

REPORT OF THE
TECHNICAL SUBCOMMITTEE OF THE
CANADA-UNITED STATES GROUND FISH COMMITTEE

Appointed by
The Second Conference on Coordination
of Fisheries Regulations Between
Canada and the United States

23rd Annual Meeting
June 9-10, 1982
Port Ludlow, Washington

Report of the Technical Subcommittee of the Canada-United States
Groundfish Committee, Appointed by the Second Conference on Coordination
of Fisheries Regulations Between Canada and the United States

Date: June 9-10, 1982

Place: Port Ludlow, Washington

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I. CALL TO ORDER

The 23rd Annual Meeting of the Technical Subcommittee of the Canada-United States Groundfish Committee was called to order at 9 a.m. June 9, 1982 by Chairman Mr. A. Cass under instructions set forth by the Parent Committee in 1959.

II. APPOINTMENT OF SECRETARY

Mr. J. Tagart, Washington Department of Fisheries, was appointed recording secretary.

III. APPROVAL OF AGENDA

The draft agenda supplied by Chairman Cass was approved with minor modifications. The revised adopted agenda is presented in Appendix A.

IV. INTRODUCTIONS

Each participant introduced himself and stated his affiliation.

V. TERMS OF REFERENCE OF THE SUBCOMMITTEE

In November 1978 the Parent Committee recommended to their respective governments to change the committee's name from the International Groundfish Committee to the Canada-United States Groundfish Committee. The name change accompanied the revision of the committee's terms of reference. New terms of reference, presented below, were approved in 1981 and the committee name change was approved in 1982. Terms of reference:

- a. exchange information on the status of groundfish stocks of mutual concern and to coordinate, whenever possible, desirable programs of research;

- b. recommend the continuance and further development of research programs having potential value as scientific basis for future management of the groundfish fishery;
- c. review the scientific and technical impacts of existing or proposed management strategies and their component regulations relevant to conservation of stocks or other scientific aspects of groundfish conservation and management of mutual interest;
- d. transmit approved recommendations and appropriate documentation to appropriate sectors of Canadian and U.S. governments and encourage implementation of those recommendations.

VI. REVIEW OF AGENCY GROUND FISH PROGRAMS

A. Canada

The primary emphasis of groundfish research at the Pacific Biological Station during 1981 continued its management orientation. While research directly in support of management remained a high priority, attention was increasingly directed to the examination of mechanisms underlying the dynamics of both exploited and unexploited stocks. To this end ongoing studies of stock delineation and abundance have been supplemented by increased research into analytical methods and ecosystem linkages. Particular attention was directed to investigation of abiotic factors controlling stock dynamics. In late 1981 a major multi-disciplinary study of marine fish stocks in Hecate Strait (PMFC areas 5C/D) was initiated. This study will integrate activities of oceanographers and managers with those of marine fish researchers, with the objective of providing an experimental, fisheries ecosystem to examine hypotheses of system and component control variables.

During 1981 the first survey of the abundance of Dover sole off Vancouver Island (PMFC areas 3C/D) and the second survey of juvenile English and rock sole abundance in Hecate Strait (PMFC areas 5C/D) were conducted. Commercial quantities of Dover sole were detected by the

former survey. Indices of juvenile abundance from the latter survey were incorporated into predictive yield models.

Analytical projects completed during 1981 included an improved matrix standardization of fishing effort for sole fisheries in Hecate Strait, and an examination of the northern Hecate Strait rock sole stock using a method of sequential population analysis. Investigation staff also completed a review of methods used in short-term forecasting of yields from fish stocks. The latter project is noteworthy for its comparative treatment of some yield models commonly used on the Pacific coast.

An analysis of the Pacific cod stock in northern Hecate Strait was completed. Results of this analysis suggest strong intergeneration effects on stock abundance and a possible internal mechanism for the "oscillatory" behavior of this stock. Age composition data for Pacific cod in Hecate Strait were generated using a new computer technique making optimal use of length information from sampled but un-aged fish. This technique offers considerable promise for time savings in the derivation of necessary age spectra.

Results from previous tagging studies were used to update analyses of growth and migration of Pacific cod in Canadian waters. The bathymetric distribution of Pacific cod was further analyzed through increased resolution of existing catch statistics. In addition, these data were used to develop a technique resolving species-specific effort in a multi-species trawl fishery. The method may be of use where consistent bathymetric segregation of species exists.

The increasing importance of Pacific whiting to the traditional domestic fleet and the cooperative fishing arrangements between Canadian trawlers and offshore processors has resulted in a concomitant increase in research effort. Major studies of the biology and distribution of whiting in PMFC area 4B were continued as was the application of ichthyoplankton surveys to the assessment of spawning biomass. Results of these surveys were also used to examine spawning success and early life history characteristics. Additionally, a tripartite survey (ichthyoplankton, swept-volume, hydroacoustic integration) of whiting

and pollock abundance was carried out. Preliminary results of this survey indicate good agreement among estimates of spawning biomass derived by the three techniques.

Studies of age- and size-specific fecundity of Pacific whiting were continued in 1981. The biology, distribution, and age composition of the component of the offshore whiting stock which enters Canadian waters was also investigated, primarily to determine the implications of harvesting these older fish.

Field projects conducted during 1981 included a survey of Pacific ocean perch biomass in Hecate Strait, continued tagging of yellowtail rockfish for stock delineation and validation of ageing techniques, as well as a longline-gillnet survey of Bowie Seamount. The stock of Sebastes alutus in Hecate Strait (Moresby Gully) may be of major scientific importance due to its apparently unexploited state and the associated opportunity to examine the biology and management of this species. It will be one component of a long-term study of Pacific ocean perch reproductive biology.

Returns of tagged and oxytetracycline injected S. flavidus have been very limited due in part to an absence of mid-water trawling in the tagging areas. While holding studies indicate minimal short-term mortality (<5%) the possibility of significant long-term mortality must be entertained. This dilemma can only be resolved through fishery results.

While catch rates of rockfishes (primarily S. ruberrimus and S. aleutianus) at Bowie Seamount were comparable to commercially attractive inshore areas, major fishery potential seems unlikely due to the limited area of the seamount. Seamount populations do have considerable value as reference populations for the natural dynamics of rockfishes.

The analysis of growth and mortality parameters of rockfishes initiated in 1980 was completed. Application of new ageing techniques resulted in estimates of mortality ranging from only one-third to one-half of previously accepted values, whereas estimated growth parameters changed only marginally. The implication of these lower mortality estimates for stock management may be profound.

Models for the reconstruction of stock history and development of rehabilitation trajectories for the S. alutus stocks in Queen Charlotte Sound were completed. These models suggest rehabilitation will be possible only at levels of fishing mortality of about one-half of that imposed in 1977 (last year of unrestricted fishing). The analysis of rockfish species assemblages was completed; most assemblages appeared to be stable in broad species composition but relatively dynamic in proportional composition. New projects initiated included a multivariate analysis of environmental effects on cohort strength in S. alutus stocks, and a long-term study of the implications of different protocols of reproductive effort allocation in populations of S. alutus.

Development of a new method of sablefish age determination was completed and the method partially validated with oxytetracycline-injected fish. Continuing projects included the tagging of adult and juvenile sablefish, the analysis of previous tagging experiments, the demonstration of effective escape panels for traps and the development of a population model. In addition, the distribution of the eggs and larvae of sablefish was investigated as a major component of the off-shore ichthyoplankton surveys.

Analysis of existing tag-return data indicates limited short-term movement of adult sablefish but increasing range of movement with time. Juvenile sablefish appear to recruit from shallower, inshore areas to the offshore centers of adult abundance. Tag-return data also provided estimates of growth rates which were consistent with estimates derived from length-at-age analysis. Centers of abundance of eggs and larvae coincide with those of the spawning adults. Results of the population modelling project are not yet available.

Investigation of escape devices showed that rings were effective at reducing the retention of juvenile sablefish and that diagonal slashes were not effective as savings gear in lost pots. Only rectangular or square panels laced with twine that deteriorates were effective savings gears.

Walleye pollock was one of the targets for the tripartite survey in PMFC area 4B. A study of the spawning biology of pollock in the Dixon

Entrance region and a general review of the biology of the species in Canadian waters were completed.

Length- and age-specific fecundity studies of walleye pollock were continued in conjunction with the ichthyoplankton surveys. Finally, development of a harvesting strategy applicable to both roe and fillet fisheries was initiated.

Research on spiny dogfish and lingcod concentrated in PMFC area 4B, although a study of dogfish diet in Hecate Strait was also completed. In Area 4B the tagging of dogfish continued and a preliminary analysis of the 1978-1981 tag returns was initiated. The development of an adequate long-term tag is an integral part of this tagging program and fish tagged in 1981 carried the titanium wire tag developed in 1980. Additional studies in the 4B area involved determination of the age and size at maturity and the fecundity of dogfish.

Lingcod research in PMFC area 4B was primarily directed at survey work to develop an index of larval/juvenile abundance that can be used in the assessment of factors affecting cohort strength. A preliminary validation of fin-spine ageing techniques for lingcod was obtained using returns of tagged and injected fish.

Several projects without species orientation were also conducted during 1981. Included in this group were: a review of age validation techniques; the production of an ageing techniques manual; a review of trawl survey methodology; an analysis of trawl-mesh selectivity for English and rock soles; and a long-term study to determine the distribution, magnitude and species composition of discards at sea from domestic trawlers.

The commercial fishery sampling unit continued to provide the Program with catch and effort information and biological samples from the groundfish fishery. Percent of landed weight for which trawl interviews (and thus effort) were obtained, averaged 79% of landed weight coastwide.

B. United States

1. National Marine Fisheries Service

Groundfish resource assessment at the Northwest and Alaska Fisheries Center is conducted within two divisions: the Resource Assessment and Conservation Engineering (RACE) Division under the direction of Dr. Murray Hayes, and the Resource Ecology and Fisheries Management (REFM) Division directed by Dr. Richard Marasco. These divisions are organized into a number of tasks and subtasks on regional or scientific discipline bases. A review of pertinent work by these tasks and subtasks during the past year is presented below.

RACE DIVISION

MARMAP II: Multi-species, Bering Sea, and NE Pacific Task

Bering Sea Groundfish Subtask--During May 20-August 5, 1982, two U.S. and one Japanese cooperating vessels surveyed the continental shelf and slope waters of the eastern Bering Sea to assess the abundance and biological condition of demersal fish and crab resources. Most of the demersal fish resources were found to be in satisfactory condition, including walleye pollock. Its abundance has been relatively stable since 1975. The Pacific cod and yellowfin sole resources are currently at a high level of abundance because of one or more strong year-classes in the population. Adult population of Pacific ocean perch and sablefish remain at low levels of abundance, but a strong year-class of pre-recruits may increase the abundance of the sablefish population during the next several years.

RACE Division is undertaking intensive surveys of fishery resources in the Bering Sea, Gulf of Alaska, and Washington to California regions on a three-year rotation basis. The second of these intensive surveys in the eastern Bering Sea is scheduled during the summer of 1982. Two U.S. and one cooperating Japanese vessels will survey the continental shelf and slope waters of the region with demersal trawls. A third U.S. vessel will use hydroacoustic and mid-water trawling techniques to

survey mid-water concentrations of pollock in the eastern Bering Sea to provide, when combined with the demersal trawl data, a comprehensive assessment of the pollock resource. A second cooperating Japanese vessel will survey the sablefish population in the eastern Bering Sea with longlines. In addition to these assessment surveys, three special research projects will be undertaken in 1982. Nearshore waters along the Alaska Peninsula will be sampled with small mesh trawls and beach seines to determine if nursery areas for young-of-the-year king crab and groundfish can be located and sampled. A second special research project will be a study of the distribution and feeding habits of demersal species relative to oceanographic fronts and domains between these fronts that have recently been defined in the southeast Bering Sea by the PROBES program. The third special research project will be a study of the feasibility of tagging trawl-caught pollock and Pacific cod. If appropriate methods can be developed, an expanded tagging program will be planned to study movements and stock structure of pollock and cod in the eastern Bering Sea, Aleutian Islands region, and Aleutian Basin.

In addition to the survey activities and special research projects in the eastern Bering Sea, a fourth U.S. research vessel will survey the red king crab and groundfish resources in Norton Sound during September 1982.

Gulf of Alaska Groundfish Assessment Subtask--During the summer of 1981, five rockfish/roundfish and five flatfish resource assessment index sites were established throughout the Gulf of Alaska. These sites will be sampled by bottom trawl every three years to provide CPUE and biological information on which to judge the condition of groundfish stocks in the region. The U.S.S.R. and R.O.K. cooperated in the first of these surveys last year.

During February-April, 1982, a Pacific cod assessment survey was conducted along both sides of the Aleutian Islands chain from Unimak Pass to Atka Island. Primary objectives were to locate spawning aggregations and to estimate their distribution and abundance. Large concentrations of cod were found along the north side of the chain from Cape Serachef to Unimak Island and west off Seguam Island. Spawning

commenced in early March and continued at least through the end of the month when the survey was concluded.

Pacific Coast Groundfish Assessment Subtask--During 1981-1982 the subtask has been involved in developing assessment techniques applicable to the study of widow rockfish and has continued annual abundance indexing of sablefish stocks off southeast Alaska and in the Washington-California region.

Widow rockfish assessment methodologies have been undergoing evaluation since 1980 in cooperation with the University of Washington College of Fisheries in 1980-1981. Generally, the approach included line transect/line intercept theory with a combination of hydroacoustic and sonar systems employed to increase sampling power. The evaluation was concluded with a survey off Oregon in March-April, 1982 designed to answer questions posed by earlier work and analysis of those results is in progress.

Sablefish abundance indexing began off southeast Alaska in 1978 and has expanded to include areas off Washington, Oregon, and California. This effort is to provide information on trends in abundance in areas where commercial fishery data is inadequate for assessment purposes. Relative abundance estimates, size composition, and migration behavior are products of the program.

A comprehensive triennial west coast survey of the Pacific whiting and rockfish resources is scheduled for the summer of 1983.

