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I. CALL TO ORDER

Mr. Sandy McFarlane, acting chairman, called to order the 34rd Annual Meeting of the Technical Sub-Committee (TSC) at 0810 hours on May 4, 1993, at Hudson House, in Monterey, California.

II. APPOINTMENT OF SECRETARY

Mr. Dave Thomas of the California Department of Fish and Game 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. Sandy McFarlane (acting Chairman)
Dr. Jake Rice
Mr. Ed Zyblut

United States

Pacific States Marine Fisheries Commission (PSMFC)
Mr. Larry Six (for Mr. Guy Thornburgh)

Pacific Fishery Management Council (PFMC)
Mr. Jim Glock

National Marine Fisheries Service - Auke Bay Lab
Mr. Dave Clausen

National Marine Fisheries Service - Alaska Fisheries Science Center (AFSC)
* Mr. Mark Wilkins
Mr. Tom Wilderbuer

National Marine Fisheries Service - Southwest Fisheries Science Center (SWFSC)
Dr. Pete Adams

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. Bill Barss

California Department of Fish & Game (CDFG)
* Mr. Dave Thomas

IV. APPROVAL OF THE 1992 REPORT AND THE 1993 AGENDA

The 1992 TSC report, prepared by Mr. Tom Jagielo, Washington Department of Fisheries, was approved as submitted. TSC commended Mr. Jagielo 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 as follows:

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. CARE

See Appendix C.

See TSC recommendations to CARE

B. PacFIN-PSMFC Data Series Project

M Wilkins noted that NMFS-REFM will provide copies of HAL database on request but no further updates of the database are planned. PacFIN data reports will be adopted as the data of choice.

C. Stock assessment groups

3. Yellowtail rockfish

See Appendix D for Yellowtail Report prepared by R.D. Stanley.

The TSC accepted the report and thanked everyone for their effort. They encouraged continued cooperation in stock assessment but recommended that the working group be disbanded.

4. Pacific whiting (hake)

Canadian and U.S. scientists continue to agree on the status of the stock but Can./U.S. allocation continues to be a problem. It was noted that there are two working groups, one diplomatic in nature supporting the Can./U.S. negotiations and the second generating the assessments.

5. Dover sole age validation

No progress has been made on Dover sole age validation. The west coast flatfish survey(NMFS) was canceled. Mr. Tom Jagielo and Mr. Bill Barss drafted recommendations concerning Dover sole and Arrowtooth Flounder.

D. Other

1. Sablefish Symposium report

A TSC successfully sponsored a symposium on the Biology and Management of Sablefish April 13-15, 1993 in Seattle WA. Proceedings will be published as a NOAA document. There was concern that although the papers will be published, the panel discussions will be lost. Therefore TSC will ask session chairs to put together a summary of important management issues and suggested areas of cooperative research, coordinated by Mr. G. McFarlane.

2. Transboundary stocks

There was discussion regarding the need for a sablefish working group. Mr. Sandy McFarlane said that Canada believed B.C. stocks were separate and could be managed individually by Canada and that there was no need for a new working group. Mr. Barry Bracken felt that the Alaska work showed interchange between Alaska and B.C. there was a need to document interchange of stocks and ranges. Although cooperative research was encouraged there was not support at this time for a transboundary, sablefish working group.

VII. REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENTS, MANAGEMENT, AND FISHERIES

A. Agency Overview

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

Groundfish research is conducted within the recently formed Marine Fish Division under Dr. J. Rice. The breakdown of tasks within the Division are as follows:

Assemblage Management	L.J. Richards
Groundfish 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.

Jake Rice added that the east cost stock assessment group was disbanded, they no longer provide advice on harvest levels - only state of resource. The fishery conservation councils will make the recommendations. He added that the organization structure in Canada had been changing a lot and that an environmental agenda is beginning to influence work. They now had native co-management in which natives were actively involved with salmon and herring research. Natives would be doing independent stock assessments on salmon and lingcod. The bands will be managing portions of B.C. and some of the species in the near future (shellfish and groundfish) with the Canadian government in support. He added that inshore rockfish and lingcod are of primary native (band) interest and that

Canada was in the process of handing over authority of regulations to conservation councils (user groups) leaving scientists without much latitude to make decisions.

2. Pacific Fishery Management Council (PFMC)

In 1992, the PFMC continued several management processes and operations initiated under the revised fishery management plan. Harvest guidelines were established for species in need of individual management attention, providing flexibility to allow landing of incidental amounts in case an annual harvest target was reached prematurely. For the first time, Pacific whiting, shortbelly rockfish and jack mackerel were managed under harvest guidelines instead of quotas, since American fishermen and processors were expected to utilize the entire amount available for harvest. Little fishing for shortbelly rockfish and jack mackerel occurred, but the entire whiting harvest was taken and processed by U.S. operations. Allocation of the whiting resource between competing user groups was accomplished through an emergency federal regulation.

Most trip limits were replaced with periodic limits on the cumulative catch by individual vessels in 1992. This approach appeared successful and was continued in 1993. Two week cumulative limits were initially 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.

On May 9, a regulation went into effect increasing the minimum codend mesh size for roller trawl gear from 3.0 to 4.5 inches (between knots). This made the minimum mesh size for all roller and bottom trawls the same coastwide. Also, double-walled codends were prohibited and provisions regarding rollers and tickler chains were removed. The PFMC is now considering extending the minimum mesh size to the entire trawl net. Final action is expected in September 1993.

The PFMC's license limitation plan for the groundfish fishery was approved on September 4, 1992. As of January 1, 1994, limited entry permits for groundfish will be required aboard all vessels fishing groundfish trawl, longline and fishpot (trap) gear under the limited entry quota and regulations (limited entry gears). Longline and fishpot vessels without permits, along with all other gears except trawl, will be allowed to continue fishing in an open access fishery. Trip limits and other management measures will be used in the open access fishery to keep harvest within the historic levels of that segment of the fleet not receiving permits. The implementation process, including applications for limited entry permits, is being handled by NMFS in Seattle, Washington.

The PFMC is now in the process of considering individual quota (IQ) programs for halibut and fixed gear sablefish. It is likely that the sablefish IQ program will only cover those vessels with limited entry permits and that provisions will continue to be made for a small open access sablefish fishery. In April 1993, the PFMC formally adopted goals and objectives for a fixed gear sablefish IQ program. The PFMC is still considering options for initial allocation,

transferability and other conditions for ownership and use. An analysis of the various options is in preparation and will be considered at the upcoming September meeting. Due to lack of funds and personnel, development of a program for fixed gear halibut IQ has been put on hold.

The PFMC is also considering a fishery observer program, contingent on amendment to the MFCMA to allow collection of fees to cover program costs. An analysis will be prepared over the next several months for PFMC consideration later this year.

3. National Marine Fisheries Service - AFSC

M. Wilkins reported on AFSC multi-species studies.

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. Recent publications and reports produced by RACE, REFM, and ABL scientists are presented as Appendix I.

RACE Division

In 1992 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. Tom Dark retired in March 1993 and Russ Nelson (previously the leader of the REFM Observer Program) was promoted to replace him as Deputy Director of the RACE Division. Dr. Robert McConaughy, previously with the Maryland Department of Natural Resources, Fisheries Research Group, joined the eastern Bering Sea Subtask in January, 1993.

Groundfish surveys were conducted by the Bering Sea, Gulf of Alaska, and West Coast subtasks. There were four bottom trawl surveys and two longline surveys in 1992. Major emphasis in 1992 was in the Washington-Oregon-California (West Coast) area, in keeping with the triennial rotation of comprehensive surveys among three major geographic areas. The focus will be in the Gulf of Alaska in 1993. The Pelagic Resource Assessment Task conducted two surveys of pollock abundance in the Gulf of Alaska and Bering Sea. The Recruitment Processes task conducted four Fisheries-Oceanography Coordinated Investigations (FOCI) cruises in the spring of 1992, investigating the interaction between the environment and the spawning products of Gulf of Alaska and eastern Bering Sea 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 Modelling, and Status of Stocks and Multispecies Assessments. 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. Personnel changes: James Ianelli was hired to work as a population dynamics expert in the Bering Sea and Aleutian Islands sub-task.

Auke Bay Laboratory

The Auke Bay Laboratory (ABL), located near Juneau, Alaska, is a major division of the NMFS Alaska Fisheries Science Center (AFSC). ABL's groundfish task (part of the laboratory's marine fisheries assessment program) since 1982 has mostly been involved with research and assessment of sablefish and rockfish in the Gulf of Alaska. Presently, the groundfish task is staffed by 10 permanent biologists.

In 1992 field research, ABL's groundfish task participated in two longline surveys that primarily assessed sablefish abundance in the Gulf of Alaska: the annual Japan-U.S. cooperative longline survey, and the annual domestic longline survey. Other field studies by ABL, all in the eastern Gulf of Alaska, included: 1) submersible observations of slope rockfish and their habitat, 2) an experiment that used hook timers on longlines to determine the effect of competition for hooks upon sablefish catch rates, 3) longline studies on shortraker and rougheye rockfish, 4) a walleye pollock tagging feasibility study, and 5) observations aboard a commercial rockfish trawler to help plan future rockfish assessment cruises.

Many analytic activities were conducted by groundfish task members on sablefish and rockfish in 1992-93. Much of the staff's efforts focused upon the recently completed 1993 sablefish symposium. Twelve papers, by nine separate authors, were presented at this symposium. During the past year, there was considerable controversy regarding condition of rockfish stocks in the Gulf of Alaska, and an alternative assessment model, "stock synthesis", was applied to Pacific ocean perch in this region. Ongoing research activities involved management of ABL's sablefish tag database and preparation of three annual status of stocks documents for Gulf of Alaska groundfish: sablefish, slope rockfish, and pelagic shelf rockfish.

4. National Marine Fisheries Service - SWFSC

P. Adams reported on SWFSC multi-species studies.

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. Richard Parrish (Acting); 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 PFMC. These studies address both short and long term problems in biology and economics that affect management efforts for groundfish. Biological 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. Economic work is focussed primarily on ITQ (individual transferable quota) management and benefit-cost analysis.

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 been recently published. 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, have been published. At present, Division scientists are attempting to measure the abundance of sablefish using similar methods.

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, three 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.

One project designed to improve management of thornyhead (Sebastolobus spp.) stocks is underway. It 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 Division recently completed a description of relationships between depth and length of Dover sole off Oregon and California that is in press. A similar study for shortspine and longspine thornyheads is underway.

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). 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. Analyses are ongoing.

The Coastal Division is conducting a molecular genetics project that focuses on the population structure of Dover sole, longspine thornyhead and shortspine thornyhead. Mitochondrial DNA sequences from samples of dover sole and thornyhead from Alaska, Oregon and California have 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 Dover sole and thornyheads are retained in their natal regions even though both species have planktonic larval and juvenile stages longer then 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. 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. An analysis has been completed of Dover sole growth and metabolism in conditions characteristic of the oxygen minimum zone (600 to 1,000 m, oxygen concentrations 96-98% less than surface values) where the bulk of spawning biomass occurs. The analysis shows that Dover sole are able to maintain growth rates at extremely low oxygen rates, despite smaller rations, by reducing their metabolism. These results suggest that productivity of Dover sole may be relatively unaffected by conditions in the oxygen minimum zone. Another interesting analysis completed last year shows that activities of the enzyme LDH decline precipitously in large longspine thornyheads. LDH levels normally scale with body weight and this result suggests that longspine thornyheads may experience senescence.

Coastal Division economists regularly develop and analyze information regarding the commercial and recreational groundfish fisheries off the Pacific Coast. 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. Highlights from the last year include a published paper describing planning models for ITQ programs and a pioneering benefit-cost analysis for allocation decisions in the Alaska pollock and Pacific whiting fisheries.

The Division's economic research for commercial fisheries is supplemented by economic investigations of recreational fisheries. A report describing US anglers in Mexican waters was completed last year that provides information about fishing effort, travel costs, ethnic participation, target species, and catch rates for the recreational groundfish fisheries.

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 modelling etc., (4) development of appropriate environment-dependent fishery modelling 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, a staff member participates on the PFMC's Groundfish Management Team, principally in stock assessments and exploring management alternatives.

Recent publications include papers on the diets of pelagic YOY rockfish and assemblage analysis of groundfish off Oregon and Washington. A staff member completed his MS thesis on the pelagic distribution of juvenile sanddabs off Central California. Papers on the utility of different types of auxiliary data, oceanic factors influencing occurrence patterns of pelagic YOY rockfish, and the Cobb Seamount fishery are in press. A manuscript on the influence of oceanographic factors on otolith growth in pelagic YOY rockfish 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 March 1993 an extensive survey was conducted off Central California with the MIK trawl. The MIK trawl (5 m^2) survey was aimed at determining the distribution and abundance of late larval rockfish. This life stage is poorly sampled by plankton nets. 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 have been processed and we hope to complete a preliminary report by late 1993.

In a collaborative OTC age validation study with the AFSC, more than 2500 sablefish were tagged and released during the 1991 pot index survey. A $50 reward for recoveries of tagged fish has resulted in more than 300 recoveries. Early work on use of an image analysis system for examining the OTC marked otoliths is promising.

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 not conducted in 1992. The sampling started again in 1993, but the fish will not be aged unless an additional ager is hired. The data from the port samples are compiled with software developed by project members and routinely used in stock assessments.

The Physiological Ecology of Groundfish Investigation (PEI) 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 of all life stages. Information is integrated and research activities are coordinated with those of other research Investigations and university and other governmental agencies.

In the last research year, PEI investigators focussed efforts into two areas: first, completing reports on seven consecutive years of studies of yellowtail rockfish from Cordell Bank, California; secondly, while continuing to monitor the yellowtail rockfish population, new research was developed into several areas on new groundfish species and different life stages.

An in-depth study of lipid dynamics in relation to the annual reproductive cycle in yellowtail rockfish was completed. By monitoring tissue and serum lipids, we determined that lipids were transported to the ovaries prior to fertilization. Energetic lipids were transferred via the serum primarily during the period of yolk accumulation, prior to fertilization. They subsequently declined during gestation, when embryos and larvae were being formed. Detailed analyses before and after fertilization provided evidence of both lecithotrophy and matrotrophy; that is, nutritional support of developing embryos and larvae from endogenous yolk and maternal

tissues. This strategy may optimize reproduction and survival potential by coupling the disparate times of food abundance and gestation.

A multi-year comparison of temporal and spatial variation in fecundities of yellowtail rockfish was completed last year. Seven consecutive years of data on California fish were contrasted with three years of information on Washington fish. Because fish were asymptotically related to body length, somatic weight, and especially age, they were analyzed in categories of young fish (i.e. # 14 years) and old fish (i.e. $ 15 years). Significant interannual differences were found only among fecundities of young California yellowtail. Washington fish were younger, larger at age, and generally more fecund than California fish. Age- and length-specific fecundities of young Washington yellowtail were significantly greater and less variable than those of California fish. These findings imply that age plays an important role in how fish respond to environmental conditions and how they allocate energetic resources to growth, maintenance, and reproduction. They also suggest that senescence may occur in the reproductive output of this long-lived species.

A third and last year of laboratory experiments was successfully concluded on determining the sequence and rate of development of embryos and larvae during gestation in yellowtail rockfish. This information is particularly needed to accurately estimate spawning stock biomass using the larval production technique. Twenty-two previously inseminated adult yellowtail rockfish were maintained in large tanks in the laboratory and catheterized approximately every three days. Development followed that established for other rockfish species with the mean time from fertilization to hatching being 23 days, and from hatching to parturition 29 days. When holding temperatures were lowered to 10 CE a 2 - 3 day delay was found for both time to hatch and to larval release.

New research was begun this last year on shortbelly rockfish and a research cruise was done for collection of information on adult reproduction and larval condition. We anticipate that data obtained during this cruise will allow us to estimate spawning biomass, determine areas of greatest spawning effort, and to assess the physiological condition and potential viability of larvae and juveniles.

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 NiZos. 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.

In nearshore waters, the investigation is involved in monitoring the numbers of juvenile rockfish by SCUBA surveys and through examination of predator stomachs. The investigation also looks into the relationship between oceanographic parameters and juvenile rockfish abundance. Recently, a manuscript has been completed estimating juvenile blue rockfish natural mortality. As part of this work, juvenile rockfish identification guides are developed. Juveniles frequently have very different pigmentation and appearance from the adults. This has resulted in the completion of a manual for juvenile rockfish identification and ongoing work on identification of chilipepper and stripetail rockfish larvae and juveniles. Another project examines the effects of feeding conditions on physical condition and recruitment success of adult blue rockfish. Results through 1991 showed that physical condition of adult females during the January-February spawning season is strongly influenced by feeding conditions during the previous summer and fall. There also were indication that recruitment resulting from the current spawning season is influenced as well.

The investigation also contributes to assessments of the lingcod stock for the Groundfish Management Team of the PFMC, and conducts research based on comments made in response to the stock assessment document. Present studies include age validation, coordination of lingcod port sampling off Oregon and California and modelling the basis of what may be a disturbed sex ratio. Age validation research consist of a OTC injected tag and release study and a comparison study of the nucleus and interannual distances of fin ray sections of different sized fish. The investigation coordinates commercial lingcod sampling and limited recreational sampling by ODFW and CDFG, and ages fin ray sections. Finally, a project is attempting to define depth related sex ratio trends of lingcod, to model the impact of different levels of mortality imposed by the recreational and commercial fishery.

The final investigation project is a general ecological study of the deep slope community which off the coast of Washington, Oregon, and California, supports a large and expanding fishery for Dover sole, sablefish, and thornyheads. Trawl survey records from the RACE database for surveys that went out to 700 m will be analyzed for all species by depth and size. This will be incorporated with stomach content data for sablefish, thornyheads, Dover sole, deepsea sole, grenadiers, and slickheads into a comprehensive picture of the ecological interactions of this community.

5. Alaska Department of Fish & Game (ADFG)

B. Bracken on the Alaska groundfish management program.

Description of the State of Alaska groundfish program:

The Alaska Department of Fish and Game (ADFG) has management jurisdiction over all groundfish fisheries within the internal waters of the state and to three miles offshore along the

outer coast. 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 also manages the lingcod resource in both state and federal waters of Alaska.

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). As mentioned above, state management of both demersal shelf rockfish and lingcod extends beyond the territorial sea. The information related in this report is only from the state-managed groundfish fisheries.

Southeast Region

During 1992 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, and Craig. In addition, age readers in Kodiak and Juneau were funded by the Southeast Region for parts of the year, and the project received biometric assistance from the regional office in Douglas.

The Southeast Region's groundfish project has responsibility for research and management of all commercial groundfish resources in the 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 1992 the Central Region was staffed by a biologist located in Homer. The only active

management program conducted in the region was the monitoring and in-season management of the Prince William Sound sablefish fishery. Regulations were implemented which closed portions of Cook Inlet to groundfish trawling and pot fishing to protect critical crab habitat. Proposals for regulatory changes were presented to the Alaska Board of Fisheries during the fall of 1992 for implementation during 1993. Many of these focussed on new regulations for rockfish and lingcod management in the Central Region.

Westward Region

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

Headquarters

ADFG personnel continued to enter fish tickets from the EEZ off Alaska during 1992 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 ADFG 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, ADFG and PacFIN.

Names, titles, and addresses of full-time state groundfish personnel are shown in **Appendix 1.**

Groundfish Management (General)

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

Fish tickets are required by regulation for all onshore landings in 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 inseason 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 particular fishery.

Groundfish Research (General):

Groundfish research is currently being conducted by ADFG 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 ADFG in Southeast Alaska during 1992. Two were designed to assess the relative abundance of sablefish and the other was designed to determine the distribution of nesting lingcod. A more complete description is included in the sections on those species.

Mr. Barry Bracken added that they will be having to determine subsistence needs for changes in allocation for natives for nearshore rockfish, lingcod, halibut, etc., for eating and bartering (not sale).

6. Washington Department of Fisheries (WDF)

T. Jagielo presented the WDF report.

In September of 1993 the MF/SF program consolidated many of it's field personnel into the new Natural Resources Building in Olympia, Washington. Organizational changes since the last report resulted in elimination of the Technical Services Division; the Age Determination Unit of this division was assigned to the Coastal Division, and the Data Management and Hydroacoustics Units have been absorbed by the Puget Sound Division.

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 PFMC, membership on the Science and Statistical Sub-Committee (SSC) of the Pacific and North Pacific Fishery Management Councils, 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 PFMC 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 examinations of otoliths, spines, and other bony structures from marine fish samples to determine the age of specimens in support of marine fish stock assessment. We are currently ageing yellowtail rockfish, black rockfish, and lingcod from the coast. English sole, quillback rockfish, and copper rockfish samples are aged from Puget Sound.

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, the Marine Fish Monitoring and Operations Unit, the Hydroacoustics Unit, and the Data Management 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 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 our 37-foot boat, M/V Pasquale, with specialized on-board hydroacoustic equipment. Species and areas surveyed on an ongoing 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 provides a variety of data processing services to the Marine Fish Program including: operating and maintaining our shared computer resources; user training and support; maintaining the WDF Fish Ticket, Otter Trawl Logbook, and Biological Sample Databases; and designing and implementing new computer applications.

7. Oregon Department of Fish and Wildlife (ODFW)

B. Barss presented the ODFW report.

Bob Demory retired July 1 after working about 25 years with Oregon groundfish.

ODFW hired a new full time groundfish ager. Most aging previously done by Bob Demory (retired) and Bill Barss will be done by the new ager, Bob Mikus.

B. Review of Multi-species Studies by Agency

1. Canada - Pacific Biological Station (PBS)

Hecate Strait Project

To date, five research surveys have been conducted in Hecate Strait from 1984-1991 to obtain species abundance estimates and information on assemblages. In a previous analysis, interannual variability in species distributions was partitioned into three characteristic patterns: (i) species with consistent overall distributions and peak densities between years; (ii) species with consistent overall distributions but variable locations of peak densities; and (iii) species with widely varying overall and peak distributions between years. A study has been initiated to identify the associations of representative species of each of these distribution patterns with environmental conditions using cumulative relative frequency curves. The environmental factors examined include invariant conditions such as bottom type and depth, and temperature which is variable. It is suggested that stable geographic distributions are related principally to invariant environmental conditions, while variable distributions are related to changeable oceanographic and biotic conditions. Interannual variability in oceanographic conditions are examined as an explanation for those species with variable peak and overall distributions. Understanding the response of fish populations to such interannual variability in physical conditions is an important component to developing workable multispecies assemblage management strategies.

The biannual species assemblage survey of Hecate Strait will continue in May/June 1993. The survey will provide relative abundance estimates for a number of species including Pacific cod

and rock sole will be used in the 1993 stock assessment.

La Perouse Program

This cooperative research project, with the Institute of Ocean Sciences, was continued in 1992. 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 and a climate-copepod hypothesis is being tested for sablefish.

Strait of Georgia

2. National Marine Fisheries Service - AFSC

a. Research

West Coast (Washington, Oregon, and California region)

1992 was a "triennial year" for focussing research survey efforts in the West Coast region off Washington, Oregon, and California. As such, two bottom trawl surveys and one echo integration/midwater trawl survey were conducted in this area by the AFSC. The sixth in a series of coastwide triennial groundfish surveys was conducted during July through early October to monitor the distribution and abundance of groundfish resources of the continental shelf. An echo integration/midwater trawl survey was conducted in the same area during July and August to assess the midwater resource of Pacific hake. In October and November, a bottom trawl survey of the continental slope waters (183-1,280 m) off Washington and northern Oregon extended the coverage of previous investigations of the deeper groundfish resources off the Pacific coast.

1992 Triennial Bottom Trawl Survey of West Coast Groundfish Stocks

The triennial groundfish survey series is designed to describe and monitor the distribution, abundance, and population biology of groundfish stocks off the US Pacific coast. The specific objectives of the 1992 survey were unchanged from those in 1989, namely to describe and assess the demersal component of the Pacific whiting resource with concurrent bottom trawl and echo integration surveys; assess the abundance of the pre-recruit component of sablefish, specifically

those 1.5 years old, since survey estimates of this component have been consistent with estimates inferred from commercial catch levels; and continuing to monitor the status of other groundfish stocks.

The bottom trawl survey was conducted aboard two chartered trawl vessels, the commercial trawler Green Hope (90 days) and the University of Washington R/V Alaska (50 days) using standard Noreastern trawls rigged with roller gear. Together the vessels collected successful samples from 528 stations between Pt. Conception, California, and Nootka Sound, British Columbia, between the depths of 55 and 366 m. Data from trawl samples included species composition by weight and number, size frequencies of major species in the catch, and an array of biological information from target species, such as individual length-weight observations, age structure samples, gut contents, and maturity stages.

Shortbelly rockfish dominated the catches in both the Conception and Monterey International North Pacific Fishery Commission (INPFC) areas and jack mackerel dominated in the Eureka INPFC area. Pacific hake had the highest mean CPUE in the Columbia INPFC area and in the U.S. and Canadian portions of the Vancouver area, and was second in abundance in the Conception area; third in the Eureka area; and fourth in the Monterey area. Other dominant catch components included chilipepper and white croaker in the Monterey area; Pacific herring in the Eureka area; sablefish and jack mackerel in the Columbia area; and spiny dogfish in the U.S. and Canadian portions of the Vancouver area. In the three northernmost INPFC areas, the shallow stratum was dominated by Pacific hake and the deep stratum was dominated by either sablefish, Pacific ocean perch or Pacific hake. The shallow stratum in the Conception, Monterey, and Eureka areas was dominated by boccaccio chilipepper, and jack mackerel whereas the deep stratum was dominated by shortbelly rockfish and Pacific hake.

As the 1992 field season approached, it became evident that a mild El NiZo event was forming. In response, we incorporated a more intense sampling of physical oceanographic data, including temperature profiles at all stations and CTD casts at 89 of the inner- and outermost stations of the tracklines. Bottom temperatures from 502 stations were extracted from either the data logger or CTD temperature-depth profiles, exceeding previous triennial survey bottom temperature data sets by threefold. From this information we hope to be able to make some conclusions about the responses of species or communities to environmental shifts seen between El NiZo events and normal conditions.

The International Pacific Halibut Commission (IPHC) also participated in the survey and collected 222 specimens for analysis of age, length, gender and parasites for comparisons with commercial fishing data.
(Mark Wilkins at (206) 526-4104)

1992 West Coast Continental Slope Bottom Trawl Survey
The west coast slope survey dates back to 1984, when it was conducted to provide a benchmark of the distribution and abundance of sablefish, Dover sole, thornyheads, and arrowtooth flounder

stocks off the central coast of Oregon. The survey was replicated in 1988 during two cooperative cruises involving investigations by both AFSC and SWFSC scientists. The primary objectives of that survey were to describe the structure of the continental slope groundfish community and to gather data on the reproductive biology of these species. The successful completion of the initial cruises led to expanding this type of survey to the continental slope areas off California and Washington during fall cruises in 1989 through 1992. The objectives of the current survey were to extend the investigation of distribution and abundance of slope groundfish resources to the Washington coast, continue collecting biological data on selected species of commercial importance, and to further describe the community structure and relate it to physical oceanographic factors such as depth, temperature, and salinity.

