington season opening was delayed until January 1, and Oregon and California were advised of the high incidence of soft-shells off Washington. Pre-season test fishing and plant processing of samples subsequently were carried out for a number of Oregon and California areas. Sampling showed a high incidence of soft-shells off Astoria in late November, and a very poor meat yield of 13-14% (Table 2). Samples off Newport were somewhat better, with 40-50% soft-shells and about 20% pickout. Charleston and Brookings samples showed further improvement, and included a high yield of 27% in 1 sample (Table 2). Although recognizing the soft-shell problem, Oregon stayed with its December 1 opening. The Fish Commission of Oregon did, however, close the Washington coast to Oregon crab fishermen in order to recognize the later Washington opening.

TABLE 2

Condition and Meat Recovery from Pre-season Crab Samples off Oregon

Port	Date	Area	% soft	% pick-out[1]
Astoria	11/22/69	S. of Buoy 4, 12 fm	89	13.1
Astoria	11/24/69	S. to Tillamook Head	87	14.3
Newport	12/1/69	Alsea-Shellpile, 17 fm	54	19.3
Newport	12/1/69	Heceta Head-Siuslaw	41	21.5
Charleston	11/28/69	North of bar, 18 fm	33	22.8
Charleston	11/28/69	Whiskey Run, 17 fm	11	27.0
Brookings	11/25/69	Pelican Bay, 30 fm	59	22.0

[1] Meat recovery after brining as percentage of live weight.

California obtained several random samples for meat recovery checks prior to and during the 1969-1970 season which opened December 1. Samples in late November, 1969 yielded 19.8 to 23.5% for an average of about 21.5%. Meat recovery checks in December, January, and March ranged from 22.6 to 26.3% (Table 3), but no particular trend was evident for the 5 samples collected during this period.

TABLE 3

Meat Recovery from Northern California Crab Samples

Date	Catch area	Depth (fms)	No. of crabs	% recovery[1]
11/23/69	Samoa to Trinidad	15-29	308	19.8
	Table Bluff to False Cape	15-27	300	19.6
	Redding Rock to Crescent City	28-32	300	22.4
	Usal to Cape Mendocino	7-24	265	23.5
12/8/69	Table Bluff to False Cape	18-20	286	22.6
	Samoa to Trinidad	18-22	285	23.7
	Patrick Pt. to Stone Lagoon	14-26	290	26.3
1/12/70	West of Eureka	20-26	142	23.2
3/9/70	Off Eel River	30	175	25.3

[1] Meat recovery after brining as percentage of live weight.

The respective percentages of crabs by grade taken in random pot samples off Washington and in Willapa Bay from October 1969 through September 1970 are plotted in Figures 1 and 2. October-November samples included 80-90% recently-molted soft-shells, and few hard-shells in either area. Ocean crabs showed some improvement in December, but less than 30% were graded hard (I). The percentage of hard crabs increased to only 45% in January. Because of the relatively poor condition of crabs, most processors refused to buy until late January, holding the catch to 1.1 million lb., compared to 4.2 million in February. In February, just over 80% were graded I. Grade III soft-shells were virtually absent from March through June, but there were 5 to 10% in Grade II. Some soft-shells

(III) showed up again in the August sample. The early Willapa Bay samples revealed poor condition of crabs, and the improvement in condition was even later than in the ocean (Figure 2). Of interest in the Willapa samples was the decline in percentage of I's between October and November which indicated that molting extended later than in the ocean.

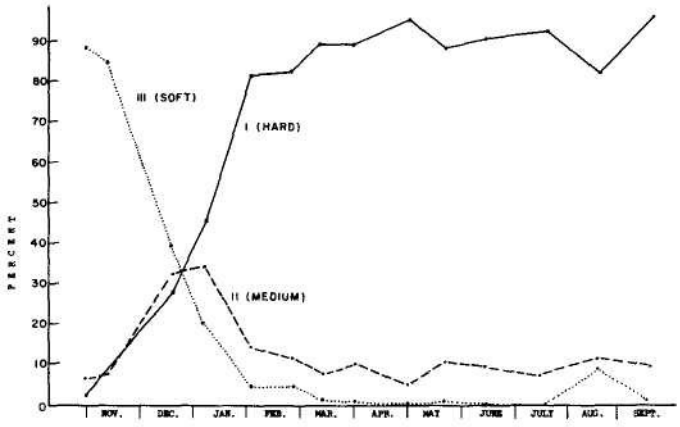

FIGURE 1. Percentage of ocean crabs by grade in pot-run samples off Washington, October 1969–September 1970.

Three indices of condition based on meat yield per green weight and volume are plotted in Figure 3 for ocean samples off Washington. Grades were combined to show the overall change in condition of pot-run samples. Sharp rises in condition occurred from December into February for each abundance index. Thereafter, the pickout percentage fluctuated, and did not show any appreciable gain. The dried yield continued to increase until April, then levelled off through June. All indices of crab condition then declined. Similar information for the Willapa Bay samples is plotted in Figure 4. All indices showed a steady rise from early December to early June, then showed a decline in the late-July sample. The decreasing spread in the index lines (picked meat compared to dried meat) indicates decreasing water content in tile meat as overall condition improved.

Very few areas along the coast from northern California to Washington produced crabs of overall acceptable condition in December 1969. Crabs were in particularly poor condition off northern Oregon and Washington. Sampling in 1969 indicated that molting began strongly in mid-September in Washington, and continued until mid- or late-November. It is apparent that for several years the molting cycle has been later than average, but not so late that it explains the extremely late recovery to overall acceptable condition. In some manner, possibly food supply, late conditioning appears related to the high abundance of crabs that has prevailed for several years. Record landings were made in Washington in 1969, and the 1970 catch was second only to 1969. The 1969-1970 crab catch is reportedly a record for both northern California and Oregon.

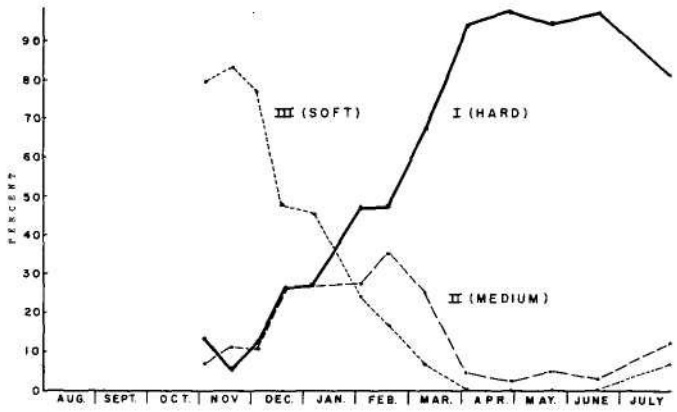

FIGURE 2. Percentage of Willapa Bay crabs by grade, October 1969–July 1970.

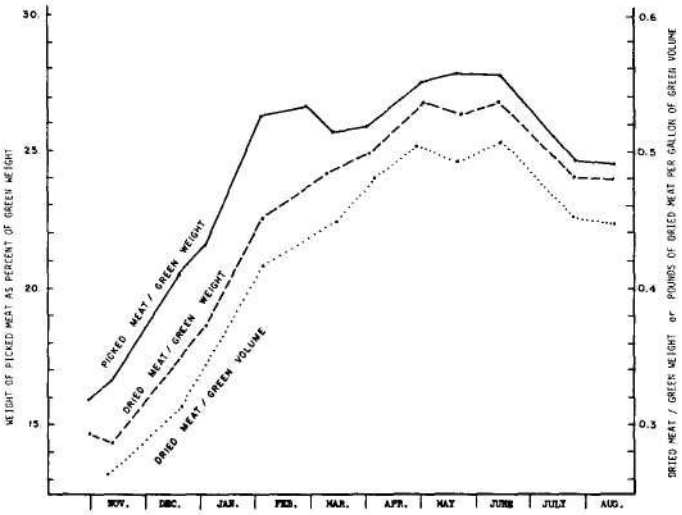

FIGURE 3. Condition indices for pot-run ocean crab samples taken off Washington, grades combined.

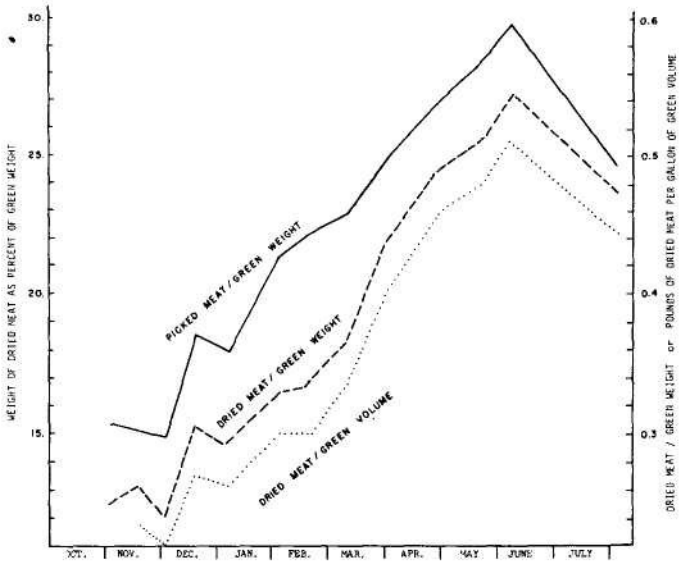

FIGURE 4. Condition indices for pot-run Willapa Bay samples, grades combined.

Comparison of Grades

The Washington sampling program permits a comparison of yield by grade so that the validity of the grading procedure can be considered. For comparison, pickout/green weight and dried meat/volume are plotted by grade in Figure 5. The consistent differences between the 3 grades from November through February indicate that the grading was meaningful with respect to quality during this period. The 3-grade comparison was suspended because of sample size when less than 5% were III's (March through June). In July and August, the **III's** increased in relative abundance and again produced distinctly lower yield indices. There was, however, little apparent difference between the quality of crabs graded I and II in May through August. This was at least partly due to the softening of the shell of some crabs prior to molting, and the classification of these crabs as II's instead of I's. As a result, all old-shell crabs are now graded as I's.

Crab weights have certain inherent variables that we hoped to avoid with a volumetric approach. For example, weight loss due to draining between the time of taking the crab sample out of water and finally weighing the live crab is approximately 5%, but would be expected to vary by time and possibly by grade. Weight-volume comparisons show that **III's** weigh consistently less than I's and II's per volume of water displaced despite equal draining periods (Table 4). II's weighed less than I's except during the summer period when there was

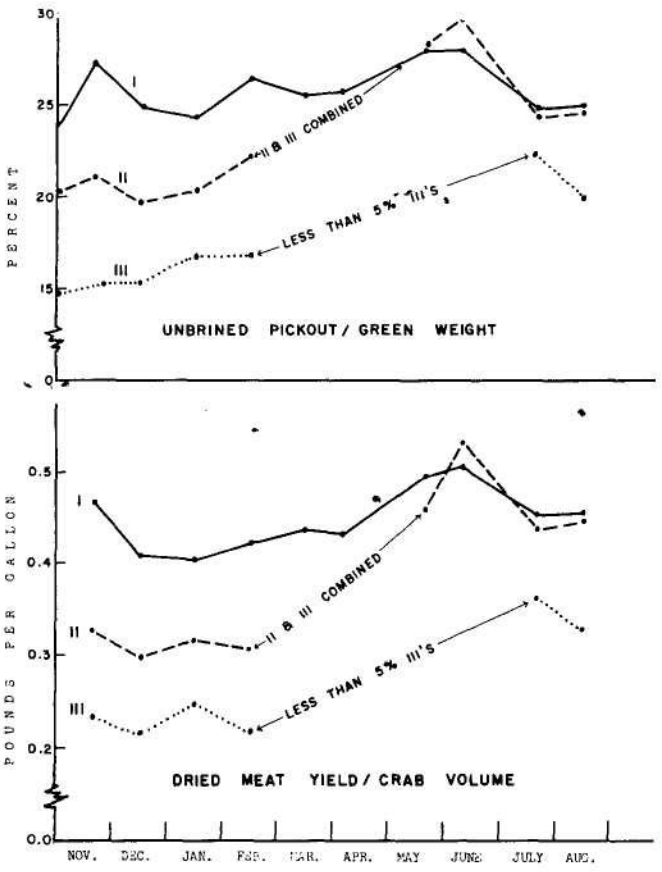

FIGURE 5. Yield indices by crab grade, ocean and Willapa Bay samples combined.

TABLE 4

Weight of Crab Per Volume of Water Displaced by Grade, November 1969–August 1970

Month	Lb/gallon I	II	III
November 1969	9.49	8.97	8.88
December 1969	9.27	9.22	8.83
January 1970	9.29	9.07	8.97
February 1970	9.29	9.00	8.90
May 1970	9.31	9.26	8.88
June 1970	9.42	9.47	—
July 1970	9.37	9.35	9.09
August 1970	9.31	9.43	9.06
Average	9.34	9.22	8.94

little apparent difference in quality between I's and II's (Figure 5). This indicates a weight differential of approximately 5% between I's and III's that is not accounted for in the conventional calculation of pickout based on weights, and points to a greater loss from harvesting II's and III's than previously measured.

Inasmuch as some processors had reported greatest weight loss in canned crab produced early in the season, water content of the meat has been suspect. Consequently, we have dried crab meat samples, and have found that weight loss differs by grade as would be expected. Exact differences cannot be shown by the present procedures, however, because of variable draining time of the wet meat prior to taking the sample for drying.

The index values plotted in Figure 5 indicate that dried meat/crab volume is a more sensitive measure than unbrined pickout/green weight in that the former shows a greater range in values. This appears to be true because this measure considers the difference in water content of picked meat for a given volume of whole crab.

HANDLING MORTALITY STUDIES

Early Washington studies by Cleaver (1949) showed greatly reduced returns of soft-shell Dungeness crabs tagged with the Petersen disc as compared to tagged hard-shell crabs. In Oregon, Waldron (1958) reported lower tag recovery of Grade II (carapace slightly to moderately flexible) than of Grade I (carapace rigid) crabs. He did not tag crabs in Grade III condition (carapace very flexible). Although handling mortality probably occurs when soft-shells are discarded in normal fishing operations, reliable quantitative estimates have not been available. A preliminary series of experiments, funded under PL 88-309, were carried out in Willapa Bay, Washington, in 1969 to investigate handling mortality on soft-shell Dungeness crabs. This information is essential for management purposes in considering closed periods and maximum yield. The initial results were reported by Tegelberg and Magoon (1970).

In the Willapa Bay experiments, crabs were captured in commercial pots fished overnight, then graded and held briefly in running seawater in a compartmented tank. When sufficient numbers of crabs had been graded, experimental lots were carefully transferred to holding pots and lowered to the bottom in 3 to 7 fathoms of water. The holding pots were made by wiring shut the tunnels and escape rings on commercial crab pots. There was some loss from the holding pots for 2 apparent reasons: (1) escapement and (2) predation on weak or dead crabs. Pieces of carapace were all that remained of some dead crabs. The number unaccounted for (less than 5%) was subtracted from the sample, which would provide a minimal estimate of mortality. The experiments were to include tagged and untagged crabs of each grade (I, II, III).

An initial experiment was carried out to determine an appropriate sample size. Since there was no indication that mortality was different at holding densities of 15, 25, 40, and 60 crabs per pot, a sample size of 25 crabs per holding pot was chosen for subsequent experiments.

Since progressive mortality was encountered (approximately 10% in 2 days, 25% in 7 days for soft-shells), the role of additional handling vs. time was investigated on untagged and tagged (Petersen disc) soft-shells. Difficulty was encountered in getting exact counts without excessive handling, and greater total mortality accompanied additional handling during comparable holding periods. However, due to variability among replicates, this trend was not statistically significant. Mortality of tagged soft-shells ranged from 23% (2 days, 1 handling) to 41% (6 days, 3 handlings) and was consistently 6% to 12% higher than of untagged soft-shells.

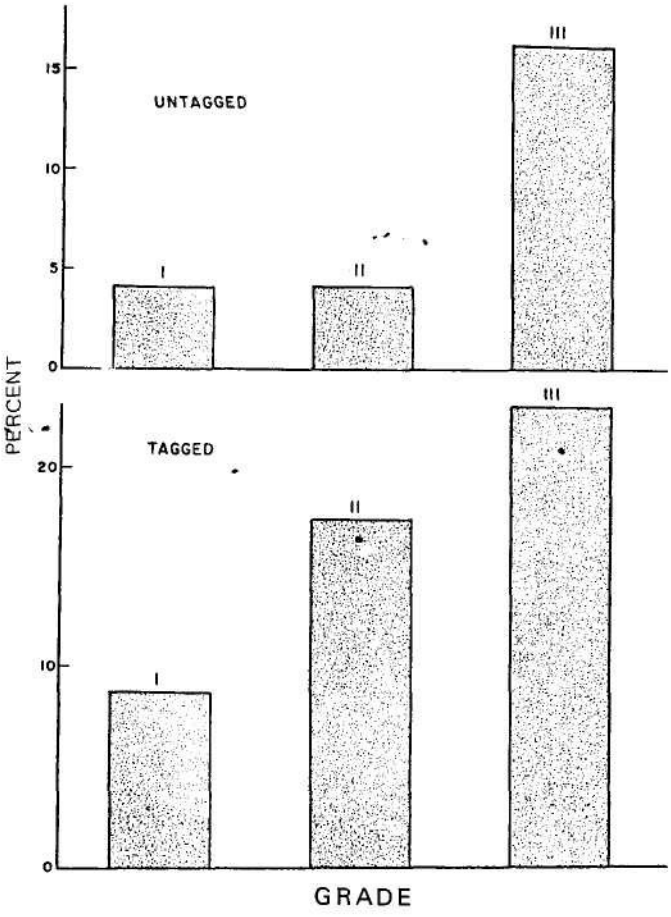

FIGURE 6. Average mortality of graded Dungeness crabs held 4 days in triplicate lots of 25 crabs.

Finally, triplicate lots of 25 crabs, untagged and tagged, of the 3 grades were held for 4 days. The average results are shown in Figure 6. Mortality of Grade III untagged soft-shells averaged 16% compared to 4% for I's and II's. Mortality of crabs tagged with the Petersen disc ranged from 9% for I's to 23% for III's. Some tag loss was noted among the III 's.

Ready availability of III's permitted additional experimentation. Two lots tagged with a Floy dart tag experienced 16% mortality in 4 days, the same as untagged III's. Four experimental lots of III's suffered 57% mortality after being individually dropped on the deck of the vessel.

It is difficult to duplicate experimentally the handling of soft-shells during commercial fishing. In these experiments, the chartered fisherman thought that the handlingwas less severe than in normal fishing procedures. Although additional experiments are planned, the information to date indicates that soft-shells are subject to significant mortality from discard handling when crab fishing is permitted during periods of soft-shell abundance. The study indicates that previous low recovery rates of soft-shell crabs tagged with the Petersen disc have been due primarily to mortality, but that tag loss was a probable additional factor.

SUMMARY

1. Late conditioning of crabs the past 2 years has resulted in open seasons during periods of high incidence of soft-shells in certain areas along the coast. Yield and condition records indicate that the December 1, 1969 opening was earlier than desirable in nearly all fishing areas from northern California to Washington.
2. All States have sampled experimentally for meat yield based on industry procedures. Under a PL 88-309 contract, the State of Washington is experimenting with various indices of condition, including wet and dried meat yields compared to. both weight and volume displacement. Between grades, these studies showed differences in live weight per volume of crab, and in water content of picked meat, indicating that the conventional measure of wet meat/live weight has shortcomings as a condition factor.
3. Recent experiments confirm that soft-shell crabs are not as hardy as hard-shell crabs, and that the former are subject to mortality when discarded in fishing operations. Probable short-term mortality is in the 15 to 20% range.
4. Opening the crab season too early causes economic losses because of 2 factors: (1) mortality of soft-shells due to discard handling and (2) lower production from crabs not harvested in prime condition.

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A Review of the Subject of Hooking Mortalities in Pacific Salmon *{Oncorhynchus)**

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ABSTRACT

Examination of available data on the subject of hooking mortalities in Pacific salmon indicates that the mortality rate for nonretainable Chinook and coho taken during experimental trolling operations is probably between 15 and 30%. Any justification of higher rates must include the basic assumption that either artificial conditions imposed during live-tank holding experiments did not significantly affect survival rates of the salmon tested or that virtually all seriously injured fish succumbed.

Mortality rates would seemingly increase during normal commercial fishing operations since lines are generally checked less frequently, but this effect could well be neutralized by a lesser degree of physical damage due to handling.

Of the two major species considered, coho seemed more prone to physical damage from hooking, but it could not be adquately demonstrated that this necessarily caused a mortality rate higher than that sustained by Chinook.

For pink salmon, hooking mortality does not appear to be excessive, and regulations requiring their release can be justified when unusually poor returning runs are expected.

For nonretainable salmon taken on sport angling gear, the hooking mortality rate is probably somewhat less than encountered in the troll fishery, possibly 5 to 10% or less.

In both troll- and sport-caught salmon, important but as yet unmeasured additional losses may occur due to handling damage, involuntary releases, and sublethal effects. Damage maytae greater for fish just under existing minimum size limits which might be brought onboard and measured.