Ecological Processes Subtask--The subtask is involved with five major programs: walleye pollock production systems, flatfish production systems, structure and dynamics of demersal communities; juvenile groundfish biology and recruitment; and stock identification. These programs are composed of a number of projects. The results of three bottom trawl surveys in bay, nearshore, and mid-continental shelf regions in the northwestern Gulf of Alaska are being used in a manuscript describing the distribution, abundance, and interspecific relationships of juvenile benthic fishes. A model simulating the population dynamics of walleye pollock in the eastern Bering Sea has been validated and a description of procedures and data used in fitting the model is in progress.

Standard Bering Sea survey data (1971-1980) is analyzed and presented in a manuscript describing the distribution and abundance of juvenile flatfish in the eastern Bering Sea. Similar survey data is being used to examine benthic fish and invertebrate assemblages in the eastern Bering Sea. Survey data bases are also being used to map the spawning locations of groundfish in the Bering Sea and Gulf of Alaska. Pacific cod tissue samples have been collected from 20 locations along the north Pacific rim for use in determining the population genetic structure. Finally, juvenile distributions and recruitment patterns of four gadid species in the eastern Bering Sea are under study with a manuscript to be completed by summer, 1982.

Hydroacoustic Assessment Task

Since June, 1981, the Task has been involved in a number of activities. Data from 1980 and 1981 acoustic trawl surveys of a spawning stock of walleye pollock in Shelikof Strait were analyzed and the results reported. The surveys indicated pollock are much more abundant in the area than was previously suspected. A series of three surveys in 1981 suggested that the biomass of the stock was approximately 550,000 tons. The importance of the Shelikof Strait spawning stock to the total Gulf of Alaska pollock resource is unknown.

The acoustic-mid-water trawl survey section of the joint U.S.-Japan report on groundfish investigations in the eastern Bering Sea in 1979 was completed and incorporated in a manuscript prepared for submission to the INPFC Bulletin.

An analysis of dual beam target strength data obtained for pollock in the eastern and central Bering Sea was completed. The results of this analysis, together with the results of an extensive computer simulation of the dual beam method, were documented in a paper for the 1982 ICES Symposium on fisheries acoustics.

A survey aimed at helping determine the feasibility of surveying spawning pollock in the eastern Bering Sea was completed on the NOAA R/V CHAPMAN during April 15-May 7, 1982. The survey covered the outer shelf-upper slope region between Unimak Pass and the Pribilof Islands.

Pollock were found in nearly the entire area, but most fish were in a spent condition and no large concentrations were located.

Plans were completed for a 100-day acoustic-mid-water trawl survey of pollock in the eastern Bering Sea. The survey will be conducted during June-September, 1982 by the charter vessel U.S. DOMINATOR and the NOAA R/V CHAPMAN.

Construction of a new van-contained computerized acoustic system was completed. This involved outfitting a new van and converting the data processing system from a PDP 11/45 computer to an HP1000 computer. The new system will be used during the 1982 eastern Bering Sea pollock survey.

REFM DIVISION

Sablefish Simulations--A simulation model was developed to estimate how alternative management strategies would affect a gulf-wide domestic longline fishery. The model was used both to determine how sensitive the estimated effects of alternative strategies are to values of the biological and economic parameters used in the model and to provide information that can be used to rank a large number of alternatives with a variety of criteria. The strategies were defined in terms of alternative fishing mortalities and minimum size restrictions for the simulation period of 1981 through 1985.

The model was found to be relatively sensitive to several parameters for which the actual values are not known with certainty. Using what is thought to be an appropriate set of values, the model indicated: 1) the current level of harvest is too high to permit sablefish resources to be rebuilt to a level which will encourage domestic utilization of the gulf-wide sablefish resources, and 2) the level of resource abundance necessary to encourage such utilization may be possible by 1985 if yields are severely limited during 1982 through 1984.

Limitations of the model, in addition to the uncertainty concerning the values of both biological and economic parameters, were identified. These limitations indicate areas for further research, the most critical

of which is the extension of the model to allow an evaluation of management strategies which are defined in terms of alternative allocations among gear types, as well as in terms of alternative fishing mortalities and minimum size restrictions.

Pacific Whiting Studies--REFM scientists continued studies on Pacific whiting which were begun in 1981. The life history, including processes of reproduction, mortality, feeding, growth, and migration was reviewed and information on the size of whiting stocks and fisheries was generated.

An age structured computer simulation model was developed to explore the population and trophic dynamics of whiting. In particular, attempts are made to quantify the biological mechanisms of growth, mortality (natural and fishing), migration, and bioenergetics in such a way that both fishery and trophic dynamics can be examined. Through the model, the implications of two different representations of individual fish growth and age-specific natural mortality on both stock bioenergetics and fishery dynamics were explored.

A second model, developed by Getz and Swartzman (1981), was also applied to the Pacific whiting (Merluccius productus) fishery off the North American Pacific continental shelf. Recruitment in this stock is linked both to stock level and water temperature in their spawning area. This link formed the basis for developing a transition matrix in the model for recruitment which depends both on stock level and spawning grounds temperature. Comparison with historical data on fishery catch and stock estimates shows model output to be realistic.

As an aid to management of the fishery, a policy algorithm was developed which aims to utilize strong year-classes in a practical and efficient manner while at the same time maintaining the productive capacity of the stock. The policy algorithm was compared with traditional constant effort and constant quotas management, and the strategy contained in the algorithm was found to be superior, specifically with regard to prevention of stock collapse and having a higher average catch per unit effort (CPUE). In the policy algorithm, average yield can be increased at the expense of CPUE.

Multi-species Modeling--The basic framework models for multi-species models have now been developed and documented (i.e., DYNUMES, PROBUB, and HN models). Emphasis is now shifting to application of the models in the Gulf of Alaska, with special emphasis on the Kodiak area.

The main purpose of this project is to facilitate unified long-range research for fisheries development and management. Although the project consists of a number of research objectives, all of them lead to the possibility of development of domestic fisheries in the northeast Pacific and the full utilization of the renewable resources in this area. Initial emphasis will be on exploration of factors affecting shrimp and cod stocks in the Kodiak area, and shrimp, crab, pollock, and cod interactions.

Population Fluctuations and Trophic Interactions of Alaska Pollock in the Eastern Bering Sea--A study of the trophic interactions and population dynamics of the Alaska pollock is being conducted. Alaska pollock has been the world's largest single species fishery since the mid-1970s and although the fishery has been dominated by foreign countries, it is becoming increasingly important to the U.S. fishery through joint venture operations. Beside its enormous commercial value, Alaska pollock also play an important role in the Bering Sea ecosystem and undoubtedly interact with the dynamics of other commercially important species. The first year of this two-year project has been completed. This proposal briefly summarizes the work accomplished and outlines plans for the coming year.

Bio-socioeconomic Analyses--The overall objective of the bio-socioeconomic analyses task is to provide the bio-socioeconomic data and analyses required for the efficient management of fishery resources in the U.S. FCZ off Oregon, Washington, and Alaska. During the past year, efforts undertaken to meet this objective have been concentrated on the king crab, Tanner crab, salmon, halibut, herring, and groundfish fisheries off Alaska.

One project is addressing two issues: (a) the relative merits of quantity and price instruments with respect to optimizing the level of fishing effort in a fishery for which the level of resource abundance is

not known with certainty at the time the price or quantity instrument is implemented, and (b) the determination of the optimum path of fishing effort over time in a fishery in which the level of resource abundance randomly fluctuates about a mean level.

A bioeconomic analysis of the Alaska pollock fishery is being conducted. It is considering the feasibility of encouraging domestic participation in the fishery by increasing the relative abundance of larger, higher valued pollock.

Another study is an attempt to articulate the natural processes of decision-making in commercial fishing and to systematically analyze them as responses to implemented fishery policy. The objectives of this study are, through comparative case studies, to examine (1) the context of natural decision-making of fishermen within one segment of the commercial fishing industry, and (2) to generalize and test theories of decision-making which incorporate economic and social factors.

2. Alaska

The Alaska Department of Fish and Game (ADF&G) presently has three groundfish biologists who are responsible for research and management programs in the Westward (western Gulf and Bering Sea), Central (Cook Inlet and Prince William Sound), and Southeastern Regions. They are stationed at Kodiak, Homer, and Petersburg respectively. A coordinator position located in Juneau is responsible for interaction with other agencies and development of the Department's statewide groundfish program and in 1981 a biometrician stationed in Juneau was added to work primarily on groundfish issues.

The ADF&G groundfish program can be divided into six tasks: catch reporting, observer-port sampling, resource assessment, regulation development, management action, and logbook collection and analysis. In general, research and management are conducted on a regional basis. The groundfish staff is continuing the standardization of sampling methods, and the regional staffs cooperate on statewide projects. In FY 82, beginning July 1, 1981, the Department lost funding for its groundfish

research and management program. Federal funding designated for fishery monitoring was found to maintain the permanent staff and a low level of onboard and dockside sampling. The groundfish program is now operating at a lower than projected level.

Activities within the Southeastern Region groundfish program include dockside and onboard catch sampling; logbook interview and collection; sablefish tagging; information dissemination; in-season management of flounder and sablefish fisheries; and regulation development, including cooperation with the North Pacific Fisheries Management Council (NPFMC) and its Gulf of Alaska groundfish planning team. Also, annual reports and proposals for regulation changes are presented to the Alaska Board of Fisheries and its advisory committees.

Catch data (fish ticket) editing and batching is done in Petersburg. In-season catch log are maintained for the sablefish and winter trawl fisheries. During the next fiscal year, dockside sampling will be expanded with samplers in major ports especially for sablefish and rockfish. The logbook program, presently limited to the few vessels of the inside flounder fishery and to vessels fishing sunken gill nets, may be expanded statewide to include all trawl and longline vessels if supplemental NPFMC funding is made available. Additional sablefish tagging was conducted in June 1981 near Ketchikan, increasing the total number of fish tagged to over 10,000 since 1979. The tagging program, hopefully expanded to new sites, will continue to provide insight into juvenile migrations and the contributions of nearshore rearing areas to the commercial fisheries besides contributing basic biological data, e.g., growth, age class strength, and food habits. Future tagging may include other species such as starry flounder and rockfish. A contracted assessment of the nearshore rockfish complex was completed in April with a final report expected by July. Management activities included onboard observation of the winter trawl and sunken gill net fisheries and aerial observations of the sablefish fleet.

The Central Region program, which began its first full year in 1981, has concentrated on monitoring the nearshore rockfish fishery,

assisting in data collection onboard shellfish cruises, and establishing a data collection and retrieval system.

Activities of the Westward Region groundfish program also include catch data collection; information dissemination; regulation development; resource assessment; and as a primary activity, the domestic trawl observer program. The domestic observer program has in the past sampled trawl vessels from Southeastern Alaska to the Bering Sea with the greatest sampling effort centralized near Kodiak. Catch per unit of effort, species composition, prohibited species incidence, and other biological data are obtained. Because of the critical importance of assessing crab and halibut incidence within the expanding groundfish fishery and because of the programs' value in obtaining biological data prior to sorting and discard on the grounds, the Department intends to continue the observer program either with state and/or federal funds and to expand the program within the Bering Sea.

As part of the regional assessment program, a trawl survey for tanner crab and groundfish in waters south of the Alaska Peninsula was conducted during July of 1981. This survey will again be conducted in 1982. The regional groundfish biologist assists the Bering Sea groundfish plan team of the NPFMC. Management action in the Westward Region has been limited to fishery observation. No closures have been needed as yet. Dockside sampling was initiated in 1981 to obtain better AWL information, and catch data is compiled on a monthly basis in Kodiak using the minicomputer of the Computer Services Section.

The headquarters groundfish section has been primarily involved in the coordination of federal and state research and management activities. The Groundfish Research Coordinator is a member of both NPFMC groundfish management plan teams - Gulf of Alaska and Bering Sea.

With regard to issues associated with the NPFMC, sablefish management in the Gulf of Alaska and the ecosystem management approach and incidental species problem for the Bering Sea have been special concerns. The headquarters staff has worked in conjunction with the regional staff to provide the Council input on these issues. During 1981 a trawl logbook was developed and initially distributed; however,

program development. Future emphasis for this position will include the analysis of population parameters and their relationship to management of groundfish species.

3. Washington

The staff of Marine Fish Program, headed by an assistant director, is responsible for research, management and enhancement of non-anadromous finfish resources, and participates in national and international issues related to marine fish. Four divisions within the program deal with groundfish.

Extended Jurisdiction Division--Established in 1977, Extended Jurisdiction Division handles all issues requiring interstate, regional or international cooperation for management, conservation or protection of marine fish resources in coastal waters not under sole authority of the state of Washington. Unit responsibilities include: (1) participation in the development of Groundfish and Herring Fishery Management Plans for the Pacific Fisheries Management Council (in March, 1982 development of the herring plan was discontinued by the Pacific Fisheries Management Council because of a severe shortage of funds), (2) all multi-jurisdictional issues concerning groundfish, (3) membership in the Scientific and Statistical Committee of the North Pacific Fishery Management Council, and (4) stock assessment and management of groundfish stocks in the Fishery Conservation Zone (3-200 miles) adjacent to Washington. Major accomplishments during the past year have been: (1) gaining final approval of the Groundfish Fishery Management Plan by NMFS and the Secretary of Commerce (the plan will be implemented about June, 1982), (2) completion of a revised draft Pacific Herring Fisheries Management Plan, (3) analysis of the status of the stocks of yellowtail rockfish, (4) assistance in development of a new approach, Stock Reduction Analysis, to stock assessment, (5) contribution toward the stock assessment of widow rockfish, and (6) review of status of the western Vancouver Island stock of Pacific ocean perch.

Groundfish Management Division--During the past year, the work of this division has been directed toward research and management on Washington groundfish resources and their fisheries.

Monitoring work included collection of biological samples of landings from several commercial and recreational gears. In addition to collection of biological samples, fishery data are collected from the trawl (Trawl Interview System), set net, troll, hand line jig, set line, and pot fisheries, as well as the recreational charter boat fleets. The Division provides supervision for the state portion of the National Recreational Fisheries Statistical Survey.

The major effort of the Division during the past year has been development of a groundfish management plan for Washington inside waters (Puget Sound). The objectives of the plan are to: (1) examine the harvest of groundfish species in Washington state's inside waters by user group, (2) distinguish between commercial and recreational fisheries management goals and establish allocation guidelines to achieve those goals, and (3) recommend management strategies to prevent over-fishing, that consider the multi-species nature of the groundfish fisheries.