The 1992 survey was conducted between October 17 and November 12 from the Canada-U.S. border (northernmost transect line was at 48E05'N lat) to 45E25'N lat off northern Oregon. The vessel sampled stations laid out along east-west tracklines spaced 9 nm apart between the depths of 183 and 1,280 m. The vessel successfully collected trawl samples at 78 stations with the standard slope-rigged Noreastern bottom trawl. Many of the pre-selected stations had to be relocated or abandoned because fishing was impossible on the rugged terrain. Oceanographic data was also collected at 42 of these stations with CTD casts and temperature profiles were obtained with XBTs at another 10 stations. The net was towed for 30 minutes at stations shallower than 728 m and for an hour at stations deeper than 728 m. Standard data sets were collected from the fish in each haul including catch weights and numbers, length distributions of all fish species, and specimen data from subsamples of target species and major components of the catch (sex, length, weight, maturity, stomach contents, gonadal-somatic indices, and otoliths for age determination). Experimental use of bar-coded length frequency collection recorders was successful and, by the second week of the survey, most of the length data was being collected with this equipment. When they are analyzed, results from this survey will complete the description of upper continental slope groundfish resources north of San Francisco when added to results from surveys since 1988.

Subtask scientists also collected data and specimens for the following institutions: University of Washington (phytoplankton for domoic acid studies), Moss Landing Marine Labs (two-line eelpouts and Pacific grenadiers for biological studies), REFM Division (stomach contents, rougheye and shortraker rockfish reproductive biology specimens), Washington Department of Fisheries (arrowtooth flounder maturity and gonadal-somatic index data.
(Mark Wilkins at (206) 526-4104)

Bering Sea Crab/Groundfish Survey

The 1992 crab-groundfish survey of the eastern Bering Sea, conducted from June 3 through August 6, continued the annual series of eastern Bering Sea resource assessment surveys which began in 1971. The primary purpose of this survey is to assess the distribution, abundance, and biological condition of the demersal fish and crab populations on the eastern Bering Sea continental shelf. Other research included collecting stomachs from various groundfish species

for food trophic interaction studies, collecting tissue and other biological samples from red king crab, blue king crab, Pacific herring (Clupea harengus pallasi) walleye pollock, and Pacific cod for histopathology and parasitology studies, assess yellowfin sole size and age at maturity and determining the timing and location of spawning, delineating the distribution and relative abundance of the closely-related species of arrowtooth and Kamchatka flounder, flathead sole and Bering flounder, and great and plain sculpin.

The survey region encompassed approximately 465,000 km^2 and included continental shelf waters from inner Bristol Bay west to the 200 meter depth contour and from the Alaska Peninsula north to St. Matthew Island. Fishing was conducted aboard the chartered University of Washington research vessel Alaska and the fishing vessel Tracy Anne. All stations were sampled using an 83-112 eastern bottom trawl. A total of 336 bottom trawls were successfully completed, including 26 special study tows to collect additional information on king and Tanner crab near the Pribilof Islands and near St. Matthew Island. Sea water temperature profiles were recorded at most sampling sites using either a micro-bathythermograph (MBT) attached to the headrope of the net or an expendable bathythermograph (XBT) probe released from the vessel.
(Gary Walters, (206) 526-4143)

U.S.-Russian Federation Cooperative Survey of the Northern and Western Bering Sea Shelf

The AFSC participated in a cooperative bottom trawl survey of the Bering Sea shelf with scientists from the Pacific Research Institute of Fisheries and Oceanography (TINRO) of the Russian Federation. The primary purpose of this survey was to assess the distribution and relative abundance of the demersal fish and shellfish assemblages in the western and far northern Bering Sea shelf, areas which have not previously been accessible to the eastern Bering Sea surveys. This survey was conducted aboard the Russian research vessel Mys Babushkina. The survey area included Bering Sea shelf waters north of St. Matthew into the Gulf of Anadyr and west into Russian waters to Cape Olyutorski. In addition to the standard haul, catch and size composition data collections from the 124 successful bottom trawls, U.S. scientists collected age and tissue samples from walleye pollock for stock identification studies. Skates were also collected and preserved for systematics and identification studies conducted at Bucknell University.
(Gary Walters, (206) 526-4143)

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 (1 position is currently empty). Ages are usually determined from otoliths, but scales and/or finrays are sometimes used.

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, sablefish, Pacific Ocean perch, rougheye rockfish, miscellaneous rockfish species, Atka mackerel, yellowfin sole, rock sole and rex sole.

The rex sole are now being aged from otoliths baked in a muffled furnace, following the result of investigations by Kent Scott. Delsa Anderl has been studying the first year growth in the otoliths of Atka mackerel. Her study has included examining the sagitta, asteriscus, and lapillus for daily growth rings.

Craig Kastelle is extending his radiometric ageing studies to investigate the feasibility of ageing several rockfish species: Pacific Ocean perch, shortspine thornyheads, shortrakers, rougheye, northern and dusky.
(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 9,647 and 996 stomachs were collected from the Bering Sea 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, skates and Pacific halibut. West coast species sampled were Pacific hake, sablefish, longspine and shortspine thornyhead, deepsea sole, and Dover sole. Shipboard scans of fish stomach contents were performed on 401 fish (primarily walleye pollock) in the eastern Bering Sea. Laboratory analysis of stomach contents by regions totalled 10,991, 2,850, and 1,731 stomachs for the Bering Sea, Aleutian Islands, and West coast regions, respectively.

Further analysis of groundfish, marine mammal, and bird predation on walleye pollock and Pacific herring from 1985 to 1988 in the eastern Bering Sea was completed. Although walleye pollock cannibalism was the largest source of mortality for age-0 pollock, predation mortality on pollock by Pacific cod and marine mammal consumption was also very important for age-1+ pollock. Instantaneous annual predation mortality rates from groundfish predation were estimated for ages 0-2 pollock. Interannual variation in these rates suggested the occurrence of density-dependent predation processes. Higher predation mortality rates at age for the 1985 yearclass of pollock were observed relative to the 1986 and 1987 yearclasses. The 19985 yearclass was more abundant than the other yearclasses in the analysis, which suggests that predators may tend to partially switch to feeding on a more abundant yearclass.

A report summarizing the food habits and population level consumption of Bering Sea groundfish through 1989 was completed. Numbers at age of snow crab, Tanner crab, and walleye pollock consumed by groundfish predators were estimated for 1984 through 1989. Fluctuations in estimates of annual predation mortality coefficients at age for these prey were present. Larger than average natural mortality at age was noted for abundant yearclasses of these prey.

A Bering Sea flatfish food habits study was recently completed. It compared the food habits of yellowfin sole, Alaska plaice, and rock sole for the period of 1984-88. Analysis showed that yellowfin sole had the broadest diet of the three, consuming benthopelagic prey such as clams, gammarid amphipods, and polychaetes. Seasonal variation was seen in the diet of yellowfin sole as they migrated throughout the eastern Bering Sea. Rock sole primarily consumed polychaetes, gammarid amphipods, and other marine worms (sipunculans, echiurids). Alaska plaice exhibited the narrowest diet, consisting of polychaetes and other marine worms. In an area where all three species were abundant, and sampled concurrently, dietary similarity was slight. Additionally, the areas of highest abundance of each of these fish were geographically separate. It was concluded that dietary competitions was minimal.

The University of Wisconsin bioenergetics model of Hewett and Johnson has been parameterized for Bering Sea walleye pollock. Sub-models for consumption, respiration, egestion, and excretion were chosen and parameterized based on the availability of suitable parameter estimates for walleye pollock and on the appropriateness of the given sub-model for a boreal, marine fish. An initial sensitivity analysis of the model was performed. The model was most sensitive to errors in the respiration parameters. Only one of the respiration parameters produced a larger than 10% deviation when perturbed by 10%. This was expected since this parameter is an exponent of weight in the maximum respiration equation and would be expected to have a non-linear effect on model outputs. The model will be used to better define seasonal, size, and interannual changes in daily ration to improve population consumption estimates by pollock.

A draft report summarizing the food habits of Gulf of Alaska groundfish in 1990 has been completed. Diet composition, predator prey size relationships, and locations of consumption of commercially important prey are summarized for 11 species of groundfish including walleye pollock, Pacific cod, arrowtooth flounder, sablefish, and several species of rockfish. Initial estimates of total predation on walleye pollock, capelin, and herring by groundfish populations have also been completed but are not part of the draft report. These estimates indicate that arrowtooth flounder is the dominant predator of capelin, herring, and juvenile walleye pollock. This dominance is due to the large biomass of arrowtooth flounder in the Gulf of Alaska and to its piscivorous nature. Fish become a dominant fraction of the diet by weight when arrowtooth flounder reach approximately 25 cm TL.
(Pat Livingston, (206) 526-4242)

b. Stock Assessment

Status of Stocks and Multispecies Assessment Task

The Status of Stocks and Multispecies Assessment Task is responsible for conducting studies which will enhance fishery manager's abilities to manage marine fishery resources. Scientists in this task assist in preparation of annual 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 technical support for the evaluation of potential impacts of proposed fishery management measures. The Task is organized with one sub-task for the Bering Sea/Aleutian Islands area and one sub-task for the Gulf of Alaska and West Coast.

During the past year, 15 stock assessment documents were prepared for the Gulf of Alaska and Bering Sea/Aleutian Islands plan development teams of the North Pacific Fishery Management Council and 4 assessments were prepared for the Pacific Fishery Management Council. In addition, scientists provided analytic assistance on many current fisheries management issues. These included: 1) Provided analysis for the section 7 (Endangered Species Act) biological opinion concerning the interaction between the Gulf of Alaska commercial pollock fishery and the threatened Steller sea lion population; 2) Provided environmental assessments for the proposed amendment to the Bering Sea/Aleutian Islands FMP to district the Aleutian subarea to allocate Atka mackerel and other groundfish species and to amend the Gulf of Alaska FMP to separate Atka mackerel from the other species management category; 3) Continued to develop a plan to identify and prioritize research activities that would lead to improved rockfish stock assessments; 4) Continued experiments to develop an acoustic tag to monitor the mortality of halibut discarded in trawl fisheries; 5) Provided an environmental assessment for the proposed amendments to the Bering Sea/Aleutian Islands and Gulf of Alaska FMPs examining alternative harvest strategies for the rebuilding of Pacific ocean perch stocks; 6) Provided an environmental assessment for the proposed amendments to the Bering Sea/Aleutian Islands FMP to allocate harvest of Pacific cod by gear and season; 7) Provided a review of salmon bycatch in the west coast trawl fishery for Pacific hake; and 8) Provided biological assessment of hake allocation between the U.S. and Canada and between shoreside and at-sea processors in the U.S. In the past year the computer resources of the Task were enhanced and staff made significant advances in our ability to analyze geographic patterns in fish abundance. In addition, staff members participated on national NMFS committees for age-structure modelling, risk assessment in stock assessment analyses and overfishing definition review.
(Dr. Richard Methot, (206) 526-6525)

c. Management

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 1992, 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 595 observers to domestic vessels fishing off Alaska, and 39 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.
(Janet Wall, (206) 526-4195)

3. Oregon Department of Fish and Wildlife (ODFW)

Staff participated in RecFIN committee work and planning. Oregon will start up RecFIN sampling in 1993.

Coastwide species composition sampling continues on recreational catches.

ODFW proposed to reduce the recreational bag limit of rockfish from 15 to 10 fish. This issue may go into effect in 1994.

Species composition sampling of rockfish and thornyheads is on going on commercial trawl landings. A few species composition samples have been taken from fixed gear landings. A sampler was assigned to the Port Orford area to sample (species composition, age, etc.) line gear caught groundfish.

Truck tire trawl gear (footrope) was being used by a few Oregon trawlers when fishing for rockfish and lingcod. This gear was most frequently used off the northern Oregon coast and off of Washington.

Cumulative trip limits were used in 1992, and seemed to be appreciated by both fishermen and enforcement agents.

A Cape Lookout line was established for different trip limits of Yellowtail Rockfish landed north and south of the line. This regulation did not prove to be successful, and the line was eventually dropped.

C. By Species, by Agency

1. Pacific cod

a. Canada-DFO

Research programs

An exploratory survey of juvenile Pacific cod was conducted off the west coast of Vancouver Island during September 1992, to investigate whether such surveys could produce annual recruitment indices for stock assessment purposes (Hand et al. 1993). The primary objectives were to identify and characterize juvenile habitats, examine the relationship between juvenile Pacific cod distribution and environmental variables, and investigate species associations. Juvenile cod were captured, exclusive of adults, on sand/gravel slopes in depths ranging from 50-110 m. There was a high degree of variability in catch rates between tows, due both to the difficulty in targeting on schools on steep slopes and to the highly mobile and unpredictable nature of these schools. Unless the factors which influence the catch rates can be quantified, such imprecision would overwhelm the annual recruitment variability for any but extremely large year-classes. This work will not be continued in 1993.

Laboratory work has involved the complete re-ageing of the time-series of Pacific cod biological samples using the MULTIFAN system of length-frequency analysis. A new program has been initiated to validate the ageing methods used for Pacific cod and to determine the best method or combination of methods to use on a production basis.

Stock assessment

Landings of Pacific cod in 1992 continue to be relatively high, despite lower catch rates coastwide. Biological sampling indicates that stocks in 1992 and early 1993 are dominated by fish of the 1989 year-class. There is no evidence of a strong incoming year-class to sustain the fishery in the near future. Major new analysis was conducted for the Hecate Strait stock where catch, effort and age composition data were explored with contemporary modelling tools (Stocker and Hand 1993). All models examined indicate a substantial decrease of Pacific cod biomass since the peak in 1987. Stock abundance in Hecate Strait are projected to further decline, especially if fishing in 1993 continues to be heavy.

Management

An annual quota of 5100 t is imposed for Hecate Strait, 60% of which is allocated for the period Jan-June, 20% for Jul-Sep and 20% for Oct-Dec. A coastwide trip limit of 22.7 t (50,000 lb)is in effect January through June or until 70% of the Jan-Jun quota is attained. For the remaining 30% of the quota, an 11.3 (25,000 lb) trip limit will be in effect coastwide. Trip limits for the remaining fishing periods will be determined at a later date through consultation with the Groundfish Trawl Advisory Committee. In addition, a maximum of 4 groundfish landings per month in excess of 4.5 (10,000 lb) are permitted for the first and fourth quarters, and 4 in excess of 2.3 t (5,000 lb) for the second and third quarters.

b. National Marine Fisheries Service - AFSC

Bering Sea/Aleutians

Pacific cod in the EBS and Aleutian Islands is 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. In 1992, survey biomass increased slightly (about 3%), but still remained well below the levels observed during the 1980s. Of the last five year classes, four have been at least 20% smaller than the historic average, and none have been larger than average.

The current stock assessment model was developed using the stock synthesis approach. It differs from the model developed for past assessments in the following ways: 1) the 1992 survey results are incorporated, 2) additional age data are incorporated, 3) the current (1992) ratio of trawl catch to longline catch is used to project future catches, and 4) the new model considers the foreign longline and domestic longline fisheries separately. As with previous models, the current model was unable to track the severe biomass declines observed by the survey in 1990 and 1991. However, because the 1992 survey did not indicate a further decline in biomass, the model was finally able to "catch up" with the survey, and now indicates a biomass level almost identical to that observed by the survey.

Because reliable estimates of F_{MSY} and B_{MSY} are not available for Pacific cod, overfishing for this stock would occur at the fishing mortality rate that reduces the biomass-per-recruit ratio to 30% of its pristine value. This fishing mortality rate ($F_{30\%}$) is 0.139, which corresponds to a 1993 catch of 142,000 t for the EBS and Aleutians combined.

For the past two years, the $F_{0.1}$ strategy was used to recommend ABC values. However, the current estimate of $F_{0.1}$ (0.142) exceeds $F_{30\%}$, making the former strategy inadmissible. As an alternative, and to provide a buffer between the overfishing level and ABC, the $F_{35\%}$ fishing mortality rate (0.121) is used to recommend a 1993 ABC of 127,000 t for the EBS and Aleutians combined.

Gulf of Alaska

The Gulf of Alaska stock yielded a catch of 74,500 t in 1992, surpassing the recommended ABC of 63,500 t. Stock reduction analysis was used in this stock assessment, incorporating biomass estimates of the 1984, 1987, and 1990 bottom trawl surveys and a natural mortality rate of 0.27, and a 3% discard rate to estimate exploitable biomass for 1993 at 324,000 t. This is a decline from previous years and the projection model estimates that the decline may continue. The $F_{0.1}$ harvest strategy (F=0.18) was used to set both ABC and TAC, giving a recommended 1993 catch of 56,700 t. Overfishing is defined to occur at F=0.25, or a 1993 catch of 78,100 t.

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

c. Alaska Department of Fish & Game

Research

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. A logbook program was initiated in 1992, but to date no results have been determined.
Fisheries

Most of the Pacific cod harvested in Southeast Alaska, Prince William Sound, and the North Coast District is taken by longline gear. In Cook Inlet pots comprise the dominant gear. Much of the cod taken in Southeast is 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 1992 with a total of 3,953 mt reported from state-managed fisheries. Southeast Alaska which has dominated the cod harvest in past years accounted for less than 10% of the total 1992 harvest.

2. Rockfish

a. Canada-DFO

Research programs

A study of the early life history of Pacific ocean perch (*Sebastes alutus*) was continued in 1992. In **1991** (Gillespie et al. 1992), sampling coincided with the beginning of parturition at the Queen Charlotte Sound study site. Overall, 92% of adult females at depths of 280-300 m had not yet undergone parturition. Trawl catches at the beginning of the **1992** cruise indicated that the females had almost completed spawning; 82% were spent at the beginning of the survey. Nine days later, catches in three tows showed that 99% of mature fish had spawned.

In **1991**, there were low numbers of larvae spread throughout the study grid at the beginning of the cruise. As the cruise progressed, the abundance of larvae increased dramatically and the larvae were located overwhelmingly at the depth of parturition (>200 m). In **1992**, when the cruise coincided with completion of spawning, much higher larval densities overall were observed. The maximum catch for an individual tow was 5,000 larvae at 200 m depth. In addition, while the greatest abundance was still at the depth of parturition (200-400 m), a greater proportion than in 1991 was captured in the 125-175 m depth interval. A temporal increase in the proportion of larvae at shallower depths was also seen within the 1992 cruise. Larvae were predominantly at the edge of the continental shelf, near the area of parturition, but there was also

a small increase in abundance in the centres of the gullies in Queen Charlotte Sound. There was no evidence that larvae had moved up onto the banks, or offshore.

Results of diel sampling at a master station were similar between the two years. Nocturnal sampling showed highest larval catches in the deepest stratum (>175 m), while diurnal samples showed highest catches in the 125-175 m stratum. The number of larvae caught was substantially higher nocturnally. This observation conforms with those from most studies of ichthyoplankton in the northeast Pacific Ocean, and is generally attributed to net avoidance. However, if avoidance accounted for diel differences in vulnerability for *S. alutus* larvae, it is unexpected for larvae at such an early ontogenetic stage (#30 days post-parturition).

These results are in sharp contrast to earlier Soviet reports, based on hydroacoustic observations. They reported that *S. alutus* larvae "exploded" to surface waters immediately after parturition and remained at the surface subsequently. For Queen Charlotte Sound *S. alutus*, it is clear that larvae are well below surface waters through March and April. The 1992 observations indicate a gradual, rather than rapid, upward movement with ontogeny.

The depths of the larvae in March-April suggest that they are not subject to onshore Ekman transport associated with southeast winds, as has been suggested for many other fish on the west coast of North America. Indeed, strong recruitment of larvae and young-of-the-year onto coastal banks could be correlated with years of minimal onshore transport, since onshore transport must be related to downwelling and potential advection of deep-dwelling larvae off the shelf. Optimal years for Pacific ocean perch recruitment may therefore depend on minimal southeast winds and maximal upwelling. Larvae may remain in relatively deeper waters into the early summer and rely on the slower upwelling bottom waters to move them onto the continental shelf and into the gullies. Thus, good recruitment could be correlated with strong northwest winds during the late spring and early summer, to maximize upwelling in this period. This study is projected to continue for three more years, with subsequent surveys conducted 4-6 weeks later each year in order to track the physical process of recruitment.

Investigations of the effects of school and diel behavior of *S. alutus* and *S. flavidus* on the application of acoustic techniques also continued in 1992. A study of the precision of biomass estimation for discrete schools of *S. flavidus* showed high conformity of biomass estimates over a diel period, but some differences in the precision of the estimates between day and night. Joint two-boat observations of *S. alutus* schools showed primarily a downward movement of fish as the trawl approached. The data indicate this response is generated well in advance of the trawl but are inconclusive as to whether the trawl warps or the propeller of the fishing vessel is the dominant stimulus.

Stock assessment

A major revision to the slope rockfish assessment is planned for 1993. The revision will include a catch-age analysis for the two major stocks of Pacific ocean perch with sufficient catch-age

data. To date, an analysis of the CPUE time series has been completed. The management practise of varying trip limits has resulted in a CPUE time series of questionable value. Under unrestricted fishing, the relationship between trip catch and effort is approximately linear. Under small trip limits, however, there is only a weak relationship between catch and effort that suggests misreporting or dumping of large catches. Furthermore, statistically significant differences in CPUE have been found under different trip limits within a stock and year. These differences are not necessarily related to the size of the trip limit.

Offshore rockfish are currently assessed and managed as single species (with a few exceptions). Because of problems with the management plan, we have begun to examine alternative harvest strategies. One alternative under consideration is management of a rockfish aggregation, with all species combined in one quota. Assessments further exploring this possibility are planned for 1994, but we will consider the level of the aggregate quota and aggregate CPUE time series in 1993. We are hampered by poor data because there was no historical observer coverage of rockfish trawl vessels.

A full revision of shelf rockfish stock assessments was presented for the 1992 Pacific Stock Assessment Review Committee (PSARC) cycle. Recommendations for two yellowtail rockfish stocks were relatively unchanged from previous years. Recommended yield ranges for four of the five silvergray (*S. brevispinis*) and canary rockfish (*S. pinniger*) stocks were lowered, in response to declining commercial CPUE and observations of truncation in the age distribution. Harvest guidelines for widow rockfish (*S. entomelas*) were introduced for the first time.

Management and regulations

Off British Columbia, 24 species of rockfish are harvested by the trawl fishery. Seven species are managed by a combination of quarterly (coastwide) quotas and trip limits, with one additional species managed by a trip limit only. There are no restrictions on the other rockfish species, except that four landings only can be made in a 30-day period. Trip limits decrease over the quarter in proportion to the quota remaining. Under new regulations in 1993, Pacific ocean perch and yellowmouth rockfish are now managed under one quota/trip limit, as are canary and silvergrey rockfish. There are also plans later in the year to institute a prohibition of discarding rockfish at sea and a port monitoring program.

ROCKFISH - inshore

Research programs

A hook and line survey was conducted off northeast Vancouver Island in 1992. Catch per unit effort for quillback rockfish (*Sebastes maliger*) was higher at most depth/sites than in three similar surveys conducted between 1986-88. Median lengths and ages of quillback rockfish decreased between the surveys, in part, due to a strong 1985 year class (age 7). This strong year-class also accounts for the increase in CPUE between the 1986-88 and the 1992 surveys.

Estimates of rockfish abundance using the depletion method may be possible in conjunction with commercial catch data.

Onboard monitoring of the live hook and line fishery in 1992 was increased to cover three primary fishing areas in the Strait of Georgia. Biological sampling was also increased in areas outside the Strait of Georgia.

Stock assessment

Further improvements were made to the habitat based assessment. Rockfish habitat coverage (km^2) by statistical area was determined from higher resolution digital maps in 1992 than in 1991. In addition, rockfish habitat coverage was determined from sea bottom areas rather than sea surface areas. The maps were used to calculate the ratio of total annual catch to habitat coverage for each statistical area coastwide. Based on catch history and other fishery indices from these areas, a high-risk value and a low-risk value of the ratio was estimated for each of five management regions. High-risk and low-risk yields for each statistical area were calculated from the product of the estimated ratio for each region and the habitat coverage of each statistical area.

Management and regulations

Licence limitation and area licensing was completed for the 1993 hook and line rockfish fishery. Fishermen have elected 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. The remainder of the coast is open to other types of hook and line fishing. The hook and line rockfish fishery is managed coastwide by five regional catch quotas as well as staggered regional fishery openings. Halibut fishermen are limited to a 20% rockfish bycatch.

The recreational fishery is limited to a daily limit of 5 rockfish per day in the Strait of Georgia and 8 per day in other areas of the coast.

b. Pacific Fishery Management Council

The PFMC changed the manner in which trip limits are applied for the Sebastes complex. Cumulative trip limits now apply. These allow any number of landings within the specified period, but the total amount of those species landed must not exceed the specified limit. The coastwide cumulative trip limit for each 2-week period was 50,000 pounds with no more than 8,000 pounds of yellowtail rockfish north of Cape Lookout (not Coos Bay, as in the past) and no more than 10,000 pounds of boccaccio south of Cape Mendocino. In July 1992, it became apparent that yellowtail rockfish landings had greatly exceeded expectations, in part due to the Cape Lookout management line. The line was moved back to the north jetty at Coos Bay and the cumulative two week landing limit north of that point was reduced to 6,000 pounds. On January 1, 1993, the limit was increased to 8,000 pounds.

The catch of the Sebastes complex in the Columbia and Vancouver INPFC areas in 1992 was 13,133 mt, including 10,706 mt of landed Sebastes complex, 1,067 mt of landed unspecified rockfish, 710 mt discarded at sea in the whiting fishery, and an estimated 651 mt discarded yellowtail rockfish. The total catch of yellowtail rockfish in 1992 was 7,072 mt, including 5,301 mt landed as yellowtail rockfish and 509 mt pro-rated portion of the unspecified rockfish (which is now done on a gear specified basis), 611 mt discarded by the at sea whiting fishery and the estimated 651 mt discarded because of the highly restrictive trip limit. The yellowtail rockfish total catch substantially exceeded its harvest guideline of 5,400 mt, especially when the additional 303 mt from the Eureka area is included. Most of the excess catch was due to the elimination of the trip limit south of Cape Lookout prior to July 27.

The 1993 harvest guideline for Sebastes complex in the Vancouver-Columbia area is 11,200 mt, which includes a 4,400 mt harvest guideline for yellowtail rockfish. The trip limit for the complex continued to be 50,000 lbs cumulative per two weeks, with no more than 8,000 pounds of yellowtail rockfish north of Coos Bay. On April 21, the yellowtail rockfish portion of the limit was reduced to 6,000 pounds.

The landed catch of boccaccio from the Conception, Monterey, and Eureka areas increased from 1,120 mt in 1991 to 1,478 mt in 1992. (Some of this increase may be due to reporting.) The catch in 1992 exceeded the harvest guideline and overfishing level in effect at the time, but a new stock assessment conducted in 1992 raised the harvest guideline to 1,540 mt for 1993. The catch for the early part of 1993 was only 53 percent of the 1992 rate.