Minimum size limits and species variable»seasons can be justified in certain cases but not necessarily as they existed in 1969. It is'recommended that the hooking mortality rates cited above be utilized in the development of management options for the marine salmon hook-and-line fisheries until such time as more definitive data become available.

INTRODUCTION

In the ocean hook-and-line fisheries (commercial troll and sport) for Pacific salmon, regulatory controls initiated in the name of resource conservation have been manifested primarily as season and minimum-size limit restrictions, plus bag limits in the case of sport fisheries. These deal almost exclusively with two species which are highly susceptible to capture on hook-and-line gear during the ocean feeding stage of their life history—chinook *(Oncorhynchus tshawytscha)* and coho *(O. kisutch)* salmon.

The major statutes (excluding special regulations and exceptions) in effect during 1969 for these two species were as follows (Wendler, 1970):

Copies of the April 1970 issue of this report were distributed early in 1970. Two other reports, "A Review of Trolling Gear Studies on Chinook and Coho Salmon" by Paul H. Reed and "A Review of Chinook and Coho Shaker Catches in the Pacific Coast Troll Fishery" by Patrick O'Brien, Stephen N. Taylor and Paul T. Jensen, were distributed just before the Annual Meeting in Palo Alto on November 17-20, 1970. Verbal summaries of all three reports were presented on November 19 as part of the panel discussion of the "U. S. Troll Fishery for Salmon." A fourth report, "Ocean Salmon Regulations Along the Pacific Coast" by Henry O. Wendler was published in the 22nd Annual Report of the Pacific Marine Fisheries Commission for the Year 1969." It is considered part of this series of special reports on the troll fishery.

Regulatory unit	Minimum size (total length) Troll	Sport	Season Troll	Sport
		Chinook		
California	26 in.	22 in.	4/15-9/30	Year-round north of Tomales Pt.
Oregon	26 in.	20 in.	4/15-10/31	Year-round
Washington	26 in.	20 in.	4/15-10/31	4/15-10/31
British Columbia	26 in.	12 in.	4/15-10/31	Year-round
Alaska	26 in.	None	4/15-9/20	Year-round
		Coho		
California	25 in.	22 in.	4/15-9/30	Year-round north of Tomales Pt.
Oregon	15 in.	20 in.	6/15-10/31	Year-round
Washington	20 in.	20 in.	6/15-10/31	4/15-10/31
British Columbia	3 lb. rd. (or 2.5 lb. dr.)	12 in.	6/15-10/31	Year-round
Alaska	None	None	6/15-9/20	Year-round

The rationality of all minimum-size limits and any species variable fishing seasons presently in existence or contemplated in the future is greatly dependent on one factor: the mortality rate, due to the trauma of being hooked, which is applied to fish required to be released because" of«a specific regulation. At present, published references document hooking mortality rates ranging down to a low immediate rate of only 2 out of 348 chinook (0.6%) taken on sport angling gear during April and May, 1960, near the southern tip of Whidbey Island in Puget Sound (Haw, 1963). On the opposite end of the range a ■delayed mortality rate of 71% for 66 fish (with 0.95 binomial confidence limits of 40 to 86%) has been determined for chinook (Parker and Black, 1959). This latter rate was additive to any immediate mortality since the fish tested were selected for maximum survival as judged from external appearances.

Obviously, if the chinook and coho resources are to be intelligently managed and if attempts to develop the proper regulatory tools through accepted methods of scientific analysis are to be successful, the true rates of hooking mortality for a given set of conditions must be pinpointed within relatively narrow confidence limits.

Intent of the following discourse is presentation and evaluation of available data on the subject of hooking mortality in Pacific salmon. Basic organizational approach is by (1) general method of study and (2) species. When available to the author, sufficient detail will be presented for each individual experiment to allow the reader sufficient latitude to reach his own conclusion on the subject.

IMMEDIATE HOOKING MORTALITY RATES

Known Absolute Minimum Rates

A relatively straight forward method of estimating the absolute minimum rate of hooking mortality is simply by determining the percentage of fish which are dead when brought onboard. As mentioned in the introduction. Haw (1963) found a rate of 0.6% for sport-caught chinook. In this group, 181 were taken on treble hooks and 167 on single hooks. The 346 chinook which were tagged and released ranged from 19- to 60-cm fork-length and averaged 36.6 cm or 14.5 inches. The equivalent average total-length was 40.6 cm or 16.6 inches. In examining the recovery rates for the 2 groups of tagged fish, no evidence was found to indicate that released treble-hooked chinook suffered either a greater or lesser mortality than released single-hooked fish. Haw concluded: "The possibility exists that the mulitiple wounds of the treble hook were at least partially compensated for by the depth of penetration by the single hook and further, that the size and shape of the treble hook used inhibits its deep inhalation by small fish".

Van Hyning (1951) reported the lowest rate, only 2.5%, for a sample of legal and sublegal troll-caught chinook, 10 mortalities of 393 fish taken off the Oregon coast in 1948 and 1949. I observed in 1968 that 13 of 389 chinook (3.3%) taken by trolling in outer Juan de Fuca Strait and off Cape Flattery in June and July were dead when brought onboard. The 389 fish averaged 46-cm fork-length (the 13 dead fish averaged 44 cm) and ranged from 24 to 91 cm. Over 90% were less than the troll minimum of 26 inches (66 cm) while more than 60% fell under the ocean-sport minimum of 20 inches (50.8 cm). Jensen (1969) shows mortality for 28 of 572 sub-26-inch "shaker" chinook (4.9%) taken off Crescent City (northern California) by trolling in June, 1969. The combined total for the above 3 troll-fishery observations (which are mainly of sub-26-inch fish and include only chinook completely dead when brought onboard) is 51 of 1,354 for an absolute minimum hooking-mortality rate of just under 4%.

Absolute rates for coho are also available from studies coincidental with the chinook studies. Lasater and Haw (1961) reported on the tagging of sport-caught coho concurrently with the 1960 Puget Sound chinook tagging discussed by Haw (1963). In this case, a total of 185 coho were tagged, 77 being taken on treble hooks and 108 on single hooks. Again, there was no significant difference in tag-recovery rates between the treble- and single-hook groups. The fish ranged from 28- to 50-cm fork-length and averaged 40.3 cm (15.9 inches). The authors do not mention possible immediate hooking mortalities on coho, but Lasater (unpublished data)[1] states: "In the experiment on Puget Sound, only 3 salmon (chinook plus coho) were killed outright by the gear." It is assumed, therefore, that only 1 of 186 coho (0.5%) sustained immediate loss. Lasater further states that: "With careful observation, none of the salmon released was seen to be taken by sea gulls and others were deliberately dragged for 15 minutes at trolling speed with no visible ill effects."

For coho taken on commerical trolling gear. Van Hyning (1951) again reports the lowest rate, 15 of 794 coho (1.9%) taken off the Oregon coast in 1948 and 1949. I tallied losses for 40 of 664 troll-caught coho (6.0%) taken during the 1968 outer Juan de Fuca Strait-Cape Flattery tagging project. These fish averaged 51-cm fork-length (dead fish 49 cm) and ranged from 29 to 75 cm. About 30% were under 20 inches, the commercial-troll and ocean-sport fishery minimum sizes for Washington in 1969. Further additive losses for these same fish will be considered in a subsequent section on "Control Group" experiments. Jensen (1969) cites losses for 11 of 158 coho (7.0%) caught off Crescent City in June, 1969. All of these fish were "shakers", i.e., less than California's minimum of 25 inches. As in the case of Chinook, the aggregate for 3 troll sources (66 of 1,616 fish) shows an absolute minimum hooking mortality rate of **4%.**

Rates Determined from Short-Term Observations

Several available estimates of immediate hooking mortality rates apparently include fish which were still alive when brought onboard but were very seriously injured and succumbed after a brief period of holding and observation.

For sub-26-inch Chinook taken by 2 trollers on barbless hooks off the Oregon coast in 1967 and 1968, there were 59 mortalities (6.4%) in the 918 fish taken (Reed, personal communication).[2] For sublegal Chinook taken on barbed hooks by the same 2 trollers, the immediate mortality rate was 7.9% (71 of 901). Fish that were dead on landing or did not resume normal position and action in the recovery tank were termed immediate mortalities. During the joint Oregon-Washington chinook-tagging project from mid-March to mid-April in both 1959 and 1960 off the Columbia River-Grays Harbor area, Bergman (1960) reported that a total of 765 of 841 fish caught were tagged and released. Thus, the mortality of 76 chinook (9.0%) is implied. Bergman states: "Most salmon were lifted onboard by the leader and dropped into the anesthetic box. When the fish was calm—usually less than 1 minute—it was unhooked, removed to the tagging cradle, measured, and tagged. After tagging, the salmon was placed in a recovery tank of fresh salt water, where it was allowed to revive in order to be sure the fish was not severely injured, and to reduce chances of predators taking fish still in a sedated state. One-half of the hooks used (fad the bards bent down so that they would not catch and tear; the other half were the same type of single hook, but with normal barbs." In examining the length-frequency distribution, there was no apparent difference in size of chinook caught by the 2 types of hooks. Of the 298 fish taken during Washington operations only, 81% equalled or exceeded the 26-inch troll minimum.

Heyamoto (1963) reports that 17 of 22 chinook taken north of the Columbia River mouth from May through August, 1957, were tagged and released. It is implied that the remaining 5 fish (23%) were mortalities since he states: "The live-box proved useful in that fish of doubtful condition were placed in the box before and after tagging to revive before releasing". Of the northside fish, 82% were sub-26-inch chinook. No mention was made of mortalities in 61 chinook taken on the south side of the Columbia River mouth during the same study, the percentage of sublegals again being 82%.

Additional evidence on the immediate hooking mortalities of chinook is provided in 3 Department of Fisheries and Forestry tagging studies (Hollett, personal communication)[3]:

Date	Area	Number caught	Percent mortality
Oct.-Nov. 1966	Strait of Georgia	1,366	4.7
Mar.-Apr. 1967	Strait of Georgia	570	5.2
1969	W.C. Vancouver I.	481	0.7
	TOTAL	2,417	4.0

In these studies, fish were tagged at capture and then placed in a holding tank for a few minutes. The percentages given represent fish that actually died shortly after tagging. Hollett makes an important point: "In all tagging operations, the trolling lines were pulled almost continually so that hooked fish were landed within a few minutes. This, of course, differs from the normal commerical trolling procedure". This factor is applicable not only to all further Department of Fisheries and Forestry investigations to be discussed, but also to most hooking mortality data in general.

For coho salmon, catches by 2 trollers prior to June 15 in 1967 and 1968 off the Oregon coast (Reed, personal communication) showed that 79 of 962 coho (8.2%) taken on barbless hooks and 122 of 983 coho (12.4%) taken on barbed hooks sustained immediate mortalities. As stated with chinook, these included fish found dead when landed plus those not assuming a normal position and action in the recovery tank. Heyamoto (1963) implies mortality for 8 of 64 coho (13%) taken north of the Columbia River mouth in 1957 but again fails to indicate any losses for 60 coho taken on the south side.

Hollett (personal communication) gives mortalities for **coho in the same 3 tagging operations listed for chinook:**

Date	Area	Number caught	Percent mortality
Oct.-Nov. 1966	Strait of Georgia	197	19.7
Mar.-Apr. 1967	Strait of Georgia	19	0.0
1969	W.C. Vancouver I.	321	4.0
	TOTAL	537	9.7

Criteria utilized for determining loss were as stated for chinook with the additional qualification that: "As mortality appears to be size related, the time of tagging (for coho at least) is a factor".

Rates Determined from Extent of Injuries

While the assignment of individual research efforts to general categories is admittedly arbitrary and considerable overlap exists, the third possible means of estimating immediate hooking mortality might best be categorized as "based on extent of injuries". In these cases, judgments are based mainly on the fish's probable ability to survive from a certain degree of physical injury.

Parker and Kirkness (1956) stated a minimum estimate of hooking mortality for Chinook by taking the percentage of fish not tagged or graded "C" during Alaska troll tagging operations. This category included fish that came aboard dead or severely injured with excessive bleeding, and it was believed that only a small fraction would survive if released. From Table 15 of their report, the following data are available:

Fork-length cell in inches	No. fish in sample	No. fish tagged	Percent not tagged
12.5 or less	1	1	0.0
15.0	10	4	60.0
17.5	9	4	55.5
20.0	19	15	21.0
22.5	35	28	20.0
25.0	56	46	17.8
27.5	147	115	21.2
30.0	114	95	16.8
32.5	42	34	19.0
35.0	21	16	23.8
37.5	6	6	0.0
40.0	1	1	0.0
Total	461	365	20.8

From these figures, a mortality rate of approximately 20% is indicated, although there appears to be a much higher rate (50% or more) for fish under 20 inches.

Based on physical damage Hone, Van Hyning and Naab (1967) estimated that 30% of a large sample of troll-caught Chinook under 24 inches would probably die if released. Loeffel (1961) reports on a research study conducted immediately preceding the June 15 opening of the 1961 coho season in the area from the Columbia River south to Cannon Beach and relates the following: "The experiment was not designed to yield estimates of immediate and delayed mortality of Chinook salmon (as was the case with coho). These fish (chinook) were handled carefully and, if at all viable, were anesthetized, tagged, and released after recovery from the anesthetic. The mortality sustained under these conditions was 31% for sublegal (under 26 inches) and 13% for legal chinook". A total of 222 chinook was involved in the sample with the majority (147 or 66%) being less than 26 inches.

During Department of Fisheries and Forestry, Canada, tagging operations, data were available on an additional 7 groups of chinook:

Date	Area	Number caught	Percent mortality
June-Aug. 1967	Browning Entrance	154	24.0
June-Aug. 1967	Dixon Entrance	36	13.9
June-Aug. 1968	Dixon Entrance	7	18.6
June-Aug. 1968	Hecate Strait (Group 1)	134	26.9
June-Aug. 1968	Hecate Strait (Group 2)	17	29.4
June-Aug. 1968	Browning Entrance (Group 1)	139	16.6
June-Aug. 1968	Browning Entrance (Group 2)	77	49.3
	TOTAL	564	25.7

In these cases, Hollett (personal communication) stated the following criteria: "Captured fish were placed in a holding tank for about 10 minutes after which dead or badly injured fish were rejected for tagging. Fish suffering loss of equilibrium, bleeding gills or loss of an eye were rejected. Thus, the percentages given represent both dead and badly injured fish".

For coho, Milne and Ball (1956) report on trolling operations in the Strait of Georgia in July, 1954. In a catch of 67 coho varying in length from 15 to 24 inches, 12 fish (18%) jvere not tagged because "they were either drowned in hauling up or so severely hooked that they were almost dead". Further additive delayed losses will be discussed in a later section. Loeffel (1961) further reports on the Columbia River-Cannon Beach area experiment in 1961 which was designed to study immediate and delayed hooking mortality rates for coho salmon. As each fish was caught and brought aboard during normal commercial trolling operations, the fisherman determined if the fish was viable, dead, or dying. The fish were segregated subjectively by using criteria based on gill damage, eye or brain damage, and lack of activity. All dead and dying fish were excluded from the holding study and the estimated immediate mortality rate was 18.5% or 238 fish in a total sample of 1,286 coho (99% confidence limits of 15 and 22%) (Loeffel and Van Hyning, 1962). Mortality was disproportionately heavy among the smaller size groups in this 1961 study. Additional work on these same fish will be discussed in a later section.

In Department of Fisheries and Forestry tagging, Hollett (personal communication) gives the following for coho:

Date	Area	Number caught	Percent mortality
June-Aug. 1967	Browning Entrance	328	18.6
June-Aug. 1967	Dixon Entrance	302	19.2
June-Aug. 1968	Dixon Entrance	248	19.8
June-Aug. 1968	Hecate Strait (Group 1)	428	20.8
June-Aug. 1968	Hecate Strait (Group 2)	186	16.1
June-Aug. 1968	Browning Entrance (Group 1)	451	17.3
June-Aug. 1968	Browning Entrance (Group 2)	334	11.7
	TOTAL	2,777	18.0

The criteria were identical to those described for chinook, i.e., dead plus seriously injured fish. Possible additional delayed mortality for these same fish will be discussed in a subsequent section on "Control Group" experiments.

While the primary concern on the question of hooking mortality lies with chinook and coho, some excellent data are available for pink salmon and should be considered since this species appears, at least on the basis of observations by the author, to be even more prone to physical injury than either chinook or coho. During tagging studies by the Canadian Department of Fisheries and Forestry in Dixon Entrance during 1967 and 1968, captured fish were placed in a live tank for 10 minutes after which dead oc'habjy injured fish were rejected for tagging. Hollett (personal communication) provided the following statistics:

Year	Vessel	Number caught	Number tagged	Percent tagged
1967	1	398	348	87.4
1967	2	995	831	83.5
1968	1	3,138	2,781	88.6
1968	2	1,747	1,467	83.9
1968	3	3,743	3,287	87.8
1968	4	3,305	3,006	90.9
1968	5	3,470	2,893	83.4
Cumulative total		16,796	14,613	87.0

In this large sample, the probable minimum hooking mortality rate was 13%.

CONDITION CLASSIFICATION AND TAG RECOVERY RATES

Condition of Chinook Versus Coho

It is appropriate at this time to begin exploring possible differences in hooking mortality rates by species since researchers seem in general agreement that coho sustain a greater degree of physical damage due to being hooked than chinook. Obviously, this implies a higher hooking mortality rate for coho.

Neave (1951), for example, in discussing coho, states: "Since this species tends to struggle violently when on the hook and in the hand, the problem of returning tagged fish to the water in good condition is more serious than in the case of chinook". Van Hyning (1951), in considering chinook, concludes that "the condition of the fish when released is better, since the chinook do not fight as strenuously as coho and are easier to unhook without injury". Parker (1948)[4], in discussing coho, states the following: "When hooked, they jump and turn and whirl in a fashion unsimilar to the chinook salmon. They are bleeding profusely when taken aboard. The chinook salmon, on the other hand, will attempt to escape by straight rushes which lead them in - in a more docile fashion".

Jensen (1969) adds further support to this hypothesis by presenting data on "shaker" catch and condition when boated and released off Crescent City in June 1969.

From these data, he concludes that "consistent differences were evident between the two species in the apparent effects of the trauma of being hooked and released. Percentages of fish dead when boated, bleeding when boated, and fish which did not swim normally when released were all greater with coho than chinook". He interprets this to mean that coho have a considerably higher hooking mortality rate than chinook. The following are his data:

	Chinook		Coho	
	Number	Percent	Number	Percent
Total number caught	572	100.0	158	100.0
	Condition of fish when boated			
Dead	28	4.9	11	7.0
Alive	539	94.2	145	91.8
Questionable	5	0.9	2	1.2
Bleeding	60	10.6	39	24.7
	Swimming nature when released			
Swam normally	355	62.1	63	39.9
Swam erratically	122	21.4	54	34.2
Did not swim	90	15.6	39	24.8
Not observed	5	0.9	2	1.2

4 Robert R. Parker. 1948. Memorandum on troll fish regulations—June 18, 1948. Olympia, Wash. Dept. Fish.

My observations also concur with those of other researchers, the most noteworthy feature of possible significance for greater survival being apparent in the "leading" habit of Chinook when brought in, i.e., their tendancy to swim forward without a great deal of strenuous fighting or lateral movement and thus, maintain slack on the troll leader.

Tag Recovery by Condition Category

In a related vein, a rough yet potential means of determining the minimum rate of hooking mortality might exist in various tagging projects where numbers of fish tagged and recovered were tabulated by condition categories. In addition, possible differences between Chinook and coho can be explored further.

Fry and Hughes (1951), for example, graded Chinook tagged in 1948 and 1949 as "good", "fair", and "poor". Van Hyning (1951) categorized chinook caught in 1948-1949 as good (if it swam away rapidly), fair (swam away slowly at surface and appeared stunned), and poor (floated away), while Kauffman (unpublished data)[5] classified chinook tagged during the same year as grades "A" (excellent condition, hooked in outer mouth parts, no apparent bleeding, vigorous movement when released), "B" (doubtful condition, hooked through thick parts of the head, moderate bleeding but expected to live), and "C" (not expected to live, bled profusely, was badly hooked, and in some cases had broken gill arches). I graded chinook tagged in 1968 as good (extent of hooking damage not expected to significantly affect performance), fair (hooking damage appears capable of influencing vital functions such as vision or feeding ability) and poor (extensive damage, fish not expected to survive). Although the criteria for condition assignments varied somewhat, it is still reasonable to examine the 'aggregate total from the 4 sources since each was attempting to produce the same end result, i.e., showing the possibility of predicting differential mortalities based on physical condition at the time of capture. Results were:

	"Good"		"Fair"		"Poor"	
Source	No. tagged	No. recovered	No. tagged	No. recovered	No. tagged	No. recovered
Fry & Hughes (1951)	707	124	102	14	22	0
Van Hyning (1951)	174	10	29	0	18	1
Kauffman (unpubl.)	549	97	86	7	44	4
Author (Wright)	319	44	41	5	16	0
TOTAL	1,749	275 (15.7%)	258	26 (10.1%)	100	5 (5.0%)

[5] D. E. Kauffman, Wash. Dept. of Fish., Olympia, Washington.