Other investigations by the Division included: (1) studies of the biology and fisheries for lingcod in Puget Sound, (2) a study to determine the catch and effort by shore anglers in Puget Sound, (3) assessment of the Pacific whiting stock in Port Susan, (4) tagging of black rockfish off the Washington coast to determine migration, rates of exploitation, mortality and growth and validate ageing techniques, (5) determination of the catch and effort by the recreational charter boat fleets, and (6) the analysis of the commercial set line fishery for rockfish and beach seine fishery for surfperch in Puget Sound.

Marine Fish Enhancement Division--The Enhancement Division's continued emphasis was to develop access to quality fishing from shore and boats near metropolitan centers on Puget Sound. The Elliott Bay Public Fishing Pier with surrounding habitat enhancement was opened in January. The site of the Tacoma Fishing Pier, to be constructed during 1982, was enhanced with approximately 4,000 cubic yards of donated scrap concrete

and 105 "triad" automobile tire modules during late 1981 and early 1982. Existing boat angler and fishing pier habitat enhancement structures were surveyed monthly (or quarterly) to monitor colonizing fish populations exposed to intensive recreational fisheries.

Efforts to enhance depressed lingcod stocks in Puget Sound continued. Large numbers of lingcod were observed guarding egg masses on several boat angler habitat enhancement structures. Limited numbers of juvenile lingcod were captured from Grays Harbor and the Strait of Juan de Fuca near the Pysht River. Hatchery rearing experiments began at the Point Defiance Aquarium with varying degrees of success. Hatched lingcod larvae fed on planktonic crustaceans, but did not survive past 24 days.

Technical Services Division--Computer simulation was used to study the effects of schooling on the variability of hydroacoustics biomass estimates (Kimura and Lemberg, 1981). Stock Reduction Analysis, a new method of stock assessment, has been formulated and submitted for publication (Kimura and Tagart, unpublished manuscript). A large effort is being made to redesign our biological data storage, retrieval, and processing systems.

Hydroacoustic surveys to assess herring abundance were conducted for populations throughout Puget Sound and the Strait of Georgia. Hydroacoustic estimates of biomass were also made for Pacific hake in central Puget Sound. The purchase of a microcomputer has added data storage, retrieval and processing capabilities to our Biosonics hydroacoustics systems.

4. Oregon

Substantial work went into the monitoring of the widow rockfish pelagic trawl fishery (catch, area, age-size-sex sampling as in 1980). As in 1980, the Pacific ocean perch (Sebastes alutus) fishery was closely monitored also, especially catch/area in line with staying current with the cumulative removals from INPFC Columbia Area vs. the OY of 950 mt.

current with the cumulative removals from INPFC Columbia Area vs. the OY of 950 mt.

Data reporting requirements of the Fishery Information Network (FIN) were met in 1981. By the end of 1981 Oregon's contribution to FIN (catch by species per monthly period) were meeting agreed upon goals for accuracy and timeliness.

Pacific Fishery Management Council (PFMC) activities continued to take much staff time. J. Robinson became a member, and Chairman, of the PFMC's Groundfish Management Team in early summer. Team meetings and discussions have been frequent since, resulting in a stock assessment (status report) of widow rockfish in the Washington-Oregon area by November, 1981. The Groundfish Fishery Management Plan was implemented September 30, 1982, when NMFS adopted regulations.

Oregon (and Washington) adopted a 2.3 mt (5,000 lb.) or 10% of total landing/delivery, limit on S. alutus late in 1981 (on February 1, 1982 in Oregon) after the PFMC recommended such measure, to be effective in 1982. The 950 mt OY was exceeded in Columbia Area during 1981 (by about 50-75 mt). The lower limit should effect a 1982 catch less than or equal to the optimum yield and hopefully allow slow rebuilding of the stocks.

Resource assessment activities consisted largely of data collection input on widow rockfish to Dr. William Lenarz, NMFS (Tiburon, CA), CPUE-vessel class analyses, and canary rockfish (S. pinniger) behavior-availability-physical statistics correlation analyses from field work completed in 1980. Draft reports on the latter two activities were completed.

Budgetary constraints in 1981 resulted in state general fund cuts in FY 80 and a lowered 1981-1983 Biennial Budget starting July 1, 1981. Marine Region lost most of its vessel charter funding capability and seasonal aide funding as a result. State budget cuts were necessitated by the general economic recession which is still only slowly improving, if at all. Permanent staff and programmatic funding from PFMC and NMFS have been adequate to keep our programs going, however, at 1980-1981

levels, although no further chartered survey work has been possible since mid-1981.

5. California

The objectives of groundfish research and management activities of the California Department of Fish and Game are to provide management alternatives for the various fisheries.

The Marine Resources Region, Marine Resources Branch, and the Planning Branch are groups involved with groundfish.

Monitoring, surveillance, and assessments of commercial and recreational groundfish fisheries were accomplished by the Region. The sampling program provided age, size, sex, and species composition for assessments. Logbook data were processed for trawl, pot, and Commercial Passenger Fishing Vessels (CPFV).

Marine Resources Branch has two Dingell-Johnson projects, one each in southern and central California. Both projects deal with groundfish in recreational fisheries. Biological, distributional, tagging, and assessment studies are conducted on important inshore groundfish. In 1981, the southern California project initiated a study of the gillnet fishery.

Planning Branch processes groundfish data by computer, provides systems analyses and design, and provides biometrical assistance.

VII. REVIEW OF NORTHEAST PACIFIC GROUND FISH FISHERIES

A. Canada-United States Fisheries

1. Commercial Fisheries

Commercial groundfish landings from the northeast Pacific Ocean by Canadian and United States fishermen totalled 168,298 mt in 1981, representing an 11% increase over the 151,286 mt landed during 1980. Trawl fisheries accounted for 88% (147,513 mt) of the 1981 landings (Table 1). Principal species in the trawl landings continued to be

Table 1. Trawl landings (mt) from the northeastern Pacific Ocean by Canadian and United States vessels in 1980 and 1981, and mean for 1971 to 1980. (Joint venture catches are excluded)

Species	1980						1981						Mean 1971-1980d/
	B.C.	WA	OR	CA	AK	Total	B.C.	WA	OR	CA	AK	Total	
English sole	1,244	1,112	718	2,043	-	5,117	1,500	870	729	1,689	-	4,788	4,367
Rock sole	1,843	149	13	-	46	2,051	1,060	141	10	3	-	1,214	1,506
Petrale sole	223	599	850	1,027	-	2,699	291	356	884	800	-	2,331	3,311
Dover sole	1,274	2,010	4,008	7,762	-	15,054	1,246	1,930	5,232	9,219	-	17,627	13,037
Rex sole	145	186	524	820	-	1,675	190	153	610	782	-	1,735	1,473
Starry flounder	118	608	193	290	55	1,264	198	720	400	-	100	1,418	1,133
Arrowtooth flounder	1,448	375	188	a/	-	2,011	946	432	587	48	3	2,016	a/
Other flatfish	51	278	427	868	40	1,664	180	178	484	882	73	1,797	2,509
Pacific cod	8,667	5,704	156	-	2,703	17,230	6,677	9,954	46	-	7,354	24,031	12,268
Lingcod	1,311	1,324	652	1,161	-	4,448	1,729	811	906	1,176	-	4,622	3,816
Sablefish	334	430	1,026	2,902	16	4,708	234	570	1,303	3,572	6	5,679	3,498
Whiting	606	123	257	44	-	1,030	5,692	936	162	52	-	6,842	335
Pollock	2,201	425	-	-	987	3,613	1,252	941	-	-	558	2,751	e/
Rockfish	9,444	15,064	16,482	15,346	4	56,340	9,592	14,475	23,580	16,512	8	64,167	25,256
Miscellaneous species	292	190	92	278	497	1,349	264	165	192	280	124	881	1,198
Dogfish	2,871	828	23	-	-	3,722	638	932	5	-	-	1,575	1,322
Animal food	191	1,165	-	-	-	1,356	42	814	-	-	-	856	1,533
Reduction	528	4,230	-	-	-	4,758	303	2,726	-	-	-	3,029	1,937
Total	32,791	34,800	25,609	32,541	4,347	130,088	32,034	37,104	35,134	35,015	8,226	147,513	78,264
Percent of total	25.2	26.8	19.7	25.0	3.2		21.7	25.2		23.8	5.5		
Total hours	46,924	66,072	46,605	b/	b/		38,706	65,511	68,297f/	b/	b/		
CPUF, mt/hr (excluding dogfish)	0.638	0.514	0.362	b/	b/		0.811	0.552	0.303f/	b/	b/		

a/ Included with Other flatfish

b/ Not available

c/ Included with Miscellaneous species

d/ Excludes Alaska

e/ Some whiting and pollock included with Miscellaneous species

f/ Excludes mid-water trawl

Dover sole, Pacific cod, and rockfish. Canadian rockfish landings are predominantly Pacific ocean perch, yellowmouth and silvergray rockfish, while U.S. rockfish landings are primarily widow yellowtail and canary rockfish (Table 2).

Non-trawl groundfish landings totalled 20,785 mt in 1981 (Table 3), representing a 4% drop from the 1980 landings of 21,738 mt. Sablefish continue to be the primary target species of the non-trawl fisheries.

a. British Columbia

Canadian landings of groundfish were 37,346 mt in 1981, 5% lower than 1980 landings of 39,145 mt. While trawl landings were down only 2%, from 32,791 mt in 1980 to 32,034 mt in 1981, landings of some traditional species decreased substantially. Total trawl production was maintained only as a result of the infusion of Pacific whiting landings by a domestic processing vessel. Decreased landings of some traditional species was caused by several factors, including rising costs of operation, management closures and diversion of fishing effort to joint venture fisheries.

Total trawl landings of flatfish decreased 12% from 6,346 mt in 1980 to 5,611 mt in 1981. Landings of rock sole and arrowtooth flounder declined sharply, down 42% and 35% respectively. Lower landings of rock sole resulted from lower allowable catches and area closures, while weakened market demand caused declines in arrowtooth flounder landings. Increased landings of Dover and English sole helped to offset declines in the rock sole and arrowtooth flounder fisheries.

Roundfish trawl landings increased 19% from 13,119 mt in 1980 to 15,584 mt in 1981. Principal landed species are Pacific cod, lingcod, Pacific whiting and pollock. Lingcod appear to be showing some signs of stock recovery in PMFC areas 5A/B as a relatively strong year-class recruits to the fishery. Noteable was the large increase in Pacific whiting landings from 606 mt in 1980 to 5,692 mt in 1981. These increased landings result from the use of onboard processing and development of new markets for land processed fish.

Table 2. Landings (mt) of major rockfish species taken by Canadian and United States trawlers in 1981.

Species	B.C.	WA	OR	CA	AK
Bocaccio (<u>S. paucispinis</u>)	68	102	736		
Canary (<u>S. pinniger</u>)	380	569	1,632		
Darkblotched (<u>S. crameri</u>)	-	35	352		
Pacific ocean perch (<u>S. alutus</u>)	5,104	370	864		7
Redbanded (<u>S. babcocki</u>)	93	24	32		
Redstripted (<u>S. proriger</u>)	151	568	222		
Silvergray (<u>S. brevispinis</u>)	948	317	63		
Widow (<u>S. entomelas</u>)	27	6,923	15,896	5,598	
Yellowmouth (<u>S. reedi</u>)	1,039	9	418		
Yellowtail (<u>S. flavidus</u>)	426	5,142	2,588		
Other	1,356	433	777		
Total	9,592	14,492	23,580	16,512 ^{a/}	8

^{a/} Except for widow rockfish no catch composition data available

Table 3. Total groundfish landings (mt) from the northeast Pacific Ocean by Canadian and United States vessels in 1980 and 1981. (Joint venture catches are excluded)

Gear	1980						1981					
	B.C.	WA	OR	CA	AK	Total	B.C.	WA	OR	CA	AK	Total
Trawl	32,791	34,800	25,609	32,541	4,347	130,088	32,034	37,104	35,134	35,015	8,226	147,513
Pot	3,214	392	1,246	a/	97	4,949	3,276	1,331	285	2,386	35	7,313
Longline	2,062	2,223	492	a/	1,729	6,506	976	1,388	804	a/	1,536	4,704
Shrimp trawl	42	842	1,306	a/	-	2,190	12	665	1,019	a/	-	1,696
Other	1,036	1,527	280	5,000	250	8,093	1,047	1,100	311	4,512	102	7,072
Total non-trawl	6,354	4,984	3,324	5,000	2,076	21,738	5,311	4,484	2,419	6,898	1,673	20,785
Total	39,145	39,784	28,933	37,541	6,423	151,826	37,345	41,588	37,553	41,913	9,899	168,298

a/ Included with other gears

Trawl landings of rockfish totalled 9,592 mt in 1981, up 2% from the 9,444 mt landed in 1980. Principal landed species continue to be Pacific ocean perch and yellowmouth rockfish. Landings from historical fishing locations have continued to decrease and production has been maintained through exploitation of new areas. However, it is believed that no remaining unexploited stocks or areas exist. Management will continue to reflect the low rates of growth and mortality in these species. Despite the characteristic low yields of rockfishes, they are expected to continue to attract fishing effort because of their high economic return and product quality.

Non-trawl landings totalled 5,311 mt in 1981, 16% lower than the 1980 landings of 6,354 mt. Landings were primarily from the pot fishery with sablefish the target species. That fishery continued almost unchanged from 1980, although an increase in effort resulted in more rapid attainment of the total allowable catch. Prices paid for sablefish decreased from the record levels of 1980. Landings of longline-caught dogfish decreased by almost 70% due to weak markets early in the year and the resulting decrease in ex-vessel price.

b. Alaska

Groundfish landings in Alaska totalled 9,899 mt in 1981, representing a 54% increase over the 1980 landings of 6,423 mt. Trawl landings increased by 87% between 1980 and 1981 rising from 4,347 mt to 8,226 mt. The trawl fishery accounted for 83% of the total Alaskan groundfish landings in 1981. The principal species landed was Pacific cod, the majority of which came from the developing shore-based fishery in the Bering Sea.

Alaskan non-trawl landings totaled 1,673 mt in 1981, 19% below the 1980 landings of 2,076 mt. The longline fishery was the primary non-trawl gear, with sablefish the principal target species of the fishery.

c. Washington

Washington's commercial groundfish landings totaled 41,588 mt in 1981, representing a 5% increase over 1980 landings of 39,784 mt.