Pacific ocean perch continues to be managed as an incidentally caught species. In 1993, the ABC was kept at zero, and the harvest guideline was again 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 1,034 mt in 1992. Also in 1992, an uncommonly high level of 308 mt was discarded in the at-sea whiting fishery operating off northern Washington and an estimated 200 mt was discarded because of the trip limit.

The total landed catch of widow rockfish in 1992 was 6,010 mt. In addition, 448 mt were discarded by at-sea whiting processors. The total was 8 percent below the harvest guideline of 7,000 mt. The 1992 widow rockfish fishery operated under a cumulative 4 week limit of 30,000 pounds through August 12, then was then was reduced to an incidental catch limit of 3,000 pounds. The 1993 coastwide harvest guideline for widow rockfish remains at 7,000 mt, along with the cumulative limit of 30,000 lbs per four week period.

c. National Marine Fisheries Service - AFSC

Stock 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. At certain times, however, some of these fish are caught in bottom trawls. Dusky rockfish appears to be the most abundant species in the group, and has been the target of an increasing bottom trawl fishery in the past few years. A jig fishery for black rockfish has also developed in the central Gulf of Alaska since 1991. 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: 74,889 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 estimated rate of natural mortality for dusky rockfish (0.09). Applying this exploitation rate to the current exploitable biomass yields a Gulfwide ABC of 6,740 mt for 1993.

There has been concern that the recent jig fishery for black rockfish may already be selectively overharvesting these fish in localized areas. To prevent such depletion, it has been proposed that black rockfish be separated from the pelagic shelf assemblage and assigned a separate ABC. So far, however, the North Pacific Fishery Management Council (NPFMC) has decided that there are insufficient data to enact this recommendation.
(Dave Clausen at (907) 789-6049 or Jonathan Heifetz at (907) 789-6054)

Slope rockfish

Research

Submersible/Trawl Studies of Slope Rockfish

The 2-man submersible Delta completed thirty-three dives in the eastern Gulf of Alaska in May 1992. The purpose of these dives was to categorize substrates for future sonar calibrations and to observe habitats and behavior of rockfish. A new approach for assessing rockfish is to associate rockfish with specific substrates and to quantify substrates with sonar. Substrates were categorized on eleven of the dives, and position of each site was charted using GPS. These sites will be used to develop and calibrate sonar equipment in 1993. Fifteen dives were completed at depths from 335-365 m to observe shortraker rockfish (Sebastes borealis) and rougheye rockfish (Sebastes aleutianus). These rockfish were using a wide variety of substrates on the shelf break. They were distributed both as individuals and in small groups of 2-8 fish. Some shortraker rockfish were observed sinking toward the bottom as the submersible approached. Seven dives were used to observe nighttime distribution of Pacific ocean perch (Sebastes alutus). Compared to daytime summer observations, Pacific ocean perch were concentrated further offshore (on the continental slope) and at deeper depths. A higher percentage were in midwater, and they ranged further above the bottom.

Bottom trawl research was continued in 1992 to determine the amount of time the trawl continues to fish on the bottom after haulback begins. This information will be used to calibrate a trawl catch efficiency estimate derived by comparing counts of rockfish from a submersible to bottom trawl catch rates.
(Ken Krieger at (907) 789-6053)

Longline studies of shortraker and rougheye rockfish

The NOAA R/V John N. Cobb was used in July 1992 to fish longline gear for shortraker and rougheye rockfish along the continental slope of southeastern Alaska. The objective of this cruise was to evaluate the use of longline surveys as an assessment technique for these species. Because of the narrow depth range inhabited by adult shortraker and rougheye rockfish (301-450 m), it proved difficult to set the gear along this stratum, and many of the hauls ended up too shallow or too deep. This may be less of a problem in other areas of the Gulf of Alaska where the continental slope is not as steep. When the gear was set at the proper depth, catch rates for shortraker and rougheye rockfish were highly variable, which indicates a very patchy distribution for these fish. Additional research is needed to determine the feasibility of using longlines to assess abundance of these fish.
(Dave Clausen at (907) 789-6049)

Parasite study of shortraker and rougheye rockfish

A parasite study of shortraker and rougheye rockfish, which began last year, is still in progress. Specimens of these two species were collected from each of the five INPFC areas in the Gulf of Alaska during the 1991 domestic longline survey. The objective of the study is to determine if parasites can be used to identify stocks of these species. To date, approximately one third of the specimens have been processed for parasites. A preliminary analysis of the data indicates that 6 parasite species of rougheye rockfish were significantly different by area. No significant difference was seen for the parasites in shortraker rockfish, although one species was nearly significant, and this parasite may prove useful in the future given a larger sample size. These results look promising, but should be viewed with caution because of the relatively small number of specimens processed and the proximity of the sample locations for some areas.
(Jonathan Heifetz at (907) 789-6054)

Observations of commercial rockfish trawl operations

As part of the Center's Rockfish Working Group effort to evaluate whether commercial trawl operations could be adapted to rockfish surveys, working group scientists from the REFM and ABL Divisions made observations aboard commercial trawl vessels during the shortraker/rougheye rockfish opening in the Central Gulf of Alaska during the summer of 1992. The vessels used for the observations were the factory trawlers F/V Alaska Spirit and F/V Unimak Enterprise (215 ft and 180 ft long, respectively). Both vessels are considered to be among the best as far as having expertise in fishing slope rockfish. The scientists observed the

methods used to target on rockfish and fish the net, as well as fish processing procedures. It was felt that such operations could be adapted to assessment surveys, and a pilot study is being initiated to further evaluate the feasibility of such surveys.
(Dan Ito (206) 526-4231 or Jeff Fujioka (907) 789-6026)

Stock Assessment

Bering Sea

Pacific Ocean Perch

The POP complex consists of true POP (*Sebastes alutus*) and four other red *Sebastes* species (northern rockfish [NO], rougheye rockfish [RE], sharpchin rockfish [SC], and shortraker rockfish [SR]). Prior to 1991, the complex was managed as a unit in each of the two management areas. In 1991 and again in 1992, however, the NPFMC managed *S. alutus* separately from the other species in both areas, and also split out rougheye and shortraker in the Aleutians. This was done to avoid excessive catches of the less abundant members of the complex, particularly shortraker and rougheye. For the 1993 harvest year, the NPFMC retained the 1991 and 1992 approach of splitting out rougheye and shortraker in the Aleutians but not in the Bering Sea.

The stock assessment for this complex is based mainly on *S. alutus*, which has the most data and is the most abundant species in the complex. The stock synthesis approach was used as the primary analytic tool for the current assessment. As with the stock reduction analysis used in previous assessments, stock synthesis results indicate that the *S. alutus* stocks in both areas underwent declines in abundance during the 1960s and early 1970s, and remained low in abundance through the early 1980s. For several years, the NPFMC set TAC well below (normally at 50% of) ABC to promote rebuilding of the stocks. Through a combination of these management actions and improved recruitment, the stocks have been recovering slowly, although the most recent survey from the EBS region indicates some downturn in that portion of the stock.

For *S. alutus*, ABC had previously been set on the basis of an F_{MSY} harvest strategy. Results of the current assessment, however, have led the chapter authors and the Plan Team to conclude that previous F_{MSY} and B_{MSY} estimates are no longer reliable. Therefore, the recommended 1993 ABC is based on a harvest strategy that reduces the equilibrium level of spawning biomass per recruit to 35% of the pristine level ($F_{35\%}$). This strategy results in a fishing mortality rate of 0.059 for the EBS portion of the stock and 0.056 for the AI portion. When applied to the projected 1993 biomass levels of 59,700 t in the EBS and 260,000 t in the AI region, the resulting 1993 ABCs for *S. alutus* are 3,330 t and 13,900 t, respectively. The 1993 overfishing limit for *S. alutus* is based on the harvest strategy that reduces the equilibrium level of spawning biomass per recruit to 30% of the pristine level ($F_{30\%}$), resulting in fishing mortality rates of 0.067 in the EBS and 0.069 in the AI region, and catches of 3,750 t and 16,800 t, respectively.

For the other subcomplexes ("others" in the EBS and northern/sharpchin and shortraker/rougheye in the AI), ABC was calculated as the product of the natural mortality rate (0.06 for northern and sharpchin, 0.025 for rougheye, and 0.03 for shortraker) and exploitable biomass. Since estimates of other biological parameters are unavailable, harvesting at the F=M strategy also corresponds to the NPFMC's overfishing limit.

The "other rockfish" complex includes both of the thornyhead (*Sebastolobus*) species and all *Sebastes* species not included in the Pacific ocean perch complex. U.S. observers have identified 15 confirmed species within this complex, and another 14 species have been tentatively identified. The complex is managed as two separate stocks, one in the EBS and one in the Aleutian Islands.

Little is known about the species in this complex. Commercial catch and effort data are of little use in examining abundance trends for these species since most of the catch is probably incidental. The species in this complex are primarily located on the EBS slope and in the Aleutian Islands region. Although both of these areas were surveyed in 1991, biomass estimates for the species in this complex were not available in time to be used in this SAFE report. Therefore, the 1988 slope and 1986 Aleutian biomass estimates are used for the purpose of computing 1993 ABC.

The natural mortality rate for species in this complex has been estimated at 0.05, which was used as the target fishing mortality rate in calculating ABC. Lacking estimates of other biological parameters, the resulting ABC values also correspond to the limit specified by the Council's overfishing definition. A reliable estimate of F_{MSY} does not exist for this complex.
(Daniel Ito (206) 526-4231)

Gulf of Alaska

Rockfish of the genus Sebastes are divided into three assemblage groups in the Gulf of Alaska for management purposes: slope rockfish, pelagic shelf rockfish, and demersal shelf rockfish. ABL has stock assessment responsibilities for slope and pelagic shelf rockfish, whereas ADFG has this responsibility for demersal shelf rockfish.

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 1960s. Recent stock assessments have applied the "stock reduction analysis" model to Pacific ocean perch to determine population abundance and potential yield. This model, however, relies heavily on biomass estimates from triennial trawl surveys of the Gulf, the results of which are uncertain. The 1987 trawl survey indicated stock abundance was increasing, whereas the 1990 survey showed a sharp decline. In 1992, an alternative model, "stock

synthesis" was also applied to Pacific ocean perch. This model incorporates age composition, in addition to using other parameters such as estimated biomass and fishery CPUE. Based on this model, our best estimate of exploitable biomass for Pacific ocean perch in the Gulf of Alaska is now 153,600 mt. Exploitable biomass for the other species in the assemblage is estimated from the average values in the 1987 and 1990 trawl surveys, and totals 303,436 mt.

Pacific ocean perch age samples from the 1990 trawl survey reconfirm the presence of a strong 1976 year class, which has been identified as strong in all Pacific ocean perch ageing studies in Alaska dating back to 1983. The 1980 year class, however, which also appeared to be strong based on samples from the 1987 trawl survey, was relatively minor in the 1990 samples. This discrepancy between age compositions in the 1987 and 1990 surveys is unexplained at present.

To prevent possible overexploitation of the more desirable species, the slope rockfish assemblage since 1991 has been divided into three subgroups: Pacific ocean perch, shortraker/rougheye rockfish, and other slope rockfish. In response to recent evidence of selective harvesting of northern rockfish, this species in 1993 was also separated out as its own subgroup. Separate ABC's are assigned to each subgroup. Pacific ocean perch are presently managed using an adjusted F35% strategy, where the ABC is adjusted downward in proportion to the ratio of current biomass to a target biomass. Target biomass is set at 35% of the estimated virgin biomass. The other subgroups are managed under an F=M strategy, in which the annual exploitation rate is set equal to the rate of natural mortality. The 1993 ABC's are as follows: Pacific ocean perch, 5,560 mt; shortraker/rougheye rockfish, 1,960 mt; northern rockfish, 5,760 mt, and other slope rockfish, 8,300 mt.
(Jonathan Heifetz (907) 789-6054 or Dave Clausen (907) 789-6049)

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 significant amount of information useful for stock assessments has become available since the Council adopted its Pacific ocean perch rebuilding plan. For example, a National Marine Fisheries Service (NMFS) triennial survey of west coast Pacific ocean perch stocks was completed in the summer of 1989 and only recently has this information become available for detailed analysis. Since the earlier assessments, improved aging methods suggest that the instantaneous natural mortality rates is lower than previous estimates. In 1990 a stock assessment of Pacific ocean perch on the west coast was performed using stock reduction analysis. In this assessment the stock synthesis model was used which incorporated explicit size and age information along with fishery and survey catch rate data.

Based on the analysis performed in 1992, the stock has not shown any significant increase. A strong 1985 year-class is evident from the 1989 triennial survey and estimates from the stock

synthesis model suggest that it is similar in magnitude to the 1970 year class. In the short term, the mature biomass level is likely to increase if the 1985 year class remains as high as it currently appears. A more accurate indication of this year-class strength should be available after the 1992 triennial survey data are analyzed. Varying the absolute level of discards do not affect conclusions that were drawn about the condition of the Pacific ocean perch stock off the west coast of the continental U.S. However, the overall contribution of discards to fishing intensity may compromise rebuilding plans. Discards should be monitored so that more accurate age (or size) specific fishing mortality can be estimated. Simulation analyses suggest that under any harvest strategy, the average stock rebuilding rate is slow.
(James Ianelli (206) 526-6510)

Management

Pacific ocean perch rebuilding

By the mid 1970s the biomass of Pacific ocean perch (POP) in the Gulf of Alaska (GOA) had been reduced to about 10% of the level during the early 1960*s. For the period 1961-1977, the average annual catch of POP was 40,790 tons, and thereafter, landings averaged 6,078 tons. Although fishing mortality has been greatly reduced, the stock has shown only modest increases; the current estimate of spawner biomass is between 15-20% of the level observed during the 1960s. This has raised concern that past management measures may have been inadequate to rebuild the stock of POP in the GOA. Consequently, the North Pacific Fishery Management Council requested that a detailed analysis be performed to: a) identify optimal fishing rates for rockfish species such as Pacific ocean perch; b) identify the biomass level that would achieve an optimum yield; and c) evaluate the effect of alternative fishing policies on rebuilding POP. The purpose of this analysis was to provide the Council with information to assess alternative harvest policies and their effect on rebuilding the stock of POP in the GOA.

Based on this analysis, the optimal fishing rate is about 71% of the rate previously used for setting ABC ($F_{35\%}$). Current estimates of spawner biomass are about 50% of the desired target level. Analyses of four alternative policies were evaluated in order of decreasing harvest rate as:

Alternative Policy 1. Status quo: the fishing mortality rate used to provide this year*s ABC recommendation, i.e., based on an adjusted $F_{35\%}$);

Alternative Policy 2. The optimal fishing mortality rate based on analyses presented in this study.

Alternative Policy 3. A fishing mortality rate intermediate to the optimal rate (Policy 2) and the bycatch rate (Policy 4).

Alternative Policy 4. The fishing mortality rate equal to bycatch only fishing policy.
(Jim Ianelli (206) 526-6510 or Jon Heifetz (907) 789-6054)

d. National Marine Fisheries Service - SWFSC

Slope Rockfish

The SWFSC Tiburon Laboratory reviewed age composition data from the 1991 widow rockfish fishery and concluded that results of the previous assessment were still valid. We are conducting a full assessment of this fishery in 1993. We conducted an assessment of the Boccaccio fishery in 1992 using the stock synthesis model and are conducting a similar assessment on the Chilipepper rockfish fishery this year. We will also do a less sophisticated assessment of the Darkblotched rockfish fishery 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. We are also concerned that up to several days may be included in the first ring counted by agers. We are investigating this problem through collaboration with other scientists using SEM. 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

Research

Port sampling, skipper interview, and logbook programs used by ADFG to monitor the demersal shelf rockfish fishery continued in Southeast Alaska through 1992.

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 1992 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

No stock assessment surveys specifically designed for rockfish were conducted during 1992.

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 the six 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 1992, however, the area was expanded to include the former East Yakutat District.

Fisheries

Harvest of all rockfish from state-managed fisheries totalled 752 mt in 1992. Approximately 90% of the harvest was taken in Southeast Alaska; with most of the remainder reported from Prince William Sound. Virtually all rockfish harvested in state-managed fisheries is taken by hook-and-line gear either in directed fisheries or incidental to fisheries for other species.

f. Washington Department of Fisheries

Yellowtail rockfish

Research was completed on the genetic evidence for yellowtail rockfish stock differentiation. This research was undertaken by Jack Tagart and Steven Phelps of the Washington Department of Fisheries and by Rick Stanley of the Canadian Department of Fisheries and Oceans. A paper is in progress. Results of the research are described below.

Using electrophoretic analysis, we examined 1000 yellowtail rockfish taken in 10 collections from five areas over two seasons. The collection area extended from southern Oregon to Queen Charlotte Sound in British Columbia. Fish were collected between September 30 and November 6, 1990 and again between March 23 and May 23, 1991. We used 33 loci for the analysis of stock heterogeneity and found allelic variation at 23 loci. However, only six loci were polymorphic at frequencies greater than 0.03. Average observed heterozygosity was 0.04. We found significant genetic heterogeneity among collections and consequently reject the coast-wide homogenous stock hypothesis. At four of the five 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 collections from U.S. waters. Yellowtail rockfish collected from the northern Washington coast were significantly different from fish collected to the south, but were not significantly different from Canadian collections.

The status of yellowtail rockfish stocks is being updated in 1993. Last assessed in 1991, the status of stocks was determined using age data through 1987. The updated assessment includes coast-wide age data through 1991, additional trawl survey data from 1989 and 1992, and catch data through 1992. Biomass will be estimated using the stock synthesis model. Results are expected in June, 1993.
(Jack Tagart (206) 902-2855)

Black rockfish -- Biological Investigations

Due to the lack of funding, collection of black rockfish maturity and fecundity samples was concluded prior to the 1992-1993 winter collection period. Data collected earlier in this study has provided baseline data enabling the development of models to produce estimates of abundance and exploitation of black rockfish along the Washington coast. Analysis using the Stock Synthesis model is currently in progress.
(Farron Wallace/Brian Culver (206) 249-4628)

Mr. Tom Jagielo asked about the stock assessment on black rockfish. He suggested that Washington and Oregon could cooperate in estimating ABC's of Blacks.

g. Oregon Department of Fish and Wildlife

Shelf rockfish:

a. Black Rockfish-

1) Stock Assessment is being conducted using both CAGEAN and Cohort Analysis.
(Elaine Stewart (503) 867-4741)

2) Coastwide sampling continues on recreational catches of Black rockfish. Sampling includes biological sampling for age, length and sex. Age determination is done by ODFW.

b. Widow rockfish from Cobb Seamount were sampled for age, length and sex. Additional biological samples were obtained on an irregular basis on other species from Cobb Seamount catches. Age determination for widow rockfish from otoliths was done by NMFS, Tiburon.
(Dave Douglas (503) 325-2462 or Bill Barss (503) 867-4741)

c. ODFW continues to collect routine age samples on Canary rockfish, Yellowtail rockfish and Widow rockfish. Canary rockfish age determination was done by ODFW, and our department also provides age determination for WDF samples of Canary rockfish. Yellowtail rockfish age determination is done by WDF, and Widow rockfish age determination is done by NMFS, Tiburon.

Slope rockfish

Most sampling is limited to species composition sampling. Some length frequency samples were taken on darkblotched rockfish.

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 landed catch of thornyheads from the Monterey, Eureka and Columbia areas in 1992 was 6,960 mt, near the harvest guideline of 7,000 mt, but trip limit induced discard (estimated 605 mt) caused a small overage. The catch in the Conception area increased to 1,068 mt. The 1993 trip limit was a two week cumulative limit of 20,000 pounds, reduced to 35,000 pounds per 4 weeks on April 21. The projected catch for 1993 is below the harvest guideline. In the first quarter of 1993, the percentage of longspines remains above 50 percent (57 percent in Oregon and 81 percent in California).

b. National Marine Fisheries Service - AFSC

Stock Assessment

Gulf of Alaska

Based on results of the 1990 trawl survey the best estimate of current exploitable biomass for 1992 is 26,207 t. The estimate has been adjusted upward to account for the lack of survey stations in 1990 at depths greater than 500 t. To adjust the 1990 estimate for the unsampled depths, the average proportion of the total biomass found deeper than 500 t in 1987 and 1984 (33%) was assumed to be the same proportion of the total that would have been found in 1990. The estimated 1990 trawl survey CPUE represents a large decrease from that of 1987. The 1987 survey biomass estimate was not used because extremely high CPUEs were observed. These high CPUE values may have been caused by fishing power correction factors applied to the deepwater observations.

Also, the cooperative longline survey shows that thornyhead relative abundance has declined since 1988. Therefore, the 1990 trawl survey biomass estimate was considered to be the best indicator of current biomass. Length-frequency distributions from the 1984 and 1987 surveys do no indicate any incoming strong year classes.

Previous natural mortality rates of M = .07 were replaced with M = .05. This rate was determined by averaging the previously assumed M (.07) with the value applied to the Pacific coast shortspine thornyhead stocks (M = .03). The choice of the M value has a large impact on the optimal F strategy to apply to this species. With an M = .05 and an $F_{35\%}$ = .045, the resulting ABC value is 1,180 t for 1993. The 1992 catch was nearly 1,700 t and the stock is considered fully exploited.

(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.

d. Oregon Department of Fish and Wildlife

Sampling included species composition sampling, age sampling and length frequency sampling. Age determination from otoliths is done by NMFS.

4. Sablefish

a. Canada-DFO

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 five discrete (100 fm) depth strata to examine the variation in abundance and life history parameters with depth. 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 1993. The quota is split between trawl (8.75%) and longline/trap (91.25%) vessels. Both trawl and longline licenses are limited entry.

In 1993 longline/trap licence holders are again entitled to an individual vessel quota. Fishers are entitled to 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 fourth year and its future rests with a review that is currently underway.

b. Pacific Fishery Management Council

The 1993 sablefish ABC and harvest guideline were reduced to 7,000 mt north of the Conception area. (The Conception area is managed without a harvest guideline.) Sablefish continues to be managed under an allocation of the harvest guideline between trawl gear and other gears. In 1992, each allocation was considered a harvest guideline with management measures to keep harvests within those guidelines. Trawl sablefish landings are 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 1992 was 5,435 mt, which exceeded the harvest guideline of 4,988 mt. The 1993 trawl allocation is 3,886 mt (58 percent of 6,700 mt, which is the 7,000 mt harvest guideline minus the tribal catch target of 300 mt), but catches from the Conception area do not apply. In 1992, the trawl catch from the Conception area was 291 mt, mostly from Morro Bay. The sablefish trawl trip limit in 1993 is 1,000 pounds or 25 percent of the deepwater complex, whichever is greater. The sablefish trawl trip limit in 1993 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, which was reduced on April 21 from 45,000 pounds per two weeks to 60,000 pounds per four weeks.

Non-trawl: In November 1991, the PFMC adopted a framework to set the season opening date for the unrestricted nontrawl fishery (for 1992 and beyond) 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. The season opening date was implemented in 1992 by emergency rule. The 1992 management plan 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. The season ended May 27, with the 250 pound daily trip limit in effect through the remainder of the year. In 1993, the 250 pound trip limit was extended through May 12, at which point sablefish landings would be prohibited for three days until the unrestricted season opened. An 18 day season is projected.

On the horizon. The PFMC has continued development of individual transferable quota (ITQ) programs for the halibut and fixed-gear (longline and pot) sablefish fisheries, although halibut has been put on hold. The PFMC will examine the following as possible periods on which to base the amount of ITQ initially allocated: 1984 - November 13, 1991, and August 1, 1988 - November 13, 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, initial issuance of ITQ would be only to those who would qualify for "A" permits under the license limitation program. 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

Research

Gulf of Alaska

Japan-U.S. Cooperative Longline Survey

For the fifteenth consecutive year, a cooperative longline survey for sablefish was conducted in the Gulf of Alaska by Japan and the United States. The 1992 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. Survey results showed that sablefish relative population number (RPN) increased 8.8% for the upper continental slope of the Gulf of Alaska from 1991 to 1992. An especially large increase was seen in the Chirikof INPFC area. There was no evidence of any substantial recruitment of sablefish to the survey area.

The relative abundance of sablefish in the 1992 cooperative survey was similar to that found in a duplicate longline survey of the Gulf of Alaska, the 1992 domestic longline survey. The results of the two surveys had differed markedly in 1990 and 1991, when the domestic survey indicated a much higher relative abundance of sablefish in the Gulf of Alaska. Both surveys are planned to continue in 1993.

During 1992, Gulf of Alaska groundfish subtask field activities included an experiment conducted aboard the Japanese longliner to compare the relative fishing efficiencies of the U.S. and Japanese fishing gears.
(David Clausen (907) 789-6049 or Eric Brown (206) 526-4157)

Hook competition model

A stochastic model was developed relating longline catch rate to estimated fish abundance. The model directly accounts for hook competition; some information regarding local depletion and bait wear also can be inferred from the model. The model parameters are estimated from interarrival time data collected using hook timers. A hook timer experiment was conducted in Chatham Strait, southeastern Alaska using the R/V John N. Cobb from 27 June to 2 July 1992. (Michael Sigler (907) 789-6037)

Age-Length Study

The sablefish age-length relationship varies between sex and large geographic areas (e.g. Bering Sea, Gulf of Alaska). The purpose of this study was to determine if the relationship varies within the Gulf of Alaska and also among depths. Otoliths were collected during June to September, 1987 and 1989. The statistical significance of differences between age-length relationships was tested. Mean length at age and mean age at length generally were greater in deeper depths compared to shallower depths. A movement model was hypothesized based on the comparison between depths. The results of this study were presented at the recent sablefish symposium. (Michael Sigler (907) 789-6037 or Sandra Lowe (206) 526-4230)

Harvest Strategies

The primary harvest policy for groundfish in the Exclusive Economic Zone off Alaska has been a constant exploitation fraction (:) policy. We compared alternative harvest policies to the constant : policy for the sablefish fishery in the Gulf of Alaska. Criteria for comparing policies were average biomass, average spawning biomass, average catch, catch variability, and a measure of the risk of overfishing. The risk criterion was defined as the lowest spawning biomass observed. The risk of overfishing was defined as the frequency the population falls below the risk criterion. The results indicated that the risk of overfishing will be lessened in the long run by implementing a threshold or variable : policy. Risk is reduced at the expense of decreased average catch. The results of this study were presented at the International Symposium for the Management of Exploited Fish Populations in Anchorage, Alaska from October 21-24 and are

expected to be published this fall.
(Michael Sigler (907) 789-6037 or Jeffrey Fujioka (907) 789-6026)

Sablefish Recruitment Curve

A recruitment curve to the commercial longline fishery was estimated from recoveries of juvenile sablefish tagged and released in inside waters of southeast Alaska from 1985 to 1988. Tagged fish were released at ages 1 and 2 and were recovered in the commercial fishery at ages 2 to 6. A maximum likelihood method was used to estimate a recruitment curve to the sablefish fishery from the release and recovery information. The method consisted of (1) population dynamics and (2) observation models, (3) a likelihood function of the tag recoveries, and (4) a nonlinear optimization to estimate recruitment parameters. Percent recruitment to the fishery for ages 2, 3, and 4 was 12, 54, 91, respectively, and by ages 5 - 6 recruitment was essentially 100%. These results were sensitive to the estimate of natural mortality applied in the model.
(Ellen Varosi (907) 586-7228)

Sablefish Tag Recovery Program

Analysis was begun on the movements of 67,000 adult sablefish tagged and released by ABL in the Eastern Gulf of Alaska (EGOA) over the last 10 years. The 3,649 recoveries to date were made at locations ranging from the West Coast of the U.S. to the Bering Sea.