For these chinook, 1,749 of 2,107 (83.0%) were rated in the best physical condition category, and the recovery rate declined by a factor of 3 from the "good" to "poor" rating. In support, Van Hyning (1968) states "in the 1948 through 1955 Oregon troll tagging, 4% of chinook tagged in poor condition were recovered compared to 16% for fish in good condition", Apparently, the results from the 1948-1949 work (Van Hyning, 1951) are included in his estimate.

If it is assumed, for the moment, that all chinook in "good" condition survived the rigors of being hooked (i.e., rate of mortality or r_1 equals 0), then the mortality for fish in "fair" condition (or r_2) would be the relationship:

$$r_2 = 1 - \frac{N_1 n_2}{n_1 N_2}$$

where: N_1 = Number good condition fish tagged
N_2 = Number fair condition fish tagged
n_1 = Number good condition fish recovered
n_2 = Number fair condition fish recovered

substituting the required numbers gives

$$r_2 = 1 - \frac{(1749)(26)}{(275)(258)} = 0.36.$$

The mortality rate for fish in "poor" condition (or r_3) would be the relationship:

$$r_3 = 1 - \frac{N_1 n_3}{n_1 N_3}$$

where N_3 = Number of poor condition fish tagged
n_3 = Number of poor condition fish recovered

substitution gives

$$r_3 = 1 - \frac{(1749)(5)}{(275)(100)} = 0.68$$

The mortality rate (M) of the entire group of fish would then be $M = P_1 r_1 + P_2 r_2 + P_3 r_3$

where P_1 = Percentage of good condition fish in sample
P_2 = Percentage of fair condition fish in sample
P_3 = Percentage of poor condition fish in sample

substituting the proper values gives M = (0.83) (0.0) + (0.12)(0.36) + (0.05) (0.68) = 0.077 or roughly 8%

The total hooking mortality rate would then be 8% of the "live" segment *plus* the percentage of fish dead when brought onboard or judged to be too seriously injured for tagging. If, for example, the absolute minimum of 4% developed earlier is utilized, then the total rate would be approximately 12% [or 0.08 (96) + 4 = 11.7].

In the case of coho salmon, Van Hyning (1951), Kauffman (unpublished data) and the author also report on groups of this species taken concurrently with Chinook and rated on physical condition by the same criteria. In additional work, Milne (1957) categorized coho tagged off the northwestern end of the Queen Charlotte Islands in 1951 as "good", "fair", and "poor" while Neave (1951) rated coho tagged in 1949 in a similar manner. The bulk of these latter fish were taken in the Quatsino Sound area off the west coast of Vancouver Island. These various observations show the following:

	"Good"		"Fair"		"Poor"	
Source	No. tagged	No. recovered	No. tagged	No. recovered	No. tagged	No. recovered
Van Hyning (1951)	311	21	109	3	85	5
Kauffman (unpubl.)	42	10	28	6	19	0
Author (Wright)	332	95	208	41	84	10
Milne (1957)	536	43	57	4	19	2
Neave (1951)	336	30	61	3	31	1
Total	1,557	199 (12.8%)	463	57 (12.3%)	238	18 (7.6%)

In this case, 1,557 of the 2,258 coho involved, or 69%, were rated in the "good" category as opposed to the 83% for chinook. Thus, 14% more of the coho showed some degree of physical impairment as evidenced by their assignment to the "fair" and "poor" groups. This supports evidence presented earlier which indicated a greater tendency for physical damage in this species. When the tag recovery rates by condition category are examined, however, the reduction from "good" to "poor" is substantially less than in the case of chinook. The same calculations of losses can also be made for coho:

$$r_2 = 1 - \frac{N_1 n_2}{n_1 N_2} = 1 - \frac{(1557)(57)}{(199)(463)} = 0.04$$

$$r_3 = 1 - \frac{N_1 n_3}{n_1 N_3} = 1 - \frac{(1557)(18)}{(199)(238)} = 0.41$$

$$M = P_1 r_1 + P_2 r_2 + P_3 r_3 = (0.69)(0.0) +$$

$$(0.215)(0.04) + (0.105)(0.41) = 0.05$$

The 5% loss for live coho, added to an absolute minimum of 4%, would give a total hooking mortality estimate of only about 9% [or 0.05(96)+4 = 8.8]. Thus, this particular evidence examined indicates that, while coho may exhibit a greater amount of physical damage, this does not necessarily cause a hooking mortality significantly greater than that sustained by chinook.

A factor of possible significance to this and other considerations of hooking mortality, particularly in contrasting Chinook and coho, is depth of capture. On the average, chinook are hooked at greater depths and this could conceivably neutralize any advantage gained by a lesser degree of external physical damage. Parker and Black (1959), for instance, in describing operations off Cape Fairweather, Alaska, in August, 1957, state that "fishing (for chinook) took place over depths ranging from 70 to 80 meters (35 to 40 fathoms). Chinook captured generally came from water with a temperature between 7 to 10°C while the surface water temperature ranged from 14 to 15°C". Parker, Black, and Larking (1959) report on 1958 trolling operations in the Gulf of Alaska, with fishing over depths from 20 to 100 m. Although salmon were taken at all depths, coho were more abundant above a depth of 30 m and in water ranging from 10° C upward with chinook being more frequent below 30 m and at 7 to 10°C. In this experiment, the range for surface water temperature was given as 13 to 15°C.

Milne (1955) reports that, during a 1953 troll gear selectivity study off the southwest coast of Vancouver Island, coho were taken at depths varying from 5 to 10 fathoms (most at 5) while chinook were taken at depths between 10 and 15 fathoms (mostly at 15). No temperature data were given.

Milne (1957) states that most coho salmon are caught in the top 10 fathoms and within 20 miles from shore, while most chinook are taken closer inshore and deeper. He adds that coho are often observed to jump clear of the water surface and are usually found in clear, blue water, but chinook seldom jump while feeding in brown, plankton-filled water. Possible significance of the depth-temperature factor will be further explored in a later discussion of "Delayed Mortality" studies.

CONTROL GROUP EXPERIMENTS

Troll Versus Seine

Another potential means of attacking the problem of hooking mortality exists in the use of "test" and "control" lots; specifically, tagging groups of both troll- and seine-caught salmon. In this case, mortality (M) for troll-caught fish would be the relationship:

$$M = 1 - \frac{N_1 n_2}{n_1 N_2}$$

where N_1 = Number captured by seine and tagged
N_2 = Number captured by troll and tagged
n_1 = Number of seine tags recovered
n_2 = Number of troll tags recovered

Three important conditions must, however, be satisfied. First, the two groups must present equal chances for tag recovery and this strongly implies equalities in time and place of capture plus size distribution of the fish tagged. Second, losses attributable to seine capture must either be (a) known and included in the calculations or (b) considered, based on adequate evidence, to be insignificant (i.e., equal to zero). Third, enough fish must be tagged and released to provide,

through subsequent recovery, statistically significant results within relatively narrow confidence limits. Although these assumptions have yet to be fully satisfied in any Chinook or coho research study of which the author is aware, it is timely to review several investigations.

For chinook, the Canadian Department of Fisheries and Forestry conducted a considerable amount of troll and seine tagging during the 1960's, but in no instance were the various projects designed to specifically investigate hooking mortality. Thus, the conditions necessary for a "control group" experiment of this type were generally lacking. Exceptions were the 1967 and 1968 troll and seine tagging in the Dixon Entrance region but the small numbers of fish initially tagged (less than 200 chinook for both gears combined) plus present incompleteness of recovery data prevent any meaningful comparison.

The 1968 troll and seine tagging in outer Juan de Fuca Strait and off Cape Flattery were designed specifically to study hooking mortality, but in this case, it appears that chinook tag recovery rates were probably influenced to a large degree by the size of fish tagged and released. Reasonable consistences were achieved in terms of time and place of operations with the sizes of fish tagged in 1968 and recovered in 1969 being as follows:

	Troll			Seine		
Fork length cm	No. tagged	No. recovered (1969 only)	% recovered	No. tagged	No. recovered (1969 only)	% recovered
under 25.0	1	0	—	0	—	—
25.0–29.5	0	—	—	9	1	11
30.0–34.5	12	1	8	86	3	3
35.0–39.5	82	10	12	180	18	10
40.0–44.5	99	14	14	73	5	7
45.0–49.5	72	10	14	14	1	7
50.0–54.5	31	—	—	10	2	20
55.0–59.5	46	7	15	1	0	—
60.0–64.5	17	2	12	—	—	—
65.0–69.5	5	1	20	0	—	—
70.0–74.5	4	2	50	0	—	—
75.0–79.5	4	1	25	0	—	—
80.0–84.5	1	1	100	0	—	—
85.0–89.5	1	0	—	0	—	—
90.0–94.5	1	0	—	0	—	—
Total	376	49	13	373	30	8
	($\bar{x}$ = 46 cm)			($\bar{x}$ = 38 cm)		

It seems obvious that size played the dominant role in producing a 13% recovery rate for tagged troll-caught compared to only 8% for tagged seine-caught fish. The size differentials also imply variables in terms of age composition, maturity, and freshwater life-history types. The only possibility for a valid comparison exists in comparing groups of fish by individual size categories but the numbers involved in this particular study appear too small to be of significance.

Coho Salmon, since they are caught primarily as a single age and freshwater life-history type in the southern part of their eastern Pacific range (i.e., 32 fish), seemingly offer much greater potential for "control group" type hooking mortality experiments. The Canadian Department of Fisheries and Forestry tagged both troll- and seine-caught coho in the Dixon Entrance region during 1967 in roughly the same location and during comparable time periods. Results were (Hollett, personal communication):

Tagging method	Number tagged	Number recovered	Percent recovered
Troll	728	93	12.8
Seine	555	91	16.4

The mortality rate for tagged troll-caught coho would then be the relationship:

$$M = 1 - \frac{n_2 N_1}{n_1 N_2} = 1 - \frac{(93)\ (555)}{(91)\ (728)} = 0.22$$

In 1968, further troll and seine tagging were again conducted in the Dixon Entrance region, but differed from the 1967 operations in that the troll tagging took place a considerable distance seaward (up to 60 miles) of the seine-tagging location. Results were:

Tagging method	Number tagged	Number recovered	Percent recovered
Troll	1,841	355	19.3
Seine	792	200	25.2

In this case, the calculated mortality of tagged troll-caught coho would be:

$$M = 1 \quad \text{——} \quad = 1 - \frac{(355)\ (792)}{(200)(1841)} = 0.24$$

$$\frac{n_2 N_1}{n_1 N_2}$$

The mortality rates of 22% and 24% for 1967 and 1968, respectively (when applied to 82.0% of the population originally caught), would be additive to the 18% rate developed in a previous section for dead and seriously injured fish. Thus, the total estimated losses due to troll hooking for the 2 years are 18+(22)(.82) and 18+(24)(.82) or 36% and 38%. It should be noted, however, that the estimates assume a complete mortality for seriously injured fish included in the 18% statistic. In addition, the effects of possible differences in size distribution due to gear selectivity are unknown.

Although no further coincidences in timing and areas of operation were achieved, the Department of Fisheries and Forestry conducted a considerable amount of additional troll tagging from 1966 through 1968 and seine tagging from 1963 through 1968. The specifics are shown on the opposite page.

In examining these cases, it is of interest to note 2 key

factors. First, the aggregate total for troll tagging experiments shows a recovery rate of only 19% as compared to 27% recovery rate for seine tagging experiments where recovery data are complete. Second, the seine tagging produced 10 individual groups with recovery percentages greater than the 31% high recorded for any single group of troll-caught coho.

Seine Tagging

Year	Tagging area	Tagging period	No. tagged	No. recovered	% recovered
1963	Frederick Arm	Dec.	353	27	8
1963	Teakerne Arm	Dec.	293	115	39
1963	Hornby-Denman	June	48	29	60
1963	Head Jervis Inlet	June-July	38	3	8
1963	Mid Jervis Inlet	May-July	201	29	14
1963	Enter. Jervis Inl.	May-June	75	30	40
1963	Nanoose-Nanaimo	May-June	186	81	44
1963	Satellite Channel	June-Dec.	16	3	19
1963	Saanich Inlet	May-June, Dec.	1,350	278	21
1964	Hornby-Denman	June	80	82	40
1964	Head Jervis Inlet	June	38	8	21
1964	Mid Jervis Inlet	June	5	0	—
1964	Nanoose-Nanaimo	May-June	124	52	42
1964	Stuart-Trincomali	Jan.	1,003	365	37
1965	Kelsey Bay	Jan.	189	46	24
1965	Frederick Arm	Jan.	319	35	11
1965	Bute Inlet	Feb.	1,092	251	23
1965	Teakerne Arm	Feb.	430	80	19
1965	Mid Jervis Inl.	April	91	16	18
1965	Stuart-Trincomali	April	1,232	473	38
1965	Saanich Inlet	Jan.	5,605	1,464	26
1966	Dixon Entrance	June-Aug.	759	187	25
1966	Dundas Island	June-Aug.	145	38	26
1966	Browning Entrance	July-Aug.	47	16	34
1966	Upper Johnstone Str.	July-Sept.	234	56	24
1966	Hornby-Denman	May-June	946	410	43
1967	Dundas Island	June-Aug.	19	3	16
1968	Dundas Island	June-Aug.	792	176	22
1968	Satellite Channel	May	23	4	17
1968	Satellite Channel	Oct.	122	6	5*
1968	Saanich Inlet	Oct.	1,158	115	10*
1968	Sooke-Victoria	May	218	40	18
1968	Sooke-Victoria	Oct.	1,156	29	2*
Cumulative total			18,387	4,497	24
Completed recovery data only total			15,951	4,347	27

*Recovery to July 7, 1969 is incomplete for the 3 experiments indicated, but is complete for all others.

Troll Tagging

Year	Tagging area	Tagging period	No tagged	No. recovered	% recovered
1966	Mid-Gulf-North	Feb.	22	5	23
1966	Mid Gulf-South	Feb.	186	57	31
1966	Nanoose-Nanaimo	Oct.-Nov.	108	12	11
1966	Stuart-Trincomali	Feb.-Mar.	13	4	31
1966	Stuart-Trincomali	Oct.-Nov.	48	3	6
1967	Browning Entrance	June-Aug.	180	16	9
1967	Nanoose-Nanaimo	April	18	5	28
1968	Dixon Entrance	June-Aug.	609	90	15
1968	Hecate Strait	June—Aug.	716	154	22
1968	Browning Entrance	June-Aug.	516	112	22
1968	Sooke-Victoria	May-July	55	15	27
1968	Port San Juan	May-July	213	43	20
Cumulative total			2,684	516	19

Recovery is complete for all troll-tagged coho.

Fork length cm	Troll No. tagged	Troll No. recovered	Troll % recovered	Seine No. tagged	Seine No. recovered	Seine % recovered
Under 20.0	0	—	—	1	0	—
20.0–24.5	0	—	—	1	0	—
25.0–29.5	1	1	100	11	1	9
30.0–34.5	2	1	50	28	4	14
35.0–39.5	24	4	17	42	10	24
40.0–44.5	103	21	20	97	30	31
45.0–49.5	142	28	20	51	10	20
50.0–54.5	151	39	26	27	12	44
55.0–59.5	124	37	30	13	5	38
60.0–64.5	58	10	17	7	1	14
65.0–69.5	18	4	22	5	2	40
70.0–74.5	0	—	—	1	0	—
75.0–79.5	1	1	100	0	—	—
Unknown	0	—	—	2	0	—
Total	624	146	23	286	75	26

During the 1968 troll and seine tagging in outer Juan de Fuca Strait and off Cape Flattery, coho were studied concurrently with Chinook. As stated for Chinook, approximate equalities were achieved for area and time considerations. Size and recovery data were as shown in opposite column.

Although not as pronounced, size differences again existed between the 2 groups, the troll coho averaged 51 cm as opposed to 43 cm for seine coho. Obviously, bias introduced because of gear selectivity was an important consideration in these studies, as well as the Canadian investigations discussed previously.

Losses would be:

$$M = 1 - \frac{n_2 N_1}{n_1 N_2} = 1 - \frac{(146)(286)}{(75)(624)} = 0.11$$

The mortality of 11% (for 92% of the population) would be additive to the 6% rate stated previously for fish dead when brought onboard, giving a total loss of 6+11 (.92) or about 16%. (It should be noted, however that the recovery rates for the 2 groups did not differ significantly at the 95% confidence level.)

In further consideration of "control group" experiments, work with pink salmon appeared to most closely approach the prerequisites stated at the beginning of this section. In conjunction with the Chinook and coho tagging, the Depart-

ment of Fisheries and Forestry also worked with pink salmon in the Dixon Entrance region in 1967 and 1968. Again, during 1967, both troll- and seine-caught fish were tagged in the same area while in 1968 the seine tagging was conducted in a net fishing area while the troll tagging was conducted adjacent to but seaward of the net fishing. The results of these efforts were as follows (Hollett, personal communication):

Year	Tagging method	Number tagged	Number recovered	Percent recovered
1967	Troll	1,024	241	23.5
1967	Seine	3,337	732	21.9
1968	Troll	13,386	3,466	25.9
1968	Seine	9,331	2,061	27.9

In sharp contrast to the results with coho, the close similarity of the recovery percentages offers sound evidence that the troll-caught pinks suffered little, if any, delayed loss due to hooking mortality over and above the 13% determined in a previous section for "captured fish placed in a live tank for 10 minutes after which dead or badly injured fish were rejected for tagging".

The possibility of significant and species differential delayed losses of seine-caught fish also exists. Since Parker and Black (1959) and others have shown a positive correlation between mortality and concentrations of blood lactate and have considered a critical level to be that exceeding 125 mg/100ml of blood, it is important to examine this relationship for seine-caught salmon.

Gronlund, et al., (1968) reported that blood lactate concentrations in sockeye salmon caught by purse seine in offshore waters rose to 42 mg/100 ml of blood after 110 minutes, while those of inshore seine-caught sockeye rose to 30 mg/100 ml. For both groups, the concentrations after 110 ■mirtutes were more than double the initial values but were still considerably below .the "critical" level. In contrast, blood lactate concentrations of sockeye captured by longline and sampled up to 380 minutes were 2 to 5 times as high as the values for fish captured by purse seine at comparable times.

Gronlund, et at., (1968) also report that under conditions of similar stress, blood lactate concentrations were 60% to 120% higher for chum than for sockeye salmon. This was interpreted as a possible indication of differences between species.

Troll Versus Trap

Another possible source of "control group" experiments is troll and trap tagging described by Milne (1957). The following summary is given of chinook tagged in British Columbia waters from 1949 to 1952:

Tagging area	Gear	Year	Number tagged	Number recovered	Percent recovered
Queen Charlotte Islands	Troll	1951	64	7	11.0
Quatsino Sound	Troll	1949	45	12	26.6
Quatsino Sound	Troll	1951	54	8	15.0
Kyuquot Sound	Troll	1950	22	4	18.2
Barkley Sound	Troll	1949	772	71	9.2
Barkley Sound	Troll	1950	140	38	27.2
Sooke	Trap	1952	125	28	22.4
Total			1,222	168	13.7

The indication is that the trap-caught chinook with a 24.4% recovery rate showed a higher survival than the troll-caught fish since the cumulative recovery rate for all groups combined was only 13.7%. A valid comparison is impossible, however, since the troll chinook consisted of various percentages of mature and immature fish (as reflected by tag recoveries in subsequent years) while all 28 of the recoveries from the Sooke Traps occurred in the same season as the tagging.

The troll- versus trap-coho tagging experiments documented by Milne (1957) offer much greater comparative value since the fish were in their final year and recoveries were confined to the season of tagging. Milne's data were:

Tagging area	Gear	Year	Number tagged	Number recovered	Percent recovered
Queen Charlotte Is., N. Coast	Troll	1951	380	27	7.1
Queen Charlotte Is., W. Coast	Troll	1951	234	22	9.4
Cape Scott	Troll	1951	178	12	6.8
Quatsino Sound	Troll	1951	366	28	7.7
Quatsino Sound	Troll	1949	470	41	8.7
Kyuquot Sound	Troll	1950	110	5	4.5
Barkley Sound	Troll	1949	40	5	12.5
Barkley Sound	Troll	1950	262	41	15.6
Sooke	Trap	1951	150	32	21.3
	Total		2,190	213	9.7

The trap-tagged coho showed a recovery rate higher than any of the 8 groups of troll-caught fish, although differences in origins of the coho involved may have been at least partially responsible. Milne (1957) states that the trap-caught fish were in better condition and probably survived better since the other chinook and coho were caught by hooks and hauled up from considerable depths.

HOOK INJURIES

Incidence of Hook Scars

Information on the incidence of hook scarring, although not offering a direct means of measuring hooking mortality, still provides valuable supplemental information pertinent to analysis of the problem.