Trawl landings accounted for 37,104 mt, or 89% of the total groundfish landings, this represented a 7% increase over 1980 landings of 34,800 mt. Trawl fishing effort declined from 66,072 hours in 1980 to 65,511 hours in 1981, a 1% drop.

Washington's trawl caught landings of flatfish were 4,780 mt in 1981 compared to 5,317 mt in 1980. This 10% decline in flatfish landings resulted from reduced landings of several key species, including English sole, petrale sole, Dover sole and rex sole. Dover and English sole remain the primary target species.

Landings of trawl caught roundfish increased 65% from 8,006 mt in 1980 to 13,212 mt in 1981. This large jump in landings was primarily a result of increased landings of Pacific cod from Alaskan fishing grounds in the Bering Sea.

Rockfish landings declined 4% from 15,064 mt in 1980 to 14,475 mt in 1981. Imposition of more severe trip limits on Pacific ocean perch contributed to the overall drop in rockfish landings. Widow rockfish were the principal component of the catch, comprising 48% of the rockfish landings; yellowtail rockfish followed, making up 35% of the landings. Although landings of widow rockfish remained high, harvest dropped off in the INPFC Columbia area in the last half of 1981 while simultaneously increasing in the INPFC Vancouver area. Despite reduced landings of Pacific ocean perch, Washington's and Oregon's combined harvest from the INPFC Columbia area exceeded the recommended acceptable biological catch and more severe limits will be implemented in 1982.

Washington's non-trawl landings were 4,484 mt in 1981, compared to 4,984 mt in 1980. However, 1981 landings were equally divided among pot, longline, and miscellaneous gears. Among all non-trawl gears sablefish represented 45% of the landings followed by dogfish at 25% and rockfish at 19%.

d. Oregon

Commercial groundfish landings in Oregon totaled 37,553 mt in 1981, compared to 28,933 mt in 1980, representing a 30% increase between

1980 and 1981. Trawl landings dominated the commercial harvest, with 35,134 mt, of which 14,431 mt were landed by pelagic trawl. Total trawl effort was 68,297 hours in 1981 compared with 46,605 hours in 1980, a 47% increase in trawl hours.

Oregon's trawl landings of flatfish species increased 29% between 1980 and 1981, rising from 6,921 mt to 8,936 mt. Dover sole dominated landings but increase in landings of rex sole, starry flounder and arrowtooth flounder contributed to the overall rise in flatfish landings.

Trawl caught roundfish landings were 2,417 mt in 1981, representing an 16% increase over 1980 landings of 2,091 mt. Sablefish and lingcod were the principal target species of this fishery.

Rockfish landings increased from 16,482 mt in 1980 to 23,580 mt in 1981. The pelagic trawl fishery, essentially a widow rockfish fishery, landed 14,431 mt in 1981 or 61% of the total rockfish landings.

Oregon's non-trawl landings totaled 2,419 mt in 1981, down 27% from 1980 landings of 3,324 mt. The largest component of the non-trawl fishery came from incidental landings of groundfish by the shrimp fishery. This fishery landed 1,019 mt in 1981, of which 79% was miscellaneous rockfish. Longliners landed 804 mt, 87% sablefish, while pot fishermen took 285 mt, 97% sablefish.

e. California

California's commercial groundfish landings totaled 41,913 mt in 1981, a 12% increase over landings of 37,541 mt in 1980. Trawl landings accounted for 84% of the total groundfish landings or 35,015 mt. Pelagic trawl contributed 6,155 mt or 18% of the trawl landings. Effort data for 1981 was not available.

California's trawl caught flatfish landings rose 5% between 1980 and 1981 from 12,810 mt to 13,423 mt. Dover sole remained the primary target species.

Landings of trawl caught roundfish were 4,800 in 1981 compared to 4,107 mt in 1980, representing a 17% increase. Sablefish was the principal species landed.

Trawl landings of rockfish totaled 16,512 mt in 1981, an 8% rise over 1980 landings of 15,346 mt. Widow rockfish landings continued to increase in 1981, reaching 5,598 mt.

Landings from non-trawl gear were 6,898 mt in 1981, 38% higher than the 5,000 mt landed in 1980.

f. International Pacific Halibut Commission

The 1981 halibut fishery produced a total catch of 11,612 mt: 91 mt off Washington and Oregon, 2,495 mt off British Columbia, 1,814 mt in southeast Alaska, 6,668 mt in the Gulf of Alaska (area 3) and 544 mt in the Aleutian and Bering Sea regions (area 4).

The 1981 halibut fishery was notable for its sharp contrasts. In waters off Alaska, the CPUE increased sharply from 1980 to 1981, particularly off southeast Alaska. The high CPUE coupled with increased effort resulted in a 7-day season in southeast Alaska and a 13-day season in most of the Gulf of Alaska. In contrast, the CPUE off British Columbia declined. This, combined with a license limitation program in the Canadian fishery, resulted in a 58-day fishing season. The reason for the low CPUE off British Columbia is not understood and research activities in the coming year will concentrate on this problem.

2. Recreational Fisheries

a. Canada

Recreational landings of groundfish in British Columbia remain almost entirely undocumented. The report of a large creel survey, conducted by a consulting firm in the Strait of Georgia during 1980, is expected soon. Preliminary results indicate a predominance of salmon as target species for recreational anglers. For example, less than one lingcod or rockfish per three boat-trips was recorded over the summer months of 1980. However, enforcement personnel have noted depletion problems in some areas and bag-limits for groundfish are being considered. Research staff have stressed that such limits should reflect resource productivity.

b. United States

Estimated landings of groundfish by recreational fishermen was approximately 5,538 mt in 1981. California landings totaled 3,500 mt predominantly rockfish; Washington followed with 1,426 mt with target species pollock and miscellaneous rockfish; and Oregon's landings were 612 mt, 64% of which was black rockfish. No data were available from Alaska.

B. Joint Venture Fisheries

1. Canada

The 1981 British Columbia Pacific whiting cooperative fishery involved the utilization of Canadian mid-water trawl vessels which delivered their catch to foreign processing ships. Fourteen Canadian trawlers participated in the fishery catching 17,193 mt of Pacific whiting during July-October, 1981. They delivered to four Polish vessels, three U.S.S.R. vessels and one Greek vessel.

2. United States

During 1981 joint venture fisheries were conducted between U.S. domestic fishermen and Japan, R.O.K., U.S.S.R., Poland, West Germany, Bulgaria and Greece. Separate fisheries occurred in the Bering Sea, Gulf of Alaska and Washington-California region. Joint venture processors numbered 19 in the Bering Sea, four in the Gulf of Alaska and 20 in the Washington-California region.

U.S. fishermen delivered 140,640 mt of groundfish to foreign processors during 1981. The principal species were pollock (42,082 mt), yellowfin sole (16,045 mt) and Pacific cod (9,158 mt) in the Bering Sea; pollock (16,855 mt) in the Gulf of Alaska; and Pacific whiting (43,555 mt) in the Washington-California region. The precise number of U.S. catcher vessels delivering to foreign processors is unknown.

C. Foreign Fisheries

1. Canada

A foreign fishery for Pacific whiting took place in 1981 involving six Polish vessels and two Japanese vessels. These boats fished from July to October and caught 3,376 mt of Pacific whiting.

2. United States

Foreign fisheries operated in the U.S. Fishery Conservation Zone during 1981 from California to the Bering Sea landing 1,521,312 mt of groundfish.

In the Bering Sea Japan, Republic of Korea, Poland, Taiwan, and West Germany fished primarily for walleye pollock (986,943 mt), yellow-fin sole (81,255 mt), turbot (57,847 mt), and Pacific cod (39,113 mt).

Gulf of Alaska fisheries were conducted by Japan, Republic of Korea, and Poland. Important species were walleye pollock (130,323 mt), Pacific cod (34,968 mt), Atka mackerel (18,726 mt), flounders (14,442 mt), and Pacific ocean perch (12,177 mt).

Only Poland and Bulgaria fished in Washington-California in 1981. Pacific whiting was the target species (70,364 mt) while jack mackerel, rockfish, sablefish, and flounders were taken in small quantities as incidental catches.

VIII. GROUND FISH RESEARCH

A. Stock Assessment

1. Pacific cod

a. Canada

Pacific cod are commercially abundant in four regions of Canadian waters--PMFC areas 4B (Georgia Strait and vicinity), 3C

(southwest Vancouver Island), 5A/B (Queen Charlotte Sound), and 5C/D (Hecate Strait and Dixon Entrance). Inter-regional migration is minor or negligible, based on numerous tagging experiments.

Stock assessment techniques are still primitive for the most part, because we have lacked both detailed analyses of landing statistics and age compositions of landings. For the three major cod-producing regions (3C; 5A/B; 5C/D), landing statistics are now in good shape, and computation of age composition data (based on length-frequencies, but not validated yet) will be complete this year.

Pacific cod stocks appear to be in satisfactory condition in areas 4B, 5A/B, and 5C/D, but not so in area 3C. Only conventional analyses of landing statistics were employed for all regions except Hecate Strait (5C/D). There, both landing statistics and age composition data were available and used in a complex computer analysis, the results of which were presented at the INPFC Groundfish Symposium in October, 1981. Principal conclusions were (1) historically the stock has been underfished and increased fishing mortality should decrease abundance oscillations; and (2) natural mortality may be density-dependent. A detailed description of how the model operates is scheduled for completion this year.

In area 3C, Pacific cod abundance remains at a low level, and may be due in part to adverse environmental conditions, particularly in 1978 and 1981.

Despite our prediction of a small spawning stock for 1982, the fishery was opened during February 1-March 12. Unfortunately, the prediction was correct. We will continue to recommend a January-March closure of this area until cod abundance increases substantially, because we believe that this stock is vulnerable to recruitment overfishing during the spawning season at low levels of abundance. The principal spawning ground is relatively small, and new, more efficient trawling techniques have been developed for this ground.

b. United States

Mr. Pedersen commented on Pacific cod in Puget Sound, indicating that tag returns suggest that Puget Sound contains only one Pacific cod stock which apparently utilizes five or six major spawning areas. Mr. Pedersen noted that landings have varied from 250 to 400 mt between 1978 and 1981 with peak landings in 1980. Landings from the Gulf of Georgia region have shown no appreciable decline but CPUE is decreasing.

2. Rockfish

a. Canada

Mr. Leaman reported on Canadian efforts at Pacific ocean perch reconstruction using a sequential analysis model of Fournier and Archibald (1982). This model uses a stochastic orientation that incorporates errors in catch and age estimation. Using the model they determined that Pacific ocean perch virgin biomass in Goose Island Gulley was 81,000 mt, but following extensive exploitation between 1965 to 1968 that stock size had declined to 13,000 mt by 1977.

Mr. Leaman discussed his Pacific ocean perch trawl survey methods described as "an encounter response design." There was considerable exchange of views on the comparison of this method and the random stratified sampling approach typically employed for the area-swept method of estimating groundfish populations.

b. United States

Studies to evaluate the application of hydroacoustic/sonar techniques in the assessment of widow rockfish were conducted by NMFS in 1981 and 1982. In 1981, the work was a cooperative venture with the University of Washington and was focused on four known commercial grounds off the central Oregon coast. Significant findings were that (1) the Simrad S Q sonar is inferior to omnidirectional sonars as an assessment tool, (2) extremely contagious distribution and dynamic schooling behavior will produce large variations in population estimates, (3) future survey designs must incorporate two stages--location

and identification of schools and then intensive assessment effort on those well defined areas of aggregation, (4) diel series of measurements are needed to establish period of greatest resource aggregation and most appropriate survey times, and (5) more fishing is required to assist in hydroacoustic target identification.

A second study was conducted on the same grounds and one additional area in March-April, 1982 to examine many of the questions posed by the preceding work. Primary objectives were to increase efforts to identify mid-water hydroacoustic targets through trawling and to determine variability in availability (schooling) over short- and long-term intervals through replicate hydroacoustic/sonar sampling. The study was hampered by small quantities of widow rockfish, evasive behavior exhibited by trawl targets, and high densities of Pacific whiting in the study area.

Fishing results indicate that predominant mid-water species on the grounds are Pacific whiting shortbelly rockfish, widow rockfish, and redstripe rockfish. The species most likely to be confused with widow rockfish on echograms is shortbelly rockfish, but with proper equipment and practice even they can be distinguished. Widow rockfish were very patchy in their distribution and absent from some grounds, but sufficient repetitive surveying was completed to allow a measure of availability variability.

Preliminary analyses indicate that the methodology will have to undergo further refinement before effective resource monitoring can be achieved. Problems related to sonar and hydroacoustic target identification, determining real school sizes detected by sonar, and accounting for changing availability will require further investigation. The rationale and justification for accepting such a commitment will be evaluated given the present status of the fishery, the resource availability of other assessment methods, and the need to meet other research needs.

Mr. Tagart presented preliminary results on the status of the yellowtail rockfish stocks in the United States portion of the INPFC Vancouver and INPFC Columbia areas. (Following the TSC meeting the

yellowtail rockfish status of stocks document was completed and is available as Washington Department of Fisheries Technical Bulletin No. 71.)

Mr. Demory informed the TSC that Oregon biologists are preparing a status of stocks document on canary rockfish summarizing life history, distribution, fishery trends, as well as producing estimates of biomass, sustainable yield and allowable catch.

Mr. Jow states that California would also be preparing status of stocks documents on bocaccio and chillipepper rockfish.

Mr. Pedersen discussed initial attempts of the Washington Department of Fisheries hydroacoustic staff to estimate black rockfish abundance at offshore pinnacles. Assessments were attempted by traversing the pinnacle in a star pattern. Preliminary results suggest further research should be conducted.

3. Sablefish

a. Canada

Sablefish are managed as a single stock in the Canadian zone. The present annual quota of 3,500 mt was based on general production modeling of catch and CPUE data for the 1969-1979 Japanese longline fishery. The discontinuation of this fishery and the absence of a suitable time-series of catch at age data and domestic trap fishery statistics have precluded an assessment of the current performance of the sablefish stock(s) using traditional methods. Stock assessment methods are presently being re-evaluated with a substantial emphasis on biological considerations. Preliminary results of population modeling using tag release and recovery data indicate the method may provide a useful tool to assess stocks. Fishery statistics indicate stock(s) are currently in a steady state.

