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I. EXECUTIVE SUMMARY

Background

The Technical Sub-committee of the Canada/U.S. Groundfish committee (TSC) met during May 3-5, 1994 in Nanaimo, B.C.. Members participating included the Canadian Department of Fisheries and Oceans, the National Marine Fisheries Service, Alaska Department of Fish and Game, Washington Department of Fisheries and Wildlife, Oregon Department of Fish and Wildlife and the Pacific Fishery Management Council. The TSC was established in 1959 by the Canada/U.S. Groundfish Committee and is the only forum for official exchange of information on the status of groundfish stocks and groundfish research among U.S. federal and state agencies and the Canadian Department of Fisheries and Oceans. The terms of reference for the TSC are 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 to encourage implementation of these recommendations.

The TSC makes recommendations both to itself and to its Parent Committee. The Parent committee has one member from each country and they have the authority to contact representatives of their respective countries to act on recommendations from the Parent Committee and/or the TSC.

In 1994, the TSC exchanged information on research, stock assessment and management activities conducted during 1993 and work planned for 1994. The agency and TSC working groups reports have been collated in the accompanying document. The report contains additional information that scientists and managers may find useful including agency overviews, publication lists and staff lists.

Working Groups

The TSC facilitates activity through working groups of which five are currently active. These

include the Pacific hake and Yellowtail rockfish working groups that are responsible for coordinating stock assessments for these two trans-boundary species. The Pacific hake working group has also been heavily involved in the preparation and analysis of data required for the continuing Canada/U.S. hake allocation negotiations.

Ongoing working groups include the Groundfish Catch Data group and the Committee of Age Reading Experts (CARE). The Data group ensures continuing dialogue on catch related issues ie PacFIN and the PMFC data series. Given the importance of fish ages in developing assessments and the need to ensure consistency among age readers from the numerous agencies ageing transboundary stocks, CARE was formed in 1993 with a mandate to:

a. Control deviations from standard ageing procedures.
b. Review new ageing techniques and equipment.
c. Resolve technical problems related to ageing.

CARE meets every two years and is scheduled to meet in June 1994. The meeting will include reports on several recent age structure exchanges and a special session reviewing the application of computer imaging to ageing studies. CARE is expected to complete an Ageing Manual which brings together under one cover the methods and criteria applied in ageing west coast groundfish.
The TSC made several recommendations to CARE mainly aimed at improving communication including:

1. CARE was asked to formalize the minutes of its biennial meeting including recommendations both to CARE itself and to the TSC and sections on the progress on recommendations from CARE and from the TSC .

2. CARE is to prepare a document to be submitted to the TSC in 1995, summarizing CARE's history and accomplishments since its inception in 1983.

3. CARE is to provide an annual summary of age structure exchanges and a summary of results. These exchanges were highlighted as a key activity of CARE. The TSC also asked that the CARE develop a comprehensive list of all groundfish species aged by each agency. This inventory will include a summary of structures aged and any concerns associated with the ageing of each species. Recommended species for exchange will be identified and the list updated with CARE's annual report to the TSC.

Finally there is a Sablefish Symposium Committee that organized the 1993 symposium on Biology and Management of Sablefish. They are in the final stages of editing of the symposium proceedings which will be printed as a National Marine Fisheries Service Techical Report.

1994 Business

1. The TSC has been notified informally that the California Department of Fish and Game will no longer be participating in the TSC. This is regrettable given the common interest of all agencies in NE Pacific activities related to research, assessment and management of groundfish species. The TSC recommended to the Parent Committee that the California Department of Fish and Game be contacted formally and urged to continue participation.

2. The TSC acknowledged the efforts of the Pacific States Marine Fisheries Commission in organizing and hosting a workshop on nearshore rockfish. The workshop provided a valuable forum for inter-agency discussions on issues related to nearshore rockfish management. The TSC supports a wide distribution of the workshop summary document following its approval by participating agencies. The TSC also noted that all of the workshop goals could not be achieved within the time frame available. In particular, there was no comment on whether existing management strategies were appropriate for nearshore rockfish or whether new management strategies need to be implemented. A future workshop should be considered to address this issue. Specifically, the workshop should identify management alternatives for nearshore rockfish and other species in the absence of reliable fishery and biological data.

3. The TSC noted that the combined Can./U.S. harvest of Pacific hake continues to exceed the adopted yield option and recommended to the Parent Committee that the bilateral negotiations be encouraged to arrive at a quick resolution.

4. The TSC recommended that the two previous (1984 and 1992) reports which detailed the accomplishments of the TSC, be combined, updated, and submitted to the TSC.

5. Finally, and most importantly, there was considerable discussion on the future of the TSC. Major issues included the mandate of the TSC and the length and format of the annual meetings. The 1994 recommendations to the Parent committee and to the TSC itself, reflected the consensus reached during these discussions. Briefly, we agreed that the TSC terms of reference were appropriately focussed on the exchange of information and the review of technical issues pertaining to management and scientific study of groundfish stocks of mutual interest. We felt however that with timely (earlier) dissemination of materials, that the exchange of information role at the meetings could be reduced, and increased effort could be devoted to discussion of current important issues. To this end , a request for suggested topics on research and management issues will go out to the Parent committee and member agencies well in advance of the annual meeting.

If you require any further information on the TSC please do not hesitate to call either Barry Bracken (ADFG 1995/96 TSC Chair) at 907-772-3801) or Mark Saunders (DFO, 1993/94 TSC Chair) at 604-756-7154.

II. CALL TO ORDER

Chairperson, Mr. Mark Saunders called to order the 35th annual meeting of the Technical Sub-Committee (TSC) at 0810 on May 3, 1994 in Nanaimo, B.C.

III. APPOINTMENT OF SECRETARY

Mr. G.A. McFarlane, Canada Department of Fisheries and Oceans, Nanaimo, B.C., was appointed to serve as secretary.

IV. INTRODUCTIONS

Members and invited participants introduced themselves. Participants are listed below by agency, with members indicated by asterisks. A complete list of names and telelphone numbers of those attending is included in Appendix D.

Canada - Department of Fisheries and Oceans (DFO)

Pacific Biological Station
Mr. Mark Saunders
Ms. Shayne MacLellan
Mr. Sandy McFarlane
Mr. Rick Stanley
Dr. Laura Richards
Ms. Lynne Yamanaka

United States

National Marine Fisheries Service

Alaska Fisheries Science Centre (AFSC)
Mr. Mark Wilkins
Mr. Thomas Wilderbuer

Auke Bay Laboratory
Mr. Dave Clausen

Alaska Department of Fish and Game (ADFG)
Mr. Barry Bracken

Washington Department of Fish and Wildlife (WDFW)
Mr. Tom Jagielo

Oregon Department of Fish and Wildlife (ODFW)
Mr. Bill Barss

California Department of Fish and Game (CDFG) - Not Represented

Pacific Fishery Management Council (PFMC)
Mr. Jim Glock

North Pacific Fisheries Management Council - Not Represented

Pacific States Marine Fisheries Commission (PSMFC) - Not Represented

International Pacific Halibut Commission - Not Represented

V. APPROVAL OF THE 1993 REPORT AND THE 1994 AGENDA

The 1993 report was not complete and approval withheld. The 1994 agenda was approved.

VI. TERMS OF REFERENCE

No changes in the terms of reference of the Technical Subcommittee were proposed.

The Terms of Reference of the Technical Subcommittee are 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 regulations.

VII. WORKING GROUP REPORTS

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

Mr. Saunders presented the CARE report received from Mr. J. Butler, the current CARE chair. The report, presented below, includes an agenda for the next CARE meeting scheduled for June 1994. The TSC discussed at length the role of CARE and its relationship to the TSC and drew up recommendations in this regard . Since CARE has not met for two years it will consider both the 1993 and 1994 TSC recommendations.

1994 report of the Committee of Age Reading Experts (CARE) to the Technical Sub-Committee of the Canada-U.S. Groundfish Committee:

The biannual meeting of CARE will be June 14 to 16 at the Alaska Fisheries Science Center. Normally this meeting would be held prior to the TSC meeting, but lack of funding for travel resulted in a rescheduling of the meeting.

An agenda and list of prospective participants for the meeting are attached. The meeting will include an exchange of otoliths from sablefish. This exchange has been requested by the Alaska Department of Fish and Game.

The meeting will also include an update of the manual for age determination. This manual has been in preparation for several years and is intended as a update of the very popular manual written by Doris Chilton and Richard Beamish.

There will also be a discussion of validation studies. Several of the participants have been involved in radiochemical and edge analysis validation studies. Several participants have offered to report on their recent findings.

A comparison of software and equipment to automatically read otoliths is planned. Two systems will be bench tested, the Optimus software available from Bioscan, which runs on PC based machines and the public domain BonyParts and NIH Image, which run on Macintosh computers. The two systems will use the same image from a CCD camera mounted on a microscope, and both systems will be used to analyze the otolith.

I will make a full report of the meeting in June.

PROSPECTIVE ATTENDEES TO 1994 CARE MEETING

NMFS/AFSC - Seattle, Washington

Ms. Delsa Anderl	Ms. Jill McKay
Ms. Betty Goetz	Mr. Dean Melton
Ms. Shelly R. Jay	Ms. Julie Pearce
Mr. Craig Kastelle	Mr. Kent Scott
Dr. Dan Kimura	Ms. Julie Waltz
Ms. Julie Lyons	Ms. Chris Johnston

NMFS - Tiburon Laboratory

Ms. Anne McBride
Mr. Don Pearson

IPHC - Seattle, Washington

Mr. Calvin Blood	Ms. Tracee Geernaert
Ms. Joan Forsberg	

ALASKA DEPT. OF FISH AND GAME

Ms. Joan Ried Brodie	Kodiak
Ms. Kristen Munk	Douglas
Mr. Pete Hagen	Douglas

OREGON DEPT. OF FISH AND GAME

Mr. Bob Mikas	Newport

CALIFORNIA DEPT. OF FISH AND GAME

Ms. Brenda Erwin	Menlo Park
Mr. Larry Quirollo	Eurcka
Mr. John Mello	Sebastopol
Mr. Rob Titus	Sacramento

SOUTHWEST FISHERIES SCIENCE CENTER

Dr. John Butler, Chairperson, CARE	La Jolla, California

CAN. DEPT. OF FISHERIES AND OCEANS

Ms. Shayne MacLellan	Nanaimo

WASH. DEPT. OF FISH. AND WILDLIFE

Ms. Ruth Mandapat	Seattle
Ms. Sandra Oxford	Seattle
Ms. Sandra Rosenfield	Olympia

Committee of Age Reading Experts Proposed Agenda

June 14, 1994

9:00 am	Opening Remarks Introductions Approval of proposed agenda Minutes of last meeting Update of age determination manual Update list of species read by each agency
11:00 am	New business: Discussion of validation problems
12:00 noon	Lunch
1:30 pm	New Business: Continuation of discussion of validation problems Recommendations from the TSC Discussion of future of CARE Selection of new Chairperson and Vice Chairperson
5:00 pm	Break for the Day

June 15, 1994

8:00 pm	Presentations
12:00 noon	Lunch
1:30 pm	Comparison of image analysis systems and otolith reading software PC and MAC systems
5:00 pm	Break for the Day

June 16, 1994

8:00 am	Hands on work with microscopes and photographs
10:00 am	Summarization of meetings/suggestions
12:00 noon	Adjourn meeting

B. Groundfish Catch Data

The TSC endorsed and supported continued cooperation between agencies for the PacFIN data series.

C. Stock Assessment Groups

1. Yellowtail Rockfish

This document follows earlier annual progress reports. It summarizes progress made from June 1993 to June 1994 and outlines the objectives through June 1995.

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:

a) Review the status of the yellowtail rockfish stocks;
b) Study management strategies for yellowtail rockfish;
c) Review the implications of the various management strategies on the yellowtail rockfish stock;
d) Report to the TSC and Parent Committee on their progress.

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.

Stock delineation Studies

The results of various stock delineation studies were summarized in the previous working group reports. The supporting work includes a genetics analysis still in preparation (Tagart et al., in prep) and a tagging summary which is to be published in the Fishery Bulletin in the fall of 1994 (Stanley et al. in press).

We continue to recommend against 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 costly.
Stock Assessments 1994

Canada

An interim assessment for yellowtail rockfish was conducted in 1993 for the 1994 fishing

year (Stanley, in press). Yield recommendations were unchanged from the previous year (Stanley 1993). For central and northern B.C. waters (PMFC Areas 3D, 5A-5E) the recommended yield range 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.

The management plan for 1994 included yellowtail rockfish in the management category, "Aggregate 1", with Pacific ocean perch, yellowmouth rockfish, rougheye rockfish, canary rockfish, and silvergray rockfish. The coastwide quota for "Aggregate 1" for 1994 is 12,574 t.

United States

The 1994-96 U.S. recommendations for acceptable biological catch (ABC) are based on a revised analysis of stock biomass (Tagart, 1993). The revised analysis added four years of age data (1988-1991), included catch data through 1993, added a 1992 datum on trawl survey biomass, and added trawl survey length frequency data for 1977, 1980, 1983, and 1986. In addition, the catch time series included a vector which assumed a yellowtail rockfish discard rate of 16% of the retained catch in the U.S. domestic trawl fishery from 1985 to 1993. Finally, the maturity at age vector, originally estimated by Gunderson et al. (1980), was replaced with the vector estimated by Tagart (1991). The revised maturity function predicts earlier maturity. Biomass was fixed in the stock synthesis model (Methot 1990) by fixing either, the 1987 fishing mortality rate for fully recruited year classes or, initial recruitment.

Biomass estimates for the S. Columbia/Eureka stock indicate that the stock is healthy. Bolstered by strong recruitment in 1983 and 1984, total 1993 biomass was estimated to be 25,000 t. The 1993 spawning biomass was estimated to be 93% of the unfished spawning biomass. The N. Columbia stock shows a continuing trend of declining total biomass, while the exploitable biomass, bolstered by above average 1981 and 1983-84 year classes, remains stable. Estimated total biomass in 1993 was 30,000 t. Spawning biomass in 1993 is estimated to be 50% of the unfished spawning biomass.
Yellowtail rockfish abundance in the S. Vancouver stock continues to be difficult to determine. Fitting the model to either biomass surveys or age data indicates a continuous state of decline in biomass, as in the N. Columbia stock, but the decline is far much more severe when the model is driven by age data. At one extreme, the 1993 total biomass is estimated to be a 8147 t (17% of the 1967 biomass) based on age data, but 39,700 t (60% of the 1967 biomass) based on survey biomass estimates. For these conflicting parameterizations, spawning biomass in 1993 ranges from 7 to 42% of the unfished spawning biomass. The current fishery is dominated by the 1981 year class. Unlike the southern stocks, the 1983-84 year classes appear to be at or below average, and the 1985-86 year classes are quite poor. Early indicators are that the 1987 year class may be

above average but additional observations will be necessary to confirm this.

The GMT recommended an annual ABC of 4160 t for the management zone which includes the N. Columbia stock and the U.S. portion of the S. Vancouver stock. The combined ABC is based on the sum of independent ABCs of 2970 t and 1190 t respectively. The U.S. ABC for the S. Vancouver stock is 60% of the total stock ABC. The recommended annual S. Columbia/Eureka stock ABC was 2580 t.

Future catch-at-age assessments

Canada

An interim assessment will produced for July 1994, with a full assessment to be presented in July 1995.

United States

The stock abundance of yellowtail rockfish in U.S. waters will be reassessed in 1996.

Joint assessment work

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

Additional research

Canada

DFO conducted a hydroacoustic study of yellowtail rockfish in November 1991. A data report which summarizes cruise activities has been published (Kieser et al. 1993). A full report has been submitted for publication (Stanley et al. in review). No additional work is currently planned.

United States - Washington Department of Fisheries

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

Management options

The TSC asked that the working group to 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 with the fishery of 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.

Literature Cited

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Kieser, R., K. Cooke, R. D. Stanley, and G. E. Gillespie. 1993. Experimental hydroacoustic estimation of yellowtail rockfish biomass off Vancouver Island, November 13-25, 1991. Can. Man. Rep. Fish. Aquat. Sci. No. 2185. 40 p.

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Tagart, J. V. 1991. Population dynamics of yellowtail rockfish (Sebastes flavidus) stocks in the northern California to southwest Vancouver Island Region. Ph. D. Thesis, Univ. of Washington, Seattle, Washington. 323 p.

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2. Pacific Whiting (Hake) Allocation

This working group has been active since 1980 and meets at least once annually to exchange data and discuss the direction and results of current year stock assessments. Stock assessments are prepared jointly and reported independently by DFO and NMFS. The working group has also been actively assisting Canadian and U.S. negotiations in providing survey data and analyses that have formed the basis for allocation discussions.

The Pacific whiting working group met at New Westminister, B.C., Canada September 9 and 10, 1993 and the minutes are included below.