DiDonato (1968), in an extensive effort, studied the incidence of mouth injuries on Chinook and coho, the origin of observed scars, and the relationship between scarring and hook-and-line gear. For Chinook in 1964, the following rates were observed in the various Washington fisheries:

Fishery	Sample size	Percent scarred
Ocean troll	14,460	5.17
Ocean sport	31,768	3.20
Puget Sound sport	675	2.52
Puget Sound net	1,008	4.56

Each fish sampled was examined externally about the mouth and immediate head region for deformed or otherwise damaged areas. In chinook returning to hatcheries, artificial spawning channels, and spawning grounds in 1964, a cumulative sample of 23,050 fish showed that 1,399, or 6.1%, bore externally visible scars. It might reasonably be expected that scarring would increase with age but incidence of mouth injuries on troll-caught chinook by ocean age in 1964 did not bear this out:

Ocean age	Sample size	Percent scarred
1	135	2.22
2	2,101	5.38
3	501	4.99
4	39	2.56

In the case of coho, scarring rates determined in the various Washington fisheries during 1964 were:

Fishery	Sample size	Percent scarred
Ocean troll	20,057	1.27
Ocean sport	60,789	1.31
Puget Sound sport	1,488	2.82
Puget Sound net	14,419	10.02

A sample of 17,299 coho escaping the fisheries and observed in various artificial and natural spawning populations during 1964 showed that 1,795 or 10.4% were scarred.

An interesting situation for coho in the ocean troll and sport fisheries was a significant positive relationship between percent scarred and time from June to October:

	Troll		Sport	
Time period	Sample size	% scarred	Sample size	% scarred
3/15–6/14	—	—	249	0.40
6/15–6/30	2,929	0.41	1,358	0.74
July	4,734	0.76	13,154	0.76
August	7,543	1.33	24,544	1.63
September	4,851	2.21	21,329	1.29
October	—	—	155	7.74

Since coho are harvested almost entirely during this relatively brief period as 3-year-olds in their final year and a very high percentage of them equal or exceed the troll- and ocean-sport-fishery minimum-size limits (22 and 20 inches, respectively, in 1964), the increase in rate of scarring must be attributed primarily to fish escaping from the gear as opposed to "shakers" being voluntarily released by the fishermen.

This raises the question of a possible source of hooking mortality which is additive to the rate normally considered by investigators. Lasater and Haw (1961) explored the question of fish lost from sport gear before being brought onboard and found that with treble hooks there were 54, or 41.9%, of the salmon missed or lost out of 129 chances and with single hooks there were 54, or 33.3%, of the salmon missed or lost out of 162 chances.

It should be noted that sampling of coho "jacks" returning to Minter Creek Hatchery in 1965 showed that 23% of the 2,104 fish examined were scarred. A substantial number of injuries were found only in the interior of the mouth with no discernible external signs. This indicated that the rates of scarring reported from the 1964 observations based on visible external evidence were minimum values.

Fulmer and Ridenhour (1967) examined 84 fall-run chinook in the Mad and Eel Rivers of California during 1965. Of the total, 70 fish were 2-year-old males or "jacks", and this group contained 40 (or over 50%) with evidence of old jaw injuries. Of the 40 fish, 21 were judged as moderately or extensively injured. The most noteworthy finding, however, was that of a significant negative relationship between healed jaw injuries and condition factor. Again, an aspect seldom considered is brought to light; i.e., the losses to fish which survive the rigors of hooking in terms of poorer condition, slower growth, impairment of reproductive capabilities, etc.

Position of Hooking

In some cases, investigators have attempted to develop various relationships between position or type of hook injury and rates of hooking mortality. Van Hyning (1951) gave both position of hooking and tag recovery rates for chinook and coho tagged off the Oregon coast in 1948 and 1949:

Position hooked	No. tagged	No. recovered	% recovered
Chinook			
Upper or lower jaw, corner of mouth, or cheek	135	7	5.2
Gills, eye, or throat	26	0	0.0
Unknown	60	4	6.7
Coho			
Upper or lower jaw, corner of mouth, or cheek	394	24	6.1
Gills, eye, or throat	40	2	5.0
Foul-hooked in back or operculum	3	0	0.0
Unknown	69	3	4.4

Van Hyning concluded that there seems to be a tendency for chinook to be hooked in the gills or eye slightly more often than coho. The recovery of 2 coho in the "gills, eye, or throat" group was cited as an indication that at least some fish with serious injuries can be expected to survive.

Milne and Ball (1956) stated, based on a sample of 12 troll-caught coho taken in the Strait of Georgia in July, 1954, that "hooking in the gills resulted in total mortality". They also reported that when caught in the eye, about one-half (5 fish out of 9) died and the lowest mortality of about one-quarter (9 fish out of 40) resulted from those caught in the jaw. DiDonato (1968) reports the following on chinook and coho mouth injuries by location of scar:

	Chinook		Coho	
Position	Number	Percent	Number	Percent
Upper jaw and maxillary	531	15.7	561	14.1
Lower jaw	722	21.4	1,118	28.2
Maxillary only	1,749	51.8	1,641	41.4
Surrounding head region	375	11.1	646	16.3

These data indicate that chinook and coho both incur and survive a wide variety of hook injuries.

DELAYED MORTALITIES

Experimental Work

The complex question of "delayed" mortalities in Pacific salmon captured on and released from hook-and-line gear has received considerable attention from investigators. Black (1958) reports that death occurs in fishes under certain circumstances following severe-'muscular activity, but the precise cause is not yet known. It is believed, however, that severe disturbance to acid-base relationships following substantial increase in lactic acid due to muscle glycogen being hydrolized in the absence of or at low concentrations of oxygen may be the principal cause of mortality. The acid concentration is sufficient to reduce oxygen combining power of blood, reduce the alkali reserve or carbon dioxicfe combining capacity of blood, and alter the shape and probably the volume of red blood cells. There also appears to be a marked reduction in ability of the heart to pump blood following severe exercise. Equilibrium and respiration are commonly disturbed immediately prior to death.

Black (1958) describes experiments involving severe muscular activities such as struggling in a live box, responding to vigorous chasing, swimming through swift passages of water, and struggling on a troll line. Mortality has been observed under these conditions both for fishes such as salmon, striped bass, and shad in fresh water, and for fishes such as 2-year-old sockeye salmon, nearly mature chinook salmon, and codfish and flatfish in sea water.

Black (1957a) reports that yearling and 2-year-old Kamloops trout *(Salmo gairdenerii)* showed marked increases in blood lactic acid following strenuous exercise and that for older fish, the recovery was slower but the levels attained were lower than for the yearling trout. In contrast to mammals, the increase was markedly delayed and there was a much longer period of decline. This was ascribed to the slower rate of diffusion of lactic acid and ultimate removal from the blood at the lower temperatures encountered in fishes. A marked decline in the maximum swimming rate followed a short sustained spurt of activity and this could be of significance in survival from predators. Sixteen hours were required for full recovery.

For lake trout *(Salvelinus namaycush)* Black (1957b) states that following severe muscular exercise, the blood lactic acid level increased sevenfold immediately following and continued to increase during the first 2 hours of recovery. The level then declined rapidly between the 2nd and 6th hours with the initial low unexercised level being reached by the end of 24 hours. Black (1957c) reported a similar response for yearling sockeye salmon *(Oncorhynchus nerka)* following vigorous muscular activity in fresh water; i.e., a sevenfold increase in blood lactic acid following activity and further increases during the first 2 hours of recovery. Yearling sockeye acclimated in sea water for 2 days and then exercised exhibited higher immediate increases in lactic acid but showed less fatigue. Sea water appeared to aid yearling salmon in coping with fatigue products. However, 2-year-old sockeye that had been acclimated 1.5 years in sea water showed the same change in lactic acid following exercise as yearlings in fresh water. During the recovery period of this latter group, 5 out of 19 fish died between the 1st and 2nd hours after exercise. Relatively high temperatures and extensive scale loss may have been contributing factors.

Parker, Black, and Larkin (1959) concluded that chinook and coho caught by trolling undergo hyperactivity and this often leads to a distressed condition which is delayed and the severity of which cannot be predicted for any individual at the time of capture. The distressed condition may advance beyond • the ability to respond to stimuli or to recover orientation and may terminate in death. Mortality rate and blood lactate levels are closely correlated in relation to postexercise time; and for fish which died, blood lactate rose until death. Survival occurred either when blood lactate did not reach critical levels (above 125 mg/100 ml of blood) or reached a critical level and then subsided.

In considering specific experiments with chinook, Milne and Ball (1958) found that 18 out of 91 chinook (20%) taken on barbless hooks and carefully handled were not suitable for tagging after being retained in a live box for at least 1 hour after capture. The sample was mainly 10- to 27-inch fish taken in December, 1956, off the mouth of the Fraser River. With the relatively short holding period, it is possible that some fish were not held beyond the time of expected maximum mortality.

Black (1958) and Parker and Black (1959) report on an experiment with 66 chinook caught by trolling off Cape Fairweather, Alaska, in August, 1957, and held in a live box

aboard the fishing vessel. The fish showed a gradual increase of blood lactic acid to high levels in the 3rd and 4th hours, followed by a general decline. Death was strongly associated with high blood lactic acid but the level of lactic acid response was not significantly increased with more than 10 minutes of vigorous exercise nor was it significantly affected by size of the fish within ranges sampled in this experiment. The mortality rate of 66 chinook was estimated at 71%.

Parker, Black, and Larkin (1959) report on a delayed mortality experiment by D. H. Fry in which a group of 96 chinook sustained a loss of 44% during a 16- to 24-hour holding period. The 3 studies described above offered a common denominator in terms of experimental approach but produced point mortality values ranging from 20 to 71%. All included only fish uninjured and fit for tagging; all agreed in the use of immature, feeding fish in salt water and showed that mortality is delayed and subsequently complete within 6 hours. A possible source of error lies in the relatively short holding period of Milne and Ball (1958). Loeffel and Van Hyning (1962) report that 32 chinook were caught and held in 1957. One hour after catching, 5 of the chinook (16%) were dead. Experimental details are not available.

Two additional experiments on delayed mortalities of chinook followed a different approach. Jensen (1958) conducted one of these in March and April, 1958, at the Bowman's Bay (Puget Sound) research station. The experimental group of 780 chinook consisted of 2- and 3-year-olds ranging from 10 to 20 inches in length and was held in an 80- x 20-ft. saltwater pond varying from 2 to 4 ft. in depth. The fish were hatched at Samish Hatchery, converted to salt water at 90 days and usually fed generously 1 day each week. Most were bright and active, except for a few ripening males. The ■ chinook were hooked on various types»of angling gear and then played until they were exhausted (1 to 2 minutes) so that the head could be easily held above water. After removing the hook, each fish was marked by an identifiable fin clip and returned to the same pond. The results for this experiment during the period March 10 to April 7 were:

Group	No. fish	No. mortalities	% loss
1. Control (not hooked)	580	18	3.1
2. Treble hook—daredevil	25	0	0.0
3. Double spin hooks—herring strip	100	5	5.0
4. Siwash hook—daredevil	50	3	6.0
5. Single spin hook—herring strip	25	5	20.0
Total	780	31	4.0

Obviously, no significant rate of delayed loss due to hooking can be inferred from the above data. The position of hook injuries was also noted, with the lower jaw and cheek being the most commonly damaged mouth parts. The gills of many fish were damaged with profuse bleeding being noted in 8.

In research by Gronlund et al. (1968), small chinook (23 to 37 cm fork length) were again utilized at the Bowman's Bay station in June, 1965. Few fish died among starved or fed individuals within 10 days after capture by hook-and-line or after being chased to exhaustion. Blood lactate concentrations were usually below the previously reported critical level of 125 mg/100 ml. Thus, their work also failed to indicate that mortality, either immediate or delayed, was associated with exercise or handling.

In delayed mortality studies on coho, 4 experiments were carried out with the same approach employed in the first 3 chinook experiments described. Milne and Ball (1956) report on 67 coho salmon, 15 to 24 inches in length, taken on trolling gear off Nanaimo, Strait of Georgia, in July 1954. Of 55 fish, which were considered to be suitable for tagging, 16 fish (29%) sustained delayed mortalities. They were held onboard in a live box from 1 to 6 hours and then transferred to a floating enclosure for further observation. Since this experiment included both immediate losses (12 fish, described in a previous section) and delayed losses (16 fish), the total hooking mortality was 28 of 67 fish or 42%.

In a later experiment, Milne and Ball (1958) reported on a group of 289 coho salmon varying in length from 16 to 24 inches fork length. These were mainly fish taken by trolling in May and June, 1956 along the east coast of Vancouver Island. In order to reduce mortalities, barbless hooks were employed and the fish were carefully handled. The coho were retained in a live box on the boat for at least 1 hour after they were caught and, following this procedure, 51 out of 289, or 17.6%, were considered unsuitable for tagging purpose. As noted for chinook, the relatively short holding time may not have encompassed the period of maximum delayed mortality.

Parker, Black, and Larkin (1959) report on the study of troll-caught coho in the Gulf of Alaska in July and August, 1958. In this instance, a sample of 115 fish sustained a delayed mortality rate of 44%. The fish showed a typical delayed blood lactate response after hooking, the level increasing at least fourfold from pre-exercised levels in 2 hours. The mortalities reached a maximum in the second hour, then declined and were substantially complete by the end of 6 hours. In additional work, coho were studied in fresh water with simulated troll-capture conditions. The blood lactate response was again typical but of a much lower magnitude than observed in the previous group and no deaths occurred among fish tested in fresh water. This difference was thought to be due to cessation of feeding and to have adaptive significance for survival.

Loeffel and Van Hyning (1962) report that 18 coho were caught and held in 1957 with 4 of the fish (22%) dying within 1 hour after capture. Parker, Black, and Larkin (1959) also report on an experiment by D. H. Fry in which a sample of 88

coho sustained a delayed mortality of 38% during 16 to 24 hours of observation.

For sockeye salmon. Black (1958) gives the following account: "During the summer of 1956 and 1957, DeLacy and Paulik (1958) tested the swimming capacities of adult migrating sockeye salmon from the Columbia River. In 1957 there were 6 mortalities from a total of 168 fish tested at the McNary Dam; 4 mortalities out of 252 tested at Rock Island Dam; and no losses out of 48 tested from the Tumwater Dam, in spite of the fact that the fish were hauled to Rock Island Dam for testing".

Gronlund et al. (1968) measured blood lactate concentrations in 306 sockeye taken at sea in 1965 and 1966 by purse seine, gill net, or longline. It was found that the levels were generally below those reported by previous researchers as related to stress-induced mortality in salmon. No sockeye salmon held in shipboard tanks for observation died within 2 days after capture.

Weaknesses of Delayed Mortality Experiments

In general, attempts to determine delayed mortality rates by holding troll-caught salmon in live tanks have been criticized due to their seeming inability to seperate stress caused solely by the trauma of being caught on hook and line from the additional stress created by artificial conditions inherent in the various experimental procedures. In other words, it is possible that, in aggregate, two additive stressing agents would produce mortality while either alone would not.

Black and Barret (1957) studied hatchery-reared cutthroat and steelhead trout and found that even minimal handling caused significant increases in muscular activity as measured by blood levels of lactic acid. In addition, handling and live transportation for 2 hours caused a very significant degree of muscular activity.

Ellis (1964) compared a sample of 8 Chinook held in a tranquilizing solution and a sample of chinook held in circulating sea water (without tranquilizer) by Parker and Black (1959). Blood lactate levels were essentially the same in f.h*e 2 groups of fish through the first 1.5 hours, of holding. From that time orr, fish held in a tranquilizing solution had blood lactate levels well below non-tranquilized fish.

Ellis also measured the levels of lactic acid in the blood of sexually mature 2-year-old male coho held in freshwater live tanks with and without tranquilizer (groups of 33 and 32 fish, respectively). The results of these tests indicated that the mean blood lactate level for all tranquilized fish, as a group, was significantly lower than for the non-tranquilized group. Ellis concluded that the holding of fish in live tanks may contribute materially to high blood lactate concentrations and use of unnatural confinement in the assessment of fatigue as a cause of mortality in troll-caught salmon should take into account the possible additional stress of such confinement.

Loeffel and Van Hyning (1962) report on additional delayed mortality work with coho previously mentioned in the 1961 Columbia River-Cannon Beach experiment. Their program design included derivation of 3 independent estimates of delayed mortality. The first, considered as minimal due to the brief period of observation, was based on the mortality of taggable fish scheduled for release immediately following recovery from anesthetic. The second was to be based on observed mortality for 2 groups of fish held in tanks (1 group with and 1 without tranquilizer), and the third was to be based on comparison of percent of tag recoveries from the 3 groups (released immediately, held with tranquilizer, and held without tranquilizer).

In the first phase, 93 of the 754 coho put in the recovery tank immediately following recovery from anesthetic died for a mortality rate of 12.3%. This rate applied to the 1,048 fish declared taggable gave a calculated delayed mortality of 129 coho, or 10.0% of the 1,286 fish initially caught. By totalling the estimates of immediate mortality (18.5%, described in a previous section) and delayed mortality (10.0%), a value is obtained for total hooking mortality of 28.5%.

The remainder of the experiment failed to show any significant differences in various rates and was beset by a multitude of problems. Fish held in tranquilizer showed a mortality rate of 19% as opposed to a loss of only 17% for non-tranquilized fish. Tag recovery rates were 19% for fish released immediately, 18% for fish held in tranquilizer, and 14% for fish held without tranquilizer. One prominent problem was a correlation between low dissolved oxygen levels in the tanks and higher mortalities of the fish being held. In addition, there was an apparent relationship between number of fish in each individual group held in the tanks and subsequent tag recovery rates. The phenomenon of "larger the group—poorer the tag return" was attributed to significant mortalities caused by toxic concentrations of metabolic wastes built up in the tanks by the normal excretory functions of the fish themselves.

Other hints of possible additional stresses are given by Parker and Black (1959) who report that fish utilized in their experiment generally came from waters of a temperature between 7 and 10° C, while the surface water supplied to the live box was between 14 and 15° C. Before being places in the live box, individual fish were coded by using a tag applied dorsally to the caudal fin. Parker, Black, and Larkin (1959) report that before entry into the live box, all noncritically damaged fish were tagged, using standard Petersen type tags. It was also found that, in comparison with fish tagged and released immediately after capture (control group), the lower tag recovery percentage for the survivors of the holding experiment suggested a poorer survival rate for this latter group. The treatment during liberation was, however, suspected as the main cause.

Milne and Ball (1956) report that coho in their 1954 study were either tagged or marked prior to their introduction into the live box. Milne and Ball (1958) also report tagging prior to live box release in their 1956 studies.

Fry and Hughes (1951) held chinook for 24 hours in live tanks with a constant stream of fresh ocean water passing

through. Fish that were in good condition at the end of the holding period were tagged and released. At the time, holding did not appear to have injured the fish in the slightest but the difference between rate of tag returns of the tank-held chinook (1.63%) and the controls (tagged and released when caught) (10.6%) was highly significant statistically. Parker, Black, and Larkin (1959) suggest that the additional stresses of capture, tagging, and releasing after the holding period may have been an important factor in the apparent lower survival rate.

DISCUSSION AND CONCLUSIONS

Sport Fishery Hooking Mortality

Although the data presented were somewhat meager in the case of salmon taken on sport angling gear, indications were that hooking mortality is somewhat less than encountered in the troll fishery. For this reason, plus the divergent management principles applicable to the 2 fisheries, separate discussion seem appropriate.

The only 2 hooking mortality rates given in this report for sport-caught salmon were 0.6% for chinook (Haw, 1963) and 0.5% for coho (Lasater, unpublished data). In discussing their experiment with coho, Lasater and Haw (1961) report that after a salmon is tagged and released, it is subject to disease and predation, tag loss occurs, some tags are not turned in by fishermen, and there is an unseen-spawning escapement. In spite of these factors, there was a 22.2% recovery rate of tags for coho and they concluded that "hooking mortality cannot be extreme".

The theory of low mortality was supported by Jensen (1958) in his work at Bowman's Bay. He reported that even if it was assumed that all deaths among-the^test fish during the extended holding period following their capture were due to hook damage, the absolute rate would be only 5%. Jensen concludes that "the mortality among immature chinook as a result of their being hooked by commonly used sport gear and released again appears to be lower than anticipated". Further support is offered in work by Gronlund et al. (1968), again with chinook at Bowman's Bay. In this instance, th*e conclusion was that few fish died in salt water within 10 days after their capture by hook and line or after being chased to exhaustion.

The impact of hooking and releasing sport-caught salmon should not, however, be dismissed as "negligible". There are definite possibilities of additional losses to fish which are hooked but lost (i.e., released involuntarily), or which experience sublethal effects on vital functions such as feeding or reproduction. Rough or abusive handling by anglers could result in a significant loss but again adequate data to evaluate this possibility do not exist.

Black (1958) in discussing losses of sockeye in the Columbia River (from unpublished work by DeLacy and Paulik) states that mortality was probably caused by mechanical injury including loss of scales, rather than from effects of muscular exercise. Again, Black (1957c) relates that "extensive loss of scales may be a principal condition causing mortality, as noted by Vernon D. Someren during tagging of Atlantic salmon smolts in Scotland (personal communication)". Another consideration might be abrasion of the mucus coat and breaks in the epidermis which result in secondary infection or osmotic imbalance. Potentials in the category of "unrecognized internal injuries" also exist.

Troll Fishery Hooking Mortality

Before attempting to digest some meaningful conclusions from the variety of troll fishery hooking mortality percentages already presented, it is timely to discuss 4 other interpretations derived from certain parts of the same data package.

