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## **I. CALL TO ORDER**

Mr. Mark Wilkins, chairman, called to order the 33rd Annual Meeting of the Technical Sub-Committee (TSC) at 0810 hours on May 5, 1992, at Sand Point NOAA Building 4 in Seattle, Washington.

## **II. APPOINTMENT OF SECRETARY**

Mr. Tom Jagielo of the Washington Department of Fisheries was appointed to serve as secretary.

## **III. INTRODUCTIONS**

Members and other participants introduced themselves. Participants are listed below by agency, with Technical Sub-Committee members indicated by asterisks.

### **Canada - Department of Fisheries and Oceans (DFO)**

#### **Biological Sciences Branch**

\* Mr. Mark Saunders

### **United States**

#### **Pacific States Marine Fisheries Commission (PSMFC)**

Mr. Larry Six (for Mr. Guy Thornburgh)

#### **Pacific Fishery Management Council (PFMC)**

Dr. Jim Glock

#### **National Marine Fisheries Service - Auke Bay Lab**

Mr. Dave Clausen

#### **National Marine Fisheries Service - Alaska Fisheries Science Center (AFSC)**

Mr. Craig Kastle

Dr. Rick Methot

Mr. Tom Wilderbuer

\* Mr. Mark Wilkins (Chairman)

#### **National Marine Fisheries Service - Southwest Fisheries Science Center (SWFSC)**

Dr. William Lenarz

#### **Alaska Department of Fish & Game (ADFG)**

\* Mr. Barry Bracken

#### **Washington Department of Fisheries (WDF)**

\* Mr. Tom Jagielo

Oregon Department of Fish and Wildlife (ODFW)

\* Mr. Bob Demory

California Department of Fish & Game (CDFG)

\* Mr. Dave Thomas

#### IV. APPROVAL OF THE 1991 REPORT AND THE 1992 AGENDA

The 1991 TSC report, prepared by Mr. William Barss of the Oregon Department of Fish and Wildlife, was approved as submitted. The TSC commended Mr. Barss for his timely report preparation and a job well done. The group expressed that it was nice to have time to review the report prior to the meeting.

The agenda was adopted as drafted (Appendix A).

#### V. TERMS OF REFERENCE

No changes in the terms of reference of the Technical Subcommittee were proposed. The Terms of Reference of the Technical Subcommittee are:

1. Exchange information on the status of groundfish stocks of mutual concern and to coordinate, whenever possible, desirable programs of research.
2. Recommend the continuance and further development of research programs having potential value as scientific basis for future management of the groundfish fishery.
3. Review the scientific and technical impacts of existing or proposed management strategies and their component regulations relevant to conservation of stock or other scientific aspects of groundfish conservation and management of mutual interest.
4. Transmit approved recommendations and appropriate documentation to appropriate sectors of Canadian and U.S. governments and encourage implementation of these recommendations.

#### VI. WORKING GROUP REPORTS

##### A. Committee of Age Reading Experts (C.A.R.E.)

C.A.R.E. chairman Craig Castelle reported that C.A.R.E. will meet at the end of May, 1992. The CARE report is attached (Appendix B). C. Castelle reported four current groundfish age structure exchanges currently in progress:

- 1) Pollock - AFSC/PBS/Poland

- 2) Rougheye rockfish - ADFG/AFSC
- 3) Sablefish - ADFG/AFSC/PBS
- 4) Arrowtooth flounder - WDF/AFSC

The TSC discussed the need for groundfish age validation in a variety of species and the use of OTC in particular. W. Lenarz noted that from his experience, getting FDA approval is tough. He suggested that a process should be set up to get formal FDA blanket approval for using OTC for groundfish age validation studies. The TSC concurred, and W. Lenarz was appointed to draft a recommendation from TSC to the Parent Committee to secure a memorandum of understanding with the FDA for OTC use in groundfish age validation studies.

W. Lenarz suggested that TSC should recommend to C.A.R.E. that age validation studies for thornyhead (longspine and shortspine) should be conducted. M. Wilkins volunteered to draft the recommendation.

#### B. PacFIN - PSMFC Data Series Project

R. Methot explained that the PSMFC Data Series Project has been incorporated into the PacFIN "re-definition" process. The TSC expressed an interest in learning more about this process, and Mr. Daspit of the Pacific States Marine Fish Commission was invited to give an impromptu presentation to the group. W. Daspit provided a brief but comprehensive overview of PacFIN and explained the re-definition process. The new system will involve more centralized data processing by PacFIN. Trawl logbook data feeds from the states will be sent to PacFIN, which will allow logbook corrections to be applied to the landings data, and thus more detailed areal summaries of catch by area will be available from the system. The group thanked W. Daspit for a fine presentation requested on very short notice.

B. Bracken said that if the PacFIN system couldn't deliver more area specific information, Alaska would continue to use other sources of information for management.

The group then launched into a discussion of area specific information, and the use of Geographic information Systems (GIS) to manage fisheries. It was suggested that we should go directly to collection of data at the lat-long level of precision, to get the best area specific information possible for area management.

#### C. Stock Assessment Working Groups

##### 1. Yellowtail Rockfish

The report from the working group on yellowtail rockfish fisheries by Tagart and Stanley was given by T. Jagielo. He summarized the report by saying that the study indicated that there were discrete stocks of yellowtail rockfish and that there was a Canada-US transboundary stock. The full report is given in Appendix C.

L. Six asked if the report indicated that there is a conservation problem. From a management perspective, he wished that the report went further. The report confirmed the transboundary stock, but it would be useful to know the harvestable surplus and harvest rates by both countries on that stock for proper management.

M. Wilkins reported that, based on a conversation he had recently had with Jack Tagart, that the harvestable surplus was approximately 2000 mt. for the Southern Vancouver -3B/3C (transboundary) stock. The historical split in the landings by the countries has been 60% US: 40% Canada, but increased harvests by Canada has brought the ratio to about 50:50 in recent years.

L. Six asked if the TSC should be concerned. Would it be useful to make a statement about where we are with yellowtail rockfish?

R. Methot suggested that the TSC could request that the working group explicitly deal with the allocation issue in future reports.

T. Jagielo pointed out that the working group fulfilled the technical task of identifying the separate stock and the conservation issue; it was up to the managers to act on the allocation problem.

M. Saunders agreed that the TSC should inform the managers that, based on the findings of the working group, the stock should be managed as a unit. He questioned that agreement exists between the countries for what the combined 3B/3C yield should be.

M. Saunders and T. Jagielo were appointed to write a statement on yellowtail rockfish.

## 2. Pacific Whiting (Hake)

The report from the working group was given by M. Saunders. The working group continues to exchange data and jointly develop the coastwide stock assessment. Data were assembled to begin employing the sex-based stock synthesis model. A detailed description of the assessment is given the NMFS-AFSC report on Pacific Hake. The papers are currently under review and will be made available at the 1993 TSC meeting.

M. Saunders reported on the status of the Canada/U.S. allocation issue. At a meeting of managers in October, it was decided that the allocation should be based on the mature biomass in the respective countries. The working group was asked to give a recommendation based on the biomass in each zone using NMFS triennial trawl survey data. Two meetings were held in Nanaimo in February. The working group presented a report on the biomass based split analysis, and a second summary report was prepared detailing the results of the meetings.

Primary issues in the allocation talks are 1) a Canadian concern about the U.S. survey



coverage north of 49 degrees, 2) the survey design employed in 1989 was different from previous surveys and may not have been sufficient where the bathymetry is complex, and 3) how to include the Monterey and Conception areas due to the desire to estimate only mature biomass for the allocation decision.

M. Wilkins asked about the importance of the trawl survey to the allocation process. With budget cuts, he must cut back coverage and asked what should be dropped?

M. Saunders suggested that the TSC should recommend that joint Canada/U.S. funding be found to support extending the trawl survey in Canada. M. Wilkins volunteered to write a recommendation to this effect with M. Saunders.

### 3. Flatfish (Dover sole and arrowtooth flounder)

The report from the flatfish working group was given by B. Demory.

The lack of age validation remains a primary concern for Dover sole and arrowtooth flounder. The NMFS flatfish survey scheduled for summer of 1992 was canceled, and the opportunity to conduct an age validation experiment for Dover sole and arrowtooth flounder was lost. The plan was to perform OTC injections of the flatfish and tag the fish with external tags for subsequent recognition and recovery by fishermen and processors. B. Demory did not feel that commercial trawl ride-along tagging trips would be adequate to accomplish the age validation experiment with flatfish, due to the mortality problem from long tow times.

M. Saunders asked if the TSC should push for charter boat time to pursue flatfish age validation experiments. He noted that in Canada, it might be possible to get boat time from the industry if agencies would cover the fuel costs. It was decided to draft a recommendation from the TSC to itself to ask the Dover sole working group to pursue age validation studies for Dover sole and arrowtooth flounder.

## VII. REVIEW OF AGENCY GROUND FISH RESEARCH, ASSESSMENTS, MANAGEMENT, AND FISHERIES

### A. Agency Overview

#### 1. Canada - Department of Fisheries and Oceans (DFO)

Biological Sciences Branch -Pacific Biological Station (PBS)

In 1991 considerable changes were made within the Biological Sciences Branch of the Department of Fisheries and Oceans. The Groundfish, Shellfish and Herring sections were amalgamated with the formation of the Marine Fish Division under Dr. J. Rice. The breakdown of tasks within the Division are as follows:

Assemblage Management -- L.J. Richards  
Fish Population Dynamics -- G.A. McFarlane  
Shellfish -- G.S. Jamieson  
Ocean Environment and Fisheries -- D. Mackas

Researchers from each of the above groups are working cooperatively in multidisciplinary studies reported under 'Other Related Studies'.

The management of marine fish falls under the Fisheries Branch of the Department of Fisheries and Oceans.

## 2. Pacific Fishery Management Council (PFMC)

In 1991 the Pacific Fisheries Management Council (Council) changed several management processes and operations under the newly revised fishery management plan. Quotas for most species were replaced by harvest guidelines, which provide additional flexibility to allow landing of incidental amounts after the annual harvest target has been reached. The three species managed under quotas were Pacific whiting, shortbelly rockfish and jack mackerel, due to the possibility of foreign or joint venture fishing. However, no joint venture fishing occurred for any species, and the entire whiting harvest was taken and processed by U.S. operations. In 1992, all quotas were eliminated and replaced by harvest guidelines.

A major change in 1992 is the replacement of most trip limits with limits on the rate of cumulative catch. Two week cumulative limits are placed on most species and a four week limit on widow rockfish. The levels of these limits were intended to provide for a year-round fishery while keeping total catch within the harvest guideline.

The 4.5 inch minimum codend mesh size regulation for roller and bobbin trawls was expected to go into effect in July 1991. However, implementation was delayed until May 9, 1992.

The Council also took final action on a license limitation plan for the groundfish fishery. Under the plan, which is expected to go into effect in January 1994, vessels using trawl, longline and fish pot gear would have to acquire permits. Eligibility for initial issuance will be based on landings during a 1984-1988 window period. Other gears would be restricted to small amounts of groundfish.

## 3. National Marine Fisheries Service - AFSC

Essentially all groundfish research at the Alaska Fisheries Science Center (AFSC) is conducted within the Resource Assessment and Conservation Engineering (RACE) Division, the Resource Ecology and Fisheries Management (REFM) Division, and the Auke Bay Laboratory (ABL), which is responsible for groundfish assessment in the Gulf of Alaska east

of Cape St. Elias. The RACE and REFM Divisions are divided along regional or disciplinary lines into a number of tasks and subtasks. A review of pertinent work by these tasks during the past year is presented below.

### **RACE Division**

In 1991 the primary activity of the RACE Division continued to be fishery-independent stock assessments of important groundfish species of the northeast Pacific Ocean and Bering Sea. Dr. David Somerton was hired in October 1991 to lead the RACE Groundfish Assessment Task. Dr. Richard Bakkala retired in December 1991 and Gary Walters was recently promoted to replace him as Subtask Leader of the Bering Sea Groundfish Subtask.

Groundfish surveys were conducted by the Bering Sea, Gulf of Alaska, and West Coast subtasks. There were five bottom trawl surveys, two longline surveys, and one trap survey conducted in 1991. Major emphasis was in the Bering Sea and Aleutian Islands, in keeping with the rotation of comprehensive surveys among three major geographic areas on a triennial basis. The focus will be off the West Coast in 1992. The Pelagic Resource Assessment Task conducted two surveys of pollock abundance in the Gulf of Alaska and Bering Sea. A recent reorganization places the old Conservation Engineering (gear/fish interactions and behavior research) under the Pelagic Resource Assessment Task to capitalize on developments in technology. The Recruitment Processes task conducted four Fisheries-Oceanography Coordinated Investigations (FOCI) cruises in the spring of 1991, investigating the interaction between the environment and the spawning products of Gulf of Alaska pollock.

### **REFM Division**

The research and activities of the Resource Ecology and Fisheries Management Division (REFM) are designed to respond to the needs of the National Marine Fisheries Service regarding the conservation and management of fishery resources within the U.S. 200-mile Exclusive Economic Zone (EEZ) of the northeast Pacific Ocean and Bering Sea. Specifically, REFM's activities are organized under the Foreign Fisheries Observer Program and the following tasks: Age and Growth Studies, Socioeconomic Assessments, Resource Ecology and Ecosystems Modeling, and Status of Stocks and Multispecies Assessments. The work of these tasks culminates as technical reports and advice to the appropriate fishery management councils and international fisheries commissions. Some changes were made in significant positions within the Division since last year. Dr. Jim Balsiger left the Status of Stocks Task to become the AFSC Deputy Director. He was replaced by Dr. Richard Methot as Task leader and Drs. Anne Hollowed and Vidar Westpestad were promoted to Sub-Task Leaders for the North Pacific (Gulf of Alaska and West Coast) and Bering Sea/Aleutian Islands sub-tasks, respectively. Scientists at AFSC assist in preparation of stock assessment documents for groundfish in the three management regions (Bering Sea/Aleutian Islands, Gulf of Alaska, and Washington-Oregon-California), conduct research

to improve the precision of these assessments, and provide management support through membership in regional groundfish management teams. Two stock assessment documents were prepared for West Coast stocks and 15 assessments were prepared for Gulf of Alaska and Bering Sea/Aleutian Islands stocks.

#### **Auke Bay Laboratory**

The Auke Bay Laboratory (ABL) groundfish task (part of ABL's marine fisheries assessment program) has focused its efforts since 1982 on research and assessment of sablefish and rockfish in the Gulf of Alaska. Presently, the groundfish task is staffed by 10 permanent and 1 temporary biologist. In 1991 field research, ABL's groundfish task participated in two longline surveys that primarily assessed sablefish abundance in the Gulf of Alaska: 1) the annual Japan-U.S. cooperative longline survey, and 2) the annual domestic longline survey. ABL also conducted a sablefish population experiment in Chatham Strait, southeastern Alaska, in cooperation with the Alaska Department of Fish and Game (ADF&G). Other major field activities included a submersible/trawl study of slope rockfish in the eastern Gulf of Alaska, and early life history studies of sablefish and rockfish.

Several analytic activities were conducted by groundfish task members on sablefish and rockfish in 1991-92. A hook competition model was developed to provide improved estimates of sablefish abundance from longline surveys. The "stock synthesis" model was applied to sablefish to provide alternative estimates of biomass and recruitment. An age and growth study of northern and dusky rockfish in the Gulf of Alaska was completed. A parasite study of shortraker and rougheye rockfish is currently in progress to determine if parasites can be used to identify stocks of these species in the Gulf of Alaska. Task members also prepared three status of stock documents for Gulf of Alaska groundfish: sablefish, slope rockfish, and pelagic shelf rockfish. Other ongoing research activities included a sablefish tag recovery program, analysis of data on migration and growth of juvenile sablefish, and food of adult and immature sablefish.

#### **4. National Marine Fisheries Service - SWFSC**

Groundfish-related research and management support is conducted by three major components of the NMFS Southwest Fisheries Science Center (SWFSC): the Coastal Division (La Jolla), directed by Dr. John Hunter; the Pacific Fisheries Environmental Group (Monterey), directed by Dr. Andrew Bakun; and the Tiburon Laboratory (Tiburon), directed by Dr. Alec MacCall.

##### **Coastal Division (La Jolla)**

The Coastal Fisheries Resources Division is involved in a large number of research studies that support management of groundfish by the Pacific Fishery Management Council. These studies address both short and long term problems in biology and economics that affect management efforts for groundfish. Work in the Coastal Division is focused primarily on

the deep water complex (sablefish, Dover sole and thornyheads) but work on rockfish (Sebastes spp.) in shallow water is also ongoing.

A program to describe the distribution and abundance of groundfish eggs and larvae is being conducted in connection with the CalCOFI program and groundfish research cruises. In addition, definitive studies of the reproductive biology of sablefish and Dover sole have recently been completed and either published or accepted for publication. This information will aid future attempts to measure species abundance by egg and larvae surveys.

The Division recently completed a pioneering effort to measure the abundance of Dover sole from egg and larva data. This work builds on the descriptive work and reproductive studies described above. Two papers, one describing the method and the other describing an application are in press.

The Coastal Division initiated the FORAGE Program to investigate effects of oceanographic processes on groundfish recruitment. This study involves detailed measurements of oceanographic and biological variables stratified by area, depth and season. To date, two successful cruises have been conducted during which sampling techniques for physical and biological variables were developed and tested. The Division is currently seeking funding for additional work through the NOAA Coastal Oceans Program.

Three projects designed to improve management of thornyhead (Sebastolobus spp.) stocks are underway or have been completed. The first project is a joint effort involving scientists at Scripps Institution of Oceanography, Moss Landing Marine Laboratory and the University of Hawaii that involves use of radioisotope ratios to validate criteria used to age shortspine and longspine thornyhead. The second project, which has been completed, is an assessment of fisheries for shortspine and longspine thornyheads north of Point Conception. An analysis of national and international economic factors affecting the fishery for thornyheads is also underway.

The Division recently completed a description of relationships between depth and length of Dover sole off Oregon and California. This work has been submitted for publication and is expected to be immediately useful for stock assessment work.

Coastal Division scientists, in cooperation with the SWFSC Tiburon Laboratory, NOAA's National Undersea Research Program (NURP), and the Monterey Bay Aquarium Research Institute (MBARI) continue to develop technology and procedures for estimating abundance of fish stocks using remotely operated underwater vehicles (ROV's). Three cruises were conducted during 1991 during which equipment was tested and refined and preliminary biomass estimates were obtained for a number of species. ROV estimates of abundance were compared to swept-area method estimates from trawl surveys for the same area. It appears that traditional swept-area methods may underestimate biomass in many cases. These studies are intended to develop new, cost effective means for measuring biomass,

provide information about ecology of the slope community and help improve trawl based biomass estimates.

The Coastal Division is conducting a molecular genetics project that focuses primarily on the population structure of longspine and shortspine thornyheads but is also concerned with Dover sole and sablefish. Mitochondrial DNA sequences from samples of thornyhead from Alaska, Oregon and five sites in California have now been sequenced. The data show a high degree of site specific variation that indicate less mixing of individuals between sites than originally anticipated. These results indicate that thornyheads are retained in their natal regions even though both species have planktonic larval and juvenile stages longer than one year in duration. The influence of various current patterns on larval retention is being investigated.

Investigations of the physiological ecology of the groundfish complex are proceeding based on extensive shipboard studies in Monterey Bay and through laboratory experiments. The most important observation to date is that the center of the groundfish distribution, between 600 and 1,000 m, is also the center of the oxygen minimum zone. Oxygen concentrations throughout the year are 96-98% less than oxygen concentrations at the surface. These exceptionally low oxygen conditions probably place limits on the metabolism, scope for activity and ultimate productivity of the fish community. These studies will help define limits on productivity of deep water fisheries and help predict the effects of exploitation on groundfish adapted to life in the deep water community.

Coastal Division economists regularly develop and analyze information regarding the commercial and recreational groundfish fisheries off the Pacific Coast, emphasizing the California region. Regular data collection activities include the periodic updating of cost and earnings data for groundfish trawlers, fuel prices, and economic indices of trawl fishery productivity. Research is currently focused on building models that predict the effects of individual transferable quota (ITQ) system on groundfish fisheries.

The Division's biological research is supplemented by economic investigations, particularly recreational fishery surveys, analysis of management options, and economic characterization of groundfish fisheries. A manuscript describing the Southern California Angler Survey was completed last year that provides information about fishing effort, travel costs, ethnic participation, target species, and catch rates for the recreational groundfish fisheries. A similar survey for U.S. anglers in Mexican waters is currently underway.

#### **Pacific Fisheries Environmental Group (Monterey)**

Pacific Fisheries Environmental Group (PFEG) develops methods to address the linkages between natural environmental variability and fish populations dynamics. Data series developed within the PFEG research program are made available to scientific collaborators. Co-location with the U.S. Navy's Fleet Numerical Oceanography Center provides access to ocean and atmospheric data on a global scale. Major categories of scientific activity at

PFEG include: (1) Development of environmental index time series, (2) ocean anomaly diagnostic studies, (3) identification of environmental-biological causal linkages through interregional comparative studies, exploratory data analysis, empirical modeling etc., (4) development of appropriate environment-dependent fishery modeling methodologies, (5) development of biological time series for calibration, verification and parameter estimation. A study of potential effects of climate change on marine ecosystems and resources is a major focus of PFEG research activity at the present time. In addition, PFEG personnel are increasingly involved in inter-institutional collaborative field studies of the coastal groundfish habitat off the U.S. west coast.

#### Tiburon Laboratory (Tiburon)

Field and laboratory research on groundfish is cooperatively conducted at the Tiburon Laboratory by three interrelated investigations: Groundfish Analysis, Groundfish Communities, and Groundfish Physiological Ecology.

The Groundfish Analysis Investigation develops methods to predict rockfish recruitment, sample groundfish landings and age groundfishes; staff members also study rockfish life histories, develop new management models and conduct stock assessments. In addition, staff participates on the Pacific Fishery Management Council's Groundfish Management Team and Scientific and Statistical Committee, principally in stock assessments and exploring management alternatives.

Recent publications include documentation of our YOY database, two papers on the early growth of rockfish, a paper on the dynamics of shortbelly rockfish, and a paper on the depth distribution of pelagic juvenile fish. A report on the distribution of important invertebrates and larval, juvenile and adult fish off of San Francisco was submitted to the EPA as part of the characterization of potential dredge disposal sites. A manuscript on the utility of different types of auxiliary data was submitted for publication.

The recruitment work, which aims to detect differences in relative strength of rockfish year-classes prior to their entry into the fishery, continues. Annual surveys using midwater trawls determine the relative abundance and distribution of first-year juvenile rockfishes off the coast of central California. Recently these surveys were expanded to include abundance and growth during an earlier larval stage. During February and March 1992 extensive surveys were conducted off Central California with MIK trawl and MOCNESS gear. The MIK trawl (5 m<sup>2</sup>) survey was aimed at determining the distribution and abundance of late larval rockfish. This life stage is poorly sampled by plankton nets. The MOCNESS work was aimed at determining the depth distribution of larval rockfish. Both 1 m<sup>2</sup> and 10 m<sup>2</sup> MOCNESS nets were used. Factors that influence year-class strength are another area of study. In this work, staff members are evaluating interannual variation in oceanographic conditions, plankton abundance, juvenile rockfish diet, time of spawning, and growth rate. Oceanographic data are collected with a CTD and an acoustic doppler current profiler. Staff members collaborate with staff of the SWFSC-PFEG in analyses of the oceanographic

data.

Work continues on a pilot study to investigate the feasibility of estimating spawning biomass of shortbelly rockfish from larval production. A plankton cruise and two adult cruises were made in early 1991. Specimens are now being processed and we hope to complete a preliminary report by early 1993.

Rockfish landings have been sampled since 1977 in a cooperative program with the California Department of Fish and Game. Since 1986 staff members coordinated an expanded coastwide port sampling of sablefish landings, but because of staff reductions this program was terminated at the end of 1991. The data from the port samples are compiled with software developed by project members and routinely used in stock assessments.

The Physiological Ecology Investigation conducts research to determine factors most affecting physiological condition and reproduction of groundfishes. Research findings contribute to the assessment of stocks and the understanding of how and why recruitment varies. Research emphasis is on factors that influence the ability of populations to grow, reproduce and persist. Both field and laboratory studies are conducted to provide comparison of temporal and spatial patterns. Information is integrated and research activities are coordinated with those of other research Investigations and university and other governmental agencies.

During the last research year, a six year study of yellowtail rockfish, collected monthly from Cordell Bank, California, was completed. Major findings from this research were presented in a number of fora including presentations at scientific meetings, seminars, 4 papers that have been submitted or published in peer reviewed scientific journals, and a thesis.

General aspects of the reproductive life history for both male and female yellowtail rockfish were described including ages and sizes at maturity, seasonal sex ratios, reproductive life spans, and seasonal changes associated with gonadogenesis. Six consecutive years of fecundity data showed that significant interannual differences occurred in these rockfish. This strongly suggests that the assumption of constant reproductive effort between years is not valid. Fecundity best correlated with somatic body weight and there was some evidence of a decline in reproductive effort with advancing age. Although only six years of environmental data were available, storm activity, availability of food, and body condition appeared linked to reproductive performance.

The annual pattern of oocyte, embryonic and larval development was histologically described and divided into 9 developmental stages. Seasonal changes were identified histologically long before they were observed macroscopically. In a companion study, the morphology of the male reproductive system was also described from the macroscopic organ level to the ultrastructure of the gametes. Unique features of the spermatozoa were found that separates Sebastes species from other internally fertilizing fishes.



The importance of maternal nutrient dynamics in relation to the annual reproductive cycle was highlighted in a study that showed that energy rich lipids accumulate in mesenteries and livers and are translocated to the ovaries during periods when yolk is being accumulated in the eggs. The significance of these findings is that larval growth and survival may be compromised if the reproducing female is stressed by conditions in the habitat, such as low food abundance or high water temperatures.

The establishment of the link between habitat conditions, physiological states of adults, and reproduction efforts is one of the primary objectives of the investigation. Present research focuses on defining these relationships and in demonstrating their relevance to fisheries management.

The major objective of the Groundfish Communities Investigation is to determine how changes in the environment affect the distributions, abundances and the relative success of recruitment in groundfish species. Changes considered include regular seasonal transformations of the habitat, as well as changes associated with irregular environmental events like El Niños. Emphasis is on how these changes affect interspecific relationships, particularly those between predator and prey. Because prey populations fluctuate widely in response to habitat transformations, the ability of specific predators to accept alternate prey in the absence of preferred prey is a major topic of study. Information from these studies should help managers anticipate not only the effects of environmental change on the relative availability of prey, but also the impact of fisheries for such important prey as shortbelly rockfish and anchovies. In addition, recruitment strength is thought to correlate with certain elements of environmental change, and so is another topic of study.