The recruiting strong 1977 year-class is being monitored to assess its contribution to the fishery and to help evaluate optimal harvesting policies.

b. United States

Sablefish abundance indexing was begun in 1978 and continued in 1981 with longline trap gear at specific sites off southeast Alaska, Washington, Oregon and California. Results of the 1981 work indicate that the relative abundance of sablefish off southeast Alaska was about 34% less than in 1980 in contrast to modest increases which had been observed at most sites between 1979 and 1980. Prerecruit sablefish (<57 cm) seemed to be more abundant in 1981, but catch rates of marketable-size sablefish were down by 53%. What appears to be a strong 1977 year-class dominates the prerecruit component and should be entering the marketable-size group over the next two to three years. Results of the 1981 U.S.-Japan longline survey produced trends opposite to those above, and this discrepancy has not been resolved. Declines in relative abundance off Washington, Oregon and California were also indicated by the trap survey in 1981. The greatest decrease was found off Oregon where catch rates were down 53% from 1980. Decreases occurred in both prerecruit and marketable sizes off Oregon, but only in the larger fish off Washington.

The sablefish abundance indexing program is undergoing reevaluation and as a result, changes in the experimental design are likely to be implemented.

4. Flatfish

a. Canada

A wide variety of techniques have been employed for flatfish stock assessment.

In Hecate Strait (PMFC 5C/D/E) three major species are involved: rock sole, Dover sole, and English sole. On the west coast of Vancouver Island (PMFC 3C/D) Dover sole and petrale sole are the major species considered.

In Hecate Strait long (greater than or equal to 30 year) time series of catch/effort and ageing data exist for rock sole and English sole.

Both surplus production analyses and dynamic pool models have been used in assessments for these species. Recently, a surplus production model incorporating a stock-recruitment relationship was used. Results were similar to Schnute-Schaefer estimates for rock sole and English sole (area 5D).

Surplus production analyses failed with the English sole time series when 1981 catch data were included.

Estimates for q were poor and the 1981 catch/effort observation was consistent with a much larger stock size than the previous year's observations.

For rock sole in Hecate Strait, surplus production, dynamic surplus production, Deriso estimates, and yield simulations based on cohort analysis are in close agreement. Results indicate a slow recovery for the rock sole stock in area 5D while the stock in area 5C is near optimum levels.

Trip limits and a spawning area closure (5C), implemented in 1980 have helped maintain the stock level for rock sole in area 5C and promote rehabilitation of rock sole in area 5D.

Cohort analyses have been completed for area 5D rock sole and English sole, and yield simulations undertaken. Analysis of ageing error in rock sole and English sole time series is to lower estimates of M for both species.

Surplus production analysis for Dover sole in Hecate Strait is limited by the quality of fishery data. Only 11 years of catch data is suitable for this purpose. Detailed age statistics are being compiled for the stock. Analysis of CPUE data indicates that the stock is currently being exploited at an optimum level.

An alternative to qualified catch per unit effort time series has been used by Westrheim. New catch-effort time series (possibly more reflective of true effort in a multi-species fishery) for rock sole and English sole (area 5C/D) will soon be available for analysis.

In PMFC 3C/D catch rates for Dover sole appear to be consistent with recent biomass estimates and estimated natural mortality rates for the species.

Petrale sole catches for areas 3C/D have been previously determined to be a function of recruitment. A trip limit has been imposed to protect spawning stocks. The petrale sole age data base is being updated to assess the effects of trip limits and area closure on stock levels.

Flatfish stocks in other areas are presently being monitored with regard to changes in catch per unit effort and age structure.

b. United States

Late in 1981, in response to PFMC Groundfish Management Team assignments to its members, Oregon began major analyses of our long time series of data from the Dover sole fishery. Objective is to produce a document which summarizes life history, distribution, the fishery, and produce the usual estimates of biomass, MSY, allowable biological catch, etc. needed for management, for each INPFC area.

Mr. Rigby stated that the status of the starry flounder population in southeast Alaska was determined by monitoring sex ratio of the catch with onboard observers. A precursor to declining CPUE is a decline in the proportion of female starry flounder. Management has been changed to allow fishing for starry flounder by permit only.

5. Pacific whiting

a. Canada

Pacific whiting in the Strait of Georgia are managed as a distinct stock separate from the offshore whiting.

Biomass estimates from ichthyoplankton, hydroacoustic and swept volume assessment techniques undertaken in the Strait of Georgia in 1981 indicate abundance is greater than previous, less comprehensive studies have shown. Preliminary estimates from the 1981 study ranged from 80,000-120,000 mt. Mortality estimates are now thought to be lower than earlier estimates. Hence, although the abundance of whiting is greater than earlier biomass surveys indicated, the lower rate of mortality dictates a lower rate of exploitation. As a result, the annual quota of 10,000 mt remains unchanged. The whiting fishery in the Strait of Georgia began in 1979. The landed catch in 1979 and 1980 was 516.3 mt

and 508.1 mt, respectively. In 1981 landed removals rose to 2,408 mt. The present quota will be reevaluated if and when full utilization is anticipated.

A review of the commercial fishery for whiting in offshore waters suggests that a whiting fishery could be sustained annually for four to six months during June-November. Concentrations of whiting in Canadian offshore waters are considered part of a stock that undergoes an extensive coastal migration from Baja California to Vancouver Island.

Studies have indicated larger individuals of any particular year-class are found in the Canadian zone, indicating the large fish undergo more extensive migrations and that larger fish tend to migrate into the Canadian zone. There was strong evidence of prominent year-classes with the 1970 year-class accounting for 26.1% of all fish sampled in 1979, 49% in 1980, and 30% in 1981. A strong 1973 year-class entered the Canadian fishery in 1980, representing 23% of the catch and 30% in 1981. While there is little doubt that the concentration of whiting present in the Canadian zone can support a commercial fishery, the implications of overfishing the large older and predominantly female whiting are poorly understood. Preservation of this component of the stock may be maintaining the reproductive potential of the stock particularly during adverse environmental conditions. Until more is known about the stock dynamics, particularly with respect to the role of older, larger females, it is believed that the portion of the stock in the Canadian zone should be harvested conservatively.

Until more reliable estimates of the biomass in the Canadian zone are made, and until the value of the older and larger female whiting to recruitment has been assessed, the quota for Pacific whiting in the Canadian zone is 35,000 mt.

b. United States

The effects of environmental conditions on recruitment of Pacific whiting have been examined in a statistical study. Upwelling during the spawning months appeared to be closely correlated to year-class strength. The hypothesized mechanism is the transport of larvae

offshore. In a multiple regression model, 72% of the variability in year-class strength may be explained by three factors: upwelling, temperature, and spawning biomass. The model was apparently accurate in predicting weak year-classes in 1974, 1975, and 1976, and a strong year-class in 1980. The strengths of the 1978 and 1979 year-classes are as yet unknown. The model predicted 1977 to be moderately strong, although it actually appears to be very strong.

Additional modeling efforts have been directed at simulating Pacific whiting population dynamics, especially those related to highly variable recruitment. Management problems associated with the Pacific whiting offshore stock and fishery appear to lend themselves well to an application of a slightly modified version of the Getz-Swartzman model. Since variability in year-class strength appears to be an important and regular feature of most commercially important fish stocks, management must begin to consider the resulting year-to-year variability in stock biomass when setting fishing quotas and general management policy. With this in mind, Getz and Swartzman developed a model of a fish population and resultant fishery dynamics based on classical Beverton and Holt analysis but featuring a stock-recruit relationship that is a transition matrix giving the probabilities that given recruitment levels can arise from different levels of stock abundance. With this model the population age class distribution is replaced by a probability vector for each age class, giving the probability that the (biomass) level of that age class is in each of n arbitrary biomass categories ranging between zero and some maximum. Instead of computing deterministic yield and stock level, the model computes expected values and variances for each of the variables.

A first application of the model indicated above all that the concept of MSY is rather meaningless when dealing with a resource that exhibits both short- and long-term variability. Environmental conditions over the past 10-15 years have been favorable for higher than average production and at this high point of a long-term production cycle an MSY of 225,000-250,000 metric tons (mt) is suggested. However, if MSY is estimated for the entire stock over a longer period (>20

years), the analysis indicated that MSY should be no larger than 175,000 mt. Short-term variations in production reduce the utility of the MSY principle even further.

The analysis suggested that significant improvements in average yield and CPUE would be obtained through year-to-year adjustments of yield and effort. Such an approach would utilize surplus production in as efficient a manner as possible, while maintaining the productive capacity of the stock.

Future study will be devoted to examining the sensitivity of management decisions to changes in the algorithm and model parameters.

6. Dogfish

a. Canada

Our stock assessment of dogfish has relied on a discrete-time, deterministic "age-structure" model completed in 1978 (see Wood et al., 1978, J. Fish Res. Bd. Can.). Marketable biomass was estimated at 120,000-150,000 mt. A coast-wide estimate of MSY was 8,000-10,000 mt.

Current research in pursuit of rational management of the dogfish resource has concentrated on tagging dogfish, primarily in the Strait of Georgia, for the purpose of stock delineation and age validation. Short-term tag recovery data indicates dogfish move extensively within the Strait of Georgia. Recent studies of oxytetracycline-injected fish recovered after tagging indicate estimates of age are valid. Additional tagging studies are planned.

b. United States

Mr. Pedersen stated that CPUE for the Puget Sound dogfish fishery had declined recently. Furthermore, the market for dogfish collapsed in 1980. The fishery is currently limited to the Strait of Georgia and Strait of Juan de Fuca.

7. Pollock

a. Canada

The fishery for pollock has only recently developed with the creation of markets for fillets and roe, and the general use of mid-water trawls. Production peaked in 1980 and has since declined.

As pollock form a component of the whiting-pollock biomass in the Strait of Georgia, estimates of pollock biomass were obtained during the 1981 hydroacoustic, swept-volume, and ichthyoplankton surveys. During the survey period, pollock biomass was estimated at approximately 20,000 mt. Stock delineation problems regarding pollock in southern British Columbia waters have not been resolved.

b. United States

There was no reported stock assessment for pollock. Mr. Pedersen reviewed the pollock fishery in Washington state, indicating the fishery apparently collapsed by early 1982.

8. Pacific halibut

a. International Pacific Halibut Commission

With the exception of British Columbia, halibut abundance and productivity are increasing, although part of the increase in CPUE observed in the fishery appears to have resulted from higher availability of fish rather than greater abundance.

Surplus production (formerly called equilibrium yield) was estimated at 29,030 mt under 1981 conditions. This surplus is almost as high as earlier estimates of MSY, suggesting that halibut stocks are in good conditions. Unfortunately, nearly half of this production (12,701 mt) was estimated to be lost to incidental catches in other fisheries, leaving only 16,329 mt of surplus for the setline fishery. The IPHC staff has recommended harvesting at a rate of 75% of the available surplus production; thus, the recommended setline harvest would be 12,247 mt. The IPHC is hopeful that incidental catches will be reduced and this would mean additional surplus for the halibut fishery. Larger

numbers of juvenile halibut have been observed in recent years, indicating that halibut stocks should continue to improve during the 1980s.

Recent increases in fishing effort which, in turn, have contributed to short seasons are a serious problem to the proper management of the fishery. Although IPHC has no authority to institute a limited entry program, the Canadian government and the U.S. North Pacific Fisheries Management Council are presently considering a "share system" type limited entry program. Under this program, each vessel owner would be allocated a percentage of the catch limit based on past performance in the fishery. Such a system could result in essentially a year around halibut fishery because there would be little need to restrict the time of year the fishery takes place.

9. Lingcod

a. Canada

Lingcod in the Strait of Georgia are currently managed as a single stock. As a result of declining lingcod abundance in the Strait of Georgia, an extension of an existing winter closure was implemented in 1979 to protect spawning stocks and to reduce the catch. Research activities have included a program to monitor larval production in an attempt to evaluate the success of the closure at increasing stock abundance and to examine factors controlling recruitment. Until the principal factors affecting recruitment can be identified, and until the impact of the various exploitation processes is recognized, the selection of the most appropriate rebuilding strategy will be impaired.

In offshore waters, lingcod abundance undergoes marked oscillations as a result of fluctuating year-class abundance, whereby one or more strong year-classes recruit at periodic intervals and sustain the fishery for the duration of the cohort(s). The absence of an adequate time-series of catch at age data has precluded a comprehensive assessment of lingcod stocks in Canadian waters. Validation experiments, based on OTC recovered tagged lingcod, indicate the method of ageing lingcod is valid over the range of ages examined. These studies are continuing.

b. United States

Mr. Pedersen discussed the results of a report on the biology and fisheries for lingcod in Puget Sound (see Bargmann, 1982, Wash. Dept. Fish. Tech. Rept. No. 66). It's felt that the lingcod population is rebounding in Puget Sound and lifting the fishery closure in the moratorium area on a trial basis is being considered.

B. Related Studies

1. Sablefish-Stock Delineation and Transboundary Considerations

Sablefish discussion focused on two topics, the need for a coast-wide status of stocks documentation on sablefish, and the implications of Mr. Bracken's theory on sablefish movement.

Mr. Bracken hypothesizes that southeast Alaska and Canada represent pooling areas for sablefish spawning stocks and that juvenile sablefish found in the Gulf of Alaska are destined for these pooling areas. He supports this theory with evidence from tag recoveries.

Criticism of Mr. Bracken's theory centers on his failure to adjust tag recovery data according to the concentration of fishing effort. Mr. Cass reports that Canadian biologists have released 125,000 tagged sablefish since 1977 and recovered 8,000 tags. Information from tag recoveries shows little adult migration, 1-8% from one Canadian zone to another, with 4-5% movement from one INPFC area to another. Tag recoveries of juveniles released at inshore waters show extensive movement offshore, but 95% are recovered in Canadian waters.

Mr. Bracken pointed out a need to resolve differences on sablefish ageing, natural mortality and movement before an agreed upon scenario for the status of sablefish stocks can be resolved.

Some discussion followed on the use of INPFC as a vehicle for organizing a sablefish workshop. Dr. Balsiger informed the TSC that INPFC is preparing a comprehensive report on sablefish, but the report will not be published until late 1983. Meanwhile, Alaska Sea-Grant is organizing a meeting to discuss sablefish in March, 1983. The TSC

recommended a working group be formed to provide Alaska Sea-Grant with suggestions for agenda topics at their sablefish workshop. (See agenda item XI, TSC recommendations.)