Van Hyning (1968) felt that with some recent tagging experiments giving returns as high as 47%, a hooking mortality greatly in excess of 40% for chinook can hardly be accomodated when considering tag loss, tags recovered but not turned in, natural mortality, and tagged fish undetected on the spawning grounds. After examination of data which he considered pertinent. Van Hyning concluded that "an estimated mortality of 40% does not appear unreasonable".

Milne and Ball (1956) stated that the mortality involved in catching and releasing small salmon from commercial trolling gear is about one-third initially, with a final loss of about one-half of the fish. Further, even when only the fish that are landed in good condition are released, the mortality is probably about one-third. They conclude that, because of this high mortality, any regulation requiring the release of small troll-caught salmon does not appear to be a promising conservation measure.

Jensen (1969) felt that his data showed coho have a considerably higher hooking mortality than chinook and that a loss greater than 60% for coho was indicated. Based on this figure, it was judged that the release of coho in their final year by commercial troll fishermen results in a net loss to the fishery. Jensen gives an immediate loss for coho of 31.7% since 7.0% were dead when boated and 24.7% were bleeding from the gills. Almost 60% of the coho released either did not swim at all (floated or sank, belly up) or swam erratically.

Parker (1960) considered critical size and maximum yield for chinook in the troll fishery by using a hooking mortality rate derived from two sources, direct and delayed. A 20% direct loss was extracted from Parker and Kirkness (1956). The range for delayed mortality was 40 to 86%, the 0.95 confidence limits in the experiment by Parker and Black (1959). From the results of his analysis, Parker (1960) concluded that yield cannot be increased by a minimum-size regulation, for losses due to both direct injury and hyperactivity reduce critical size to levels not ordinarily encountered by existing fisheries. Furthermore, the most feasible alternative to a minimum-size regulation appears to be spatial and temporal restriction of the fishery to known concentration of maturing fish together with the encouragement to use non-size selective gear.

Thus, 4 separate views on the subject of troll fishery

hooking mortality give a "minimum" loss of 40% for at least 1 major species.

In order to review the various percentages developed in this report for troll-fishery hooking mortalities, a summary tabulation is essential. In Table 1, 35 estimates of hooking mortality rates are shown. In cases where 2 independent but additive rates were determined from the same group of fish, 2 numbers are shown in the "Number fish in sample" column, and a "+" is shown in the "Type of mortality determination" column.

In general, numbers below the 15% level must be considered as definitely minimal since they account primarily for immediately observable losses and lack any adjustment for delayed mortalities. In considering the 9% and 12% rates developed from condition classification data for coho and chinook, it would be virtually impossible to justify use of a troll-hooking mortality rate less than 10%.

A notable exception in the first half of the values shown is the 13% level for pink salmon. This large-scale experiment provides sound evidence that the mortality rate for this species is not excessive and that regulations requiring the release of troll-caught pink salmon are justifiable in certain special cases. In 1969, for example, Washington issued an emergency order requiring the release of troll-caught pink when it became apparent that every possible fish from a disastrously poor run returning to Puget Sound streams was required for reproductive (escapement) purposes. Since pink salmon are available to the troll fishery for only a brief period during their second and final year of live, season- and size-limit restrictions are not generally considered in the ocean fishery management scheme for this species. Thus, the type of "special case" described above would be the only problem presently anticipated for pink where the question of hooking mortality might be pertinent. A possible source of error might exist in the form of significant mortalities for seine-caught fish, particulary if large numbers of pink salmon were held for extended periods awaiting tagging.

TABLE 1. Summary of Experimental Work on Hooking Mortality for Pacific Salmon in the Commercial Troll Fishery

% mortality	No. fish in sample	Species	Type of mortality determination	Reference
1.9	794	Coho	Immediate only, no holding period	Van Hyning (1951)
2.5	393	Chinook	Immediate only, no holding period	Van Hyning (1951)
3.3	389	Chinook	Immediate only, no holding period	Author
4.0	2,417	Chinook	Immediate only, brief holding period	Hollett (personal communication)[1]
4.9	572	Chinook	Immediate only, no holding period	Jensen (1969)
6.4	918	Chinook	Immediate only, barbless hooks	Reed (personal communication)[2]
7.0	158	Coho	Immediate only, no holding period	Jensen (1969)
7.9	901	Chinook	Immediate only, barbed hooks	Reed (personal communication)[2]
8.2	962	Coho	Immediate only, barbless hooks	Reed (personal communication)[2]
9.0	841	Chinook	Immediate only, brief holding period	Bergman (1960)
9.0	2,258	Coho	Based on condition classification	Author
9.7	537	Coho	Immediate only, brief holding period	Hollett (personal communication)[1]
12.0	2,107	Chinook	Based on condition classification	Author
12.4	983	Coho	Immediate only, barbed hooks	Reed (personal communication)[2]
13.0	75	Chinook	Immediate including seriously injured	Loeffel (1961)
13.0	64	Coho	Immediate only, brief holding period	Heyamoto (1963)
13.0	16,796 & 27,078	Pink	Immediate including seriously injured + delayed	Hollett (personal communication)[1]
16.0	32	Chinook	Immediate and delayed	Loeffel & Van Hyning (1962)
16.0	664 & 910	Coho	Immediate + delayed	Author
17.6	289	Coho	Immediate and delayed	Milne & Ball (1958)

(continued)

TABLE 1. Summary of Experimental Work on Hooking Mortality for Pacific Salmon in the Commercial Troll Fishery (continued)

% mortality	No. fish in sample	Species	Type of mortality determination	Reference
20.0	91	Chinook	Immediate and delayed	Milne & Ball (1958)
20.8	461	Chinook	Immediate including seriously injured	Parker & Kirkness (1956)
22.0	18	Coho	Immediate and delayed	Loeffel & Van Hyning (1962)
23.0	22	Chinook	Immediate only, brief holding period	Heyamoto (1963)
25.7	564	Chinook	Immediate including seriously injured	Hollett (personal communication)[1]
28.5	1,286 & 754	Coho	Immediate + delayed	Loeffel & Van Hyning (1962)
30.0	——	Chinook	Estimate based on physical damage to sublegal	Van Hyning & Naab (1967)
31.0	147	Chinook	Immediate including seriously injured	Loeffel (1961)
36.0	2,777 & 2,633	Coho	Immediate including seriously injured + delayed	Hollett (personal communication)[1]
38.0	88	Coho	Delayed, extended tank holding period	Fry (personal communication)[3]
38.0	2,777 & 1,283	Coho	Immediate including seriously injured + delayed	Hollett (personal communication)[1]
42.0	67 & 55	Coho	Immediate + delayed	Milne & Ball (1958)
44.0	115	Coho	Delayed, extended tank holding period	Parker, Black & Larkin (1959)
44.0	96	Chinook	Delayed, extended tank holding period	Fry (personal communication)[3]
71.0	66	Chinook	Delayed, extended tank holding period	Parker & Black (1959)

The first 16 of 17* hooking mortality estimates for Chinook and coho above the 15% level form the backbone of experimental research on this subject. While deficiencies can be found in each individual experiment cited, the group, in aggregate, would make any meaningful justification of rates below 15% or above 45% for either species quite difficult, if not impossible. Available evidence indicates that small fish sustain somewhat higher rates and that coho may sustain higher losses than chinook. Evidence on the latter point is somewhat contradictory, however, and this implied difference would be difficult to either substantiate or refute due to lack of adequate "control group" type experiments for chinook.

Within the 15 to 45% range, it is difficult to assign a narrower zone of "probable hooking mortality" much less a "point value" or "average". As a rule, however, estimates above 30% are probably somewhat excessive since they are based either on control-group experiments where seriously injured fish were included as total mortalities or on tank-holding experiments where the stress caused by artificial experimental conditions may have contributed materially to observed losses.

In general, the possible additional factors of loss mentioned for the sport fishery are also of importance in considering commercial troll-caught salmon. Involuntary losses, sublethal effects, and handling damage may all be of tremendous importance but adequate data do not exist for their proper evaluation. Handling, for example, includes great differentials in the rate at which troll lines are checked or "run". The "clubbing" and, to a lesser extent, the "shaking" techniques of removing small fish from the lines offer promise of producing substantial mortalities. In contrast, the technique practiced by many fishermen of reversing the hook by means of the point of a gaff and allowing the fish to drop off the hook appears to offer the greatest promise for returning small

fish to the water with a minimum of scale loss, puncture of the epidermis and abrasion of the mucous coat.

Observations by the author indicate one final point to consider. Experienced trollers can recognize sublegal fish more than 1 to 2 inches below a minimum-size limit without even lifting them from the water. This allows their release with a minimum of handling, thus producing a situation never achieved during experimental work. Further, losses might be maximized by setting a size limit at the mode of a population's length distribution and minimized by setting it between modes.

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A Review of Trolling Gear Studies on Chinook and Coho Salmon

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ABSTRACT

The two kinds of gear studies persued by fisheries agencies have been lure-selectivity and hook-type studies. Lure-selectivity work suggests that the use of plugs substantially reduces shaker salmon catches compared to catches when using other lures. However, a"redut:tion in the legal salmon catch was also observed. For chinook this reduction ranged from 51 to 68% of catches made on the most effective lures. Two studies showed that plugs caught larger chinook than other lures and one of the studies demonstrated a preference for large plugs and spoons by large chinook. Coho mortality differences between fish released from treble and those released from single hooks were not significant. Catch differences between chinook caught on barbed and on barbless hooks were not significant but between coho the differences were significant and favored the barbed hook. Tests of immediate mortality differences between salmon caught on barbed and on barbless hooks were not significant for sublegal chinook but were significant for coho and favored barbless hooks. There was no significance between delayed mortality differences for sublegal chinook or coho released from barbed or barbless hooks. *

INTRODUCTION

Several reports on different aspects of the Pacific Coast salmon shaker[1] problem were scheduled for preparation at the 1969 meeting of the Pacific Marine Fisheries Commission's Salmon and Steelhead Committee. The Fish Commission of Oregon agreed to prepare this report reviewing gear studies on chinook and coho salmon.

Differences in salmon trolling seasons and size limits between Pacific Coast management areas result in the release of many non-legal chinook and coho. Some of these fish will die from being hooked and shaken from the gear. The purposes of gear studies have been: (1) to minimize the chance of hooking sublegal salmon with the least possible reduction in the legal catch, and (2) to reduce the mortality associated with unhooking and releasing sublegal salmon. Corresponding lines of investigation, reviewed below, have dealt with the selectivity of various lure types for legal and sublegal salmon and the effects of hook type on survival of released salmon.

LURE-SELECTIVITY STUDIES

Data are available from several studies and are presented below by investigating agency.

Washington Department of Fisheries

Onboard gear-selectivity studies were conducted in 1948 (Robert R. Parker, unpublished data). Observations were made during 29 fishing days from May to September and included 314 chinook and 562 coho salmon caught off southern Vancouver Island and northern Washington (Table 1). No data

are available for each lure type fished on specific days. Apparently flasher gear was not used.

During 22 fishing days from May 23 to June 29 plugs took 96 chinook of which 91 (95%) equalled or exceeded the 26-inch total-length minimum-size limit while only 76 of 145 chinook (52%) taken on spoons were of legal size. The selectivity was also apparent in the size distribution as plug-caught Chinook averaged 33.1 inches total length while those taken on spoons averaged only 25.7 inches (Table 2)[2]. In the case of coho salmon, spoon gear took 185 of the 190 fish observed.

^Salmon lengths were converted to total extended length for text discussion. Lengths presented in tables may be converted by referring to Appendix 1.

TABLE 1. Summary of 1948 Troll Gear Selectivity Observations by the Washington Department of Fisheries

Date of observation	Chinook catch: Sublegal fish Plug	Sublegal fish Spoon	Legal fish Plug	Legal fish Spoon	Coho catch: Plug	Coho catch: Spoon	Area fished
5/23		4					Cape Beale
5/24		2	1	1			Cape Beale-Ucluelet
5/25	1						Ucluelet
5/26		3		1			Pachena Point
5/28		2		3			Cape Beale-Pachena Point
5/29		2	1	8	1	1	40 Mile Bank*
5/30				3			40 Mile Bank
6/7			2				Lennard Island
6/11	2		10	5			Umatilla Reef-Cape Flattery
6/12		2	1	5		1	Umatilla Reef-Cape Flattery
6/14		15	6	8		10	Swiftsure-Pachena Point
6/15		14	7	13	1	56	Swiftsure-Pachena Point
6/16		15	6	14	1	41	Swiftsure-Pachena Point
6/22		2		1		55	Umatilla Reef
6/24		1				3	Umatilla Reef
6/26			18	4		2	40 Mile Bank
6/26	1	4	17	4		10	Swiftsure-40 Mile Bank
6/27			6	2		2	40 Mile Bank
6/27		2	3	1		2	40 Mile Bank-Pachena Point
6/28			3	1	1	1	40 Mile Bank
6/28	1	1	1	1			Swiftsure-Pachena Point
6/29			9	1	1		40 Mile Bank
5/23–6/29[1] Subtotal	5	69	91	76	5	185	
8/27	3	1	3		6	68	Carroll Island-Umatilla Reef
8/28	1	2	2	2	1	78	Carroll Island-Umatilla Reef
8/29	3	15				4	Cape Flattery
8/27–8/29[2] Subtotal	7	18	5	2	7	150	
9/16		11		2		40	Umatilla Reef-Cape Flattery
9/17		13		2		58	Cape Flattery-Swiftsure
9/18		5				87	Swiftsure
9/19		7		1		30	Umatilla Reef-Swiftsure
9/16–9/19[3] Subtotal	0	36	0	5	0	215	

*40 Mile is local name for La Perouse Bank.

[1]Original data show terminal gear as: 5-, 5½-, 6-, and 7-inch plugs; No. 6 and No. 7 spoons; 2-inch brass and 2-inch red spoons.

[2]Terminal gear: 7-inch plugs and 2-inch red spoons.

[3]Terminal gear: No. 6 spoons and 2-inch spoons in the following patterns: brass, silver, red, yellow, red and yellow. No record of plugs being used.

TABLE 2. Length Frequencies of Chinook and Coho Salmon Taken During 1948 Washington Department of Fisheries Troll Gear Selectivity Observations

Fork length (inches)	May 23–June 29				August 27–29				September 16–19	
	Chinook		Coho		Chinook		Coho		Chinook	Coho[1]
	Plug	Spoon	Plug	Spoon	Plug	Spoon	Plug	Spoon	Spoon	Spoon
13		5						1		1
14		5		1					2	
15		8		1						
16		4		1					2	
17	1	8		4		1			1	
18		9	1	3		5			7	
19	1	4		4		3		2	10	
20	1	9	2	6	2	4		2	7	1
21		2		12	4	3			4	
22	1	6		15		1			2	1
23	1	9		32		1		5	1	1
24	2	8		57				6		
25	2	6	1	29				14		4
26	5	2		15	1		4	19	1	4
27	7	9		2	1			32		6
28	14	16		1			2	37	2	12
29	8	8	1	1	1		1	18		7
30	11	11				1		8		2
31	1	5						6		1
32	7	3			2	1				
33	4	2								
34	7	2							1	
35	7	1								
36	1									
37	8									
38	4	3							1	
39	3									
Total no.	96	145	5	185	12	20	7	150	41	40
$\bar{x}$ length	30.7	23.7	22.4	23.2	24.1	20.7	27.0	26.9	20.4	26.9

[1]Only the first 40 coho taken were measured. Remaining records show only measurements for 5 sublegal coho ranging from 12 to 17½ inches.

From August 27 to 29, Chinook catches were quite meager but still exhibited a similar selectivity trend. Twelve fish caught on plugs averaged 26.2 inches and 5 were legal, while on spoons the 20 fish taken averaged only 22.5 inches and only 2 were legal. The trend for coho during August 27 to 29 was consistent with May and June work since 150 of the 157 fish were taken on spoons.

From September 16 to 19, no catches were listed for plug gear, thus, it is unlikely that plugs were fished during these observations. A total of 41 Chinook taken on spoons averaged 22.2 inches and only 5 were of legal size.

Gear selectivity studies were also conducted onboard trollers off the Grays Harbor-Willapa Bay area on April 24, May 24-26, and June 6-7, 1955 (Siegfried Kiemle, unpublished data). The kinds of lures used varied from day to day, but the total numbers of plugs and spoons used during the study were similar (Table 3). The catch during the 6 fishing days was 99 chinook and 1 coho salmon. Flasher gear was used sparingly and captured a few fish. Plugs and spoons were again the predominant lures and demonstrated a selectivity pattern consistent with that observed in 1948. On plugs, 40 of 45 chinook captured (89%) were of legal size and the catch averaged 30.2 inches (Table 4). Chinook taken on spoons averaged only 27.4 inches and only 37 of the 48 fish (77%) were of legal size.

Fisheries Research Board of Canda

A lure-selectivity study was conducted by the Fisheries Research Board of Canada in 1953 off the southwest coast of Vancouver Island (Milne, 1955). A troller was chartered to fish 4 different lures. Four lures of the same type were spaced 5 fathoms apart on a line. There was no mention of switching

TABLE 3. Summary of 1955 Troll Gear Selectivity Observations by the Washington Department of Fisheries

	Chinook catch									
	Sublegal fish			Legal fish				Coho catch		
Date	Plug	Spoon	Flasher-hootchie	Plug	Spoon	Flasher-hootchie	Herring	Spoon	Terminal gear utilized	Area fished
4/28				19	3				20 plugs, 9 spoons	Grays Harbor
5/24		1		1	16	1			1 plug, 23 spoons, 1 flasher-hootchie	Grays Harbor–Willapa Bay
5/25	2	9		1	17				3 plugs, 21 spoons	Grays H.–Willapa
5/26	3			16	1		2	1	17 plugs, 3 spoons, 4 flasher herring	Grays Harbor–Willapa Bay
6/7			1	1		2			16 plugs, 6 flasher-hootchie	Grays H.–Willapa
6/8		1		2					11 plugs, 9 spoons, 6 flasher-herring	Grays Harbor–Willapa Bay
Total	5	11	1	40	37	3	2	1	68 plugs, 65 spoons 17 flashers	

gear between lines. From June 29 to August 2, a total of 54 coho and 97 chinook were caught (Table 5).

For coho, 47 of 54 fish (87%) were caught on spoons and the remaining 7 (13%) were caught on plugs. Small spoons and plugs caught more coho than large spoons and plugs. Milne noted little difference in average length by lure as the coho were maturing in their third year of life (size range 21.1 to 30.1 inches), however, the small lures caught more coho and size of plugs appeared to be more selective than size of spoons.

For chinook, 65 of 97 fish (67%) were caught on spoons and 32 (33%) were taken on plugs, fn contrast to coho the large spoons and plugs were more successful than the small spoons and plugs. Since chinook mature at various ages, the range in fish size was large (15.2 to 38.9 inches). Average size of chinook caught by lure type demonstrated that larger lures caught larger fish than smaller lures. Milne noted that although lartje and small spoons caught more chinook (35 and 30 fish respectively) than large plugs (20 fish) the per cent of the total chinook catch by weight (36%) was greatest for the large plugs. Additional information showed the stomach contents of the chinook caught on large lures contained more fish than the stomachs of fish caught on small lures. Chinook caught on large plugs had the highest incidence of fish in their stomachs.

Canada, Department of Fisheries and Forestry

Lure-selectivity studies were conducted by the Canadian Department of Fisheries and Forestry during the 1968 and 1969 off the West Coast of Vancouver Island (Pitre, 1970). In 1968, observations were made aboard a troller during 27 fishing days from May 1 to June 11 (Table 6). Different lures were fished simultaneously, one type per line, and were rotated between lines daily. The vessel fished Canadian statistical areas 21, 23, and 24 between Bonilla Point and Estevan Point. In 1969 three vessels were chartered and fished 72 days from April 15 to June 7 off Barkeley Sound at Big Bank or South Bank (Table 6). Each boat was randomly assigned one of three lure types and one of the two fishing areas each day. Operations were divided into four 6-day periods. Catch data are given as fish per standard troll-day based on 120 hook-hours per troll-day.

Pitre reported similar results for both years. Shaker catches were lower on plugs than on either spoons or flashers. Flashers took the most coho followed by spoons. Spoons caught more chinook shakers than flashers did in 1969, although during 1968 catches by spoons and flashers were equal. Spoons caught legal chinook more effectively than flashers or plugs.

"California Department of Fish and Game

During April and May 1969, a troller was contracted to fish between Eureka and Fort Bragg usually over depths ranging from 40 to 100 fathoms (L. B. Boydstun, unpublished data). Five types of lures were fished on four of the vessel's six main trolling lines. Plugs, bait, and small spoons were randomly assigned to three main trolling lines, one type to a line each day. Flashers with plastic skirts, and large spoons were fished simultaneously in alternating order on the fourth line. There were eight leaders on each line. Float bags were used on the four experimental lines. The fisherman used whatever lures he preferred on two bow lines. Legal fish caught were property of the fisherman, providing incentive to troll in the most efficient manner possible.