The generally held theory about movements of sablefish in the Gulf of Alaska is that small fish tend to move north and west of their release sites while larger fish, tagged in the westward areas, move in a southeasterly direction. Larger fish tagged in the eastern areas seem to exhibit less movement altogether.

Results of this study support this theory: of the fish that were captured outside the EGOA, most West Coast recoveries were larger fish from the southern release areas, and most Central and Western Gulf of Alaska recoveries were small or medium fish from the northern release areas of the EGOA. Over 3/4 of all recoveries were made in the EGOA, many of them in the original release area or in immediately adjoining areas.

Preliminary analysis of tag recoveries over time indicates that the smaller, westward-migrating fish return to eastern areas after 3 years. There is also some evidence of a net influx of fish into Chatham Strait and a corresponding outward movement from Clarence Strait and the 2 northern areas. The effects of higher fishing and reporting rates for Chatham Strait must be taken into consideration in future analysis.
(Nancy Maloney (907) 789-6060)

Domestic Longline Survey

The sixth annual NMFS longline survey of the upper continental slope and deep gullies of the

Gulf of Alaska was conducted aboard the chartered U.S. longline vessel *Ocean Prowler* from July 13 to September 27, 1992. This research program has been a joint effort of RACE Division and ABL, since its inception in 1987, and is designed to continue the time series (1979-92) of the Gulf of Alaska portion of the Japan-U.S. cooperative longline survey, replicating as closely as practical the Gulf of Alaska portion of the Japan-U.S. cooperative longline survey and also sampling gullies not sampled during the cooperative survey.

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.

A total of 115,095 sablefish with an estimated total round weight of 393,935 kg was recorded at the rail during the 1992 survey. The length composition for sablefish shifted upward slightly from 1991 to 1992, indicating growth in length within the population. Recruitment appeared to be only slightly higher than in past years.

Prior to the initiation of sampling in gullies, certain assumptions had been made to extrapolate sablefish CPUE's and size compositions from the cooperative longline survey upper slope stations to deep gully areas that were not actually sampled. Results of the 1988-1990 NMFS longline surveys show that extrapolated relative population estimates were not appropriate. The 1989 NMFS survey detected a statistically significant decrease in numbers of sablefish on the upper continental slope from the previous year, most of which was associated with decreases in the Shumagin and Chirikof INPFC statistical areas. The 1990 NMFS survey detected a statistically significant increase in numbers of sablefish on the upper continental slope, mostly associated with increases in the Shumagin, Chirikof, Kodiak, and Yakutat INPFC areas. In 1988 and 1989 sablefish abundance in the two major gullies in the western Gulf of Alaska (Shumagin Gully and Shelikof Trough) was mostly unchanged. However, in 1990 sablefish numbers in those gullies decreased remarkably, and increased by the same amount on the upper continental slope adjacent to those gullies. In 1991 total sablefish abundance was largely unchanged, but the population appeared to be shifting eastward. In 1992 a significant decrease in gulfwide sablefish abundance (sablefish relative population numbers decreased 12.4% from 1991-92) was detected. The eastward shift in population was again apparent. More detailed results for sablefish and the other species sampled during the survey will be reported in a subsequent technical document. (Michael Sigler (907) 789-6037 or Harold Zenger (206) 526-4158)

Stock Assessment

Bering Sea and 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 1993 for outside waters estimated by calibrating the relative abundance trends to trawl survey biomass estimates from 1991, and including projected recruitment, is 190,400 mt for the Gulf of Alaska and 227,400 mt for the Gulf of Alaska, eastern Bering Sea, and Aleutian Is. combined. A single calibration factor was adopted for the EBS, Aleutians, and Gulf of Alaska. The projected 1993 exploitable biomass was 13,400 t for the EBS and 23,600 t for the Aleutians. (These values are higher than last year's projected biomass because a less conservative recruitment prediction is now used, although the combined survey indices in 1992 were actually slightly lower than in 1991).

Yield estimates are determined from a 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 ABC's for 1990-92 were computed by multiplying the $F_{0.1}$ exploitation rate (0.116) by the estimate of exploitable biomass at the beginning of the fishing year. In 1993, however, a variable exploitation rate policy has been adopted. The particular policy adopted here prescribes a fishing mortality rate that varies proportionally with biomass, starting at a value of zero at the origin and increasing to $F_{35\%}$ at the biomass level ($B_{35\%}$) that would be obtained in equilibrium if the stock were fished at the $F_{35\%}$ rate and recruitment were constant at the historic average level. Because the projected biomass for 1993 is 89.3% of $B_{35\%}$, the $F_{35\%}$ rate of 0.137 was scaled back to 0.122 (exploitation rate = 0.11), giving a 1993 ABC of 1,500 t in the EBS, 2,600 t in the Aleutian Islands region, and 20,900 t in the Gulf of Alaska. The recent history of recommended acceptable biological catch (ABC) for the Gulf of Alaska has been 26,200 mt in 1990, 22,500 mt in 1991, 20,800 mt in 1992, and 20,900 mt in 1993.

It is generally believed that available estimates of F_{MSY} and B_{MSY} are unreliable. Therefore, the NPFMC's overfishing definition defaults to the $F_{30\%}$ level, giving a 1993 catch of 2,000 t in the EBS and 3,400 t in the Aleutian Islands region under a fishing mortality rate of 0.166 (exploitation rate = 0.146).

NMFS conducts two longline surveys to track abundance trends in the Gulf of Alaska: the Japan-U.S. Cooperative Survey and the domestic survey. In 1990, results of the two surveys diverged significantly from each other, and the difference between the two surveys continued in 1991. In 1992, the difference between the two surveys decreased from that observed in 1990 and 1991. Studies are now in progress by the AFSC's RACE Division to determine the reason for the difference in results. In computing the 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)

West Coast

The west coast landings of sablefish were 9,454 mt in 1991 and 9,269 mt in 1992. The

coastwide ABC of 8,900 mt was slightly exceeded in both years. The sablefish stock in the Monterey through the U.S.-Vancouver INPFC area was assessed in 1992 through application of the synthesis model to fishery size and age composition data from 1986-1991 and trawl and pot survey data. The Conception area was excluded because of the smaller size-at-age and delayed maturity in that area. Only about 400 mt has been landed in the Conception area in recent years. Slope trawl surveys have now been conducted in the northern half of the Monterey area through the middle of the Columbia area. The extrapolated biomass for the Monterey through U.S.-Vancouver areas is 106,714 mt, which represents approximately the age 2+ biomass with a reduced availability for the larger females. The southern area pot survey in 1991 added evidence for a decline in the abundance of medium and large sablefish, and the assessment model was configured to directly examine this decline. A decline in the abundance of large sablefish is supported by trends in the percentage large in longline and pot landings. New age data indicate that natural mortality should be reduced from 0.0875 to about 0.07, and that the movement of sablefish into deep water is primarily a function of age, not size.

The synthesis model was used to explore trade-offs in fitting the magnitude of the slope trawl survey biomass and the trend of medium+large sized sablefish in the pot survey. An optimistic model scenario provides a reasonable fit to the slope trawl survey biomass and to the fishery size and age composition data, but a poor fit to the trend in the pot survey. This scenario is similar to recommendations made in the past few years, and indicates that average fishing mortality over the past eight years has been near the target level of $F_{35\%}$ (6.8% exploitation rate on the age 2+ biomass) and that the female spawning biomass is near its long-term target level, but declining because of weaker than average recruitment since 1980. The pessimistic model scenario provides a better fit to the trend of the pot survey and to the fishery size and age composition data, but indicates that the slope trawl survey overestimates biomass by more than a factor of two. The calculated ABC for 1993 ranges from 7,800 mt to 1,800 mt for the two scenarios, but neither assessment extreme provides an entirely satisfactory description of the sablefish situation. An ABC of 7,000 mt was adopted by the PFMC for landed catch in the Monterey-Vancouver areas.
(Richard Methot (206) 526-6525)

d. National Marine Fisheries Service - SWFC

The SWFSC Tiburon Laboratory assisted scientists from the Alaska Fisheries Science Center on an assessment of the sablefish fishery using the stock synthesis model in 1992.

e. Alaska Department of Fish & Game

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.

Stock Assessment

Sablefish stock assessment surveys were conducted in each of the two Southeast Alaska inside management areas during 1992, for the fifth consecutive year. The surveys use snap-on longline gear set on randomly selected stations for a standardized fishing period and are utilized 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 ADFG age reading laboratories in Kodiak and Juneau for age determination.

Preliminary results of the surveys show that there has not been a significant linear trend in abundance in either area over the duration of the surveys. Between year differences in numbers of fish were noted in both areas, but differences in kg per hook were insignificant.

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 a 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 area, the Southern Southeast Inside area, and the Prince William Sound area 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 reach the harvest objective.

Fisheries

In the Northern Southeast Inside area 120 vessels harvested approximately 2,045 mt round weight in 24 hours. In the Southern Southeast Inside area 30 vessels harvested approximately 393 mt round weight in a 57-hour fishery.

Although both of the Southeast Alaska inside area fisheries are under limited entry, the number

of vessels participating in each area exceeds the optimum level established under the program 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 harvest of 196 mt nearly doubled the annual harvest objective of 100 mt. A total of 49 vessels participated.

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.

f. Oregon Department of Fish and Wildlife

Routine age samples were obtained on sablefish. Otoliths were sent to NMFS for age determination.

Some analysis of sablefish bycatch sampled from Pacific whiting shoreside deliveries was conducted and subsequently presented by Dr. Sampson at the Sablefish Symposium in Seattle. Sablefish bycatch in whiting catches was generally modest, but a few landings contained over the 1,000 pound trawl limit for sablefish.
(Dave Sampson (503) 867-0100 or Bill Barss, Mark Saelens (503) 867-4741)

5. Flatfish

a. Canada-DFO

Research programs

Age composition data has been updated through 1991 for Hecate Strait English sole and rock sole. The data will be analyzed during 1993 to prepare for detailed stock assessments to be conducted for these species in 1994. A study of halibut bycatch in the Hecate Strait trawl fishery was conducted. The study involved 43 observer trips (695 tows monitored) aboard vessels involved in this fishery. This represented approximately 9% of the total trawl effort expended between September 1991 and August 1992. Bycatch of halibut caught in the Hecate Strait trawl fishery was estimated for summer (May-August) and winter (September-April) periods. Total discards in the Hecate trawl fishery were also estimated during the bycatch study. The condition of trawl-caught halibut was monitored during the study and this data has been analyzed. Time-on-deck, weight of the total catch, size of fish caught, depth fished and tow length all had significant effects on the condition of halibut caught.

Stock assessment

Interim stock assessments were produced for five species (nine stocks) of flatfish in 1992. Landings in 1992 were among highest since monitoring began in the 1950s. The high landings are the result of strong recruitment in the late 1980s. Landings for Hecate Strait English sole continued to be above average in 1992 and yield for this species is currently well above the average for the 1956-92 period. The high level landings in recent years is believed to be the result of strong recruitment in 1990-91. Landings for Dover sole in Area 3C-D continued to increase in 1992 and CPUE in 1992 increased from the 1991 level as well. This is a deepwater (600-800m) fishery, which takes place mainly in the first quarter of the year. This fishery began in 1989. Landings for the northern (Area 5CDE) Dover sole stock in 1992 remained below the average for the 1970-92 period. Yield for petrale sole stock remains low and recruitment is also low. The continuous low level of recruitment for these stocks for the last decade may be the result of overfishing in the 1960s and 70s.

Management

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 5CDE Dover sole and English sole are managed using area quotas. Dover sole in Area 3CD will be managed using a combination of quota and trip limits in 1993. Trip limits for flatfish stocks will be subject to mid-season review and may be revised accordingly. Rock sole in Hecate Strait were overharvested in 1992 despite the trip limit regulation. The trip limit level has been revised down to 20,000 lb with a limit of 2 trips per 30 day period. This is because of sustainable yield overruns in 1991 and 1992. Revision of sustainable yield options for Hecate Strait rock sole will be discussed during PSARC meetings in 1993.

A minimum mesh size (140 mm/5.5 in) regulation will be in place for the trawl fishery in Hecate Strait sometime in 1993. The purpose of this regulation is to reduce the bycatch of undersize soles and Pacific cod in this fishery. Longterm yield for rock and English sole stocks in this area may increase as a result of this measure.

b. Pacific Fishery Management Council

Dover sole

The coastwide catch of Dover sole in 1992 was 16,011 mt, down about 2,000 mt from 1991 and well below the 1992 harvest guideline of 19,400 mt. The 1993 coastwide harvest guideline is 17,900 mt and a harvest guideline of 6,000 mt has been established for the Columbia area. The 1992 catch in the Columbia area fell to 5,665 mt from the 1989-1991 average of about 7,700 mt. The year started with the cumulative 2-week trip limit for the deepwater complex is 45,000 pounds (down from 55,000 mt in early 1991), with sublimits on the amounts of thornyheads and sablefish. Dover sole landings early in 1993 were only 80 percent of the catch rate through the same period in 1991-1992.

c. National Marine Fisheries Service - AFSC

Stock 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

Yellowfin sole (Pleuronectes asper), which suffered a severe decline in abundance from overfishing in the early 1960s, is currently the second most abundant species in this region after walleye pollock. Three abundance estimators (trawl survey, virtual population analysis, and stock synthesis) indicate that the yellowfin sole resource increased slowly during the 1970s and early 1980s to a peak during the mid-1980s and that the resource has remained abundant and stable until the present. This trend is indicative of a slow-growing species that is known to have been lightly exploited while experiencing average to strong recruitment during the past 15 years. Good recruitment from the 1981 and 1983 year-classes is expected to maintain the abundance of yellowfin sole at a high level in the near future.

The recommended ABC for 1993 was calculated by applying the $F_{35\%}$ fishing mortality rate from the stock synthesis model to the 1993 projection of exploitable biomass. The $F_{35\%}$ rate is appropriate because it makes use of the available information regarding age-specific fishing selectivities and maturity. As with most North Pacific flatfish species, sexual maturity in yellowfin sole occurs well after the age of entry into the fishery. Yellowfin sole are fully selected to the fishery by age 11 but only about 50% of the females are mature by this age. The $F_{35\%}$ rate of 0.106 (exploitation rate = 0.095) corresponds to a 1993 ABC of 238,000 t. This catch is below the level of 275,000 t corresponding to the NPFMC's overfishing definition, computed under an $F_{30\%}$ value of 0.124 (exploitation rate = 0.11). A reliable estimate of F_{MSY} does not exist for this stock.

Rock sole

Rock sole (Pleuronectes bileneatus) catches from the eastern Bering Sea in 1992 was 39,314 t, primarily from a valuable roe fishery conducted northward of the Alaska Peninsula during the winter spawning period. Harvest levels remained well below the 1992 ABC of 260,000 t, although they exceeded the TAC of 34,000 t. Because of sustained good recruitment (the 1991 survey age composition indicated that 84% of the population numbers were fish 4-8 years old), rock sole biomass increased steadily throughout the 1980s to its present high level. Biomass estimates from stock synthesis, cohort analysis, and the trawl survey all indicate that the present

stock size is near 1.5 million t.

Past assessments computed ABC from estimates of F_{MSY} and $F_{0.1}$ obtained from a simple dynamic pool model. For the present assessment, however, an $F_{35\%}$ strategy was developed from a stock synthesis model. The $F_{35\%}$ rate is appropriate because it makes use of the available information regarding age-specific fishing selectivities and maturity. Rock sole attain sexual maturity well after the age of entry into the fishery (83% of the females are selected by the commercial gear by age 8, but only 50% are mature by that age). The $F_{35\%}$ fishing mortality rate (=0.14) gives an exploitation rate of 0.12 and a 1993 ABC of 185,000 t. This ABC is below the level corresponding to the NPFMC's overfishing definition, which gives a 1993 catch of 270,000 t under an F_{MSY} value of 0.21 (exploitation rate = 0.174).

Other flatfish

Results of the 1992 Bering Sea trawl survey estimate the "other flatfish" species to be at a high level of abundance. The flathead sole (Hippoglossoides elassodon) estimate of 650,000 t is the highest yet observed and the Alaska plaice (Pleuronectes quardrituberculatus) estimate remains at a high and stable level of 550,000 t. These estimates, combined with the miscellaneous flatfish species estimate of 50,000 t, provide the highest estimate of "other flatfish" abundance ever observed by the EBS trawl survey.

Past assessments of "other flatfish" have determined ABC by using the $F_{0.1}$ rate for rock sole (0.159, derived from a simple dynamic pool model) as a proxy. For this assessment, exploitation rates are derived from the fishing mortality values that would reduce flathead sole and Alaska plaice exploitable biomass per recruit to 35% (ABC) and 30% (overfishing) of their unfished levels. These rates are preferable to the rock sole proxies since they are calculated from the life history characteristics (von Bertalanffy parameters) of the species in question. A reliable estimate of F_{MSY} does not exists for this complex.

Greenland turbot and Arrowtooth flounder

The conditions of the two principal species of large flatfish in the eastern Bering Sea, arrowtooth flounder (Atheresthes stomias) and Greenland turbot (Reinhardtius hippoglossoides), differ. Based on survey estimates, the exploitable abundance of arrowtooth flounder has increased from less than 100,000 t in 1982 to 480,000 t in 1992. 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 1992 catch of 8,500 t taken primarily in the pursuit of other species. For 1993 the ABC and TAC of arrowtooth flounder is set at 72,000 t and 5,500 t, respectively.

Gulf of Alaska

Management of the Gulf of Alaska flatfish resource has been divided into four categories by the NPFMC 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 28,000 t in 1992, well below the combined TAC of 66,480 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. The flatfish species are managed under the $F_{0.1}$ approach which is considered a conservative strategy which is appropriate for managing a complex of species which are at varying levels of abundance.
(Thomas Wilderbuer (206) 526-4224)

West Coast

Dover Sole

Size and age composition data from the INPFC Eureka and Columbia areas were analyzed in this assessment by stock synthesis, a separable catch-at-age model. Recruitments were estimated by the model for the Columbia area instead of the assumption of constant recruitment used in 1990. For both areas, separate fishery selectivities were estimated for several time periods to fit the changes in size, age and fraction female. In both areas the model was run at various levels of virgin recruitment to generate a range of fits to the slope survey abundance estimates. Runs with the slope survey ratio (observed slope survey abundance divided by the population biomass after survey selectivities are applied) between 0.5 and 1.0 were taken as a plausible range of biomass levels.

In the Eureka area, recent landed catches have declined to about 3,400 mt in 1991. MSY, estimated under an assumed level of density-dependent recruitment is 3,300 to 3,552 mt for the low and high biomass scenarios respectively. The current female spawning biomass is estimated to be below the $F_{20\%}$ level for the low biomass scenario and below the $F_{35\%}$ level but above the $F_{20\%}$ level for the high biomass scenario. The recommended yield for 1993 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 a yield of 1,732 to 4,134 mt for 1993.

The current quota in the Eureka area is 4,900 mt. In the Columbia area, MSY, estimated under an assumed level of density-dependent recruitment, is 2,160 mt and 4,388 mt for the low and high biomass runs respectively. The current female spawning biomass is estimated to be at the target level ($F_{35\%}$) for the low biomass scenario and above the target level for the high biomass scenario. The low and high biomass range produce 1993 yields (applying $F_{35\%}$) of 2,248 mt and 5,766 mt respectively. The current quota in the Columbia area is 6,100 mt and the 1991 catch was 8,016 mt.
(Jack Turnock (206) 526-6549)

d. Alaska Department of Fish & Game

Research

No research was conducted on flatfish species by the State of Alaska during 1992. 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 ADFG 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 Southeast Alaska inside area flatfish trawl fishery was restricted to only three small areas during the 1991-92 season with a harvest objective set for each area. Less than 4 mt of harvest was reported from Southeast Alaska and less than 1 mt from Prince William Sound during 1992. Most of the Southeast harvest is starry flounder while the Prince William Sound harvest is a mixture of shallow-water species.

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

Arrowtooth flounder

The results of the 1991-1992 maturity study of arrowtooth flounder are being written up for publication. Arrowtooth flounder aging has been problematic. A planned age validation study has been shelved due to inadequate funds. We are waiting for results of comparative age readings from NMFS, which has been working to refine their ageing methods for arrowtooth flounder. Meanwhile, WDF is continuing to collect age structures but is not ageing this species. Stock assessment work on arrowtooth flounder is going forward using non-age structured models.
(Martha Rickey (206) 902-2850)

f. Oregon Department of Fish and Wildlife

Age sampling continued on Dover sole, English sole, arrowtooth flounder and petrale sole. Ages are determined at ODFW for Dover, English and petrale soles. ODFW also provides age determination for some English sole samples taken by WDF.

Halibut:

1) ODFW participated in the weekly catch monitoring of recreational catches in light of the catch quota.

2) About 1/2 of the recreational catch was sampled for average weight and enforcement purposes.

3) Considerable staff time was involved with litigation involving the Makah tribe.
(Jerry Butler (503) 867-4741)

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. A port sampling initiative was drawn up to ensure samples are collected from the increasing domestic fishery for offshore hake.

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 1,101,328 mt of which 668,419 mt was found north of 49 degrees north latitude.

A side by side comparison was conducted with the NOAA ship MILLER FREEMAN and the

DFO vessel W.E. RICKER and the results were encouraging. Over the typical range of hake densities, the biomass of the transects compared were not significantly different between the two systems. Over the Canadian zone the U.S. survey found slightly less hake, 931,660 mt.

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. During the 1992 survey fish were found much further offshore than during previous surveys and factors contributing to this movement are being examined.

Stock assessment

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

A discussion of offshore hake stock status is presented in the progress report of the Can/U.S. working group on Pacific hake.

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 1992 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 1993 quota is 11,000 mt.

b. Pacific Fishery Management Council

The 1992 Pacific whiting harvest guideline was set at 208,800 mt, 90 percent of the 232,000 mt coastwide ABC. The PFMC and NMFS delayed the season opening date to April 15 in order to maintain the fishing patters of the traditional whiting fishery, to keep the bycatch 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 PFMC intended to enhance product quality, yield per recruit, and sustainable yield by delaying the season beyond January 1. The PFMC also adopted an allocation plan for dividing the harvest guideline between competing users. The plan, which NMFS implemented by emergency rule on April 13, initially limited at-sea processors (catcher-processors and mothership-processors combined) to 98,800 mt, allocated 80,000 mt for delivery to shore-based processors, and retained 30,000 mt in reserve. On May 6,

the at-sea fishery was closed, having reached its initial limit. On September 4, the 30,000 mt reserve was released, which lasted until September 12 when the at-sea fishery was closed again. On October 24, an additional 24,000 mt was made available for at-sea processors, bringing the total at-sea allocation to 152,800 mt. The fishery was closed October 7. On October 30, the harvest guideline was reached and a 3,000 pound trip limit was implemented for the remainder of the year.

Bycatch regulations for the whiting fishery were implemented by emergency rule on April 13, 1992. Those regulations prohibited at-sea processing south of 42EN, whiting fishing in the morning between midnight and one-half hour after official sunrise, and whiting fishing inside conservation zones around the mouths of the Klamath and Columbia Rivers. A trip limit was also established to limit landings of whiting caught inside 100 fathoms in the Eureka area to 2,000 pounds.

The PFMC established a harvest guideline of 142,000 mt (80 percent of the coastwide whiting ABC) as the U.S. allocation and adopted a multi-year framework (regulatory) amendment to allocate the harvest guideline between at-sea and onshore interests. This amendment was rejected and a one-year only substitute implemented that made the first 112,000 mt of the harvest guideline available on a first come, first served ("Olympic") basis. The remaining 30,000 mt was retained as a reserve for shoreside vessels. The at-sea fishery was closed by emergency rule on May 5 when 100,000 mt had been processed at sea, leaving a total of 42,000 mt for the shoreside sector.

c. National Marine Fisheries Service - AFSC

Research

Hydroacoustic assessment of Pacific Whiting along the West Coast

Pacific whiting abundance was surveyed along the Pacific Coast during July 7 to August 19, 1992. The area of operations extended along the west coast of the U.S. from central California to the north end of Vancouver Island, British Columbia, Canada. Considerable numbers of whiting were encountered in all of the surveyed strata between Point Sur, California and the northern end of Vancouver Island, Canada. Average sizes and ages of the fish were found to be progressively greater in the more northerly geographical areas covered by the survey. The overall population of whiting was composed mainly (92.6 %), in order of relative abundance, of 6 cohorts; the 1984, 83, 80, 91, 90 and 88 year classes; age 8,5,12,1,2 and 4, respectively. Nearly 77% of the total estimated number of age 1 fish were found in the Monterey INPFC area. Forty four percent of the age-2 fish were also located in Monterey, with the remainder distributed about equally between the Eureka and south half of the Columbia INPFC areas. No age-1 and only trance amounts of age-2 fish were found in the strata north of the central Columbia area. About 88% of the total estimated whiting biomass was found to the North of the Eureka INPFC area and considerably more than half of the total was found to the north of the Columbia INPFC area.

(Dr. Ed Nunnallee (206) 526-4163)

Stock Assessment

The U.S. and Canadian harvest of Pacific whiting in 1991 was 321,893 metric tons (t). In 1992, the yield is expected to be 298,000 t. A geographic version of the stock synthesis model that modelled the division of the population into U.S. and Canadian components was used to assess the Pacific whiting population. The biomass of age 2 and older fish in 1991 was estimated to be 2.027 million t. The recruitment abundance of the 1987 and 1988 year classes were estimated at 1.840 and 1.176 billion fish respectively, close to the average 1977-91 recruitment of 1.527 billion age-2 fish. The 1989 year class appears to be much weaker (age-2 recruitment 0.071 billion).

An age-structured model was used to forecast yields for 1993-95. 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 1993, the potential total yield is calculated to be 122,000 at low harvest rate, 177,000 t at a moderate harvest rate, and 220,000 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 slow decline in annual yield. The recruitment of a strong year class to the fishery would substantially increase the projected yields.
(Martin Dorn (206) 526-6548)

d. Oregon Department of Fish and Wildlife

ODFW with cooperation from PSMFC, NMFS and the fishing industry, conducted an observation program to sample the by-catch of landings made to shoreside processors and provide data on by-catch discard at sea. The main objectives were to determine the feasibility of conducting a cooperative observation program between industry and government, the appropriate sampling rate for the shoreside whiting fishery to confidently show whether fishing is maintaining a by-catch rate less than .05 salmon per metric ton of whiting, the impact of regulation on fish catch and industry, and the manpower and funding needed to conduct a successful program.