The investigation also contributes to assessments of the lingcod stock for the Groundfish Management Team of the Pacific Fisheries Management Council and conducts research based on comments made in response to the stock assessment document. Present studies include age validation, examination of the fishery and modeling the basis of what may be a disturbed sex ratio.

A fourth program at the Tiburon Laboratory is Fishery Management Advisories, which is coordinating a multi-agency investigation of possible radioactive contamination of groundfish at the Gulf of the Farallones Radioactive Waste Dump. A cruise is scheduled for the summer of 1992. Sablefish is one of the target species for sampling.

## 5. Alaska Department of Fish & Game (ADFG)

### Description of the State of Alaska groundfish program:

The Alaska Department of Fish and Game (ADF&G) has management jurisdiction over all groundfish fisheries within the internal waters of the state and to three miles from shore along the outer coast. In addition, a provision in the federal Gulf of Alaska Groundfish Fishery Management Plan gives the State of Alaska limited management authority for

demersal shelf rockfish in the federal waters east of 137° W longitude.

The State of Alaska is divided into three maritime regions for marine fisheries management. For groundfish management the Southeast Region extends from the fisheries conservation line in Dixon Entrance north and westward to 147° W. longitude. The Central Region includes the internal waters of Prince William Sound, Cook Inlet, and Bristol Bay. The Westward Region includes all territorial waters of the Gulf of Alaska west of 147° W. longitude and the Bering Sea.

With the exception of the territorial waters of Southeast Alaska, Prince William Sound, and Cook Inlet, all groundfish fisheries are managed in conjunction with the federal management of the adjacent Exclusive Economic Zone (EEZ). The information related in this report are from the state-managed fisheries only.

### **Southeast Region**

During 1991 the Southeast Region commercial fisheries Groundfish Project was staffed with the project leader in Petersburg, an assistant project leader and a resource assessment coordinator in Sitka. Seasonal port samplers were employed in Petersburg, Ketchikan, Craig, and Yakutat. In addition, age readers in Kodiak and Juneau were funded by the Southeast Region for parts of the year.

The Southeast Region's groundfish project has responsibility for research and management of all commercial groundfish resources in territorial waters of the Eastern Gulf of Alaska. The project also cooperates with the federal government for management of the waters of the adjacent EEZ and the project leader participates as a member of the Gulf of Alaska Groundfish Plan Team.

Project activities center around fisheries monitoring and in-season management of the groundfish resources based on data collected from the fisheries and from resource assessment surveys. Primary tasks include fish ticket collection, editing, and data entry for both state and federal-managed fisheries; dockside sampling of lingcod and rockfish landings; skipper interview and logbook collection and data entry; and biological studies of important commercial species. Three resource assessment surveys were completed during the year. Regulation development and review and information dissemination also require considerable staff time.

### **Central Region**

During 1991 the Central Region was staffed by a biologist and a fish ticket editor in Homer. Both of these persons worked only part time on groundfish issues. The only active management program conducted in the region was the monitoring of the Prince William Sound sablefish fishery. Regulations were implemented for the first time which closed portions of Cook Inlet to groundfish trawling to protect critical crab habitat. Some

additional effort was expended monitoring the rapidly increasing black rockfish jig fishery in the Outer Kenai District.

### **Westward Region**

In the Westward Region a Shellfish/Groundfish Coordinator was responsible for the oversight of fish ticket data entry and integration of data analysis of groundfish data from shellfish stock assessment surveys. The Kodiak staff also increased their monitoring of the near-shore black rockfish fishery around Kodiak Island.

### **Headquarters**

ADF&G personnel continued to enter fish tickets from the EEZ off Alaska during 1991 as the result of a renewed cooperative agreement with the National Marine Fisheries Service (NMFS) to accomplish that task. Fish tickets from all groundfish fisheries in federal waters were collected, edited, and entered on microcomputers by ADF&G personnel in five coastal communities. A programmer analyst working in the NMFS Regional Office in Juneau was responsible for setting up and maintaining the master database and for providing summary groundfish catch information to NMFS, ADF&G and PacFIN. A state-wide groundfish biometrics support position was transferred from Headquarters to the Region I office during the year and diverted primarily to herring stock assessment work.

### **Groundfish Management -- General**

State groundfish fisheries are managed by the Department of Fish and Game under regulations set biennially by the Board of Fisheries. The department announces the open and closed fishing periods consistent with the established regulations, and has authority to close on-going fisheries for conservation reasons. The department also cooperates with NMFS for opening and closing fisheries which are managed jointly.

Fish tickets are required by regulation for all on-shore landings to Alaskan ports and for all landings from state-managed fisheries. The catch data from the fish tickets is used as the primary means of tracking the in-season harvest levels. Fish tickets are collected from as many as thirty or more processors which accept groundfish within the state. The fish tickets are edited for accuracy and the data is entered on microcomputers in Petersburg, Sitka, Ketchikan, Homer, Kodiak, and Dutch Harbor. Because of the intensity of many of the groundfish fisheries, a "soft data" accounting system using processor contacts is also utilized when necessary to track landings during a season.

### **Groundfish research -- General**

Groundfish research is currently being conducted by ADF&G only in Southeast Alaska. Groundfish research is divided into two major components; port sampling/ skipper interviews and resource assessment. Three groundfish resource assessment surveys were

conducted by ADF&G in Southeast Alaska during 1991. Two were designed to assess the relative abundance of sablefish and the other was designed to determine the relationship between near-shore rockfish species composition and abundance and habitat type. A more complete description is included in the sections on those species.

#### 6. Washington Department of Fisheries (WDF)

In 1991, the Washington Department of Fisheries Marine Fish Program merged with the Washington Department of Fisheries Shellfish Program. The program is called the "Marine Fish and Shellfish Program" (MF/SF Program). The new organizational structure includes a Puget Sound Marine Fish/Shellfish Division and a Coastal Marine Fish/Shellfish Division. With the reorganization, the technical services division was eliminated and most of its previous functions have been absorbed by the remaining two divisions. The Age Determination Unit and the Habitat Unit are now under the Coastal division, and the Data Management Unit is now under the Puget Sound Division.

In September of 1992, the MF/SF program will consolidate personnel into the new Natural Resources Building in Olympia, Washington.

#### **Coastal Marine Fish Management**

Coastal Marine Fish Management occurs within the Coastal MF/SF Division. This Division is responsible for management and research of groundfish in all coastal waters and in the outer Strait of Juan de Fuca. The Division also handles all issues requiring interstate, regional, federal or international cooperation. Division responsibilities include membership on the Groundfish Management Team (GMT) of the Pacific Fishery Management Council (PFMC), membership on the Science and Statistical Sub-Committee (SSC) of the North Pacific Fishery Management Council, and Pacific Fishery Management Council, multi-jurisdictional management and stock assessment of groundfish stocks in state waters (0-3 miles) and in the Fisheries Conservation Zone (3-200 miles) adjacent to Washington, and joint research with other agencies or institutions on questions of mutual interest.

Effective management of the coastal groundfish stocks is primarily accomplished through membership on the GMT which develops annual estimates of "Acceptable Biological Catch" for major species/species groups and proposes management strategies to the PFMC. Division personnel implement Council decisions by drafting state regulations and coordinating state enforcement regarding groundfish management. Division personnel are stationed in major ports of landing to collect catch and biological data and other fishery related information.

The Age Determination Unit conducts microscopic examination of otoliths, spines, and other bony structures from marine fish samples to determine the age of specimens in support of marine fish stock assessment.

The Habitat Unit conducts studies to evaluate marine habitat important to Marine Fish resources.

### **Puget Sound Marine Fish Management**

The Puget Sound MF/SF Division defines Puget Sound as those waters east of the Sekiu River including the Strait of Juan de Fuca. Marine Fish management occurs in three units of this division: The Baitfish Unit, The Marine Fish Assessment Unit, and The Marine Fish Monitoring and Operations Unit.

The Baitfish Unit is responsible for all research and management of the baitfish resource; chiefly Pacific herring and smelt. The goal of this unit is to maintain sustainable yields of baitfish harvested by commercial and recreational fishermen. To achieve this goal the unit conducts extensive field sampling programs to determine annual spawning escapement, biological characteristics such as age, size and maturity of the fish, and biomass estimates of the commercial catch. From analysis of the data collected, a management plan is formulated and regulations are implemented to allow for an efficient harvest and conservation of the species while minimizing conflict between user groups. In addition this unit is responsible for the definition and resolution of environmental issues affecting the spawning habitats of baitfishes.

The Marine Fish Assessment Unit is partially supported by a Wallop-Breaux Project. The goal of this unit is to evaluate specific groundfish stocks in order to manage at the stock level. This unit performs analysis of fishery and biological data from regional field surveys and a historical data bases to evaluate stock trends, and resource conservation problems. With consideration of these trends a management plan is developed, implemented and evaluated.

The goal of the Marine Fish Monitoring and Operations Unit is to maintain sustainable yields of groundfish species to the various user groups while providing for the conservation of harvested fishes and minimize conflict between user groups. The unit is subdivided in regional management units which are responsible for the management and operations in their region. These Units perform extensive field sampling and analysis of fishery and biological characteristics in order to insure orderly harvest. This section is responsible for the development and evaluation of management strategies, usually gear and time/area restrictions.

The Hydroacoustics Unit conducts biomass surveys for marine fish stock assessment from the 37-foot boat, M/V Pasquale, with specialized on-board hydroacoustic equipment. Species and areas surveyed on an on going basis include: black rockfish coastwide; true cod in Agate Pass; herring in Bellingham Bay, Hood Canal, Gulf of Georgia, and South Puget Sound; whiting in Port Susan; and sockeye salmon presmolts in Lake Washington. Other activities include bottom mapping coastwide and testing of new dual-beam hydroacoustic gear that will potentially provide greater accuracy in correlating target strength with actual

biomass.

The Data Management Unit is responsible for software and hardware support for the entire Marine Fish and Shellfish Program.

## 7. Oregon Department of Fish and Wildlife (ODFW)

The Oregon Department of Fish and Wildlife was only marginally involved in performing stock assessments during 1991. However, the Department supported several assessment programs in other agencies in the form of samples and data requests from other researchers.

We were also involved in several fishery analyses which included codend mesh size, sablefish allocation and a change in management lines relative to management of the Sebastes complex in the INPFC Eureka and Columbia areas.

B. Demory reported that ODFW now has one full time ageing position paid for with PacFIN funds.

### **B. Review of Multi-species Studies by Agency**

#### 1. Canada - Pacific Biological Station (PBS)

M. Saunders provided information on PBS multi species studies.

#### **Hecate Strait project**

The biannual species assemblage survey of Hecate Strait was continued in June 1991. Results of this survey have been summarized in a report. A primary publication on multispecies research for this region was also completed and published. We are now deriving abundance indices for a number of species within the Strait using geospatial systems techniques. We plan to estimate the variance for the selected species and answer the question of whether the abundance index computed is capable of detecting a specific relative increase or decrease in abundance for the species.

The first assemblage stock assessment will be produced later this year. This assessment will employ surplus production analysis of the pooled catch and effort for rock sole, English sole, and Pacific cod to estimate sustainable yield for this species group. Catch data for each of these species will be estimated from observer data.

#### **La Perouse program**

This cooperative research project, with the Institute of Ocean Sciences, was continued in 1991. As in past years, the primary objective is to measure the amount of inter-annual variation in physical and biological conditions on La Perouse Bank. After this period we

should be able to identify the dominant physical processes affecting the circulation and water property structure, quantify the statistical variability of the seasonal cycle and begin to obtain estimates of the impact on inter-annual abundance of Pacific herring, sablefish and Pacific hake. These species have experienced strong fluctuations in recruitment success recently, that seem to be associated with long-term changes in oceanic conditions.

Considering the diversity in the life history biology of the species being studied, the Fisheries group is developing specific hypotheses to explain recruitment variability for each case. At this point in time, a predator and food-based hypothesis is being tested to explain year-class strength variations in herring; a climate-copepod hypothesis is being tested for sablefish, and a transport-based hypothesis for Pacific cod.

### **Strait of Georgia**

The program began in 1988 to study the marine community structure of the Strait of Georgia. To date, studies have concentrated on an investigation of the early marine mortality of hatchery-released salmon due to predation. Primarily, this has involved a field study of the diet of spiny dogfish in the Big Qualicum river estuary. An experimental program to modify the behavior of juvenile salmon in an attempt to reduce the risk of mortality due to predation was initiated in 1991. Research in 1992 will look at the growth, distribution and survival of salmon during their first period of marine residence in the Strait. A database of the physical and chemical oceanography of the Strait is being developed to investigate the relationship between marine productivity and salmon survival.

## **2. National Marine Fisheries Service - AFSC**

M. Wilkins reported on AFSC multi-species studies.

### **Bering Sea Crab/Groundfish Survey**

An expanded bottom trawl survey was conducted in the eastern Bering Sea, covering the upper continental slope, the north shelf up to St. Lawrence Island, Norton Sound, and the standard survey area of the southeast shelf. The Ocean Hope 3 and Alaska sampled the south east shelf and north shelf from June 4 to August 18 and the Ocean Hope 3 sampled Norton Sound from August 12 to September 3. All stations were sampled with a 83-112 eastern trawl. Catches were sorted to species level, weighed and enumerated. Fish lengths and crab carapace widths were measured and age structures were collected. The Miller Freeman sampled 94 stations on the eastern Bering Sea slope from August 31 to Sept. 27 with a polyethylene Noreastern trawl net equipped with roller gear. Catches were analyzed as above except that no crab carapace widths were taken.

Other research conducted during the survey included collections of:

- 1) stomachs from various groundfish species for food habit studies,
- 2) fish specimens for identification training,

- 3) skates for meristic studies to develop a key to the species of the eastern Bering Sea,
- 4) individual pollock weights for developing relationships to age and length,
- 5) liver samples and lamprey scar counts on pollock from the slope for stock separation study,
- 6) otoliths from Pacific halibut in the standard survey area and otoliths and pituitaries on the continental slope,
- 7) a variety of pathology samples, including tissues from red and blue king crab for studying a microsporidian (*Thelohania* sp.) and a Herpes-like virus, tissues from tanner crabs for studying a parasitic dinoflagellate (*Hematodinium* sp.) and a fungal pathogen, bloodsmears from tanner crabs to study *Hematodinium*, and tissues from 4 dungeness crab,
- 8) separate catch data and otoliths from arrowtooth and Kamchatka flounder to determine if there are significant differences in their growth and distribution, and
- 9) maturity stage data and 100 pairs of ovaries from yellowfin sole for histological examination of ovarian development.

Blue king crab were also tagged near St. Matthew Island to study their growth and migration.

In conjunction with the main survey, a nearshore beam trawl survey was conducted along the Alaska Peninsula and in inner Bristol Bay to examine potential long-term monitoring sites for juvenile red king crab and juvenile flatfish. Beam trawl hauls were successfully completed at 75 stations and 2 scallop dredge tows were completed during this investigation.

Preliminary results of the 1991 survey, comparing the biomass estimates in the standard survey area to the 1990 survey, indicate a change in the population estimates for several species. Biomass estimates of commercially important roundfish such as pollock (-33%) and Pacific cod (-25%) are down considerably from last year. There was generally little change in biomass estimates for small flatfish species such as rock sole (+13%), yellowfin sole (+10%), Alaska plaice (+6%) and flathead sole/Bering flounder (-12%). Estimates of large flatfish species such as arrowtooth flounder/Kamchatka flounder were lower (-14%), Greenland turbot continued to decline (-24%) while biomass of Pacific halibut was up slightly (+9%).

#### Joint U.S.-U.S.S.R. survey

Just prior to the NMFS survey of the eastern Bering Sea, the R/V Novodruetsk, a vessel of the former U.S.S.R., began a cooperative bottom trawl survey. They covered the standard area of the eastern Bering sea and continued across the treaty line to Soviet waters at Cape Navarin and westward past Cape Olyutorski to Karaginski Island. This survey was conducted from May 11 to June 25, covering alternate rows of U.S. stations with a much larger net (94 m footrope compared to 34 m footrope) than in the NMFS survey. This was similar to the 1990 cooperative survey conducted by the R/V Novokotovsk, but the 1991 survey was limited in coverage of the north shelf by ice, and continued west of Cape



Olyutorski. Five U.S. scientists participated in the survey.

The biomass estimates of several commercially important species in the standard (annual coverage) Bering Sea survey area from the last two U.S. and Soviet surveys are listed for comparison in Table 1. The total biomass of the Soviet catches of species selected for comparison was 50% of the U.S. biomass estimate. Exceptions were Pacific cod, which was higher in the Soviet survey, and Pacific halibut and Greenland turbot catches, which were approximately the same as in the U.S. survey. Especially noteworthy were low catches of tanner crabs and king crabs in the 1991 Soviet survey. The 1990 Soviet survey also had generally lower catches than the 1990 U.S. survey. Since the U.S. and Soviet surveys were conducted with different vessels using different nets, at different times of year, it is uncertain how to compare the survey data.

Table 1. Comparison of 1990 and 1991 Soviet and U.S. survey biomass estimates (metric tons) of selected groundfish and crabs in the standard Bering Sea survey area.

Species	Soviet 1990	U.S. 1990	Soviet 1991	U.S. 1991
Pollock	3,153,300	7,653,400	3,070,300	5,109,000
Pacific cod	656,500	708,600	716,700	532,600
Subtotal	3,809,753	8,361,984	3,786,991	5,641,559
Yellowfin sole	2,429,100	2,183,800	805,800	2,393,300
Rock sole	1,304,100	1,409,000	792,100	1,588,300
Flathead sole	333,100	646,000	272,200	570,300
Alaska plaice	679,400	525,800	238,500	529,100
Other flatfish	48,100	46,600	15,100	73,900
Subtotal	4,793,860	4,811,170	2,123,727	5,154,946
Skates	269,600	573,900	202,200	464,400
Arrowtooth flounder	255,900	454,100	155,400	389,900
Pacific halibut	99,800	89,500	95,700	97,600
Greenland turbot	3,200	14,100	10,000	10,700
Subtotal	628,341	1,131,669	463,321	962,189
Sculpins	156,052	224,145	133,600	272,973
Tanner crab	832,800	947,800	68,400	1,017,200
King crab	47,100	84,000	6,600	106,700
Subtotal	879,815	1,031,790	74,971	1,123,827
Total	10,267,821	15,560,758	6,582,610	13,155,494

Perhaps the most valuable data from the 1991 Soviet survey is the catch data off the Soviet coast between Cape Olyutorski and Karaginski Island, which was not examined in a joint survey before. Although the biomass estimates may not be directly comparable to other surveys, the catch data were compared between subareas by the relative catch rate. Catches on the Soviet side may be of concern to U.S. fishermen as they enter into agreements to venture across the Bering sea and fish in the Soviet Exclusive Economic Zone. Catch rates were much lower on the Soviet side than on the U.S. shelf for small flatfish species such as rock sole, Alaska plaice, yellowfin sole and flathead sole/Bering flounder. Skates and larger flatfish, such as arrowtooth/Kamchatka flounder were also less abundant on the Soviet side. Catch rates of Greenland turbot were relatively high in some Soviet subareas. Catch rates of Pacific halibut were also relatively high between Cape Navarin and Karaginski Island.

There were several high catch rates of roundfish on the Soviet side, including Pacific cod and pollock. Overall catch of pollock on the Soviet side was about the same (69.41 kg/ha) as for the U.S. standard area (66.26 kg/ha).

Overall, catch rates of invertebrates were very low in this survey in comparison to the 1991 U.S. survey, and both the Soviet and U.S. surveys from 1990. The low catch rates of king and tanner crabs yielded a combined biomass estimate of less than 7% of the estimated biomass from the 1991 U.S. survey. Apparently the gear did not function well for sampling crabs and other invertebrates.

(Gary Walters, (206) 526-4104)

Table 2. Relative catch rates of subareas in kg/ha for the 1991 Novodruisk survey.

Species	United States			Former U.S.S.R.											
	Southeastern Bering Sea			North			Western Bering Sea								
	1	2	3	4	5	6	9	14	15	16	17				
Skates	.05	0	3.37	2.85	11.03	9.88	7.72	.23	5.41	.16	.82				
Arrowtooth	0	0	2.46	0.44	13.00	7.92	0.05	0	0.18	0.07	0.14				
Greenland t.	0	0	0	0.06	0	0.99	0.34	0.04	0.57	0	0.32				
P. halibut	0.82	0.56	2.48	1.69	4.09	2.89	0.13	0	0.82	3.43	3.40				
Flathead sole	0.14	0.08	12.89	2.12	4.91	10.12	5.84	3.63	3.36	0.11	1.11				
Yellowfin sole	27.60	42.11	16.85	22.63	0.01	0.01	0.03	0.03	0	0	0.64				
Rock sole	34.54	8.58	16.34	25.12	0.12	5.06	0.12	0.03	0.81	1.27	0.09				
Alaska plaice	9.35	12.23	4.38	6.18	0	0.37	1.04	0.83	4.00	0.05	1.73				
Chupeidae	1.89	2.64	0.47	3.94	0	0.03	0.67	0	0	25.14	0.04				
Sculpins	2.94	2.86	1.13	4.97	0.82	3.23	2.37	0.70	9.79	4.68	3.18				
Pacific cod	3.76	2.06	14.77	14.60	9.53	35.11	23.10	10.11	45.36	12.33	21.92				
Pollock	24.63	6.31	67.35	43.37	13.72	173.02	9.01	0.86	48.50	129.82	62.05				
Tanner crabs	0.13	0.15	1.36	1.56	1.18	3.31	1.16	2.39	5.47	0.07	2.75				
King crabs	0.09	0.02	0.32	0.23	0	0.01	0	0.02	0.03	0.13	0.14				
Squid	0	0	0	0	0.23	0.01	0	0	0	0	0.21				
Ast. starfish	12.77	1.97	0.26	0.37	0.03	0.94	0.40	0.22	0.82	0.03	24.37				
Echinoidea	0.05	0	0	0	0.04	0.01	0	0	0	0.01	0.26				



## Bottom Trawl Survey of the Aleutian Islands

The fourth triennial bottom trawl survey of the Aleutian Islands region was completed during the summer of 1991 by the RACE Division of the AFSC. The triennial groundfish surveys are designed to describe and monitor the distribution, abundance, and biological condition of the important groundfish stocks in the Aleutian Islands area. Previous surveys in this series were conducted in 1980, 1983 and 1986. Historically, the Aleutian Islands have been important fishing grounds for a variety of groundfish species including Pacific ocean perch, Atka mackerel, walleye pollock, Pacific cod, Pacific halibut, sablefish, rockfishes, and several invertebrate groups, including crabs and squid.

The survey was conducted aboard two chartered commercial trawlers, the *Ocean Hope I* and the *Green Hope* from July 17 to September 27, 1991. The survey area covered a portion of the southern Bering Sea, from 165°W long. to 170°W long. and throughout the Aleutian Islands from 170°W long. to Stalemate Bank 170°30'E long. Sampling proceeded from east to west at pre-selected stations at depths ranging from 9 to 285 fm (16-521 m).

The stratified random survey design used for the 1983 and 1986 triennial surveys was employed during 1991 to make the most efficient use of limited vessel time and to provide consistency with earlier surveys. The area was stratified based on historical abundance of major commercial species and by depth. A total of 452 stations were randomly selected from a pool of previously successful stations. The proportion of the total available sampling effort allocated to each minor subarea-depth interval was consistent with past surveys. To ensure complete geographical coverage, each minor subarea-depth interval was sectioned into longitudinal strips.

Standard trawl hauls were 30 minutes in duration. Efforts were made to maintain each tow at a constant depth. Catches were sorted to species, weighed and enumerated according to standard AFSC and RACE Division protocol. A variety of biological data (age, length, sex, weight, and maturity of individual specimens) were taken. Special requests were also fulfilled for stomach, tissue, and whole fish samples.

Successful trawls were achieved at 350 of the 379 stations attempted. A total of 108 fish species were identified in survey catches. In addition to the groundfish species, catches also contained representatives from numerous invertebrate orders. In the Aleutian Islands, Atka mackerel, Pacific ocean perch, northern rockfish, walleye pollock, and Pacific cod dominated the catches in most strata. The largest fish concentrations encountered during the survey were in the western Aleutian Islands (west of 180° W) and were composed primarily of Atka mackerel, Pacific ocean perch, and northern rockfish. Catches in the eastern Aleutian Islands were represented mainly by Atka mackerel, Pacific ocean perch, and walleye pollock. Pacific cod were relatively evenly distributed throughout the survey area. Important components of catches from the southern Bering Sea portion of the survey were walleye pollock, arrowtooth flounder, Pacific cod, and rock sole.

(Eric Brown, (206) 526-4157)



## West Coast Continental Slope Research Survey

The RACE Division conducted a bottom trawl survey of the upper continental slope groundfish resources in the INPFC Monterey area aboard the Miller Freeman between October 25 and November 18, 1991. The primary objectives of the survey were to describe the community structure and biological characteristics of the groundfish stocks of the continental slope in the northern segment of the INPFC Monterey area and to resurvey stations in the 300-399 fm zone of the INPFC Columbia and Eureka areas to resolve apparent anomalies observed during past surveys. Successful trawl hauls were completed at 66 of the primary survey stations in the Monterey area. Twenty-six additional successful hauls were completed in the Columbia and Eureka area resurvey project. We also collected shortbelly rockfish specimens for the Tiburon Lab of the SWFSC with 4 targeted midwater tows in the San Francisco area and made 7 phytoplankton tows to obtain specimens for studies of domoic acid toxins.

Concern arose when the 1990 continental slope bottom trawl survey showed that catch rates of sablefish and longspine thornyhead in the Eureka area were markedly lower than those observed in adjacent areas to the north in 1988 and 1989. To determine whether this represented real changes in density, trawl samples were obtained at resurvey stations (300-399 fm) in both areas. The Columbia area catch rates for sablefish, longspine thornyhead, and Dover sole from this year's resurvey in the Columbia area were markedly lower than in 1989; the mean catch rate of shortspine thornyhead, however, increased. The Eureka area catch rates for these species remained about the same in 1990 and 1991, except for an increase in longspine thornyhead in 1991.

Successful trawl samples were obtained from 70 of 73 Monterey area stations. Dover sole was the most abundant species overall in the Monterey area, taken in all strata. It was the most abundant species in the 200-400 fm strata and was among the four most abundant species all but one of the other depth strata. Longspine thornyhead was the second most abundant species, taken in all except the shallowest stratum. It was the most abundant species between 400 and 600 fm. Pacific hake was very abundant inside 400 fm and ranked third in abundance over all depths. Sablefish catch rates were relatively consistent over all depth strata, making it the fourth most abundant species overall. Pacific grenadier, grooved Tanner crab, shortspine thornyhead, and giant grenadier were also important components of the overall catch.