In attendance:

Canada	United States
J. Rice	R. Methot
G. McFarlane	M. Dorn
M. Saunders	J. Ingraham
I. Perry	

The meeting was called to order at 1400 and was chaired by Dr. J. Rice.

The following proposed agenda was adopted:

Update on 1993 Canadian hydroacoustic survey.

Update of 1993 assessment.

Re-calculation of expansion factors and resulting Can./U.S. biomass split.
Progress report on use of environmental factors to estimate the biomass split in non-survey years.

Update on 1993 Canadian hydroacoustic survey.

A report on the preliminary results of the 1993 Canadian hyroacoustic survey was presented Canadian scientists. The survey was conducted using the W.E. RICKER, between August 3 and September 2, 1993. The survey design was the same as that agreed to by U.S. scientists and used by both countries in 1992. A total of 10,618 km^2 were surveyed and 678,160 t of hake were found. In the area north of 49 degrees, 429 thousand t (63.2% of the total) were present. The 1993 total is below the 1992 biomass estimate of 1,100 thousand t but higher than 1990 and 1991 levels. These numbers are very preliminary. The series of transects north of 49 degrees have been estimated using conventional analysis and will be re-analyzed using proximal methods as agreed to during previous meetings of the working group.

There have been anecdotal reports of hake in Hecate Strait by Canadian trawlers and in research tows conducted by the NOAA vessel MILLER FREEMEN (cruise 939) fishing in waters off Craig Alaska. Given the presence of hake above the survey's northern limit, the estimate of 678 thousand t is considered a minimum estimate of the biomass in the Canadian zone.

Update of 1993 assessment.

An updated version of the 1993 assessment was presented by U.S. scientists. Yield estimates were higher than reported in the documents tabled at the June U.S. Assessment Review meeting and the July Pacific Stock Assessment Review Committee (PSARC) meeting due to corrections made to the recruitment time series and to the method used to model the time series of survey estimates. Canadian scientists agreed to substitute the new values for the ones in the earlier documents, and to recommend the low risk Hybrid yield option given the uncertainty surrounding the 1992 hydroacoustic estimate.

Canadian scientists indicated that they are willing to request two weeks of ship time to survey offshore areas in the U.S. in July 1994. The broad objectives would be:

To survey, using hydroacoustics, selected transects from previous U.S. cruises to examine the repeatability of the offshore distribution observed in 1992.

To examine the species composition of the deep scattering layer using fine mesh trawls to confirm that hake is the dominant target.

To collect biological samples from inshore and offshore aggregations of hake.

U.S. scientists agreed that the broad objectives were worth pursuing and were willing to participate in the planning and execution of the work.

Re-calculation of expansion factors and resulting Can./U.S. biomass split.

Canadian scientists tabled selected revised estimates of the Can./U.S. biomass split based on re-calculated expansion factors and inclusion of the 1992 survey results. It was agreed by Canadian and U.S scientists that this report should provide details of the new expansion factors and the entire range of estimates as given in Table 6b of the 1992 working group report should be re-calculated and presented. Details of the re-calculation of expansion factors are presented in Table 1 and a revised Table 6b (four scenarios) presented in Table 2.

The three expansion factors increased slightly due to the high proportion of hake north of 49 degrees found during both 1992 surveys of the Canadian zone. Revised estimates of the percentage of exploitable hake biomass (four scenarios) found in the Canadian zone during the U.S. triennial surveys increased from 23.3-28.7% to 27.6-32.1% (Table 2). Canadian and U.S. scientists agreed that other scenarios examined in the 1992 Working Group report would increase in a similar fashion.

U.S. scientists requested that the computer spreadsheet used to calculate the percentages in the revised Table 6b be forwarded to them to insure that survey numbers used are the most recent. It was agreed that the U.S. survey and U.S. fishery selectivity factors used in calculations of biomass percentages reported in the original Table 6b, were appropriate to use in calculating the revised numbers. These selectivity factors were first reported in the 1992 assessments.

Progress report on the use of environmental factors to estimate the biomass split in non-survey years.

A draft report was tabled by U.S. scientists detailing a method developed to use environmental factors to estimate the Can./U.S. split in biomass in non-survey years (Appendix A). They had calculated the correlation of seven environmental indices with the proportion of hake in the Canadian zone during the five survey years. The best correlation was achieved using the temperature at 100m off California. They used a simple regression model of that relationship to estimate the proportion of biomass in the Canadian zone in non-survey years. The average estimated proportion of biomass in the Canadian zone over all years (1977-1992) was 27.3%.

The results of a similar but independent analysis conducted by Canadian scientists were presented (Appendix B). The proportion in the Canadian zone as determined by U.S. surveys was correlated with the time series of sea surface temperatures at Amphitrite Pt. lighthouse near Barkley Sound. Again, a simple linear regression model estimated the

proportion of the biomass in Canada over the 1977-92 time period. The average of the separate annual estimates was 27.5%

U.S. scientists demonstrated their OSCURS model used to model wind-driven surface currents in the north Pacific. The estimated monthly surface transport vectors show great promise for the investigation of oceanographic factors and their relationship to the migration of hake and other marine species.

Other

The U.S. scientists tabled length frequency and monthly fleet distribution figures from the U.S. fishery as evidence for the timing of the seasonal progression of the large fish northward. Canadian scientists asked that the plots be broken down by latitude to determine whether the catches of large fish in the early months were widespread or limited to the areas where anomalously large fish are caught throughout the summer. U.S. scientists agreed to provide revised plots.

Scientists from both countries reviewed their schedule for further scientific peer review and industry meetings. It was noted that the U.S. process occurs sooner than the Canadian process.

Table 1. Detailed re-calculation of northern expansion factors

The northern expansion factors reported in the May 1992 working group report were calculated to correct the earlier U.S. triennial surveys that did not adequately survey the Canadian zone. The average of the 1990 and 1991 Canadian survey data were used and the conversion factors with and without using the July catch were as follows:

Survey extent	Expansion factor	Expansion factor (July catch in Canadian zone included)
50.0 deg N	1.5	1.4
49.5 deg N	1.6	1.5
49.25 deg N	1.7	1.6

The July catch was added in to account for the biomass removed from the southern portion of the zone by the fishery prior to the August surveys. To incorporate the results of the U.S. and Canadian 1992 surveys of the Canadian zones, the average of the two surveys was calculated. The new expansion factors reported below are the mean of the 1990, 1991 and 1992 (average of the two surveys) surveys.

Survey extent	Expansion factor	Expansion factor (July catch in Canadian zone included)
50.0 deg N	1.54	1.48
49.5 deg N	1.76	1.68
49.25 deg N	1.93	1.83

The expansion factor for each of the three U.S. survey limits was calculated as follows:

$$\text{Factor} = \frac{\text{Can. survey total hake biomass + July catch in Canadian zone}}{\text{Can. survey biomass south of survey limit + July catch in Canadian zone}}$$

The biomass estimates and resulting expansion factors by survey are presented below.

	Survey extent (degrees)					
	50.0		49.5		49.25	
	Survey biomass (no catch included)	July catch in Canadian zone included	Survey biomass (no catch included)	July catch in Canadian zone included	Survey biomass (no catch included)	July catch in Canadian zone included
1990 survey						
Total biomass (t)	317,338	352,094	317,338	352,094	317,338	352,094
Biomass (t) up to northern limit of U.S. survey	176,968	211,724	161,496	196,252	149,726	184,482
Expansion factor	1.79	1.66	1.97	1.79	2.12	1.91
1991 survey						
Total biomass (t)	563,308	591,700	563,308	591,700	563,308	591,700
Biomass (t) up to northern limit of U.S. survey	469,105	497,497	468,702	497,094	465,544	493,936
Expansion factor	1.20	1.19	1.20	1.19	1.21	1.20
1992 U.S. survey						
Total biomass (t)	931,660	955,981	931,660	955,981	931,660	955981
Biomass (t) up to northern limit of U.S. survey	511,310	535,630	425,195	449,515	388,843	413,164
Expansion factor	1.82	1.78	2.19	2.13	2.40	2.31
1992 Can. survey						
Total biomass (t)	1,101,328	1,125,649	1,101,328	1,125,649	1,101,328	1,125,649
Biomass (t) up to northern limit of U.S. survey	779,155	803,476	541,845	566,166	440,055	464,376
Expansion factor	1.41	1.40	2.03	1.99	2.50	2.42

Table 2. The percentage of exploitable hake biomass found in the Canadian zone during U.S. triennial surveys[1] based on expansion factors with and without the 1992 survey (in brackets). All percentages adjusted for modified northern expansion factors (addition of July catch in Canadian zone).

	1977	1980		1983		1986	1992	AVERAGE
Minus Conception and Monterey	25.38 (24.34)	27.64 (26.54)	32.37	34.03 (29.50)	34.96	30.88 (31.53)		(27.98)
Using maturity ogive	24.82 (23.80)	19.45 (18.60)	41.45	33.71 (40.27)	38.71	31.63 (29.42)		(28.02)
Using maturity and U.S survey selectivity ogives	22.20 (21.22)	16.12 (14.88)	32.29	31.41 (29.67)	36.05	27.61 (27.26)		(23.26)
Using U.S. survey and U.S. fishery selectivity ogives	24.19 (23.18)	20.62 (19.72)	46.91	30.76 (45.49)	37.86	32.07 (26.70)		(28.77)

[1] 'Minus Conception and Monterey' calculations used the acoustic and bottom trawl survey estimates combined while the acoustic surveys alone were used in other three cases.

Appendix A to Report From The Pacific Whiting (Hake) Working Group

Interannual variability in Pacific whiting migration--the effect of population size/age structure and oceanography.

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Summary

Population size/age structure

The effect of population size/age structure on the fraction of the population migrating into the Canadian zone was examined using data from the triennial NMFS acoustic surveys in 1977-92. Migration into the Canadian zone was found to be strongly size-dependent. The number of fish less than 40 cm in the Canadian zone was always less than 1% of the total number of fish less than 40 cm estimated by the survey. Fish that are greater than 40 cm show considerable variation in fraction migrating into the Canadian zone from one survey to the next. The proportion migrating into the Canadian zone always increases with fish size, but tends to level off with increasing age for fish older than age 9. The population size-frequency is strongly dependent on relative year-class abundance. For example, 61% of the fish in the 1986 acoustic survey were less than 40 cm due to the abundance of the 1984 year class, but by 1989 fish less than 40 cm accounted for only 15% of the total estimated abundance. Because fish less than 40 cm were never common in the Canadian zone, some of the interannual variation of fraction of the population found in the Canadian zone can be accounted for by changes in the size structure of the population.

Correlations with oceanographic variables

Linear correlations between the fraction of four age groups migrating into the Canadian zone (ages 1-3, 4-6, 7-9, and greater than 9) and a suite of environmental variables that measured the strength of northward transport in California Current system were investigated. The environmental variables examined were monthly sea surface temperature anomalies, monthly temperature anomalies at 100 m, and monthly alongshore poleward transport from the OSCURS surface current model. Although high correlations were obtained for some months for each environmental variable, temperature anomalies at 100 m tended be more highly correlated with hake migration than the other environmental variables. The highest correlations for temperature at 100 m occurred during the months January-April off the California coast.

Estimating the bi-national distribution of biomass

A method was developed to estimate the proportion of hake in the Canadian zone during the non-survey years using temperature at 100 m off the California coast for the months January-April. A logistic regression model gave the predicted proportion migrating into the Canadian zone for each of the four age groups as a function of temperature at 100 m. To interpolate biomass

distributions for the non-survey years the following procedure was used: 1) the population age structure was estimated using the stock synthesis model; 2) regression coefficients from the logistic regression were used to split the population between the U.S. and Canadian zones for each age grouping; 3) the zone-specific population numbers were multiplied by zone-specific weights at age to obtain biomass at age for each zone. The distribution of population biomass was obtained by summing the biomass at age for each zone. The average estimated proportion of age 2+ biomass in the Canadian zone during the summers of 1977-92 was 23.0%. When discounted by the survey selectivity pattern, the 1977-92 average proportion in the Canadian zone was 27.3%, which is similar to the 28.3% mean from the survey years only. Our conclusion from this analysis is that the estimates of the bi-national distribution of biomass from the triennial surveys are reasonably representative of the bi-national distribution of the hake population during the period 1977-92.

Appendix B to Report From The Pacific Whiting (Hake) Working Group

Summary of Environment - Pacific Hake Migration Analyses

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Objective: to identify relationships between environmental conditions and the proportion of Pacific hake biomass observed in the Canadian zone during triennial U.S. surveys, and to apply these relationships to estimate the proportion of Pacific hake in the Canadian zone during non-survey years.

Background: Ware and McFarlane (In Press. Climate induced changes in hake abundance and pelagic community interactions in the Vancouver Island upwelling system. Special Public. Can. J. Fish. Aquat. Sci.) identified a positive relationship between the biomass of Pacific hake in the La Perouse Bank area of B.C. and the sea surface temperature (SST) as measured at Amphitrite Point at the mouth of Barkely Sound, averaged during June and July. They concluded that SST at this location provided a predictor for the extent of Pacific hake migration onto the lower west coast of Vancouver Island.

Approach: Pacific hake data were obtained from the triennial U.S. surveys, for the period 1977 - 1992. Mature biomass was estimated by applying a partial recruitment vector of [0, 0.5, 0.75, 1.0, ..., 1.0] to ages [2, 3, 4, 5, ..., 15]. In addition, the Canadian biomass for the years [1977, 1980, 1983, 1986, 1989, 1992] was expanded by [1.5, 1.5, 1.6, 1.7, 1.5, 1.0] to account for hake biomass north of the survey area.
Sea surface temperatures were taken as the average during May-June from Amphitrite Point. May-June was chosen since it is the period during which the fish are expected to be moving into the Canadian zone.

Statistical analyses used simple linear regression and analysis of variance.

Results: the regression equation between May-June average SST (SSTMJ) and the (expanded) proportion of hake biomass in the Canadian zone was

$$\text{CDN proportion} = 0.119\ (\text{SSTMJ}) - 1.135$$

with an $r^2 = 0.579$, $p = 0.079$. When this equation was applied to the (May-June) sea surface temperatures for all years 1977-1992 (in order to estimate the proportion of hake in the Canadian zone during non-survey years) the mean proportion was 27.5%, with a standard deviation of 10.6%. When the survey year 1989 was excluded (due to questions of insufficient coverage of the Canadian zone) and the regression recalculated then applied to the non-survey years, the mean proportion of hake in the Canadian zone was calculated as 27.6%.

Conclusions: These results suggest that there does appear to be an influence of the environment

on the extent of migration of Pacific hake. Further, the values for the proportion of hake in the Canadian zone estimated from two different environmental data sources and two different methods are surprisingly similar (27.5% for the Canadian analysis; 27.3% for the U.S. analysis). This suggests the extent of Pacific hake migration along the west coast of North America is probably under large-scale environmental control, and not very sensitive to a particular environmental variable or its measurement location.

D. Other

1. Sablefish Symposium

Mr. Wilkins reported that all but one manuscript had been received and were in the hands of the Technical editor to be sent out for peer review.

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

A. Agency overview

1. Alaska Department of Fish and Game

a. Description of the State of Alaska groundfish program:

The Alaska Department of Fish and Game (ADF&G) has management jurisdiction over all groundfish fisheries within the internal waters of the state and to three miles 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 140° 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 waters of the Bering Sea.
With the exception of the territorial waters of Southeast Alaska, Prince William Sound, and Cook Inlet, all groundfish fisheries, except lingcod, are managed in conjunction with the federal management of the adjacent Exclusive Economic Zone (EEZ). State management of demersal shelf rockfish and lingcod extends beyond the territorial sea. The information related in this report is from the state-managed groundfish fisheries only.

1) Southeast Region

During 1993 the Southeast Region Commercial Fisheries Groundfish Project was staffed with a 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 part of the year, and the project received assistance from a biometrician at 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 North Pacific Fisheries Management Council's 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, Pacific cod, and rockfish landings; skipper interview and logbook collection and data entry; and biological studies of important commercial species. Five resource assessment surveys were completed during the year. Regulation development and review and information dissemination also required considerable staff time.

b. Central Region

During 1993 the Central Region was staffed by a biologist located in Homer. Rockfish and lingcod management plans adopted by the state Board of Fisheries during the fall of 1992 were implemented 1993. In-season management of the Prince William Sound sablefish fishery also required staff time.

c. Westward Region

In the Westward Region a Shellfish/Groundfish Coordinator was responsible for supervising fish ticket data entry and analysis of groundfish data from shellfish stock assessment surveys. The Kodiak staff continued monitoring the near-shore black rockfish fishery around Kodiak Island and new regulations were implemented during 1993 which restricted harvest levels for black rockfish in two bays near Kodiak.

d. Headquarters

ADF&G personnel continued to enter fish tickets from all shore-based groundfish landings from Alaskan waters during 1993 under a renewed cooperative agreement with the National Marine Fisheries Service (NMFS). Fish tickets from all shore-based groundfish fisheries were collected, edited, and entered on microcomputers in five coastal communities. A programmer analyst working in Juneau was responsible for setting up and maintaining the master database and for providing summary groundfish catch information to NMFS, ADF&G, and PacFIN.