Based on initial statistical analysis, a sampling rate of 20% for at-sea observations and 30% for shoreside observations were selected. Sampling sites were Astoria and Newport, Oregon, and sampling was conducted from May until the season's end in October.

Four Oregon processors and their vessels participated in the program. Experimental Fishing

Permits (EFP) were issued to participating vessels so that they could land unsorted catches containing salmon. The EFP's required that the catch be sorted upon landing and that ODFW be given any salmon bycatch.

Fifteen vessels participated in Oregon's whiting shoreside observer program. About 49,000 mt of whiting was landed at Oregon ports. Observers observed 15% of the trips at sea including the offload of those trips. Observers observed the offloading of an additional 34% of the trips. Overall salmon catch rate in Oregon's whiting fishery for fish delivered shoreside was 0.010 Salmon per mt of whiting. Some 241 salmon were obtained from observed trips. Other observed bycatch included 60,408 pounds of Yellowtail rockfish, 28,713 pounds of Widow rockfish, 14,865 pounds of misc. rockfish, 29,488 pounds of sablefish, 1,162,945 pounds of jack and Pacific mackerel and 63,573 pounds of misc. other fish.
(Bill Barss (503) 867-4741.)

b. ODFW collected biological samples for NMFS, Seattle (otoliths, length, sex, weight).

7. Dogfish

a. Canada

Research programs

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).

b. 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. Preliminary studies were conducted on dogfish aging. The purpose was to collect and archive a sample from an unexploited population for future comparisons if the fishery expands.

Management

There are no seasons, gear restrictions, or harvest limits for dogfish in the territorial waters of the state at this time. Directed fisheries for dogfish were very limited in state waters during 1992.

8. Lingcod

a. Canada

Research programs

The 1992 live hook-and-line rockfish fishery was monitored in the Strait of Georgia for the incidental catch of lingcod to aid in assessing the rebuilding of the stock. This program will continue in 1993.

Stock assessment

The inshore lingcod stock assessment remains unchanged.

Management and regulations

The commercial lingcod fishery closure in the Strait of Georgia, initiated in 1990, will continue through 1993. The recreational fishery remains open between June 1 and September 30, with a minimum size limit of 65 cm, bag limit of 1 per day, possession limit of 2, and an annual limit of 10 which must be recorded on the angler's licence.

b. National Marine Fisheries Service - SWFC

Research on lingcod at the Tiburon Laboratory is conducted in three areas: age validation, sampling of commercial and recreational landings and modelling 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 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 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 modelling. 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 1992. 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 onboard 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.

An additional survey was conducted during 1992. The research submersible *Delta* was used in April, 1992 to delineate the depth distribution of lingcod nests (egg masses) below 30 m in the vicinity of Sitka. A total of 13 nests were observed during the 14 dives made in the rocky habitat typical of lingcod nest sites. No nests were observed during the 7 dives conducted over muddy or silt bottom areas. The known depth of lingcod nests deposition was increased significantly to 97 m. Males observed guarding nests were distinctly colored and most had obvious scarring on the head and dorsal areas. Two types of nest-guarding behaviors were noted. Although nests were not seen below 97 m, lingcod displaying behavior and coloration typical of nest-guarding males were seen as deep as 126 m.

Management

The Southeast Alaska lingcod fisheries are managed with a 27-inch year-round minimum size limit. The fishery is closed inside the "surfline" from January 1 to May 31 to protect nest guarding males. A regionwide quota of 500,000 is in effect for the directed fishery.

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 475 mt of lingcod was harvested by all gear types during 1992. Over 95% of this was taken from Southeast Alaska.

d. Washington Department of Fisheries

Our nearshore tagging study at Neah Bay is in its eighth and final year. We are computing estimates of abundance, survival, and fishing mortality. In 1993, 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 5998, with 983 recoveries to date. Offshore releases total 5241 with 1118 recoveries to date. A final offshore release of 3000 fish is planned for 1993. A pilot Genetic Stock Identification (GSI) project is in progress to evaluate the feasibility of using GSI for lingcod stock delineation. Three fifteen-fish samples will be collected from Puget Sound, the Washington coast, and the California coast for an initial screening to detect variable loci. Also, an age-structured stock assessment of lingcod in areas 3A/3B/3C is in progress.

(Tom Jagielo (206) 902-2837)

e. Oregon Department of Fish and Wildlife

Age samples were collected and sent to NMFS, Tiburon for age determination.

9. Other Species

a. Canada-DFO

Walleye pollock

Research programs

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.

b. National Marine Fisheries Service - AFSC

Walleye pollock

Research

Bering Sea

Hydroacoustic Assessment of Walleye Pollock on the Bering Sea Shelf

Scientists from the RACE Division conducted an echo integration-midwater trawl (EIMWT) survey of the Bering Sea during the winter of 1993. The purpose of this work was to assess the distribution and abundance of walleye pollock (Theragra chalcogramma). Previous winter surveys (1988, 1989, 1991, and 1992) focussed on spawning concentrations of pollock in the Aleutian Basin and Bering Sea shelf waters in the U.S. EEZ. The 1993 survey area was expanded to include western Bering Sea (WBS) waters. The survey was a coordinated effort of scientists from Japan, Russia, and the United States, with additional participation from China,

Poland, and South Korea.

Two research vessels participated in this survey. U.S. operations were conducted aboard the NOAA Ship Miller Freeman from February 2 to March 12. Japanese operations were conducted aboard the Japan Fisheries Agency's R/V Kaiyo maru from January 3 to March 14. Standard operations for both vessels included 1) the collection of echo integration data from quantitative acoustic systems, 2) midwater and/or bottom trawling to identify echo sign and collect biological data, and 3) the collection of oceanographic data from XBT's and CTD's.

The Kaiyo maru surveyed Aleutian Basin waters in both the Russian and U.S. EEZ's - including the Donut Hole and the Bogoslof Island region. Very little pollock echosign was observed in the western and eastern Aleutian Basin, with the exception of the spawning aggregations near Bogoslof Island. Vessel mechanical problems aboard the Miller Freeman prevented coverage of the entire western and eastern Bering Sea shelf, as originally planned; however, the critical spawning areas were surveyed. These included the Bogoslof Island region, the eastern Bering Sea (EBS) shelf/slope south of St. Paul Island, and the WBS shelf/slope north to 61EN latitude. Two passes of the Bogoslof Island region indicate that abundance has not changed significantly from the 1992 winter survey estimate. Spawning pollock ranged in length from 40-60 cm with a modal length of 51 cm. In the WBS, most of the pollock were encountered in the shelf/slope region between the Gulf of Ozernoi and Cape Olyutorsky. On the slope, pollock ranged in size from 25 to 50 cm; in shallower shelf waters, few pollock > 40 cm were captured. East of Cape Olyutorsky, pollock densities were low. On the eastern shelf, pollock echosign was observed from just off the slope in to 100 meters. Very few one and two year old pollock were encountered; the majority of the fish captured ranged in length from 32 to 45 cm - most likely the 1989 and 1990 year classes.

Preliminary planning is underway to involve Japanese, Russian, and U.S. research vessels in a repeat of this survey effort in summer, 1994.
(Neal Williamson (206) 526-6417)

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, and walleye pollock stock structure and recruitment in the eastern Bering Sea. Bering Sea FOCI is part of the NOAA Coastal Ocean Program. 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 stock structure, and pollock behavior. FOCI conducted four cruises aboard the NOAA ship

Miller Freeman during the spring of 1992, three in the Shelikof Strait region of the Gulf of Alaska, and one in the Eastern Bering Sea to study the effects of the environment on the eggs and larvae of walleye pollock. 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 in Seattle and to the Hatfield Marine Center of Oregon State University, where the behavioral studies were conducted.
(Dr. Art Kendall (206) 526-4108)

Hydroacoustic Assessment of Walleye Pollock in the Gulf of Alaska

Walleye pollock abundance was surveyed in the Gulf of Alaska during March 13-22, 1993. Three transect series were run during the period; one series covered the whole of the strait and the other two included selected parts. The first series progressed from S to N, from near Cherikof Island to mid Afognak Island. Parallel transects were run across the strait between 50 fm depth contours and were spaced 5 nm apart. Two limited transect series were run in the western central part of the strait to better map aggregations of spawning adult pollock. The 1988 year class (age-4) was the most abundant cohort found in the strait and accounted for perhaps half of all fish of age 4 and older. A very preliminary estimate of the biomass of all cohorts indicated that the abundance of pollock was somewhat less than that encountered during 1991 survey. Further analyses are necessary before meaningful comparisons are possible.
(Dr. Ed Nunnallee (206) 526-4163)

Walleye pollock tagging feasibility study

An experiment was conducted at ABL in June-December 1992 to determine the most appropriate methods for tagging walleye pollock. Walleye pollock, most of which were juveniles <age 4, were caught in local waters using hook and line gear. Approximately one-half the fish were tagged with Floy lock-on tags that passed completely through the dorsal musculature of the fish; the remainder were tagged with Floy anchor tags inserted a short distance into the dorsal musculature. The fish were transported back to ABL and held in a large tank of running seawater for the duration of the experiment. Results showed infections from scale loss apparently caused most of the mortality. In particular, landing the fish with a dipnet resulted in much scale loss and a low rate of survival. Fish landed without a dipnet and handled carefully to reduce scale loss had mortality rates <10%. There was no significant difference in the survival rate between the two types of tags used. Too few adult walleye pollock were caught to determine meaningful survival rates. However, it appeared that, in addition to scale loss, the adult fish were adversely affected by pressure differences as they were brought to the surface. Thus, the study indicated that tagging of juvenile walleye pollock is feasible if scale loss can be kept to a minimum, but additional research on tagging of adults is needed.
(Richard Haight (907) 789-6052)

Stock Assessment

Bering Sea and Aleutian Islands

Pollock abundance in the EBS was estimated from trawl surveys and age-structured models. Surveys indicated that pollock abundance was high and stable from 1982 to 1988, but declined substantially from 1988 to 1991. Preliminary results of the 1992 trawl survey indicate that abundance of the on-bottom component of the stock may have declined further (by 12%) from 1991 to 1992.

Three models were used to track pollock abundance on an age-structured basis--cohort analysis, CAGEAN, and stock synthesis. All three models were calibrated against the survey biomass time series, and successfully capture the trend described above. Given that the various models yield similar results, and given that cohort analysis has been the primary assessment tool for this stock in the past, the estimates from cohort analysis are again used as the primary basis for estimating biomass and ABC in this assessment.

The North Pacific Fishery Management Council accepted the absolute biomass given by the more pessimistic scenario in the cohort analysis model, which indicated that the EBS pollock stock biomass would decline to a low of 5.9 million t in 1993 and increase steadily thereafter to 8.1 million t in 1997. This projection is based upon a conservative estimate of the 1989 year class. An alternative model run using a stronger 1989 year class (twice as high as the conservative case) indicated that biomass in 1993 would decline to 7.5 million t and remain fairly stable through 1997. Although the Plan Team used the lower estimate of the 1989 year class, commercial fishery data indicate that this cohort may be stronger than indicated by the trawl survey. In addition, the trawl survey indicates that the 1990 and 1991 year classes may also be stronger than average. Another survey planned by NMFS this winter should confirm the strength of these year classes.

The 1993 exploitable biomass is projected to be slightly below B_{MSY} (6 million t, section 1.6.1). The ABC for EBS pollock was computed with an exploitation rate based on the F_{MSY} estimate of 0.38. In keeping with the NPFMC's overfishing definition, the 1993 catch projected under this fishing mortality rate (1,360,000 t) was scaled downward by the ratio of projected 1993 biomass to B_{MSY} (0.983) to yield a 1993 ABC of 1,340,000 t. This ABC is identical to the maximum level allowed under the NPFMC's overfishing definition.

The Aleutian Islands pollock stock was surveyed by bottom trawl in 1991, and an on-bottom exploitable biomass of 180,000 t was estimated (section 1.3.3). From this estimate, the projected biomass for 1993 is 196,000 t. Given the growth characteristics of the Aleutian region stock, $F_{35\%}$ for this stock was estimated at 0.42, giving an exploitation rate of 0.30. Multiplying this exploitation rate by the projected biomass gives a 1993 ABC of 58,700 t. This is below the overfishing level of 62,600 t, computed under an $F_{30\%}$ value of 0.45 (exploitation rate = 0.32). A

reliable estimate of F_{MSY} does not exist for this stock.

Pollock taken near Bogoslof Island exhibit a consistently different age composition and slower growth than pollock in the EBS. Winter hydroacoustic surveys estimated the biomass of Bogoslof pollock at 0.6 million t in 1991 and 0.8 million t in 1992 (section 1.3.3). There is evidence of slightly stronger 1982 and 1984 year classes recruiting to this area in recent years. The 1993 estimate of biomass (0.65 million t) was derived by discounting the 1992 value by the natural mortality rate (M=0.2). Based upon the growth characteristics of the Aleutian Basin stock, $F_{35\%}$ for this stock was estimated at 0.33, giving an exploitation rate of 0.26 and a 1993 ABC of 169,000 t. This ABC is below the overfishing level of 196,000 t, computed under an $F_{30\%}$ value of 0.40 (exploitation rate = 0.30).

The Bogoslof pollock stock is believed to be part of a broader Aleutian Basin stock that is harvested both inside and outside the U.S. EEZ. Directed pollock fishing was prohibited in the Bogoslof area in 1992 but small amounts of pollock have been harvested in international waters. The 1993 biomass estimate therefore assumes that removals from fishing will be balanced by recruitment. In setting a TAC for Bogoslof pollock, the expected harvest (if any) in international waters should be considered.

The large catches removed from the international zone of the Aleutian Basin from 1986-1990 have fallen off recently due to poor recruitment. The Aleutian Basin pollock stock may be connected to pollock on the surrounding shelves through spawning and recruitment processes. Lack of observed spawning in the Aleutian Basin, together with the older mean age of Basin pollock, indicate migration of shelf pollock to the Basin. The extent to which spawning by Basin pollock in the Bogoslof area contributes to recruitment of pollock on the EBS shelf remains unclear. The current spawning contribution of Bogoslof pollock to the EBS stock may be small in view of the reduced Bogoslof spawning biomass.
(Dr. Vidar Wespestad (206) 526-4249)

Gulf of Alaska

Estimates of the exploitable biomass of walleye pollock (Theragra chalcogramma) were 1,088,000 t in 1991 and 838,000 t in 1992 as determined from the stock synthesis (SS) model in those years. The 1993 biomass is estimated at 1,062,000 t from the current SS analysis which incorporates an index of biomass from the 1992 Shelikof Strait hydroacoustic survey. Comparisons of the 1993 biomass to previous years' levels should be made with biomass levels from the revised hindcast in the current assessment.

Relative to the previous assessment, new information became available which includes: a) the 1992 Shelikof Strait hydroacoustic biomass estimate; b) length-frequency data from the 1992 hydroacoustic survey; c) length-frequency data from the 1991 and first quarter 1992 fisheries; d) estimates of catch-at-age from the 1991 fishery; e) updated estimates of discard and catch; and f) an evaluation of various fishing strategies.

The 1992 hydroacoustic survey utilized new equipment with improved detectability of pollock in low density situations, and improved measurements from the near-bottom region. The 1992 Shelikof Strait biomass estimate based on the new system is 680,000 t. A value of 580,000 t is the best estimate of biomass that would have been obtained had the old system been utilized in 1992, and should be used for comparison to previous hydroacoustic estimates.

Length-frequency data from the 1992 hydroacoustic survey indicates that the 1988 year class will be above average, while the 1989 and 1990 year classes are below average. The 1991 fishery age composition data are dominated by the strong 1984 year class.

Seven SS models that differed in the estimation and number of selectivity-at-age vectors, and in the inclusion and emphasis of the bottom trawl biomass estimates prior to 1990 were evaluated for this assessment. Evaluations of the first four models (Models A-D) indicated that inclusion of the 1973, 1987, and 1990 bottom trawl biomass estimates (weighted equally) was appropriate. Models E-G, which included the above surveys, were evaluated with respect to the fishery selectivity-at-age vector. Model E estimated a selectivity vector for each year of the fishery, while Models F-G estimated selectivity vectors for various groupings of years.
Based on the exploratory runs and data analysis, Model D was chosen as more appropriate relative to Models A-C. The stock assessment statistically evaluated the relative improvement in the fits with Models E, F, and G relative to Model D, given the increase in the number of parameters. It was found that Model D could be rejected in favor of Models E, F, and G. Model G was rejected because it does not accurately portray the magnitude of the 1988 year class. Models E and F were similar, but Model E provided the best overall fit to the data, a better fit to the bottom trawl data in recent years, and a better fit to the 1988 year class, and was thus chosen.

Estimates of various fishing mortality rates based on biological reference points were determined from a dynamic pool model which incorporated age specific selectivity, weight-at-age, and maturity-at-age information. The $F_{0.1\%}$, $F_{35\%}$, and $F_{30\%}$, rates were 0.57, 0.49, and 0.62, respectively. An estimate of F_{msy} equal to 0.49 was determined assuming a form of the Beverton-Holt stock-recruitment relationship with 90% of virgin recruitment when the stock has been reduced to 50% of virgin levels.

Given these fishing mortality rates, the long term productive potential of the pollock stock was explored with a stochastic age structured simulation with different recruitment scenarios. The simulation assumed selectivity-at-age from the most recent time period (1985-92) from Model G. One selectivity-at-age vector was used because yearly changes in the selectivity-at-age could not be predicted. Projections were made over a 70 year time horizon with 30 bootstrap replications. The risk associated with a given fishing strategy was measured by monitoring the number of times out of the bootstrap total that the spawner biomass fell below the threshold level, defined as 20% of the pristine spawner biomass level. Stochastic variation was incorporated into the model through process error associated with recruitment variability and measurement error in the

assessment.

The simulations were made under 2 different recruitment assumptions. Under one option, the probability of high or low recruitment at high or low spawner biomass levels was determined from the observed spawner-recruit data points. Under this assumption, there was a 50% chance of a strong year-class at low spawner biomass levels, and 22.2% chance of a strong year-class at high spawner biomass levels. A second recruitment option was considered because the observed data showed that the majority of strong year-classes occurred during the 1970s. In the most recent decade, only one year class was above the mean recruitment level. To simulate recent recruitment conditions, the probability of a strong year class at high or low spawner biomass levels was set at 10%.

In order to estimate an optimal fishing mortality rate, the tradeoffs between increased yield and the risk of falling below the threshold were evaluated. The optimal fishing mortality rate that simultaneously maximized yield and minimized risk was determined to be 0.32 (full-recruitment value).

Model E was then utilized to project biomass and yield under a 0.201 fishing mortality rate which is equivalent to a full-recruitment fishing mortality rate of 0.3. The 1993 yield was projected to be 203,000 t which is the recommended ABC for the western and central Gulf of Alaska. All indications suggest that the 1988 year class will be larger than the 1984 and 1985 year classes. Model E is consistent with an above average 1988 year class. Furthermore, the exploitation rate is considered to be conservative since it was determined by simulation results based on recent recruitment trends.
(Dr. Anne Hollowed (206) 526-4223.)

c. Alaska Department of Fish and Game

There were no regulations in effect for other species of groundfish in state waters of Alaska during 1992. 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.

d. Oregon Department of Fish and Wildlife

(1) Extensive biological sampling was conducted on surfperch along the southern Oregon coast. Special emphasis was spent on redtail surfperch. Aging determination was done by ODFW.
(Darrell Pruden (503) 888-5515)

(2) Striped Bass catches occurred in the surf off Coos Bay. This is unusual for Oregon.
(Darrell Pruden (503) 888-5515)

(3) Herring roe fishery in Yaquina Bay produced 198 tons which was just short of the 210 ton

quota. This is a limited entry fishery with only 10 permits to take fish.
(Jerry Butler (503) 867-4741)

(4) Hagfish: Limited sampling was conducted on the hagfish pot fishery. The fishery was spotty with most fishing activity in the spring of the year and most landings being made into Coos Bay and Port Orford. A total of 280 landings produced 685,676 pounds of hagfish (mostly Pacific hagfish). This is up from the 274,535 pounds landed in 1991.
(Bill Barss (503) 867-4741)

(5) Jack Mackerel: In September, tuna fishermen reported large quantities of dead, floating mackerel off Florence, Oregon. Samples of the fish were tested by OR Department of Health. They found high levels of PSP toxin in the viscera of the fish. The meat tested as being safe to eat. These fish were also tested by Dr. Olsen of OSU for bacteria and parasites. He found nothing unusual to report.

D. Other Related Studies

1. Canada

Statistics and Sampling

Principal activities in 1992 included maintenance of the trawl and trap catch and effort database, and biological sampling of commercial landings. Two hundred and fifty-one biological samples were collected from commercial catches. Catch and effort statistics were summarized for the 1991 fishery (Rutherford 1992). Statistical area boundaries were digitized for use in a computer program for conversion of latitude/longitude bearings to statistical areas. Statistics staff participated extensively in the planning of a region-wide statistics and database system.

Mr. Sandy McFarlane added that a report documenting a proposed business model for fishery and management data/information was available. He is willing to forward it to anyone interested.

2. National Marine Fisheries Service - AFSC

Conservation Engineering Studies

Trawl Mensuration

The research arm of the task has continued its work to determine the effects of variability in the operating dimensions of bottom trawls on survey results. Extensive use of acoustic trawl mensuration equipment both during the surveys and in experimental work has shown that the trawl's shape can vary considerably within and between stations in both width and height.

These data have been analyzed to determine the best predictors of this variation and to evaluate it's effects on survey results. A strong association has been found between trawl width and the length of cable used to tow the trawl (scope), with longer scopes associated with wider trawl openings and lower heights. Since longer scopes must be used in deeper water, trawl openings tend to be wider in the deeper areas covered by the surveys.

Trawl mensuration equipment was routinely used during all surveys with a goal of obtaining accurate measurements or estimates of the area swept by the trawls at each site. Where measurements were not available, a regression based on the above work and measured tows during that cruise was used to provide an estimate.

Research on the variability of trawl shapes and their effects on survey results will continue in 1993. This work will include testing of a restrictor line placed ahead of the trawl doors for controlling trawl shape variation. Catch comparisons will be made to test for changes in catchability due to the restrictor itself or due to changing trawl widths. Another set of experiments will test attempt to measure the effects of herding by the doors and bridles on catch rates of flatfish.

Behavior Observations to Facilitate Bycatch Reduction

The task continued a project, begun in Spring of 1990, to facilitate the improved selectivity of commercial trawls used in fisheries off of Alaska. The bycatch of Pacific halibut (Hippoglosus stenolepis) in trawl fisheries off of Alaska is a major concern to fishery managers. Bycatch limits have closed several fisheries before the allowable catch of the target species was taken. Representatives of the International Pacific Halibut Commission, the fishing and fishing gear industries and the RACE division have been cooperating in a research project to develop fishing gear technology capable of both effective fishing and bycatch reduction.

Low light underwater video systems have been developed and used to obtain observations of fish behavior in and around operating trawls. These observations are used to test and further the development of trawl modifications for reducing bycatch. This work will continue in 1993, with continued observations of the behavior of halibut, cod and small flatfish in the vicinity of a range of trawl modifications as well as in unmodified nets.
(Craig Rose (206) 526-4128)

Electronic Measuring Board

An electronic measuring board using bar codes was devised for use aboard longline surveys. The measuring board was tested in 1991 and was used throughout the 1992 domestic longline survey. This electronic method is faster, more convenient, and less error prone than recording lengths manually and generally is useful because electronic data collection is the most direct method of recording information in a time when data analyses are performed on a computer. In 1992, the electronic measuring board also was adapted by others for fishery sampling in British Columbia

and for use on trawl surveys, including successful implementation on the West Coast continental slope trawl survey, during which samples of virtually all fish species from each catch are measured. The electronic measuring board is adaptable to any experiment or survey where large amounts of data are collected. In general, bar code systems are applicable to streamline many types of data collection (e.g. collection of maturity information).
(Michael Sigler 907-789-6037)

Socioeconomic Task - REFM

During 1992, 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 bycatch in the groundfish fisheries off Alaska, the allocation of the BSAI Pacific cod TAC among gear groups and seasons, individual transferable quota (ITQ) management for the Alaska and West Coast fixed gear sablefish and halibut fisheries, and the allocation of selected Alaska and West Coast groundfish quotas between at-sea and on-shore processors.

Task members served on the BSAI, GOA, and West Coast groundfish plan teams and on both NPFMC and PFMC technical work groups. Task members assisted the Northwest and Alaska Regions, NMFS Fishery Statistics Division, Alaska Commercial Fisheries Entry Commission, and the Alaska Department of Fish and Game to collect quarterly wholesale price, product form, and employment data from the processing sector of the Alaska groundfish industry for 1992.

A Task member served on work groups dealing with recovery programs for the EXXON VALDEZ oil spill and was NOAA's lead economist in preparing draft regulations to implement the Oil Spill Act of 1991. A Task member has been actively involved in the work groups that are evaluating the redefinition of PacFIN and evaluating the development of RecFIN for the Pacific Coast. A task member is vice chairman of the Organization for Economic Cooperation and Development (OECD) Committee for Fisheries Ad Hoc Expert Group. The Group will be involved in cooperative, multi-national research on the economic aspect of the management of living marine resources.

In addition to the management topics listed above, the topics of the reports and papers by Task members included the following: fishery product exports from the Pacific Northwest and Alaska; the economic status of the Alaska groundfish fisheries; price linkages between Japanese and United States markets for sablefish and thornyheads; the role of economics in the development of limited entry programs; monopsony, trade restrictions, and international markets for intermediate seafood products; and cooperative fishing arrangements between coastal countries and distant water fleets.
(Dr. Joe Terry (206) 526-4253)

3. Alaska Department of Fish & Game

Age Reading Laboratory

The age lab moved from its temporary facility in Douglas to a permanent facility in Juneau. The facility shares its time between groundfish aging and thermal marked salmonid otolith reading. Initial groundfish aging emphasis was on sablefish and near-shore rockfish. A study was begun to compare ages obtained by reading lingcod otoliths and fin rays. While inconclusive, it appears that otoliths compare quite well and are much easier to prepare. This work is on-going. The age reading position was maintained in Kodiak for part of the year. A major portion of the Kodiak reader's time was devoted to otolith exchange and precision testing.

Port Sampling and Skipper Interviews

During 1992 port sampling and skipper interview programs were conducted in Sitka, Ketchikan, Petersburg and Craig. Port sampling provides biological information from the landed catch. In recent years this activity has been limited to sampling landings of rockfish, Pacific cod, and lingcod. This component provides information on species composition and AWL data from important commercial species by management area. It also provides an opportunity to collect data on sex ratio and reproductive status from round deliveries of rockfish.