Otoliths and data on individual length, weight, and maturity stage were collected from sablefish, Dover sole, shortspine and longspine thornyhead. Stomach samples were collected from six slope groundfish species for feeding habits studies and, 83 juvenile sablefish were tagged, injected with OTC, and released in good condition in the study area. Oceanographic data (CTD or XBT water column profiles) were obtained at most stations.  
(Paul Raymore, (206) 526-4121)

## Sablefish and rockfish early life history studies

Two ichthyoplankton sampling cruises were conducted by ABL using the RV John N. Cobb in waters offshore southeastern Alaska in May and June 1991. Sablefish larvae were found most abundant 140-160 km offshore in neuston tows taken during the May cruise. Although sablefish catches were not as high in 1991 as in a similar cruise in 1990, they were still the most abundant (up to 960 per 15 minute tow) and most frequent (20 of 26 stations) fish larvae in the neuston samples. These observations confirm that early life history stages of sablefish in the eastern Gulf of Alaska depend on the offshore pelagic habitat. Foul weather restricted the June 1991 sampling to only 10 stations along 57°N. Sablefish were much fewer in the June samples but still restricted to those stations furthest offshore.

As in 1990, rockfish were among the most numerous fish larvae taken in oblique bongo tows during the May and June 1991 cruises. All rockfish larvae were preflexion stage and could not be identified to species, although several distinct pigment patterns were present. (Bruce Wing (907) 789-6043)

M. Saunders remarked on the surprisingly high abundance offshore; these results are unlike the Canadian neuston survey results, where abundance is centered much closer to shore.

B. Bracken suggested that the results may illustrate the importance of the gyre and its influence on strong sablefish year classes. Larval fish may be transported offshore and then back onshore.

## Age and Growth Task - REFM

The Age and Growth Task of the REFM Division serves as the Alaska Fisheries Science Center's ageing unit for groundfish species. The task consists of a biometrician, data manager/technician, and 10 age readers (2 positions are currently empty). Ages are usually determined from otoliths, scales or finrays.

Data provided by the task are used in stock assessment work which contributes to the estimation of the allowable catch of many commercially important groundfish species. These species include walleye pollock, Pacific whiting, Pacific cod, Pacific ocean perch, rougheye rockfish, misc. rockfish sp., Atka mackerel, yellowfin sole, and rock sole.

Craig Kastle received a M.S. in Fisheries in August, 1991, for his thesis titled "Radioisotope age validation and an estimate of natural mortality from the gonad to somatic weight index for sablefish (Anoplopoma fimbria). The highlight of the thesis was validation of ageing criteria for sablefish using the radiometric technique. The possibility of further radiometric work is being considered for rockfish species.

We have recently completed a paper which "Examines the effects of year-class strength on age determination" for walleye pollock. This paper will appear in a special age and growth



issue of the Australian Journal of Marine and Freshwater Research.  
(Dr. Daniel K. Kimura (206) 526-4200)

#### Food Habits Studies - REFM

The Food Habits Program continued regular collection of food habits information on key fish predators in the North Pacific. Program personnel and fishery observers collected fish stomachs. About 9455, 2647, and 847 stomachs were collected from the Bering Sea, Aleutian Islands and Wash.-Ore.-Calif. coast, respectively. Bering Sea species sampled were walleye pollock, Pacific cod, yellowfin sole, Alaska plaice, rock sole, flathead sole, arrowtooth flounder, Greenland turbot and Pacific halibut. Aleutian Islands species sampled included walleye pollock, arrowtooth flounder, Pacific cod, Pacific halibut, sablefish, Pacific ocean perch, and miscellaneous rockfish species. West coast species sampled were Pacific hake, sablefish, longspine and shortspine thornyhead, deep sea sole, and Dover sole. Shipboard scans of fish stomach contents were performed on 993 fish (primarily walleye pollock) in the eastern Bering Sea and Gulf of Alaska. Laboratory analysis of stomach contents by regions totalled 4637, 1885, and 615 stomachs for the Bering Sea, Gulf of Alaska and West coast regions, respectively.

Food habits data from yellowfin sole, flathead sole, and Pacific cod from the Bering Sea were examined to determine the location, size, and timing of Tanner crab consumed with the intent of examining the usefulness of the data as growth and abundance indicators for early Tanner crab instars. There was too much variability in the appearance of a given instar in stomach contents across months to use the data to track abundant instar groups and their molts. Bering Sea groundfish diet information was provided to University of Alaska researchers examining Bering Sea food webs.

Groundfish predation data from 1987 and 1988 in the eastern Bering Sea was summarized and trends in consumption of walleye pollock and herring by groundfish were examined for the time period of 1985 to 1988. Groundfish predation on walleye pollock during this time period was dominated by cannibalism on age-0 walleye pollock by adults. Highest predation rates during the 4 years occurred in 1985, which coincided with the higher 1985 pollock year-class size (relative to 1986 through 1988) as predicted by cohort analysis estimates of year-class size at age 3 and trawl survey estimates of the 1985 year-class size at age 1. Estimated numbers of a particular year-class of pollock consumed at age 0 by groundfish predators were highly correlated both with cohort analysis estimates of year-class size at age and trawl survey estimates of year-class size at age 1. Herring consumption by groundfish predators tended to be sporadic in time and space and may depend on encounter rates of herring schools rather than overall biomass. No particular age group of herring was consumed although Pacific cod ate large numbers of age 1 herring. Sizes eaten by groundfish mainly ranged from 19 to 30 cm. Pacific cod tended to be the most consistent predator on herring, consuming herring in all four years. Herring were consumed by cod in widely scattered locations on the eastern Bering Sea shelf from May to September. During winter, herring consumption by cod was observed only near the continental slope between 59-60° N latitude. Other groundfish predators on herring were walleye pollock, arrowtooth flounder, and

Greenland turbot. Consumption by these predators occurred in only 1 or 2 out of the 4 years sampled. There was no apparent relationship between biomass of herring consumed by groundfish predators and cohort analysis estimates of herring biomass in a given year.

The Japanese groundfish food habits data base, which contains data collected from 1970 to 1985 in the Bering Sea was restructured and converted into a format similar to the Food Habits Program data base to allow the use of our data analysis programs. Unfortunately, the data were collected in different geographic areas over time and have very few recorded prey lengths. Only 104 lengths of prey pollock cannibalized by adults were recorded for the 15 year time span and, given the variable areas covered, greatly limit the ability to calculate total cannibalism by year.

(Pat Livingston, (206) 526-4242)

#### Observer Program - REFM

The Fisheries Observer Program is responsible for placement of observers on foreign and domestic vessels fishing in the EEZ of the northeastern Pacific Ocean and Bering Sea. Observers collect data which provide the basis for in-season management of foreign, joint venture and domestic fisheries by NMFS, and a means for evaluating and developing management strategies by regional management councils and NMFS. Observers play important roles in monitoring compliance to U.S. fishing regulations and provide information that is useful in promoting development of the U.S. fishing industry.

During 1991, no foreign vessels were allowed to catch or process fish in the U.S. EEZ along the west coast and Alaska. All of the allotted groundfish were given to U.S. vessels and processing plants, both for catching and processing. The Observer Program trained and deployed 429 observers to domestic vessels fishing off Alaska, and 31 observers to domestic vessels fishing off the Washington-Oregon-California coast. The Program was responsible for defining the sampling duties and data collection methods used by observers, training of the observers prior to deployment, debriefing of observers upon their return, and editing and managing the resulting data. The catch data were provided to the Alaska and Northwest Regional Offices to assist in management decisions regarding the catches of groundfish and prohibited species. These data were also used in the implementation of the Vessel Incentive Program in Alaska, where vessels were prohibited from exceeding certain prohibited species catch standards. Valuable data were also collected regarding the operations of the domestic groundfish fishery.

(Russell Nelson, (206) 526-4194)

## C. By Species, by Agency

### 1. Pacific cod

#### a. Canada-DFO

M. Saunders presented the Canadian report on Pacific cod.

#### Research programs

A number of previously published hypotheses explaining recruitment patterns of Pacific cod in Hecate Strait were combined into a single modelling framework (Tyler and Crawford 1991). Of the five hypotheses examined using response surface analysis, two were supported by the response surface fit and prediction tests. Recruitment was found to decrease with increasing northward water transport during the period when cod were in the larval stage because of loss due to advection. A dome-shaped stock-recruit relationship emerged when data on transport and stock size were fitted simultaneously. This two-factor model predicted 73% of the observed value of the strong 1985 year-class, higher than any other model. Pacific cod recruitment patterns were not well explained by the abundance of herring, either as larval herring as food for larval cod or as adult herring in the year prior to spawning as food for spawning adults.

#### Stock Assessments

The exceptionally strong 1985 year-class which dominated the landings since 1987 has completely passed through the fishery. Landings in the Strait of Georgia decreased in 1991 for the third year in a row to the lowest level in the 36-year time-series. Landings off the west coast of Vancouver Island increased in 1991 to a level comparable to the mean of landings from 1970-1991, a time-series that included three upward and three downward stock swings. An intense fishery in Hecate Strait resulted in the second highest landings there in 25 years. Early indications of a moderately strong 1989 year-class in Hecate Strait were substantiated.

The computer model developed in 1990 for estimating potential yields for the Hecate Strait cod stock indicated that continued high exploitation rates would result in a spawning biomass lower than that needed to provide optimum recruitment (4000 t plus or minus 1000 t).

Year	Total* Biomass	Spawning* Biomass	Estimated Yield	Actual Yield
1990	7100	2200	3590	3508
1991	4800	1100	7600	7782
1992	4376	754	4738	-

\* year-end

Results for 1992 were estimated on the basis that trawling effort would have been the same as in 1991. The following catch limitations were recommended to ensure that the spawning stock was not overfished:

Low-risk sustainable: 1100 t  
Sustainable level: 2100 t  
High-risk sustainable: 3400 t

The yield model predicted an increase in spawning biomass if landings were no greater than 3400 t. The high risk option was considered acceptable if a closure was implemented to protect aggregated cod during their spawning season.

#### Management and regulations

The southern portion of Hecate Strait is closed to fishing for the first quarter of the year and an annual quota of 3400 t is imposed for Hecate Strait. A coastwide trip limit of 31.8 t (70,000 lb) is in effect January 1 through March 31, 1992, subject to in-season reviews of catch rates in Hecate Strait.

#### b. National Marine Fisheries Service - AFSC

##### Bering Sea/Aleutians.

Pacific cod in the EBS and Aleutian Islands are managed as a unit, although nearly all of the assessment research focuses on the EBS portion of the stock. Annual trawl surveys indicate that the biomass of Pacific cod in the EBS remained high and stable throughout the 1980s. However, the 1990 survey showed a 26% drop in biomass relative to 1989, and the 1991 survey showed a 25% drop in biomass relative to 1990. Concern has been expressed over this decline and the poor recruitment observed during the past three years. It has further been noted that the stock's dynamics may be entering a new phase defined by different environmental conditions or ecological relationships. However, the 1990 and 1991 surveys also show evidence of stronger-than-average year classes that will recruit at age 3 in 1992 and 1993.

The stock assessment model used to calculate ABC for Pacific cod in the EBS was re-tuned for the 1991 assessment, incorporating survey and catch data from 1991 and an expanded supply of age data. This resulted in new estimates for all parameters estimated by the model, and led to the conclusion that reliable values for  $MSY$ ,  $F_{MSY}$ , and  $B_{MSY}$  were no longer available. Because the model is tuned to the survey results, it showed a decline in biomass between 1990 and 1991. However, the decline indicated by the model was smaller than that indicated by the survey (8% vs. 25%, respectively).

The EBS cod model calculates ABC by applying the target exploitation rate (in this case the  $F_{0.1}$  rate, 0.145) to projected biomass through a complex schedule of age- and time-

dependent fishing mortality rates. This procedure produced a 1992 ABC of 162,000 t for the EBS portion of the stock, which was scaled upward by a factor of 1.124 to give a 1992 ABC of 182,000 t for the EBS and Aleutian Islands combined.

Because reliable estimates of  $F_{MSY}$  and  $B_{MSY}$  are no longer available for the EBS Pacific cod stock, overfishing is defined to occur at the fishing mortality rate that reduces the biomass-per-recruit ratio to 30% of its pristine value. This fishing mortality rate is 0.149, which corresponds to a 1992 catch of 188,000 t for the EBS and Aleutians combined.

The Gulf of Alaska stock yielded a catch of 81,100 t in 1991, surpassing the previous record of 78,300 t set in 1990. The stock reduction analysis used to assess this management unit was recalibrated, incorporating new estimates of growth, discard, and natural mortality parameters. As in the two previous assessments, a correction factor was used to allow the model to exhibit continuous growth and continuous harvest simultaneously. The  $F_{0.1}$  harvest strategy ( $F=0.18$ ) was used to set both ABC and TAC, giving a projected 1992 catch of 63,500 t. Overfishing is defined to occur at  $F=0.25$ , or a 1992 catch of 87,600 t.

(Dr. Grant Thompson at (206) 526-4232)

#### c. Alaska Department of Fish & Game

Mr. Bracken presented the ADF&G report on Pacific cod.

#### Research

There are currently no research or stock assessment programs conducted by ADF&G specifically for Pacific cod. Catch rates and limited biological information is gathered from fish ticket records and port sampling programs and also during stock assessment surveys for other species. Anecdotal information from surveys for other species and from conversations with fishermen suggest that Pacific cod stocks in the Southeast area may be increasing after several years at relatively low levels.

#### Fisheries

Much of the Pacific cod harvested in Southeast Alaska is taken by longline gear and utilized as bait in fisheries for other species. In other areas of the state, Pacific cod are harvested in both state and federal waters and utilized primarily as food fish. Harvests of Pacific cod in state waters increased dramatically in 1991 with total of 2,190 mt reported from state-managed waters. Southeast Alaska which has dominated the cod harvest in past years accounted for only 13% of the total in 1991 with the balance evenly split between Prince William Sound and Cook Inlet. An undetermined amount is also taken from within three miles of shore in the remainder of the Gulf of Alaska and the Bering Sea.

## 2. Rockfish

### a. Canada-DFO

Mr. Saunders gave the DFO report on rockfish.

#### **Rockfish - offshore**

#### **Research programs**

In 1991, a major investigation of the early life history and recruitment biology of commercial shelf and slope rockfishes was initiated. This investigation will examine the behavioral and physical process of recruitment for these important rockfishes, which do not recruit to commercial fisheries until they are 10-20 y old. A March cruise investigated depth and area distribution of spawning adults and larvae of *Sebastes alutus* at the mouth of Queen Charlotte Sound. Intra-ovarian and pelagic samples of larvae were obtained for DNA analysis, as well as pre-extrusion larvae of *S. flavidus*. Larvae were widely dispersed although many females were still pre-parturition. Larvae were found at depths of 50-500 m over bottom depths of 100-2000 m. Distribution indicated passive transport by contour-following southeast wind driven currents. May and June cruises investigated distribution, abundance and feeding relationships of nearshore assemblages of juvenile shelf and slope rockfishes off the west coast of Vancouver Island. Gillnet, bottom and midwater trawl collections showed depth gradation of size for both *S. flavidus* and *S. pinniger* and obtained the first specimens of *S. brevispinis* <20 cm. These cruises also collected length, age, maturity, and feeding information on *S. emphaeus* and *S. wilsoni*, two relatively unknown dwarf rockfishes.

#### **Stock assessment**

Stock assessments for slope rockfish will be revised and updated over the next one or two years. This work will include a new catch-age analysis for Pacific ocean perch (POP) stocks in Queen Charlotte Sound. In addition, simulation studies are planned to examine management options for the slope rockfish assemblage. As a first step, the POP biological sample data base was updated. We have also re-examined POP CPUE data; interpretation of CPUE trends has been complicated by restrictive trip limits.

Stock assessments for shelf rockfish were relatively unchanged from the previous year; only the *S. brevispinis* assessment for Queen Charlotte Sound showed indications of lower biomass. A detailed study of reproductive strategies and their management implications for *S. alutus* was also published. A paper reviewing the application of F-based reference points for fisheries management on the west coast of Canada was presented at and submitted for publication of a symposium on risk assessment and biological reference points for fisheries management. An additional paper describing the results of two experimental management programs for rockfishes was also submitted to this symposium.

The need for a well-defined and agreed-upon evaluation framework, and the potential for problems in conduct and interpretation of such experiments as a result of data misreporting were highlighted. Unrestricted fishing in one of these experiments has reduced a strong cohort of *S. alutus* to subordinate status.

A paper describing the examination of parasites of *S. flavidus* as potential indicators of stock identity was completed and accepted for publication. In general, parasites indicate a high degree of mixing for putative stock units within B.C. waters.

### Management and regulations

The majority of commercially harvested rockfishes are managed using a combination of quarterly quotas and trip limits. The management goals are to provide an orderly harvest, to stay within assigned quotas and to extend the fishing season for at least 10 months.

In 1991, shelf and slope rockfishes are being managed by coastwide quota, i.e., there are no quotas for specific stocks, although assessments are conducted on a stock by stock basis. Quarterly quotas are managed under a graded set of trip limits depending on the amount of quota remaining in the quarter. In addition, vessels have the option of declaring (for a six month period) two or three trips per 30-day interval, with different trip limits for the two types.

In order to provide sufficient protection for the Goose Island Gully *S. alutus* stock, the area is closed to *S. alutus* fishing until June 1 and a 4.5 t trip limit will be imposed upon attainment of the area quota.

### Rockfish - inshore

#### Stock assessment

In addition to assessment methods used in past years, a new habitat based assessment was developed for assigning yield in 1992. Rockfish habitat coverage (km<sup>2</sup>) by statistical area was determined from digitized maps. The ratio of total annual catch to habitat coverage was then calculated for each statistical area in the Strait of Georgia. Based on catch history and other fishery indices from these areas, a high-risk value and a low-risk value of the ratio were estimated. High-risk and low-risk yields for each statistical area coastwide were calculated from the product of the estimated ratio and the habitat coverage. We plan to improve this technique in 1992, by defining habitat coverage as the bottom habitat area rather than surface habitat area. We also plan to increase biological sampling of the directed fishery.

## Management and regulations

Area licensing was implemented for hook and line vessels. Fishermen will be required to choose annually to fish in either the Strait of Georgia or the remainder of the coast. In the Strait of Georgia, all rockfish except yelloweye must be kept alive while on board the vessel (20% dead allowed) to encourage a live rockfish fishery. Area specific quotas are in effect coastwide. Halibut fishermen are limited to a 15% rockfish bycatch.

Area license limitation for the "hook and line rockfish" fishery will be established for the Strait of Georgia in 1992 and for the remainder of the coast in 1993. Criteria for license selection is to be based on total landed catch between 1987 and 1990. In addition, a live-fishery only is permitted in Major Area 4B, with the remainder of the coast open to other types of fishing. A 15% rockfish bycatch in the halibut fishery will remain in effect for 1992.

### b. Pacific Fishery Management Council

The PFMC continues to manage the Sebastes complex as a unit, with an overall trip limit and individual species sublimits for yellowtail rockfish and now bocaccio. In 1991 the management approach was modified to establish a single coastwide trip limit of 25,000 pounds for the complex as a whole. North of Coos Bay this was a weekly limit of which no more than 5,000 pounds could be yellowtail rockfish. South of Coos Bay, there was no frequency limit but there was a sublimit of 5,000 pounds of bocaccio. The catch of the Sebastes complex in the Columbia and Vancouver INPFC areas in 1991 was 11,309 mt including 9,646 mt of landed Sebastes complex, 769 mt of landed unspecified rockfish and 322 mt discarded at sea in the whiting fishery, and an estimated 511 mt discarded yellowtail rockfish. The total catch of yellowtail rockfish in 1991 was 4,764 mt including a pro-rated portion of the unspecified rockfish, 269 mt discarded by the at sea whiting fishery and an estimated 511 mt discarded because of the highly restrictive trip limit.

The 1992 harvest guideline for Sebastes complex in the Vancouver-Columbia area is 11,800 mt, which includes a 5,400 mt harvest guideline for yellowtail rockfish. The trip limit for the complex has been changed to 50,000 lbs cumulative per two weeks. The yellowtail rockfish limit has been changed to 8,000 lbs per two week period north of Cape Lookout.

Pacific ocean perch is managed as an incidentally caught species. In 1992 the ABC was kept at zero, and the harvest guideline was set at 1,550 mt for the Vancouver plus Columbia areas to allow for incidental catch under a trip limit of 3,000 lbs. The annual catch under this trip limit was 1,358 mt in 1991.

The total landed catch of widow rockfish in 1991 was 6,782 mt. In addition, 263 mt were discarded by at-sea whiting processors. The total was close to the harvest guideline of



7,000 mt. The 1991 widow rockfish fishery operated under a 10,000 pound trip limit (per week) through September 24, then was reduced to an incidental catch limit of 3,000 pounds. The 1992 coastwide harvest guideline for widow rockfish is 7,000 mt. There is a cumulative limit of 30,000 lbs per four week period.

#### c. National Marine Fisheries Service - AFSC

### **Shelf rockfish**

#### **Research**

#### **Age and Growth of Northern and Dusky Rockfish**

Age-length samples collected during the 1984 and 1987 trawl surveys were analyzed to provide the first break and burn estimates of maximum age and growth parameters for northern and dusky rockfish in the Gulf of Alaska. Based on a sample of 853 aged fish, maximum age of northern rockfish was 49 years with estimated von Bertalanffy parameters of  $L_{inf} = 35.6$  cm;  $K = 0.19$ ; and  $t_0 = -1.51$ . Based on a sample of 488 aged fish, maximum age of dusky rockfish was 49 years with computed von Bertalanffy parameters of  $L_{inf} = 47.9$  cm;  $K = 0.14$ ; and  $t_0 = -2.72$ . (Jonathan Heifetz (206)526-4165)

#### **Assessment**

#### **Gulf of Alaska**

The pelagic shelf rockfish assemblage is comprised of five species that inhabit waters of the continental shelf of the Gulf of Alaska and that are thought to exhibit midwater schooling behavior. Dusky rockfish appears to be the most abundant species in the group. Current exploitable biomass for the pelagic shelf assemblage is based on the average of the biomasses estimated in the 1984, 1987, and 1990 triennial trawl surveys: 76,501 mt. Similar to slope rockfish, however, results of all these surveys are highly uncertain, especially when applied to species that may be somewhat pelagic in distribution. Pelagic shelf rockfish are presently managed using an  $F=M$  strategy, in which the annual exploitation rate is set equal to the rate of natural mortality. Based on the recent age and growth study for dusky rockfish, natural mortality of dusky rockfish is estimated to be 0.09. Applying this exploitation rate to the current exploitable biomass yields a Gulfwide ABC of 6,886 mt for 1992.

In 1991, a small boat jig fishery for black rockfish (one of the species in the pelagic shelf group) developed in the central Gulf of Alaska in the Kodiak-Kenai Peninsula area. This fishery took a sizeable proportion of the reported catch for pelagic shelf rockfish in this region. To prevent future selective overexploitation of this species, the Gulf of Alaska Groundfish Plan Team recommended that black rockfish be split from the pelagic

shelf assemblage, and that it be assigned a separate value of total allowable catch. The North Pacific Fishery Management Council decided, however, that there were insufficient data to enact this recommendation in 1992.  
(Dave Clausen (907)789-6049)

## **Slope rockfish**

### **Research**

#### **Submersible/Trawl Studies of Slope Rockfish**

The NOAA research vessel John N. Cobb, the manned submersible Delta, and the submersible tender MV Pirateer completed a 12-day combined cruise on 16 June 1991. Study sites, located offshore of Iphigenia Bay in Southeastern Alaska to Yakutat Valley in the northern Gulf of Alaska, were surveyed from the submersible to determine the numbers, spatial distribution, and habitat of offshore rockfish. Selected sites were then trawled by the RV John N. Cobb to confirm identities and quantities of fish observed visually from the submersible. Nine submersible/trawl comparisons were made in 1991, adding to the nine similar comparisons made in 1990. Observations from 30 submersible dives in 1991 confirmed the behavior and habitats occupied by rockfish on 20 previous dives in 1988 and 1990. Depths of submersible dives ranged from 188 to 365 m. Counts of Pacific ocean perch and other rockfish, as well as comments made by personnel aboard the submersible and tender vessel, were recorded on video tape along 4 transects across a rectangle 0.25 nmi wide by 0.3 nmi long. Observation along the transects was limited to 7 m distance as determined by a portable sonar gun.

Submersible observations of fish behavior and habitats provided insight as to the vulnerability of fish to trawl gear. Most Pacific ocean perch were in groups of 2-200 individuals located over flat, pebble substrate. Individual fish within the group were 1-4 m apart, usually oriented into the current, and distributed 0-7 m above the bottom. When approached closely, these fish dove for the bottom. Shortraker rockfish were on 3-12° sloping terrain comprised of silt or pebbles interspersed with boulders. These fish were on or near the bottom, solitary, and showed little or no reaction to the close approach of the submersible. Other Sebastes spp. were associated with rugged habitat such as cobble, boulders, and coral.

Densities of rockfish estimated from bottom trawl catches were higher than densities observed from the submersible, indicating that the trawl gear herded rockfish into the opening of the trawl. This possible herding effect and the preference of Pacific ocean perch for smoother substrate may result in systematic overestimates of abundance for this species in bottom trawl surveys.

(Ken Krieger 907-789-6053 or Dick Haight 907-789-6052)

## Parasite Study of Shortraker and Rougheye Rockfish

Parasites often have proven useful as biological markers for separating stocks of fish. Autopsies are currently underway on shortraker and rougheye rockfish collected in the 1991 domestic longline survey to assess the use of parasites in identifying stocks of these two species. Initial results suggest that the prevalence of acanthocephalans is highest and cestodes and nematodes are lowest in the central Gulf of Alaska. Gill and gut parasites show promise for separating stocks within Alaska and appear quite different from parasite species reported from Canadian rockfish.  
(Adam Moles (907)789-6023)

## Assessment

### Bering Sea

#### Pacific Ocean Perch

Results from recent stock assessments, indicate that recruitment has improved. This has resulted in an increasing trend in biomass in both regions, particularly in the Aleutian Islands region. Overlapping confidence intervals between the trawl survey point estimates, however, indicate that this trend may not be statistically significant. Because of the uncertainty regarding trawl survey biomass estimates, alternative survey methodologies are presently being explored that may lead to improved estimates in the future (e.g., as described in the AFSC's Rockfish Working Plan).