2. Washington Department of Fish and Wildlife

In 1994, the Washington Department of Fisheries merged with the Washington

Department of Wildlife to become the Washington Department of Fish and Wildlife. The new agency is expected to have one Fish Program which will encompass salmon and steelhead as well as marine fish and shellfish. The current marine fish program is expected to become a division of the new Fish Program.

a) Coastal Marine Fish Management.

Coastal Marine Fish Management occurs within the Coastal MF/SF section, which is responsible for management and research of groundfish in all coastal waters and in the outer Strait of Juan de Fuca. The coastal section also handles all issues requiring interstate, regional, federal or international cooperation. Responsibilities include membership on the Groundfish Management Team (GMT) of the Pacific Fishery Management Council (PFMC), membership on the Science and Statistical Sub-Committee (SSC) of the 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 Council decisions by drafting state regulations and coordinating state enforcement regarding groundfish management. Division personnel are stationed in major ports of landing to collect catch and biological data and other fishery related information.

The Age Determination Unit conducts microscopic 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.

b) Puget Sound Marine Fish Management.

The Puget Sound MF/SF section 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.

3. Canada

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'. Results of a major reorganization of DFO staff into a new stock assessment division is expected in May of 1994 which may result in some changes to Division structure noted above.

The management of marine fish falls under the Fisheries Branch of the Department of Fisheries and Oceans. Mr. Bruce Turris has recently replaced Mr. Ed. Zyblut as the Offshore Division groundfish manager.

4. National Marine Fisheries Service - AFSC

Essentially all groundfish research at the Alaska Fisheries Science Center (AFSC) is conducted within the Resource Assessment and Conservation Engineering (RACE) Division, the Resource Ecology and Fisheries Management (REFM) Division, and the Auke Bay Laboratory (ABL), which is responsible for groundfish assessment in the Gulf of Alaska east of Cape St. Elias. The RACE and REFM Divisions are divided along regional or disciplinary lines into a number of tasks and subtasks. A review of pertinent work by these tasks during the past year is presented below. Recent publications and reports produced by RACE, REFM, and ABL scientists are presented as Appendix I.

a) RACE Division

In 1993 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. Groundfish trawl surveys were conducted by the Bering Sea, Gulf of Alaska, and West Coast subtasks. There were three bottom trawl surveys and two longline surveys in 1993. Major emphasis in 1993 was in the Gulf of Alaska, in keeping with the triennial rotation of comprehensive surveys among three major geographic areas. The focus will be in the Bering Sea and Aleutian Islands in 1994, although budgetary constraints have caused us to scale back the scope of these surveys relative to previous triennial surveys in those areas. The Midwater Assessment and Conservation Engineering Task conducted three acoustic surveys of pollock abundance in the Gulf of Alaska and Bering Sea in early 1994 and has continued studies of fish behaviour relative to trawl gear with the objective of reducing bycatch rates. The Conservation Engineering group has also been refining methods used to stabilize research survey trawls and monitor their fishing configurations. The Recruitment Processes task conducted four Fisheries-Oceanography Coordinated Investigations (FOCI) cruises in the spring of 1993, investigating the interaction between the environment and the spawning products of Gulf of Alaska and eastern Bering Sea pollock.

b. 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 Observer Program and the following tasks: Age and Growth Studies, Socioeconomic Assessments, Resource Ecology and Ecosystems Modeling, 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. Dr. William Karp was hired to replace Russ Nelson as the leader of the Observer Program.

c. NMFS - AFSC - 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 1993 field research, ABL's groundfish task participated in three resource assessment surveys in the Gulf of Alaska: 1) the 1993 triennial trawl survey of the eastern Gulf of Alaska; 2) the annual Japan-U.S. cooperative longline survey; and 3) the annual domestic longline survey. ABL was also involved in a pilot rockfish trawl survey in the Yakutat area of the Gulf. Other field studies by ABL, all in southeastern Alaska, included: 1) an experiment to determine the amount of rockfish caught in a trawl during retrieval; 2) a longline study using hook timers to investigate possible effects of gear saturation on catch rates; and 3) a continuation of juvenile sablefish life history studies at a bay near Sitka.

Several analytic activities were conducted by groundfish task members on sablefish and rockfish in 1993-94. One staff member completed a doctoral dissertation on stock assessment and management of sablefish in the Gulf of Alaska. 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.

5. Oregon Department of Fish and Wildlife

Jack Robinson and Larry Hreha retired during the year. Each had worked about 25 years

on marine programs including Oregon groundfish.

Jerry Butler is filling the Robinson position as the new Fin Fish Program Leader Butler's old position as Project Leader, Field Operations may not be filled due to budget shortfalls. Larry Hreha's vacated position as Project Leader, Pelagic Fish Investigations will not be filled. Bill Barss position was upgraded to Fish and Wildlife Biologist 3 and he continues to serve as Whiting Coordinator. Claire Wood's Research Analyst 2 position was upgraded to Fish and Wildlife Biologist 2. Elaine Stewart has been reassigned to a new Fin Fish Stock Assessment position located in Newport.

6. National Marine Fisheries Service-SWFSC

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

a) Coastal Division (La Jolla)

The SWFSC Coastal Fisheries Resources Division is involved in a large number of research studies that support management of groundfish by the Pacific Fishery Management Council. These studies address both short and long term problems in biology and economics that affect management. Work in the Coastal Division is focused primarily on the deep water complex (sablefish, Dover sole and thornyheads) but work on rockfish (Sebastes sp.) in shallow water and Pacific whiting is also ongoing.

b) Pacific Fisheries Environmental Group (Monterey)

Pacific Fisheries Environmental Group (PFEG) develops methods to address the linkages between natural environmental variability and fish population dynamics. Data series developed within the PFEG research program are made available to scientific collaborators. Co-location with the U.S. Navy's Fleet Numerical Oceanography Center provides access to ocean and atmospheric data on a global scale. Major categories of scientific activity at PFEG include: (1) Development of environmental index time series, (2) ocean anomaly diagnostic studies, (3) identification of environmental-biological causal linkages through interregional comparative studies, exploratory data analysis, empirical modeling etc., (4) development of appropriate environment-dependent fishery modeling methodologies, (5) development of biological time series for calibration, verification and parameter estimation. A study of potential effects of climate change on marine ecosystems and resources is a major focus of PFEG research activity at the present time. One of these biological data bases involves long time series of groundfish growth from otolith back-calculations. In addition, PFEG personnel are involved in completing

inter-institutional collaborative field studies of the coastal groundfish habitat off the U.S. west coast.

c) 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, estimate spawning biomass, sample groundfish landings and age groundfishes; staff members also study rockfish life histories, develop new management models and conduct stock assessments. In addition, staff participates on the Pacific Fishery Management Council's Groundfish Management Team, principally in stock assessments and exploring management alternatives.

Recent publications include a paper on the utility of different types of auxiliary data, a paper on groundfish assemblages, a paper on the effects of oceanic factors on juvenile rockfish, a note on the Cobb Seamount fishery, and a note on estimating weight-length relationships from group measurements. Two papers on early growth of rockfish and Pacific whiting are in press. A paper relating the distribution of juvenile sanddabs to oceanic features was submitted for publication.

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 reduced at the end of 1991. The data from the port samples are compiled with software developed by project members and routinely used in stock assessments.

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

The research year is designed and scheduled around the general rockfish annual reproductive cycle for the central California area, namely April through March. The 1993-1994 research year for PEI was a transition year in which studies on yellowtail

rockfish were wrapped up, except for continued monitoring of annual fecundity efforts, and new studies were developed on shortbelly rockfish. Presentations of research findings were made at two international meetings and 4 papers were submitted for published.

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

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

7. Pacific Fishery Management Council

In 1993, 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 second year, all managed species were managed under harvest guidelines instead of quotas. Little fishing for shortbelly rockfish and jack mackerel occurred, but the entire whiting harvest was taken and processed by U.S. operations. The whiting resource was again allocated between competing user groups by federal regulation.

The policy of using cumulative 2- and 4-week catch limits for individual vessels in 1992 was continued in 1993. The levels of these limits were intended to provide for a year-round fishery while keeping total catch within the harvest guidelines for each species or species group.

The PFMC took final action to apply the minimum trawl codend mesh size to the entire trawl net. This is expected to take effect sometime early in 1995.

As of January 1, 1994, limited entry permits for groundfish are 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, are allowed to continue fishing in an open access fishery. Trip limits and other management measures are 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, has been handled by the new limited entry office of NMFS in Seattle, Washington.

The PFMC continues working on an individual quota (IQ) program for fixed gear sablefish. If approved, the sablefish IQ program will only cover those vessels with limited entry permits and separate provisions will be made for the open access sablefish fishery. In April 1993, the PFMC formally adopted goals and objectives for a fixed gear sablefish IQ program. Final action on the proposal has been delayed until August 1994, and a proposal for a sablefish trip limit fishery will be considered as an alternative to IQs.

The PFMC is still considering a fishery observer program, contingent on amendment to the MFCMA to allow collection of fees to cover program costs. This issue has been moved up and down the PFMC's list of management priorities, and in April 1994 was again elevated to highest priority under sablefish IQs. An analysis will be prepared over the next several months for PFMC consideration later this year.

B. Review of Multi-Species Studies by Agency

1. Canada

a) Hecate Strait Project

Hecate Strait is an area of variable topography with a variety of bottom habitats, which supports an important mixed-species groundfish fishery. To date, six research surveys have been conducted; from 1984-1993, to obtain species abundance estimates and information on assemblages. Previous analyses have identified three characteristic assemblages of groundfish species. Recently, relationships between the dominant species of these assemblages and environmental conditions in early summer 1989 and 1991 have been identified. The environmental factors examined were bottom type and depth (invariant conditions), and temperature (a variable condition). Three categories of species were identified: (i) those consistently associated with particular depths and temperatures between years; (ii) those with variable depth and temperature associations; and (iii) those with no apparent relationships to depth, temperature or sediment type. Category (i) was dominated by flatfishes, and could be further separated into groups associated with deep and cool, shallow and warm, and intermediate depth and temperature conditions.

Category (ii) included roundfishes plus Pacific halibut, and were widely distributed. At least one species (Pacific cod) tended to maintain a particular temperature range while changing its depth range between years. Identification of significant associations between fish species and habitat conditions is the first step towards incorporating environmental information into survey abundance indices and reducing by-catch problems.

b) La Perouse Program

This program was continued in 1993.

This project is a multi-disciplinary, multi-species investigation conducted by the Pacific Biological Station and the Institute of Ocean Sciences in support of long-term management of the major fish stocks off the west coast of Vancouver Island. Initiated in 1985 following the large 1982/83 El Niño event in the Pacific Ocean, the primary focus of the La Perouse/MASS program has been directed toward describing and understanding the causes of annual and interannual variability of the fish and zooplankton stocks over La Perouse Bank on the southwest portion of the shelf. Located within the coastal upwelling production zone that extends from northern Vancouver Island to Baja California, La Perouse Bank is an extremely productive fishing area.

Considerable progress has now been made toward identification of the dominant physical processes affecting the circulation and water property structure, to quantifying the statistical variability of the seasonal and interannual cycles and toward direct estimation of the impact of interannual fluctuations on the planktonic food web.

2. National Marine Fisheries Service - AFSC

1993 West Coast Continental Slope Bottom Trawl Survey

The West Coast continental slope groundfish bottom trawl survey series was continued during 1993 in the area between Cape Lookout and Cape Blanco, Oregon (45°30' to 42°50'N lat.) between 183 and 1,280 m. 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, obtain information on their population biology, and to further describe the community structure and relate it to physical oceanographic factors such as depth, temperature, and salinity. The survey has been conducted annually since 1988 in different areas of the coast between the U.S.-Canada border and Point Reyes, California. The 1993 survey (October 12 - November 12) successfully sampled 125 stations with the standard slope-rigged Nor'eastern bottom trawl. 1993 catch rates of Dover sole were highest in the shallowest stratum and decreased with depth. In contrast to other surveys, however, the highest sablefish catch rates were seen in the shallowest stratum. Usually this species is more abundant in the middle depth strata of this type of survey. The two thornyhead

species exhibited their typical overlapping depth distributions with shortspine thornyhead dominating the two shallower strata, being displaced by longspine thornyhead in the deeper strata. Arrowtooth flounder catch rates were higher than seen in more southern areas, although this was expected since the survey area is near the southern extent of this species's range. Tanner crab catch rates were also generally consistent with earlier years, but with a slightly higher proportion of crabs in the two deepest strata.

The first day of the 1993 slope survey was spent observing the NMFS west coast slope poly Nor'eastern trawl in Puget Sound using direct diver observation and video to document the operating configuration of the Nor'eastern trawl with "mudsweep" roller gear confirming that, at least in shallow waters, it was tending bottom at towing speeds normally used during the slope survey. Results of the 1990-1993 west coast slope surveys are currently being integrated into a data report covering the region between Pt. Reyes, California, and the U.S.-Canada border. Publication is expected in November 1994.

A representative from the west coast commercial trawl fishing industry also joined us on the first leg of the slope trawl survey to get a firsthand look at sampling procedures, data collection, and trawl performance. Prior to the cruise he visited our net shed personnel to familiarize himself with the sampling gear and he had discussions with Gary Stauffer and Rick Methot concerning how trawl survey data are used to estimate abundance and in the management process. He freely shared his impressions with scientists, officers and crew of how he thought the net was performing in response to the physical and environmental conditions encountered during the slope survey. During the mid-cruise break in Coos Bay, Oregon, other local fishermen came aboard to discuss trawl gear design and performance and aspects of survey design.

Jean Rogers, a scientist from the SWFSC Tiburon Laboratory, joined RACE scientists on the first leg of the survey and collected 270 stomach samples from four slope groundfish species to study the trophic relations of slope groundfishes. Specimens of twoline eelpouts, Pacific grenadier, and giant grenadier were collected for graduate students at Moss Landing Marine Laboratory doing research on resource partitioning, age, and age validation using radiochemical techniques. The AFSC pathology lab collected 70 pathology samples from seven different slope groundfish species to monitor fish health. White muscle tissue samples from seven commercial slope species were obtained for the NWFSC's Environmental Conservation Division to assess the contamination of fisheries resources.

Gulf of Alaska Triennial bottom trawl survey

The fourth comprehensive triennial bottom trawl survey of western and central Gulf of Alaska groundfish resources was conducted between June 2 and September 8, 1993. The main objective was to describe the distribution, abundance and biological condition of various Gulf of Alaska groundfish stocks. The survey was conducted concurrently in the

central and western Gulf of Alaska by the RACE Division and in the eastern Gulf of Alaska by the ABL, which used the NOAA Miller Freeman from 20 July to 31 August to sample offshore waters <500 m depth from the U.S.-Canada boundary in Dixon Entrance to Cape St. Elias west of Yakutat, Alaska. A total of 153 successful hauls was completed. The data from both surveys have been combined for Gulfwide analysis of abundance trends.

The western and central Gulf of Alaska survey area is dominated by the continental shelf, which varies in width from approximately 10 nm in the westernmost region to nearly 100 nm off the Kenai Peninsula and Kodiak Island. Representing approximately 90% of the 76 thousand nm2 survey area, the continental shelf is cut by several 100-300 m deep gullies which extend from the outer shelf shoreward to the coast. These features, along with an extensive and complex shoreline bathymetry, provide a rich variety of habitat types for many commercially important juvenile and adult groundfish. Adjacent to the continental shelf, but representing only about 10% of the total survey area, the steep and rugged continental slope provides habitat for other important species. such as Pacific ocean perch, Dover sole, and adult sablefish.

A stratified random sampling design divided the continental shelf into 24 sampling strata based primarily on the 100 and 200 m depth contours and geographical features such as banks, gullies and flats. The 100-200 m, 200-300 m and 300-500 m depth intervals, which form narrow bands along the outer edge of the continental shelf, were divided into four additional strata corresponding to International North Pacific Commission statistical boundaries. Stations to be sampled were randomly selected within these strata, based on the coefficients of variation, mean CPUE, and sampling densities for all fish species combined from the 1984, 1987, and 1990 surveys. The 1990 survey results were given more weight in this process than the previous surveys. Successful trawls were achieved at 623 of the 674 sample sites visited, in depths ranging from 20 to 513 m, a 23% increase over the 508 stations sampled during 1990.

Arrowtooth flounder (*Atheresthes stomias*) had, by far, the highest abundance of any species, 1.4 million t, down approximately 21% from the 1990 triennial survey. Walleye pollock, with 750,000 t, was similar to its 1990 abundance, but with a major shift in its distribution from the Kodiak area to the Shumagin area. Species exhibiting large apparent increases in abundance included Pacific halibut, up 77% from 1990 to 558,000 t, and Pacific ocean perch, up 472% to 338,000 t. Several other rockfish species including rougheye and shortraker rockfish and shortspine thornyheads also showed large increases from the 1990 survey. The abundance of sablefish (213,000 t) and rock sole (181,000 t) increased moderately from 1990. In addition to arrowtooth flounder, other species showing decreases in abundance were flathead sole, down 22%, rex sole, down 17% and Dover sole and Atka mackerel, down 35% and 33% respectively. Pacific cod (405,000 t) and northern rockfish had the least change in abundance.