Skipper interviews are conducted for landings of the key groundfish species. Interview effort concentrated on the state-managed sablefish, rockfish, and lingcod fisheries during 1992. This program is designed to provide detailed location and effort information which, when coupled with the fish ticket data, provides an estimate of CPUE for the landed catch by management area.

Miscellaneous Stock Assessment

Catches of groundfish species are also observed routinely during stock assessment surveys for other species. That information provides an indication of population trends for some commercially important groundfish species which are not assessed directly. Two surveys in particular, the Kodiak/Alaska Peninsula crab trawl assessment survey and the Southeast area crab pot indexing survey provide information on the relative abundance and length frequency of commercial groundfish species such as Pacific cod, pollock, juvenile sablefish, and some shallow water species of flatfish.

4. Washington Department of Fisheries

Marine Fish Shore Fisheries

This project was designed to collect catch, effort, and biological information from recreational shore fisheries targeting marine fish along the Washington coast. This three year project has

been concluded a year early due to funding shortfall. Final report is currently in progress.
(Farron Wallace/Brian Culver (206) 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.
(Wayne Palsson (206) 902-2845)

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 1992 at 19 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. A comprehensive Puget Sound trawl survey database has been compiled which includes tow by tow species composition data.
(Sandie O'Neill (206) 902-2843)

Habitat Investigations - beach spawning habitat surveys

The goal of this investigation is to document the distribution of upper intertidal spawning and spawn 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 2 of a proposed 6-year study). 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.
(Dan Penttila (206) 428-1007)

Habitat Investigations - Marine fish Habitat Requirements and Habitat Functions

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 focussed on identifying and protecting natural nursery habitats for marine fishes of importance to the recreational fishery. In 1992, biologists identified critical juvenile rockfish settlement and nursery habitats at 12 new locations in the San Juan Islands, Hood Canal, and Puget Sound. Data from these studies suggest that vegetated habitats of kelp (e.g. *Nereocystis leutkeana*, *Lamininara* sp., *Agarum*) and eelgrass (*Zostera marina*) at these locations serve as important settlement and nursery habitats for juvenile copper, brown and quillback rockfish. Information indicates that

juvenile rockfish seek refuge in these kelp and eelgrass habitats for a 4-5 month period in the late summer and fall before they move into deeper rocky reef habitats. The rockfish nursery habitats identified in 1992 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 resources.
(Dan Doty (206) 902-2832)

Habitat Investigations - Enhancement of Natural Production Habitats for Rockfish

This project has focussed on enhancing natural production of rockfish (*Sebastes* spp.) by providing refuge habitat for juvenile forms of target species. The juvenile lifestage and their transition from pelagic to benthic habitats are considered particularly vulnerable to perturbation. Results from the second settlement season indicate that young-of-the-year (YOY) rockfish survive better on, exhibit higher fidelity to, or are attracted more to artificial nursery habitats than nearby natural nursery areas. Densities of juvenile rockfish were higher on artificial nurseries than natural nursery habitats. Preliminary analysis of (YOY) densities between artificial reef types suggests that Isolated Nursery Reefs are marginally more effective than Integrated reefs. The 1992 settlement season was poor, however, with densities of YOY low in all habitats. It is likely that more apparent differences will emerge with higher overall YOY densities. On reefs that provide a variety of substrate types and relief (Integrated Reefs), YOY were segregated according to substrate, with highest YOY densities found in complex, low-relief habitat.
(Jim West (206) 902-2842)

Habitat Investigations - 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 WAC's and other regulations. Two studies conducted over the last twelve months have focussed on utilization of drift algae and kelp bed habitats by juvenile rockfish (Sebastes sp.). Preliminary results have revealed critical habitat information. Juvenile rockfish use the drift algae habitat primarily for refuge during summer months, and depend on it for a food source in fall months. Calanoid copepods and gammarid amphipods that make up juvenile Sebastes sp. prey are very sensitive to oil and dispersant, indicating that oil spills may have an impact on the success of juvenile rockfish use of this habitat. Trophic use of the kelp bed habitat by juvenile Sebastes sp. also appears to shift with season. Newly settled fish feed equally on planktonic and epiphytic prey which appear to be more abundant in kelp habitat relative to adjacent unvegetated areas. Larger fish depend on larger motile macrobenthic prey, including grass shrimp, which are more abundant in kelp habitat. This information is currently being used to advance the protection and enhancement of these vital habitats that provide food for marine resource production.
(Anne Shaffer: (206) 902-2852)

Mr. Tom Jagielo mentioned that the surf perch final report was coming out.

VIII. OTHER TOPICS FOR DISCUSSION

No report.

IX. PROGRESS ON 1992 RECOMMENDATIONS

A. From the TSC to Itself

1. Coordination of coastwide synoptic surveys

The close cooperation between US and Canada during planning and implementation of the 1992 Pacific whiting hydroacoustic surveys resulted in the most accurate and useful information generated from any such survey to date. Research directors at DFO Canada and NMFS RACE Division, the primary agencies with survey responsibilities, have been apprised of these results and have received letters from the 1991-1992 TSC chairperson advocating similar cooperation in all types of future surveys involving assessments of transboundry stocks.

2. Recommendation to CARE regarding age validation of rockfish and thornyhead.

The TSC is pleased to hear that some work has been conducted on radionucleotide validation of ages of thornyhead, although it notes the results appear to be inconclusive at this time. The TSC endorses continuation of this work to resolve the discrepancies on the present results. The TSC further notes that in general, age validation of rockfish is a desirable activity and encourages such projects. However, because no specific issues in rockfish ageing were raised at the 1993 TSC meeting, the TSC did not view the current lack of activity on rockfish age validation with special concern.

3. Age validation of Dover sole and arrowtooth flounder.

Little progress has been made on the 1992 recommendations.

B. From TSC to the Parent Committee

(See Appendix **xx**, May 3, 1993 memo from L. Six to TSC)

X. 1993 TSC RECOMMENDATIONS

A. TSC to Itself

1. Recommendations to CARE - Prepared by Mark Wilkins - APPROVED

The TSC considered the five recommendations made to it by the CARE (Kastelle memo dated July 7, 1992) resulting from the May 1992 CARE meeting. The responses of the TSC to these recommendations follow.

1. The TSC endorses and encourages the thorough investigation of and search for alternative compounds to OTC for marking otoliths for age validation studies. If suitable alternatives can be found, they would facilitate badly needed validation research.
2. Although the TSC recognizes the value of radiochemical methods of age validation, we suggest that , due to the complex and sensitive chemical procedures involved, such studies would be most effectively carried out in cooperation with established chemistry research facilities. Instead of establishing a radiochemistry lab, the TSC recommends that radiochemical validations studies continue to be pursued as they have been, through studies in cooperation with academic institutions.

3. The TSC encourages and endorses the development and full utilization of imaging technology and commends the CARE for their efforts in extending the technology as widely as possible.

4. The TSC supports the continued frequent exchange of age structures for interagency calibration. We recommend that the CARE compile an annual summary of these exchanges, including pertinent results, and that this summary be included in the CARE report to the TSC for the TSC annual meetings.

5. The TSC understood that the "CARE Ageing Manual" was a "living document" in the sense that it exists as a loosely bound manual amenable to continued additions and refinements. The CARE's recommendation to finalize and publish the manual is inconsistent with our understanding of its purpose. The TSC would like to ask the CARE for further explanation regarding their objectives behind the move to publish this manual before we solicit support for publication. Further, the TSC suggest that the CARE consider the use of some multimedia technologies (i.e. video tape, computer imaging, etc.) to enhance the effectiveness of the CARE Ageing Manual as an instructional and standardization

tool.

2. Regarding age validation of Dover sole and arrowtooth flounder - Prepared by Tom Jagielo - APPROVED

The TSC discussed age validation of Dover sole and arrowtooth flounder and re-affirmed the need for age validation of these species. The importance of precision testing, once a valid ageing method has been established, was also discussed. While OTC has proven useful for age validation experiments, problems with FDA approval persist and investigators are encouraged to evaluate the use of substitutes such as SrCl, calcine, and alizarine compounds. In lieu of tagging studies, investigators are encouraged to conduct alternative analyses, such as radioisotope dating, when appropriate.

B. From the TSC to the Parent Committee

1. Regarding a rockfish management workshop - Prepared by Jake Rice - APPROVED

The TSC discussed the request from the Parent Committee for clarification of the purpose of the rockfish management workshop. There was a clear consensus that the focus of the workshop should be on management approaches for nearshore rockfish stocks. The TSC considers presentation of case histories and discussion sessions on options for managers should be prominent at the workshop, but significant presentations on rockfish biology would not be consistent with the objectives of this workshop. TSC recommends organizers of the workshop continue their planning with this focus.

2. Regarding FDA approval for OTC use as an age validation tool - Prepared by Dave Thomas - APPROVED

At its 1992 meeting TSC discussed difficulties in obtaining approval from the FDA to release marked fish that have been injected with OTC for age validation studies. The TSC recommended that a standard, well-documented procedure be developed for the approval process. That procedure has yet to be established and the TSC request the U.S. section of the parent committee continue to move forward on OTC approval.

3. Regarding Pacific hake allocation - Prepared by Jake Rice - APPROVED

The TSC notes that the combined Canada/US harvest of Pacific whiting continues to exceed the ABC. The TSC considers this level of harvest to be undesirable, and recommends the bilateral negotiations be encouraged to arrive at a quick resolution to this issue.

XI. SCHEDULE OF NEXT MEETING

The next meeting will be hosted by Canada in Nanaimo, British Columbia, in the first week of May, 1994.

XII. ADJOURNMENT

APPENDIX A - 1993 TSC MEETING AGENDA

I. CALL TO ORDER
II. APPOINTMENT OF SECRETARY
III. INTRODUCTIONS
IV. APPROVAL OF THE 1992 REPORT AND THE 1993 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)
        3. Dover sole age validation
    D. Other
        1. Sablefish Symposium report
        2. Transboundary stocks
VII. REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENTS, MANAGEMENT, AND FISHERIES
    A. Agency Overview
    B. Review of Multi-species Studies by Agency
    C. By Species, by Agency
        1. Pacific cod
        2. Shelf Rockfish
        3. Slope Rockfish
        4. Thornyheads
        5. Sablefish
        6. Flatfish (Dover, English, arrowtooth, petrale, halibut)
        7. Pacific whiting
        8. Dogfish
        9. Lingcod
        10 Pollock
        11. Other Species
    D. Other Related Studies
VIII. OTHER TOPICS FOR DISCUSSION
IX. PROGRESS ON 1992 RECOMMENDATIONS
    A. From the TSC to Itself
        1. Synoptic surveys - carried out
        2. Rockfish and thornyhead validation
        3. Flatfish age validation
    B. From TSC to the Parent Committee
        1. FDA OTC approval
        2. Pacific hake

3. Rockfish management
4. Yellowtail management

X. 1993 TSC RECOMMENDATIONS TO CARE

XI. SCHEDULE OF NEXT MEETING

XII. ADJOURNMENT

APPENDIX B - Reports Published By The Member Agencies During 1992

CANADA
(Reports published by the Marine Fish Division during the period May 1, 1992 to April 30, 1993.

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APPENDIX C - WORKING GROUP REPORT - CARE

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southwest Fisheries Science Center
P. O. Box 271
La Jolla, Ca 92038

April 28, 1993

Mark Saunders, Chairman TSC
Dept. Fisheries and Oceans, Canada
Pacific Biological Station
Nanaimo V9R 5K6
B. C. Canada

Dear Mark,

I am sorry that I will not be able to attend the Technical Subcommittee meetings in Monterey in May, but budget constraints have severely limited our travel.

The Committee of Age Reading Experts met in Seattle on 27-29 May 1992 and discussed issues of age determination. Methods of age validation were discussed in length. The TSC's recommendation of edge analysis was discussed as well as the problems with fisheries of limited seasonal coverage. Other methods of validation discussed were OTC, alizarin and strontium chloride marking and radiochemical analysis of otoliths.

The meetings also included presentations of research by members of CARE. John Mello, CDFG, presented his results on age validation of chilipepper rockfish, Sebastes goodi. His results indicate that the opaque zone was produce from May to December, that opaque and hyaline zones are produced once per year. Joan Forsberg, IPHC, presented her paper on sex determination of Pacific halibut using shape analysis and otolith morphology. Descriminant analysis was able to correctly sex 79-91% of known sex fish. Craig Kastelle presented results of radiochemical age validation of sablefish growth. He used Pb-210/Ra-226 disequilibrium to validate the age determination methods of sablefish. John Butler presented results of radiochemistry validation of shortspine thornyhead, Sebastolobus alascanus. Based on two different criteria to read otolith

sections of thornyhead, Butler had determined longevities of 150 or 80 y. Radiochemical ageing of the cores of these otoliths supported the latter interpretation of otoliths.

There was a great deal of interest in equipment and software that would store images and automatically read otoliths. At present there are at least two systems available. On system is commercially available but at a price of 20k for the software. That system is DOS based and requires a 486 PC, a frame grabber and a camera mounted on a microscope. The other system was developed by the University of California at Davis. The software is public domain. The system requires a Macintosh computer, a frame grabber and a camera. The Macintosh computer is slightly more expensive than DOS based machines, but then they are Macs. CARE is interested in comparing the strengths and weakness of these two programs. Aside from the time saved reading otoliths, the ability to transmit otolith images over computer networks, promises to greatly facilitate communication and reduce reader variability. CARE recommended that a demonstration of the two systems be a part of the next meeting.

Please convey this information to the Technical Subcommittee.

Sincerely,

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UNITED STATES DEPARTMENT OF COMMERCE
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January 22, 1993 F/AKC1:MEW

MEMORANDUM FOR: TSC Members

FROM: F/AKC1 - Mark Wilkins

SUBJECT: Minutes from May 1992 CARE Meeting

At our last meeting early last May, we decided that we should await the results of the late May meeting of the CARE and incorporate their report of that meeting in our 1992 minutes. Additionally, members showed general interest in receiving copies of the minutes of their upcoming meeting. I cornered Craig Kastelle, the CARE chairman, and have received copies of both the report to the TSC and the minutes of their May meeting from him.

The first document is a two-page memorandum to the TSC and CARE from Craig (representing CARE) outlining the recommendations that came out of their May 1992 meeting. It is this memo that Craig intended for inclusion into the TSC minutes.

The second document is the full version of the minutes of the May 1992 CARE meeting.

Attachments

Distribution:

Mr. Calvin Blood	IPHC
Mr. Barry Bracken	ADFG
Mr. Dave Clausen	NMFS/ABL
Mr. Chris Oliver	NPFMC
Mr. Jim Glock	PMFC
Mr. Dave Thomas	CDFG
Dr. Bill Lenarz	NMFS/SWFSC/Tiburon
Mr. Bill Barss	ODFW
Mr. Mark Saunders	DFO/PBS
Mr. Larry Six	PFMC
Mr. Guy Thornburgh	PSMFC
Mr. Tom Wilderbuer	AFSC/REFM
Mr. Ed Zyblut	CDFO

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Alaska Fisheries Science Center
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Management Division
Age and Growth Task
7600 Sand Point Way N.E.
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July 7, 1992

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

From: Craig Kastelle
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.

OUTLINE OF THE MINUTES OF THE 1992 CARE CONFERENCE
SEATTLE, WASHINGTON
27-29 MAY, 1992

MINUTES TO THE CONFERENCE OF THE COMMITTEE OF AGE READING EXPERTS (C.A.R.E.)

May 27-29, 1992
National Marine Fisheries Service
Seattle, Washington

I. INTRODUCTIONS AND ORGANIZATION

Craig Kastelle, chairperson for the 1992 CARE conference, opened the meeting at 9:10 a.m. welcoming everyone to this year's conference. He began by suggesting everyone introduce themselves and state the organization they represented. A list of the participants can be found in Appendix I.

For the first order of business, he directed attention to two handouts, the first being the proposed agenda (Appendix II) and the second was a memo from Mark Wilkins, current TSC chairperson (Appendix III). Mr. Kastelle had hoped to have Mr. Wilkins present for a 20 minute talk on the organizational status of the Technical Subcommittee (TSC) and the role of the CARE, but unfortunately Mr. Wilkins was on vacation. Mr. Kastelle briefly outlined the organizational network tracing CARE's lineage to the TSC whose parent organization is the Canada-US Groundfish Committee. All these groups are under the Pacific States Marine Fisheries Council (PSMFC).

On the proposed agenda, Mr. Kastelle asked for further suggestions and thoughts. Since these meetings have always been held in a semi-informal fashion, he suggested we feel free to include other topics of concern.

Shayne MacLellan (DFO) began by recalling a letter she drafted to the TSC as a result of the 1990 CARE conference. The letter listed 4 recommendations CARE felt needed investigation. TSC endorsed these 4 recommendations. Tom Jagielo, then chairperson of the TSC, circulated a letter to all participating fish ageing units outlining these recommendations (Appendix IV). Ms. MacLellan suggested that we discuss what has occurred in our different agencies and what has been implemented as a result of these recommendations.

This was followed by a discussion of the other activities planned for the conference. Several speakers had presentations to give Thursday morning. Hands-on microscope work was scheduled for Thursday afternoon.

Betty Goetz (AFSC) suggested that we talk about current and upcoming age validation projects.

Dan Kimura (AFSC) suggested we discuss the status of the ageing manual. The manual has been in draft form since the first CARE meeting in 1983. At the last meeting Ms. MacLellan was given the responsibility of compiling the body of the manual. She brought a copy of the latest draft. Ms. MacLellan asked for input from everyone on the manual from spelling and grammar to content and structure. She felt the manual was something needed by each agency not only as a reference guide but also as a teaching tool for new age readers. She stressed the importance of good quality photos for training.

The group discussed the publication of the manual. One suggestion was to print it in the form of a NOAA Technical Report. Then there was the question of incorporating pictures in the publication. The majority preferred illustrating with colored photographs because it showed better clarity and resolution but the cost would be high. Someone suggested that Ms. MacLellan or Mr. Kastelle approach the TSC for their ideas. How would TSC like to see this document handled and will TSC provide funding for publication? Ms. MacLellan said she wouldn't mind approaching TSC after we have all accepted the final draft of the manual.

II. APPROVAL OF THE 1990 MINUTES

Going back to the agenda, Mr. Kastelle asked everyone for formal approval of the 1990 minutes. None of the past participants had anything further to add and they were approved.

III. OLD BUSINESS

Mr. Kastelle asked Ms. MacLellan to read the letter from Tom Jagielo listing the TSC endorsed recommendations from the 1990 meeting. In summary, the recommendations stated that:

1. Each agency should develop a systematic precision testing program as a routine ageing procedure.

2. Each agency have a formal training program for new fish agers.

3. Each agency document marginal growth increments for each species to determine more accurately deposition time for the annulus thereby properly assigning an age-class.

4. Adopt a single age designation system to avoid confusion during inter-agency exchanges and cooperative work.

Mr. Kastelle began by describing the AFSC plans for a marginal increment study analyzing 0- to 2-year-old sablefish otoliths. These fish were caught over a 2-3 year period from St. John-the-

Baptist Bay in Alaska. Biologists from the NMFS Auke Bay Lab collected the otoliths for the Seattle Age Unit (AFSC) specifically for this study and included various months of the year.

Ms. Goetz added that age readers at AFSC have been systematically assigning an edge-type code as part of the ageing routine. Dr. Kimura pointed out, however, that this system has not been in effect very long. The data is all in the AFSC data base and has yet to be analyzed.

Mr. Kastelle mentioned that the AFSC also does a systematic 20% precision testing of all otolith batches/cruises read. Usually, tester and reader are two different persons. In all cases, tester has no prior knowledge of reader age. Currently the AFSC has two designated testers.

Cal Blood (IPHC) said that the IPHC has followed suit and has implemented a similar 20% reader-tester system. Furthermore, they routinely do blind testing where two readers read the same batch without knowing the other readers estimated age. A third reader resolves any differences.

Ms. MacLellan commented that different agencies probably have different methods. In their case, they used to do double readings which involved 2 different readers ageing the same batch of otoliths. Reader #2 was aware of Reader #1 ages during the second ageing. This two reader system was too time consuming so they changed to a single reader system with 15% testing. The tester ages a minimum of 10 otoliths if there is less than 100 fish in a sample. They have not decided whether a 15% sample is sufficient. She introduced a paper by Richards, Schnute, Kronlund and Beamish titled Statistical Models for the Analysis of Aging Error which is currently in press. This paper pointed out that error is inherent to ageing and should be taken into account. However error is something that will not go away no matter what the test sample size may be or how often a sample is read and tested.

Mr. Blood asked Dr. Kimura if he (being a statistician) had any thoughts on what percentage of a given sample is necessary for valid test results. Dr. Kimura said he had some thoughts on it but cannot see doing more than 20% testing because of the volume required in production ageing.

Moving to another topic, Mr. Blood asked Ms. MacLellan what her thoughts were on reader drift. Ms MacLellan did not feel that reader drift is a problem when multiple readers are involved and have access to well documented (written and photographic) criteria. Ms. MacLellan felt that drift may occur when a reader has not read a particular species in a long time and the criteria has not been well documented.

Ms. MacLellan mentioned that Rick Stanley (DFO) once looked at

their precision testing results with S. flavidus. Interestingly, Mr. Stanley found that percent agreement increased as the ages approached about 18- to 19-years-old then fell off again. Ms. MacLellan added that it may not be too unusual to find a novice reader underageing the older fish and overageing younger fish.

John Butler asked Ms. MacLellan what her definition was of an "expert reader". She defined an expert reader as a reader who has shown the ability to maintain a high level of precision with themselves and with others. To train a new reader they have the trainee read previously aged otoliths. Then they are tested against their own original ages and tested with an expert reader. DFO does not have designated testers. Any reader expert in the trainee's species participates in testing. To pass training they are required to achieve an acceptable percent agreement which is arbitrary. An acceptable value depended more on the users' preference which, in most cases, is 80% +/- 1 year. This training normally takes about 2-6 months depending on previous experience.

John Butler asked if anyone ever routinely used size and weights of otoliths to help in ageing. Mr. Kastelle said that Dave Somerton at AFSC once investigated this idea. He used otolith weights and surface area measurements. Through multiple regression analysis he tried to predict age. This was quite a large study. The results showed that these measurements could predict age but with a considerable decrease in precision.

Dr. Kimura pointed out that this is an idea that is resurrected every so often but has never produced any good results. His personal feeling was that it is not sufficiently precise to be useful.

Julie Lyons (AFSC) wanted to go back and make a comment on reader drift. She believed this happens to all readers even when they have current reading experience with a particular species. Mr. Kastelle mentioned that in ageing sablefish, he tests against his original ages and when there is a between-reading bias, it usually leans toward ageing older the second time. In looking for drift, Ms. Lyons would like to see that readers reread otoliths every few years.

Ms. MacLellan added that "reader drift"/"lack of precision" (there may be some confusion in the use of these terms) may also be identified simply when users complain that not enough fish were assigned to particularly strong age-classes compared to previous years. This may show up especially in flattened year-classes.

Dr. Kimura continued by adding that users do not like it either when too many fish are aged in the dominant year-classes. This was a complaint he received recently. When plugged into their models, it resulted in unreasonable bounds among the year-classes.

Dr. Kimura addressed the problem of reader bias when ageing fish knowing the year classes. To study this, he designed a test where 3 readers aged pollock otoliths previously aged 9, 10, and 11. These otoliths were taken from samples collected during 3 consecutive years from the strong 1978 year-class. Results showed that without having the year-class information, the readers still identified the dominant year-classes but with some spreading into the adjacent classes. This study was summarized into a paper currently in press titled The Effects of Year-class Strength on Age Determination by Kimura, Lyons, MacLellan and Goetz.

The topic returned to the 4-point TSC recommendations on precision testing, Ms. Goetz commented that with her group they've adopted as acceptable for POP a percent agreement comparison of +/- 0 age difference up to age 12, +/-1 up to age 25 and +/-2 above age 25. Ms. MacLellan felt that this might be a very useful way to examine precision results for longer-lived species.

Mr. Kastelle commented that AFSC does not have a set precision criteria for what might be considered an "expert" level. Ms. Lyons pointed out that setting levels is difficult because of the varying difficulty between otolith batches even within a given species. This variability could be due to differences in area, between cohorts, and even from one collection year to another. A poor percent agreement could reflect the difficulty of that batch in which case, it should be re-evaluated. She recommended requiring the tester to re-age the test sample without knowing his/her previous ages. The precision between the two sets of test ages should be indicative of the difficulty of the samples.

Going back to the comment on modeling and relying on the interpretations of the models, Larry Quirollo (CDFG) wanted to add a cautionary note on the effects of the commercial fisheries to these models. In California, age readers found they were ageing Dover sole younger and younger. They discovered this was not due to reader drift but was a result of the commercial fisheries targeting the younger, shallower fish which had a better commercial appeal than the older, deeper fish. On precision testing, Mr. Quirollo added that Dover sole can be difficult and checky. Precision testing could result in poor agreements because even with himself he might come up with multiple ages for one otolith. Conflicting ages could result from reading different axes and the light casting on the otolith cross-section.

Mr. Butler asked Mr. Quirollo what he does when he is confronted with multiple readings and has to assign one age. Does he take the average? Mr. Quirollo answered that he does not take an average but decides which age is the most appropriate after analyzing all the characteristics of the otolith. Then he tries to come up with that same age again. Mr. Kastelle added that for sablefish, he too does not take an average but tended to choose the oldest reasonable age. He does this because of validation studies

indicating a tendency for this species to be older than previously thought.

Mr. Kastelle directed discussions to item four on the 4-point TSC recommendations. Ms. MacLellan clarified this item by explaining that some agencies reported their results in year-classes such as fish "born in 1950" whereas other agencies reported in age-classes such as a "50-year-old fish". This can result in some confusion. Mr. Quirollo said their computer programs required them to input data in year-classes but they converted to age-classes when reporting otolith ages. Mr. Mello (CDFG) said he did the opposite by starting with age-classes and converted his results to year-classes. Someone pointed out that the Tiburon lab also reported in year-classes. Ms. MacLellan cautioned everyone about the potential of year-class biasing that might occur when using the year-class system. All the other participants conformed to age-classes.

At that point Mr. Kastelle declared that aside from item three, to be further discussed later, the other three points of the TSC recommendations were considered dealt with.

A BREAK was called at 10:15 a.m.

The meeting was reconvened at 10:50 a.m.

First business was the updating of the species list aged by the various West Coast age reading units (Appendix V). Sandra Rosenfield (WDF) requested that Mr. Kastelle quickly read through the list and members were to call out revisions to their agency list when necessary.

The next item on the agenda was the status of the ageing manual. Members received photocopies of the current form of the manual. Ms. MacLellan explained why she had revised it to its current format. The manual was separated into three sections, the first was a general ageing procedure applicable to all species. The second part was an ageing procedure for rockfish and the final part was an ageing procedure for sablefish. If published as is, she foresaw it as a simple matter to include other species in the form of future addenda without further revisions to the format.