Previously, the NPFMC assigned a single ABC annually for the Pacific ocean perch complex. This complex is comprised of Pacific ocean perch, northern rockfish, rougheye rockfish, shortraker rockfish, and sharpchin rockfish. Recent evidence indicates that commercial fishermen may be targeting upon certain species in the complex, especially shortraker and rougheye rockfish. There is an economic incentive to target on rougheye and shortraker rockfish because they command a much higher ex-vessel price than the other species in the complex. The ability and tendency of the commercial fishery to target on these species poses a major conservation concern. To prevent possible depletion of these more desirable species, the NPFMC in 1991 divided the Pacific ocean perch complex into management subgroups.

In the eastern Bering Sea region, the Pacific ocean perch complex has been divided into two subgroups -- a subgroup containing S. alutus only and a subgroup containing shortraker, rougheye, sharpchin, and northern rockfishes combined. In the Aleutian Islands region, the Pacific ocean perch complex has been divided into three subgroups -- a subgroup containing S. alutus only; a subgroup comprised of shortraker and rougheye rockfishes; and a subgroup containing northern and sharpchin rockfishes. Separate ABCs are now assigned to each management subgroup.  
(Daniel Ito at (206) 526-4231)

## Gulf of Alaska

Slope rockfish are defined as those species of Sebastes that, as adults, inhabit waters of the continental slope, generally in depths greater than 150-200 m. Twenty species of rockfish are classified into the slope assemblage, the most abundant of which are Pacific ocean perch, and northern, rougheye, sharpchin, redstripe, harlequin, and shortraker rockfish. The stock abundance of slope rockfish is considered to be depressed compared to its former abundance in the early 1960's. Recent stock assessments have been based mostly on triennial trawl surveys of the Gulf, the results of which are uncertain. The 1987 survey indicated stock abundance was increasing, whereas the 1990 survey showed a sharp decline. Because of the uncertainty regarding these surveys, exploitable biomass of slope rockfish is presently based on the average of the two surveys, and is estimated at 532,575 mt.

To prevent possible overexploitation of the more desirable species, the slope rockfish assemblage is divided into three subgroups: Pacific ocean perch, shortraker/rougheye rockfish, and other slope rockfish. Separate ABC's are assigned to each subgroup. The subgroups are managed under an  $F=M$  strategy, in which the annual exploitation rate is set equal to the rate of natural mortality. For the Pacific ocean perch subgroup, the  $F=M$  exploitation rate is reduced by 50% to conform with the North Pacific Fishery Management Council's definition of overfishing. The 1992 ABCs are as follows: Pacific ocean perch, 5,730 mt; shortraker/rougheye rockfish, 1,960 mt; and other slope rockfish, 14,060 mt.

(Jonathan Heifetz (206)526-4165)

## West Coast

### Pacific Ocean Perch

A rebuilding program was established for Pacific ocean perch in 1981 following depletion of this stock during the 1960s and early 1970s. An assessment in 1987 indicated that the stock remained depleted. A review in 1990 of recent commercial fishery length data did not indicate any significantly strong year classes entering the fishery. The research surveys, which generally capture younger fish did indicate some evidence of incoming strong year classes, although none rivalled the magnitude of the 1970 cohort. This signal is encouraging, but significant rebuilding has not occurred. A new assessment of the Pacific ocean perch resource will be conducted in 1992. This assessment will employ the stock synthesis model for the first time and will simultaneously examine all of the available fishery and research data. The results should prove useful in providing a status report to the Council regarding its rebuilding program and provide the necessary information for establishing future harvest levels.

## National Marine Fisheries Service - SWFSC

The SWFSC Tiburon Laboratory reviewed age composition data from the 1990 widow rockfish fishery and concluded that results of the previous assessment were still valid. We will conduct a full assessment of this fishery in 1993. We are conducting assessments of the bocaccio and chilipepper rockfish fisheries using the stock synthesis model and will submit the results to the PFMC this year.

The pilot larval production survey by the Tiburon Laboratory was aimed specifically for shortbelly rockfish because this species is very abundant and larvae can be identified. Preliminary results indicate that the most serious problem may be in obtaining representative samples of the adult population. We found considerable differences in the size and age compositions of catches made during two surveys for adults. This result suggests that only a portion of the stock is available at a given time and that the available portion may not be representative of the entire population. Preliminary examination of results from the larval survey indicate that, while station distribution should be modified, the amount of sampling effort (6 days) was sufficient to estimate larval production for the 100 mile stretch of coast.

### e. Alaska Department of Fish & Game

B. Bracken presented the ADF&G report on rockfish.

#### Research

Port sampling, skipper interview, and logbook programs used by ADF&G to monitor the demersal shelf rockfish fishery continued in Southeast Alaska through 1991.

The logbook and interview programs are designed to furnish detailed catch and effort information, to estimate at-sea discards, and to obtain more detailed information regarding specific harvest location. The port sampling program provides species composition from the landed catch and an opportunity to collect biological samples. During 1991 otoliths were obtained from principal demersal shelf rockfish species and sent to age labs in Kodiak and Juneau for age determination. Data from these programs is entered on a microcomputer in Sitka.

#### Stock Assessment

Second-year funding was secured from the NOAA Undersea Research Program (NURP) for a near-shore rockfish survey to determine the relationship between species composition and abundance and habitat type. Weather problems restricted the 1991 survey to the vicinity of Sitka Sound. The study area is characterized by a large highly convoluted lava flow and has been heavily exploited for the past ten years.

Line transect methods were used to determine the relationship between abundance and habitat type. Data from the 1990 and 1991 surveys were analyzed to produce preliminary biomass estimates for the Central Southeast Outside area of the Southeast Outside District and the East Yakutat District.

## Management

The only component of the rockfish complex actively managed by the state at this time is the demersal shelf rockfish assemblage in Southeast Alaska. Rockfish management for this group is based upon a combination of seasons and guideline harvest ranges. The state has management authority for demersal shelf rockfish in both state and federal waters of Southeast Alaska. In state waters harvest of rockfish is restricted to hook-and-line gear only.

Separate harvest ranges have been established for each of five southeast management areas based upon the best available information on the condition of rockfish stocks in each area. No new regulations were adopted for rockfish in 1991.

## Fisheries

Harvest of all rockfish from state-managed fisheries totaled 745 mt in 1991. Approximately 90% of the harvest was taken in Southeast Alaska, with most of the remainder reported from Prince William Sound. A very small amount of rockfish harvest was also reported from Cook Inlet. Virtually all rockfish harvest in state-managed fisheries is taken by hook-and-line gear either in directed fisheries or incidental to fisheries for other species.

Harvests of black rockfish increased dramatically during 1991 with nearly 545 mt taken in waters off Kodiak Island alone. Another 75 mt was landed in Southeast Alaska and 102 mt taken in waters of the North Gulf Coast. This prompted a request to establish provisional total allowable catch limits which was presented to the North Pacific Fisheries Management Council during the fall status of stocks review. They failed to take action and so black rockfish will remain as part of the pelagic shelf rockfish group under the federal FMP until further action is taken. The state is considering a recommendation to establish separate quotas for black rockfish within the territorial waters as a conservation measure until this issue can be resolved.

B. Demory inquired what the price was on Alaskan trawl caught rockfish, and was there any trawling in state waters?

B. Bracken replied the price was \$ 0.45 in the round, and trawling is prohibited within 3 miles of shore. The black rockfish fishery near Kodiak is a jig fishery, which provides fresh fish locally.

The TSC discussed micro-area management of black rockfish. M. Saunders asked how small area closures were enforced in Alaska. B. Bracken replied that they relied mostly on the honor system.

#### f. Washington Department of Fisheries

T. Jagielo gave the WDF report on rockfish.

##### Yellowtail rockfish

Jack Tagart is writing up the results of a genetic stock identification project for publication. Jack worked with Rick Stanley as a member of the Yellowtail Working Group (report attached as Appendix C).  
Contact: Jack Tagart. 206-545-6793

##### Black rockfish -- Biological Investigations

This project is designed to collect biological and fisheries data and to produce population estimates for black rockfish (*Sebastes melanops*) off the Washington coast. Data from this study is enabling the development of models to produce estimates of abundance and exploitation of black rockfish along the Washington coast. This work will provide baseline data for spawner/recruit analyses of black rockfish populations. Collection of maturity and fecundity samples (stratified by length in centimeters) from female black rockfish during the larval extrusion period (January-February) continued in 1991. Eggs collected from gravid females were stored in Gilson's fluid for subsequent enumeration using gravimetric methods. Fecundity ranged from a low of 176,894 for a 35 cm fish to a high of 1,214,921 for a fish measuring 49 cm (SL). Maturity criteria for female black rockfish collected during the period surrounding parturition have been established. Approximately 10% of mature females collected did not show any visible sign of imminent or recent spawning. Histological analyses of ovaries collected from these fish indicated that these fish have spawned previously, but not during the year of capture.  
Contact: Farron Wallace 249-4628

##### Black rockfish -- Hydroacoustic Investigations

Hydroacoustic assessment of the population of the Washington coastal black rockfish population continued. In 1991 new split beam technology was incorporated into the project. This aids in biomass estimation and provides information on fish sizing of fish assemblages. Arriving at an absolute abundance estimate has been limited by sampling techniques to apportion hydroacoustic data. In 1991, a comparison of daytime gillnet sampling to nighttime gillnet sampling indicated that nighttime samples contained smaller fish. A test of low light black and white underwater video was conducted to see if visual identification could be used to apportion hydroacoustic observations. Problems were encountered with turbulence limiting visibility. The current plan to provide

improved accuracy for black rockfish population estimates is to 1) use split beam hydroacoustic estimates to apportion biomass estimates based on fish size, 2) refine techniques for positive identification with underwater video, and 3) apply habitat related abundance estimates.

Contact: Norm Lemberg 545-6586

#### g. Oregon Department of Fish and Wildlife

Aging of black rockfish continued in preparation for an assessment scheduled to begin in 1992. Oregon State University is a cooperator via Dr. David Sampson. Other rockfish work was limited to species composition sampling, otolith collections for ODFW use (canary rockfish) as well as other agencies, i.e., NMFS Tiburon lab (widow rockfish) and Washington Department of Fisheries (yellowtail rockfish).

During the year we collected numerous samples of longspine and shortspine thornyheads. Otoliths were forwarded to NMFS LaJolla lab.

The TSC discussed the status of the poorly understood, minor components of the shelf rockfish *sebastes* complex and the concern of potential overharvesting.

D. Thomas reported that the longlining of shelf rockfish is a controversial issue among California sport fishermen.

L. Six asked to what extent the status of Southern California rockfish stocks was known.

D. Thomas replied that not much was known; they are not monitored due to budget problems.

L. Six asked - How about a length monitoring program? He expressed the concern that if something wasn't done, it could "catch us short" later.

B. Demory noted that not much is known of Oregon minor nearshore rockfish species. What we know of yelloweye, for instance, is just what the fishermen tell us.

B. Bracken voiced the opinion that at some point, we will have to do away with all high-volume *Sebastes* fisheries, due to the biology of the fish. He also noted that black rockfish may need to be separated out of the complex, with dusky rockfish, for management purposes.

M. Saunders suggested that a symposium on rockfish management would be welcomed.

B. Bracken volunteered to draft a recommendation to the Parent committee that a management workshop should be held to consider the minor components of the nearshore *Sebastes* complex.



### 3. Thornyheads

#### a. Pacific Fishery Management Council

The two thornyhead species continue to be managed with a single harvest guideline although separate ABCs were adopted in 1992. The coastwide catch of thornyheads in 1991 was 6,536 mt, well within the harvest guideline of 7,900 mt. The harvest guideline in 1992 was reduced to 7,000 mt to protect the less productive shortspine thornyheads and the trip limit was liberalized by converting to a two week cumulative limit of 25,000 pounds. The Council expects landings to be split roughly evenly (about 3,500 mt each) between the two species. This is above the shortspine ABC and just below the overfishing level.

#### b. National Marine Fisheries Service - AFSC

##### Assessment

##### Gulf of Alaska

Thornyheads are managed under the North Pacific Fishery Management Council's Gulf of Alaska Groundfish Fishery Management Plan. Catches were exclusively foreign in the late 70's and early 80's and were less than 1,400 t. With the decrease in foreign quota in the Gulf catches decreased in the mid 1980s before peaking in 1989 at 3,079 t as the domestic fishing industry grew. Catches have decreased to 1,646 t in 1990 and 1,168 t in 1991.

Based on trawl survey data in the Gulf of Alaska, abundance of thornyheads has sharply declined from 99,000 t in 1987 to 26,000 t in 1990. There is no evidence the fishery is responsible for the decline. Since the abundance of thornyheads was first measured in 1984, landings have never exceeded 6.5% of the best interpolated estimate of biomass and throughout 1984-1988 landings did not exceed 4%. The stock is fully utilized and is harvested under an  $F=M$  strategy. In 1992 the Acceptable Biological Catch is 1,800 t. (Pierre Dawson (206) 526-4245)

#### c. National Marine Fisheries Service - SWFSC

The SWFSC Coastal Division continues a joint effort involving scientists at Scripps Institution of Oceanography, Moss Landing Marine Laboratory and the University of Hawaii that involves use of radioisotope ratios to validate criteria used to age shortspine and longspine thornyhead. While early results indicated failure of the method, subsequent results seem more promising.

#### 4. Sablefish

##### a. Canada-DFO

M. Saunders gave the Canadian report on sablefish.

#### Research programs

A species interaction trawl survey was continued in August to assess the impact of sablefish on hake and herring stocks in the La Perouse region of the Vancouver Area.

A trap survey of sablefish in the Charlotte and Vancouver areas was conducted in November. The purpose of the survey was to collect abundance (number and weight) information, and biological samples from pre-selected indexing sites. Traps were set at four discrete (100 fm) depth strata to examine the variation in abundance and life history parameters with depth. Preliminary results indicate that deeper sets contain age frequencies dominated by older and slower growing fish.

A survey to examine the distribution and abundance of larval sablefish off the west coast of Vancouver Island was conducted during April. This is the sixth survey conducted over the period 1984-1992.

A theory which linked climate (Aleutian lows) to copepod abundance and larval success was proposed.

#### Stock assessment

The present assessment is based on a catch-at-age analysis. Several models are being examined to complement or replace the VPA, including a length-based version of the synthesis model and a weight based model. It is anticipated that the fall trap surveys will begin playing a role in the upcoming assessments.

The variability in trap-caught biological samples with area and depth is currently under review.

#### Management and regulations

Sablefish are managed by quota with a 5000 t coastwide quota in effect for 1992. The quota is split between trawl (8.75%) and longline/trap (91.25%) vessels. Both trawl and longline licenses are limited entry.

In 1992 longline/trap license holders are again entitled to an individual vessel quota. The fishermen receive a proportion of the quota rather than a permanent tonnage. The allocation of quota is based on a combination of vessel size criteria and the best landing

from the previous two years. An observer program, paid for by fishermen and overseen by a consultant, is used to verify the landings in five designated ports. This experimental program is in its third year and its future rests with a review that is currently underway.

#### b. Pacific Fishery Management Council

Sablefish continues to be managed under an allocation of the 8,900 mt harvest guideline between trawl gear and other gears. In 1991, each allocation was considered a quota which was not to be exceeded. In 1992 the two allocations are harvest guidelines. Sablefish is managed as part of the deepwater trawl complex, which includes Dover sole and the two thornyhead species. A single trawl trip limit covers the complex, with sublimits for sablefish and thornyheads.

**Trawl :** The total landed catch of sablefish by trawl in 1991 was 4,918 mt, close to the quota of 4,988 mt. For the first time in several years, the trawl trip limit was unchanged all year. The 1992 trawl allocation is again 4,988 mt (58 percent of 8,600 mt, which is the 8,900 mt harvest guideline minus the Tribal catch target of 300 mt). The sablefish trawl trip limit in 1992 is 1,000 lbs or 25 percent of the deepwater complex, whichever is greater. The entire deepwater complex (sablefish, Dover sole and thornyheads) is managed through a biweekly cumulative limit of 55,000 pounds.

**Non-trawl:** In 1991, the unrestricted non-trawl season opening date was changed to April 1 to coincide with the Alaska sablefish opening in an attempt to reduce fishing effort early in the season. However, the Alaska opening was delayed. From January 1 to April 1 the fishery was managed under a 1,500 pound trip limit. April landings were four times the previous average April landings, with the coastwide catch rate about 80 mt per day during April and 50 mt per day during the first 23 days of May. The unrestricted fishery was terminated May 23 with imposition of 500 lb trip limit. On July 21 the fishery was completely closed due to achievement of quota; on September 30, a daily trip limit of 300 lb (round wt) was implemented by emergency federal regulation for the remainder of the year. The total landed catch of sablefish by non-trawl gear in 1991 was 4,223 mt by non-tribal fishers and 299 mt by tribal fishers. The non-trawl allocation was exceeded by about 600 mt even though the April 1 to May 23 season was the shortest on record.

In November 1991, the Council adopted a framework to set the future season opening date for the unrestricted nontrawl fishery to be three days before the May longline season in Alaska. Under this framework, the 1992 West Coast season was to open May 12, following a three day closure beginning May 9.<sup>1</sup> The 1992 management plan

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<sup>1</sup>. However, the proposed season date regulation was delayed by a Presidential moratorium on new federal regulations and had to be implemented by emergency regulation. The proposed three day closure was dropped.

included a 500 lb daily trip limit (i.e., no more than 1 landing per day) January-February increasing to 1,500 lb daily on March 1 with intention of continuing until May 9 or until 440 mt was harvested, whichever happened first. If the 440 mt guideline was reached early, the intention was to reduce the trip limit to 500 pounds until May 9. At the end of the unrestricted season, the 500 pound daily trip limit was to take effect until December 31. The 400 mt guideline was reached the first week in March, and the trip limit was reduced to 500 pounds per day on March 21. However, landings had reached over 1,200 mt (30 percent of nontrawl harvest guideline) so the trip limit was further reduced to 250 pounds per day on April 17. In addition, the post-season 500 pound trip limit was reduced to 250 pounds per day in order to preserve as long an unrestricted season as possible. Even under the most optimistic scenario, the season is expected to end during the first week of June.

On the horizon. The Council decided to proceed with the development of individual transferrable quota (ITQ) programs for the halibut and fixed-gear (longline and pot) sablefish fisheries. The Council will examine the following as possible periods on which to base the amount of ITQ initially allocated: 1984-1988, 1984-1991, and 1981-1991. Qualification would likely be either on the basis of an individual's catch history as a vessel owner or on the catch history of the vessel. With respect to the sablefish fishery, a program which would give ITQ only to those who would qualify for "A" permits under the proposed license limitation program will be considered. A portion of the sablefish harvest guideline would be set aside for vessels participating in the open access fishery.

#### c. National Marine Fisheries Service - AFSC

D. Clausen reported on Alaska sablefish for AFSC.

#### Research

#### Gulf of Alaska

#### Japan-U.S. Cooperative Longline Survey

For the fourteenth consecutive year, a cooperative longline survey was conducted in the Aleutian Islands region, Bering Sea, and Gulf of Alaska by Japan and the United States. The primary objective was to obtain indices of sablefish and Pacific cod abundance, assessment of other major catch components such as Pacific halibut, arrowtooth flounder, Greenland turbot, rockfish, thornyheads, and grenadiers; to tag sablefish; and to collect biological information about sablefish. The 1991 survey used the Anyo Maru No. 22, a commercial Japanese longline vessel provided by the North Pacific Cooperative Fisheries of Japan. A scientist from the AFSC's RACE division participated in the cruise in the western Gulf of Alaska, and one from ABL in the eastern Gulf of Alaska. As in previous years, 47 stations were fished along the upper continental slope of the Gulf

from the eastern Aleutian Islands to Dixon Entrance. At each station, one longline 16 km long containing 7,200 hooks was set and retrieved.

Sablefish and Pacific cod made up most of the total catch. Sablefish were most abundant in the Gulf of Alaska, and Pacific cod were most abundant in the eastern Bering Sea. Compared to the 1990 cooperative longline survey catches of sablefish declined substantially in the Aleutians and especially in the eastern Bering Sea, where catches declined by over 50%. In the Gulf of Alaska, sablefish relative population number (RPN) declined by 2.6% for the upper continental slope from 1990 to 1991. This slight decrease was not statistically significant and it indicates that the population of sablefish remained relatively stable over this time. When compared with the survey results for the years 1984-88, however, it appears that sablefish abundance has substantially declined. The survey catches of Pacific cod were similar in the Aleutians between 1990 and 1991, but declined by 23% in the eastern Bering Sea.

For the second consecutive year, the cooperative survey showed results that were markedly different from the results seen in the 1991 domestic longline survey. The domestic survey indicates relative abundance of sablefish in the Gulf of Alaska is much higher than that observed in the cooperative survey. Both surveys are planned to continue in 1992, which will provide another year of comparisons. (David Clausen (907)789-6049 and Eric Brown (206)526-4157)

### Domestic Longline Survey

The AFSC has conducted an annual longline survey of sablefish and other groundfish in the Gulf of Alaska from 1987-91. The survey is a joint effort involving ABL and the RACE Division. As in past surveys, the primary objective was to determine the relative abundance and size composition of four slope-resident groundfish species: sablefish, shortspine thornyhead, and rougheye and shortraker rockfishes, and secondarily to determine the relative abundance and size compositions of other species such as Pacific cod, grenadiers (Macrouridae), arrowtooth flounder, and Pacific halibut. It replicates as closely as practical the Gulf of Alaska portion of the Japan-U.S. cooperative longline survey conducted from 1978-91 and also samples gullies not sampled by the cooperative longline survey. Sixteen kilometers of groundline are set each day, containing 7,200 hooks baited with squid. In 1991, 73 stations were sampled from 26 June to 12 September by the chartered longline vessel Ocean Prowler.

Sablefish relative population numbers (RPN) for the upper continental slope increased 5% from 1990-91. The RPN increase was significant only in the Southeastern area. Some unknown fraction of the increase probably is due to a relatively strong year class recruiting through Shelikof Trough and onto the upper continental slope. Further, the length composition for sablefish shifted upward from 1990-91, indicating growth in length within the population and no significant recruitment. There is no evidence for any other strong year classes.

(Michael Sigler (907)789-6037 and Skip Zenger (206)526-4158)

### Population Experiment in Chatham Strait

ABL and ADF&G conducted a cooperative sablefish population experiment in Chatham Strait, southeastern Alaska, during the period July-October 1991. Objectives of the study were twofold: 1) estimate the population size of sablefish in a study area within Chatham Strait; and 2) estimate the catchability coefficient ( $q$ ) of sablefish caught on the longline gear used. The second objective was ABL's main interest in the study; if successful, the catchability coefficient would be applied to the domestic longline survey, and an estimate of sablefish biomass would be computed for the Gulf of Alaska based on the survey's CPUE. The experiment was a follow-up to a similar study conducted in 1989 that used the NOAA RV Townsend Cromwell. The 1991 study used the NOAA RV John N. Cobb to fish trawl and longline gear for four cruises, two before the September commercial sablefish fishery in Chatham Strait, and two after the fishery. The experiment attempted to estimate sablefish population in the study area using two methods: a mark-recapture experiment, in which sablefish were tagged before the fishery and then recovered from fishermen during the fishery; and a Leslie-Delury depletion experiment, based upon the John N. Cobb's CPUE before and after the fishery. Results of the study showed trawl and longline catch rates declined 26.8% and 18.3%, respectively, after the fishery. Neither decline, however, was statistically significant because of the large variability in catch rates between hauls. Consequently, the CPUE data could not be used to compute a population estimate or a catchability coefficient. The mark-recapture data will be analyzed by ADF&G at a later date.

An ancillary objective of the study was to compare the survival of sablefish caught in trawls vs. longlines. Sablefish were randomly selected from various hauls of each gear type and transported live back to ABL, where they were retained in a large tank for 28-50 days. The overall survival rate of longline-caught fish was 98%, whereas only 52% of the trawl-caught fish survived. The trawl-caught fish, however, showed a wide variation in survival from haul to haul. Abrasion in the net appeared to be the major factor affecting survival of the trawl-caught fish. In hauls with much abrasive material such as sea urchins and shell debris, many of the sablefish were badly de-scaled and did not survive; in contrast, sablefish from hauls with little abrasive material appeared in good physical condition, and survival rates were up to 100%.

(David Clausen (907)789-6049)

## Hook Competition Model

A stochastic model was developed which provides estimates of fish abundance from longline surveys. The model accounts for hook competition and is based on a binomial-Poisson mixture distribution. Fish are assumed to arrive randomly at the gear at some rate  $\lambda$ , proportional to abundance (Poisson process). The probability of successive captures  $p_x$  is assumed to be related to the number of fish already caught  $x$  (binomial process). The parameters  $\lambda$  and  $p_x$  are estimated from interarrival time data collected using hook timers during August 1991 for sablefish, Pacific halibut, and Pacific cod in the Gulf of Alaska. The estimated parameters will be applied to a time series of longline survey data for sablefish to correct the abundance estimates for the effect of competition for hooks.

(Michael Sigler (907)789-6037)

## Sablefish Tag Recovery Program

Since 1983, ABL has tagged and released adult and juvenile sablefish for migration, population, and age studies in the eastern Gulf of Alaska. Tag releases currently total ~88,500, and recovered tags total 3,747, of which 2,728 have valid recovery information. Additionally, ~500 recoveries from 1991 are presently being processed. Two factors have helped increase the number and quality of tag returns in 1990 and 1991: the new sablefish cap reward to fishermen who return tags, and an increase in observer coverage aboard commercial fishing vessels.

A total of ~66,500 adult sablefish have been tagged and released by ABL. Of these, ~35,000 have been released in Chatham Strait during the course of various experimental studies since 1983. A total of 1,525 of the Chatham releases have been recovered, and 83% of these have remained in Chatham Strait, despite a mean time at large of 541 days. Apparently, most sablefish in Chatham Strait tend to remain there, and outmigration may be relatively low. More detailed analysis is in progress.

Approximately 22,000 of the ABL tag releases have been juvenile sablefish (ages 0+, 1+, or 2+) tagged in southeastern Alaska. Most of these fish (74%) were released over several year's time in one small bay, St. John Baptist Bay, located near Sitka, Alaska. This bay has been the only locality in southeastern Alaska where juvenile sablefish have been found consistently from year to year. Fish tagged as juveniles and recovered as adults in the commercial fishery now total 166. The recoveries are distributed as follows: Vancouver and Charlotte, 2.4%; Southeastern outside waters, 28.5%; Southeastern inside waters, 20.9%; Yakutat, 17.9%; Kodiak, 17.3%; Chirikof, 3.1%; Shumagin, 4.9%; and Bering Sea, 4.9%. Thus, these initial recoveries show a tendency for juvenile sablefish to migrate westward in the Gulf of Alaska.