Bering Sea Crab/Groundfish Bottom Trawl Survey

The 1993 eastern Bering Sea crab-groundfish bottom trawl survey was conducted from June 1 to August 9, continuing the annual series of eastern Bering Sea resource assessment surveys which began in 1971. The primary purpose of the survey was to assess the abundance, distribution, and biological condition of the major demersal fish and crab resources on the eastern Bering Sea shelf. Further research included: collection of stomachs from various groundfish for use in trophic interaction studies; additional sampling in areas of high king crab and Tanner crab abundance to reduce variability of population estimates; collection of yellowfin sole ovaries to examine batch fecundity, spawning frequency, and mature ovarian cycling; retrieval and redeployment of bottom temperature sensors in Bristol Bay which record seawater temperatures for a 12 month period; a localized depletion experiment designed to evaluate capture probability of animals in the path of the standard research bottom trawl.

The survey encompassed an area approximately 465,000 km2 which 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. The survey was conducted aboard two chartered fishing vessels. A total of 476 bottom trawls were made using the standard 83-112 eastern bottom trawl. These included 376 successful and 6 unsuccessful hauls at scheduled sampling sites, 14 opportunistic hauls for additional king crab and Tanner crab abundance information, and 80 hauls near St. Paul Island for the localized depletion experiment. Seawater temperature profiles and tow bottom depths were collected at most sampling sites using micro-bathythermographs (MBT) attached to the headrope of the net.

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, age validation researcher, data manager/technician, and 9 age readers. 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, northern and dusky rockfishes, Atka mackerel, yellowfin sole, rock sole, rex sole, and misc. sole and rockfish species.

Craig Kastelle's radiometric age validation work on sablefish has been accepted for publication, and work is proceeding to extend this work to investigate the ageing of several rockfish species: Pacific Ocean perch, shortspine thornyheads, shortrakers, rougheye, northern and dusky.

Delsa Anderl has teamed up with Dr. Akira Nishimura of Japan's National Research Institute of Far Seas Fisheries to complete her study on the first year growth in the otoliths of Atka mackerel. Dr. Nishimura brought expertise in SEM work that was needed on the study.

he Age Unit is now close to establishing a radiometric lab for ageing and age validation work on fishes. We believe this to be the first lab of its type established by the National Marine Fisheries Service.

The unit has also completed its purchase of a video imaging system with Optimus software. The equipment will be used in otolith growth studies and to investigate the possibility of video assisted ageing.

Trophic Interactions Program - REFM

The Trophic Interactions Program continued regular collections of food habits information on key fish predators in the North Pacific. Program personnel and fishery observers collected fish stomachs. About 11,237 and 6568 stomachs were collected from the Bering Sea and Gulf of Alaska, respectively. Bering Sea species sampled were walleye pollock, Pacific cod, yellowfin sole, Alaska plaice, rock sole, flathead sole, skates, arrowtooth flounder, Greenland turbot and Pacific halibut. Gulf of Alaska species sampled included walleye pollock, arrowtooth flounder, Pacific cod, Pacific halibut, sablefish, Pacific ocean perch, and miscellaneous rockfish species. Shipboard scans of fish stomach contents were performed on 436 fish (primarily walleye pollock) in the eastern Bering Sea. Laboratory analysis of stomach contents by regions totalled 6479, 4879, 1063, and 1787 stomachs for the Bering Sea, Gulf of Alaska, Aleutian Islands, and West coast regions, respectively. The University of Wisconsin fish bioenergetics model has been parameterized to predict walleye pollock rations in the eastern Bering Sea using quarterly pollock growth data for the southeast and northwest shelf areas. Results obtained thus far show, for example, spring and summer rations of age 4 pollock to be about 2.2% body weight daily while autumn and winter rations were estimated to be 0.6% body weight daily. Seasonal variation in food intake affects estimates of prey consumption, including cannibalism by walleye pollock.

A collection of gill arches from common North Pacific marine fish is available in the Trophic Interactions Program laboratory. Gill arch specimens from about 84 species of fish have been archived. Photographs and data on gill raker counts for each specimen are available. The primary use of these specimens is to aid in species identification of fish consumed by groundfish.

A report detailing the food habits of important groundfish species in the Gulf of Alaska has been completed. A total of 4,429 stomachs from 11 species of groundfish (Walleye

pollock (Theragra chalcogramma), Pacific cod (Gadus macrocephalus), arrowtooth flounder (Atheresthes stomias), Pacific halibut (Hippoglossus stenolepis), sablefish (Anoplopoma fimbria), Pacific ocean perch (Sebastes alutus), northern rockfish (Sebastes polyspinis), dusky rockfish (Sebastes ciliatus), rougheye rockfish (Sebastes aleutianus), shortraker rockfish (Sebastes borealis), and shortspine thornyhead (Sebastolobus alascanus)) collected in the Gulf of Alaska in summer 1990 were analyzed. Stomach content analysis showed that arrowtooth flounder, Pacific halibut, sablefish, Pacific cod, and pollock were the main piscivores. Walleye pollock was the most important food of arrowtooth flounder and Pacific halibut, comprising 66% and 57% by weight of the total stomach content weight, respectively. Schoener's indices were calculated to compare the diet overlap between the species. Arrowtooth flounder and Pacific halibut had a high dietary overlap value of 64%. The overlap values between Pacific halibut, sablefish, and Pacific cod were moderate. Walleye pollock had low dietary overlap with the piscivores and moderate overlap with the rockfishes.

A manuscript comparing walleye pollock diet and cannibalism patterns between the early 1970's and 1985-1989 period in the eastern Bering Sea has been completed. The contribution of copepods to the diet by weight was related more to predator size than to year with the diet of small pollock containing more copepods than the diet of large pollock. The percent weight of euphausiids in the diet was relatively constant by year and was similar between small and large pollock. There was a definite trend in cannibalism by pollock size and year. The degree of cannibalism appeared to be directly related to the abundance of age-0 and age-1 walleye pollock in each year. Although cannibalism is an important aspect of walleye pollock feeding behaviour, consumption of euphausiids and copepods by the pollock population as a whole dominates the food intake.

The stock synthesis model (Methot 1989, 1990) was used to incorporate predation by adult walleye pollock (Theragra chalcogramma), Pacific cod (Gadus macrocephalus), and northern fur seals (Callorhinus ursinus) into a population model of walleye pollock in the eastern Bering Sea. These predators were thought to be the main sources of predation mortality for age 1+ walleye pollock based on estimates by Livingston (1989, 1993). Predators were entered into the model as "fisheries" by defining 1) a time series of predator abundance (i.e., effort) over the whole modelled period, 2) a series of predator consumption data (i.e., catch per unit effort) for each predator for each year where food habits data were available, and 3) the age composition of pollock consumed for each year where food habits data were available. When removals by these 3 predators are included in the model, estimates of age-1 pollock numbers were much higher than in the model without predation. However, estimates of age 3 numbers were very similar between model versions with and without predators because most predation occurs on pollock younger than age 3. Predation mortality of pollock at age 1 was primarily due to cannibals and showed a large increase beginning in 1983, the year when the large 1978 yearclass of pollock reached age 5, the first age when predation on age 1 fish begins. Predation mortality at age 2 was due to predation by cod and fur seals and estimated rates were

relatively constant over the time period at about 0.05 yr-1. Model estimates of age 1 recruits and spawning biomass shows an asymptotic relationship, implying that mortality rates at age 0 are density-dependent. The exceptions to this appear to be the years of 1978 and 1982, which were years with an unusually large pollock yearclass. Variation in pollock recruitment has also been linked to environmental factors (Quinn and Niebauer, 1992). Presumably, the environment for pre-recruits of those two yearclasses was favorable in a way that enhanced normal survival rates of young pollock. The change in the shape of the recruitment curve from an asymptotic relationship for age 1 recruits (Fig. 3) to a curve with an even steeper decline in number of age 3 recruits at high spawning stock sizes (Fig. 4) highlights the importance of cannibalism on age-1 pollock. The apparent effect of cannibalism on age 1 fish is to depress the number of fish recruiting into the fishery at age 3 at large spawning stock sizes.

e. Stock Assessment

Status of Stocks and Multispecies Assessment Task

The Status of Stocks and Multispecies Assessment Task is responsible for preparation of annual stock assessment documents for groundfish in the three management regions (Bering Sea/Aleutian Islands, Gulf Of Alaska, and Washington-Oregon-California). In addition, Task members conduct research to improve the precision of these assessments, and provide technical support for the evaluation of potential impacts of proposed fishery management measures.

During the past year, 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 for the groundfish management team of the Pacific Fishery Management Council. These included a substantial new modelling effort for Greenland turbot in the Eastern Bering Sea, an analysis of potential rebuilding for Pacific ocean perch in the Gulf of Alaska, and a significant reevaluation of survey data for Pacific hake.

Assessment scientists also provided analytic assistance on many current fisheries management issues. These included: 1) 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) identification and prioritization of research activities that may lead to improved rockfish stock assessments; 3) experiments to develop an acoustic tag to monitor the mortality of halibut discarded in trawl fisheries; 4) modelling of pollock stock structure in the Bering Sea; and 5) biological assessment of hake allocation between the U.S. and Canada and between shoreside and at-sea processors in the U.S.

Research activities spanned a broad range of topics. Field studies initiated by staff members included pilot trawl surveys in collaboration with the fishing industry, and

maturation studies for slope rockfish, Pacific hake, and Pacific cod. Significant research contributions on sablefish growth, bycatch analysis, pollock cannibalism, and bioeconomic modelling of pollock stock dynamics were presented at various symposia. In addition, staff members participated on nationwide NMFS committees for age-structure modelling, risk assessment in stock assessment analyses, and review of overfishing definitions.

Observer Program - REFM

The Fisheries Observer Program is responsible for placement of observers on vessels fishing for groundfish species in the EEZ of the northeastern Pacific Ocean and Bering Sea. Observers collect data which provide the basis for in-season management of the groundfish fisheries by NMFS, provide a means for evaluating and developing management strategies by regional management councils and NMFS, and are used in the stock assessment process. Observers play important roles in providing information that is critical to the continuation of the U.S. fishing industry.

During 1993, 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 503 observers to vessels fishing off Alaska, and 20 observers to 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 groundfish fishery.

3. Oregon Department of Fish and Wildlife

Staff participated in RecFIN committee work and planning. Sampling was conducted in 1993 and continues in 1994.

Coastwide species composition sampling continues on recreational catches.

Species composition sampling of rockfish and thornyheads continues on commercial trawl landings. A few species composition samples have been taken from fixed gear landings.

Cumulative trip limits were again used in 1993, and seemed to be appreciated by both fishermen and enforcement agents. Trip limits changed from by-weekly to monthly in 1994.

Completed one cruise evaluating the reduction of groundfish bycatch in the pink shrimp trawl fishery produced by a soft mesh fish excluder; results look promising. In 1994 we expect to begin a Staltonstal-Kennedy funded research project examining the effectiveness of a variety of bycatch reduction devices in the pink shrimp trawl fishery; approximately 27 days of research charter work spanning 94-95.

Under the Pacific whiting observation program, we continue to coordinate the sampling of by-catch from landings made to shoreside processors. We also collect and analyze the data including data on by-catch discard at sea. Some samples of sardine were collected for CDFG.

CORE studies:

The Cooperative Reef Ecosystem study (C.O.R.E.) continued work on subtidal rocky bottom habitats off the southern Oregon coast near Port Orford. A dive survey to characterize sea urchins and habitat of Orford Reef was completed. A combined SCUBA and submersible study of the reef was accomplished in September. Fish, invertebrate, and habitat associations were investigated. Comparisons were made between SCUBA and submersible methods of observation.

The shellfish/Habitat Program will begin a survey of kelp bed fish, invertebrates, algae, and habitat characteristics in 1994. The survey will continue for several years and will be performed in conjunction with experimental kelp harvest to begin determining potential kelp harvest impacts.

C. By species, by agency

1. Pacific Cod

a. Alaska Department of Fish and Game

a) Research

Catch rate and biological information is gathered from fish ticket records, port sampling programs, and during stock assessment surveys for other species. A logbook program was initiated in 1992, but to date no results have been determined.

b) Management

Regulations adopted by the Alaska Board of Fisheries during November 1993 established guideline harvest range (GHR) of 340 to 570 mt for Pacific cod in the internal waters of Southeast Alaska. The department will manage the fishery within that range with the pre-season harvest objective set according to the best available information. The GHR was

based on average historic harvest levels rather than on a biomass-based ABC estimate.

c) 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. Prior to 1993 much of the cod taken in Southeast was utilized as bait in fisheries for other species. Cod harvested in 1993 were evenly divided between bait use and human consumption. 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 totalled 1,888 mt in state-managed fisheries during 1993.

b. Washington Department of Fish and Wildlife

No active programs.

c. Canada

a) Research programs

Pacific cod are currently aged with length frequency analysis. As part of a new study to validate ageing methods, monthly stratified samples of Pacific cod dorsal fin rays and otoliths from Hecate Strait were collected throughout the year to track seasonal growth patterns and to determine the timing of annulus formation. The first series of dorsal fin rays have been examined and were found to be highly variable. Monthly sampling will be continued in 1994 to allow the examination of annuli formation from a single cohort over several years.

b) Stock assessments

Pacific cod stock assessments were presented for four areas on the British Columbia coast. No new analysis were conducted for the Strait of Georgia or Queen Charlotte Sound stocks where fisheries are small and of low management priority. Major new catch-at-age analysis were conducted for the west coast of Vancouver Island and Hecate Strait stocks. Results indicate that fishing mortality rates and fishing effort are at above average levels in both areas. Stock abundance is around average for the west coast of Vancouver Island and is below average levels for Hecate Strait. Yield recommendations were based on a one year projection from a Bayesian procedure. Biological sampling from 1993 and early 1994 does not indicate a strong incoming year-class.

c) Management

Annual 1994 quotas of 3850 t and 2170 t are imposed for Hecate Strait and the west coast

of Vancouver Island, respectively. A coastwide trip limit of either 40,000 lb, 20,000 lb or 5,000 lb, depending on which landing option (number of trips/month) the license holder opted for, is in effect for the first quarter. Trip limits for the remaining fishing periods will be determined at a later date through consultation with the Groundfish Trawl Advisory Committee.

d. National Marine Fisheries Service - AFSC

a) 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%), followed by a 26% increase in 1993. Following four consecutive years of well-below-average recruitment, two strong year classes have been observed at age 3 in 1992 and 1993.

The current stock assessment model was developed using the stock synthesis approach. It differs from the model developed for last year's assessment primarily in that it is a length-based assessment rather than an age-based one. The change in methodology was prompted by concern over possible misaging of Pacific cod. The new model tracks the size compositions from both the fishery and the survey, where the fishery is composed of winter trawl, summer trawl, longline, and pot components. Root-mean-squared errors ranged between 2% and 5% for the survey and the four fishery components.

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 level of spawning per recruit to 30% of its pristine value. This fishing mortality rate ($F_{30\%}$) is 0.43 (full selection value), which corresponds to a 1993 catch of 142,000 t for the EBS and Aleutians combined.

For some recent years, the $F_{0.1}$ strategy was used to recommend ABC values. However, the current estimate of $F_{0.1}$ (0.54, full selection value) exceeds $F_{30\%}$, making this strategy inadmissible. As an alternative, and to provide a buffer between the overfishing level and ABC, the $F_{35\%}$ fishing mortality rate (0.35, full selection value) was used to arrive at a 1994 ABC of 191,000 t for the EBS and Aleutians combined.

b) Gulf of Alaska

As in previous years, stock reduction analysis (SRA) was used in this stock assessment, incorporating biomass estimates from the 1984, 1987, and 1990 bottom trawl surveys. As

before, the assessment projects further declines in the stock. The $F_{0.1}$ harvest strategy (F=0.17) was again used to recommend ABC, giving a 1994 catch of 50,400 t. Overfishing is defined to occur at F=0.24, or a 1994 catch of 71,100 t.

In anticipation of a change in methodology for next year's assessment, a preliminary analysis using a length-based Synthesis model was also conducted. A smooth transition from the SRA model was achieved by imposing a number of constraints on Synthesis, thus forcing it to mimic SRA, then relaxing the constraints one at a time. The results of this preliminary analysis suggest that both fishery and survey selectivities may be strongly peaked at an intermediate size, meaning that the survey estimate of biomass may be biased downward.

e. Oregon Department of Fish and Wildlife

No work was conducted on Pacific cod.

2. Shelf Rockfish

a. Alaska Department of Fish and Game

a) Research

Port sampling, skipper interview, and logbook programs used by ADF&G to monitor the demersal shelf rockfish fishery continued in Southeast Alaska through 1993.