2. Feasibility of Applying Hydroacoustic Sonar Techniques to Widow Rockfish Assessment

Mr. Wilkins, NMFS, reported on a three phase project conducted by NWAFC to assess widow rockfish abundance. Phase 1 of the project was a study of widow rockfish behavior; phase 2 was the development of methodology for estimating widow rockfish abundance; and phase 3 was a feasibility study of the applications of the developed methodology on a production basis.

During phase 1 observations were made on the diel variation in widow rockfish abundance at a known ground, using conventional sonar and hydroacoustic echo integration the number of schools, school shape and school density were recorded. During phase 2 a method was developed using sector scanning sonar and conventional hydroacoustic echo integration to determine the number and size of schools and the density of fish within a school. During phase 3 the methods developed in phase 2 were applied to fishing grounds at Hecate Bank, Fingers and Halibut Hill, all located along the southern Oregon coast.

Widow rockfish were found to be largely off bottom, feeding in the deep scattering layer during the day and aggregating at night. Schools were found to form dense cigar shaped traces on chart recorders and be several fathoms tall. Shortbelly rockfish could be mistaken for widow rockfish and dense layers of whiting could mask the presence of widow rockfish.

During phase 3, considerable problems were encountered with variability and availability of widow rockfish schools as well as target identification. Prognosis for future application indicates the method is of limited use due to a reduction in overall widow rockfish abundance. The method may be useful in assessing shortbelly rockfish, however further development and application are temporarily suspended.

3. Suggestions for Joint Research

a. Pacific cod

Mr. Westrheim reviewed recent landing trends for Pacific cod in PMFC area 4B (Canadian MSA 19). He's concerned with large increases in landings of apparently transitory Pacific cod and is curious about the effects of these landings on spawning stocks in PMFC area 4A. Mr. Westrheim suggests a review of the Pacific cod fisheries in PMFC area 4A, looking for fishery developments similar to those observed in area 4B or any other unusual trends in recent production.

b. Otolith exchange

Mr. Tagart suggested that an exchange of rockfish otolith be arranged between WDF and the age reading laboratory at FAO in Naniamo. Mr. Leaman concurred and an exchange will be initiated.

4. Other

a. Centralized age reading laboratory

Mr. Tagart discusses a U.S. proposal to create a centralized groundfish age reading laboratory. Canadian biologists were asked to comment on the usefulness of such a laboratory in standardizing age reading techniques.

b. Age determination and validation

Discussions continued on the merits of the "break and burn" versus the whole otolith technique of otolith ageing. The TSC passed a resolution calling for action by each government agency (see agenda item XI, TSC recommendations).

c. SCUBA fishermen survey

Mr. Pedersen discussed WDF's program to obtain groundfish catch data from SCUBA fishermen. Through a logbook and interview system the number of divers, diving days, and proportion of dives dedicated to spear fishing are determined. Interviews provide data on the catch composition and CPUE. WDF has been working closely with organized diving groups to promote the program.

C. Cooperative Research with Other Nations

1. Canada

There was no information provided on this topic by Canada although Canadian scientists did participate with U.S. scientists at the Pacific whiting workshop (see agenda item X.B) and with the U.S. in a working group on Pacific ocean perch (see agenda item X.A.2).

2. United States

In 1981 the United States had cooperative research arrangements with Japan, Poland, Republic of Korea, and Canada. Cooperative arrangements ranged from approval of research and sharing of results to integration of foreign vessels into comprehensive resource surveys with joint analysis and reporting of results. Twenty-one foreign vessels conducted research inside the U.S. FCZ. These vessels participated in ichthyoplankton/pollock/crab surveys in the Bering Sea, ichthyoplankton/pollock/Atka mackerel/rockfish trawl surveys and sablefish/Pacific cod longline surveys in the Gulf of Alaska, and ichthyoplankton/Pacific hake/rockfish/herring surveys in the Washington-California region.

Additionally, as a result of the 1982 U.S.-Canada Pacific whiting workshop, scientists of both countries will work together on studies of Pacific whiting parasitology, population dynamics modeling, fecundity, and sex ratio differences by area.

IX. OTHER TOPICS FOR DISCUSSION

A. Purpose and Re-assessment of Agency Reports

Discussions of the agency reports concerned their length, content and relevancy. It was determined that readers of the agency reports not intimately familiar with the fisheries find them informative as written. Nonetheless, condensation of the fishery review section of the report to

the Parent Committee was found to be useful. Additional reports from working groups should be appended to the Parent Committee report.

B. Other

1. PAC FIN Update

Dr. Harville reviewed the purpose and progress of PAC FIN (Pacific Fisheries Information Network). He requested that TSC consider at its next meeting an evaluation of the current PMFC groundfish data series and PAC FIN to determine if each should be continued or consolidated.

2. Puget Sound Groundfish Management

Mr. Pedersen reviewed a proposed new management plan for Puget Sound groundfish fisheries. The plan examines harvest of 20 key species in nine areas by various user groups and establishes allocation guidelines among the user groups. This plan is a continuing effort to promote regulations which prevent overfishing.

X. PROGRESS ON 1981 RECOMMENDATIONS

A. Technical Subcommittee

1. Tagging Inventory

All agencies exchanged information on tag releases from 1971 to 1981.

2. Pacific ocean perch Working Group

The report of the working group on Pacific ocean perch is contained in Appendix C of this report. Central to the disagreements between Canada and the United States was interpretation of age data for Pacific ocean perch. This issue resulted in a discussion of the

usefulness of a Pacific ocean perch workshop. The idea of a workshop was dismissed on the grounds there was inadequate time for its organization.

B. Parent Committee

1. Pacific whiting Workshop

The report of the working group on Pacific whiting is presented in Appendix C of this report.

XI. TECHNICAL SUBCOMMITTEE RECOMMENDATIONS

A. Technical Subcommittee

1. Sablefish Status of Stocks Working Group

The TSC recommends that a sablefish working group be formed which will consist of G. McFarlane (FAO, Canada), B. Bracken (ADF&G) and Chairman J. Balsiger (NMFS). This working group is to consider inadequacies and uncertainties in present data and data analyses which lead to status of stocks documents and consequently management decisions on a coast-wide basis (California to the Bering Sea).

The working group will subsequently communicate with sponsors of the upcoming sablefish symposium to be held in Anchorage, Alaska in March, 1983. They will suggest agenda items for that meeting which might provide additional data or alternate analytical methodologies to alleviate the uncertainties mentioned above.

Following the sablefish symposium the working group will review the proceedings and report to the next TSC meeting with any further recommendations.

2. Age Reading Review

The TSC recognizes that resolution of the disagreement over the validity of the break and burn method of age determination from otoliths

requires immediate attention, because of management implications of the different instantaneous natural mortality values derived from the break and burn versus the whole otolith methods of interpretation. The TSC recommends that a) each agency should critically review the evidence regarding the break and burn method of age determination; b) determine the agency's position regarding whether or not the method should be accepted as the current state-of-the-art method of ageing otolith; and c) bring that position in writing to the January, 1983 meeting of the Parent Committee.

3. Council Participation at TSC Meetings

The TSC recommends that representatives from the Pacific and North Pacific Fishery Management Councils be invited to attend annual TSC meetings.

B. Parent Committee

There were no recommendations to the Parent Committee.

XII. SCHEDULE OF FUTURE MEETINGS

A. Parent Committee is scheduled to meet on January 10, 1983 in Monterey, California.

B. The 1983 meeting of the TSC will be held in California at a date and place to be determined.

XIII. ELECTION OF CHAIRPERSON

Phil Rigby, ADF&G was elected Chairman of TSC.

XIV. ADJOURNMENT

The TSC expressed their appreciation to Mr. Tagart and WDF for arranging the meeting location and accommodations. The meeting was adjourned at 5:30 p.m. on June 10, 1982.

APPENDIX A

AGENDA FOR THE 23rd ANNUAL MEETING OF THE TECHNICAL SUBCOMMITTEE OF THE CANADA-UNITED STATES GROUND FISH COMMITTEE

- I. CALL TO ORDER
- II. APPOINTMENT OF SECRETARY
- III. APPROVAL OF AGENDA
- IV. INTRODUCTIONS
- V. TERMS OF REFERENCE OF THE SUBCOMMITTEE
- VI. REVIEW OF AGENCY GROUND FISH PROGRAMS
- VII. REVIEW OF NORTHEAST PACIFIC GROUND FISH FISHERIES
 - A. Canada-United States Fisheries
 - 1. Commercial fisheries--new fisheries, notable changes in resources, landings, markets, etc.
 - a. British Columbia
 - b. Alaska
 - c. Washington
 - d. Oregon
 - e. California
 - 2. Recreational fisheries--where applicable
 - a. British Columbia
 - b. Alaska
 - c. Washington
 - d. Oregon
 - e. California
 - B. Joint-venture Fisheries
 - 1. Canada
 - 2. United States including Bering Sea and Gulf of Alaska
 - C. Foreign Fisheries
 - 1. Canada
 - 2. United States including Bering Sea and Gulf of Alaska
- VIII. GROUND FISH RESEARCH
 - A. Stock Assessments
 - 1. Pacific cod
 - 2. Rockfish

3. Sablefish
4. Flatfish
5. Pacific whiting
6. Dogfish
7. Pollock
8. Pacific halibut
9. Lingcod
10. Other

B. Related Studies

1. Sablefish--stock delineation and transboundary considerations.
2. Feasibility of applying hydroacoustic sonar techniques to widow rockfish assessment.
3. Suggestions for joint research.
 - a. Pacific cod
 - b. Otolith exchange
4. Other
 - a. Centralized age reading laboratory
 - b. Age determination and validation
 - c. SCUBA fisherman survey

C. Cooperative Research With Other Nations

IX. OTHER TOPICS FOR DISCUSSION

- A. Purpose and re-assessment of agency reports and the report to the Parent Committee with respect to current data needs, data systems, report requirements, etc., for management plans.
- B. Other
 1. PAC FIN Update
 2. Puget Sound Groundfish Management

X. PROGRESS ON 1981 RECOMMENDATIONS

- A. Technical Subcommittee
 1. 1971-1981 Tagging Study Inventory
 2. Pacific ocean perch Working Group
- B. Parent Committee
 1. Pacific hake workshop

- XI. 1982 TECHNICAL SUBCOMMITTEE RECOMMENDATIONS
 - A. Technical Subcommittee
 - B. Parent Committee
- XII. SCHEDULE OF FUTURE MEETINGS
- XIII. ELECTION OF CHAIRPERSON
- XIV. ADJOURNMENT

APPENDIX B

LIST OF REPORTS PUBLISHED BY MEMBER AGENCIES FOR THE PERIOD MAY 1, 1981 TO APRIL 30, 1982

Canada - Department of Fisheries and Oceans

- Archibald, C. P., W. Shaw, and B. M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-1979. Can. Tech. Rep. Fish. Aquat. Sci. 1048: 57 p.
- Barner, L. W. and F. H. C. Taylor. 1981. Midwater trawl tows and catches made on G. B. REED GBR80-6, Dixon Entrance and north end Hecate Strait, June 4-24, 1980. Can. Data Rep. Fish. Aquat. Sci. 294: 54 p.
- Barner, L. W., F. H. C. Taylor, and P. B. McCarter. 1981. Midwater trawl tows and catches made on C.G.S. G. B. REED cruise GBR81-1 Strait of Georgia, January 12-23, 1981. Can. Data Rep. Fish. Aquat. Sci. 310: 40 p.
- Beamish, R. J. 1981. A preliminary report of Pacific hake studies conducted off the west coast of Vancouver Island. Can. MS. Rep. Fish. Aquat. Sci. 1610: 43 p.
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- Beamish, R. J. and D. A. Fournier. 1981. A method for comparing the precision of a set of age determinations. Can. J. Fish. Aquat. Sci. 38: 982-983.
- Beamish, R. J., M. S. Smith, V. Egan, D. Brown, and G. McFarlane. 1981. Results of spiny dogfish (Squalus acanthias) tagging in the Strait of Georgia in 1979. Can. Data Rep. Fish. Aquat. Sci. 262: 73 p.
- Carter, E. W., L. A. Lapi, and J. E. Richards. 1981. Catches and trawl locations of M/V ARCTIC HARVESTER during the Dover sole biomass survey off the west coast of Vancouver Island, February-March 1981. Can. Data Rep. Fish. Aquat. Sci. 295: 57 p.
- Carter, E. W. and B. M. Leaman. 1981. Exploratory fishing of Bowie Seamount by the automated longliner M/V VIKING STAR, August 28-September 12, 1980. Can. Data Rep. Fish. Aquat. Sci. 266: 30 p.
- Carter E. W., D. A. Nagtagaal, B. M. Leaman, C. P. Archibald, and B. J. Westman. 1982. Catches and trawl locations of M/V TENACIOUS during the rockfish biomass survey in southern Hecate Strait (Morseby Gully), June 1981. Can. Data Rep. Fish. Aquat. Sci. 321: iv + 67 p.