Mr. Blood suggested adding a section on flatfish. Ms. Goetz recommended that perhaps we should have something written up on all basic species groups before publication. Ms. MacLellan thought that might delay publication for years considering how long it has already taken to get this far on just two species groups. However, if some groups felt comfortable with their ageing criteria for the other species and wrote it up within a time frame before publication, it could be included in the manual.

Ms. MacLellan and Mr. Kastelle suggested organizing a small committee to prepare the manual for publication. Dr. Kimura thought it might be difficult to have this committee meet because of the distances involved between the different agencies. He suggested assigning an "editor-in-chief" who would have the overall responsibility for the final draft of the manual. The editor would make sure each agency reviewed the final form. Dr. Kimura suggested that Ms. MacLellan be the "editor-in-chief" since she has already contributed so much time to it. Ms. MacLellan accepted.

Ms. MacLellan commented that she wanted to see more figures/photos incorporated in the manual and asked for good quality photos from other members. A discussion began on the expense of including the photos, especially for high quality results. However, the group agreed that if this manual was to be a good teaching tool we could not compromise good quality photos. Ms. MacLellan agreed to talk to Guy Thornburgh of the Pacific Marine States Fisheries Commission over the possibility of funding.

IV. NEW BUSINESS

Returning to the agenda, Mr. Kastelle introduced the first of the new business topics. He commented on the TSC's support in encouraging marginal increment analysis or edge-type studies.

Mr. Blood said that the IPHC has been working with the treaty Indian tribes on an ad hoc basis. The tribes have been collecting halibut otoliths for the IPHC. The problem is that the commercial fishing occurs from May to September and interpretation of marginal increment formation in May is always difficult because this is believed to be the beginning of the growing season.

Ms. MacLellan felt that we may never get clear answers to the problem of interpreting marginal growth formation. Numerous factors could affect annulus formation even in a given species. Variations could occur between cohorts, location, sex, age-classes, environmental factors, etc.

Mr. Blood questioned Dr. Kimura about the Observer Program and all the otoliths collected over various months throughout the years. He asked if AFSC has done any historical studies on this problem using those otoliths. Dr. Kimura said that they haven't really done anything historical but are just beginning a systematic study on marginal increment as mentioned earlier. Mr. Kastelle pointed out that the collections from the Observer Program were dependent upon the fishery openings, often for limited time spans once or twice a year.

Someone asked how the AFSC did their edge-type determination. Ms. Goetz explained that it was a relatively subjective system where each reader assigns a code ranging from 0-5 for each otolith

read. Zero was an indication of a clear, strong annulus on the edge. Assignment of 1-4 would represent the increasing growth increment beyond the last annulus and 5 would be the indistinct formation of a new annulus on the edge.

Ms. MacLellan mentioned that DFO also has a similar system on a scale of 1-4. She emphasized that she thought this problem will always be a continuing nuisance. Part of the problem is our use of the break-and-burn technique which may leave a dark mark at the edge of the otoliths. Is the mark really an annulus, a check or a result of the burning process?

Mr. Butler summarized the discussion by commenting that to undertake this study properly we needed to have samples collected at least quarterly to identify the incremental growth and annulus formation. This led him to voice a concern about our current system where we have users who request these ages. They may not be aware of the problems of ageing but want "real" ages to make their stock assessments. Then we have the researchers who study the problems of ageing but do not generate the ages for the users. Then there are the production age readers who are aware of the ageing problems but are normally not in the position of studying these problems. He questions this current system and wants to see production readers, who directly affect the ages for stock assessment calculations, more involved in studying some of these problems.

The morning session was adjourned for lunch at 11:55.

The afternoon conference session was reconvened at 1:06.

The first topic was a continuation of the discussion on marginal increment validation. Mr. Kastelle talked about the proposed project he mentioned earlier this morning about the juvenile sablefish otolith collected by the Auke Bay lab for studying marginal increments. He hoped to do a thorough study leading towards publication.

Ms. MacLellan talked about being involved in an English sole OTC validation study which led her to believe that growth is affected by the season of reproduction. She began the study on the premise that otolith growth begins around June and full growth is seen in September. However, she found that in some fish she identified growth from February to June. The principle researchers were pleased to learn this because it conformed to their thoughts on growth occurring after reproduction which was in the fall. So another possibility in the scheme of otolith growth is to consider younger fish growing from June to September and older fish possibly delaying somatic growth until after reproduction. Of course this could mean different growth periods between males and females and between different species.

Mr. Butler added that he too felt that post-reproduction is strongly linked to somatic growth.

Ms. MacLellan noted that for most groundfish species, if we considered gonad development beginning in September with spawning resulting around January to March, it made sense that somatic growth should occur afterwards. This could explain why she sometimes noticed very little growth occurring as late as June or July and suddenly saw large amounts of growth in August. However, this is difficult to assess because at their lab, reader ageing assignments jumps from species to species, month to month, and year to year.

Mr. Kastelle directed the discussion back to the memo from Mark Wilkins where it referred to age validation of rockfish and thornyheads. He asked John Butler if he had knowledge of other studies on thornyheads. Mr. Butler said he knew of a graduate student at the Moss Landing Lab who is doing validation studies of longspine and some shortspine thornyheads as part of her master's thesis due in June. He added that with his work on them, there were still a lot of questions in his mind about the correct ageing criteria for these fish. He also had some questions concerning the choice of ageing structure.

Ms. Goetz pointed out that Vicki Poage, a former AFSC age reader, studied several possible ageing structures and eventually eliminated the use of opercles and fin rays. This brought it back to the otolith. Mr. Butler said that the otolith may be the structure of choice but a valid set of criteria for thornyheads needed to be identified.

Ms. Goetz continued by presenting a project just begun at AFSC in conjunction with Dan Ito and Julie Pearce of the AFSC rockfish working group. They plan to compare scales and otoliths of young shortspine thornyheads to try to identify characteristics which might lead to some ageing criteria for the younger fish.

Mr. Kastelle added that Mr. Ito had obtained funding for a radiochemical validation study for shortspine thornyheads and other rockfish species.

This led to a discussion over the importance of radiochemical validation studies and the possibilities of a NMFS sponsored lab for the sole purpose of age validation. The idea was to create a central lab where all West Coast ageing units could send samples for age verificaton of their species of interest. Mr. Butler wanted to emphasize the importance that this lab functions solely for age validation and working only with the necessary isotopes to reduce the possibility of contamination. The working levels of these isotopes are so minute that cleanliness is crucial. As an example, Mr. Kastelle pointed out there was probably a higher level of radium in the soles of our shoes than in 1 gram of otoliths.

Mr. Kastelle mentioned that in searching for a lab to do the radioisotope studies for Dan Ito, they discovered a lab within NOAA's Building 3. This lab is not in use currently and already housed some of the necessary equipment. A request was made through proper channels for the use of this lab. But the request was denied for various reasons.

The discussion turned to the cost of such a set-up. Mr. Kastelle and Mr. Butler estimated that it would be approximately $30,000 - $40,000. Someone pointed out this is less than the cost of a SEM and less than the cost to fund a survey cruise. The discussion was concluded by recommending that this be one of the recommendations to TSC.

Returning to a second point from Mark Wilkins' memo, Mr. Kastelle opened discussion on FDA concerns over the use of OTC in tagged fish studies. The problem was in the possibility of an injected fish ending up in the market-place.

Mr. Blood began by saying that before he did his work with OTC fish injections he did a literature research on the historical use of OTC. He found some work done in aquaculture where OTC treatment was allowed with the requirement that these fish could not be harvested earlier than 21 days after treatment. So when IPHC did their tagging studies they made sure they released their fish in areas away from possibly entering the sport fishery at least 21 days before a commercial opening in the vicinity.

To explain the FDA's concern over this matter, Mr. Butler thought this could be traced to the problems in the poultry industry where OTC was used in treating chickens. Later, it was discovered this resulted in OTC resistant strains of the Salmonella bacteria. Mr. Butler further pointed out there are other dyes that could be used in place of OTC. These dyes were proven to be just as useful, and may require less approval requirements with the FDA. He mentioned the use of strontium chloride (absorbed instantaneously), calcine and alizarine compounds. John Gunn from the CSIRO lab in Hobart, Tazmania did some work with strontium chloride and is due to publish a paper on this soon. Tsukamoto (1988) reported successful use of alizarine and illustrated this with colored picures.

Someone asked how OTC became the dye of choice. Mr. Blood thought perhaps it's history goes back to Kobayashi's paper in the 1960s which described the potential use of OTC in otolith marking. Everyone has used it since. This discussion concluded with a suggestion for a recommendation to TSC on the use of other dye products for future tagging studies to alleviate the problems with the FDA.

The final item on the Mark Wilkins' memo was age validation of Dover sole and arrowtooth flounder. But, as pointed out in the

memo, this was put on hold due to the cancellation of the 1992 west coast flatfish survey. This concluded the discussion on the Mark Wilkins' memo.

The next topic was OTC use and application. Mr. Kastelle voiced regrets that the two members who wanted most to address this topic, Bill Barss (ODFG) and Don Pearson (SWFC-Tiburon), were not able to attend this conference. However, Mr. Kastelle and Mr. Blood were able to put together an impromptu demonstration on the equipment and techniques used in OTC tagging work.

Mr. Blood's equipment included an 18-gauge needle connected to a dark bottle by a flexible surgical tubing used on large halibut. He stressed the importance of housing the OTC solution in a dark bottle. He pointed out the difficulties and potential dangers involved in using this needle on a large, flopping fish aboard a moving vessel at sea. It is important to inject the OTC into the peritoneal cavity of the fish because of the large volume necessary (it actually causes a distention of the abdominal region). Also, OTC injected into the flesh region causes discoloration of the fish meat, an unappealing quality should it end up in the food stores.

Mr. Kastelle demonstrated a similar set-up used for sablefish. The bottle and tubing were smaller but the needle was bigger. He pointed out that the needle size must be sufficiently large due to the highly viscous nature of the OTC solution.

It was emphasized that the time of year for doing the injections was thought to be crucial. You wanted it available during the period of fast growth allowing it to be incorporated into the otolith. Mr. Blood said that for halibut it would be between July to September.

Mr. Blood pointed out that as far as reading the OTC marked otoliths, there are some problems with otoliths autofluorescing. This could lead to misreading the OTC mark. Ms. MacLellan concurred and described studies where some people believed OTC did not lay down marks on salmon scales. To verify this, Ms. MacLellan was asked to identify the OTC mark on a mixture of tagged and untagged (control) salmon otoliths, fins and scales. She was able to discern the OTC mark on scales with difficulty, but it was possible if one knew what kind of mark to look for. It is important that experienced people be involved with OTC mark studies.

The next agenda item was the selection of a new chairperson and vice-chairperson. The next TSC meeting will be in California so it was suggested that one of the newly elected persons be from California. It was also suggested that the other elected person be from Washington. CARE meetings were traditionally held in Seattle because of its central location on the West Coast and is the site of 3 member agencies, AFSC, WDF, IPHC. A person from Washington could facilitate the preparation for the next meeting. Mr. Kastelle

called for volunteers. Mr. Butler and Mr. Blood volunteered. Others wanted to think about it so Mr. Kastelle suspended further discussion on this matter until Thursday or Friday.

Pete Hagen (ADFG) asked if anyone has ever addressed validation work studying the El Nino influence on growth increment. Ms. MacLellan said she had done some literature research and otolith studies on this question with Mark Saunders (DFO) on hake. Ms. Goetz confirmed the presence of a natural mark in the 1977 hake year-class. In addition, she noted that since a strong year-class of 3- to 4-year-olds (in 1991) is coming into the fishery, it will be interesting to observe possible impacts of the current strong El Nino event on growth patterns of these fish. Ms MacLellan added that she sees a growing interest in documenting otolith and scale growth patterns leading to the use of digitizing and computerized image analysis equipment. She pointed out the usefulness of these image analysis systems in storing the data.

This evolved into a technical discussion on the usefulness of these computer systems and the variety of hardware and software packages now available. Many fisheries agencies along the West Coast already had these systems on line or will be getting them in the near future. Mr. Butler felt that we hear so much talk about these systems, but few fully understand the extent of their usefulness or understand the differences between them. He proposed CARE set up a special study of these systems. He was concerned that some people not familiar with ageing methods think that these machines could replace humans in production ageing. Mr. Kastelle suggested that these systems are useful as a data gathering tool, but will always require a skilled age reader to oversee any attempt at "ageing".

Mr. Kastelle directed attention to last year's TSC recommendations for CARE, reading from page 113 of the 1991 TSC minutes. In summary TSC encouraged CARE to solicit participation from the SWFC La Jolla lab. This resulted in John Butler's participation at this meeting. TSC recommended more hands-on and regional workshops. It encouraged more communication between agencies on validation work and looking into biostatistical methods, Pb-210/Ra-226 studies and lipofuscin. Mr. Butler enlightened everyone on the definition of lipofuscin. These are spots that develop on the body as a result of growing old. This happens to humans as well as fish. There was a study which suggested an ageing method for euphausids by measuring their lipid spots. Some people thought the same could be done for fish, but subsequent studies showed inconclusive results.

A break was called at 3:20 p.m.

The afternoon session was reconvened about 3:40 p.m. The discussion returned to the ageing manual. Ms. MacLellan had photos spread out on the table and encouraged everyone to review them

because xerox copies would not replicate the quality of the photos. These photos were selected to illustrate the points outlined in the draft of the ageing manual. Again she asked for group input on the manual such as suggestions on which direction the group wished to pursue as far as the final form of the manual, what kind of publication to gear toward, at what quantities, and quality of photo reproductions.

The first conference day was called to conclusion at 4:20 p.m.

Thursday, May 28, 1992

V. PRESENTATIONS

The second day of the conference was called to order by Mr. Kastelle at 8:20 a.m. The morning was scheduled for presentations.

The first presentation was by John Mello on the results of an age validation study on chilipepper rockfish. The study is summarized in a paper titled Validation of Otolith Annuli for Use in Age Determination of Chilipepper Sebastes goodei. This study involved monthly collections of chilipepper otoliths in 1987. All the otoliths were pooled together and a reader recorded the outer edge growth as either opaque, translucent, or unknown for each otolith. To avoid biasing the reader, he was not given any information on the fish or the month caught. The data resulted in a histogram (Fig.1) showing the frequency of occurence of opaque edges (rapid growth period) are over 50% from May through December.

Fig.1

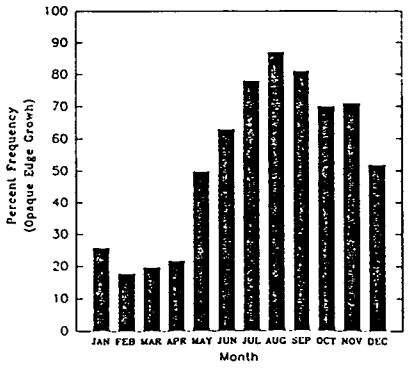

Figure 1. Frequency of opaque edges (rapid growth period) for broken and burnt chilipepper rockfish otoliths by month for the year 1987. A sample size of 100 fish per month was used except for February where only 80 fish were available.

The study suggested the seasonality of opaque and translucent zone formation for chilipepper rockfish and that they are deposited once a year. Mr. Mello believed he could identify the 82-83 El Nino effect on the otolith pattern which produced a distinctively darker annulus. The following year's growth increment also appeared wider. An apparent effect of El Nino in the fishery seemed to indicate fewer new fish in 1983 and a year class increase in 1984.

The second speaker was Joan Forsberg from the IPHC. Her study is summarized in a paper titled Estimating Sex of Pacific Halibut (Hippoglossus stenolepis) Using Fourier Shape Analysis being reviewed for publication. The study was attempted because otoliths sampled from the commercial fisheries arrived at the IPHC labs without sex information. Fish sex information is needed for proper stock management. Age readers given otoliths with sex information observed some differences between female and male otoliths of the same age-class. There were size and weight differences where the females were generally bigger than the males. The shape of the male otolith tended to be thicker and more elongated while the female shape was broader towards the posterior lobe. Also in older males, the annuli tended to be more closely spaced toward the edge.

Simple visual examination of otoliths to predict sex was inadequate for use in current stock models, but gave promising results. The researchers hoped that better classification rates could be achieved using a mathematical technique which could pick up differences too subtle for the human eye to detect. The technique used was Fourier shape analysis; a method that converts a shape outline (computer-digitized otolith outlines in this case) into a series of coefficients that can be compared numerically. For this preliminary study, a single age group (11-year-olds) of halibut otoliths were used. One hundred forty four left side sagittal otoliths (74 male, 70 female) were digitized and the data was divided into "training" and "test" sets for linear discriminant function analysis. The training set used the shape information from all the otoliths of the 2 sexes and generated 2 discriminant functions; one for each sex. The test data set used the discriminant functions to classify by sex. Successful classification rates ranged between 79% to 91% for the training set and 63% to 65% for the test set.

When otolith weights were incorporated into the analysis, successful classification rates range increased to 82% -87% for the training sets and 71% - 73% for the test sets. From these results, it was concluded that otolith shape alone was not a reliable enough indicator to predict sex in the Pacific halibut.

The third speaker was Craig Kastelle who presented a radioisotope age validation study on sablefish which was part of the work required for his masters thesis. It is summarized in a paper titled Using Pb-210/Ra-226 Disequilibrium for Sablefish (Anoplopoma fimbria) Age Validation in review for publication. This study was based on the fact that when fish take in calcium for bone growth, radium accompanies calcium in the process. This is because radium is a calcium analog which is naturally occurring in seawater. Three assumptions in this study were that radium: (1) is selectively incorporated in the bone; (2) locked in a closed-system structure along with its daughter products and; (3) its input rate is constant in the parts of the bone analyzed.

Mr. Kastelle began his discussion with a brief summary of the decay chain from Ra-226 to Pb-210. The ratio of Pb/Ra is a function of time and is known. Therefore, it is possible to use the Pb:Ra ratio measured in the otolith core (the section of the otolith found inside the first year annulus) with the known function to estimate the age of the fish. This study involved measuring levels of the isotopes Ra-226 and Pb-210 in the core of fish otoliths. To do this, Mr. Kastelle needed a minimum of one gram of otolith material. To obtain this much material with the samples he had available, he pooled the otoliths into 4 age groups. The first group consisted of all 1-year-olds, the second group consisted of 9- to 11-year-olds, the third group consisted of 14- to 23-years-old, and the fourth group consisted of fish 24- to 34-years-old. Fish in the first and second group were aged by only one reader but fish from groups 3 and 4 were aged by 3 experienced age readers and an average age per reader was taken. The results were summarized in Fig.2.

Mr. Kastelle said he used the ratio of Pb-210:Ra-226 because this was appropriate for the lifespan of sablefish. Other isotope pair ratios may be more appropriate for other species, especially the shorter-lived fish.

A break was called at 10:35 a.m.

Fig.2

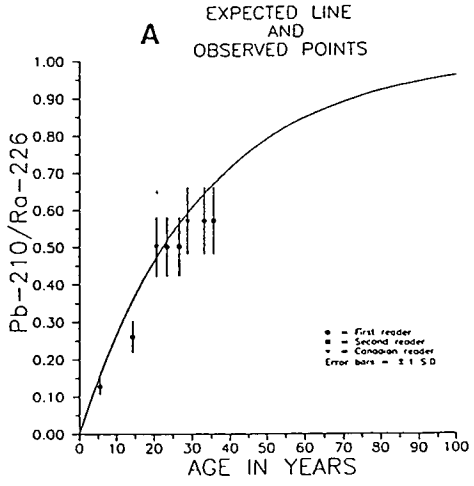

Fig. 2.9A. Expected Pb-210/RA-226 curve and observed points for Pb-210/individual Ra-226. The observed points were adjusted by 4.5 years, the time between collection and analysis.

The next speaker was John Butler who presented results from an Age Determination of Shortspine Thornyhead, Sebastolobus alascanus, Using Otolith Sections and 210Pb:226Ra Ratios. His results will be written up into a paper upon his return to La Jolla. Mr. Butler

began this study because of growing commercial importance of the thornyheads in California. To manage the fisheries properly, users needed to know how old these fish get. Mr. Butler was assigned the task of finding this out.

Mr. Butler started his ageing experience by looking at various fish structures including opercles and scales but decided to use the otoliths. He began by counting all the reasonable bands. This resulted in ages up to 150-years-old. Then he went back, using the same otoliths, and decided to do more banding. This resulted in another set of data ranging in ages up to around 80 years. To validate his ages he did a radioisotope study with the otoliths. The resulting ages (Fig.3) appeared to indicate the second criteria (leaning toward younger ages) may be more appropriate to ageing this species. However, he believed these to be preliminary results and needs more work especially in the study of radium and the use of ratios.

In addition to his results, Mr. Butler briefly talked about another radioisotope age validation study on Sebastes rufus (Fig.4). This work is being done at the Moss Landing lab by a graduate student as part of her masters thesis.

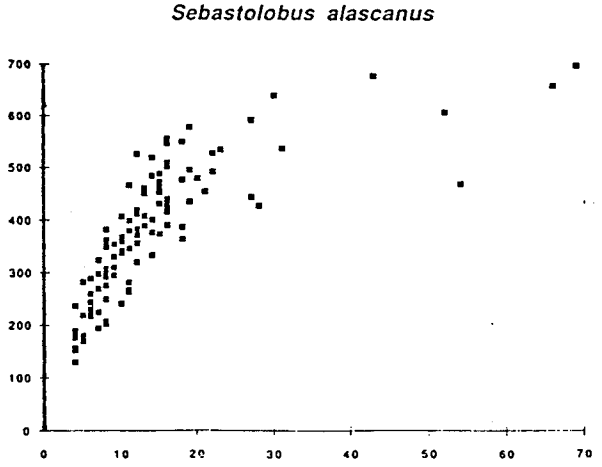

Fig.3

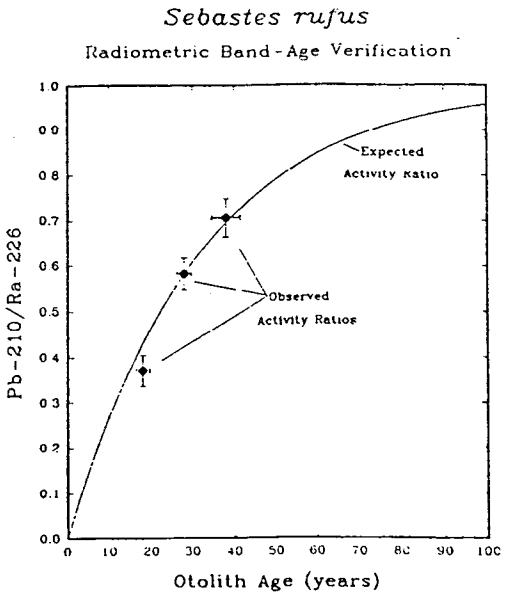

Fig.4

Results such as these led Mr. Butler to believe in the usefulness of radiochemistry for age verification. He would like to see NMFS support such a lab. He reiterated the importance of having a lab solely for fish age validation to minimize contamination from unwanted isotopes. He pointed out another advantage to one central lab is by having methods and equipment standardized for all

agencies.

The final presentation was from Larry Quirollo on the Dover sole ageing workshop between CDFG and ODFG. Mr. Quirollo regretfully mentioned that his talked required slides which the Oregon group was supposed to bring. Since they could not attend, he passed out copies of a memo to himself from Bob Mikus (ODFG) summarizing the meeting (Appendix VI). The subject title of the memo was Report on CDFG/ODFW Dover Sole Aging Workshop 04-14-92 through 04-16-92.

VI. IMAGE (VIDEO) STORAGE SYSTEMS

After the presentations concluded, discussion began on the use of cameras and video recorders for storing images. Mr. Kastelle asked each agency what equipment they used. Ms. Munk (ADFG) said they have a video printer for printing images. DFO uses a simple set-up with a 35mm camera mounted on a photo tube over a microscope. ODFG was thought to have a computerized system with a high resolution camera mounted on a photo tube. No one recalled the name of the system. AFSC ageing lab uses a computerized Wild Photoautomat with a 35mm camera on a photo tube. The AFSC larval fish group has a high resolution video camera and recorder.

This was followed by discussions on the more sophisticated, computerized image analysis systems. Mr. Butler pointed out there is a choice between IBM and MacIntosh hardwares. Multiple kinds of software are available for each of the two types of hardware. He happened to be using McIntosh mainly because the software is available and free. He suggested that CARE evaluate the utility, resolution, and the ease of communicating between agencies using different systems.

VII. AGE VALIDATION AND OTHER SPECIAL PROJECTS

Ms. Goetz introduced the topic of current and future age validation projects. Julie Pearce began by outlining a project, in the beginning stages, involving the AFSC rockfish working group and the age lab. The project is devoted to age validation of rockfish species. The rockfish working group have collected scales, fin rays, otoliths and opercles from 79 specimens of shortspine thornyheads with an average length of 23 cm. Ms. Pearce asked for group suggestions that may be incorporated into their strategy. Mr. Butler suggested they weigh the otoliths. He pointed out that for the California and Oregon samples, they found it sometimes difficult to separate the shortspine and longspine thornyheads just by physically examining the fish. However, they found that there exists a distinct difference in the otolith weight to fish length relationship between the species. He didn't know how far north the longspine thornyhead species extends up the coast and he cautioned

that this relationship for the Alaskan stocks should first be verified.

Ms. Goetz added it is their intention to compare scales against the otoliths of the shortspine thornyhead to try to interpret the pattern in the younger years.

Ms. Goetz discussed another study the AFSC age lab would like to pursue involving the verification of some 0- to 1-year-old pollock. A problem occurred when readers aged a certain group of fish 0 taking into consideration the time of year and no visible annulus. Some users complained because the reported length of the fish indicated to them that these fish should be 1-year-olds. To verify the age, Ms. Goetz planned to do a daily growth study with the help of the larval fish group who is experienced in doing daily increment ageing. Using an eyepiece micrometer, AFSC is currently measuring the size of the first year on clear otolith surfaces of fish aged 2 which were collected the following year. These measurements will help identify the size range of 0- to 1-year-old pollock otoliths.

Ms. MacLellan said that from what pollock she had seen, there had been a variety of sizes of first year growth. Ms. Goetz commented that sometimes it is difficult to convince users of this. She further added that data exists documenting a very wide range of spawning dates (up to as late as September/October) in the Bering Sea.

Mr. Kastelle spoke of the upcoming study at AFSC documenting marginal increments on the juvenile sablefish collected by the Auke Bay lab mentioned earlier in the meeting. There is also a radioisotope study planned for the various rockfish species.

Kent Scott (AFSC) outlined a study investigating alternate ageing methods for rex sole. The otolith break-and-burn is difficult to interpret due to faint annuli formation so he is exploring other methods of preparing the otoliths to define the annuli more clearly. One method involved the use of EDTA to etch out the opaque zones thereby highlighting the transluscent zones. Other possibilities include looking at thin sections and various dye treatments.