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. Otoliths were obtained from principal demersal shelf rockfish species and sent to the age-reading laboratory in Juneau for age determination. Data from these programs is entered on a microcomputer in Sitka. (Contact Victoria O'Connell, ADF&G, 304 Lake St. Room 103, Sitka, AK 99835)

Approximately 300 otoliths were collected from port samples of black rockfish in the Kodiak area. The structures were read at the Kodiak age-reading laboratory and the data is being compared to black rockfish ages from Southeast Alaska. (Contact Al Spalinger, ADF&G, 211 Mission Road, Kodiak, AK 99615)

b) Stock Assessment

One rockfish survey was conducted during 1993. The *F/V Ida June* was contracted to conduct relative abundance indexing on the Fairweather Grounds in the East Yakutat

Section during May and early June. The objective was to collect summer catch rate and biological information to compare with late winter and early spring when the fishery is usually conducted. (Contact Victoria O'Connell, ADF&G, 304 Lake St. Room 103, Sitka, AK 99835)

c) Management

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

Separate harvest ranges have been established for each of six Southeast Alaska management areas based upon the best available information on the condition of rockfish stocks in each area. New regulations adopted in 1993 include reduced GHRs in internal waters, reduced weekly trip limits, and a requirement that logbook pages must be submitted weekly with fish tickets from each fishing trip. These new regulations will be implemented in 1994. (Contact Barry Bracken, ADF&G, P.O. Box 667, Petersburg, AK 99833)

Rockfish management plans were adopted and implemented for the Prince William Sound and the North Gulf Coast Districts during 1993. The provisions of the plan place a trip limit on all landings and a reversion to bycatch status when an annual harvest limit has been reached. (Contact William Bechtol, ADF&G, 3298 Douglas St., Homer, AK 99603)

Harvest limits were implemented for black rockfish in two areas near Kodiak during 1993. Harvest rates were low during 1993 and in-season closures were not required. (Contact Tom Dinnocenzo, ADF&G, 211 Mission Road, Kodiak, AK 99615)

d) Fisheries

Harvest of rockfish from state-managed fisheries totalled 844 mt in 1993. Over 90% of the harvest was taken in Southeast Alaska; with most of the remainder reported from Prince William Sound and the North Gulf Coast. 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.

b. Washington Department of Fish and Wildlife

Black rockfish

This project is designed to collect biological and fisheries data and to produce population estimates for black rockfish *(Sebastes melanops)* off the Washington coast. A pilot study to assess the feasibility of using Genetic Stock Identification (GSI) as a technique to identify stock structure is underway. Analysis using the Stock Synthesis model is currently in progress.

Yellowtail rockfish

An updated assessment of yellowtail rockfish was completed in 1993 and an ABC of 6,740 was recommended for the U.S. Vancouver-Columbia-Eureka areas. The previous ABC for these areas was 4700 mt and the catch in 1992 was 6029 mt. The increased ABC is due to evidence from trawl surveys that biomass has not declined in recent years, and evidence in fishery age composition data of strong year classes in 1983 and 1984.

c. Canada

a) Research programs

Onboard monitoring of the live hook and line fishery in 1993 continued in the Johnstone Strait and central Strait of Georgia fishing areas. Onboard monitoring was also expanded to the southern Queen Charlotte Islands. Biological sampling continued for the major fishing areas coastwide.

b) Stock assessment

For inshore rockfish, further improvements were made to the habitat based assessment. Rockfish habitat area (km^2) by management statistical area was refined by fishermen's knowledge of suitable bottom types.

An interim assessment of shelf rockfish stocks was presented for the 1993 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. An updated assessment for widow rockfish (*S. entomelas*) re-evaluated the performance of the fishery for this species in B.C. waters relative to the fishery off Washington and Oregon.

c) 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.

There were considerable changes to the management of trawl-caught shelf species which are reported under Slope Rockfish.

d. National Marine Fisheries Service - AFSC

a) Gulf of Alaska - Pelagic Shelf Rockfish

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 a bottom trawl fishery in recent years. A jig fishery for black rockfish, which developed in the central Gulf of Alaska in 1991 and 1992, diminished greatly in 1993. Current exploitable biomass for the pelagic shelf assemblage is based on the average of the biomasses estimated in the 1984, 1987, and 1990 triennial trawl surveys: 76,500 mt. Results of these surveys, however, are highly uncertain for rockfish, 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 6,886 mt for 1994.

e. Oregon Department of Fish and Wildlife

a) Black Rockfish

A stock assessment for the north coast stock component was completed and included in PFMC's 1993 status of stocks report.

The recreational bag limit for black rockfish was reduced from 15 to 10 fish, effective 1/1/94.

Commercial fishery restrictions have been proposed and will likely become effective in late 1994 (state) and early 1995 (federal). Trip limits of 65 fish or 200 pounds, whichever is

greater, will be in effect for all gears except trawl for many areas off the Oregon coast.

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

Widow rockfish from Cobb Seamount continue to be 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.

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.

f. National Marine Fisheries Service-SWFSC

New genetic studies of rockfish (Sebastes) are being initiated by the Coastal Division in three areas: 1) determination of phylogenetic relationships among species, 2) development of genetic techniques for identification of eggs and early stage larvae, not identifiable by other means (by amplification and sequencing of larval DNA followed by comparison to adult sequences from phylogenetic studies), and 3) analysis of rockfish population structure based on microsatellite DNA allele frequencies.

g. Pacific Fishery Management Council

In 1992, the PFMC changed the manner in which trip limits were 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 Coos Bay, and no more than 10,000 pounds of bocaccio south of Cape Mendocino. In late April 1993 the 2-week cumulative limit for yellowtail rockfish caught north of Coos Bay was reduced to 6,000 pounds, and in October the bocaccio limit south of Cape Mendocino was increased to 15,000 pounds. For 1994, the cumulative trip limit for Sebastes complex is 80,000 pounds per calendar month. Within this, no more than 14,000 pounds may be yellowtail rockfish caught north of Cape Lookout (not Coos Bay, as in 1993), no more than 30,000 pounds may be yellowtail rockfish caught south of Cape Lookout, and no more than 30,000 pounds may be bocaccio caught south of Cape Mendocino.

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. This same management was continued in 1994.

The 1993 widow rockfish fishery operated under a cumulative 4 week limit of 30,000 pounds through December 1, then was then was reduced to an incidental catch limit of 3,000 pounds. The harvest guideline was reached about November 6. The 1994 coastwide harvest guideline for widow rockfish was reduced to 6,500 mt, and the cumulative trip limit was set at 30,000 lbs per month.

3. Slope Rockfish

a. Alaska Department of Fish and Game

a) Management

In Southeast Alaska slope rockfish are managed as part of the "other rockfish" complex which have an area-wide annual harvest limit of 500 mt. In the Central Region slope rockfish and shelf rockfish are managed as a single complex. Slope rockfish are included in the trip limits and annual harvest objectives under the Central Region's Rockfish Management Plan.

b) Fisheries

In all state-managed waters of Alaska slope rockfish harvest occurs primarily as bycatch in fisheries for other species, primarily hook-and-line fisheries for halibut and sablefish.

b. Washington Department of Fish and Wildlife

No slope work to report.

c. Canada

There was considerable discussion about the management changes, in particular aggregations and trip limits.

a) Research Programs

A study of the early life history of Pacific ocean perch (*Sebastes alutus*) was continued for a third year in 1993. This study examines the distribution and abundance of larvae in relation to physical oceanographic features. The objectives are to understand the physical

process of recruitment from larval to juveniles stages, identify the factors governing cohort success and determine the fidelity of reproductive output to the parent stocks among the gullies surrounding Queen Charlotte Sound and the west coast of Vancouver Island (Gillespie et al. 1993). Sampling in 1993 was conducted in the third month post-parturition (June) and found that peak larval abundance was still in relatively deep water (75-124 m), although shallower than the 175+ m modal depth recorded in 1991-1992. Larvae also remained localised near the spawning areas but had moved closer inshore and nearer the centre of Goose Island Gully. These observations provided additional support for an alternative recruitment hypothesis for these deepwater spawners, compared with species whose larvae are near the surface after spawning. The distribution of *S. alutus* larvae at 100+ m for such protracted periods supports a mechanism forced by minimal southeast winds and maximal upwelling. Larvae appear to rely on the slower upwelling bottom waters to move them onto the continental shelf and into the gullies. Thus, good recruitment should be correlated with strong northwest winds during the late spring and early summer, to maximize upwelling.

Investigations of the effects of school and diel behaviour 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, with increased diurnal variance over nocturnal but no bias in the estimated total biomass (Kieser et al. 1993). A paper which partitions the survey-based and behaviourally-based components of variation in biomass estimation has been prepared. In addition, a paper which presents a method for correcting bias in acoustic measurements of fish school dimensions was published (Kieser et al. 1993).

A combined hydroacoustic and trawl survey is planned for summer 1994 in Queen Charlotte Sound. It is hoped that the survey will resolve some of the uncertainty in Pacific ocean perch abundance identified in the 1993 assessment.

b) Stock assessments

Among slope rockfish species, detailed data are available for Pacific ocean perch in the Queen Charlotte Sound region only. A major assessment update was conducted for this region in 1993, including a re-examination of CPUE as an abundance index and a catch-age analysis based on 1963-92 data. One conclusion was that the management strategy of variable trip limits altered the catch-effort pattern in the rockfish fishery, with the consequence that CPUE had questionable value as an abundance index. CPUE was positively correlated with the magnitude of the trip limit. No recent fishery-independent data were available as an alternative abundance index. The last biomass survey in Queen Charlotte Sound was conducted in 1984. Without a suitable index for `tuning' the catch-age analysis, the age structure data were equally consistent with a continuation of the stock decline in Goose Island Gully or a complete recovery from foreign overharvesting during the late 1960s and early 1970s. The development of a fishery-independent

abundance index for this stock is a high priority.

Reviews of the management of B.C. marine fishery resources using F-based reference points (Leaman 1993) and of the experimental management programs for rockfish stocks in B.C. waters were published (Leaman and Stanley 1993).

c) Management and regulations

Significant changes in rockfish management were introduced in the 1994 trawl management plan. Coastwide trip limits and quarterly quotas now apply to four aggregates, defined as follows:

A. Pacific ocean perch, yellowmouth rockfish, rougheye rockfish, canary rockfish, silvergray rockfish and yellowtail rockfish.
B. Redstripe rockfish and widow rockfish.
C. Shortraker rockfish and shortspine/longspine thornyheads.
D. All other rockfish species.

Vessels choose among three options which vary in the number of landings permitted in a 30-day period and in the size of their respective trip limits. In addition, overages of up to 20% of the trip limit are permitted, provided that a reconciliation occurs on a future trip. Proceeds from excess overages are placed in an industry-managed fund dedicated to groundfish research. A mandatory port monitoring program has also been established to verify rockfish landings.

d. National Marine Fisheries Service - AFSC

a) Gulf of Alaska - Rockfish Bottom Trawl Experiment

A bottom trawl experiment was completed by ABL off southeastern Alaska in July 1993 using the RV John N. Cobb to determine if rockfish are captured while trawl gear is retrieved. The experiment used a 400 mesh eastern otter trawl towed along the bottom at depths of 200-280 m. Catch rates from six "standard" trawl hauls were compared to those from six "retrieval" trawl hauls. During the "standard" hauls, the net swept the seafloor for 10 min at a vessel speed of 5.5-6.0 km/h, and then was found to remain on the bottom an additional 7-9 min while retrieved at a vessel speed of 4-5 km/h. During "retrieval" trawl hauls, the net sank to the seafloor and then was immediately retrieved, and it again was found to remain on the seafloor 7-9 min while the vessel speed was 4-5 km/h. Catch rates per unit habitat were similar for either haul type, averaging 34.9/1,000m^2 during

"standard" trawling and 29.8/1,000m^2 during "retrieval" trawling. This suggests that when the net is on bottom during retrieval, it continues to fish nearly as well as during the "standard" haul duration.

b) Rockfish Hydroacoustic Studies

During the 1993 eastern Gulf of Alaska triennial trawl survey on the RV Miller Freeman, near-bottom fish targets were quantified using the vessel's Simrad EK-500 sonar system. In a previous study, when high concentrations of Pacific ocean perch were observed from a manned submersible (Krieger 1993), their vertical distribution ranged from 0-7 m above the seafloor. A proportion were always distributed >1 m off bottom, suggesting that these fish may be accessible to sonar monitoring. If integrated sonar data is correlated with trawl catch rates of Pacific ocean perch, sonar may have application as an alternative assessment method for Pacific ocean perch. Analysis of these data is in progress.

c) Genetic Stock Identification of Slope Rockfish

During the 1993 triennial trawl survey in the eastern Gulf of Alaska, a combined total of 450 shortraker and rougheye rockfish were sampled for electrophoretic and DNA analysis. Samples of heart, liver, eye, and muscle tissues were taken. These samples are currently being analyzed. Plans for 1994 include collection of genetic samples of shortraker and rougheye rockfish from the Aleutians Islands region and collection of genetic baseline samples for other rockfish species the eastern Gulf of Alaska. Results will be used to determine if separate genetic stocks exist for various species of slope rockfish and to verify the species identification of larval and post-larval rockfish.

d) Pilot Rockfish Trawl Survey

As a continuation of the Center's Rockfish Working Group effort to evaluate whether commercial trawl operations could be adapted to improve rockfish surveys, working group scientists from the REFM, ABL and RACE Divisions conducted a pilot rockfish trawl survey operation aboard a commercial trawl vessel in the Yakutat area of the Gulf of Alaska during September 1993. The vessel was the F/V Unimak Enterprise, considered to be among the best as far as having expertise in fishing slope rockfish. To defray the charter costs, the vessel was allowed to retain and process the catch for later sale. The trial operations focused mainly on shortraker and rougheye rockfish, with objectives of evaluating the following research aspects: use of a stratified-random design modified for rockfish; the feasibility of a Leslie-DeLury application in random areas; and shipboard sampling methods. A survey approach using commercial vessels combining random and fixed station indexing of relative abundance is currently being formulated for working group evaluation and critique. For this, data from the 1993 study will be used to compute necessary number of stations. Following further evaluation, Leslie-DeLury experiments may be recommended on a "one-time" basis to survey fishing power. Development of

efficient shipboard sampling will be further evaluated.

e) Bering Sea - Pacific Ocean Perch

The POP complex consists of true POP (*Sebastes alutus*) and four other red *Sebastes* species (northern rockfish, rougheye rockfish, sharpchin rockfish, and shortraker rockfish). Prior to 1991, the complex was managed as a unit in each of the two management areas. In 1991, the North Pacific Fishery Management Council enacted new regulations that changed the species composition of the POP complex. For the eastern Bering Sea slope region, the POP complex was divided into two subgroups: 1) Pacific ocean perch, and 2) shortraker, rougheye, sharpchin, and northern rockfishes combined. For the Aleutian Islands region, the POP complex was divided into three subgroups: 1) Pacific ocean perch, 2) shortraker, rougheye rockfishes, and 3) sharpchin and northern rockfish. These subgroups were established to protect Pacific ocean perch, shortraker, rougheye, and northern rockfishes from possible overfishing. Each subgroup is now assigned an individual total allowable catch (TAC).

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 Council 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 1994 ABC is based on a harvest strategy that reduces the equilibrium level of spawning biomass per recruit to 44% of the pristine level ($F_{44\%}$). This strategy results in a fishing mortality rate of 0.062 for both the eastern Bering Sea and Aleutian Islands stocks, resulting in ABC estimates of 1,907 t and 10,890 t, respectively. The 1994 overfishing limit for *S. alutus* is based on a harvest strategy that reduces the equilibrium level of spawning biomass per recruit to 30% of the pristine level ($F_{30\%}$). Given current estimates of exploitable biomass and estimates of full-selection F for the two areas as 0.096, the corresponding overfishing levels are 2,919 t and 16,633 t for the eastern Bering Sea and Aleutian Islands, 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 Council'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 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.

f) 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 ADF&G 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 1960's. In 1993, the "stock synthesis" model was applied to Pacific ocean perch. This model incorporates age composition, in addition to using other parameters such as fishery CPUE and estimated biomass from the triennial trawl surveys. Based on this model, our best estimate of exploitable biomass for Pacific ocean perch in the Gulf of Alaska is now 101,800 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.

Biomass estimates from the 1993 triennial trawl survey have recently become available, and they indicate what appear to be large increases in the biomass of slope rockfish. For example, the estimated Gulfwide biomass for Pacific ocean perch increased from 132,369 mt in the 1990 survey to 460,755 mt in 1993. The plausibility of such a large fluctuation in biomass needs to be examined.

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. Age samples from the 1993 triennial survey, which are presently being processed, should provide updated information on year class strength.