(Ellen Varosi (907)789-6059 or Tom Rutecki (907)789-6051)

## **Sablefish Age Validation Based on Fish Tagged as Juveniles**

ABL has begun a sablefish age validation study in cooperation with the AFSC's REFM Division. The study is based upon collecting otoliths from tagged adults that were originally released by ABL as juveniles. These tagged adults are of known age and can be used to validate the ages determined from the otoliths. So far, otoliths from 10 fish tagged as juveniles have been recovered. In 1992, observers aboard commercial fishing vessels in Alaska have been instructed to collect otoliths from all sablefish caught that have ABL tags, in an effort to increase the sample size for this study.  
(Ellen Varosi (907)789-6059)

## **West Coast**

### **Sablefish Abundance Indexing**

Sablefish relative abundance off Washington, Oregon, and California has been monitored since 1979 using standardized catch per unit effort (CPUE) from trap sets. In 1991, nine index sites off southern Oregon and California were sampled. Strings of 10 conical traps each were fished twice at each of five standard depths (225, 300, 375, 450, and 525 fm) and additional sets were made at non-standard depths of 150 fm (all sites) and between 630 and 850 fm (7 sites). Sablefish catch rates were highest at the three southern sites, Cortes Bank, Carmel Bay, and Morro Bay) and lowest at Pt. Arena, Half Moon Bay, Pt. Delgada, and Cape Mendocino. Catch rates were highest at the 225 fm depth.

Catch rates declined notably from previous surveys in this area, which were conducted in 1984, 1986, and 1988. When averaged over all sites and depths, the mean number of fish caught per trap in 1991 was 67% lower than in 1988, 22% lower than 1986, and 64% lower than in 1984. Sablefish were larger on average in 1991 at all except the northernmost and the two southernmost sites. Overall mean length of sablefish caught increased almost 1 cm from 50.8 cm in 1988 to 51.7 cm in 1991, indicating a corresponding increase in mean weight from 2.71 lb to 3.06 lb.  
(Norman Parks (206) 526-4119 or Frank Shaw 526-4120)

### **Age Validation**

AFSC and SWFSC (Tiburon Lab) cooperated to develop an age validation study of sablefish. The study utilizes the method of injecting fish with oxytetracycline (OTC), which produces a mark on the otolith during tagging which can be detected when the fish is recaptured. On both 1991 surveys we tagged and released sablefish marked with oxytetracycline (OTC) to validate age determination techniques. During the trap survey, over 2,570 sablefish were released marked with special blue spaghetti tags. Only 83 sablefish were tagged, injected and released during the continental slope trawl survey. Three quarters of the released sablefish were injected with OTC and the remaining fish will serve as a control group to detect any mortality associated with the injections.



(Norman Parks (206) 526-4119 or Frank Shaw 526-4120)

## Relating Flesh Condition to Biology and Environment

During the RACE trap and continental slope trawl surveys, sablefish color and flesh firmness were graded and recorded for all fish sacrificed for age structures. These data will be used to attempt to correlate the occurrence of soft, dark fish with environmental and biological factors such as depth of capture, size, sex, and age.  
(Norman Parks (206) 526-4119 or Frank Shaw 526-4120)

## Assessment

### Bering Sea and Gulf of Alaska

Sablefish of the Gulf of Alaska, Bering Sea and Aleutians are considered one large stock. Therefore, to alleviate some of the departures from a closed population assumption that occur in separate analyses, these three regions are combined into one analysis for stock assessment. Historic biomass estimates as determined by stock reduction analysis showed a declining stock trend through 1978. During these years the stock was heavily exploited by foreign fisheries. Estimates of exploitable biomass after 1979 were determined by scaling relative biomass indices from an annual longline survey to estimates of absolute biomass, based on comparisons of longline and bottom trawl survey catch rates. Stock abundance increased after 1980 peaking in 1985 at nearly 400,000 t. Lower exploitation rates and a strong 1977 year class, which recruited in 1982, led to this improved stock condition. After 1986, the stock has been fairly stable but showing a slight decline. Although the stock is declining there is no evidence that it is being overfished. The decline is attributed to the lack of significant recruitment in recent years. The stock is at a high level and considered to be in good condition. The projected 1992 estimate of exploitable biomass (assuming zero recruitment) for the Bering Sea/Aleutian Islands region is 37,400 t, and 179,000 t for the Gulf of Alaska. Sablefish are fully utilized and are harvested under an  $F_{0.1}$  strategy. The 1992 Acceptable Biological Catches are 1,400 t for the Bering Sea, 3,000 t for the Aleutians, and 20,800 t for the Gulf of Alaska.

The sablefish population of the Gulf of Alaska is still at a relatively healthy level, but with no strong recruitment evident in recent years, the population has been decreasing. Exploitable biomass for the beginning of 1992 for outside waters as estimated from the NMFS trawl and longline surveys is 179,000 mt, down from 194,000 mt in 1991 (248,100 mt in BS, AI and GOA combined).

Yield estimates are determined from stock reduction analysis modified to explicitly track estimates of exploitable biomass and provide an estimate of recruitment. To alleviate some of the departures from the assumption of a closed population, the Gulf of Alaska, Bering Sea, and Aleutian Islands regions have been combined and analyzed as one stock

since 1989. The recommended yield is then apportioned according to estimates of current biomass. The recommended acceptable biological catch (ABC) for the Gulf of Alaska was 26,200 mt in 1990, 22,500 mt in 1991, and 20,800 mt in 1992. The ABC's are computed by multiplying the  $F_{0.1}$  exploitation rate (0.116) by the estimate of exploitable biomass at the beginning of the fishing year.

NMFS conducts two longline surveys to track abundance trends in the Gulf of Alaska: the domestic survey and the Japan-U.S. Cooperative Survey. In 1990, results of the two surveys diverged significantly from each other, and the difference between the two surveys continued in 1991. Studies are now in progress by the AFSC's RACE Division to determine the reason for the difference in results. In computing the 1992 ABC's, an average of the two surveys was used to project the exploitable biomass estimate. (Sandra Lowe (206) 526-4230 or Jeff Fujioka (907) 789-6026)

### Age-structured Population Model

Sablefish annual recruitment and biomass in the Gulf of Alaska were estimated with an age structured population model via the "stock synthesis" approach. Because no time series of age compositions was available to directly measure recruitment, recruitment was estimated indirectly from length compositions from the Japan-U.S. cooperative longline survey and a length-age relationship. Relative biomass was measured by the Japan-U.S. cooperative longline survey from 1979-90 and the domestic longline survey from 1988-90; absolute biomass was measured by the triennial trawl survey in 1984, 1987, and 1990. Absolute biomass and recruitment from 1976-90 were estimated in this study. (Michael Sigler at (907) 789-6037.

### West Coast

The landed catch of sablefish in 1991 was 9,451 mt. This exceeded the ABC of 8,900 mt primarily because of inaccuracy in projecting the rapid rate of catch by the fixed gear fleet. In 1991 the fixed gear open season lasted from April 1 only until May 23. No new assessment was conducted in 1991, primarily because of the discovery of a problem in expanding port sample data to fishery catch-at-age. The west coast sablefish stock was assessed in 1990 through application of the synthesis model to fishery size and age composition data from 1986-1989 and trawl and pot survey data. The assessment was split into northern (U.S.-Vancouver and Columbia INPFC areas) and southern areas on the basis of known low rates of mixing of adult sablefish, and increased evidence of slower growth among fish captured off southern and central California. The trawl survey biomass estimates from southern Oregon played an important role in the northern area assessment because the survey area constitutes a significant fraction of the northern assessment area and a survey in 1989 replicated abundance levels observed in 1984 and 1988. The recommended assessment results that match this biomass level do not, however, provide a good match to the decline in the pot survey's estimate of sablefish abundance. The northern area's assessment indicates that the biomass of age 3+ sablefish was about 80,400 mt at the

beginning of 1990 and the biomass of mature females was 36,100 mt. This level of spawning biomass is intermediate between 38,800 mt (35% of virgin spawning biomass) and 31,800 mt (spawning biomass that produces MSY under previously assumed level of recruitment density-dependence), so this area's stock is judged to be approximately at its optimum level. Application of the  $F_{35\%}$  exploitation policy to the expected 1991 biomass produces a recommended landed yield of 4,130 mt for the northern area. The assessment in the southern area has greater uncertainty because of the lesser amount of survey data. The recommended assessment indicates that the biomass of age 3+ fish at the beginning of 1990 was 87,600 mt and the biomass of mature females was 45,200 mt. This level of spawning biomass is above 39,300 mt (35% of virgin spawning biomass) and 33,400 mt (spawning biomass that produces MSY under previously assumed level of recruitment density-dependence). Application of the  $F_{35\%}$  exploitation policy to the expected 1991 biomass produces a recommended landed yield of 4,730 mt for the southern area. Research efforts were also directed at exploring depth and latitude patterns in the age-specific distribution of sablefish.

(Richard Methot at (206) 526-6525)

#### d. National Marine Fisheries Service - SWFSC

The SWFSC Tiburon Laboratory worked with scientists from the Alaska Fisheries Science Center on an assessment of the sablefish fishery using the stock synthesis model. The sablefish assessment will be submitted to the PFMC this year.

#### e. Alaska Department of Fish & Game

Mr. Bracken presented the ADF&G report on sablefish.

#### Research

An intensive skipper interview program is conducted during the Southeast area fisheries to obtain detailed catch and effort information from the participants. This program also provides an opportunity to collect tags recovered during the fisheries.

During 1991 ADF&G cooperated with the NMFS Auke Bay Laboratory to conduct a pre-fishery tagging and catch rate study in the Northern Inside Area of Southeast Alaska. Approximately 3,400 tags were deployed from the NOAA ship John N. Cobb one month prior to the fishery. An extensive tag recovery effort was implemented during the fishery with nearly 60% of the landings interviewed for tag recovery information. A follow-up survey compared the pre and post-season catch rates for both trawl and hook-and-line gear. Analysis of the data collected is continuing.

## Stock Assessment

Sablefish stock assessment surveys were conducted in each of the two inside management areas for the fourth consecutive year during 1991. The surveys use snap-on longline gear set on randomly selected stations for a standardized fishing period. The purpose is to determine annual changes in relative abundance. These surveys are also designed to provide unbiased biological samples from the sablefish populations. Every tenth fish captured is sampled for AWL, sex, and maturity. Otoliths taken during these surveys are sent to the ADF&G aging laboratories in Kodiak and Juneau for age determination.

Preliminary results of the surveys show that the decline observed in the Northern Southeast Inside area between 1988 and 1989 tapered off in 1990 and the catch rate actually increased by 7% in 1991. The results of the 1991 survey also indicated significant increase in the abundance of sablefish in the Southern Southeast Inside management area. A major difference was that the increase in the Northern area was the result of a higher catch rate of mature fish whereas the increase in the Southern area was the result of new recruitment into the fishery. Data from these surveys is still being analyzed.

Both of these surveys are part of a five-year study and analysis will continue until the completion of the project in 1992. Summaries of the methods used and cruise reports showing preliminary data are available by request from Mr. Bracken.

The cost of these surveys is partially offset by the sale of the fish caught. A vessel is chartered at a set daily rate to conduct the survey. The fish caught are processed according to industry standards and the state receives all revenue from the sale of the fish.

## Management

There are three separate internal water areas in Alaska which are managed exclusively by the state. The Northern Southeast Inside, the Southern Southeast Inside areas, and Prince William Sound each have separate seasons and guideline harvest ranges.

The season framework in both of the Southeast Inside management areas allows for some flexibility to avoid conflicts with other fisheries and with periods of large tides which tend to concentrate the effort and result in more lost gear. The Prince William Sound fishery is opened in conjunction with the offshore waters of the Gulf of Alaska and continues until the annual harvest objective is reached.

An annual harvest objective is selected within the guideline harvest range for each area based upon the best available information on current stock condition. In the Southeast areas the season length is set prior to the opening according to the estimated time required by the existing fleet to capture the harvest objective.

## Fisheries

In the Northern Southeast Inside area 127 vessels harvested approximately 1,140 mt dressed weight in 24 hours. In the Southern Southeast Inside area 31 vessels harvested approximately 195 mt dressed weight in a 57-hour fishery.

Although both of the Southeast area fisheries are under limited entry, the number of vessels participating in each area exceeds the optimum level established by law by a considerable amount. This factor is compounded because there is no control on vessel size or amount of gear fished. As a result, the individual fishing power of the vessels has increased dramatically in recent years.

The Prince William Sound fishery opened by regulation on May 15 and continued until mid-June. The annual harvest objective of 100 mt was exceeded by approximately 35 mt.

The offshore fishery (0-3 miles) is managed in conjunction with the federal-managed fishery in the EEZ. The state issues emergency orders to open and close the fishery consistent with field orders issued by NMFS.

### 5. Flatfish

#### a. Canada-DFO

Mr. Saunders presented the Canadian report on flatfish.

#### Research programs

A study of factors influencing recruitment for English sole in Hecate Strait has shown that water transport through the Strait in the late fall to early winter is important to year-class production. Stock size plays a relatively minor role in the production of year-classes.

#### Stock assessment

Catch-at-age time series are being updated for rock sole and English sole in Hecate Strait. These series now extend from the late 1940's to the mid 1980's and will be used as input for an age and sex structured model which will be used to assess these stocks in 1993. Data on discards of flatfish species in the trawl fishery in Hecate Strait is being collected and will be used to examine the effects of discarding on yield for flatfish stocks caught in the multispecies trawl fishery there. Biological samples from the fishery off the West coast of Vancouver Island for Dover sole are being processed. The length-age information will be used to estimate growth and mortality parameters for this stock for the first time.

## Management and regulations

Flatfish in British Columbia are managed using a combination of area specific quotas and/or trip limits. Rock sole and petrale sole are managed by trip limits while Dover sole and English sole are managed using area quotas. In 1991, rock sole in Hecate Strait were overharvested despite the trip limit regulation. The rock sole trip limit level is currently being reviewed and may be revised downward because of the overharvest in 1991 and declining recruitment. A minimum mesh size (140 mm/5.5 in) regulation will be in place for the trawl fishery in Hecate Strait in 1993. The purpose of this regulation is to reduce the bycatch of undersize sole and cod in this fishery. We expect that the longterm yield for rock and English sole stocks in this area will increase significantly because of this.

### b. Pacific Fishery Management Council

The coastwide catch of Dover sole in 1991 was 18,203 mt, 94 percent of the 1992 harvest guideline of 19,400 mt. In 1992, cumulative landing limits have replaced trip limits. The cumulative 2-week trip limit for the deepwater complex is 55,000 pounds, with sublimits on the amounts of thornyheads and sablefish. Dover sole landings early in 1992 were only 78 percent of the catch rate through the same period in 1990-91.

### c. National Marine Fisheries Service - AFSC

Dover sole, English sole, arrowtooth flounder, petrale sole

#### Assessment

#### Bering Sea

The abundance of most of the species of flatfish in the eastern Bering Sea have shown substantial increases during the 1970s and 1980s, and many are currently at observed peak levels of abundance. Yellowfin sole, which suffered a severe decline in abundance from overfishing in the early 1960s, is the second most abundant species in this region after walleye pollock. The total harvest of yellowfin sole in the eastern Bering Sea in 1991 was 84,482 t, well below the 1991 TAC of 135,000 t. This underharvest is due to the prohibited species (halibut, king and tanner crab) catch limits being attained well before the target quota can be reached. The fishery harvests a wide range of age classes beginning at age 6 with yellowfin sole not being fully recruited until age 13. The stock remains at high abundance levels after rebuilding during the late 1970s and early 1980s from a series of stronger than average year classes spawned from 1968-77. In the 1991 assessment, fishery catch-at-age information was used in cohort analysis and the stock synthesis model to discern the age-structured population abundance, believed to be at more than 2.6 million t. Fishing mortality values were developed from a yield per recruit model to evaluate potential

harvesting strategies. For 1992 a  $F_{0.1}$  value of 0.14 was used to develop an ABC of 372,000 t with the TAC set at 235,000 t.

Rock sole catches from the eastern Bering Sea in 1991 was 26,297 t, primarily from a valuable roe fishery conducted northward of the Alaska Peninsula during the winter spawning period. Harvest levels remained well below the 1991 TAC of 90,000 t. Biomass estimates from the 1991 demersal trawl survey indicate the population abundance is at 1.59 million t, continuing the trend of biomass increase seen during the 1980s. Survey age composition from the 1990 survey indicates that 88% of the rock sole population numbers are ages 3-7, corresponding to the 1983-87 year classes. Analysis of life history parameters from a dynamic pool model provide fishing mortality values at  $F_{msy}$  ( $F=0.176$ ) and  $F_{0.1}$  ( $F=0.159$ ) to explore possible harvest strategies. An ABC of 260,800 t (TAC is 40,000 t) was developed for 1991 based on the  $F_{0.1}$  exploitation rate.

Survey data have indicated that the other two principal species of small shelf flatfish in the eastern Bering Sea were also at observed high levels of abundance in 1991. The estimates were 570,300 t for flathead sole, and 529,100 t for Alaska plaice. The abundance of these species remains high, and recruitment continues to be strong for flathead sole. These two species are managed as a complex with a combined ABC of 199,600 t for 1992 and a TAC of 79,000 t. The combined 1991 catch was well below the quota at 30,400 t.

The conditions of the two principal species of large flatfish in the eastern Bering Sea, arrowtooth flounder and Greenland turbot, differ. Based on survey estimates, the exploitable abundance of arrowtooth flounder has increased from less than 100,000 t in 1982 to 461,600 t in 1991. Over this same period, recruitment of Greenland turbot has been very low and the presence of juvenile fish reported from the Bering Sea shelf and slope has been notably reduced. Assessments of the adult population, which occupy continental slope waters, is limited to triennial surveys such as in 1991, but these surveys incompletely sample this portion of the population. Because of the poor recruitment that has been observed since the early 1980s, exploitation of the adult population has been restricted and the TAC has been set at 7,000 t. Arrowtooth flounder remain lightly exploited with the 1991 catch of 4,100 t taken primarily in the pursuit of other species. For 1992 the ABC and TAC of arrowtooth flounder is set at 82,300 t and 10,000 t, respectively.

## Gulf of Alaska

Management of the Gulf of Alaska flatfish resource has been divided into four categories by the North Pacific Fishery Management Council for 1991. These categories include: "shallow water flatfish", "deep water flatfish", arrowtooth flounder, and flathead sole. This reclassification was made because of the significant difference in halibut bycatch rates in directed fisheries targeting on shallow and deep water flatfish species. Arrowtooth flounder, because of its present high abundance and perceived low commercial value, was separated from the group and managed under a separate TAC. Flathead sole are also managed under

a separate TAC because they overlap the distributions of the shallow and deep water categories.

Due to halibut bycatch in commercial trawl fisheries, the total catch of Gulf of Alaska flatfish species was 31,500 t in 1991, well below the combined TAC of 57,000 t. Biomass estimates from the 1990 Gulf of Alaska trawl survey indicates the total flatfish resource continues to increase with some species declining (rex and rock sole), some increasing (flathead sole and arrowtooth flounder) and some remaining stable (yellowfin sole). Trawl survey size compositions indicate the continued presence of juvenile fish recruiting to the stock for most species. Although the flatfish species are generally thought to be near or above virgin levels, they are managed under the  $F_{0.1}$  approach since this strategy may represent a fishery which maintains a larger spawning stock and mean size.  
(Thomas Wilderbuer (206) 526-4224)

## West Coast

### Pacific Halibut

The RACE West Coast groundfish subtask collaborated with the IPHC in an investigation comparing results of the 1977-1989 triennial trawl surveys with IPHC stock assessments based on catch-at-age data and commercial longline catch per effort in Area 2A (roughly from 43°N lat. to the US-Canada border). The surveys clearly show a dramatic increase in apparent total abundance in this area from 1980 to 1986 and 1989, coupled with a southward expansion of the range of halibut catches (as far south as San Francisco in 1989) and an increase in the frequency of their occurrence (from less than 20 fish in 1977 and 1980 to more than half of the Area 2A stations in 1989). In contrast to this order of magnitude increase in apparent abundance from survey results, commercial longline catch rates, used as an index of exploitable biomass in the IPHC stock assessments, remained flat through the late 1970s and mid 1980s. In the late 1980s, the commercial CPUE increased dramatically, while the survey estimate remained steady.

The IPHC assessment uses the CAGEAN model to estimate exploitable (age 8+) biomass, while the surveys estimate total available biomass. CAGEAN has provided estimates of exploitable halibut in Area 2A of about 125,000 fish (1.5-1.7 million lb net) while the 1989 survey estimated 466,000 fish (5.5 million lb net), including fish younger than 8 yr that are available to the survey trawl. Comparisons are hampered by the lack of age data from the survey samples, a situation that will be rectified during the 1992 triennial survey. Meanwhile, a correction was applied to the survey estimate, truncating the biomass at lengths corresponding to age 8+ fish (72 and 84 cm were used) resulting in an estimate of between 145,000 and 329,000 fish. Possible reasons for the discrepancy in the results include CAGEAN systematically underestimating abundance (an underestimate of M), the survey systematically overestimating (due to herding, etc.), or differential availability of components of the population to longline and trawl gear.  
(Mark Wilkins (206) 526-4104)



## Dover Sole

Size and age composition data from the INPFC Eureka area were analyzed by stock synthesis, a separable catch-at-age model. In this assessment recruitments are estimated by the model instead of the assumption of constant recruitment used in 1990. In the Eureka area the 1990 survey biomass estimate was used to determine plausible levels of 1990 biomass. The incorporation of the survey resulted in lower levels of biomass being more plausible than indicated in the 1990 assessment. Sharp increases in the percentage of small Dover sole in the fishery occurred beginning in 1983-84. The model accommodated this change by having separate availability and retention patterns for the periods 1971-82 and 1983-present. The change in selectivity of larger fish was modeled as a function of the increase in depth of the catch.

Two plausible levels of virgin recruitment are identified, resulting in an approximately two-fold range in estimated current biomass, and a survey ratio of 0.38 to 0.83 (where 1.0 indicates the 1990 biomass available to the survey is equal to the estimated survey biomass). In the Eureka area, recent landed catches have declined to about 3,500 t. MSY, estimated under an assumed level of density-dependent recruitment, is in the range 3,000-4,100 t. The current female spawning biomass is estimated to be slightly below the target level for the lower biomass scenario and above the target level for the higher biomass scenario. The recommended yield is calculated by applying  $F_{35\%}$  (fishing mortality that reduces female spawning biomass per recruit to 35% of its unfished level) to the exploitable biomass. This results in yields for 1992 in the range 3,071-6,815 t.  
(Jack Turnock at (206) 526-6549)

### d. Alaska Department of Fish & Game

#### Research

No research was conducted on flatfish species by the State of Alaska during 1991. A mandatory logbook program in effect for this fishery provides information on CPUE of target species and an estimate of at-sea discards.

#### Management

Trawl fisheries for flatfish are allowed in the internal waters of Southeast Alaska only under the terms of a special permit issued by the department. The permits are generally issued for no more than a month at a time and specify the area and gear configuration allowed. Mandatory logbooks are required and some areas cannot be fished without an ADF&G observer on board. This restrictive management is necessary because of reduced flatfish stocks and because of a history of very high bycatch rates of prohibited species, particularly crab and halibut, in flatfish trawl fisheries conducted in the internal waters of the state.

## Fishery

The flatfish trawl fishery was restricted to only three small areas during the 1990-91 seasons with a harvest objective set for each area. A total of 80 mt was taken during 1991 with most of the catch comprised of starry flounder.

Like Pacific cod, the flatfish fisheries in offshore waters are managed in conjunction with the fishery in the adjacent EEZ. The actual amount harvested within three miles of shore is not known.

### e. Washington Department of Fisheries

T. Jagielo reported on flatfish for WDF.

#### Arrowtooth flounder

Sampling for a one year maturity study began in July 1991. To date, results show the gonadosomatic index (GSI) increasing through December. By late March all mature females sampled were spent. Arrowtooth flounder appear to migrate to deeper water (below 250 fm) in winter and move back into shallower water in spring. Length at 50% mature was 28 cm for males and 37 cm for females, but these preliminary results are based on a very small sample as smaller fish are not well represented in commercial landings. Arrowtooth flounder are currently aged using otoliths. WDF is working cooperatively with NMFS to estimate aging error and to refine the criteria used to assign ages. Age validation tagging work has been proposed. A stock assessment of arrowtooth flounder is in its early stages. Contact: Martha Rickey 545-6595

### f. Oregon Department of Fish and Wildlife

B. Demory reported on flatfish for ODFW.

Samples of Dover sole, English sole and petrale sole were retained for analysis by ODFW. Assessments are scheduled for 1993 and 1994. We also sampled arrowtooth flounder at Astoria. Samples were forwarded to Washington Department of Fisheries.

### g. International Pacific Halibut Commission

#### The Fishery

The Pacific halibut fishery is affected by five major removal sources:

- 1) Commercial Fishery- 57.0 million pounds

- 2) Bycatch- 16.9 million pounds
- 3) Sport Fishery- 6.2 million pounds
- 4) Wastage- 3.3 million pounds
- 5) Unreported Losses- 2.0 million pounds

The 1991 commercial catch limit of 55.2 million pounds was exceeded by 1.8 million pounds, or 3.3%. The commercial catch has represented from 53 to 86% of the removals since 1962, with the 1991 catch representing 67%. Sport catch was estimated at 300,000 pounds in 1977 and has grown to the present 1991 level of 6.2 million pounds or 7% of the total production.

The 1991 commercial catch was highlighted by the installation in Canada of an Individual Vessel Quota (IVQ), which commenced May 1st and ended November 30th, in the Canadian commercial fishery. Each of 435 vessels was allowed to catch a predetermined poundage calculated by the Canadian Department of Fisheries and Oceans (DFO), based on a 7.4 million pound catch limit approved by the IPHC, for Area 2B. The total catch for Area 2B was 7.2 million pounds, 0.2 million pounds under the catch limit.

Additional enforcement costs in administering the IVQ program were covered by a flat administration fee of \$250 Canadian and a landing tax of approximately nine cents per pound of IVQ share. First year impressions were generally favorable by managers and fishermen alike.

A developing fishery of concern to the IPHC is a U.S./Russia joint venture fishery taking place in Russian waters of the western Bering Sea. An estimated 3 to 6 million pounds of halibut were caught, without size restriction, by U.S. longline and trawl vessels and landed in U.S. ports. The effects of this fishery on U.S./Canadian stocks are uncertain, as are enforcement problems created by sublegal halibut on the market. The Commission staff has started to investigate the effects of this fishery on Pacific halibut management.