During two 5-day trips from April 24-28 and May 8-12, 485 chinook and 138 coho were caught on the 4 experimental lines (Table 7). The large spoon or flasher and plastic skirt combination caught the most legal and sublegal salmon. For legal and sublegal chinook, bait, small spoons, and plugs

TABLE 4

Lengths of Chinook Salmon Taken on Plugs and Spoons During 1955 Washington Department of Fisheries Gear Selectivity Observations

Total length		Chinook		Total length		Chinook	
(cm)	(inches)	Plug	Spoon	(cm)	(inches)	Plug	Spoor
33	13.0		1	67	26.4		2
34	13.4			68	26.8	1	1
35	13.8			69	27.2	1	3
36	14.2		1	70	27.6		2
37	14.6			71	28.0	2	2
38	15.0			72	28.3	1	3
39	15.4		1	73	28.7	2	2
40	15.7			74	29.1	1	3
41	16.1		1	75	29.5	2	2
42	16.5			76	29.9	2	1
43	16.9		1	77	30.3	4	1
44	17.3		1	78	30.7		3
45	17.7	1		79	31.1	2	1
46	18.1			80	31.5	7	
47	18.5			81	31.9	2	1
48	18.9			82	32.3	1	2
49	19.3			83	32.7	3	1
50	19.7			84	33.1	2	
51	20.1			85	33.5	1	
52	20.5			86	33.9		
53	20.9			87	34.3		
54	21.3			88	34.6		
55	21.7			89	35.0	1	1
56	22.0			90	35.4		
57	22.4			91	35.8		1
58	22.8		2	92	36.2		
59	23.2	1		93	36.6	1	
60	23.6		1	94	37.0		
61	24.0			95	37.4		
62	24.4			96	37.8	1	
63	24.8	1		97	38.2		
64	25.2	1	1	98	38.6		1
65	25.6	1	1	99	39.0	1	
66	26.0	2	3	100	39.4		1
				Total number		45	48
				$\bar{x}$ length		76.7	69.5

caught fish in decreasing order of importance. The catches, respectively, or sublegal Chinook and coho on plugs were only 15% and 18% of catches on the most efficient gear, large spoons or flashers and plastic skirts. Plug catches of legal chinook were 54% by weight or 53% by dollar value of combined catches by large spoon or flasher and plastic skirt.

Discussion

There are some similarities between the lure-selectivity studies discussed above. In each study the use of plugs

TABLE 5

Number and Size of Coho and Chinook Caught by 4 Different Trolling Lures During a 1953 Study by the Fisheries Research Board of Canada

	Large[1] spoon	Small[2] spoon	Large[3] plug	Small[4] plug	Total Total
Number of coho	20	27	2	5	54
Percent by number	37	50	4	9	100
Average fork length (cm)	62	61	65	57	–
Percent by weight*	39	49	5	7	100
Number of chinook	35	30	20	12	97
Percent by number	36	31	21	12	100
Average fork length (cm)	66	58	72	60	–
Percent under 66-cm or 26-inch total length	34	53	10	58	–
Percent by weight*	34	21	36	9	100

[1]McMahon, 7 inch, brass.

[2]Gibb's Egg Wobbler, No. 2 brass.

[3]Rex Field, Model 49, 7 inch, painted yellow and blue.

[4]Rex Field, Little Doug, 5 inch, painted yellow and blue.

*Weights were estimated from individual fish length.

produced the lowest incidence of shaker salmon (Table 8). In all cases, plug catches were substantially lower than catches on spoons or flashers.

Catches of legal chinook were lowest on plugs during studies conducted in 1953, 1968, and 1969 (Table 9). Plug catches during these studies were 51 to 68% of catches made on the most productive gear in each case. However, plugs were more successful than spoons during the 1948 and 1955 studies. In 1948 the numbers of plugs (68) and spoons (65) fished during the study were comparable (Table 3), but for 1955 the numbers of each lure type used were unavailable.

Qatches of legal coho were much lower on plugs than on spoons (Table 9). Plugs were more selective for large chinook than were other lure types. Where size frequencies were available for chinook caught on large and small plugs and spoons, fish taken on the larger lures were of larger average size.

HOOK-TYPE STUDIES

Two studies are available on the effects of hook type on shaker salmon survival. The results are presented below by type of gear studied.

Single Hooks vs. Treble Hooks

A study (Lasater and Haw, 1961) to evaluate survival of sport-caught salmon released from treble and single hooks was conducted in 1960 at the suggestion of PMFC because of concern about possible excessive hooking mortality from treble hooks. The field work was conducted in Puget Sound. Single hooks used were straight shank, ball eye, round bend, and measured 7/16 inch from point to shank (size 1/0); treble

TABLE 6. Average Catch per Troll Day of Coho and Sublegal and Legal Chinook by Lure Type[1] and Time Period During Studies Conducted by the Canada Department of Fisheries and Forestry

Time period	Coho			Sublegal chinook			Legal chinook		
	Plug	Spoon	Flasher	Plug	Spoon	Flasher	Plug	Spoon	Flasher
				May 1 to June 11, 1968 – 27 fishing days					
1	19.2	51.4	57.7	1.3	5.6	1.2	3.1	4.9	3.1
2	10.2	44.0	72.5	.7	4.5	4.2	1.6	6.4	4.6
3	25.2	52.2	82.8	3.0	10.2	11.8	7.1	7.4	4.3
4	13.8	20.8	38.7	3.7	15.4	18.4	8.0	13.9	6.7
Mean	17.0	42.1	62.9	2.8	8.9	8.9	5.4	8.1	4.7
				April 15 to June 7, 1969 – 72 fishing days					
1	3.6	16.8	18.0	2.6	8.8	8.0	6.0	10.8	9.0
2	1.2	12.0	4.3	1.4	6.8	4.4	2.8	3.6	3.6
3	.8	9.8	7.6	2.4	21.6	7.8	3.8	7.0	6.4
4	9.4	19.6	49.6	1.2	11.0	4.2	8.0	9.2	5.1
Mean	3.8	14.8	21.0	1.9	12.0	6.1	5.2	7.6	6.0

[1]Lures used during 1968 and 1969 were: 6" plastic plugs, No. 5 or 6 brass or brass and nickel spoons, and No. 1 Abe and Al or Blackfish Sound flashers with plastic hootchies.

hooks were 3/8 inch from point to shank or 3/4 inch from point to point.

There were 185 coho salmon tagged during the study, 77 from treble hooks and 108 from single hooks. The larger catch on single hooks was attributed to-type of lure (polar bear hair fly) used. The recoveries by type of hook were 16 (20.8%) for treble hooks and 25 (23.1%) for single hooks. The authors state that this difference is not significant and could have happened from chance alone.

Barbless Hooks vs. Barbed Hooks

Fish Commission of Oregon studies were designed to evaluate the use of barbless hooks as a savings gear for chinook and coho shaker salmon (Robert E. Loeffel, unpublished data). Studies had two major objectives: (1) to determine if using barbless hooks would decrease the catch of salmon, and (2) to determine if using barbless hooks would reduce the hooking mortality of "shakers." Data are complete for coho but some additional chinook recovery data will be received during the 1970 and 1971 seasons.

The Fish Commission of Oregon contracted ten salmon trollers to fish both barbed and barbless hooks during some seasons from 1959 to 1968 (Table 10). Fishing was conducted off the Oregon coast and, on one occasion, north to Grays Harbor, Washington. Fishing periods were scattered from March 15 to September 27 with northern areas generally fished from March through June and central to southern areas generally fished from June to September.

Barbless hooks used in these studies were conventional hooks with the barbs depressed. A hump was formed by the depressed barb possibly providing holding potential but eliminating the barb's cutting and tearing action. A lure with a barbed hook at a given depth on one side of a boat was opposed by an identical lure with a barbless hook at the same depth on the opposite side. Gear was switched between boat sides in a predetermined manner. Equal attention was given to removing fish from lines on each side of a boat. Fishing was "conducted in the fisherman's usual manner and in the area of of his choice (within selected sections of the coast).

To reduce bias due to handling, a standard procedure for landing, tagging, and releasing fish was adopted in 1962. Fish were lifted aboard by the leader and were unhooked by inverting the hook with a gaff. Most fish were anesthetized with MS-222 and after tagging were placed in a recovery tank. During 1967 and 1968, fish that were dead on landing or that did not resume normal position and action in the recovery tank, were termed immediate mortalities. Fish were tagged with 10-inch spaghetti tags 1/2 to 3/4" below the insertion of the dorsal fin and the tag's ends were secured with a monel band. Tags had the legend "Reward Ret. Ore. Fish Comm. Astoria" and tags and bands had matching numbers. The reward paid was one dollar.

Data was analyzed to see if barbless hooks: (1) reduced the catch of salmon, (2) reduced the immediate mortality of salmon, and (3) reduced the delayed mortality of salmon as measured by return differences between fish tagged from

TABLE 7. Number Pounds (dressed weight), and Value (dollars) of Legal Chinook and Numbers Only of Legal Coho, Shaker Chinook, and Shaker Coho Caught by Type of Lure and Fishing Date During a Study by the California Department of Fish and Game in 1969.

				Fishing date										
	Fish			April					May					
Lure type[1]	size	Species &	category	24	25	26	27	28	8	9	10	11	12	Total
Large spoon	Legal	Chinook	Number	13	19	4	4	12	3	2	4	14	10	85
or flasher			Pounds	103.3	147.7	25.5	42.1	78.9	20.1	13.6	28.0	118.0	83.9	661.1
with plastic			Dollars	58.80	84.73	12.50	27.49	39.64	9.85	6.66	14.66	71.50	48.67	374.50
skirt	Legal	Coho	Number	0	0	0	0	0	0	0	1	0	0	1
	Shaker	Chinook	" "	1	18	3	12	16	3	2	6	17	16	94
	" "	Coho	" "	0	2	2	0	3	3	7	25	5	3	50
Bait	Legal	Chinook	Number	8	16	6	13	2	1	3	3	5	10	67
			Pounds	71.4	125.7	42.2	98.7	13.3	9.7	24.7	24.8	34.0	68.5	512.7
			Dollars	40.68	67.99	22.56	52.74	6.52	5.82	14.07	13.38	16.66	35.40	275.82
	Legal	Coho	Number	0	0	0	0	0	0	0	0	0	0	0
	Shaker	Chinook	" "	0	12	5	6	2	1	3	8	11	15	63
	" "	Coho	" "	0	0	0	0	0	1	2	17	3	4	27
Small spoon	Legal	Chinook	Number	7	14	2	5	10	2	0	8	6	3	57
			Pounds	65.6	104.6	16.4	39.4	77.6	18.6	0.0	62.2	39.5	22.5	446.4
			Dollars	41.60	55.63	9.06	21.56	44.55	12.62	0.00	33.50	20.26	12.14	250.92
	Legal	Coho	Number	0	0	0	0	0	0	0	1	0	0	1
	Shaker	Chinook	" "	0	10	5	7	5	2	1	6	9	17	62
	" "	Coho	" "	1	3	3	2	2	5	3	19	6	6	50
Plug	Legal	Chinook	Number	0	11	6	3	8	2	2	5	4	2	43
			Pounds	0.0	89.3	46.9	22.7	65.6	16.6	15.9	43.3	37.9	14.1	352.3
			Dollars	0.00	49.76	25.96	12.19	37.01	9.25	8.73	24.58	24.23	7.84	199.55
	Legal	Coho	Number	0	0	0	0	0	0	0	0	0	0	0
	Shaker	Chinook	" "	0	2	1	2	2	0	1	2	1	3	14
	" "	Coho	" "	0	1	0	0	0	1	0	4	3	0	9
Total	Legal	Chinook	Number	28	60	18	25	32	8	7	20	29	25	252
			Pounds	240.0	467.3	131.0	202.9	235.4	65.0	54.2	158.3	229.4	189.0	1,972.5
			Dollars	141.08	258.11	70.08	113.98	127.72	37.54	29.46	86.12	132.65	104.05	1,100.79
	Legal	Coho	Number	0	0	0	0	0	0	0	2	0	0	2
	Shaker	Chinook	" "	1	42	14	27	25	6	7	22	38	51	233
	" "	Coho	" "	1	6	5	2	5	10	12	65	17	13	136

[1]The types of lures used were: large spoon—Kachmore No. 6½, small spoon—Canadian 5, bait—6-inch Pacific herring, and plug—Ace Hi (6-inch). Chrome-plated Abe and Al No. 1 flasher was used with the plastic skirt and occasionally with bait.

barbed or from barbless hooks. Recognized tests of significance were employed to evaluate differences in each of the three analyses.

On most boats barbed hooks caught more salmon than barbless hooks but differences were not large (Table 11). It is interesting to note that on some boats barbless hooks caught more salmon. For all boats 724 (51.4%) legal Chinook were caught on barbed hooks compared to 685 (48.6%) caught on barbless hooks. Combined data for sublegal chinook showed a similar trend with 1,081 (50.7%) and 1,049 (49.3%) caught on barbed and barbless hooks, respectively. In this preliminary analysis, preseason coho and inseason coho were combined. Catches again favored barbed over barbless hooks with catches of 2,452 (52.0%) and 2,261 (48.0%), respectively. Statistical tests showed no significance at the 95% level in differences between barbed and barbless hook catches for legal and sublegal chinook. Catch differences between hook types for coho were significant at the 95% level.

Immediate mortality data were available for boats that fished during 1967 and 1968 (Table 12). Immediate mortality was least for fish caught on barbless hooks. For combined boat data, sublegal chinook immediate mortality was 7.9% and

TABLE 8
Catch Data by Lure Type for Sublegal Salmon from Lure-Selectivity Studies

Agency and study year		Sublegal Chinook[1]				Pre-season Coho[2]			
		Plug	Spoon	Flasher	Herring	Plug	Spoon	Flasher	Herring
Wash. Dept. Fish.	1948	12	123	—	—	1	12	—	—
Wash. Dept. Fish.	1955	5	11	1	—	—	—	—	—
Fish. Res. Bd. Canada	1953	9	28	—	—	—	—	—	—
Canada Dept. Fish. & Forest.	1968[3]	2.8	8.9	8.9	—	17.0	42.1	62.9	—
Canada Dept. Fish. & Forest.	1969[3]	1.9	12.0	6.1	—	3.8	14.8	21.0	—
Calif. Dept. Fish & Game	1969	14	62	94[a]	63[b]	9	50	50[a]	27[b]

[1]Chinook under 26 inches total length.
[2]Coho caught prior to June 15 of any year; in California they are legal before if 25" or longer.
[3]Mean catch per troll day.
[a]Catches by both large spoons and flashers with plastic skirts were combined.
[b]Flashers were used occasionally with herring.

TABLE 10
Boats Chartered and Time and Areas Fished During Barbless Hook Studies

Year	Name of boat	Time fished	Area fished
1959	Cluny	March 16—April 14	Mouth of Columbia River
1960	Whisper	March 15—April 15	Mouth of Columbia River
1962	Barracuda	June 1—June 25	Mouth of Columbia River & Grays Harbor
1962	Dreamer	Aug. 20—Sept. 27	Mouth of Columbia River
1962	Sea Lanes	July 30—Aug. 12	Off Newport and Heceta Head
1962	Elaine Dell	June 28—July 28	Off Coos Bay and Heceta Head
1967	Ann Marie	April 18—June 30	Mouth of Columbia River
1967	Sea Fawn	July 21—Sept. 9	Port Orford
1967	Debra K	July 25—Sept. 9	Port Orford
1968	Alibi	May 18—June 30	Brookings

TABLE 9
Salmon from Lure-Selectivity Studies

	ook[1]			Legal Coho[2]		
	Spoon	Flasher	Herring	Plug	Spoon	Flasher
	83	—	—	11	548	—
	37	3	2	—	—	—
	37	—	—	7	47	—
	8.1	4.7	—	—	—	—
	7.6	60	—	—	—	—
	57	85[a]	67[b]	—	—	—

e if 25" or longer.
ned.

6.4% of the total catch for barbed hooks, and of that for barbless hooks, respectively. For coho a larger difference was observed where respective data for barbed and barbless hooks were 12.4% and 8.2%. Tests at the 95% level for immediate mortality differences showed no significance for sublegal Chinook, but a high significance favoring barbless hooks for coho.

Examination of returns from fish tagged from barbed or from barbless hooks is used to measure delayed mortality differences (Table 13). The combined boat data for sublegal chinook show no benefit for fish tagged from barbless hooks (29.2% returns) over fish tagged from barbed hooks (30.5% returns). However, returns for individual boats, in some cases, favored barbless hooks. More coho tagged from barbless hooks (32.2%) were returned than fish tagged from barbed hooks (27.9%). Individual boat data for coho all favored barbless hooks. However, there was no significance between differences at the 95% level for sublegal chinook or for coho. Although catch rates favored barbed hooks, rates for barbless hooks were nearly similar. In the case of some boats, barbless hook catch rates were higher. Experience gained during the studies suggests barbless hooks are easier to operate, an assumption supported by the fact that some fishermen voluntarily use barbless hooks. Some savings resulting from the use of barbless

TABLE 11. Troll Catches Made Using Lures with Barbed or Barbless Hooks Fished Simultaneously and in a Similar Fashion

		Chinook					
		Legal		Sublegal		Coho	
Year	Boat	Barbed	Barbless	Barbed	Barbless	Barbed	Barbless
1959	Cluny	122	103	62	39		
1960	Whisper	87	69	32	28		
1962	Barracuda	42	38	27	22	170	136
1962	Dreamer	6	3	29	17	186	131
1962	Sea Lanes	15	12	7	7	358	314
1962	Elaine Dell	42	68	23	18	318	303
1967	Ann Marie	207	213	604	630	705	710
1967	Sea Fawn	53	57	93	78	69	57
1967	Debra K.	99	82	110	109	163	153
1968	Alibi	51	40	94	101	483	457
Total		724	685	1,081	1,049	2,452	2,261
Percent		51.4	48.6	50.7	49.3	52.0	48.0

TABLE 12. Immediate Mortality Rates for Fish Caught on Barbed and Barbless Hooks (Numerators refer to number of immediate mortalities while denominators refer to total number of fish caught; percentages refer to immediate mortalities)

		Sublegal chinook		Coho	
Year	Boat	Barbed	Barbless	Barbed	Barbless
1967	Ann Marie	53/604 (8.8%)	52/630 (8.2%)	43/500 (8.6%)	32/505 (6.3%)
1967	Sea Fawn	6/93 (6.5%)	0/78 (0%)		
1967	Debra K	4/110 (3.6%)	3/109 (2.7%)		
1968	Alibi	8/94 (8.5%)	4/101 (4.0%)	79/483 (16.4%)	47/457 (10.3%)
Total		71/901 (7.9%)	59/918 (6.4%)	122/983 (12.4%)	79/962 (8.2%)

TABLE 13. Tag Recovery Rates for Fish Tagged from Barbed Hooks or frpm Barbless Hooks (Numerators refer to the number of tagged fish recovered; denominators refer to number of tagged fish released)

		Sublegal chinook		Coho	
Year	Boat	Barbed	Barbless	Barbed	Barbless
1959	Cluny	10/55 (18.2%)	7/38 (18.4%)		
1962	Barracuda	4/27 (14.8%)	2/22 (9.1%)	1/12 (8.3%)	4/13 (30.8%)
1962	Dreamer	3/27 (11.1%)	2/17 (11.8%)		
1962	Sea Lanes	0/7 (0%)	0/6 (0%)	0/30 (0%)	0/21 (0%)
1962	Elaine Dell	3/23 (13.0%)	3/17 (17.6%)		
1967	Ann Marie	223/551 (40.5%)	213/578 (36.8%)	165/457 (36.1%)	183/473 (38.6%)
1967	Sea Fawn	20/87 (23.0%)	21/78 (26.9%)		
1967	Debra K	16/106 (15.1%)	16/106 (15.1%)		
1968	Alibi	17/86 (19.8%)	17/97 (17.5%)	86/404 (21.3%)	108/410 (26.4%)
Total		296/969 (30.5%)	281/959 (29.2%)	252/903 (27.9%)	295/917 (32.2%)

hooks are evident. This fact alone supports the practice of using barbless hooks. A disappointing fact is that sustantial savings to shaker salmon caught on barbless hooks were not realized.

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APPENDIX 1. Conversion of Salmon Length in Inches or Centimeters to Fork or Total Extended Length.