To prevent possible overexploitation of the more desirable species, the slope rockfish assemblage is divided into four subgroups: Pacific ocean perch, shortraker/rougheye rockfish, northern rockfish, and other slope rockfish. Separate ABC's are assigned to each subgroup. Pacific ocean perch are presently managed using an adjusted $F_{45\%}$ strategy, where the ABC is adjusted downward in proportion to the ratio of current biomass to a target biomass. Target biomass is set at 150,000 mt of female spawning 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, 3,030 mt; shortraker/rougheye rockfish, 1,960 mt; northern rockfish, 5,760 mt, and other slope rockfish, 8,300 mt.

e. Oregon Department of Fish and Wildlife

Slope rockfish: Most sampling is limited to species composition sampling.

f. National Marine Fisheries Service-SWFSC

The SWFSC Tiburon Laboratory conducted assessments on the chilipepper, darkblotched and widow rockfish fisheries. The assessments were published in the PFMC Status of Stocks document.

Tiburon Laboratory's recruitment work, which aims to detect differences in relative strength of rockfish year-classes prior to their entry into the fishery, continues. Annual surveys using midwater trawls determine the relative abundance and distribution of first-year juvenile rockfishes off the coast of central California. Recently these surveys were expanded to include abundance and growth during an earlier larval stage. During February and March 1993 extensive surveys were conducted off Central California with MIK trawl gear. The MIK trawl (5 m2) 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 that are

published in Technical Memoranda.

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

The Tiburon Laboratory is collaborating with the AFSC on an OTC-based study of sablefish age determination, with the intent of developing criteria that will improve reader agreement which has been poor for sablefish captured off California, Oregon and Washington. About 2500 fish were released in 1991. About 200 fish have been recaptured, and otoliths from those fish are being examined by Tiburon and AFSC scientists.

The SWFSC's Tiburon Laboratory has been studying the physiological ecology of yellowtail rockfish. Fecundities of yellowtail rockfish were compared to determine interannual variability and geographic variation, thereby assisting in stock assessment, characterization, and management. Seven years (1985-1991) of fecundity data for the central California population and three years (1989-1991) for Washington fish were analyzed. Egg production was found to be high for rockfishes and it increased linearly and sigmoidally with body weight and length, and asymptotically with age. Significant interannual differences were found in fecundities of young (< age 15) fish from California while no differences were observed in older California (> age 14) or in young or old Washington fish. Washington yellowtail rockfish had higher group fecundities because they were larger at age. Rate-specific fecundities were significantly higher in young Washington fish. Findings showed age-dependent inter-annual and geographic differences in reproductive effort, which suggest unique population-specific reproductive life histories.

Nutritional dynamics of yellowtail rockfish were analyzed from the perspective of temporal changes in tissue composition of liver, muscle, mesentery and gonad to determine dynamics specific to female reproduction. Data indicated that females accumulated somatic tissue energy reserves, mainly in the form of lipid, during summer months. Maternal lipid and protein reserves were depleted in a reciprocal relationship with ovarian growth during the winter. Greatest declines of lipid and protein occurred in mesenteries and muscle, respectively. Data revealed approximately 40% greater loss of

somatic tissue from females than males during the time interval from ovarian development to parturition. Patterns of lipid and protein accumulation and selective utilization were identified. This study is the first report of comprehensive tissue composition dynamics and allocation to reproduction in viviparous marine teleost.

Laboratory experiments were completed that determined the routine metabolic rates of adult female yellowtail rockfish during gestation. The pattern of maternal oxygen consumption during gestation showed that metabolic demands did not become significantly elevated until embryos had hatched and larvae were being incubated. Female rates at this latter stage of gestation were 82% higher than spent females and 101% higher than those of non-gestating males. In-depth analyses of embryonic and larval caloric utilization during gestation provided further evidence that these early life stages are primarily lecithotrophic.

This year the SWFSC Tiburon Laboratory undertook comprehensive studies of reproductive life history of shortbelly rockfish. Adult specimens were collected and examined for condition and reproductive states and fecundity throughout the reproductive season at approximate monthly intervals. Simultaneous studies of larval distribution, abundance, and physiological condition are being conducted. These efforts should help delimit the spawning season and provide insight into factors relating to larval production and survival.

4. Thornyheads

a. National Marine Fisheries Service - AFSC

a) 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 fm. 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 1994. The 1993 catch was 1,363 t and the stock is fully exploited.

b. 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.

c. National Marine Fisheries Service-SWFSC

Several projects designed to improve management of thornyhead (Sebastolobus sp.) stocks are underway at the SWFSC Coastal Division. The first project is a joint effort involving scientists at Scripps Institution of Oceanography, Moss Landing Marine Laboratory and the University of Hawaii that involves use of radioisotope ratios to validate criteria used to age shortspine and longspine thornyhead. Coastal Division personnel are also participating in an effort by the Alaska Fisheries Science Center to update assessments for shortspine and longspine thornyheads north of Point Conception. A paper is in preparation describing relationships between depth and length of shortspine and longspine thornyhead off Oregon and California.

The Coastal Division's molecular genetics project has focused on long- and shortspine thornyhead. However, Dover sole and sablefish have also been sequenced. Mitochondrial DNA sequences from populations of thornyhead from Alaska, Oregon and 5 sites in California have now been sequenced. The data show a high degree of site specific variation indicating less mixing of populations than was originally anticipated. The results suggest that even though both thornyhead species have protracted larval and juvenile stages of greater than one year, they are retained to some degree in their natal regions. The influence of various current patterns on larval retention is being investigated.

d. Pacific Fishery Management Council

The two thornyhead species continue to be managed with a single harvest guideline although separate ABCs were adopted in 1993. Thornyheads are managed under a cumulative trip limit for the Dover sole/thornyhead/trawl-caught sablefish (DTS) complex (formerly called the "deepwater complex") as well as a separate sublimit for the 2 thornyheads combined. The 1993 thornyhead trip limit was a two week cumulative limit of 20,000 pounds, reduced to 35,000 pounds per 4 weeks on April 21. The harvest guideline was reached about November 9, and on December 1, 1993 the DTS fishery was

effectively closed when the DTS trip limit was reduced to 5,000 pounds per trip.

5. Sablefish

a. Alaska Department of Fish and Game

a) Research

An intensive skipper interview program is conducted during the Southeast Alaska area's two internal water fisheries. The objective is to obtain detailed catch and effort information from the participants. This program also provides an opportunity to collect tags recovered during the fisheries.

b) Stock Assessment

Sablefish stock assessment surveys were conducted in each of the two Southeast Alaska inside management areas during 1993, for the sixth 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 within each area. Every tenth fish captured is sampled for AWL, sex, and maturity. Otoliths taken during these surveys are sent to the ADF&G age reading laboratory in 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. The fish are dressed and iced according to industry standards and the state receives all revenues from the sale of the fish. (Contact Barry Bracken, ADF&G, P.O. Box 667, Petersburg, AK 99833)

c) 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.

d) Fisheries

In the Northern Southeast Inside area 120 vessels harvested approximately 2,616 mt round weight in 24 hours. In the Southern Southeast Inside area 30 vessels harvested approximately 415 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 greatly exceeds the target number established by the program. This factor is compounded because there are no regulations controlling vessel size or the amount of gear. As a result, the individual fishing power of the vessels has increased dramatically in recent years.

The Prince William Sound fishery opened on May 17, closed on May 20, and then reopened on June 10 for 24 hours to harvest the remainder of the annual harvest objective. A total of 55 vessels harvested 142 mt round weight during the open fishing periods.

The offshore sablefish 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.

b. Canada

There were numerous questions about the IQ system in Canada and the recent move to recovering costs directly from the fishery.

a) Research

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. It is anticipated that this survey will be conducted in 1994.

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. This survey will be conducted again in October 1994.

An analysis of synoptic trap survey data collected off the west coast of Canada during 1989, 1990 and 1991 was conducted to examine area and depth related differences in population parameters used to model the life history of sablefish. It was found that age composition, size-at-age, size-at-maturity and age-at-maturity differed among depths and areas. Differences in most parameters with depth and between sites north of Vancouver Island and sites off the west coast of Vancouver Island result from the interaction of sablefish ontogeny, varying temporal patterns of fishing effort, the width of the available slope habitat, and the physical and biological oceanography of the fishery production domains of the two areas. Sablefish greater than ten years of age were most abundant at depth and at southern sites. The cause is believed to be the interaction of ontogenetic dispersion and differential fishing mortality. Length-at-age declined with depth and increased with latitude. Plausible explanations for the variation in size at age by depth and area include fishery effects, biotic effects including abundance and food availability, and abiotic effects including temperature and oxygen. Length-at-maturity was similar over all areas in shallow depths and decreased with depth, a relationship that was more pronounced at southern sites. Age-at-maturity was lower for northern sites and shallow depths. A two stage hierarchy of maturation was proposed with length as the primary stimulus and age as the secondary.

An analysis of the distribution and abundance of larval sablefish in the surface waters off the west coast of Vancouver Island was conducted. Larval sablefish were surveyed annually during April from 1984 to 1989 using a neuston sampler and oceanographic conditions were monitored concurrently during each survey using a CTD. The distribution of sablefish varied considerably among years and areas. Centres of abundance were typically found off the shelf (300-1000 m depth) in the La Perouse and Brooks Peninsula areas. During some years, larval fish were found on the shelf. Examination of distribution in relation to geostrophic currents indicated that sablefish larvae were most abundant in areas where mean currents were weakest, allowing larvae to accumulate. After the spring transition, the prevailing current patterns inhibited the onshore transport of near-surface larvae but may enhance the onshore transport of deep (>200 m depth) larvae. This suggests that the distribution of larvae in the water column at the onset of upwelling-favourable conditions in spring determines the region of greatest larval aggregation. An index has been developed to relate abundance of larvae to the subsequent recruitment of adults. In addition the early development of sablefish off the west coast of Canada was examined and documented.

An analysis of the dispersion of juvenile sablefish based on tagging was conducted. A total of 72,296 juvenile sablefish (*Anoplopoma fimbria*) were tagged and released off the west coast of Canada between 1979-1987. As of December 31, 1992, 2,992 (4.1%) have been recaptured. Juvenile movement varied between the northern (Queen Charlotte

Sound/Hecate Strait, and the west coast of the Queen Charlotte Islands) and southern (west coast Vancouver Island) areas when standardized for differences in recovery effort and unreported recaptures. Over 60% of juvenile fish tagged in Queen Charlotte Sound/Hecate Strait from 1979-1981 (predominantly the 1977 year class) moved north of the tagging area into U.S. waters in the Gulf of Alaska. Fish tagged in the same area from 1982-1985 also showed a tendency to move north, however the percentage that were recovered in U.S. waters (Gulf of Alaska) averaged approximately 30%. The majority of juveniles tagged and released off the west coast of the Queen Charlotte Islands from 1983 to 1985 also moved into the Gulf of Alaska. In contrast, juvenile fish tagged and released off the west coast of Vancouver Island from 1983 to 1985, and 1987 tended to remain near the release area. Of the fish that moved out of the area, approximately equal numbers moved north and south of the release area.

The parasites of sablefish (*Anoplopoma fimbria*), collected from three seamounts off Canada's west coast, were investigated for their potential as biological tags. The distribution of several parasites was shown to be significantly different between seamounts supporting the view that seamount stocks of sablefish are discrete. Other data collected on the parasites of sablefish include; new host and locality records, the relationship between host age and infection, seasonal variation in parasite prevalence, and the geographic distribution of the parasites. Of the nine species of parasites that were identified, three (*Genolinea laticauda, Gonocerca japonica and Grillotia heptanchi*) had not been previously recorded from sablefish.

b) 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. The population is stable and a major assessment is to be conducted during 1994.

c) Management and regulations

Sablefish are managed by quota with a 5400 t coastwide quota in effect for 1994. The quota is split between trawl (8.75%) and longline/trap (91.25%) vessels. Both trawl and longline licenses are limited entry.

In 1994 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 landings prior to the inception of IQ's. In 1994 a cost recovery program is in effect with revenue from the fishery used to fund research, enforcement, management and verification of landings.

c. National Marine Fisheries Service - AFSC

a) Gulf of Alaska - Domestic Longline Survey

The results of the seventh annual NMFS longline survey of the upper continental slope and deep gullies of the Gulf of Alaska were used to evaluate the condition of sablefish stocks. The survey is a joint effort involving two divisions of the AFSC: ABL and RACE. The primary objective was to determine the relative abundance and size compositions of sablefish, shortspine thornyhead, and shortraker rockfish and rougheye rockfish. One hundred twenty-four longline sets were completed at 63 preestablished stations distributed between the Islands of Four Mountains (long. 170°W) and Dixon Entrance. Forty-seven of these stations have been sampled annually since 1979 by the Japan-U.S. cooperative longline survey, the forerunner of the NMFS survey, and also samples gullies not sampled during the cooperative longline survey.

Sablefish abundance estimates for the western and central Gulf of Alaska, upper continental slope region, decreased between 1990 and 1992, but recovered slightly in 1993. Sablefish abundance estimates for the eastern gulf increased steadily from 1988 to 1992 and decreased slightly in 1993. Total sablefish abundance on the upper continental slope appears to be the highest since the NMFS longline survey began in 1988. Sampled gully areas have shown considerable variability in sablefish abundance. The presence of sablefish in the gullies was highest between 1989 and 1991. Sablefish relative population numbers for the upper continental slope and gullies (combined) increased 5.5% from 1992-93. Generally, sablefish move out of the deep gullies to the upper continental slope as they approach maturity. Higher than average sablefish abundance in the gullies suggests future higher than average recruitment to the fisheries that traditionally have been conducted on the upper slope. Sablefish represented 54% of the total 1993 NMFS longline survey catch and was by far the predominant species captured. The longline survey may not adequately reflect the abundance of rockfish and thornyheads, because their survey catch rates have shown high interannual variability that does not appear to be related to actual abundance changes.

b) Japan-U.S. Cooperative Longline Survey

For the sixteenth consecutive year, a cooperative longline survey for sablefish was conducted in the Gulf of Alaska by Japan and the United States in summer 1993. The 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 ABL participated in the cruise in the western Gulf of Alaska, and one from the RACE Division 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 overall sablefish relative population number (RPN) remained nearly unchanged for the upper continental slope of the Gulf of Alaska from 1992 to 1993. On a geographic basis, however, sablefish RPN increased in the western Gulf of Alaska,

whereas it declined elsewhere.

The relative abundance of sablefish in the 1993 cooperative survey differed somewhat from that found in the duplicate NMFS domestic longline survey. The latter survey between 1992 and 1993 showed a Gulfwide increase in sablefish RPN of 15.5% for the upper continental slope. Since 1990 each survey has shown relatively little change in gulfwide sablefish abundance on the upper continental slope, but the cooperative survey has reflected relative population levels about 25% lower than those of the NMFS survey. Catch-per-unit-effort comparison (CPUE) studies show that while the surveys yield different catch rates (NMFS CPUE is higher) their relative fishing powers have remained much the same since 1990. The results of these two surveys have been similar in some years and have diverged in other years. Recently, a study based on the Gulf of Alaska portions of the 1990-93 NMFS and cooperative surveys was completed to permit expression of the abundance estimates from the 1979-89 cooperative longline surveys in terms of the NMFS longline survey. In effect, this extends the annual NMFS estimates of sablefish abundance back to 1979. Both surveys are planned to continue in 1994.

c) 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 second hook timer experiment was conducted in Chatham Strait, southeastern Alaska using the R/V John N. Cobb from 24 May to 4 June 1993 (the first experiment was conducted during 1992). The results of the two hook timer experiments imply that gear saturation has little effect on the capture of sablefish over the range of catch rates tested.

d) ABL and RACE Sablefish Tag Recovery Programs

Processing new tag recoveries and editing of the RACE and ABL tag databases continued during 1993. Over 600 tags were recovered and returned to ABL during the year, bringing the total tag recoveries for the database to nearly 6000; releases to date are 98,300. Another 1,121 sablefish tags were returned to the RACE Division and processed in 1993.

Tagged fish recoveries with otoliths were coded into the ABL database. Of the 271 recoveries with otoliths, 53 were of fish tagged as juveniles. These "known-age" fish will be used in a study of age and growth being conducted jointly by ABL and the REFM Aging Task.