Contact: Heather Gilroy

## **Stock Assessment**

Much of the research that is conducted each year by the Commission staff is aimed at improving the procedures and assumptions that go into the halibut stock assessment. The principal areas of stock assessment include population assessment and CPUE studies.

## **Population Assessment**

The Pacific halibut stock assessment for 1991 is a catch-at-age analysis (CAGEAN) conducted by area and applied to data from IPHC Areas 2A-2B, 2C, 3A, 3B, and 4. Information is gathered from catch, catch per unit effort (CPUE), age composition and average weight data. This data is used in determining the exploitable biomass, the stock biomass available for harvest. Once the exploitable biomass has been estimated, the constant exploitation yield (CEY) is calculated with an optimal exploitation rate of 0.35.

The recommended allowable catch is finally determined by accounting for the removals from other sources (sport catch, wastage, bycatch, and unreported losses). An additional analysis of Area 2A age composition data showed that a shift from older to younger fish in the catch reflects a real change in stock rather than an artifact of sample distribution or gear selectivity.

Stock assessment results indicate the total exploitable biomass of Pacific halibut was 262.6 million pounds in 1991. This represents an overall decline in biomass of 10%, similar to the 5-10% declines observed in previous years.

### **CPUE Studies**

Two studies involving CPUE were conducted in 1991: 1) Hook Timers on Longline Gear, 2) An Age-Structured Kalman Filter for Pacific halibut Stock Assessment. The purpose of the hook timer study was to collect data on the pattern of bait removal through time, and species composition in the catch. Malfunctions and logistical problems plagued this study and results are therefore incomplete at this time. Estimates of population abundance from the Kalman filter method are being investigated and sensitivity analysis still need to be performed.

Contact: Dr. Patrick Sullivan

### **Bycatch**

Pacific halibut caught inadvertently by vessels targeting on other fish and shellfish represent a significant loss to the directed longline fishery for halibut. Bycatch mortality declined from 17.5 to 16.9 million pounds (net weight) from 1990 to 1991. The IPHC works with other agencies and industry to minimize this catch and to increase groundfish catches in fisheries that close when halibut bycatch is reached.

Mortality rates of halibut bycatch discarded from fishing vessels were revised for the 1990 groundfish fisheries off Alaska based on viability data collected by on-board observers:

Trawls: Gulf of Alaska: 65% discard mortality rate  
Bering Sea/Aleutians: 75% discard mortality rate  
Longline, all areas: 16% discard mortality rate  
Pots, all areas: 10% discard mortality rate

Analysis continued for comparing day and night bycatch rate differences in bottom trawl fisheries. A follow-up study of 1990 Bering Sea domestic bottom trawl fisheries supports the previous findings from Bering Sea joint venture operations that avoiding bottom trawl fishing during night hours reduces the total catch of halibut for a given amount of cod.

Contact: Dr. Robert Trumble

## Biological Research

The Commission staff conducted biological research in three primary areas in 1992; otoliths, tagging and general studies. Under otolith studies the staff conducted research on estimating halibut body size from otolith size, estimating sex from otolith shape, investigated the elemental composition of halibut otoliths, and compared classifier systems for automated aging of halibut otoliths. Research done on estimating halibut body size from otolith size is of particular importance. From 1962 through 1990 the IPHC estimated sizes of fish in the commercial catch from the sizes of their otoliths, using a series of statistical predictors developed over the years. It was recognized that the relationship between otolith size and body size depended on growth rate and therefore could vary among regions and over time, but this was not regarded a serious problem. Over the last ten years, however, analysis shows a major change in the relationship in the central and western Gulf of Alaska, a smaller change in Southeast Alaska, and very little change in British Columbia. Because of these variations over time, it now appears that otoliths size is not a sufficiently reliable predictor of body size for routine use in estimating mean size in the catch or monitoring changes in growth schedule. For both purposes, the Commission in 1991 resumed its earlier practice of measuring the lengths of fish in the commercial catch sample when collecting otoliths.

Tagging studies were limited by the Commission staff in 1992. In one project, analysis of more than 68,000 juvenile halibut tagged and released during 1980 and 1981 in the Gulf of Alaska and Southeast Alaska showed substantial southerly movements of juvenile halibut. An estimated 16% of fish tagged in Area 3B would recruit as adults to Area 2B and 30% of fish tagged in 3A would recruit as adults to 2B. Pending further examination of tagging analysis, no large scale tag releases were conducted by the IPHC in 1991, but 622 tags were recovered from commercial and sports fishermen, fish processors, and government agencies.

General research projects included underwater video observations of fish behavior to baited circle hooks and interactions between Pacific halibut and bottom trawls, stock identification using DNA analysis, halibut rearing and parasitology, halibut gonad collections in Area 2A, comparisons of age and length compositions between sport and commercial fisheries in Area 2A, and improve accessibility of the extensive IPHC photography data base.

Contact: Dr. Robert Trumble

### 6. Pacific Whiting (Hake)

#### a. Canada-DFO

#### Research programs

The monitoring of catch, estimation of species composition, and biological sampling in the Vancouver Area fishery was continued through an extensive offshore observer program.

Trawl and hydroacoustic studies examining the relative abundance and distribution of Pacific hake in the Vancouver Area, including northern Vancouver Island, were continued. Hake were found along the 200 m contour extending into Queen Charlotte Sound. Assuming a target strength value of -35.0 dB/kg, the biomass of hake in the Canadian zone was 563,308 mt of which 113,780 mt was found north of 49 degrees north latitude.

The 7th annual species interaction trawl survey was conducted in August to assess the impact of Pacific hake and other predators on herring survival and recruitment.

Examination of the factors influencing the distribution of offshore hake was continued. Hake concentrate in basins and along the 200m shelf break from La Perouse Bank to Queen Charlotte Sound. Preliminary results indicate the fish are in association with euphausiid populations.

#### Stock assessment

Hydroacoustic and swept-volume trawl estimates were determined for hake in the Strait of Georgia during March 1987.

A discussion of the offshore hake stock status resulting from the work of the Canada/US hake working group is presented in the NMFS AFSC Pacific whiting section of this report.

#### Management and regulations

Hake off the west coast of Vancouver Island are managed by annual quota. A proportion of the quota is retained for domestic fisheries and in 1991 as in previous years, the remainder was allocated to a joint-venture fishery. Each country participating in the joint-venture fishery negotiates for an allocation.

In the Strait of Georgia the 1992 quota is 11,000 mt.

L. Six asked if the Canadian observer program coverage included all vessels, and what was the catch in 1991?

M. Saunders replied that just factory trawlers were observed, and the catch was 99,000 mt.

#### b. Pacific Fishery Management Council

The 1991 Pacific whiting quota was set at 228,000 mt, which was 90 percent of the 253,000 mt coastwide ABC. In April 1991 the Council approved an allocation between U.S. fishermen competing for the resource. The plan, which did not go into effect until August 29, allocated 104,000 mt to catcher-processors and 88,000 mt to vessels that catch but do not process whiting (that is, for either at-sea or shore-based delivery). The remaining 36,000 mt was held in reserve to be released as needed with priority to vessels delivering shoreside.

On September 6, at-sea processing was terminated until November 17, when an additional 7,000 mt was made available for mothership-processors. A total of approximately 223,000 mt of whiting was taken.

The 1992 Pacific whiting harvest guideline was set at 208,800 mt, 90 percent of the 232,000 mt coastwide ABC. The Council and NMFS delayed the season opening date to April 15 in order to maintain the fishing patterns of the traditional whiting fishery, to keep the by-catch of rockfish and salmon from increasing over previous levels, and to prevent concentration of harvest and processing of whiting in any particular area. In addition, the Council intended to enhance product quality, yield per recruit, and sustainable yield by delaying the season beyond January 1. The Council also adopted an allocation plan for dividing the harvest guideline between competing users. The plan, which NMFS implemented on April 13, allocates 98,800 mt to at-sea processors (catcher-processors and mothership-processors combined), 80,000 mt for delivery to shore-based processors, and 30,000 mt in reserve. Any reserve not needed by vessels delivering shoreside, along with any unneeded portion of their allocation, will be made available for at-sea processing later in the year.

#### c. National Marine Fisheries Service - AFSC

##### Assessment

The U.S. and Canadian harvest of Pacific whiting in 1990 was 260,000 metric tons (t). In 1991, the yield increased by 22% to 316,000 t. The catch of Pacific whiting in the U.S. zone in 1990 was dominated by the 1980, 1984, and 1987 year classes. These year classes accounted for 24%, 42%, and 26% of the U.S. catch respectively. In the 1991 assessment, the stock synthesis model was used to estimate age-structured population abundance, past levels of female spawning biomass, and recruitment for the 1959-88 year classes. The stock synthesis model estimated the age 2+ biomass at the start of 1991 at 2.056 million t. Biomass has declined monotonically from a maximum of 3.185 million t in 1986. The age-2 recruitment estimate of the 1987 year class was 1.903 billion fish, larger than the 1960-89 mean recruitment of 1.230 billion fish, while a recruitment of 0.603 billion was estimated for the 1988 year class. An age-structured model was used to forecast yields for 1992-94. Several harvesting strategies are presented: a constant F strategy, a variable F strategy, where fishing mortality for a particular year is proportional to the level of female spawning biomass, and a hybrid strategy that combines features of the other two policies. Three harvest rates are presented for each harvest strategy. These harvest rates are determined by probability that female spawning biomass will fall below a cautionary level of 457,000 t in long-term simulations of the Pacific whiting population. When a hybrid fishing strategy is applied to the projected numbers at age in 1992, the potential total yield is calculated to be 160,000 t at low harvest rate, 232,000 t at a moderate harvest rate, and 288,000 t at a high harvest rate. If recruitment remains near the 1960-89 median recruitment of 0.678 billion fish, the outlook for the immediate future is for a continuing decline in annual yield. The

recruitment of a strong year class to the fishery would substantially increase the projected yields.

Significant 1991 research efforts were directed towards improved understanding of the migratory pattern for Pacific whiting, especially as it influences recommendations for U.S.-Canada harvest allocation, and display of patterns of salmon and rockfish by-catch in the Pacific whiting fishery.

(Martin Dorn at (206) 526-6548)

#### d. Oregon Department of Fish and Wildlife

During the summer of 1991 a small-scale observer program was undertaken to sample by-catch of landings made to shoreside processors. Of 25 observed trips we observed two salmon, 530 pounds of widow rockfish, 1,689 pounds of yellowtail rockfish and 48 pounds of other rockfish. Except for one tow of mackerel, by-catch of species other than rockfish was minuscule. We also obtained 500 whiting otoliths which we forwarded to NMFS Seattle lab.

The group discussed various aspects of the whiting surveys and fishery.

L. Six asked - What is the density of the hydroacoustic survey track lines on the U.S. side?

M. Wilkins replied that they are about 10 miles apart.

M. Saunders reported that the track lines on the Canadian side are set up so that there is more coverage where the bathymetry is complex. In some cases, the basic east-west track line is not adequate and additional transect lines are required.

W. Lenarz asked - Did the fishery take a lot of fish from outside of the survey area.

M. Wilkins replied that apparently it did, and that they now plan to extend the track lines further seaward. Also, target strength work will be done this year with the dual beam system.

B. Bracken asked - What is the utilization of the whiting?

M. Wilkins replied that tremendous strides have been made in product quality of surimi, fillets, and H & G, through the use of enzyme inhibitors and other additives.

J. Glock noted that about 99% of the surimi product came from factory trawlers. The shorebased processors produced mostly the lower value H & G product for the domestic market.



## 7. Dogfish

### a. Canada-DFO

Mr. Saunders gave the Canadian report on dogfish.

#### Research programs

A biological sampling program looking at diet, sex, size, fecundity and movement of spiny dogfish in nearshore waters of the Strait of Georgia was continued.

Processing and analysis of dogfish tag recoveries was continued. The purpose of this experiment is to assess long-term movements, in particular the rate of exchange between the Strait of Georgia and offshore stocks.

#### Stock assessment

The age-structured deterministic model developed by Wood et al. (1979) continues to be used to evaluate the condition of the spiny dogfish stocks in the Strait of Georgia and offshore. As current harvests levels are below the optimal yield in both areas, stock size is predicted to increase.

#### Management and regulations

Dogfish are managed by annual quota with separate quotas in place for the Strait of Georgia (3,000 mt) and for the remainder of the coast (15,000 mt).

### Alaska Department of Fish & Game

#### Research

The relative catch rate of dogfish is being monitored in the Southern Southeast Inside area in conjunction with the Southern Area sablefish survey.

#### Management

There are no seasons, gear restrictions, or harvest limits for dogfish in the territorial waters of the state at this time. No directed fisheries for dogfish were reported in state waters during 1991.

## 8. Lingcod

### a. Canada-DFO

M. Saunders gave the Canadian report on lingcod.

#### Research programs

Research conducted in 1991 on monitoring and rebuilding lingcod stocks in the Strait of Georgia included a young-of-the-year trawl survey and an ultrasonic tracking experiment. The tracking experiment resulted in 7 of 13 immature lingcod, transplanted 250 km to the Strait of Georgia, leaving the study area. Smaller fish (< 1.3 kg) had a greater tendency to remain in the study area.

#### Stock assessment

There was no change in the analysis from 1990.

#### Management and regulations

The Strait of Georgia is closed to the commercial harvest of lingcod for 1992. A size limit of 65 cm has been implemented for the sport fishery, along with a one fish per day limit, and a June 1 - September 30 season. The commercial size limit is 58 cm for the remainder of the coast.

### b. National Marine Fisheries Service - SWFSC

Research on lingcod at the Tiburon Laboratory is conducted in three areas: age validation, sampling of commercial and recreational landings and modeling the basis of what may be a disturbed sex ratio.

#### Age Validation

The importance of population age-structure in fisheries management places great importance on the validity of aging techniques. Thus age validation has been a major issue in lingcod management because the method currently used to age this species--examination of rings in dorsal fin rays--remains inadequately tested. To resolve this problem Tiburon researchers have undertaken a program of age validation where fish are caught and then simultaneously tagged and injected with oxytetracycline (OTC) before being released. The OTC produces a mark in the dorsal fin rays that can be seen under UV light. When the fish is recaptured it can be determined whether the number of rings beyond the mark does in fact match the length of time the fish is known to have been at liberty. As of March 1992, 288 lingcod have been tagged, and there have been 14 returns. The two that were at liberty longer than four weeks show growth outside the OTC mark, thus demonstrating

promise for success in this project. The goal is 50 returns of fish that have been at liberty for at least a year, and 20 for at least two years.

### Sampling of Commercial and Recreational Lingcod Landings

Port sampling of Oregon and California commercial landings of lingcod fin rays for aging was initiated in January 1992. Sampling is conducted by Oregon Dept. of Fish and Wildlife and California Dept. of Fish and Game, but will be coordinated through Tiburon. Aging of the lingcod fin rays will also occur at Tiburon. The target is to sample two trips per month per gear category. The eventual goal is to obtain enough years for an age structured analysis. Recreational sampling is beginning in a preliminary study in California with length-sex sampling in all ports and fin ray sampling for age analysis in the San Francisco-Princeton ports. This is because preparation of the fin rays requires substantial processing time (drying, cleaning, fixing in resin, sectioning, and mounting). Recreational sampling will be expanded as time for preparation of the fin rays permits.

### Possibility of a Disturbed Sex Ratio

Certain problems inherent in lingcod management come from the species' reproductive habits. Lingcod are segregated by sex, with males predominating in shallow water and females in deeper water. To at least some extent this distribution is related to the fact that during reproduction males guard the masses of fertilized eggs that are attached in nests to shallow-water rocks. Because the two major fisheries for lingcod--the shallow-water recreational fishery and the deeper-water trawl fishery--inflict differing mortalities, there is potential in this situation for a disturbed sex ratio. Whether or not the sex ratio has been disturbed is an important consideration for management. Although the system is complex, it is amenable to modeling. Nevertheless, to develop such a model there is need to define more precisely the extent to which the sexes are segregated.

### c. Alaska Department of Fish & Game

#### Research

A preliminary study which was begun during the winter of 1988 continued through 1991. This study is designed to determine lingcod nesting locations, spawn timing, and the timing and duration of lingcod nest-guarding in Southeast Alaska. The study is being accomplished using a two-stage approach. An on-board observer participated with cooperating local fishermen to obtain sex and size samples from the directed lingcod "dinglebar" fishery. In addition, dive transects were completed in diver depths in areas adjacent to known harvest locations to observe nesting lingcod.

Preliminary data suggests that the spawning and nest guarding period extends later in the year in Southeast Alaska compared to published information from other areas.

## Management

Beginning in July 1989 lingcod fisheries were managed with a 27-inch year round minimum size limit. This is the first commercial regulation for this species in the state and was in response to increased targeting on small fish by an expanding directed fishery. New regulations adopted for 1991 provided for a January 1 to May 31 closure inside the surfline.

## Fishery

Most of the lingcod taken in Alaskan waters come from the Southeast area. Lingcod are landed incidental to hook-and-line fisheries for other species and, in recent years, have been the target of an expanding "dinglebar" fishery. Dinglebar gear is power troll gear modified to fish for bottomfish.

A total of approximately 450 mt of lingcod was harvested by all gear types during 1991. The directed fisheries quota of 225 mt was reached in late October and the fishery was closed for the first time ever.

### d. Washington Department of Fisheries

T. Jagielo reported on lingcod for WDF.

The nearshore tagging study at Neah Bay is in its seventh year. Estimates of abundance, survival, and fishing mortality are being produced. In 1991, work continued to include both offshore and nearshore tagging releases, for the purpose of estimating the net mixing rates between the two areas. Nearshore releases total 4995, with 809 recoveries to date. Offshore releases total 2194 with 362 recoveries to date. Also, an age-structured stock assessment of lingcod in areas 3A/3B/3C is in progress.

Contact: Tom Jagielo 753-6716

### 9. Other Species

#### a. Canada-DFO

The Canadian report on other species was given by M. Saunders.

#### Walleye pollock

## Research programs

A paper was completed that describes statistical models for the analysis of ageing error. Multiple readings of fish age structures can be used to estimate a classification matrix that defines the probability of assigning an age a to a fish when its true age is b. True age proportions of fish in the sample (assuming the observation a takes the value b with highest

probability) can then be estimated from the classification matrix. Reader effects contribute significantly to the overall variance, but play a minor role in estimates of population age proportions. Similar age proportions were obtained whether or not reader effects were included in the model. The model was illustrated using data from walleye pollock.

### Stock assessment

The assessment of pollock stocks has not changed since the previous report. The Strait of Georgia quota is based on a surplus production calculation given the biomass as assessed in 1981 and 1987 using hydroacoustic and swept-volume survey methods.

### Management and regulations

Pollock are managed by annual quota in the Strait of Georgia (3,700 mt). Given extreme variation in availability and uncertainty regarding stock discreteness, fishing is not restricted in other areas of the coast.

### Hagfish

Pacific hagfish have been experimentally fished off the west coast of Vancouver Island since 1988. Permits are issued and managed by Fisheries Division staff. Participation in the fishery has ranged from 0-11 vessels depending on the time of year and market demand. Catch and effort data and monthly biological samples have been collected from all vessels active in the fishery. Two study areas have been established to monitor monthly changes in abundance, sex ratios and female gonadal conditions. Collection and analysis of CPUE and length frequencies was continued to determine sustainable harvest levels for the Pacific hagfish.

### b. National Marine Fisheries Service - AFSC

### Walleye pollock

### Research

### Bering Sea

### Hydroacoustic Assessment of Walleye Pollock on the Bering Sea Shelf

The fifth triennial survey of walleye pollock on the Bering Sea shelf was completed during June 22 - August 31. Operations were conducted within depths of about 30 to 250 fm and progressed in a northwesterly direction from 162 degrees W longitude to the US-USSR convention line. The total midwater biomass of pollock, as assessed using the hydroacoustic system, appears to be a little less than half of that encountered during the 1988 survey. Two year old pollock (1989 year class) were fairly abundant in large midwater schools over much

of the area west of the Pribilof Islands and contributed perhaps 25-30 percent to the total biomass estimate. The remaining portion of the pollock biomass was found in near bottom layers generally ranging no more than 10-15 m from bottom. The apparent decrease in total biomass since 1988 may not be as drastic as it first appears. The population of the two year old fish was large, but individual weights were small. They will contribute a significant biomass by the time they grow large enough to enter the exploitable portion of the population.

## Gulf of Alaska

### Recruitment Processes (FOCI)

Fisheries-Oceanography Coordinated Investigations (FOCI), a NOAA cooperative research program between the Recruitment Processes Task of the RACE Division and the Pacific Marine Environmental Laboratory (PMEL) is designed to investigate the causes of recruitment variations in commercially important fish and shellfish. The program's focus is the well-defined spawning population of walleye pollock in Shelikof Strait. Areas of research include field studies of eggs and larvae in relation to zooplankton and the physical environment, biochemical methods for assessing larval starvation and predation, and pollock behavior. FOCI conducted four cruises aboard the NOAA ship Miller Freeman during the spring of 1991 in the Shelikof Strait region of the Gulf of Alaska to study the effects of the environment on the eggs and larvae of walleye pollock. The unusually stormy periods of 1991 will provide a unique opportunity to study the effects of extreme environmental conditions as we analyze larval distribution and abundance. Satellite drifters indicated a higher probability that larvae would be swept off the shelf. At-sea counts of larvae caught in bongo nets over the shelf and sea valley indicated that larvae were not abundant in 1991 relative to 1988-90. During the last cruise of 1991, pollock larvae were absent from catches at 51 of 97 stations. This compares unfavorably to the last spring cruise of 1990 when pollock larvae were absent from only 2 of 96 stations. Since high concentrations of larvae were not found, improvised field work in 1991 concentrated on the process of offshore advection of larvae. A second noteworthy observation was that many of the larval pollock which were captured in the Strait had a large portion of their guts filled with phytoplankton rather than copepod nauplii as in other years.

Laboratory studies on reared pollock larvae were conducted to (1) calibrate biochemical indices; (2) estimate feeding, digestion, and gastric evacuation rates; (3) calibrate histopathological condition indices; and (4) determine larval shrinkage caused by handling and preservation. Eggs were spawned from fish trawled in the Shelikof Strait and Bogoslof Island area, maintained in refrigerators aboard ship, and then transported in thermos jugs to the culture center at Sand Point. Experiments were also conducted at the University of Washington's Friday Harbor Laboratory. As in previous years, the Sand Point larvae were raised in Elliot Bay sea water and fed on a diet of rotifers. At the Friday Harbor Laboratory the larvae were raised in higher quality sea water and fed on a local source of copepods (the main prey eaten by wild larval pollock). Growth and condition of larvae

cultured at both facilities will be compared. Larvae were fed various prey types and at different concentrations in several container sizes and sampled to determine the relative value of various prey to their growth and survival.

Laboratory studies on environmental factors which influence the distribution and survival of walleye pollock eggs, larvae, and juveniles are continuing at the Center's experimental facilities at the Mark O. Hatfield Marine Science Center in Newport, Oregon. Experiments have shown that egg density and, therefore, vertical distribution may be influenced by light conditions. Eggs developing under constant darkness showed densities and distributional trends similar to those observed at 150-200 m in the Gulf of Alaska, while those held under constant light increased in density and thereby exhibited a mechanism for avoiding light.

Behavioral studies on walleye pollock juveniles showed that the interaction of factors such as light, temperature, food and predators play an important role in determining vertical distribution. Social interactions among juveniles relative to food dispersion have also been shown to affect distribution. Juveniles feeding upon food which is distributed in patches are responsive to the behavior of other individuals and utilize shared information to locate food. Such social interaction results in a more cohesive aggregation than juveniles feeding on more uniformly distributed food where social interactions are minimal. The result of these interactive differences is that a similar number of fish could occupy markedly different spatial limits and thereby influence attempts at assessing population size. Juveniles have also been shown to possess the capability to use seagrass as a refuge from predators. The use of seagrass as a refuge from predators appears to be ontogenetic with larger 0-age juveniles having less affinity for this type of refuge as they move into deeper water.

#### Hydroacoustic Assessment of Walleye Pollock in the Gulf of Alaska

Walleye pollock abundance was surveyed in the Gulf of Alaska during March 16-27. A small area was surveyed just to the South of Sanak Island where commercial quantities of pollock were reported during a previous fishing season. Only one small school of moderate density, composed of large, old fish was encountered in the area. Two survey passes were made through Shelikof Strait and consisted of approximately parallel transects across the strait, starting and terminating at the 50 fm depth contours. The first series progressed from S to N, from near Chirikof Island to mid Afognak Island. The second series progressed from N to S and covered approximately the upper half of the strait. The most abundant year class of pollock found in the strait was three years old (1988 YC). The total estimated biomass was similar to that encountered during 1990. The abundance of pollock in Shelikof Strait appears to be increasing from year to year, but at a very slow rate. Nearly half of the spawning population was composed of fish in excess of 48-50 cm length.

## Assessment

### Bering Sea and Aleutian Islands

Pollock abundance in the eastern Bering Sea was estimated with two age-structured methods, cohort analysis and CAGEAN, with data up to and including the 1990 catch-at-age and the 1979-88 triennial combined hydroacoustic and bottom trawl survey. Age 1 indices from the 1990 and 1991 trawl surveys were used to forecast age 3 recruitment in 1992 and 1993. Cohort analysis indicates a minor decrease in abundance while the CAGEAN results indicate a sharp drop in biomass since the peak value in 1985. The confidence interval around the 1990 CAGEAN estimate overlaps the confidence interval from the trawl survey but does not contain the point estimate from cohort analysis or the trawl survey. The cohort analysis biomass estimates were chosen over CAGEAN because they track the survey biomass trend in recent years better and also because cohort analysis uses more age-specific information from the surveys than does CAGEAN.

Current abundance is above  $B_{msy}$  (6 million t). The strong 1982 and 1984 year classes now contribute substantially to the fishery. Recruitment of age-three pollock is projected to be below average in 1992 but above average in 1993. The ABC for this stock was computed with an exploitation rate corresponding to  $F_{0.1} = 0.31$  which is close to  $F_{msy} = 0.33$  obtained by Quinn and Collie. Application of this fishing mortality rate gives a 1992 eastern Bering Sea ABC of 1,490,000 t. The ABC is less than in 1991 because 1992 projected biomass is lower than the value projected for 1991 in 1990. Exploitation at the  $F_{0.1}$  rate when abundance is greater than  $B_{msy}$  does not violate the Council's overfishing definition.

The Aleutian Islands pollock stock was surveyed by bottom trawl in the summer of 1991, and an on-bottom exploitable biomass of 180,000 t was estimated. The 1992 Aleutian Islands exploitable biomass was calculated with the following assumptions: 1) The on-bottom component of the pollock stock in the Aleutian Islands area is the same as in the eastern Bering Sea (79%), the total exploitable biomass is 228,000 t. 2) The biomass trend in the eastern Bering Sea from cohort analysis is similar to the Aleutian Islands so that the 1992 Aleutian Islands biomass can be projected. The pollock biomass for 1992 should decrease to 215,000 t.