Fork length		Total length Coho		Total length Chinook		Fork length		Total length Coho		Total length Chinook	
cm	in.	cm	in.	cm	in.	cm	in.	cm	in.	cm	in.
30	11.8	32.9	13.0	33.4	13.2	70	27.6	74.4	29.3	75.7	29.8
31	12.2	33.9	13.4	34.5	13.6	71	28.0	75.4	29.7	76.7	30.2
32	12.6	35.0	13.8	35.5	14.0	72	28.4	76.5	30.1	77.8	30.6
33	13.0	36.0	14.2	36.6	14.4	73	28.7	77.5	30.5	78.8	31.0
34	13.4	37.0	14.6	37.6	14.8	74	29.1	78.5	30.9	79.9	31.5
35	13.8	38.1	15.0	38.7	15.2	75	29.5	79.6	31.3	80.9	31.9
36	14.2	39.1	15.4	39.7	15.6	76	29.9	80.6	31.7	82.0	32.3
37	14.6	40.2	15.8	40.8	16.1	77	30.3	81.6	32.1	83.1	32.7
38	15.0	41.2	16.2	41.9	16.5	78	30.7	82.7	32.6	84.1	33.1
39	15.4	42.2	16.6	42.9	16.9	79	31.1	83.7	33.0	85.2	33.5
40	15.8	43.3	17.1	44.0	17.3	80	31.5	84.8	33.4	86.2	33.9
41	16.1	44.3	17.4	45.0	17.7	81	31.9	85.8	33.8	87.3	34.4
42	16.5	45.3	17.8	46.1	18.2	82	32.3	86.8	34.2	88.3	34.8
43	16.9	46.4	18.3	47.1	18.5	83	32.7	87.9	34.6	89.4	35.2
44	17.3	47.4	18.7	48.2	19.0	84	33.1	88.9	35.0	90.4	35.6
45	17.7	48.5	19.1	49.3	19.4	85	33.5	89.9	35.4	91.5	36.0
46	18.1	49.5	19.5	50.3	19.8	86	33.9	91.0	35.8	92.6	36.5
47	18.5	50.5	19.9	51.4	20.2	87	34.3	92.0	36.2	93.6	36.9
48	18.9	51.6	20.3	52.4	20.6	88	34.7	93.1	36.7	94.7	37.3
49	19.3	52.6	20.7	53.5	21.1	89	35.0	94.1	37.1	95.7	37.7
50	19.7	53.6	21.1	54.5	21.5	90	35.4	95.1	37.4	96.8	38.1
51	20.1	54.7	21.5	55.6	21.9	91	35.8	96.2	37.9	97.8	38.5
52	20.5	55.7	21.9	56.6	22.3	92	36.2	97.2	38.3	98.9	38.9
53	20.9	56.8	22.4	57.7	22.7	93	36.6	98.2	38.7	100.0	39.4
54	21.3	57.8	22.8	58.8	23.2	94	37.0	99.3	39.1	101.0	39.8
55	21.7	58.8	23.2	59.8	23.5	95	37.4	100.3	39.5	102.1	40.2
56	22.1	59.9	23.6	60.9	24.0	96	37.8	101.3	39.9	103.1	40.6
57	22.4	60.9	24.0	61.9	24.4	97	38.2	102.4	40.3	104.2	41.0
58	22.8	61.9	24.4	63.0	24.8	98	38.6	103.4	40.7	105.2	41.4
59	23.2	63.0	24.8	64.0	25.2	99	39.0	104.5	41.5	106.3	41.9
60	23.6	64.0	25.2	65.1	25.6	100	39.4	105.5	41.5	107.3	42.2
61	24.0	65.1	25.6	66.2	26.1	101	39.8	106.5	41.9	108.4	42.7
62	24.4	66.1	26.0	67.2	26.5	102	40.2	107.6	42.4	109.5	43.1
63	24.8	67.1	26.4	68.3	26.9	103	40.6	108.6	42.8	110.5	43.5
64	25.2	68.2	26.9	69.3	27.3	104	41.0	109.6	43.2	111.6	43.9
65	25.6	69.2	27.2	70.4	27.7	105	41.3	110.7	43.6	112.6	44.3
66	26.0	70.2	27.6	71.4	28.1	106	41.7	111.7	44.0	113.7	44.8
67	26.4	71.3	28.1	72.5	28.5	107	42.1	112.8	44.4	114.7	45.2
68	26.8	72.3	28.5	73.5	28.9	108	42.5	113.8	44.8	115.8	45.6
69	27.2	73.3	28.9	74.6	29.4	109	42.9	114.8	45.2	116.9	46.0
						110	43.3	115.9	45.6	117.9	46.4

Total extended lengths were calculated from: Coho TL (cm) = 1.78433 + 1.03706 FL (cm); Chinook TL (cm) = 1.71728 + 1.05625 FL (cm)

A Review of Chinook and Coho Shaker Catches in the Pacific Coast Troll Fishery

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The intent of this report is to summarize recent information regarding the incidence of hooking and releasing "shakers" in the Pacific Coast troll salmon fishery. The term "shaker" describes a salmon which must be released because it is (a) shorter than the existing minimum-size limit, or (b) of a species for which the season is closed. The latter condition applies only to coho taken north of California between April 15 and June 15.

Of the several Pacific Coast agencies concerned with ocean salmon fishery management, only those of California and British Columbia have recently conducted studies directly concerned with shaker incidence. Fragmentary information is available from Oregon and Washington, most of which was generated by investigations into some other aspect of the troll fishery.

CALIFORNIA SHAKER ESTIMATES

Voluntary Logbook Program

Logbooks were first distributed among California trollers in 1966. During this and the following year, the program was largely developmental; few logs were in use, and the format was being continually revised. In 1968 and 1969, 93 and 55 trollers, respectively, participated in the voluntary logbook program. Logbook information includes, by day: hours trolling. Fish and Game block(s) fished, number of legal fish caught, number of shakers caught, pounds delivered, sea surface temperatures, Loran readings, depths fished, spreads fished and terminal gear used.

Ratios of shaker catch to catch of legal salmon have been computed by area and by 2-week time periods for 1968 and 1969. A description of port areas is as follows:

(1) Crescent City area-from Oregon border to Redding Rock,
(2) Eureka area-Redding Rock to Cape Mendocino,
(3) Fort Bragg area—Cape Mendocino to Point Arena,
(4) San Francisco area-Point Arena to Pescadero Point, and
(5) Monterey area-all ports south of Pescadero Point.

Shaker Estimates for 1968 and 1969

A straightforward method of estimating total shaker catch is to compute sublegal-to-legal ratios and multiply this figure by the actual landings. This method requires one major assumption, that fishermen accurately report their catches in their logbooks. Statewide seasonal estimates of total sublegal salmon hooked and released, computed by using logbook sublegal-to-legal ratios were 629,966 in 1968 and 485,193 in 1969 (Tables 1 and 2).

The troll fishery in California waters from Point Arena to the Oregon border differs from the fishery to the south in several important respects. In the central part of the State, the troll fishery is dependent upon the catch of Chinook salmon. North of Point Arena, coho often contribute significantly to the commercial catch. In 1968, 78 percent of the statewide coho catch of 2,338,000 pounds was landed north of Point Arena. In 1969, the corresponding value was 84 percent of 1,235,000 pounds.

Because of differences in catch composition, shaker estimates from northern California (Point Arena north to the Oregon border) must be distinguished from those from central California (Point Arena south to Avila).

Catches of shakers were greatest in northern California early in the season. In the area north of Point Arena, prior to June 15, an estimated 273,032 sublegal salmon were hooked and released in 1968. This estimate represents 43.3 percent of the statewide season's shaker catch. The estimate for 1969 was 246,969, or 50.9 percent.

Data regarding shaker species composition were not recorded by voluntary logbook holders. A limited number of observations, made in 1969 during the early months of the season off northern California, indicated a 1:1 ratio of coho shakars to Chinook shakers. This ratio yields an estimate of 123,500 coho shakers prior to June 15 in northern California during 1969. Assuming that the ratio was similar in 1968, approximately 136,500 coho shakers were hooked and released during the April 15-June 15, 1968 period in northern California.

The 1968 and 1969 seasons exhibited similar catch patterns of both shaker and legal salmon (Figures 1 and 2). The number of shakers captured was greatest in the northern part of the State, and the rate of shaker capture declined toward mid-season. In northern California the shaker catches for 2-week intervals were greatest in late May and early June, declined during the summer months, and increased again in the fall.

There are reasonable explanations for this pattern. During the early months of the season, many 2-plus-age chinook have not reached legal commercial size (26-inch total length) and few coho are legal size (25-inch total length). By the middle of June most of the coho have reached legal size (Figure 3) and

TABLE 1

Sublegal-to-Legal Ratios, and Estimated Catch of Sublegal Salmon by the California Commercial Troll Fishery in 1968, in Numbers of Fish, by 2-Week Periods

	Period 1 April 15–30			Period 2 May 1–15			Period 3 May 16–31		
Port area	Legal[1]	SLR[2]	Sublegal[3]	Legal	SLR	Sublegal	Legal	SLR	Sublegal
Crescent City	140	1.46[a]	204	3,675	1.42	5,219	10,461	1.61	16,842
Eureka	7,476	1.55	11,588	31,236	1.45	45,292	45,135	1.21	54,613
Fort Bragg	1,182	3.28	3,700	2,566	1.15	2,951	11,084	1.45	16,072
San Francisco	13,149	1.59	20,907	18,536	1.29	23,911	18,025	0.40	7,210
Monterey	13,180	1.12	14,762	3,614	1.14	4,120	5,399	0.41	2,214
Statewide	35,127	1.46	51,161	59,627	1.37	81,493	90,104	1.08	96,951

	Period 4 June 1–15			Period 5 June 16–30			Period 6 July 1–15		
Crescent City	37,728	1.33	50,178	1,736	0.27	469	48,890	0.25	12,222
Eureka	56,495	0.97	54,800	8,442	0.53	4,474	32,478	0.30	9,743
Fort Bragg	24,624	0.47	11,573	20,891	0.26	5,432	41,856	0.39	16,324
San Francisco	33,040	0.29	9,582	41,040	0.21	8,618	53,634	0.30	16,090
Monterey	5,007	0.30	1,502	6,801	0.57	3,877	6,106	0.31[a]	1,893
Statewide	156,894	0.81	127,635	78,910	0.29	22,870	182,964	0.31	56,272

	Period 7 July 16–31			Period 8 August 1–15			Period 9 August 16–31		
Crescent City	28,224	0.52	14,676	22,511	0.19	4,277	4,256	0.24	1,021
Eureka	10,711	0.78	8,355	9,025	0.50	4,512	1,994	1.29[a]	2,572
Fort Bragg	28,491	0.48	13,676	27,070	1.06	28,694	8,879	1.83	14,419
San Francisco	23,648	0.79	18,682	25,838	1.64	42,374	4,995	2.37	11,838
Monterey	4,995	0.41	2,048	3,556	0.32	1,138	6,518	0.69	4,497
Statewide	96,069	0.60	57,437	88,000	0.49	80,995	26,642	1.29	34,347

	Period 10 September 1–15			Period 11 September 16–30			Season April 15–September 30		
Crescent City	229	1.15[a]	263	6	0.63[a]	4	157,856	0.67	105,375
Eureka	673	1.15[a]	774	104	1.60	166	203,769	0.97	196,889
Fort Bragg	5,644	1.25	7,055	2,151	1.31	2,818	174,438	0.70	122,714
San Francisco	3,920	1.80	7,056	736	0.10	74	236,561	0.70	166,342
Monterey	4,532	0.47	2,130	2,583	0.18	465	62,291	0.62	38,646
Statewide	14,998	1.15	17,278	5,580	0.63	3,527	834,915	0.71	629,966

[1] Estimated landings in numbers of fish.

[2] Sublegal-to-legal ratios.

[3] Estimated catch of sublegal salmon

[a] No shaker catch data available for the stratum. Ratio used is the mean ratio for all other ports in the same period.

TABLE 2

Sublegal-to-Legal Ratios, and Estimated Catch of Sublegal Salmon by the California Commercial Troll Fishery in 1969, in Numbers of Fish, by 2-Week Periods

Port area	Period 1 April 15–30			Period 2 May 1–15			Period 3 May 16–31		
	Legal[1]	SLR[2]	Sublegal[3]	Legal	SLR	Sublegal	Legal	SLR	Sublegal
Crescent City	566	0.28	158	2,445	0.27	660	3,888	0.18	700
Eureka	12,225	3.03	37,042	27,454	2,80	76,871	25,854	1.66	42,918
Fort Bragg	6,029	0.93	5,607	7,321	1.42	10,396	11,214	1.29	14,466
San Francisco	22,459	0.50	11,230	18,467	0.54	9,972	24,883	0.47	11,695
Monterey	27,919	0.18	5,025	15,737	0.45	7,082	22,093	0.39	8,616
Statewide	69,198	0.85	59,062	71,424	1.47	104,981	87,932	0.90	78,395
	Period 4 June 1–15			Period 5 June 16–30			Period 6 July 1–15		
Crescent City	21,736	0.27	5,869	21,476	0.60	12,886	9,799	0.28	2,744
Eureka	43,358	1.02	44,225	13,098	0.34	4,453	9,877	0.27[a]	2,667
Fort Bragg	15,798	0.51	8,057	16,443	0.35	5,755	41,881	0.24	10,051
San Francisco	40,306	0.18	7,255	22,968	0.16	3,675	37,022	0.28	10,366
Monterey	10,791	0.30	3,237	8,240	0.18	1,483	6,172	0.38	2,345
Statewide	131,989	0.52	68,643	82,225	0.34	28,252	104,751	0.27	28,173
	Period 7 July 16–31			Period 8 August 1–15			Period 9 August 16–31		
Crescent City	5,347	0.57	3,048	1,851	1.06[a]	1,962	920	0.45[a]	414
Eureka	19,607	0.45	8,823	14,947	0.49	7,324	2,975	0.66	1,964
Fort Bragg	60,268	0.44	26,518	9,803	0.67	6,568	10,452	0.48	5,017
San Francisco	20,555	0.38	7,810	4,542	4.00	18,168	4,417	0.46	2,032
Monterey	7,544	0.14	1,056	4,712	0.86	4,052	4,438	0.21	932
Statewide	113,321	0.42	47,255	35,855	1.06	38,074	23,202	0.45	10,359
	Period 10 September 1–15			Period 11 September 16–30			Season April 15–September 30		
Crescent City	177	0.71[a]	126	232	0.78[a]	181	68,437	0.42	28,748
Eureka	352	0.71[a]	250	722	0.78[a]	563	170,469	1.33	227,100
Fort Bragg	11,613	0.75	8,710	6,504	1.05	6,829	197,326	0.55	107,974
San Francisco	3,426	0.71	2,432	5,247	0.54	2,833	204,292	0.43	87,468
Monterey	688	0.07	48	671	0.04	27	109,005	0.31	33,903
Statewide	16,256	0.71	11,566	13,376	0.78	10,433	749,529	0.65	485,193

[1] Estimated landings in numbers of fish.

[2] Sublegal-to-legal ratios.

[3] Estimated catch of sublegal salmon.

[a] No shaker catch data available for the stratum. Ratio used is the mean ratio for all other ports in the same period.

more 2-plus chinook are 26 inches or over in total length. Consequently the shaker-legal ratio drops. In late summer, the larger of the 1-year-old chinook have become vulnerable to troll gear, causing the shaker-legal ratio to swing upwards. It is of significance to note that although the shaker-legal ratio is comparatively high during the latter part of the troll season, the total shaker catch is low because of reduced effort.

Another point worth noting is the large drop in landings during the latter part of June in northern California (Figures 1 and 2). This occurred both in 1968 and 1969. A partial explanation for this decline in landings is that this time period coincides with the start of the albacore fishery, at which time many of the larger trollers leave the salmon troll fishery.

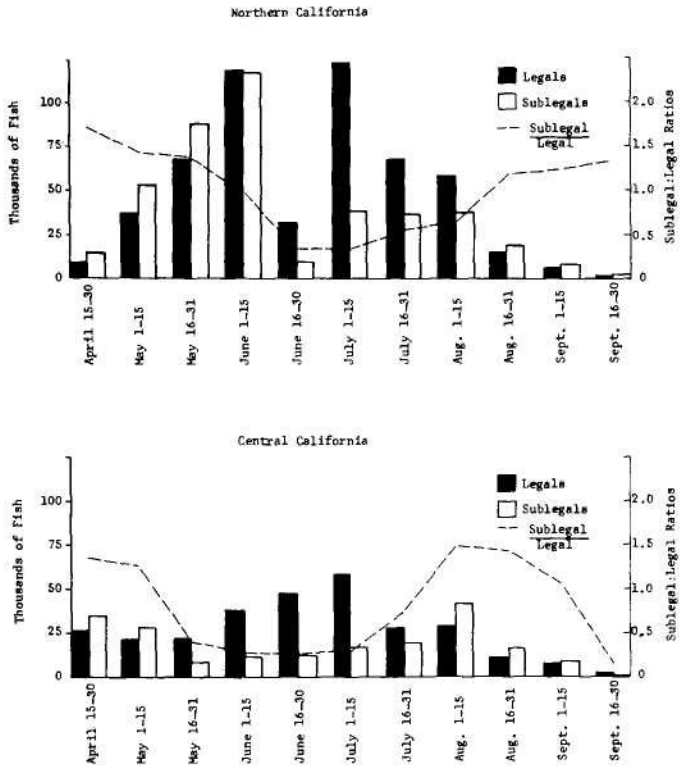

FIGURE 1. Legal and sublegal salmon catch and sublegal/legal ratios by 2-week periods and by areas, 1968 troll season.

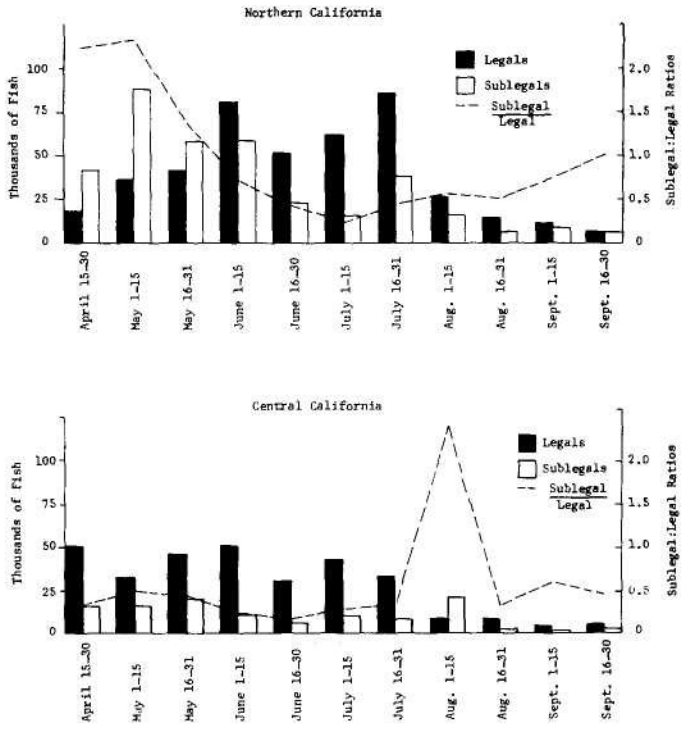

FIGURE 2. Legal and sublegal salmon catch and sublegal/legal ratios by 2-week periods and by areas, 1969 troll season.

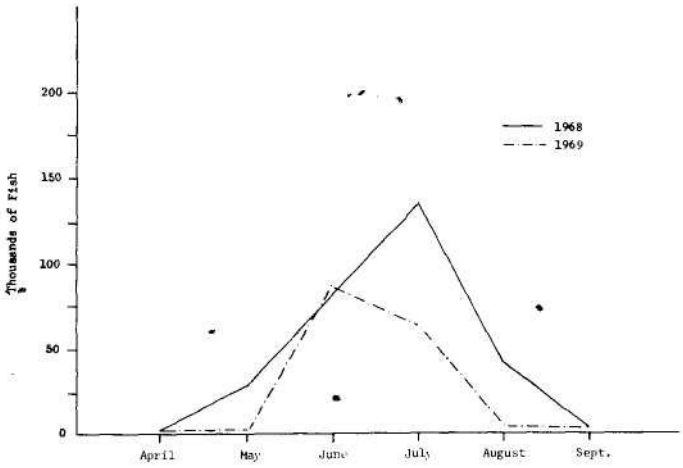

FIGURE 3. Northern California coho landings by month (1968 and 1969).

Variations in Abundance of Legal and Sublegal Salmon

The amount of salmon trolling effort varies considerably throughout the season. Weather conditions, market conditions, fishing success and the lure of other fisheries are all factors affecting total salmon trolling effort. Therefore, total landings in a given period of time may not necessarily reflect the abundance of catchable fish. The catch rate, expressed in terms of catch-per-day, is a more direct index of abundance.

The 1968 and 1969 seasons were similar in terms of catch-per-day, and logbook data have been combined for these years. In northern California, average catch-per-day for legal salmon is at a maximum in June (Figure 4). In central California, the peak in catch-per-day appears in July (Figure 5).

In both northern and central California, catch-per-day of sublegal salmon is greatest in April and May, reaching a peak of almost 40 shakers per day in -northern California during April (Figures 4 and 5). The shaker catch decreases during early summer. Toward the end of summer the shaker catch-per-day shows a slight increase, but soon starts to drop again and continues to decline until the end of the troll season. Total effort is also decreasing during August and September.

OREGON SHAKER ESTIMATES

The Fish Commission of Oregon contracted salmon trollers to fish both barbed and barbless hooks from 1959 through 1968. The primary purpose of this study was to determine if use of barbless hooks would reduce hooking mortality of "shakers" without reducing the catch of legal salmon.

Although data collected during barbless hook studies were not intended to provide shaker estimates in the Oregon troll

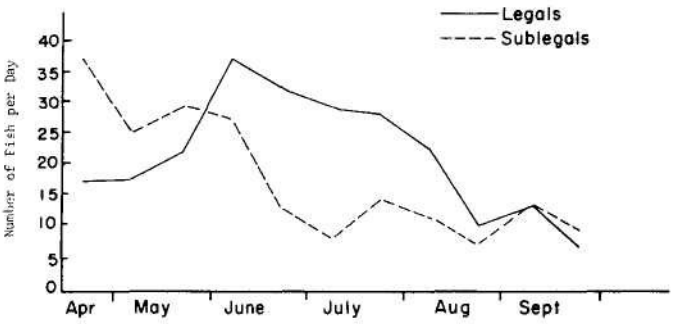

FIGURE 4. Average catch rate (fish-per-day) of legal and sublegal salmon in northern California (1968-1969).