Delsa Anderl (AFSC) discussed a validation study on atka mackerel. There is currently an ageing practice which users would like verified involving the deposition of the first clear annulus on the otolith. It was documented in old Russian literature that atka mackerel are late spawners, leading to the belief that young fish do not lay down an annulus during their first winter. AFSC age readers report to the users ages that only account for the number of annuli they see on the otolith. The users, for their stock assessment calculations, add a year to the reported ages to account for the late spawning. The first attempt at verification had been

to prepare otolith thin sections from supposed 1-year-old fish to count daily growth increments up to the first annulus using a compound microscope. If necessary, using the SEM was planned.

In the spirit of inter-agency assistance, Mr. Butler said that he currently has a technician preparing Dover sole otoliths for the SEM. He did not foresee a problem of adding in an atka mackerel otolith. Ms. Anderl said she appreciated the offer and would surely take him up on it.

Julie Lyons mentioned that users are wanting age data from arrowtooth flounder but this is a difficult species to age using the otoliths. So, the age unit is looking into other structures for ageing.

Kristen Munk mentioned two studies she would like to pursue in the future. One study is to correlate environmental variables such as El Nino cycles or sea surface temperatures to the strong patterns evident in some Southeast Alaska Yelloweye (S. ruberrimus) stocks. Another study is to look at possible stock separation using these patterns. This idea evolved from a recent observation of markedly different patterns between 2 separate otolith batches. She later discovered there had been a break in the time between sampling of the two batches corresponding to two very different areas. Digitizing the patterns (using image-processing software) and microprobe analysis of the Sr:Ca ratio may be used to evaluate patterns in both studies.

This brought the discussion back to the various hardware and software set-ups in image analysis equipment and the potential problems of transmitting images for exchange work between agencies using different systems. The group felt that perhaps a standard imaging system should be investigated and it was reiterated that this be a recommendation to TSC.

The morning session was adjourned for lunch at 12:05 p.m.

VIII. HANDS-ON SESSION

The afternoon session began at 1:45. Microscopes were available and the afternoon was devoted to hands-on work. The following list of species were available for viewing and ageing techniques were discussed between agency members.

1. Dover sole - provided by CDFG
2. Rougheye rockfish - provided by AFSC
3. Sablefish - provided by AFSC
4. Jack mackerel - provided by SWFC
5. SS Thornyheads - provided by SWFC and AFSC
6. LS Thornyheads - provided by SWFC
7. Chilipepper rockfish -provided by CDFG

8. Ling cod - provided by ADFG
9. Pollock - Polish samples aged by Poland, DFO, AFSC

Prior to the conference, AFSC compiled 22 sablefish otoliths from a batch (currently being aged) collected along the Aleutian Islands. In this batch were some otoliths with patterns common to this collection but uncommon to otoliths seen from other areas. They tended to be more difficult to interpret. These otoliths were exchanged between 4 different agencies (AFSC, SWFC, ADFG and DFO) and aged by 5 experienced readers. Resolution of the discrepancies between the age readers present at this conference took place at this time.

Kristen Munk received a request from ADF&G Groundfish Management to age lingcod. She will compare ageing potentials between lingcod otoliths and fin spines to decide which is the better structure for these northern stocks. Prior to this conference a preliminary evaluation of three Alaska stock lingcod otoliths indicated that these may be reliable structures to age.

John Butler presented a collection of shortspine thornyhead otoliths prepared into thin sections. He had never seen break-and-burn otoliths from this species before. AFSC had some stored from previous ageing attempts and showed them to John for comparison. With the break-and-burns he was able to identify the patterns he used in ageing with thin sections. Because it is simpler and faster, John was considering using the break-and-burn as a future ageing method.

With the chilipepper rockfish otoliths John Mello showed members how he had analyzed for edge growth and also pointed out the annuli which he believed were affected by the 82-83 El Nino.

The members began dispersing around 5:00 p.m.

Friday, May 29, 1992

Everyone was present around 8:15 and informal, small group discussions were occurring. Mr. Kastelle produced a draft form of the four recommendations so far discussed at this conference to be sent to TSC. He asked it be passed around to the different members for comments and revisions. Hands-on microscope work also took place with the fore-mentioned samples.

Mr. Kastelle called the meeting to order at 9:50 a.m.

IX. APPROVAL OF NEW CHAIRPERSON AND VICE-CHAIRPERSON

Mr. Kastelle announced that John Butler volunteered to chair

the next CARE meeting and Betty Goetz volunteered to vice-chair. This was approved by the group.

X. CARE RECOMMENDATIONS TO TSC

Mr. Kastelle directed attention to the list of recommendations which had various comments added to it. With group input, he made further revisions. A summary of the recommendations is in Appendix VII.

The group approved a recommendation that CARE hold a meeting in the spring of 1993 solely for comparing the different image analysis systems (hardware and software) currently available.

Ms. MacLellan suggested that we as age readers should have more interaction on a regular basis, or as needed, to maintain inter-agency calibration. We needed more sharing of ideas especially among the key species. Someone suggested that this be a recommendation of CARE to itself.

XI. FINAL COMMENTS

Mr. Blood suggested that CARE consider meeting annually as opposed to the current schedule of meeting every two years. He found these three days highly informative and worthwhile. He felt members might benefit more from annual meetings. Some members indicated agreement. Dr. Kimura reserved the right to think about it. His concern was the time required to prepare for these meetings. It can cut into production schedules.

Mr. Butler asked about funding sources for travel to these meetings. Mr. Kastelle answered that PSMFC does allow funds for one member of each agency, except DFO, to attend.

Wrapping up discussions on the ageing manual, Mr. Kastelle called for volunteers to represent their agencies in finishing the document within the next few months. Ms. MacLellan had already been appointed editor. Volunteers included: Betty Goetz (AFSC), Larry Quirollo (CDFG), Cal Blood (IPHC), Kristen Munk (ADFG), and John Butler (SWFC). Ms. Goetz mentioned that Bill Barss, who was not present, might want to participate as he was involved with the manual since the first CARE meeting. Mr. Quirollo said he would talk to Mr. Barss about it when he meets him in June.

The 1992 CARE conference was called to officially close at 11:00 a.m.

APPENDIX I

PARTICIPANTS IN THE 1992 C.A.R.E. CONFERENCE
SEATTLE, WASHINGTON
MAY 27-29, 1992

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Delsa Anderl	(206)526-4218
Shelly R. Jay	(206)526-4219
Chris Johnston	(206)526-4267
Jill McKay	(206)526-4267
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Dean Melton	(206)526-4266
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APPENDIX II

PROPOSED AGENDA

CARE MEETING

A Working group of the TSC

April 29 to May 1 or May 27 to May 29, 1992

Day One

9:00 am	Opening remarks
	Introductions
	Approval of Proposed Agenda
	Old business:
	-Update of ageing manual
	-Update list of species read by each agency
	-Other old business
11:00 am	New business:
	Discussion on establishing a systematic program for investigation of otolith edge formation, ie. validation of seasonality of growth.
12:00	Lunch
1:30 pm	New business:
	-Continuation of edge formation and validation.
	-OTC use and application
	-Selection of new Chairperson and Vice Chairperson
5:00 pm	Break for the day
6:00 pm	Possible banquet or potluck dinner ??????

Day Two

8:00 am	Presentations
12:00	Lunch
1:30 pm	Hands on work with microscopes or photographs
5:00 pm	Break for the day

Day Three

8:00 am	Continuation of hands on work
10:00 am	Summarization of meeting/suggestions etc. etc.
12:00	Adjourn meetings

APPENDIX III

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Alaska Fisheries Science Center
Resource Assessment and Conservation Engineering Division
7600 Sand Point Way Northeast
BIN C15700, Building 4
Seattle, Washington 98115-0070

May 20, 1992 F/AKC1:MEW

MEMORANDUM FOR: F/AKC2 - Craig Kastelle, CARE chairman

FROM: F/AKC1 - Mark Wilkins, TSC chairman

SUBJECT: Recommendations to the CARE from the TSC

As you are aware, the Technical Subcommittee (TSC) of the Canada-U.S. Groundfish Committee met here at the AFSC May 5-7. At this meeting, several discussions revolved around the activities of the CARE and other related issues. I wanted to inform you of these discussions so that you would be able to pass the substance of them to the participants of the CARE workshop at the end of this month.

One recommendation from the TSC involving guidance to and asking for action by the CARE was discussed and approved. The full text of that recommendation follows:

> "RECOMMENDATION FROM THE TSC TO ITSELF:
> RECOMMENDATION TO CARE REGARDING AGE VALIDATION OF ROCKFISH AND THORNYHEADS - 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."

To the extent possible, the TSC would like the researchers involved with the CARE to consider this request and pass the concerns on to those in their respective agencies who direct age validation research. If the TSC can be of assistance to the researchers by directing letters to their agencies or encouraging their pursuits in this matter, please call on me. I would be glad to help out.

Two other recommendations were approved that involve age determination and validation. Neither of these is directed at

the CARE, but I would like to inform your group of them. The TSC recommended to their parent committee (the Canada-U.S. Groundfish Committee) that they encourage NMFS to seek a Memorandum of Understanding with the U.S. Food and Drug Administration regarding approval to conduct fish age validation research through injection of oxytetracycline. The CARE may be called upon to provide information to facilitate this endeavor. The text of the recommendation follows:

> "TSC RECOMMENDATION TO THE PARENT COMMITTEE ON FDA APPROVAL OF OTC EXPERIMENTS - 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."

The final discussion about which the CARE should be informed centered around age determination plans that had been in the works for this year. At the 1991 TSC meeting, a recommendation was approved calling for an ambitious age validation research project on West Coast flatfish species. This work was to be initiated on the planned 1992 NMFS nearshore flatfish survey and would have included Dover sole, English sole, petrale sole, and arrowtooth flounder. Participation was encouraged from all interested agencies to plan and coordinate this research. The survey was, unfortunately, cancelled. At this year's meeting, the following recommendation was approved and will be communicated directly to representatives of the appropriate agencies:

> "TSC TO ITSELF - AGE VALIDATION OF DOVER SOLE AND ARROWTOOTH FLOUNDER - 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 cancelled.
>
> 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 U.S. research vessels, chartered vessels, or ride-alongs [on commercial vessels]. The slope work off the WOC [Washington, Oregon, California] area may offer the best solutions for tagging. Ride-alongs are the least preferred because tow length is not controlled."

I appreciate your help with informing the CARE workshop participants about these matters and I hope that you will seriously consider action on the thornyhead/rockfish age validation recommendation.

JOSEPH R. BLUM
Director

APPENDIX IV

STATE OF WASHINGTON
DEPARTMENT OF FISHERIES
Building 4 Room 2129
7600 Sand Point Way N.E. • Bin C15700 • Seattle, Washington 98115 • (206) 545-6573

July 27, 1990

To: West Coast Fish Aging Unit Heads and Supervisors

From: Tom Jagielo
Chairman, Technical Subcommittee of the Canada/US Groundfish Committee

The Committee of Age Reading Experts (CARE) submitted a working group report to the Technical Subcommittee (TSC) at the June annual meeting. A number of recommendations were put forth which were endorsed by the TSC:

1. All agencies should institute a well documented and regular systematic precision testing program. Work time must be made available to fish agers to do this, and it should become part of the routine aging procedure.

2. It is recommended that each agency institute a formal, documented training program which includes personnel instruction with designated goals and precision testing. It is crucial that fish agers be given the time, instruction, encouragement and assessment necessary to learn to provide age determinations with confidence.

3. Each agency should undertake to establish and document "expected" times of growth and non-growth for each stock and life history stage of species aged. This will provide fish agers with a time frame for interpreting edge growth deposition that will enable them to more accurately assign an age class.

4. It is recommended that a single age designation system be adopted to avoid confusion during future exchanges and cooperative work.

It is our hope that each agency will consider these issues in the interests of improving standardization and accuracy of aging information coastwide. The TSC looks forward to hearing of positive changes resulting from the implementation of the above recommendations from CARE.

APPENDIX V

Summary of Age Reading Methodology as updated by the CARE Conference, May 27-29, 1991

Key: GOA=Gulf of Alaska; BS=Bering Sea; BC=British Columbia; SEA=Southeast Alaska; WC=West Coast; P=Past; C=Current; F=Future

Species	Stock (Area)	Structures	Method	Validation	Status	Agency
ROCKFISH (Sebastes)						
S. aleutianus (rougheye)	BC	otolith	b&b	none	C	DFO
	SE Alaska	otolith	b&b	none	C	ADFG
	SE Alaska	otolith	b&b	radiomet (planned)	C	AFSC
S. alutus (P.O.P)	2B,2C,3A	otolith	b&b	none	P	ODFW
	BC	otolith	b&b	none	C	DFO
	Kodiak, BS	otolith	b&b	none	P	ADFG
	GOA,SEA,WC	otolith	b&b	radiomet (planned)	C	AFSC
	WC	otolith	surface	none	P	WDF
S. borealis (shortraker)	BC	otolith	b&b	none	P	DFO
	SE Alaska	otolith	b&b	none	C	AFSC
	Alaska	otolith	b&b	none	C	ADFG
S. brevispinis (silvergray)	BC	otolith	b&b	none	C	DFO
	SEA	otolith	b&b	none	C	ADFG
S. caurinus (copper)	BC	otolith	b&b	none	C	DFO
	WC	otolith	b&b	none	C	WDF

Species	Stock (Area)	Structures	Method	Validation	Status	Agency
S. ciliatus	GOA	otolith	b&b	none	C	AFSC
(dusky)	Alaska	otolith	b&b	none	C	ADFG
S. emphaeus	BC	otolith	b&b	none	C	DFO
(Puget Sound)						
S. entomelas	WC	otolith	surface	none	C	WDF
(widow)	Ore, Calif	otolith	mixed	none	C	NMFS Tiburon
	BC	otolith	b&b	none	P	DFO
S. flavidus	BC	otolith	b&b	partial OTC	C	DFO
(yellowtail)	WC	otolith	b&b	none	C	WDF
	Monterey	otolith	b&b	none	C	NMFS Tiburon S.
S. goodei	Calif.	otolith	b&b	edge type	C	CDFG
(chilipepper)						
S. maliger	BC	otolith	b&b	none	C	DFO
(quillback)	SEA	otolith	b&b	none	C	ADFG
	WC	otolith	b&b	none	C	WDF
S. melanops	2C	otolith	b&b	none	C	ODFW
(black)	Kodiak, SEA	otolith	b&b	none	C	ADFG
	WC	otolith	b&b	OTC(?)	P	DFO
	WC	otolith	b&b	partial OTC	C	WDF
S. paucispinis	Calif.	otolith	b&b	none	F	CDG
(bocaccio)	Calif.	otolith	b&b	none	P	NMFS Tiburon
	BC	otolith	b&b	none	P	DFO

Species	Stock (Area)	Structures	Method	Validation	Status	Agency
S. pinniger	Columbia	otolith	thin sect	Pb/Ra	P	OSU
(canary)	Col, Vancouver	otolith	b&b	none	C	ODFW
	BC	otolith	b&b	none	C	DFO
	Alaska	otolith	b&b	none	C	ADFG
S. polyspinis	GOA, BS	otolith	b&b	none	C	AFSC
(northern)	GOA, BS	otolith	b&b	none	C	ADFG
S. proriger	BC	otolith	b&b	none	C	DFO
S. reedi	BC	otolith	b&b	none	C	DFO
S. ruberrimus	2C	otolith	b&b	none	C	ODFW
(yelloweye)	SEA	otolith	b&b	none	C	ADFG
	BC	otolith	b&b	none	C	DFO
S. rufus	Calif	otolith	b&b & thin sect	Pb/Ra	C	CDFG
(bank)						
S. wilsoni	BC	otolith	b&b	none	C	DFO
(Wilson's)						
ROCKFISH (Sebastolobus)						
S. alascanus	BS,GOA,WC	otolith?	under review	being planned	C	AFSC
(shortspine	Calif	otolith	?	none	F	CDFG
thornyhead)	Alaska	otolith	b&b	none	C	ADFG
	Columbia	otolith	b&b	none	F	ODFW
	Calif & Columbia	otolith	thin sect	Pb/Ra in prog.	C	SWFC

Species	Stock (Area)	Structures	Method	Validation	Status	Agency
S. altivelis	Monterey	otolith	b&b	Pb/Ra	C	Moss Landing
(longspine	Calif	otolith	thin sect	none	C	SWFC
thnoryhead)						
FLATFISH						
A. stomias	WC	otolith	surface	none	C	WDF
(arrowtooth)	GOA,BS	otolith	?	none	F	AFSC
E. jordani	Calif	otolith	surface	none	C	CDFG
(petrale sole)	All Columbia	otolith	b&b	none	C	ODFW/OSU
	WC	otolith	surface	none	P	WDF
G. zachirus	Alaska	otolith	mixed	none	C	AFSC
(rex sole)						
H. elassodon	Kodiak	otolith	b&b	none	P	ADFG
(flathead sole)	GOA,BS	otolith	mixed	none	C	AFSC
	Columbia	otolith	surface	none	P	ODFW
H. stenolepis	Ca-BS	otolith	surface	completed OTC	C	IPHC
(Pacific halibut)	Alaska	otolith	surface	none	C	ADFG sport sp
L. aspera	BS,GOA	otolith	mixed	none	C	AFSC
(yellowfin sole)						
L. bilineata	BC	otolith	b&b	partial OTC	C	DFO
(rock sole)	Kodiak	otolith	b&b	none	P	ADFG
	GOA,BS	otolith	mixed	none	C	AFSC

Species	Stock (Area)	Structures	Method	Validation	Status	Agency
M. pacificus (Dover sole)	BC	otolith	b&b	none	C	DFO
	2A-3C	otolith	b&b	future OTC?	C	ODFW
	Columbia	otolith	thin sect	future OTC?	C	OSU
	Calif	otolith	b&b	future OTC?	C	CDFG
	Calif	otolith	thin sect	future OTC?	P	SWFC
P. californicus (Calif halibut)	Calif	otolith	b&b	partial?	C	CDFG
P. quadritubercullatus (Alaska plaice)	BS	otolith	b&b	none	C	AFSC
P. vetulus (English sole)	2B,3A	interopercle	surface	none	C	ODFW
	BC	otolith	b&b	completed (OTC)	C	DFO
	WC	interopercle	surface	none	C	WDF
	Calif	interopercle	surface	none	C	CDFG
R. hippoglossoides (Greenland turbot)	BS	otolith	b&b?	none	F	AFSC
ROUNDFISH						
A. fimbria (sablefish)	2B,2C,3A	otolith	b&b	none	P	ODFW
	GOA,BS,SEA	otolith	b&b	none	C	ADFG
	BC	otolith	b&b	OTC/tag	C	DFO
	GOA,BS,SEA,WC	otolith	mixed	OTC, marg incre Pb/Ra	C	AFSC
	WC	otolith	b&b	OTC	C	NMFS Tiburon

Species	Stock (Area)	Structures	Method	Validation	Status	Agency
G. macrocephalus (Pacific cod)	Kodiak, BS	otolith	b&b	none	P	ADFG
	BS,GOA	oto&scales	b&b	none	C	AFSC
	BC	fin ray	X-sect	none	P	DFO
M. productus (Pacific whiting)	BC	otolith	b&b	in progress	C	DFO
	WC	otolith	mixed	none	C	AFSC
	Puget Sound	otolith	mixed	none	C	WDF
	WC	otolith	mixed	none	F	CDFG
O. elongatus (lingcod)	WC	fin ray	surf/X-sect	none	C	WDF
	BC	fin ray	x-sect	OTC	C	DFO
	Calif	fin ray	X-sect	none	C	NMFS Tiburon
	SEAlaska	fin ray/ oto	b&b/X-sect	none	F	ADFG
P. monopterygius (Atka mackerel)	BS,GOA	otolith	mixed	1st-2nd years (in progress)	C	AFSC
Squalus spp.	BC	spine	surface	partial OTC	C	DFO
T. chalcogramma (walleye pollock)	BC	fin ray	X-sect	none	C	DFO
	WC	otolith	mixed	none	C	WDF
	BS,GOA,SEA	otolith	mixed	none	C	AFSC
	Kodiak	otolith	mixed	none	P	ADFG

Other species mentioned: black rockcod, cowcod, china rockfish, redbanded rockfish, splitnose rockfish, redstripe rockfish, shortraker rockfish, sharpshin rockfish, cabezon, smelt, Pacific grenadier, orange roughy

Non-groundfish species mentioned: herring, salmon, sturgeon, jack mackerel

High seas species mentioned: albacore, yellow tail, pomfret, neon-flying squid

Miscellaneous shellfish: geoduck, abalone, urchin

APPENDIX VI

Date: 04-27-92

To: Larry Quirollo

From: Bob Mikus

Subject: Report on CDFG/ODFW Dover Sole Aging Workshop 04-14-92 through 04-16-92.
Participating: Larry Quirollo CDFG, Brenda Erwin CDFG, Bob Demory ODFW, Bob Mikus ODFW

The theme stressed at the workshop was PRECISION OVER ACCURACY.

The meeting started off at approximately 1:00 pm at the Eureka, CA offices CDF&G. Larry Quirollo was absent for the first afternoon, attending another meeting.

A sample of 25 fish (sample #9007, provided by CDF&G) was divided between Brenda and the two Bobs. Each person broke and burned their portion, then aged the entire sample. The next morning Larry aged the entire sample, and the ages were compared (see attachments).

The rest of the workshop was spent trying to resolve differences. There were two major/consistent areas in which these occurred:

a) Determining the first annulus-

The 1st annulus is often difficult to see due to multi-directional growth layering. Measurments of scales and otoliths by L. Quirollo show that the 1st annulus is almost always hidden by the time the fish reach 140mm in length. Photos were taken of scales and otoliths from juvenile fish to show the location of the first annulus relative to the nucleus, so that on older fish, where it might not show, the age reader can more readily accept its presence.

b) Determination of an annulus on the margin-

Deciding whether or not to call an annulus on the margin is what makes age reading a black art and not a science. Three things appeared to enter into this decision; Date of capture in relation to the chosen birthdate, the overall look of the otolith (patterns, amount of organic layering in previous annuli, etc...), and general experience. The latter two items were lumped into the term "gestalt/gut feeling", and the more experienced readers felt that this would only come with time and extensive reading.

The standard discussion of whether to 'split' or 'lump' occured over and over. No hard and fast rules are possible, of course, and since precision is being stressed over accuracy, comparison readings within and between agencies should take place as frequently as possible. Photos were taken of some problem otoliths in this area, and copies will be sent around for viewing.

Our new photomicroscopic equipment was viewed with an appropriate amount of envy, and the few slides ready at the

time of the workshop showed that this equipment has the potential to be a great help in training age readers, as well as re-training and calibration. The slides projected on a wall showed a great improvement over 3-4 people hovering over a single microscope trying to verbalize what they were seeing without the ability to point to it. An attempt will be made to photograph a whole sample by the May CARE meeting.

AGE READING WORKSHOP
CDFG/ODFW
04-14-92 through 04-16-92
PARTICIPATING: Brenda Erwin CDFG, Larry Quirollo CDFG,
Bob Demory ODFW, Bob Mikus ODFW

#	B Demory age	B Mikus age	L Quirollo age	B Erwin age	Resolved age
1	9	7	7	7	8
2	12	[illegible]	10	[illegible]	[illegible]
3	22	22	22	19	22
4	11	8	10	[illegible]	[illegible]
5	7	[illegible]	[illegible]	[illegible]	[illegible]
6	14	[illegible]	[illegible]	[illegible]	[illegible]
7	10	[illegible]	[illegible]	[illegible]	[illegible]
8	13	[illegible]	[illegible]	[illegible]	[illegible]
9	8	8	[illegible]	7	[illegible]
10	17	18	11	9	11
11	9	9	7	6	6
12	13	13	10	11	11
13	10	10	8	6	10
14	24	24	28	18	25
15	9	9	9	6	9
16	8	8	7	7	8
17	9	9	7	7	8
18	22	23	21	18	24
19	9	8	9	8	9
20	12	12	9	6	11
21	17	17	18	13	17
22	13	13	13	11	13
23	24	22	24	8	23
24	9	9	6	5	8
25	12	11	10	8	10
mean=	12.92	12.64	12.36	9.36	12.52

The ages shown for each reader are those chosen by each reader before comparison between readers. These do not reflect the range of ages each reader had before settling on their final ages, so I have included copies of all the ages recorded. Many of the discrepancies that are within 3 years of each other are covered by the spread of ages recorded by each reader. This indicates that our techniques are on a convergent course.

Many of the larger discrepancies were found to be tied up in "today I lump" or "today I split", and these type of problems will hopefully be solved as the agers gain experience.

Thanks to all who participated!

APPENDIX VII

CARE RECOMMENDATIONS

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 Ageing Manual" including high quality photos, and quality reproduction of other graphics.

APPENDIX D - WORKING GROUP REPORT - YELLOWTAIL ROCKFISH

Working Group Report on the Yellowtail Rockfish
Fisheries

R. D. Stanley

June 1993

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 1992 to June 1993 and outlines the objectives through June 1994.

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 group 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.

1. Biological database

The initial compilation of the coastwide yellowtail rockfish biological database that was first completed in April 1989 has now been updated through 1991.

2. Stock delineation Studies

The results of various stock delineation studies were summarized in the previous working group report. The supporting work includes genetic analyses (Tagart et al., in prep; McGauley 1991) a parasite survey (Stanley, Lee, and Whitaker 1992) and a tagging summary (Stanley et al., in press).

We do not plan or recommend any additional work for the purposes of stock delineation. Additional work would not significantly improve the knowledge base unless it could provide quantitative estimates of mixing. Such studies would be very extensive and require a much larger dedication of supplemental resources.

3. Stock Assessments 1993

3.1. Canada

A full assessment for yellowtail rockfish was conducted in 1992 (Stanley, in prep). The yield recommendation for central and northern B.C. waters (PMFC Areas 3D, 5A-5E) for 1993 was 2500-4900 t. The recommendation for southern B.C. waters continues to be based on the U.S. assessment (Tagart 1991). The 1993 yield recommendation for PMFC Areas 3B, 3C-US and 3C-CAN combined was 1000-2000 t. These PMFC areas are within INPFC Vancouver Area.

3.2. U.S.

The 1993 U.S. recommendations were based on the 1991 analysis (Tagart 1991). For 1993, the GMT recommended an ABC of 4360 t for the INPFC Columbia Area and the U.S. portion of the INPFC Vancouver Area (PMFC 3C-US and 3B) combined. They recommended 300 t for the INPFC Eureka Area.

4. Future catch-at-age assessments

4.1. Canada

An interim assessment will be produced in 1993 and 1994, with a full assessment to be presented in June 1995.

4.2. U.S.

The U.S. stock assessment is currently being updated following the update of the coastwide master database in

February 1993. The revision will again rely on stock synthesis analysis (Methot 1990). The analysis will be updated to include estimates of hypothesized values for discarded catch. The assessment is due to be completed June 1993.

4.3. Joint assessment work

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

5. Additional research

5.1 DFO

DFO conducted a hydroacoustic study of yellowtail rockfish in November 1991 (Kieser et al, in press). A full report is in preparation.

5.2 WDF

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

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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