Pollock taken near Bogoslof Island have a consistently different age composition and slower growth rates compared with the eastern Bering Sea stock. A hydroacoustic survey in the winter of 1991 estimated the abundance of Bogoslof pollock to be 0.6 million t. Recruitment to this area has been very low in recent years. Assuming that fishery removals during 1991 were matched by growth and recruitment, the 1991 estimate can be projected forward by applying an instantaneous natural mortality rate of 0.3, giving a 1992 exploitable biomass of 444,000. Applying a catch-to-biomass ratio of 0.24 results in a 1992 ABC of 107,000 t for the Bogoslof fishery. However, it is likely that these pollock are also caught outside the U.S. EEZ and that the entire Bogoslof ABC may be caught in international waters, in which case the Bogoslof TAC should be zero. Therefore the Bogoslof ABC is not



added to the eastern Bering Sea ABC for the purpose of determining the Bering Sea pollock TAC.

Large catches continue to be removed from the international zone of the Aleutian Basin (donut hole). The 1987, 1988, and 1989 catches all exceeded the catch from the U.S. EEZ. Data collected to date suggest that donut hole pollock are related through spawning and recruitment to pollock on the surrounding continental shelves. Future ABCs in the U.S. EEZ may need to be adjusted for catches taken elsewhere.  
(Dr. Vidar Weststad, (206) 526-4249)

## Gulf of Alaska

Estimates of the exploitable biomass of walleye pollock (*Theragra chalcogramma*) are 1,050,000 t in 1990 and 1,088,000 t in 1991 as determined from the stock synthesis (SS) model. The estimated 1992 biomass is 838,000 t, which is based on a projection of the 1991 biomass estimate from stock synthesis.

The current assessment incorporates two important changes relative to 1990. First, the 1984, 1987, and 1990 gulfwide bottom trawl survey biomass estimates were revised. This was due to changes in the fishing power correction factors applied to bottom trawl survey data. Second, historical estimates of discard from the domestic fishery (1986-present) were accounted for in the SS model.

In addition, several sources of information have been updated since the last assessment. 1) biomass estimates from the 1991 hydroacoustic survey; 2) estimates of catch-at-age from the 1991 spring fishery; 3) annual estimates of weight-at-age from the hydroacoustic survey; 4) revised estimates of maturity at age; 5) updated estimates of discard and catch; 6) historical length frequency data; and 7) an estimate of biomass for the Chirikof area in 1975 that was expanded to provide a gulfwide estimate.

The addition of the varied pieces of new information required that several configurations of the model be explored. The relative impact of several factors were examined including: a) utilization of a composite model (all data components weighted equally); b) imposing 1, 2, or 3 fishery partitions; c) incorporation of historical length-frequency data or the estimated age composition data; and d) estimation of selectivity vectors for the surveys.

The 1991 hydroacoustic data continue to confirm that the 1988 year class will be above average. The fishery catch-at-age data for both 1990 and the spring of 1991 are dominated by the strong 1984 year class. In addition, the spring 1991 fishery age data showed a dominant 1982 year class which had previously not shown up in any other data set. This may be attributed to aging error. Exploratory runs with SS were not able to provide a reasonable fit to the 1991 fishery age composition. Because these data may not represent catch at age for the entire year, it was not included in subsequent runs.

Based on the exploratory runs, the following determinations are made: a) a priori assumptions regarding the information content of survey data are necessary, and b) 3 partitions of the fisheries data and the exclusion of the preliminary 1991 fisheries age composition data are justified. With these considerations, three configurations of the stock assessment model were then produced. All three versions incorporated hydroacoustic data as indices of abundance and the only absolute biomass estimate was from the 1990 bottom trawl survey. Previously, the model was tuned to either the hydroacoustic biomass estimate or the bottom trawl survey biomass estimate, as these pieces of information were contradictory and could not be simultaneously fit in the model. Recent estimates of biomass from the hydroacoustic surveys have been much lower than gulf wide bottom trawl estimates. Weighting the hydroacoustic time series equally to the fisheries data provides a mechanism for accounting for the large population estimates observed in Shelikof Strait during the early 1980s. Tuning to the 1990 bottom trawl biomass estimate adjusts the ending biomass to a level that was observed in the recent gulfwide bottom trawl survey.

The three configurations of the model with survey data incorporated as above, differed as follows: Model A did not incorporate the estimate of 1975 biomass and let the model estimate survey selectivity; Model B incorporated the 1975 biomass estimate and also let the model estimate survey selectivity; Model C incorporated the 1975 biomass estimate, but survey selectivity was fixed. The first two models (A and B) showed a linearly declining selectivity with increasing age for the hydroacoustic survey. This selectivity did not seem the appropriately represent what would be the expected selectivity for the hydroacoustic survey.

Predicted 1991 mid-year biomass was 843,000 t. A Beverton-Holt stock recruitment relationship was fit to the estimated recruitments and spawning stock biomass which produced an  $F_{msy}$  of 0.16. Harvesting at this level for 1992-94 (assuming weak recruitments during this period) would provide an average yield of 108,000 t. Current biomass is predicted to be above the  $B_{msy}$  level. The ABC for 1992 is set at 99,400 t and the TAC at 87,400 t.

(Dr. Anne Hollowed (206) 526-4223)

B. Bracken expressed the opinion that the North Pacific Fishery Management Council (NPFMC) is operating under the "PAY" system -- "Politically Acceptable Yield". He wished the ABC could be set biologically, and then the Total Allowable Catch (TAC) could be modified by political forces.

Separately, B. Bracken reported that Greenpeace lost a lawsuit against NMFS, where Greenpeace was concerned over the loss of pollock as food for stellar sea lions.

### c. Alaska Department of Fish & Game

There were no regulations in effect for other species of groundfish in state waters of Alaska during 1991. An "emerging fisheries" policy is being developed for new fisheries which will reduce the possibility that a fishery can escalate out of control before regulations can be

developed. A total of approximately 28 mt of other groundfish species were reported during 1991.

#### d. Oregon Department of Fish and Wildlife

Hagfish, primarily Pacific hagfish, have been the target of a pot fishery off Oregon since 1988. ODFW has continued a modest sampling and fishery monitoring program since the beginning of the fishery. Sampling included individual weight, length, sex, maturity, and number and size of eggs. In 1991 landings were 274,500 pounds, and most fish were landed in the southern Oregon ports of Port Orford and Charleston. Lack of market demand continued to be the limiting factor for development of this "eel skin" fishery. The demand for hagfish is expected to improve because of the recent operation of a hagfish processing plant, which includes a tannery, in the state of Washington. During the first three months in 1992 hagfish landings have already surpassed the record yearly Oregon landings of hagfish as shown below.

Year	Weight in pounds	Number of deliveries	Number of vessels
1988	25,782	4	2
1989	344,187	31	6
1990	167,453	102	11
1991	274,535	131	12
1998*	380,870	171	12

\* Landings through the first three months.

Surfperch - we initiated studies on redbtail surfperch with particular emphasis on the south coast. So far 600 otoliths have been read by the surface method which appears to be adequate.

#### **D. Other Related Studies**

##### 1. Canada- DFO

The Canadian report on other related studies was given by M. Saunders.

#### **Statistics and Sampling**

The principal activities in 1991 included maintenance of the trawl and trap catch and effort database, and biological sampling at commercial landings. A system was developed to enter sales slip data directly and to merge them with the catch and effort database. Minor modifications were also made to the trip log entry systems for trawl and trap gear. Two hundred thirty-four waterfront samples were collected in 1991. Groundfish catch and effort statistics were summarized for the 1989 fishery (Rutherford 1991) and 1990 fisheries. The

catch and effort data entry system was upgraded in 1991 to permit direct import of keypunched catch data for the sablefish trap fishery.

The optimization study of port sampling effort was also continued. Port samplers continue to record the time taken to obtain a biological sample. The fixed and variable costs of sampling will be examined in conjunction with sample variance in age composition to optimize sampling effort with respect to producing catch-at-age databases. Analysis is scheduled to begin in October 1992. A paper describing bootstrapped sampling variance of CPUE estimated from logbook data was completed and accepted for publication.

Two additional computerized measuring boards were provided to port samplers. The new boards operate on either 12 v DC or 120 v AC current. Data collected in processing plants is downloaded to a desktop computer through an RS-232 connection. Enhancements to port-based systems permit direct transfer of logbook information to mainframe computers.

## 2. Pacific Fishery Management Council

L. Six reported that the council is very active in allocation issues at this time. Social factors are gaining increased emphasis and social impact assessments seem imminent. For example, with the whiting offshore/shoreside processing allocation, the council voted to take action counter to the economic analysis results, leaving social reasons as the justification for their decision.

## 3. National Marine Fisheries Service - AFSC

### **Behavior Observations to Facilitate Bycatch Reduction**

In a joint project with industry and the International Pacific Halibut Commission, the Conservation Engineering Task of the RACE Division has been developing techniques to observe fish behavior in trawls to facilitate the development of more selective fishing gear. The goal of this project is the reduction of halibut bycatch in the trawl fisheries in the Gulf of Alaska and Bering Sea.

A remotely operated underwater video system has been developed which has been mounted on trawls to observe fish behavior in response to different components and modifications of the trawl. It consists of an ultra low light video camera mounted on a pan - tilt apparatus in a protective cage. A telemetry cable to the towing vessel allows real time viewing and control.

Observations made to date have proven the usefulness of the system for this type of observation. Behavioral comparisons made include:

1.The location and endurance of several fish species swimming in front of the trawl's footrope. Large halibut moved over a much wider area than small flatfish, and remained in that area for much longer periods.

2.Large halibut and cod tended to lead up lines suspended over the belly of the trawl, while small flatfish dove through them and moved along the net panel itself.

3.In swimming back through the intermediate section of the trawl, small flatfish were mostly close to the bottom panel, while larger halibut and cod were seen more often in the middle and top areas.

4.Halibut did not use escape holes sized to their body proportions, even though these holes were located in a region of relatively still water, allowing ample opportunity for them to locate the holes.

This project is scheduled to continue this summer, testing a new set of trawl modifications. Improvements will include adding a trawl-mounted sector scanning sonar to observe fish in front of the trawl doors and between the doors and the trawl.  
(Craig Rose (206) 526-4128)

#### Electronic Measuring Board

The NMFS surveys annually generate hundreds of thousands of groundfish length records. Fish lengths routinely are measured and recorded either by pencil markings on plastic ruler strips or by punching pin holes in plasticized paper strips. These methods are quick and efficient on deck, but suffer from several faults: the pin holes occasionally overlap and are hard to read, these holes must be tallied, pencil marks are often rubbed off, and the tallied length frequencies must be keypunched into an electronic database. Because of these faults, alternative methods of recording lengths have been explored and a promising new board was tested during the 1991 domestic longline survey in the Gulf of Alaska.

The length measuring board consists of a mylar ruler labeled with bar codes designating length and sex. In use, the fish is laid down on the board, and the appropriate bar code is read by a bar code wand. The information is stored in an electronic data logger attached to the bar code wand. The species and depth stratum are also recorded automatically when length and sex are recorded, but are reset only when they change. The advantage of this approach is that only a single stroke of the bar code wand is necessary to record all information for each fish. At the end of the day, the data in the electronic data logger is downloaded to personal computer files.

The board successfully survived twenty-one days at sea and recorded over 34,000 lengths. The reliability of the bar code scanner was checked routinely and found reliable. Battery power in the electronic data logger was sufficient for the eight to ten hour work day. The bar code wand and electronic data logger are sealed and almost entirely waterproof. The

only connection exposed, that between the bar code reader and the data logger, was sealed with plastic. The main disadvantage of the electronic measuring board is that there is no hard copy of the data until the data are downloaded to the personal computer and printed. Thus, up to one day of length data could be lost if the data logger failed. However, the data logger worked reliably throughout the cruise. The rate of recording lengths for the electronic measuring board was similar to that for the paper and punch method. The electronic measuring board reduced the time necessary for shipboard data processing by about half. Furthermore, the disadvantages of the pencil or paper punch recording methods were avoided and the tedious process of tallying and keypunching length frequency data was no longer needed.

(Michael Sigler (907) 789-6037)

#### Socioeconomic Task - REFM

During 1991, the Socioeconomic Task was actively involved in providing economic information to the Pacific and North Pacific Fishery Management Councils, NMFS, other agencies, and the industry. This included preparing reports and publications, participating on Council plan teams, and preparing and reviewing research proposals and programs.

The major issues for which information was provided included the bycatch problem in the groundfish fisheries off Alaska, limited entry in the Alaska sablefish and halibut fisheries and in the West Coast groundfish fishery, and the allocation of Alaska and West Coast groundfish quotas between at-sea and on-shore processors.

Task members also contributed to the development of studies to evaluate economic effects of the Exxon Valdez oil spill in Prince William Sound, reviewed Sea Grant and Saltonstall-Kennedy proposals, assisted in NMFS efforts to readdress issues associated with the Marine Mammal Protection Act and Endangered species Act, and participated in drafting the North Pacific Fisheries Research Plan.

The reports and publications presented the results of research concerning fishery product exports from the Pacific Northwest and Alaska and the implications of the bycatch limits on groundfish fisheries. Task members also prepared a draft report that served as the economic component of the stock assessment and fishery evaluation for the Gulf of Alaska and Bering Sea/Aleutians Island groundfish fisheries.

(Dr. Joe Terry (206) 526-4253)

#### Codend Mesh Size/Shape Studies

Trawl mesh size studies recently completed at the University of Washington and partly funded by the AFSC suggest that changing the size and shape of the mesh in the codends of trawls could reduce fishing pressure on West Coast groundfisheries and probably would not reduce long-term yield. The studies included 102 trips aboard commercial trawlers testing codends constructed of various sizes (3"-5.5") of diamond- and square-shaped mesh

during 1988-1990. The tests involved trawling on a variety of bottom types between 5 and 650 fm for rockfish, nearshore, and deepwater assemblages. Use of commercial vessels adds to the credibility of the results for actual fishing conditions and applicability for management.

Results of the field tests showed that larger-mesh codends let more young, small fish escape than did smaller-mesh codends. In addition, square-mesh codends allowed more juvenile roundfish (such as sablefish) to escape than did diamond-mesh codends of comparable size. The fish that escape may also suffer less physical stress and thus survive the escapement better, resulting in more abundant adult populations in later years. While changes in mesh size and shape won't solve all West Coast groundfisheries problems, this study suggests that judicious use of such regulations would reduce waste and could also permit relaxation of some trip limits in the short term. In the longer term, there is the potential for increases in annual quotas and reductions in the sensitivity of yields to fishing effort. Under some conditions, gain appears possible without pain. Field tests showed that larger square mesh brought in as much revenue as smaller diamond mesh in the deepwater assemblage fishery (Dover sole, sablefish, and thornyheads).

(Dr. Ellen Pikitch, UW School of Fisheries (206) 543-1513)

#### 4. Washington Department of Fisheries

T. Jagielo reported on other related studies for WDF.

##### Marine Fish Shore Fisheries

This project provides for the collection of catch, effort, and biological information from recreational shore fisheries targeting marine fish along the Washington coast.

Work in 1991 was intended as pilot study to produce a statistically based sampling procedure to estimate the catch and effort of shore-based recreational anglers at the Grays Harbor north and south jetties, Damon Point and the ocean beach between Copalis River and Grays Harbor north jetty. Relative effort from key sampling periods was expanded to provide estimates of total effort at these sites. Methodology from this project will be evaluated as to the potential application to all coastal areas.

A "bus route" sampling designed proved to be the most cost effective and efficient technique for sampling anglers at Damon Point, Grays Harbor north jetty and the ocean beach. During the month of April an estimated total of 224 anglers fishing an average of 5.4 hours per trip caught a total of 1,452 fish at Damon Point. During the same time period 238 anglers fishing the ocean beach between the Grays Harbor north jetty and Copalis River, averaged 3.7 hours per trip and caught a total of 528 surfperch. A total of 115 fishers fishing on the Grays Harbor north jetty averaged 9.1 hours per trip and caught a total of 303 fish. Over 95% of the fish caught at Damon Point and ocean beaches were surfperch while jetty fishers caught mostly greenling and black rockfish. During May, June and July angler

effort doubled and then declined during late July and August for all three sites. Angler effort was minimal in September at the three sites possibly due to effort being drawn by a salmon fishery at the Ocean Shores boat basin which was very productive during this time period. Grays Harbor south jetty sampling did not start until June, but angler effort appears to be greater than at all other sites combined during like months.

Contact: Brian Culver/Farron Wallace 249-4628

#### **Management Studies of Lingcod and Rockfish Populations in Puget Sound.**

The goal of this project is to monitor reef fish populations in Puget Sound and to develop a direct method to assess these populations that is independent of their fisheries. Creel surveys continued during the spring-time fishery for lingcod at the Tacoma Narrows. Field work was initiated to determine if underwater television cameras and advanced acoustic equipment can be used to reliably estimate fish densities on rocky reefs. Initial work shows some promise and equipment will be tested during intensive field studies in 1992.

#### **Puget Sound Ambient Monitoring Project.**

This project is part of a multi-agency effort to characterize the health of Puget Sound, monitor environmental trends and investigate potential human health issues. Survey work was conducted by WDF during 1991 at 17 sites distributed throughout Puget Sound to examine English sole for liver disease due to contaminated sediment exposure. Muscle and liver tissue specimens were analyzed for chemical contaminants of PCB's, pesticides, heavy metals and various organic compounds.

Contact: Teresa Turk 545-6605

#### **Recreational Enhancement of Puget Sound Marine Fish.**

Presently, effort is split between 1) a cooperative study with Peninsula College in Port Angeles, Washington dealing with the development of culture techniques for lingcod, and 2) the ongoing development of artificial reefs.

An experimental lingcod culture system is expected to be on line by the winter of 1992. A temporary small scale system is now functioning and preliminary hatching and rearing experiments are underway. Larval lingcod have been hatched from eggs collected in the field, and reared to an age of 2-3 weeks. Preliminary work has allowed experimentation with hatching chamber design and observation of larval lingcod feeding behavior.

Construction of artificial reefs for boat anglers was initiated in the late 1970's. The Department presently manages 9 reefs in central and south Puget Sound which range from 20-40 percent complete. Further construction depends on contributed materials; several potential sources may yield enough material to complete several reefs at no cost to the department.

Contact: Stephen Quinnell 545-6585



## Habitat Investigations - Beach Spawning Habitat Surveys.

The goal of these investigations is to document the distribution of upper intertidal spawning and incubation habitats for the surf smelt (*Hypomesus*), Pacific sand lance (*Ammodytes*), and rock sole (*Lepidopsetta*) in previously-unsurveyed sectors of Washington state shorelines for habitat protection purposes (year 1 of a proposed 6-year study). Eight sectors of generally poorly-known Puget Sound shoreline were periodically surveyed from November 1991 to April 1992. Spawn detection and documentation relied on both visual inspection of beach material in the field and the microscopic analysis of samples of upper intertidal beach surface material in the lab. Approximately 700 sampling stations were undertaken during the survey period. Major findings by species are outlined below:

**Surf smelt:** About 13 lineal miles of "new" smelt spawning beach were discovered during the past survey season, all apparently fall-winter spawning stocks. In Semiahmoo Bay, continued presence of smelt spawn through the survey period indicated that this stock, newly documented in 1990 and thought to be summer spawners, may be a year-round spawning population, a condition previously known only for the smelt spawning stock using beaches in the adjacent San Juan Islands.

**Sand lance:** The past season's surveys documented an additional 17 lineal miles of shoreline used as sandlance spawning and spawn incubation habitat. Our new technique of microscopic inspection of screened/winnowed fractions of bulk samples of beach material greatly increased our ability to detect the highly cryptic sandlance eggs beyond our capabilities of visually detecting them in the field after spawn patches had been dispersed by wave action.

**Rock sole:** The identity of this third common type of egg in Puget Sound beach spawn samples was confirmed in early 1991. By the end of this past survey season, there were 19 new sites of documented rock sole spawn and about 5.5 lineal miles of rock sole spawning and spawn incubation habitat known in Puget Sound, virtually all to be found south of Seattle. Intertidal rock sole spawn occurred most commonly in February-March.  
Contact: Dan Penttila 545-6584.

## Habitat Investigations - Habitat Requirements and Trophic Relationships of Marine Fish.

Natural habitats support the total production of marine fish resources in the state and the long-term viability of these resources depends on protection of their habitats. Studies to date have focused on identifying and protecting natural nursery habitats for marine fishes of importance to the recreational fishery. From these studies we have identified a critical lingcod settlement and nursery habitat in the Strait of Juan de Fuca. This is the first documentation of specific critical habitat for juvenile lingcod in the state. In addition, we have identified critical juvenile rockfish settlement and nursery habitats at 14 locations in the San Juan Islands, the Strait of Juan de Fuca, and in Puget Sound. Data from these studies suggest that vegetated habitats of kelp (*Nereocystis leutkeana* and *Macrocystis*

*integrefolia*) and eelgrass (*Zostera marina*) at these locations serve as important settlement and nursery habitats for juvenile copper and quillback rockfish. Information indicates that juvenile rockfish seek refuge in these kelp and eelgrass habitat for a 4-5 month period in the summer and fall before they move into deeper rocky reef habitats.

The lingcod and rockfish nursery habitats identified in these studies are now protected from degradation or loss under Washington Administrative Codes. The protection provided from these studies will help sustain or increase the natural production of rockfish and lingcod resources.

Contact: Daniel Doty: 753-3126.

#### Habitat Investigations - Artificial Reef Habitats to Enhance Marine Fish Recruitment.

This project has focused on enhancing production of recreational fishery important bottomfish such as rockfishes and lingcod, by providing shelter habitat for the vulnerable juvenile life stage. Design characteristics of older, existing artificial reefs in Washington provide habitat primarily for sub-adults and adults. Four large (ca 2240 m<sup>2</sup>) artificial "nursery" reefs designed specifically to provide refuge for juvenile copper, quillback and brown rockfish (among others) were constructed in the Puget Sound and Hood Canal in association with existing "adult" reefs in 1991. Early results indicate that juvenile rockfish are attracted to the new substrate, and that the potential for increasing their survival is high. An increase in survival of juveniles will result in increased future stocks available for fishing. The earliest direct effects of this project on fishing in the State will likely be 1994/1995, when the fish are large enough enter the fishery.

Contact: Jim Norris 753-3126.

#### Critical Foodweb Linkages for Marine Fishes.

The focus of this study is to identify trophic (food) relationships between marine fishes and their nearshore habitats. Identifying these foodweb linkages establishes the function of critical habitats in the natural production of marine fish resources. This information is a vital link in the process to preserve and protect these habitats through regulations. Juvenile rockfish and lingcod have been collected from a number of natural and artificial reef habitats over the last 18 months. Analysis of their stomach contents indicates that some species of juvenile rockfish feed on substrate associated prey, such as shrimp and amphipods, and shift prey type with season. Other juvenile rockfish species appear to exploit the planktonic community for food. Juvenile lingcod feed on kelp and eelgrass associated animals such as mysids and fish. These results, combined with future studies, will be used to further define critical habitats for juvenile rockfish and lingcod. Once identified, steps can be taken to assure the protection or enhancement of these vital habitats that provide the food for marine resource production.

Contact: J. Anne Shaffer 753-3126.

## 5. Oregon Department of Fish and Wildlife

B. Demory gave the ODFW report of other related studies.

We continued our cooperative study with Oregon State University on deep-reef fish assemblages off Oregon which began in 1987. A submersible and hydroacoustic gear were used to study the Stonewall Bank area. We used the submersible Delta to sample six stations on the bank which is located 15 nm off Newport, Oregon. Dives were conducted at depths of about 140-240 feet. We completed three daytime transects at each of the six stations, two night dives at one station and three night dives at a second station. We also made one dive at each of three stations to collect invertebrates.

We ran several acoustic surveys of the entire Stonewall Bank region, both day and night, as well as acoustic transects associated with the submersible transects. Bounce dives were made on strong acoustic midwater signals to identify the species, size, and density of fish involved.

Some general observations were: (1) acoustic data indicated that large schools of rockfish tended to stay in the same location over at least a one-week period; (2) continuous rock bottom with few shelters and a low standing crop of benthos supported few fish; (3) heterogeneous rock bottoms had patchy schools of fish which were usually mixed-species, nonpolarized aggregations of mostly yellowtail, blue, widow, and redstripe rockfishes; and (4) major day-night differences were that rockfish schools occurred closer to the bottom at night and juvenile rockfishes were relatively rare and much less abundant at night. Contact Rick Starr or Bill Barss.

## VIII. OTHER TOPICS FOR DISCUSSION

### A. Future of the TSC

The future of the TSC was discussed briefly. B. Bracken asked where we were with the participation issue.

T. Jagielo reported that, as voiced last year, there was concern at WDF about the failure of The TSC to hold management discussions that resulted in meaningful bi-national agreements. He also reported that WDF does not plan to reduce participation in TSC at this time.

M. Saunders indicated that persons at the Pacific Biological Station were supportive of TSC. He also voiced the view that the information presented at the TSC meetings was valuable and more timely than information coming from the published literature.

M. Wilkins noted that the TSC had an important role in steering the direction of future research. M. Saunders concurred, and cited the progress of the yellowtail working group, which was a direct result of TSC support.

B. Demory distributed a summary of the TSC accomplishments from 1984 through 1991 (Appendix D). In general, the group consensus was that the TSC provided a valuable ongoing forum for the exchange of research information between the member agencies and others.

B. Bracken expressed disappointment that a representative of the North Pacific Fishery Management Council (NPFMC) couldn't attend the meeting this year. He noted that TSC is an informal place for the two councils to meet.

L. Six observed that there is already a fair amount of communication between the two councils, but agreed that it would be good to have a representative from NPFMC in attendance.

## **IX. PROGRESS ON 1991 RECOMMENDATIONS**

### **A. From the TSC to Itself**

#### **1. Age Validation Studies**

Work on age validation of Dover sole and arrowtooth flounder has been put on hold because the nearshore flatfish survey was canceled. Bob Demory agreed to author a follow-up TSC recommendation for 1992.

#### **2. Recommendations to CARE**

M. Wilkins reported that the 1991 recommendations to CARE were delivered, and believed that most of the concerns would be addressed at the May, 1992 CARE meeting.

### **B. From TSC to the Parent Committee**

#### **1. Recommendation regarding Pacific whiting (hake)**

L. Six reported that the matter was elevated politically since the last TSC meeting, but efforts to reach an agreement between Canada and the U.S. were unsuccessful. Another Canada-U.S. meeting is planned.