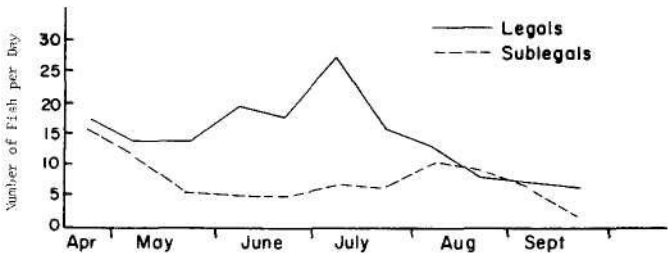

FIGURE 5. Average catch rate (fish-per-day) of legal and sublegal salmon in central California (1968-1969).

fishery, information concerning shaker[1] catches was gathered "incidental" to barbless hook studies and was made available by Research Division, Oregon Fish Commission (Table 3).

We would like to emphasize that estimates of Oregon troll fishery shaker catches made in this report do not necessarily reflect accurately what was happening in the Oregon troll fishery during the 1959 through 1968 fishery seasons. However, the data show relative trends in shaker abundance and can be used to indicate shaker catches which would have been expected had commercial trollers operated in the given areas, using similar gear during the same time period.

Chinook Shaker Catch Estimates

Oregon's chinook shaker-to-legal ratios by 2-week intervals, computed from data collected during barbless hook evaluation studies (Figure 6), are much higher than those shown by California's 1968 and 1969 logbook data; however, the distribution is quite similar. High catches of shakers occurred in the early part of the season, foflowing by a sharp decline in June. The shaker-legal ratios remained low throughout the summer months and then increased toward the end of the season.

Multiplying the monthly ratios of sublegal-to-legal chinook "(Table 4) by monthly chinook landings in month intervals produces an estimate of Oregon's sublegal chinook catch. Applying this method to 1968 Oregon landings of 110,150 chinook provides an estimate.of 152,000 sublegals for the 1968 troll season.

Because areas of high chinook shaker concentrations were purposely fished, the sublegal chinook catch computed for the 1968 Oregon troll season is likely to be a biased estimate.

Coho Shaker Catch Estimates

In order to define the pattern of Oregon's shaker coho catch, mean coho catch-per-day during 2-week intervals was computed. The average ranged from a high of 48.2 in April to a low of 7.7 in early September (Figure 7). The pre-June 15 average catch-per-day was 23.6 coho, approximately double California's 1968-69 average prior to June 15. Again, the Oregon values were derived from data gathered in the course of barbless hook studies during which attempts were made to deliberately fish areas of concentrations of sublegal salmon.

The data collected during the barbless hook studies provide a method by which the Oregon coho shaker catches can be estimated. However, the validity of these estimates depends upon the coho-to-legal Chinook ratio observed during the barbless hook studies being representative of the coho-to-legal-chinook ratio of the Oregon commercial troll catch prior to June 15.

To obtain an idea of the reliability of this assumption, we multiplied coho-to-legal-chinook ratios (from barbless hook studies) by Chinook landings (computed by month). This produces an estimate of the coho catch which can be compared with the actual coho catch. This method was applied to 1968 landing data provided by the Oregon Fish Commission. It yielded an estimate of 565,000 coho landed from June 15 to September 31. Actual coho landings for this time period were 825,154.

The computed coho shaker catch for the State of Oregon prior*to June 15, using the same method, is 128,754. By comparison, the coho shaker catch estimate for northern California (1968-69 average) was 130,000.

Increased Oregon coho landings in August correspond to a drop in the northern California coho catch during this same period (Figure 3). This relationship is expected since most coho landed in California originate in areas north of California, and in August these fish are presumed to be en route to their home streams.

WASHINGTON SHAKER ESTIMATES

Information made available for this report concerning shaker[2] catches in the Washington troll fishery was contained in "A Summary of Information of the Shaker Catch by

TABLE 3

Oregon Commercial Troll Shaker Date by Area and Year of Study, 1959—68[1]

Year	Area	Boat	Period	Days fished	Chinook		Coho	
					Legal	Sublegal	Shaker[2]	Legal
1967	Mouth of Columbia River	Ann Marie	April 18–30	11	37	125	480	—
			May 1–15	15	59	150	123	—
			May 16–31	12	114	292	43	—
			June 1–15	13	179	649	360	0
			June 16–28	12	31	18	—	410
1967	Port Orford	Sea Fawn	July 21–31	6	9	8	8	95
			August 1–15	1	0	1	—	2
			August 16–31	3	37	25	—	21
			Sept. 1–9	4	64	137	—	9
1967	Port Orford	Debra K.	July 25–31	5	10	13	—	123
			August 1–15	4	20	11	—	24
			August 16–31	7	58	93	—	85
			Sept. 1–9	6	93	195	—	84
1968	Brookings	Alibi	May 18–31	11	67	143	312	—
			June 1–15	12	23	52	582	—
			June 16–30	3	1	0	—	40
1968	Coos Bay	Electron	July 12–15	2	No record	35	0	—
			July 16–31	5	No record	34	—	—
			August 1–15	7	No record	168	—	—
			August 16–31	7	No record	46	—	—
			Sept. 1–15	6	No record	97	—	—
			Sept. 16–28	7	No record	33	—	—
1962	Mouth of Columbia River & Grays Harbor	Barracuda	June 1–15	7	38	21	11	10
			June 16–25	8	31	25	—	276
1962	Coos Bay & Heceta Head	Elaine Dell	June 28–30	3	4	0	—	28
			July 1–15	12	86	34	—	344
			July 16–28	10	20	7	—	251
1962	Newport & Heceta Head	Sealanes	July 20–31	2	8	1	—	80
			August 1–12	11	19	13	—	595
1962	Mouth of Columbia River	Dreamer	August 20–31	9	2	17	—	169
			Sept. 1–15	8	5	14	—	45
			Sept. 16–27	9	2	15	—	108
1959	Mouth of Columbia River	Cluny	March 16–31	5	73	49	8	—
			April 1–14	10	152	52	0	—
1959	Off Bandon	Flicker	June 1–2	2	22	26	93	—
	Cape Arago & Heceta Head		June 3–4	2	11	8	1	—
	Off Newport		June 13–14	2	6	8	51	—

[1] From Oregon Fish Commission, Research Division.

[2] Coho caught prior to June 15 are shakers; coho less than 15 inches are shakers after June 15.

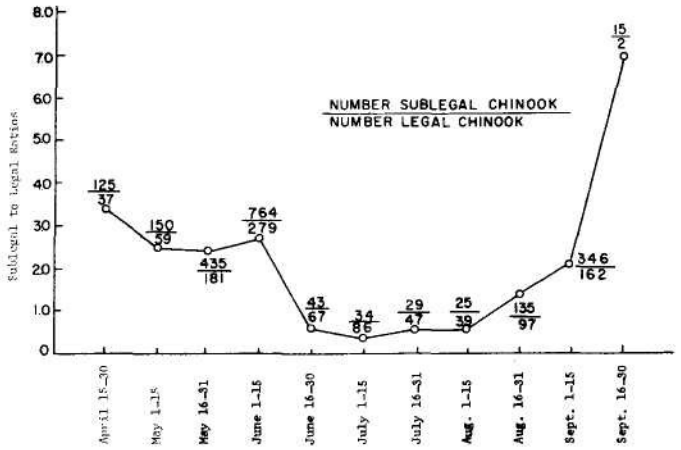

FIGURE 6. Oregon chinook sublegal to legal ratios by 2-week periods (combined data from barbless hook studies, 1959-68).

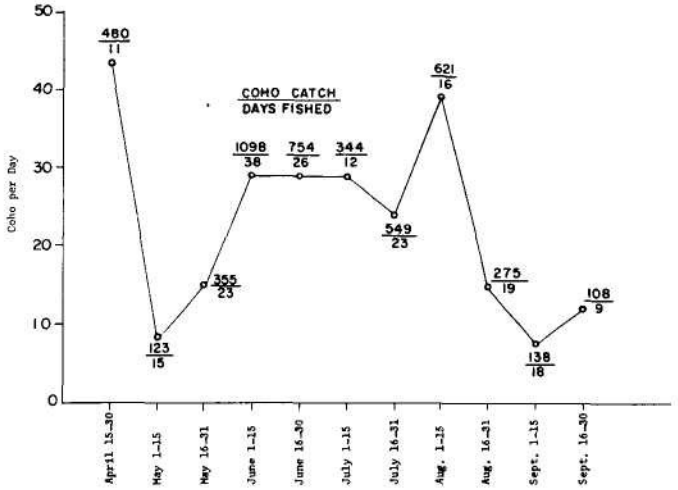

FIGURE 7. Oregon ocean troll average coho catches per fishing day by 2-week intervals (from barbless hook studies, 1959-68).

TABLE 4

Summary of Oregon Shaker Data by 2-Week Intervals (From Barbless Hook Studies 1959-68)

		Chinook			Coho[1]	
Interval	Days fished	Legal	Sublegal	Sublegal per legal	Numbers	Coho per day
April 15–30	11	37	125	3.38	480	43.64
May 1–15	15	59	150	2.54	123	8.20
May 16–31	23	181	435	2.40	355	15.43
June 1–15	38	279	764	2.74	1,098[a]	28.89
June 16–30	26	67	43	0.64	754	29.00
July 1–15	12	86	34	0.40	344	28.67
July 16–31	23	47	29	0.62	549	23.87
August 1–15	16	39	25	0.64	621	38.81
August 16–31	19	97	135	1.39	275	14.47
Sept. 1–15	18	162	346	2.13	138	7.67
Sept. 16–30	9	2	15	7.50	108	12.00

[1] All coho caught prior to June 15 are shakers; coho less than 15 inches are shakers after June 15.

[a] All coho were caught prior to June 15.

Washington Ocean Salmon Fisheries", prepared by the Washington Department of Fisheries. Data relating to recent shaker catches were almost non-existent. Most of the material presented was from voluntary logbook information collected during the **1948** through 1955 period.

Troll Chinook Shaker Catch

Troll logbook data obtained during the **1948** through 1955 period were analyzed in terms of sublegal-to-legal chinook ratios by 5-day periods (Figure 8). The sublegal-to-legal chinook ratios were exceedingly low compared to more recent data for Oregon (Table 4) and California (Tables 1 and 2). The Washington logbook data showed sublegal-to-legal ratios ranging from a low of 0.08 in early April to a high of 0.21 in late April.

During more recent on-board observations (May 24 to June 13, 1968) a higher sublegal-to legal chinook ratio of 1.4 was observed (Table 5). Although observations were limited (only 12 boat-days), the shaker-to-legal ratio of 1.4 is of the same magnitude as those recently observed in the California and Oregon troll fisheries.

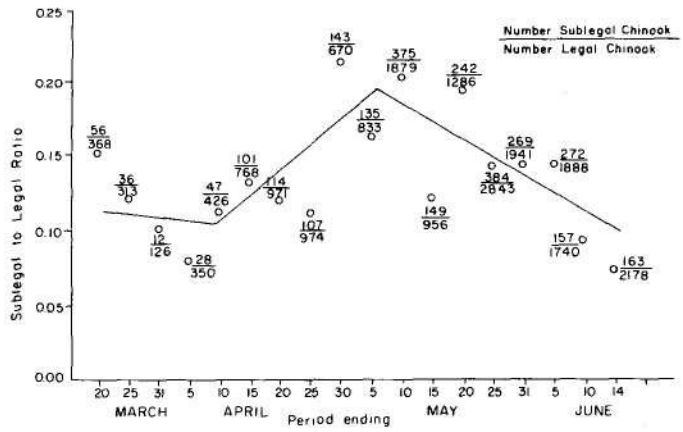

FIGURE 8. Washington ocean troll fishery average sublegal-to-legal Chinook ratios prior to June 15 by approximately 5-day intervals in the early 1950's. (A composite from troll logbook data given voluntarily by the fishermen. Trend line drawn by inspection.)

Little information is available pertaining to Chinook shaker catches after June 15; however, during a tagging project conducted from June 26 to July 30, 1969 off Cape Flattery and in the outer Strait of Juan de Fuca, 405 chinook were taken on troll gear. Ninety-four percent of this group were less than the 26-inch total-length minimum-size limit.

Troll Coho Catch

Records are also minimal concerning Washington's troll coho catch. The same 1948 through 1955 logbook data used in studying chinook-shaker catches were compiled in terms of average coho catches per 5-day period. The logbook data demonstrated that during March and early April, average coho catches per fishing day were less than 1 per day (Figure 9). Duing the latter part of April and early May the catch-per-day increased quite rapidly and reached a peak of 10 fish per day by June 15.

x . Twelve boat-days of on-board observations from May 24 to June 13 in 1968 produced coho catches ranging from 1 to 47 per day and averaging 9.6 per day (Table 5). This average catch-per-day of coho shakers during the early season is of the same magnitude demonstrated "in the Oregon and California troll fisheries.

TABLE 5

Summary of Troll Fishing Observations in the Washington Troll Fishery, May 24 to June 13, 1968

	Chinook				
Boat-days	Legal	Sublegal	Sublegal per legal	Coho[1]	Total salmon
12	61	88	1.4	115	264
Ave./boat	5.1	7.3		9.6	22.0

[1] Prior to June 15 all coho are shakers

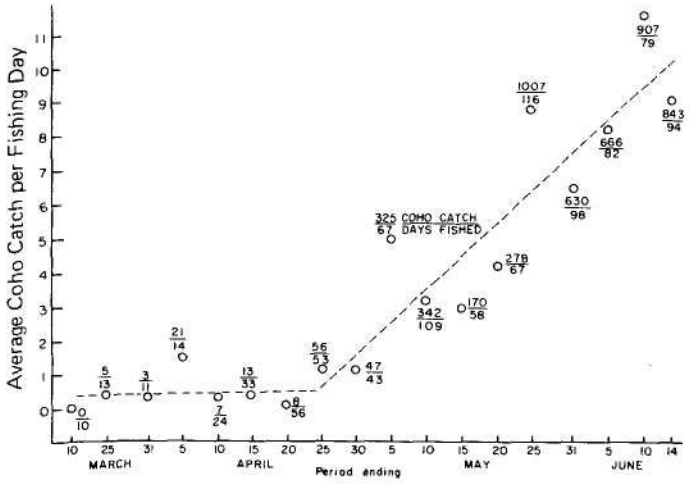

FIGURE 9. Washington ocean troll fishery average incidental coho catches per fishing day by approximately 5-day intervals in the early 1950's. (A composite from troll logbook data given voluntarily by the fishermen. Trend line drawn by inspection.)

BRITISH COLUMBIA SHAKER ESTIMATES

British Columbia has recently published the results of logbook studies conducted during the 1968 and 1969 troll seasons. K. R. Pitre in a report entitled "Summary of 'Shaker' Investigations in the West Coast of Vancouver Island Troll Fishery in 1968 and 1969" presents shaker-catch estimates based on logbook returns. Respective 1968 and 1969 estimates of shakers[3] caught prior to June 15 by the troll fleet off the West Coast of Vancouver Island are 67,200 and 87,000 Chinook and 254,000 and 120,000 coho (Table 6). These estimates are the product of mean daily catches as reported in the logbooks and total boat-days of effort in the fishery.

TABLE 6

The Actual Catch of Legal Chinook, and the Estimated Catches of Legal Chinook and Chinook and Coho Shakers (Computed from Logbook Returns) in the West Coast of Vancouver Island Troll Fishery (from Pitre, 1970)

	Actual catch	Estimated catches		
Year	legal chinook	Legal chinook	Shaker chinook	Shaker coho
1968	143,800	153,600	67,200	254,200
1969	146,300	170,100	87,800	120,800

The section of Pitre's report which deals with gear selectivity provides data with which alternative estimates of shaker catches can be made. During gear-selectivity studies in 1969, 72 days of trolling effort from April 15 to June 7 produced mean daily catches of 13.1 coho, 6.7 sublegal

[3] In British Columbia chinook less than 26 inches in total length are shakers; all coho prior to June 15 are shakers, from June 15 on, a coho weighing less than 3 pounds in the round is a shaker.

Chinook, and 6.3 legal Chinook. These daily catch rates applied to total effort figures produce estimates which in some respects differ from those derived from logbook data. For example, the coho estimate for 1969 produced from gear-selectivity data was 165,900 shakers, compared to the logbook-derived estimate of 120,800 (Table 7).

Actual catch	Estimated catches		
legal chinook	Legal chinook	Shaker chinook	Shaker coho
146,300	100,525	85,721	165,874

TABLE 7

The Actual Catch of Legal Chinook, and the Estimated Catches of Legal Chinook and Chinook and Coho Shakers (Computed from "On-Board" Observation) in the 1969 West Coast of Vancouver Island Troll Fishery (from Pitre, 1970)

Pitre cites the close agreement between actual catch of legal chinook and logbook-derived estimates of this catch as substantiating the validity of the logbook-based shaker estimates. Information obtained while sampling California landings has demonstrated that fishermen generally have an accurate idea of the number of legal fish on board their vessels, but at this time we have no measure of the accuracy of their recollection of the number of fish which they have hooked and released.

Estimated catch of legal chinooks based on the gear selectivity data is significantly lower than the actual catch. However, at least part of this discrepancy could be attributed to the enforced use of gear that was possibfy less efficient than gear generally used by the British Columbia troll fleet.

DISCUSSION AND CONCLUSIONS

Data now in hand indicate the coastwide annual commercial-yield of salmon could be increased by regulatory changes which reduce the early season effort in areas of'shaker abundance. However, any such changes will result in some redistribution of the catch, certainly temporally, possibly geographically, or both. Because of ^:he inherent political and economic problems associated with the salmon industry, both sport and commercial, any new management policies should be carefully evaluated before they are put into practice. Although the chinook and coho shaker catches are interrelated, they can and do differ in magniture, and each presents somewhat different management problems. A separate discussion of each species seems appropriate.

Chinook Shakers

Seasonal chinook shaker-to-legal ratios varied from a low of less than 0.10 (1948-55, Washington logbook data) to a high of almost 8.0 (Oregon barbless hook studies). Recent logbook data from California and British Columbia trollers and observations in the 1968 Washington troll fishery indicate that the Pacific Coast Chinook shaker catch approximates (in numbers) the legal Chinook catch. Seasonal trends are also discernible. Shaker-to-legal ratios are highest during the early season. The ratio drops during the summer months, and shows a marked increase in the fall. Since Chinook shaker catches are highest early in the troll season, a later opening date would reduce shaker catches. A later opening date might also increase coastwide Chinook landings in both pounds (from added growth during closed period) and numbers (reduced shaker mortalities).

Although coastwide salmon yield should be the prime criterion for sound management policies, changes which would cause significant redistribution of the salmon catch between states and nations should be carefully evaluated.

Coho Shakers

The coho shaker catch in all waters north of California is negligible after June 15, which is the opening date of the commercial coho troll season in those areas. Most coho that are vulnerable to the troll fishery are over the minimum-size limit (15 inches in Oregon, 20 inches in Washington, and 3 pounds round weight in British Columbia) by that date.

Available data relating to coho shaker catches in ocean waters prior to June 15 are extremely scarce. Oregon barbless hook studies indicate pre-June 15 coho shaker catches range from fewer that 10 to over 40 fish per day. Washington logbook data demonstrate a gradual increase from 1 coho shaker per boat-day in April to 11 per boat-day by June 15.

The value of a later opening for coho than for Chinook is dependent upon the ability of trollers to avoid concentrations of coho while fishing for Chinook so that the anticipated growth of coho as they mature is not offset by mortality to those hooked and released prior to the opening date. In California, the coho troll season opens April 15, concurrently with the Chinook season, with a 25-inch size limit for coho. There has been pressure to delay the coho opening in California in order to have a uniform opening date coastwide for coho.[4] However, if trollers are unable to selectively fish for Chinook, this type of regulatory change could increase rather than decrease California's coho shaker catch.

Current logbook studies being conducted by California, Oregon, Washington, and British Columbia should demonstrate the effectiveness of a delayed species opening.

SUMMARY

Information from California and British Columbia shows that large numbers of salmon are hooked and released at sea by troll fishermen. Available data from California and Oregon

indicate that incidence of shaker catch is greatest in the opening months of the season.

The most noticeable feature of data regarding shaker catches in the Pacific Coast troll fishery is its scarcity. Efforts to improve this stiuation are occurring along the entire coast.

There is a definite need for more knowledge concerning shaker catches. Areas of needed information include:

(1) Shaker abundance (by species).
(2) Distribution of shakers (both spatial and temporal).
(3) Relationship of shaker catch to gear type.
(4) Availability of shakers to troll gear (age of recruit ment to the fishery).

This information, coupled with accurate estimates of hooking mortality, is essential to proper regulation of the Pacific Coast troll salmon fishery.

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