In another age validation study, 17 fish injected with OTC in 1988 were recovered in 1993, bring the total OTC recoveries to over 50.

e) Juvenile Sablefish Studies in Southeastern Alaska

Juvenile sablefish studies in southeastern Alaska, conducted annually by ABL since 1985, were continued in 1993. For the ninth consecutive year, relatively large numbers of age 1+ sablefish were found in St. John Baptist Bay, a small bay near Sitka. About 650 of these fish were tagged and released. Although ABL has examined many locations in southeastern Alaska since 1985 for the presence of juvenile sablefish, St. John Baptist Bay is the only site where they have been consistently found. The reason for the uniqueness of this bay is unknown; periodic STD casts and plankton tows have shown nothing unusual compared with other locations. Future hydrographic and oceanographic studies are planned to examine the effects of water chemistry and currents on the distribution of juvenile sablefish in the vicinity of the bay.

f) Stock Assessment - Bering Sea and Gulf of Alaska

The sablefish population in Alaska's waters is still at a relatively healthy level, but with no strong recruitment evident in recent years, the population has slowly decreased since the mid 1980's. However, most of the decrease has been concentrated at the outer range of sablefish in the Bering Sea and Aleutian Islands, while the abundance in the Gulf of Alaska has been more stable. There has been some concern that large decreases in abundance observed in the Japan-U.S. cooperative longline survey in the Eastern Bering Sea in recent years are due to interference with the survey by killer whales. An analysis investigating the effect of killer whale presence on survey catch rates during 1989-93 revealed there is a negative impact. This impact, however, was not found to be statistically significant, and the overall abundance trend remains the same with or without the effect of killer whales. Exploitable biomass for the beginning of 1994 for outside waters as estimated from the NMFS trawl and longline surveys, and including projected recruitment, is 218,000 mt for the Gulf of Alaska, 4,600 mt for eastern Bering Sea, and 23,900 mt for Aleutian Is., or 246,100 mt combined, compared to the combined 1993 value of 227,400 mt.

Yield estimates are determined from a stock reduction analysis modified to explicitly track estimates of exploitable biomass and provide an estimate of recruitment. 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. Beginning in 1993, an adjustable fishing rate strategy was adopted for sablefish, whereby the $F_{35\%}$ fishing rate (that rate which would reduce the spawning biomass per recruit ratio to 35% of the unfished level) is adjusted in proportion to the ratio of current biomass to a target biomass level that is 35% of the unfished level ($B_{35\%}$). The estimates of $F_{35\%}$ and $B_{35\%}$ are 0.137 and 256,650 mt, respectively. Thus, the adjusted fishing rate is (246,100/256,650) x .137 = .131, resulting in a combined ABC of 28,840 mt (25,500 mt for Gulf of Alaska, 540 mt for Eastern Bering Sea, and 2,800 mt for the

Aleutian Islands).

NMFS conducts two longline surveys to track abundance trends in the Gulf of Alaska: the Japan-U.S. Cooperative Survey and the domestic survey. At times the results of the two surveys diverge significantly from each other, while at other times the difference between the two surveys decreases. 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.

g) West Coast

The west coast landings of sablefish were 9,269 mt in 1992 (ABC was 8,900 mt) and 7,722 mt in 1993 (ABC was 7,000 mt). The sablefish stock in the Monterey through the U.S.-Vancouver INPFC area was assessed most recently 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.

d. Oregon Department of Fish and Wildlife

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

Sablefish bycatch continues to be obtained from Pacific whiting shoreside deliveries. Sablefish bycatch in whiting catches was generally modest, and only a few landings (8) were over the 1,000 pound trawl limit for sablefish.

e. National Marine Fisheries Service-SWFSC

The SWFSC Tiburon Laboratory assisted scientists from the Alaska Fisheries Science Center on an assessment of the sablefish fishery. The sablefish assessment will be submitted to the PFMC this year.

The Coastal Division recently published a definitive study of the reproductive biology of sablefish. A manuscript dealing with sablefish biomass estimates using egg and larval survey data is in preparation.

f. 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 1993, each allocation was again considered a harvest guideline with management measures to keep harvests within those guidelines. Trawl sablefish landings are managed as part of the deepwater trawl DTS complex, which includes Dover sole and the two thornyhead species. A single trawl trip limit covers the complex, with sublimits for sablefish and thornyheads.

a) Trawl

The 1993 trawl allocation was 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 did not apply. The sablefish trawl trip limit set at the beginning of 1993 was 1,000 pounds or 25 percent of the DTS complex, whichever was greater. The entire DTS complex was 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. Landings through August greatly exceeded expectations, and on September 8, the trip limit was reduced to the greater of 1,000 pounds or 25 percent of the DTS complex, not to exceed 3,000 pounds. The trawl harvest guideline was reached about October 12 and on December 1 the DTS trip limit was reduced to 5,000 pounds per trip, of which no more

than 1,000 pounds could be sablefish.

b) Non-trawl

In 1993, a 250 pound trip limit was in effect through May 8, at which point sablefish landings were prohibited for three days until the unrestricted season opened May 12. The season lasted 21 days, closing June 2. On June 5, the 250 pound trip limit was reinstated for the remainder of the year.

6. Flatfish (Dover, English, Arrowtooth, Petrale)

There was an extended discussion about the relationship between recruitment and environmental conditions for all flatfish species.

a. Alaska Department of Fish and Game

a) Research

No research was conducted on flatfish species by the State of Alaska during 1993. A mandatory logbook program in effect for this fishery provides information on CPUE of target species and an estimate of at-sea discards.

b) Management

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

New regulations adopted in November 1993 implement a 20,000-pound maximum weekly trip limit in the trawl fishery. The new regulation will go into effect in 1994.

c) Fishery

The Southeast Alaska inside area flatfish trawl fishery was restricted to only three small areas during the 1992-93 season with a harvest objective set for each area. Approximately 10.5 mt of harvest was reported from Southeast Alaska and less than 1 mt from Prince William Sound during 1993. Most of the Southeast harvest is starry flounder while the Prince William Sound harvest is a mixture of shallow-water species.

New regulations adopted in 1993 extend the permit requirements for on-bottom trawling to include the waters of Alaska along the outer coast. This will essentially preclude all bottom trawl activity within three miles of shore east of 140^0 W. longitude.

b. Washington Department of Fish and Wildlife

a) Arrowtooth flounder

A first assessment of arrowtooth flounder for the U.S. Pacific coast was completed using an equilibrium yield approach. Stock biomass fluctuates widely, possibly as a result of environmental conditions. An ABC of 5,800 mt was set equal to peak catch in 1990. Maturity work is complete and results were submitted to Fishery Bulletin for publication. Arrowtooth flounder are batch spawners and spawn at depths of at least 366 m (200 fm). Spawning begins in September, extends through December, and is complete by March. The length at which 50% of fish are mature is 28.0 cm for males and 36.8 cm for females determined from fall survey data. Arrowtooth flounder aging remains problematic. No results from NMFS were obtained from a first set of otoliths submitted as part of a WDFW-NMFS cooperative aging study initiated in 1992; WDFW delivered a second set of otoliths in December 1993.

c. Canada

a) Research programs

An analysis of recruitment relationships was conducted for Hecate Strait English sole. Response surface analysis was used to investigate the effects of stock size and oceanographic conditions during the egg and larval period on subsequent recruitment. Stock size and Ekman transport through the Strait during the larval period had significant influence on subsequent recruitment. Together these variables accounted for 47% of the variation in observed recruitment. A paper summarizing results of this analysis was presented by J. Fargo at the International Flatfish Symposium in The Netherlands in September 1993. Development of a recruitment model for Hecate Strait English sole will take place in 1994.

A study of halibut bycatch in the B.C. trawl fishery was continued in 1993. Observers made 4 trips and monitored 81 tows in the B.C. trawl fishery in 1993. The study focused primarily on the west coast of Vancouver Island. Halibut catch-rates in the trawl fishery off the west coast of Vancouver Island were significantly lower than those observed for Hecate Strait. The mean length of fish caught off the west coast of Vancouver Island was significantly larger than fish caught in Hecate Strait. Analysis of halibut condition factor data was completed and a manuscript was published relating the condition of trawl-caught

halibut to biological and fishery factors. The size of halibut caught and the amount of time spent on deck before release were the most important factors associated with overall fish condition. Other significant factors were depth fished, total catch and tow length.

b) Stock assessment

Interim stock assessments were produced for five species (nine stocks) of flatfish in 1993. Landings in 1993 continued to be among the highest since monitoring began in the 1950s. The high landings are mainly the result of strong recruitment, beginning in the late 1980s for stocks of rock sole and English sole. Landings of southern Dover sole (Area 3C-D) continued to increase in 1993. This deepwater (600-800m) fishery began in 1989 and takes place mainly in the first quarter of the year. Landings for the northern (Area 5CDE) Dover sole stock in 1993 were near MSY. Landings for petrale sole remain low and recruitment has now remained at a low level for more than a decade.

c) 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 was managed using a combination of quota and trip limits in 1993. All trip limits are subject to mid-season review and revision. Rock sole in Hecate Strait have been overharvested in 1992-3 despite the trip limit regulation. The trip limit level in 1994 will be set according to a vessel-specific landing schedule (number of trips allowed per month) chosen by the captains at the beginning of the season. A voluntary minimum mesh size (5.5 inches-stretched) is in effect in Hecate Strait. This measure is directed at the fishery for rock sole, English sole and Pacific cod and is expected to result in an increase in yield in the longterm for this region.

d. National Marine Fisheries Service - AFSC

a) West Coast - California halibut

The West Coast Groundfish Assessment Subtask of RACE has been cooperating with researchers from the California Department of Fish and Game, Long Beach, to edit and analyze data collected during a trawl survey of the California halibut resource off southern and central California. The data has been analyzed using RACE programs. This survey has provided the West Coast subtask with some baseline information on flatfish distribution that will be useful for designing flatfish trawl surveys.

Stock Assessment

Bering Sea

The abundance of most of the species of flatfish in the eastern Bering Sea have shown substantial increases during the 1980s and are currently at high and stable 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 0.12 corresponds to a 1994 ABC of 230,000 t. This catch is below the level of 269,000 t corresponding to the Council's overfishing definition, computed under an $F_{30\%}$ value of 0.14. A reliable estimate of F_{MSY} does not exist for this stock.

Rock sole

Rock sole (Pleuronectes bilineatus) catches from the eastern Bering Sea in 1993 was over 54,000 t (including discards), 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 185,000 t. Because of sustained good recruitment (the 1992 survey age composition indicated that 86% of the population numbers were fish 4-9 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 at least 1.9 million t.

The $F_{35\%}$ exploitation rate was used in the assessment which 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 (0.18) gives a 1994 ABC of 313,000 t. This ABC is below the level corresponding to the Council's overfishing definition (363,000 t using $F_{30\%} = 0.22$).

Other flatfish

Results of the 1993 Bering Sea trawl survey estimate the "other flatfish" species to be at a high level of abundance. The flathead sole (Hippoglossoides elassodon) estimate of 610,000 t is the third highest observed from the trawl survey time-series and the Alaska plaice (Pleuronectes quardrituberculatus) estimate of 515,000 t is at a high and stable level. These estimates, combined with the miscellaneous flatfish species estimate of 87,200 t, provide the highest estimate of "other flatfish" abundance ever observed by the EBS trawl survey.

This assessment uses exploitation rates 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. The 1994 ABC for this complex is set at 225,000 t with overfishing equal to 270,000 t. This resource remains lightly exploited.

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 519,000 t projected for the beginning of 1994. 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 1993 catch of 8,000 t taken primarily in the pursuit of other species. For 1994 the ABC and TAC of arrowtooth flounder and Greenland turbot is set at 93,400 t and 7,000 t, respectively.

Gulf of Alaska

Management of the Gulf of Alaska flatfish resource has been divided into five categories by the North Pacific Fishery Management Council for 1994. These categories include: "shallow water flatfish", "deep water flatfish", arrowtooth flounder, flathead sole, and rex

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 and also because of the dominate biomass of arrowtooth flounder which could cause the other flatfish species to be overfished if it was not 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 and rex sole were given a separate TAC because of a problem with POP bycatch in the directed rex sole fishery in 1993.

Due to halibut bycatch in commercial trawl fisheries, the total catch of Gulf of Alaska flatfish species was 28,000 t in 1993, well below the combined TAC of 75,980 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. For 1994, the flatfish species are managed using the $F_{35\%}$ approach, resulting in a combined ABC of 335,000 t and a TAC of 79,850 t.

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 ABC in the Eureka area is 3,500 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 ABC in the Columbia area is 4,000 mt and the 1992 catch was 5,665 mt.

e. 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.

a) Halibut

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

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

Completed some work assessing halibut bycatch in the shrimp trawl fishery, including summarizing available ODFW data and reviewing other estimates.

f. National Marine Fisheries Service-SWFSC

The Coastal Division recently published a definitive study of the reproductive biology of Dover sole. This information will aid future attempts to measure species abundance by egg and larvae surveys. A new approach to measuring Dover sole biomass using egg and larval survey data was published in 1993. A manuscript describing the prolonged (two years) life history of pelagic larval Dover sole has been submitted for publication. The Division also published a description of relationships between depth and length of Dover sole off Oregon and California.

The results from the Coastal Division's study of the genetic structure of Dover sole were presented at the 1993 CalCOFI meeting, and manuscripts are in preparation. Results indicate that Dover sole mix from Alaska down to San Diego with no evidence of genetic structure.

g. Pacific Fishery Management Council

The 1993 coastwide harvest guideline was 17,900 mt and a harvest guideline of 6,000 mt was established for the Columbia area. The year started with the cumulative 2-week trip limit for the deepwater complex at 45,000 pounds with sublimits on the amounts of thornyheads and sablefish. The DTS limit was reduced on April 21 from 45,000 pounds per two weeks to 60,000 pounds per four weeks. Sablefish and thornyhead landings

exceeded expectations and on December 1 the DTS trip limit was reduced to 5,000 pounds per trip. Dover sole landings in 1993 and 1994 have generally been below the harvest guidelines due in part to restrictions on sablefish and thornyheads and in part to discard in favor of those more valuable species.

7. Pacific hake (whiting)

There were was concern expressed about the 1992 triennial survey, in particular were there really more hake out there. It was noted that there was research directed at this question planned for July 1994.

a. Canada

a) Research programs

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

Trawl and hydroacoustic studies examining the relative abundance and distribution of Pacific Hake in the Vancouver Area, including northern Vancouver Island, were continued. Hake were found along the 200 m contour extending into Queen Charlotte Sound. Assuming a target strength value of -35.0 dB/kg, the biomass of hake in the surveyed portion of the Canadian zone was 638,906 mt which is less than the 1.1 million mt found in 1992. Port samples of hake captured in Hecate Strait and Dixon Entrance during August/September of 1993 indicate that a significant biomass of hake was north of the survey limit. A hydroacoustic assessment of hake in the Canadian zone is planned for August 1994.

The 8th 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 that fish are found in association with euphausiid populations. Abundance and distribution of hake was also linked to coastal physical oceanographic features in particular sea surface temperature. During the 1992 survey fish were found much further offshore than during previous surveys and factors contributing to this movement will be examined during a survey planned off Oregon during July 1994.

b) Stock assessment

The fishery in the Strait of Georgia continues to develop with 10,686 t landed during 1992, the highest annual catch ever reported. The stock is estimated to be in good condition based on preliminary results of a hydroacoustic survey conducted during March 1993 that found a total of 245 Kt throughout the Strait of Georgia, These estimates are higher than previous surveys conducted during 1981 and 1988. The survey had a strong showing of 1 and 2 year-olds suggesting that recruitment to this stock may be good over the next several years. The yield options for the Strait of Georgia remain unchanged from the previous assessment conducted using Virtual Population Analysis (VPA) and a forward simulation model that indicated that yields up to 14,000 t may be sustainable.

Canadian and U.S. scientists conduct the assessment of offshore hake jointly. The assessment uses a catch-at-age analysis tuned to independent Canadian and U.S survey estimates to assess the current status of the stock, and uses an age-structured forward simulation model to examine long term (equilibrium) production and short term (look ahead) yield options. Overall abundance as indicated by stock synthesis runs, is declining as the strong 1980 and 1984 year-classes move through the fishery. Hydroacoustic surveys conducted by the U.S. and Canadian researchers during 1992 provided coastwide estimates that were considerably higher than predicted by previous assessments. A total of 2,921 Kt of hake coastwide were found by the U.S. hydroacoustic and bottom trawl surveys combined. Canadian and U.S. surveys found 932 Kt and 1,101 Kt of hake in the Canadian zone, respectively. The U.S. has suggested the cause for the increase is the body of hake found sea-ward of the normal survey boundaries which suggests that the previous surveys have missed fish. A number of other possible causes are under review. Yield options for three possible fishing strategies and three risk levels are presented with available yields for 1994 ranging from 245 Kt to 555 Kt which are considerably higher than 1993, a result of the increase in abundance found in the 1992 survey.

c) 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 1993 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. The 1994 quota is 111 thousand mt.

In the Strait of Georgia the 1993 quota is 11,000 mt.

b. National Marine Fisheries Service - AFSC

a) Research

The last four days of the 1993 slope trawl survey were used to attempt to locate aggregations of Pacific hake during their southward migration to spawning grounds and collect abundance and oceanographic data necessary to learn more about the timing and

paths they take on their fall migration to spawning grounds. A series of cross-shelf echo integration transects extended shoreward to a depth of 50 m and seaward to a distance of 50 km beyond the continental shelf break. Along each transect, a midwater tow was made to verify the echo sign and to obtain biological data. The ship's Acoustic Doppler Current Profiler (ADCP) was used to gather data on ocean currents and CTD data were collected to identify the temperature and salinity properties of water masses.