- Fargo, J., L. A. Lapi, J. E. Richards, and M. Stocker. 1981. Turbot biomass survey of Hecate Strait, June 9-21, 1980. Can. MS. Rep. Fish. Aquat. Sci. 1630: 84 p.
- Foucher, R. P. and K. F. Jacobs. 1981. Pacific cod age composition and landing statistics for selected fishing grounds and quarter years in Hecate Strait, 1958-80. Can. Data Rep. Fish. Aquat. Sci. 301: 11 p.
- Ketchen, K. S. 1981. Preliminary study of the incidence of halibut in catches by the Canadian West Coast trawl fishery for groundfish. Can. MS Rep. Fish. Aquat. Sci. 1628: 21 p.
- Lapi, L. A. and J. E. Richards. 1981. Data collected during rockfish (*Sebastes* spp.) assessment of the West Langara Island and West Coast Vancouver Island fishing grounds in 1979. Can. Data Rep. Fish. Aquat. Sci. 286: 113 p.
- Leaman, B. M. 1981. A brief review of survey methodology with regard to groundfish stock assessment, p. 113-123. In W. G. Doubleday and D. Rivard [ed.]. Bottom trawl surveys. Can. Spec. Publ. Fish. Aquat. Sci. 58.
- McFarlane, G. A., R. J. Beamish, M. S. Smith, V. Egan, and D. Brown. 1982. Results of spiny dogfish (*Squalus acanthias*) tagging in Strait of Georgia, Queen Charlotte Sound, Hecate Strait, and Dixon Entrance, during 1980. Can. MS Rep. Fish. Aquat. Sci. 1646: 123 p.
- McFarlane, G. A., R. J. Beamish, and K. R. Weir. 1982. Study of the biology and distribution of Pacific hake during the first commercial fishery conducted in the Strait of Georgia by the M/V CALLISTRATUS February 16-17, March 10-April 3, and May 12, 1979. Can. MS. Rep. Fish. Aquat. Sci. 1650: 111 p.
- Mason, J. C., O. D. Kennedy, and T. H. Mullin. 1981. Canadian Pacific Coast ichthyoplankton survey. 1980. Hydrography. Part One. Horizontal contours of temperature, salinity, and sigma-T, at selected depths, by monthly cruise. Can. Data Rep. Fish. Aquat. Sci. 279: 110 p.
1981. Canadian Pacific Coast ichthyoplankton survey. 1980. Hydrography. Part Two. Vertical contours of temperature, salinity, and sigma-T on transect lines by monthly cruise. Can. Data Rep. Fish. Aquat. Sci. 280: 77 p.
1981. Canadian Pacific Coast ichthyoplankton survey. 1980. Hydrography. Part Three. Vertical profiles of temperature, salinity, and sigma-T, by station. Can. Data Rep. Fish. Aquat. Sci. 281: 114 p.
- Mason, J. C., O. D. Kennedy, and A. C. Phillips. 1981. Canadian Pacific coast ichthyoplankton survey 1980. Ichthyoplankton Cruise One (January 15-22). Can. Data Rep. Fish. Aquat. Sci. 275: 57 p.

1981. Canadian Pacific coast ichthyoplankton survey. 1980. Ichthyoplankton. Cruise Two (February 13-20). Can. Data Rep. Fish. Aquat. Sci. 276: 66 p.
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- Mason, J. C., O. D. Kennedy, and A. C. Phillips. 1981. Canadian Pacific coast Ichthyoplankton survey. 1980. Ichthyoplankton. Cruise Four (April 15-23). Can. Data Rep. Fish. Aquat. Sci. 278: 80 p.
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- Shaw, W. and C. P. Archibald. 1981. Length and age data of rockfishes collected from B.C. coastal waters during 1977, 1978, and 1979. Can. Data Rep. Fish. Aquat. Sci. 289: 119 p.
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Oregon Department of Fish and Wildlife

No submissions

California Department of Fish and Game

No submissions

APPENDIX C

WORKING GROUP REPORTS

A Review of the Status of the
Western Vancouver Island Stock
of Pacific Ocean Perch

Jack V. Tagart
and
Bruce M. Leaman

1982

Submitted to the 23rd Annual Meeting of the Technical Subcommittee
of the Canada/United States Groundfish Committee, June 9-10, 1982,
in Port Ludlow, Washington.

INTRODUCTION

The Technical Subcommittee of the Canada-United States Groundfish Committee recommended at their 22nd annual meeting forming a working group of Canadian and U.S. scientists to "identify points of agreement, review areas of disagreement and review potential impacts of alternative management strategies on the status of the Western Vancouver Island (WVI) stock of Pacific ocean perch" (Sebastes alutus). The working group met in Nanaimo, British Columbia on April 13-14, 1982.

RESULTS

The WVI stock of S. alutus was described by Gunderson (1977) as occurring between 47°20'N. latitude and 49°N. latitude, which corresponds with the boundaries of PMFC areas 3B and 3C. Landings of S. alutus from area 3D have never been large (<300 mt) and while the precise northern boundary of the WVI stock is unknown, historically landings from south of Cape Cook are considered as being from the same stock as those from area 3C. PMFC areas 3B, 3C and 3D comprise the INPFC Vancouver area.

Historically, the WVI stock of S. alutus has supplied a substantial proportion of the coastwide S. alutus landings. Between 1960 and 1964 the WVI stocks were exploited exclusively by domestic (U.S. and Canadian) fishermen, landings from the WVI stock averaged 37 percent of the combined Queen Charlotte Sound, Vancouver and Columbia area landings with peak landings of 3,867 mt occurring in 1963 (Westrheim, et al., 1972). From 1965 to 1970, a period of intense

foreign fishing, landings by foreign and domestic fishermen from the WVI stock averaged 23 percent of the coastwide landings with peak landings of 16,358 mt in 1966. By 1969 as a direct result of excessive foreign fishing the WVI stock of S. alutus was severely depleted (Gunderson, 1977). By 1974 domestic landings were at an all time low of 256 mt. In 1977 the U.S. banned all non-North American fishing in the United States portion of the INPFC Vancouver area and Canada allowed only incidental landings from 1977 to 1979. United States landings began to increase on the strength of a relatively strong year class of S. alutus until by 1978 they reached 958 mt. Fearing domestic over-harvest of the remaining S. alutus biomass the U.S. joined Canada in imposing various landing restrictions in 1979. By 1981, domestic removals were approximately 750 mt (Table 1).

Since 1969, several reports have been completed describing the status of S. alutus stocks. Virgin biomass of the WVI stock was inferred from Westrheim, et al., (1972) at approximately 81,000 mt. Kimura (1981) reported that biomass in 1969 was 25 percent of biomass in 1956. Working backward from Gunderson's (1981) cohort analysis this implies a Virgin biomass of approximately 62,000 mt. Kimura and Tagart (1982) estimated virgin biomass at 53,000 mt. Westrheim et al., (1972) estimated biomass from 1966 to 1968 at 34,000 mt, while Gunderson's (1981) estimates for the same period were 36,411 mt. Kimura and Targart (1982) estimated 1969 biomass at 13,250 mt, while the TSC (1972) and Gunderson (1981) showed mean biomass from 1969 to 1971 of 18,700 and 15,454 mt respectively. Mean biomass between 1972 and 1974 was estimated at 16,700 mt by Gunderson, et al., (1977) and

at 11,626 mt by Gunderson (1981). Between 1975 and 1977 Fraidenburg, et al., (1978) estimated 17,800 mt of biomass, although they suspected this estimate was biased toward the high side. Gunderson (1981) estimated 1977 biomass at 7,391 mt, which compares with a U.S. trawl survey estimate of 10,304 mt (based on a 25:75 partition of biomass north and south of the U.S.-Canada provisional boundary and an estimate of 7,728 mt of biomass in the U.S. zone) (Fraidenburg et al., 1978). In 1979 the U.S. conducted a second trawl survey estimating 5,711 mt in the U.S. zone (Wilkins, et al., 1979), at the same time Canada conducted a similar trawl survey and estimated 6,200 mt of biomass in the Canadian zone (Stocker, 1981). It seems apparent that the abundance of the WVI stock of S. alutus was in a steady decline from 1966 at least until 1977.

The U.S. and Canada estimate allowable biological catch (ABC) in different ways. The U.S. ABC is based on a biomass growth function in Gunderson (1978). The function assumes constant recruitment, annual catch, growth rate, and natural mortality. Based on the Pacific Fisheries Management Council (PMFC) desire to rebuild the S. alutus biomass in the U.S. zone of the INPFC Vancouver area over a 20 year period, ABC is obtained by determining the catch that produces, over a 20 year period, the desired final biomass given some initial biomass. Assuming an initial biomass of 5,700 mt, average annual recruitment of 2,473 mt, growth rate $G=.08$, natural mortality rate $M=.15$, and final biomass of 22,500 mt, ABC is estimated at 600 mt per year. Canada bases ABC on estimates of equilibrium yield (EY) where $EY = MB$ and M is natural mortality and B is biomass. Canada is

currently using the WVI stock of S. alutus to conduct an experiment testing the effect of allowing large relative but small absolute increases in ABC on the abundance and mortality rates of the exploitable stock. Canada estimates EY in the Canadian zone of the Vancouver area at 300 mt, based on a biomass of 6,000 mt and an M value of .05. They have set ABC at 500 mt.

The U.S. and Canada disagree on estimates of the rate of natural mortality (U.S. $M=.15$, Canada $M=.05$). This disagreement centers on the technique employed to age rockfish. U.S. age readers use a widely accepted aging technique which counts annuli on the surface of an otolith. Canadian age readers use a recently applied technique which counts annuli on the burnt cross section of a broken otolith (Beamish, 1979). Canadian age readers have obtained good agreement between surface and either sectioned or broken/burnt age reading estimates up to age 17, but beyond age 17 the surface age technique is less reliable. Comparison of U.S. and Canadian age readings based on the surface age technique demonstrated deviations between Canada and the U.S. for fish ten years and older (Westrheim and Harling, 1973), with the U.S. consistently assigning a lower age than Canada. Thus, the U.S. and Canadian ages up to age 17 are not comparable, although anecdotal information in Gunderson, 1978 suggests that U.S. readers did begin to estimate ages as slightly greater after 1972. Maximum age based on surface age reading is approximately 30 years; while, maximum age assigned from "break and burn" or sectioned age reading is 76 years (Shaw and Archibald, 1981).

It is the recognition of an apparent extended age distribution which causes Canadian scientists to estimate a much lower value of M . Canada estimate $M=.05$ based on catch curve analysis for a newly exploited stock from Hecate Strait and West Queen Charlotte Islands (Archibald, et al., 1981). In addition, Archibald et al., (1982) using the sequential model of Fournier and Archibald (1982) achieved a best estimate of $M=.05$ for Queen Charlotte Sound S. alutus. U.S. estimates of M were derived from Gunderson (1977) in which he described M in the range of 0.1 to 0.2. Gunderson, et al., (1977) used the mid-point of this range, $M=.15$, in their analysis. While conducting cohort analysis Gunderson (1978) tested several values of M to determine which value resulted in biomass estimates closest to estimates from the trawl survey. He concluded $M=.15$ provided the best fit.

Our knowledge of some of the other life history characteristics of the S. alutus stocks is very limited. We suspect that adult aggregations of S. alutus recruited to the fishery grounds are relatively sedentary. Although they make seasonal bathymetric migrations we assume limited movement parallel to any depth contour. We don't know how S. alutus are recruited to the adult population, i.e., where the nursery grounds are or what the route of migration is from nursery grounds to fishing grounds. We are not certain that the adult population defined as the WVI stock is the sole contributor to recruitment for that stock; however, maintenance of unique age spectre of proximal stocks in other areas (Mitchell's Gulley, Moresby Gulley) suggests that recruitment to stocks arises internally.

DISCUSSION

Currently the U.S., through PFMC, is limiting harvest of S. alutus in the U.S. zone of the Vancouver area in an attempt to rebuild the stock. PFMC has imposed severe landing limits on trawl fishermen essentially allowing no more than an incidental catch of S. alutus. Landings in 1981 were approximately 241 mt, well below the 600 mt ABC. These efforts are directed at rebuilding the stock over a 20 year time period.

Canadian managers are allowing an overharvest of S. alutus in the Canadian zone of the Vancouver area "based on the view that the severely depleted state of this stock may lend some sensitivity to such small absolute (but large relative) changes in TACs (ABC)" (Stocker, 1981). Furthermore, they believe "the penalty for error in such a system would be much lower than in other S. alutus stocks, while the potential benefits to our understanding of stock dynamics may be large."

The question of whether the stock is overfished in the Canadian zone may be academic from the U.S. point of view. If as Canada estimates there is 6,200 mt of S. alutus biomass in the Canadian zone, then annual harvest of 500 mt falls well within the range needed for stock rebuilding based on U.S. criteria. Furthermore, even if the biomass for the entire Vancouver area in 1981 is as low as Gunderson's (1981) estimate for 1977 biomass, 7,400 mt, an annual harvest of 750 mt (current U.S. rate of harvest plus Canadian ABC) is well below U.S. estimates of EY and should allow stock rebuilding in 20 years.

A more severe problem arises if Canadian estimates of $M=.05$ are correct. At $M=.05$ the optimistic outlook is that EY for the entire Vancouver area is ~ 595 mt ($M \times$ U.S. plus Canadian estimates of biomass in 1979--11,900 mt). If biomass is as low as 7,400 mt $EY = 370$ mt. On the optimistic side WVI stock biomass would continue to decline until 1984 when Canada is expected to lower ABC to 300 mt. On the pessimistic side even after Canada lowers ABC to 300 mt, the combined harvest of the U.S. and Canada will remain in excess of EY and the stock decline would continue.

Which of the above scenarios presents a more accurate prognosis is unresolved. While the U.S. and Canadian scientists agree the WVI stock of S. alutus requires rebuilding, their short term management approach differs. Although U.S. scientists do not expect the Canadian management strategy to be harmful to the WVI stock of S. alutus, we are uneasy about the adoption of a management policy which consciously increases the risk of further stock decline in an acknowledged depleted stock. However, Canadian scientists stress that the small amount of incremental harvest resulting from their management plan represents a small relative increment to the probability of stock decline rather than a scale which doubles or triples the probability.

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Table 1. Estimated Pacific ocean perch landings from the INPFC Vancouver area, 1956-1981.

Year	Landings (mt)				Total
	U.S.	Canada	Foreign	JV	
1956	1,084 ^{a/}		-	-	1,084
1957	1,154		-	-	1,154
1958	675		-	-	675
1959	968		-	-	968
1960	1,575		-	-	1,575
1961	2,485		-	-	2,485
1962	3,857		-	-	3,857
1963	3,767	100	-	-	3,867
1964	2,048	451	-	-	2,499
1965	2,961	85	500	-	3,546
1966	2,283	75	14,000	-	16,358
1967	783	22	12,678	-	13,483
1968	526	26	9,865	-	10,417
1969	528	10	2,827	-	3,365
1970	1,170	746	2,368	-	4,284
1971	627	437	2,738	-	3,802
1972	468	121	1,981	-	2,570
1973	308	2	3,479	-	3,789
1974	255	1	1,186	-	1,442
1975	308	9	504	-	821
1976	729	3	521	-	1,253
1977	897	16	T	-	913
1978	958	56	-	-	1,014
1979	616	125	-	-	741
1980	397	430	-	8	835
1981	234	517	-	-	751

^{a/} From 1956 to 1962 U.S. and Canadian landings are reported together.