The group discussed progress on hake and expressed continued concern for the conservation problem resulting from the bi-national harvest over the ABC. M. Saunders agreed to draft a recommendation to the Parent Committee to voice this concern.

#### **2. Recommendation regarding the Historic Annotated Landings (HAL) data.**

L. Six reported that NMFS will not devote the resources necessary to finalize the data set, but Rich Marasco (NMFS, Alaska Fisheries Science Center) will make the data available

to scientists with the understanding that there are some problems with the data (See Appendix E, Letter from L. Six to E. Zyblut).

## **X. 1992 TECHNICAL SUBCOMMITTEE RECOMMENDATIONS**

### **A. TSC to Itself**

#### **1. Regarding coordination of coastwide synoptic surveys - Prepared by M. Sanders - Approved**

In the past, Canadian and U.S. scientists have worked cooperatively in the design of Pacific hake (whiting) hydroacoustic surveys. The TSC recommends that the hydroacoustic work continue and that the two agencies cooperate in the design and implementation of surveys to assess other transboundary stocks eg. yellowtail, sablefish. In particular the utility of expanding the U.S. triennial bottom trawl survey into Canadian waters should be examined.

#### **2. Recommendation to CARE regarding age validation of rockfish and thornyheads - Prepared by M. Wilkins - Approved**

Stock assessments of northeast Pacific groundfish species rely heavily on catch-at-age analyses. By their design, such analytical methods require accurate and reliable estimates of age for the species in question. The TSC has a concern that some rockfishes and the thornyheads (genus *Sebastolobus*) are currently being exploited without adequate information regarding their production. Validation of the ageing criteria, therefore, would provide essential information for improving the assessments of thornyheads and rockfishes. To that end, the TSC recommends that the member agencies direct significant efforts toward research validating the ageing criteria for thornyheads and rockfish species.

#### **3. Regarding Age validation of Dover sole and arrowtooth flounder - Prepared by B. Demory - Approved**

The TSC discussed age validation of Dover sole and arrowtooth flounder. Work planned for 1992 has been put on hold because the west coast nearshore flatfish survey scheduled to begin in July 1992 had been canceled.

The TSC recommends that the member agencies consider the following items in planning for these age validation studies:

- 1) That 2 or 3 sites be selected for fish releases. These tagging areas should be in areas of substantial fishing activity so that the probability of tag recovery is high.
- 2) Tagging platforms should include Canadian and US research vessels, chartered vessels, or ride-alongs. The slope work off the WOC area may offer the best solutions for tagging. Ride-alongs are the least preferred because tow length is not controlled.

## B. From the TSC to the Parent Committee

### 1. Regarding a rockfish management workshop - Prepared by Barry Bracken - Approved

The TSC discussed the problems associated with rockfish management in general and management of near-shore and minor offshore rockfish in particular. Major issues of concern include:

Lack of biological information for many species

Lack of abundance information for most species

The generally poor track record of rockfish management coast-wide and the notable difficulty in managing these species

The extreme longevity and vulnerability to over-exploitation associated with those species where some biological parameters are known. (Harvest of long-lived rockfish has often been compared to mining or clearcutting rather than sustained yield resource management.)

Given the considerable concern for the status of rockfish stocks, the TSC recommends that a workshop be convened at the earliest practical date to discuss rockfish management options and to advocate appropriate measures to manage this valuable marine resource.

The TSC further recommends that the Parent Committee take appropriate action in setting up this workshop.

### 2. Regarding yellowtail rockfish - Prepared by Mark Saunders - Approved

The Yellowtail working group has assembled the information requested by the Parent Committee at the June 6, 1991 meeting. The Parent committee asked for the following:

1. Confirm the discreteness of the stock
2. Firm up the appropriate stock boundaries
3. Estimate the ABC for the stock unit
4. Compare catches in recent years to the ABC to determine the degree to which a conservation problem exists.

The working group reported that the yellowtail stock in PMFC areas 3B and 3C is discrete. The present ABC for the stock recommended by U.S. scientists was 2,000 mt while Canadian scientists recommended a range of low risk to high risk of 1,000 to 2,000 mt, respectively. The total landings (Canadian and U.S.) since 1986 have been considerably in excess of ABC, indicating that a conservation problem exists. The TSC recommends that

Canadian and U.S. managers initiate discussions to develop management plans in their respective countries to insure that conservation mandates are met.

3. Regarding FDA approval for OTC use as an age validation tool - Prepared by Bill Lenarz - Approved

The TSC discussed difficulties in obtaining approval from the FDA to release marked fish that have been injected with OTC for age validation studies. These studies are required to resolve uncertainties in the accuracy of age determination for many species of groundfish. The FDA has not had a consistent procedure for processing requests for approvals of such studies. The TSC recommends that a standard, well-documented procedure be developed for the approval process.

The TSC recommends that the U.S. section of the Parent Committee take steps necessary to initiate the development of approval procedures. The TSC instructs CARE to provide technical assistance as necessary in communicating with the FDA.

4. Regarding Pacific hake allocation - Prepared by Mark Saunders - Approved

The Can./U.S. hake allocation issue remains unresolved and a conservation problem exists with combined Can./U.S. catches exceeding the coastwide ABC's. In 1991, the allocation issue was elevated to a formal level of discussion between Canada and the U.S. At the first meeting of Can. and U.S. negotiators no agreement was reached, although both sides felt a split based on the proportion of biomass in the two zones as indicated by U.S. triennial surveys, showed promise. The Can./U.S. Pacific hake working group of the TSC was charged with evaluating the biomass split and a report is close to completion. The TSC recommends that bilateral discussions between Canadian and U.S. governments resume as soon as possible after receipt of the document and work towards agreement.

## **XI. SCHEDULE OF NEXT MEETING**

The next meeting will be hosted by CDFG at Point Lobos, California, in the first week of May, 1993.

## **XII. ELECTION OF CHAIRPERSON**

Chairman M. Wilkins, NMFS, completed his two year service as chairman this year. The TSC thanked Mark for a job well done.

The rotation was scheduled to go to California for 1993-1994 (See rotation schedule, 1991 TSC report), but California will host next year so the rotation advanced to Canada.

M. Saunders, DFO, was elected chairman for 1993-1994.

### **XIII. ADJOURNMENT**

Prior to adjournment it was noted that Mr. Bob Demory, ODFW, would be retired before the next scheduled meeting of the TSC. The TSC commended Mr. Demory for his many contributions and years of service, and wished him a fond farewell.

The meeting was adjourned at about 1200 hours, on Thursday, May 7, 1992.



## 1992 TSC MEETING AGENDA

- I. CALL TO ORDER
- II. APPOINTMENT OF SECRETARY
- III. INTRODUCTIONS
- IV. APPROVAL OF THE 1991 REPORT AND 1992 AGENDA
- V. TERMS OF REFERENCE
- VI. WORKING GROUP REPORTS
  - A. CARE
  - B. PacFIN-PSMFC Data Series project
  - C. Stock assessment groups
    - 1. Yellowtail rockfish
    - 2. Pacific whiting (hake) allocation
    - 3. Dover sole age validation
  - D. Other
- VII. REVIEW OF AGENCY GROUND FISH RESEARCH, ASSESSMENTS, AND MANAGEMENT
  - A. Agency overview
  - B. Multispecies studies
  - C. By species, by agency
    - 1. Pacific cod
    - 2. Shelf rockfish
    - 3. Slope rockfish
    - 4. Thornyheads
    - 5. Sablefish
    - 6. Flatfish (Dover, English, arrowtooth, petrale)
    - 7. Pacific whiting
    - 8. Dogfish
    - 9. Lingcod
    - 10. Other
  - D. Other related studies
- VIII. OTHER TOPICS FOR DISCUSSION
- IX. PROGRESS ON 1991 RECOMMENDATIONS
  - A. From the TSC to Itself
  - B. From the TSC to the Parent Committee
- X. 1992 TECHNICAL SUBCOMMITTEE RECOMMENDATIONS
- XI. SCHEDULE OF FUTURE MEETINGS
- XII. ELECTION OF CHAIRPERSON
- XIII. ADJOURNMENT





**UNITED STATES DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
NATIONAL MARINE FISHERIES SERVICE  
Alaska Fisheries Science Center  
Resource Ecology and Fisheries  
Management Division  
Age and Growth Task  
7600 Sand Point Way N.E.  
Bin C15700  
Seattle, WA 98115-0070

July 7, 1992

**To:** Technical Subcommittee of the Canada - United States  
Groundfish Committee and Committee of Age Reading  
Experts

**From:** Craig Kastle  
Chairperson, Committee of Age Reading Experts

The Committee of Age Reading Experts (CARE) meeting took place from May 27 to 29, 1992 at the Alaska Fisheries Science Center, Seattle, WA. The meeting was well attended, with new participants from NMFS, (SWFSC and AFSC), CDF&G, and ADF&G.

The issues of "Age Validation Research" were a major topic. During previous CARE meetings age validation was discussed, but not a focal point. At the May 1992 meeting, a number of participants gave presentations of current research in this area. Methods of age validation emphasized were marginal increment analysis, radioisotope ratios (Pb-210:Ra-226) found in fish bones, and oxytetracycline (OTC) or possible substitutes. Though not formalized in a specific recommendation, the general consensus was that age validation research is very important, and worthy of the time spent at the recent CARE meeting, and future CARE meetings. The Technical Subcommittee (TSC) recommended (via a memo from TSC chairman, Mark Wilkins, to myself dated May 20, 1992) that rockfish, including thornyheads, should receive increased effort in the area of age validation research. Mark Wilkins' memo was noted and discussed by the participants at the recent CARE meeting.

The TSC recommended in May, 1991 that CARE members engage in age structure exchanges and hands-on microscope work at CARE meetings. This was accomplished, and CARE recommended that additional exchanges be undertaken.

The following is a list of specific recommendations made by CARE at the May 1992 meeting:

1. CARE recommends to itself and TSC that substitutes and alternatives for OTC be investigated. Possibilities include calcine, alizarine compounds, and SrCl. This might reduce the problems in receiving approval from the FDA.
2. CARE recommends that the TSC support the establishment of a radiochemistry lab, possibly within NMFS, that would



function on a coast-wide basis, being available to age samples from multiple agencies. It was further recommended that this lab should only be used for age validation of marine organisms.

3. CARE recommends, to itself, an evaluation of the different image analysis software and hardware systems available. Currently both DOS and Apple software exist to analyze and enhance images. Both systems have strengths and weaknesses and an evaluation could help agencies determine which system to purchase. A method of translating files from one system to the other would facilitate interagency communication and reader comparisons. Currently the BioScan Optimas product seems the most widely used.

Computerized image analysis is a tool being used by an increasing number of agencies. The learning curve for biologists using these systems is extreme. Therefore, a CARE meeting in the spring of 1993 is recommended to deal specifically with image analysis. Topics may include some of the following: translating files from system to system, sharing of macros between agencies, comparisons of the products available, and applications in a "production ageing lab".

4. CARE recommends to itself frequent exchanges of age reading structures for interagency calibration. The species of current concern in this area are shortspine thornyhead, sablefish, pollock, and other rockfish species.
5. CARE recommends to itself that the "CARE Ageing Manual" be completed and finalized as it exists now, with additional species added as addenda in the future. To accomplish this goal a working group was established consisting of Betty Goetz (NMFS), Kristen Munk (ADF&G), Larry Quirollo (CDF&G), Calvin Blood (IHC), John Butler (NMFS), and Shayne MacLellan (DFO, Canada) as editor.

CARE recommends that TSC solicit funds from PSFMC to publish the "CARE Aging Manual" including high quality photos, and quality reproduction of other graphics.

Appendix C

**Working Group Report on the Yellowtail Rockfish  
Fisheries**

**Jack V. Tagart  
and  
R. D. Stanley**

**May 1992**

**Submitted to the Technical Subcommittee of the Canada/United States  
Groundfish Committee**

This document follows earlier annual progress reports. It summarizes progress made from June 1991 to May 1992 and outlines the objectives through June 1993.

At the 1988 Annual Meeting of the Canada/U.S. Groundfish Committee, the Technical Subcommittee recommended to the Parent Committee that a yellowtail rockfish working be appointed. They stated that this working group should:

1. Review the status of the yellowtail rockfish stocks;
2. Study management strategies for yellowtail rockfish;
3. Review the implications of the various management strategies on the yellowtail rockfish stock;
4. Report to the TSC and Parent Committee on their progress.

The working group first met July 1988. At this meeting it was decided that in addition to updating and coordinating stock assessments, even more pressing needs included collation of a coast-wide biological database and initiation of studies into stock identification.

#### 1. Biological database

The initial compilation of the coast-wide yellowtail rockfish biological database was completed in April 1989. The coast-wide master database includes records from WDF, ODFW, NMFS and DFO and covers the period 1968 to 1987. In December of 1991, letters were sent to state and federal agencies requesting additional biological data covering the period from 1988 to 1990. All agencies have responded as indicated below. The new records we have received will be compiled into the master database during April, 1992.

##### 1.1. Canada (DFO)

The 1992 update includes ageing data from the domestic trawl samples and research samples for 1989-91. The update also incorporates, for the first time, length frequency data of yellowtail rockfish from the bycatch of the offshore Canadian hake fishery (1987-1990).

##### 1.2. California (CDFG)

Don Pearson, NMFS/SWFC, Tiburon, has provided, in the master database format, all the available yellowtail rockfish biological data collected in California from 1978 to 1990.

##### 1.3. Oregon (ODFW)

Clair Wood, ODFW, Newport, submitted Oregon's 1988 to 1990 biological data prepared in the master database format.

#### 1.4. Washington (WDF)

WDF's 1988 to 1990 yellowtail rockfish biological data has been extracted and prepared in the master database format. These data will be combined with those from other agencies and added to the master database in April.

#### 1.5. NMFS

The NMFS/AFSC collected additional length, weight, and age samples from yellowtail rockfish during their 1989 triennial groundfish survey. Mark Wilkins (NMFS) advises us that otoliths were collected from 464 yellowtail rockfish during the survey, but these otoliths have not been aged. There is not, at present, any available age reader time to age these structures.

WDF technicians aged approximately 600 otoliths collected in 1989 from the yellowtail rockfish caught during the U.S. whiting fishery. We have requested these data from Russ Nelson, NMFS/AFSC, Seattle, but they have not yet been made available; however, staff from the Observer Program are processing the data and we expect them at any time.

#### 1.6. Data report

We continue with our plans to prepare a user's guide to the database for publication in the WDF progress report series (Tagart and Stanley, in prep ). Report preparation has been delayed owing to other work commitments by working group members.

### 2. Stock delineation

#### 2.1 Genetics

Analysis of yellowtail rockfish tissues collected during 1990 and 1991 has been completed by Mr. Stevan Phelps of the Washington Department of Fisheries Genetic Stock Identification Laboratory. We are preparing a paper on these experiments (Tagart, et al., 1992) which is expected to be submitted for publication this spring. An abstract of the results of these studies is presented below.

Using electrophoretic analysis, we examined 1000 yellowtail rockfish taken in 10 samples from five areas over two seasons. The sample area extended from southern Oregon to Queen Charlotte Sound in British Columbia. Samples were collected between September 30 and November 6, 1990 and again between March 23 and May 23, 1991. Data were gathered for 33 presumptive loci, 23 of which were polymorphic. Average observed heterozygosity was 0.04. We found significant genetic heterogeneity among samples and consequently reject the coast-wide homogenous stock hypothesis. At four of the five sample locations we found no significant differences in genetic variability between seasons, however, at one location we

did observe significant between season variability. Within a season, there were no significant between area differences in genetic variability among samples taken in Canadian waters; however, in both seasons there were significant differences among samples from U.S. waters. Samples collected from the northern Washington coast were significantly different from samples collected to the south but were not significantly different from Canadian samples. Cluster analysis results suggest a possible cline in gene frequencies from Queen Charlotte Sound to the southern Oregon coast.

## 2.2. Parasites

In the previous annual report, we summarized results of a study which examined the use of parasites as biological tags. The report has since been accepted for publication in the Canadian Journal of Zoology.

## 2.3. Tagging

A publication summarizing the results of two tagging experiments of yellowtail rockfish is in first draft (Stanley, Leaman, Haldorson and O'Connell, in prep).

## 2.4. Summary of stocks

We have recognized for some time that yellowtail rockfish may be separable into discrete operational stocks. This conclusion is supported by observations of their life history. For example, mating and parturition occur at roughly the same time of year across a broad geographic zone from California to British Columbia. Therefore, at least once per year, there must be discrete isolated aggregations of yellowtail rockfish engaged in these spawning activities. Furthermore, to reinforce the notion that these local aggregations persist at other times of the year, we observe consistent differences among stocks in the annual size and age distribution and sex ratio of the landed catch. These differences could not reasonably persist if, following mating and/or parturition, there was significant movement of individuals among stocks. This circumstantial evidence of stock structure is enhanced by our recent experiments on the genetics and parasites of yellowtail rockfish.

In their investigation of yellowtail rockfish parasites as potential biological tags, Stanley et al. (in press) found a monogenean (Microcotyle sebastis) which followed a decreasing trend in frequency of occurrence and absolute abundance on fishes from southern Oregon to Queen Charlotte Sound. The apparent cline in the distribution of this parasite is consistent with the results from our genetic analysis where we find clear distinctions in the electrophoretic patterns of Oregon and Queen Charlotte Sound samples and more overlap in these patterns for the intervening samples.



It is our conclusion that the life history data in concert with the parasite and genetic data provide sufficient evidence to suggest that yellowtail rockfish are separable into operational stocks. At a minimum it appears that yellowtail rockfish from Oregon are distinct from those in Queen Charlotte Sound. There is greater difficulty separating the stocks from northern Washington and the west coast of Vancouver Island. It is unequivocal, however, that the S. Vancouver area stock is transboundary.

The limited tagging results have shown that some individuals were recovered after moving long distances which ostensibly contradicts the hypothesis of discrete stocks. However, after accounting for differential fishing pressure, a much higher proportion of tagged fish were shown to be captured in the vicinity of the release site than would have been demonstrated from non-standardized data (Stanley 1990). While we continue to propose a discrete stock approach to assessment, we acknowledge that there is mixing among stocks.

We suggest that there is little more to be determined from analysis of yellowtail rockfish enzyme polymorphism using standard electrophoretic techniques. We could obtain additional samples from the central and northern California coast and/or from southeast Alaska. The California samples would be helpful for U.S. managers, while the Alaskan samples would merely serve to complete a coast-wide analysis of genetic similarity. One question we have not addressed is whether or not there is inter-annual variability in genetic patterns. The logistical difficulties of collecting coast-wide samples in a constrained period of time and the cost of analysis of those samples is substantive. At this point we do not think it is necessary to test for inter-annual variability, however, if others felt a compelling need for this test, we would need a supplementary budget to fund the collection and analysis of samples.

For similar reasons, we do not recommend additional tagging or parasite work for purposes of stock discrimination. Additional work would not significantly improve the knowledge base unless they could provide quantitative estimates of mixing. Such studies would be far more extensive and require a much larger dedication of supplemental resources.

### 3. Stock Assessments 1991

#### 3.1. Canada

Complete yellowtail rockfish assessments for Canada are now conducted every three years. The next full assessment is to be conducted for the fall of 1992. An interim assessment was conducted for 1991 and accepted by the Pacific Stock Assessment Review Committee (PSARC) of DFO, September 1991 (Stanley, in prep). Yield recommendations were unchanged from the previous year: 1000-

2000 t for PMFC Areas 3B and 3C; 500-1000 t for PMFC Area 3D; and 1400-3000 t for PMFC Areas 5A and 5B.

### 3.2. U.S.

The U.S. yellowtail rockfish stock assessment was completed in March of 1991 and accepted by the University of Washington as Dr. Tagart's doctoral dissertation. Copies of the dissertation were mailed to a select group of state and federal agency representatives. There has been no revision to the analysis since the dissertation was completed.

## 4. Future catch-at-age assessments

### 4.1. Canada

The catch-at-age analysis of the Canadian fishery will be updated for August of 1992 using the stock synthesis model. It will include three additional years of ageing data.

### 4.2. U.S.

The U.S. stock assessment will be revised following the update of the coast-wide master database, April 1992. The revision will again rely on stock synthesis analysis. The analysis will be updated to include estimates of hypothesized values for discarded catch.

### 4.3. Joint assessment work

While Canadian and U.S. assessments will be conducted separately, there will be consultation over procedures and recommendations.

## 5. Additional research

### 5.1 DFO

DFO conducted a hydroacoustic study of yellowtail rockfish in November 1991. The focus of the cruise was to assess yellowtail biomass in one discrete area as a test of the repeatability of biomass assessments. Preliminary analysis indicated a high precision in biomass estimation for the small area examined in the survey (approx. 200 km<sup>2</sup>). Biomass estimates were similar when comparing day to night estimates even though the fish tended to rise and dis-aggregate during darkness.

Research in 1991 also included an small scale survey of juvenile rockfish distribution, including yellowtail rockfish, and ecology on the west coast of Vancouver Island. Results have not yet been analyzed.

## 5.2 WDF

WDF has no immediate plans for auxiliary yellowtail rockfish assessment research.

## 5.3 Joint work

Upon completion of individual papers on yellowtail rockfish tag results and the genetics studies, we plan to produce a summary paper which reviews the set of studies which we directed towards the stock delineation problem. No further field research is planned.

## 6. Management options

The TSC asked that the working group examine various management strategies related to the trans-boundary allocation of yellowtail rockfish harvest. Available evidence suggests that the population in the trans-boundary area mixes freely in the vicinity of the boundary, thus there is no biological basis for an allocation. Consequently, recommendations for allocation of the harvestable resource must rely on social, political, and economic factors which the current working group is unprepared to address without explicit guidance from the managers of both countries.

The working group recommends that any bilateral discussion on the trans-boundary nature of these fisheries treat PMFC areas 3C and 3B as an operational stock (the southern Vancouver stock) and exclude from consideration the fisheries to the north and south. We acknowledge that the stock affiliation of the central Vancouver Island remains unclear.

Managers are reminded that the offshore hake fishery results in a significant harvest from the southern Vancouver stock. They are also advised that the working group does not perceive any differences in the harvest selectivities between the two domestic fleets. The impact of harvesting a fixed amount will be equal regardless of which nation does the harvesting.

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Appendix D

Date: April 30, 1992

To: TSC Participants

From: Bob Demory 

Subject: TSC Accomplishments

Attached are the TSC accomplishments from 1984 through 1991. They are in the format of the earlier record produced by Westrheim and Jow in 1985. They are intended as an add-on to the earlier document.

When the entire package is reviewed, TSC achievements are something we can all be proud of. What a marvelous institution! What an outstanding group of people to work with!

Accomplishments of the TSC from 1984 through 1990

- 1984      Recommended that a fishery economic report be submitted annually by each country beginning in 1985.
- Coordinated species endorsements for the break and burn otolith age determination method.
- 1985      Established a Dover sole working group for the purpose of defining stock elements coastwide using all available tag recovery information.
- 1986      Coordinated division of PFMC area 3C and INPFC Vancouver area into national components: 3C-S (US) and 3C-N (Canada); Vancouver-S (US) and Vancouver-N (Canada).
- Recognized Mr. Jergen Westrheim and Mr. Tom Jow for their long-standing involvement in the TSC and numerous contributions. Both would be retiring within the year.
- 1987      The move to establish a POP working group was abandoned. Nothing further could be accomplished considering state of stock(low) and current management strategies.
- Recommended that management agencies make attempts to determine bycatch, bycatch mortality and at-sea discard rates in all groundfish fisheries.
- Re-affirmed its endorsement of CARE.
- 1988      Established a yellowtail rockfish working group charged to produce a joint Canada- U.S. stock assessment.
- Coordinated effort to revise the TSC agenda to focus more on transboundry stock issues and research; eliminate the U.S. section meeting as being redundant; and not request annual economic reports.
- Recommended to the Parent Committee that it request participation in TSC meetings of appointed representatives from the NPFMC, PFMC, and appropriate Canadian counterparts.
- 1989      Recommended to Parent Committee that respective national managers begin deliberations on whiting allocation.
- Dover sole working group tagging report completed. Working group dissolved.
- 1990      Accepted Pacific whiting working group report; recommended continued research on this species.

Recommended that a Dover sole working group be formed to develop a protocol for age validation for this species.

Recommended that a sablefish symposium be developed for early 1992.

Again recommended that managers deliberate whiting allocation.

Recommended to the whiting working group that they include adjustments for northern biomass; examine adequacy of survey area; and correction for inaccuracy in survey measured biomass.

1991

Recommended that a sablefish symposium be held in April 1993.

Recommended that OTC injection for age validation of Dover sole and other important flat fish be undertaken in the upcoming 1992 flat fish survey.

Recommended that CARE include agencies not now attending the annual meeting. The TSC also encourages CARE to establish a systematic program to investigate edge formation.

Reiterated the need for rapid settlement of whiting allocation between the two countries.

Recommended that the HAL database be given one final review by contribution agencies and subsequent to review be made available upon request.

## Working Groups

### Working Group/Time Established

### Result

Pacific whiting/1981;  
Joint Canada-US stock  
assessment with special attention  
to a technical fix on migration.

Progress report submitted to  
TSC in 1989. Work was to continue.

Dover sole /1985;  
Stock delineation using all  
tag return data from all  
west coast studies.

Accepted for publication by the  
North American Journal of Fish-  
eries Management, 1990

Yellowtail rockfish/1988;  
Provide joint Canada/US stock  
assessment.

Progress report submitted to  
TSC in 1990.

Dover sole/1989;  
Develop protocol for Dover sole  
age validation.

No progress as yet.



**PACIFIC FISHERY MANAGEMENT COUNCIL**

Metro Center, Suite 420  
2000 SW First Avenue  
Portland, Oregon 97201  
Phone: (503) 326-6352


**CHAIRMAN**  
*Philip Anderson*

**EXECUTIVE DIRECTOR**  
*Lawrence D. Six*

**MEMORANDUM**

DATE: May 4, 1992

TO: Ed Zyblut, Canada-U.S. Groundfish Committee  
and Technical Subcommittee

FROM: Lawrence D. Six, Executive Director 

SUBJECT: Historic Annotated Landings Database

I talked to Rich Morasco, NMFS Alaska Fisheries Science Center, on May 4, 1992, to get an update on the status of the HAL coastwide groundfish database. Essentially, Rich cannot devote the necessary resources to the task of finalizing this data set, and he doesn't think he will be able to do so in the future. (He estimates six man-months for this job.)

Rick said that if scientists want access to the database, he will allow it, with the understanding that there are some problems with the data. Anyone wishing access should contact Rich directly.

LDS



## APPENDIX F. Reports Published By The Member Agencies During 1991

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