REPORT OF THE JANUARY 1982 WORKING GROUP ON PACIFIC WHITING

The Working Group on Pacific whiting met January 20 and 21, 1982 at the Northwest and Alaska Fisheries Center, Seattle. T. A. Dark of NWAFC-NMFS convened the meeting and welcomed participants. T. A. Dark served as Chairman and G. A. McFarlane acted as Rapporteur.

1. Participants

The following persons took part in the Workshop sessions:

United States:

R. Ayers (National Marine Fisheries Service, Seattle WA)
J. Balsiger (" " " " " ")
T. Dark (" " " " " ")
R. Francis (" " " " " ")
K. King (" " " " " ")
M. Nelson (" " " " " ")
K. Bailey (College of Fisheries, University of Washington)
P. Stevens (Scripps Institute of Oceanography, La Jolla, CA)
T. Jow (California Department of Fish and Game, Menlo Park, CA)
J. Robinson (Oregon Department of Fish and Wildlife, Newport, OR)

Canada:

R. Beamish (Pacific Biological Station, Dept. Fish. & Oceans
Nanaimo, B.C.)
G. McFarlane (" " " " " ")

2. Agenda

The following agenda was adopted.

- I Call to Order
- II Appointment of a Chairperson
- III Appointment of a Rapporteur
- IV Introductions
- V Workshop Objectives
- VI Approval of Agenda
- VII A Review of Recent Research
 - A. The results of resource surveys conducted by the NMFS in 1977 and 1980--T. Dark.
 - B. An overview of the Pacific hake resource off the west coast of Vancouver Island--S. McFarlane, R. Beamish
 - C. Pacific whiting recruitment processes--K. Bailey
 - D. A management analysis of the Pacific whiting fishery--R. Francis
 - E. Pacific whiting: A multi-species management problem--P. Stevens

2. Agenda (cont'd)

- VIII Research needs and cooperative studies
- XI Review of present management rationale and practices
- X Consideration of viable U.S.-Canada joint management alternatives
- XI Adjournment

3. Workshop Objectives

The workshop objectives were to review current research being conducted on Pacific whiting, discuss research needs and cooperative studies, and consider viable U.S.-Canada joint management alternatives.

4. Review of Current Research

- A. Distribution, abundance, and biological characteristics of the Pacific whiting resource in 1977 and 1980.

Bottom trawl (area-swept)--hydroacoustic surveys of the Pacific whiting resource were conducted by the National Marine Fisheries Service (NMFS) during 1977 and 1980. Bottom trawl and hydroacoustic vessels sampled in a synoptic fashion throughout the range of commercially important components of the population (3-yr-olds and older). Sampling occurred from Monterey Bay to northern Vancouver Island (50°N lat.) between the 30- and 200-fm isobaths and deeper, if whiting echosign persisted beyond normal hydroacoustic transects. Sampling was allocated proportionally according to predicted distribution and relative abundance in an effort to optimize levels of estimating precision.

Total biomass estimates were 1,198,932 and 1,537,182 t in 1977 and 1980, respectively. The proportion in U.S. and Canadian waters will be difficult to estimate but in 1977 and 1980 about 29 and 22%, respectively, of the commercially available population occurred in the International North Pacific Fisheries Commission (INPFC) Vancouver Area. In 1977, an estimated 90% of the biomass occurred in the INPFC Vancouver, Columbia, and Eureka areas with about 10% in the Monterey Area. Relative abundance was less in the three northern areas in 1980, and over 50% of the estimated biomass was in the Monterey Area. This difference is mainly attributed to the presence of an extraordinarily large 1977 year-class in 1980, which, due to its relatively young age (3), was found primarily in the southern-most area. Bottom trawl samples indicated that 3-yr-olds in 1980 were about 100 times more abundant than the 3-yr-olds in 1977 in the Monterey Area. Other unusually large year-classes which have been major components of the population since 1977 are those of 1970 and 1973. New year-classes are first recruited to the U.S. fishery as 2-3-yr-olds, but they don't make significant contributions to the Canadian fishery until age 5-7 yr. In 1980, the average age based on research samples was 9.6 yr in the Vancouver Area and 5.5 yr in the Monterey Area.

The present relatively high population level, the strength of the incoming 1977 year-class, and signs of a strong 1980 year-class observed in preliminary 1980 commercial fishery data, portend a healthy whiting resource for the next several years.

B. An overview of the Pacific hake resource off the west coast of Vancouver Island.

Small concentrations of Pacific hake were found in the Canadian zone as early as May and as late as November 1979. Commercial quantities were observed from June until November and a review of the commercial fishery suggests that a hake fishery could be sustained for 4-6 mo annually. The population consisted of approximately 70% females that averaged approximately 55 cm FL (2.5 lb) compared to an average size of 53 cm (2.3 lb) for males. Hake ranged in age from 3-19 yr, however few fish younger than age 6 were found. There was strong evidence of prominent year-classes with the 1970 year-class accounting for 26.1% of all fish sampled in 1979, 49% in 1980 and 30% in 1981. A strong 1973 year-class entered the Canadian fishery in 1980, representing 23% of the catch and 30% in 1981.

The commercial fishery off the United States is dependent on smaller, younger fish. Only 18% of the fish sampled in 1976 were age 9 or older compared to 53% of the fish in the Canadian fishery that were age 9 or older. The larger individuals of any particular year-class were found in the Canadian zone, indicating the large fish undergo more extensive migrations and the larger fish tend to migrate into the Canadian zone.

While there is little doubt that the numbers of hake present can support a commercial fishery, there is an unanswered and unstudied question about the desirability of overfishing the larger, older and predominantly female fish in the Canadian zone. It is possible that the apparent healthy state of the offshore Pacific hake population is related to reduced fishing pressure on older fish as a consequence of their northern migration out of the area of intensive foreign effort. Preservation of these older, larger hake that are predominantly females may be maintaining the reproductive potential of the populations particularly if the population encounters unfavourable environmental conditions. Excessive removal of these older fish coupled with continued fishing pressure on younger fish might reduce the populations ability to maintain recruitment, resulting in major declines in abundance. Older fish should be harvested conservatively until more is known about their relative importance in maintaining reproductive potential.

Also, the development of the hake fishery has been hampered by a rapid softening of the flesh of this fish, occurring soon after capture. The causes of this rapid postmortem change are not fully understood. Anecdotal evidence links it to the presence in the flesh of a myxosporean parasite. Recent investigations (Kabata and Whitaker 1981) undertook to study the identity and prevalence of this parasite, within the context of a wider investigation into the cause of spoilage.

Results of this study revealed that the musculature of this fish is infected by two species of Myxospora, belonging to the genus *Kudoa*. One was identified as *Kudoa thyrsitis*; the other is considered as a new species, *Kudoa paniformis*. Data available indicates *K. paniformis* is absent from the Strait of Georgia stock of hake and is attributed to a loss of contact between this stock and offshore hake before *K. paniformis* became established.

In regard to the practical problems of the hake fishery off the Canadian Pacific coast, they appear to suggest that the offshore hake because of the presence of *K. paniformis*, might be more refractive to processing than

the Strait of Georgia hake. Should the link between *Kudoa* and rapid spoilage be established, the corroboration of these conclusions might become a factor in planning strategy of this fishery.

C. Pacific whiting recruitment processes

Much of the discussion of this workshop has centered on the tremendous variability in year-class strength observed in the coastal population of Pacific whiting and how strong year-classes dominate the stock and fishery. Several mechanisms in the recruitment process of whiting have been investigated as potential sources of major variability and are reported here. These studies have enlisted the cooperative efforts of several scientists including Bob Francis, Northwest and Alaska Fisheries Center; David Ainley, Point Reyes Bird Observatory; and Jeannette Yen, School of Oceanography, University of Washington.

Normal feeding conditions and energetics of whiting larvae are not believed to be critical in recruitment variability, especially when comparing energetic demands of whiting with those of other species, such as mackerel and anchovy. Growth, respiration, predator-prey size relationships and development rates of eggs and larvae were reviewed.

Predation by invertebrates on whiting eggs and larvae has been investigated in a model system, Dabob Bay.

Predation on juveniles by the California sea lion was studied from otoliths collected from sea lion feces every two weeks for 4 yr at the Farallon Islands. Most whiting otoliths were from 2-4-yr-old fish. Seasonal and annual dynamics of sea lion predation on whiting were correlated to the abundance of juveniles. The annual consumption of whiting by sea lions was approximated to be about 180 thousand tons. A theoretical model of predation mortality in relation to whiting abundance and sea lion feeding behaviour was briefly discussed. Sea lion feeding probably has little effect on recruitment variability.

The effects of environmental conditions on recruitment were examined in a statistical study. Upwelling during the spawning months appeared to be closely correlated to year-class strength. The hypothesized mechanism is the transport of larvae offshore. Some supporting evidence was presented. In a multiple regression model 72% of the variability in year-class strength may be explained by three factors: upwelling, temperature, and spawning biomass. The model was apparently accurate in predicting weak year-classes in 1974, 1975 and 1976, and a strong year-class in 1980. The strengths of the 1978 and 1979 year-classes are as yet unknown. The model predicted 1977 to be moderately strong, although it actually appears to be very strong.

D. A management analysis of the Pacific whiting fishery.

This work applies a model developed by Getz and Swartzman (1981) to the Pacific whiting (Merluccius productus) fishery off the North American Pacific continental shelf. Recruitment in this stock is linked both to stock level and water temperature in their spawning area. This link forms the basis of a transition matrix in the model for recruitment which depends both on stock level and spawning grounds temperature. Comparison with historical data on fishery catch and stock estimates shows model output to be realistic.

As an aid to management of the fishery, a policy algorithm was developed which aims to utilize strong year-classes in a practical and efficient manner while at the same time maintaining the productive capacity of the stock. Runs with different quota control criteria in the algorithm were compared with 9-yr and 47-yr runs at constant effort and constant quotas, and the management strategy contained in the algorithm was found to be superior, specifically with regard to prevention of stock collapse and having a higher average catch per unit effort (CPUE). In the policy algorithm, average yield can be increased at the expense of CPUE. The choice of quota control criteria depends on management preference for improving yields versus having highly variable effort and lower average CPUE.

E. Pacific whiting: A multispecies management problem.

Pacific whiting, *Merluccius productus*, provides an opportunity for a multispecies approach to defining optimum yield. Historically, the whiting fishery has primarily benefited foreign fleets. Since FCMA in 1976, this situation has been changing with the development of joint venture operations creating a viable market for U.S. trawlers. Whiting biology presents a case of extensive Pacific coast migration from Mexico to Canada. Food web/gut content studies indicate importance of the pink shrimp, *Pandalus jordani*, in the whiting diet. Speculative impact of the whiting fishery on pink shrimp include potential increase in shrimp landings due to increased whiting catch. Comparison of catch per unit effort and landings between 1960-80 do not show obvious correlation of whiting fishery on shrimp landings. The actual and potential of the two fisheries are compared. Two methods are given for estimating the predation impact by weight of whiting on shrimp; first method analyzes number of shrimp/whiting stomach; second method calculates impact from percentage of shrimp in whiting diet. Discrepancies between two methods indicate need for more detailed studies on multispecies interaction. Marketing and policy problems associated with whiting fishery are also discussed.

5. Research Needs and Cooperative Studies

Workshop participants noted the wealth of valuable information on Pacific whiting contained in the review papers and brought out in discussions during the Workshop. Participants agreed that research needs and cooperative studies should be summarized in this report. It should also be noted that although the following recommendations were not prioritized, Item (a) and (b) were considered by participants to be of major importance.

(a) Considerable discussion centered on the presence of the myxosporean parasite, *Kudoa paniformis*, in the muscle of Pacific whiting. Participants suggested that the evidence indicates *K. paniformis* can be linked to rapid softening of the flesh of Pacific whiting. Participants recommend that investigations be initiated into the physiology of the parasite, effect on whiting, and treatment of the product. It was recommended that one individual from Canada and one from the U.S. be designated to coordinate this research.

(b) Discussion took place on the feasibility of initiating cooperative studies off of the west coast of Vancouver Island. Participants suggested that during the 1983 hydroacoustic-trawl surveys conducted by the U.S. a more intensive U.S.-Canada joint survey be conducted which would result in an increased acquisition of information on abundance and distribution of whiting in this area. Participants also suggested that Canada initiate studies at that time to investigate timing of entry and persistence of whiting in the Canadian zone.

(c) Participants recommend that fishery catch data be exchanged annually by the U.S. and Canada. The data would include size and age composition by sex for each INPFC area.

(d) Participants agreed that fecundity and feeding studies on Pacific whiting be initiated by both countries. Canada requested that ripe and spent ovaries be collected for analyses and for comparison with Strait of Georgia whiting. U.S. requested stomach samples from fish captured in the Canadian fishery. Participants suggested that a detailed laboratory investigation be initiated in order to determine digestion times of various food organisms.

(e) Participants agreed that a management analysis of the Pacific whiting fishery which incorporated Canadian catch-at-age and fecundity-at-age data should be initiated, in order to explore the desirability of over-fishing the larger, older and predominantly female fish in the Canadian zone. Participants recommend that a Canadian representative (G. McFarlane) and a U.S. representative (B. Francis) coordinate the cooperative analysis.

6. Review of Present Management Rationale and Practices

Participants reviewed present management rationale for Pacific whiting. T. Dark presented U.S. management practices as outlined in the "Pacific Coast Groundfish Plan" and R. Beamish presented Canadian management strategies as outlined in "Groundfish Stock Assessments off the West Coast of Canada in 1981 and Recommended Total Allowable Catches for 1982".

7. Consideration of Viable U.S.-Canada Joint Management Alternatives

Considerable discussion took place on management strategies and preservation of the resource. Participants agreed that, as the fishery is underutilizing the resource at the present time, cooperative effort should be directed towards joint research programs as outlined above. The Pacific whiting stock requires no immediate joint management strategies be formulated however, the results of current and proposed studies should be used to develop an array of joint management alternatives. Participants felt that consideration be given to the suggestion that a U.S.-Canada team prepare a "Status of the Stock" document annually or biennially. Participants proposed that matters discussed and recommendations made at this workshop be presented to the Technical Subcommittee of the International Groundfish Committee in June 1982.