During the 1993 slope trawl survey, 362 ovary samples and maturity data were collected from Pacific whiting for a study the SWFSC La Jolla laboratory is doing on whiting reproductive biology.

b) Stock Assessment

The U.S. and Canadian harvest of Pacific whiting in 1992 was 295,189 metric tons (t). In 1993, the yield is expected to be 203,000 t. Assessment surveys conducted during summer of 1992 by National Marine Fisheries Service and the Department of Fisheries and Oceans resulted in estimates of population abundance considerably in excess of forecasts based on earlier surveys and models. Population biomass was estimated by the coastwide NMFS acoustic survey as 2.557 million t, more than double the acoustic estimate of 1.264 million t in 1989. The 1992 acoustic survey was conducted with a new echo-integration system and had a wider areal coverage than previous assessments. However, the population biomass estimates made with the new system still depend on the acoustic target strength of Pacific whiting, which continues to have a large amount of uncertainty associated with it.

A geographic version of the stock synthesis model that divided the population into U.S. and Canadian components was used to assess the Pacific whiting population. Population biomass peaked 1987 and has been declining steadily since that time. The biomass of age 3 and older fish in 1992 was estimated to be 3,055 million t. The recruitment abundance of the 1989 and 1990 year classes were estimated at 0.233 and 1.999 billion fish respectively, indicating that the 1989 year class is a weak year class, while the 1990 year class is close to the average 1977-92 recruitment of 2.170 billion age-2 fish. Indications from the 1992 assessment surveys and preliminary data from the 1993 fishery are that the 1991 year class is also average in size.

The effect of uncertainty in the acoustic target strength estimate was examined by comparing stock synthesis runs using a target strength of -35 dB/kg (the standard value) and a more conservative target strength -33.5 dB/kg. The estimated 1992 biomass for target strength of -33.5 db/kg is 2.317 million t, 25 percent lower than the estimated biomass for -35 dB/kg model. Recruitment estimates and fishery selectivity coefficients from the stock synthesis model were used with an age-structured simulation model to estimate sustainable yield.

A deterministic version of the model was used to forecast yields for 1994-96. 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 set based on the probability that female spawning biomass will fall below a cautionary level of 623,000 t in long-term simulations of the Pacific whiting population. When a hybrid fishing strategy is applied to the projected numbers at age in 1994, the potential total yield is calculated to be 325,000 at low harvest rate, 450,000 t at a moderate harvest rate, and 555,000 t at a high harvest rate.

The low harvest rate was recommended for 1994-96 in due to the dependence of the assessment on one acoustic biomass estimate. It seemed reasonable to require at least two corroborating surveys before substantially increasing yields from a fishery. If recruitment remains near the 1960-92 median recruitment of 0.941 billion fish, the outlook for the immediate future is for a fairly rapid decline in annual yield in 1995 and 1996. The recruitment of a strong year class to the fishery would substantially increase the projected yields.

c. Oregon Department of Fish and Wildlife

ODFW with cooperation from PSMFC, NMFS and the fishing industry, continued to 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 September.

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 prohibited bycatch (salmon and halibut) and the exvessel value of any trip limit overage.

Most of the landings were made by Fourteen vessels which participated in Oregon's

whiting shoreside observer program. About 35,760 mt of whiting was landed at Oregon ports. Observers observed 18% of the trips at sea including the offload of those trips. Observers observed the offloading of an additional 23% 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 153 salmon were obtained from observed trips. Other observed bycatch included 99,439 pounds of Yellowtail rockfish, 46,677 pounds of Widow rockfish, 19,338 pounds of misc. rockfish, 13,116 pounds of sablefish, 430,671 pounds of jack and Pacific mackerel and 10,929 pounds of misc. other fish.

ODFW collected hake biological samples for NMFS, Seattle (otoliths, length, sex, weight) at Astoria and Newport.

d. National Marine Fisheries Service-SWFSC

In 1993, the Coastal Division initiated a program to study the reproductive biology and early life history of Pacific whiting in the California current. The first cruise will be conducted during 1994 and a paper describing the sampling characteristics of eggs and larvae based on CalCOFI data is in preparation.

e. Pacific Fishery Management Council

By-catch regulations for the whiting fishery continued in effect for 1993. Those regulations prohibited at-sea processing south of 42°N, whiting fishing in the morning between midnight and one-half hour after official sunrise south of 42°N, 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.

For 1993, the PFMC established a harvest guideline of 142,000 mt (80 percent of the coastwide whiting ABC) as the U.S. allocation and recommended a multi-year framework 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.

For 1994 through 1996 a new allocation framework has been approved. Under this plan, each year 40 percent of the harvest guideline will be reserved for shore-based activities and the remainder will be available for an "Olympic" fishery that begins April 15 (except that shore-based activities in California between 40°30' and 42°00' N. latitude begin March 1).

8. Dogfish

a. Alaska Department of Fish and Game

a) Research

The relative catch rate of dogfish is monitored in the Southern Southeast Inside area in conjunction with the annual sablefish survey in that area. Preliminary studies on dogfish aging which began in 1992 continued into 1993. The purpose was to collect and archive a sample from an unexploited population for future comparisons if the fishery expands. (Contact Kris Munk, ADF&G, P.O. Box 240020, Douglas, AK 99824)

b) 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 1993.

b. Canada

a) 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.

b) 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.

c) 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).

c. Oregon Department of Fish and Wildlife

No work was conducted on dogfish.

9. Lingcod

a. Alaska Department of Fish and Game

a) Research

Two lingcod research surveys were conducted during 1993. The first, conducted during April and June, concentrated on collecting age structures and comparative catch rates in the off-shore waters near Sitka using "dinglebar" troll gear. The second, conducted in October, was undertaken to collect tissue samples at the request of the Washington Department of Fisheries for coast-wide genetic studies. (Contact Dave Gordon, ADF&G, 304 Lake St. Room 103, Sitka, AK 99835)

The ADF&G age reading laboratory began experiments to compare age reading from fin rays with age readings from cleared otoliths. The initial work shows a relatively strong correlation and work is continuing. (Contact Kris Munk, ADF&G, P.O. Box 240020, Douglas, AK 99824)

b) Management

During 1993 the Southeast Alaska lingcod fishery was managed with a 27-inch (69 cm) 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 was in effect for the directed fishery.

New regulations adopted for the Central Region went into effect in 1993. These included: 1.) a complete area closure from January 1 through June 30, 2.) a minimum size limit of 35 inches (89 cm) overall or 28 inches (71 cm) from the front of the dorsal fin to the tip of the tail.

A lingcod management plan was adopted for the Southeast Alaska Region during 1993, but the regulations will not go into effect until April 1994. The main elements of the plan include: 1.) extension of the winter closure to three miles from shore, 2.) modification of the closure period to December 1 through April 30, 3.) establishment of guideline harvest ranges for all six of the Southeast Region management areas based on 1/4 to 1/2 mt per nautical mile of suitable habitat within each area, 4.) apportionment of the fishery seasonally and among user groups in the two management areas where the fishery is fully utilized.

c) Fishery

Lingcod are landed incidental to hook-and-line fisheries for other species and, in recent years, have been the target of an expanding "dinglebar" troll fishery in Southeast Alaska. Dinglebar troll gear is salmon power troll gear modified to fish for groundfish.

A total of approximately 526 mt round weight of lingcod was harvested by all gear types in state-managed fisheries during 1993. Over 98% of this was taken from Southeast

Alaska. Harvest from the Central Region was less than half of what was taken during 1992, presumably because of the more restrictive regulations which were adopted during 1993.

b. Washington Department of Fish and Wildlife

Results from an 8-year nearshore tagging study at Neah Bay were written up and submitted for publication. In 1993, the final year of nearshore and offshore tagging was conducted as part of a study to estimate mixing rates between the two areas. An age-structured stock assessment of lingcod in areas 3A/3B/3C is in progress. Genetic Stock Identification sampling was conducted in 1993 to study the lingcod population stock structure. Samples were obtained from Alaska-Seward (Scott Meyer, ADFG), Alaska-Sitka (Victoria O'Connell, ADFG), Hecate Strait (WDFW), Southwest Vancouver Island (WDFW), coastal Washington (WDFW), Puget Sound (WDFW), Oregon (WDFW), and California (Pete Adams/Kelly Silberberg, NMFS-Tiburon).

c. Canada

a) Research programs

Three 2-wk Hook-and-line surveys were conducted for lingcod in the southern Strait of Georgia to determine their usefulness in assessing lingcod abundance. The variability in lingcod catch per unit of effort within each survey will be compared with the variability among surveys.

The live hook-and-line rockfish fishery was monitored in the Johnstone Strait and central Strait of Georgia for the incidental catch of lingcod to aid in assessing the rebuilding of the stock.

Offshore lingcod stocks were examined for the northwest and southwest coasts of Vancouver Island, Queen Charlotte Sound, and Hecate Strait. Changes in age determination criteria and personnel during the last decade have created difficulties in identifying cohort strengths accurately over the same time period. This difficulty is also expressed in the estimation of mortality rates from either age or growth data. This problem was examined through comparison of independently observed lengths at age with those calculated from fish samples aged in 1987 and again in 1992. This work indicates that ages estimated in recent years underestimate previously estimated ages by approximately one year. Until this discrepancy is resolved in the historical data series, the interpretation of stock condition will rely on recent trends in catch statistics and biological sampling.

b) Stock assessment

The inshore lingcod stock assessment remains unchanged.

Off the west coast of Vancouver Island (Areas 3C and 3D) and in Queen Charlotte Sound (Areas 5A-5B), stocks are at moderate levels, although recent increased in CPUE off Vancouver Island are associated with a substantial decline in fishing effort. CPUEs off the northwest coast of Vancouver Island and in Queen Charlotte Sound are relatively stable.

The results of the age analysis will be incorporated into the assessment in 1995.

c) Management and regulations

The commercial lingcod fishery closure in the Strait of Georgia, initiated in 1990, will continue through 1994. 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.

Lingcod are managed by annual quota for southwest and northwest coast of Vancouver Island, Area 3C and 3D respectively; and Queen Charlotte Sound (Area 5A-B). Annual quotas were 2700t and 2650t, respectively. Fishery effort in Hecate Strait (Area 5C-D) has recently undergone a dramatic increase in effort, but there is little biological information available to guide yield recommendations. A recommended yield level of 1000 t is provided out of concern for the sensitivity of the species to exploitation and the rapid expansion of the fishery.

d. Oregon Department of Fish and Wildlife

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

e. National Marine Fisheries Service-SWFSC

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

a) 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.

More recent work has focused on validating the first year annulus of lingcod. The annuli of known-age lingcod were measured. These lingcod were known to be one and two year-old fish by either length and time of year, or by captive growth. Those measurements were found to agree with first and second year annuli of older lingcod. This validates the marks as the first and second year annuli.

b) 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 is coordinated through Tiburon. Aging of the lingcod fin rays also occurs at Tiburon. The target is to sample two trips per month per gear category. The eventual goal is to obtain enough years for an age structured analysis. Sampling of the California recreational catch also began in 1992 with length-sex sampling in all ports and fin ray sampling for age analysis in the San Francisco-Princeton ports. In 1993, this program was expanded to age sampling statewide. Age structure sampling of Oregon's recreationally-caught lingcod began in 1994.

c) Possibility of a Disturbed Sex Ratio

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

10. Pollock

a. Canada

a) Research programs

A study was conducted and published on how errors in accuracy and precision of age determination estimates relate to the management of the walleye pollock fishery. In the mid- to late 1980's, reported catches from this fishery ranged from 6 to 7 million t, but may have approached 8 or 9 million t, making it the largest fishery in the world at this time. The participants in this fishery used different methods to age walleye pollock resulting in different interpretations of potential harvest levels. In recent years, catches have declined unexpectedly by approximately 50%. We propose that errors associated with the ageing method and errors associated with the precision of age estimates, confounded attempts to understand the effects of fishing and of the environment on the population dynamics process, making it difficult to predict the natural decline in abundance.

b) 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.

c) 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

a) Research

Acoustic Surveys - Midwater Assessment and Conservation Engineering (MACE) Task

Bering Sea

Bogoslof Island area

An acoustic survey of walleye pollock (Theragra chalcogramma) abundance was conducted in the southeast Aleutian Basin near Bogoslof Island during February 27 to March 9, 1994. Pollock echosign was observed throughout most of the survey area, with the majority of the biomass being encountered in the region near Bogoslof Island. The surveyed area within which pollock were encountered was roughly bounded between 53°23' - 54° N latitude and 167°17' - 169°19' W longitude. Pollock lengths ranged from 38-67 cm. The length compositions of nearshore and offshore fish were considerably

different. Lengths were mostly between 40-50 cm for fish over bottom depths < 500 m and from 50-60 cm in deeper water. The lone exception was a haul at 987 m bottom depth where the size composition reflected about equal abundance of both modes. Pollock depth distributions ranged from 250 m to 750 m with double echosign layers being observed in some areas. When both layers were sampled, The proportions of males captured in the deeper layer were consistently greater than in the shallower, implying vertical stratification by sex. Very little active spawning was observed by March 9 when the cruise ended. Nearly all female pollock at inshore and offshore locations (>51 cm) were in pre-spawning (ripening) condition, while smaller individuals were mostly in the developing stage and were not expected to spawn in the near future.

Gulf of Alaska

Shumagin Island Area (March 11-14, 1994)

Moderate quantities of pollock were found in relatively isolated aggregations at several locations throughout the area. The length compositions were generally single moded with peaks at about 44 cm. The size composition of one haul made just to the East of The Shumagin islands was bi-modal, with peaks at 33 and 44 cm, with the smaller fish being most abundant. The maturity compositions of fish in trawl catches indicated that about half of the females (>35 cm) within the area were spent.

Shelikof Strait (March 15-April 8, 1994)

Three survey passes were made within Shelikof Strait. The first and third covered the entire area using identical transect patterns while the second included only the west-central portion of the strait. The distribution of pollock was similar to that seen during most previous years. Most of the spawning population was concentrated toward the western side, mostly between Cape Kekurnoi and Cape Nukshak. Their abundance appears to be similar to that in 1993. The maturity composition of females progressed from about 90% maturing or ripening during the first survey pass (March 17-21) to about 60% spent during the last pass (April 4-8). The bulk of the size composition was between 40-60 cm, but significant numbers of smaller fish were also seen. No strongly dominant year class was apparent from the preliminary length frequency data.

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 1993, 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.

b) Stock Assessment

Bering Sea and Aleutian Islands

The current assessment includes several separate estimators of pollock abundance, including the EBS bottom trawl survey, two tunings of the standard cohort analysis (subjective and least squares), CAGEAN, and Synthesis. All methods indicate a total biomass (age 3+) in the neighborhood of 5-10 million t for the EBS portion of the stock. In particular, the assessment focuses on two projection scenarios (labeled "A" and "B") taken from the least squares tuning of the cohort analysis, which differ primarily in their estimates of the strength of the 1989 year class. Scenario A assumes that the total biomass of fish in the 37-47 cm size range estimated by the 1993 bottom trawl survey (2,450,000 t) is an accurate estimate of the total biomass of the 1989 year class. When tuned to fit this estimate, cohort analysis gives a 1993 age 4 biomass of 2,620,000 t. Scenario B assumes that the survey estimate should be adjusted upward by dividing a survey selectivity factor (estimated by Synthesis) of 0.45, giving a figure of 5,440,000 t for the biomass of the 1989 year class at age 4. Scenario A projects a 1994 total population biomass (age 3+) of 5,370,000 t, while Scenario B projects a value of 8,020,000 t.

As has been noted in previous assessments, it is unlikely that the trawl survey has a selectivity of 1.0 at age 4. Furthermore, the 1993 hydroacoustic survey estimated a biomass of 2,290,000 t for fish in the 35-43 cm range, even though this survey covered only about half of the area assessed by the trawl survey. Finally, the 1994 age 3+ biomass of 8,020,000 t projected under Scenario B seems more consistent with the Synthesis model's estimate of 9,110,000 t for 1992 (Synthesis projection of 1994 biomass is not available). For these reasons, the projected biomass from Scenario B is considered the best estimate for 1994. However, the dependence of these projections on a single strong (and tentatively estimated) year class requires that a cautious approach (exploitation rate) be used to set ABC.

Given Scenario B, projected 1994 biomass exceeds the B_{msy} estimate of 6,000,000 t, meaning that F_{ABC} is capped by the product of ($F_{35\%}/F_{30\%}$) and F_{MSY} or (0.38/0.46)x0.38=0.31. Coincidentally, 0.31 is also the value of $F_{0.1}$ for pollock. Harvesting EBS pollock at the $F_{0.1}$ rate under Scenario B gives a 1994 ABC of 1,330,000 t. Given the uncertainty associated with Scenario B, the $F_{0.1}$ strategy is considered suitably conservative, and the resulting harvest lies at the approximate mid-point of the range corresponding to a straight F_{msy} (or $F_{35\%}$) harvest strategy (1,020,000 t-1,590,000 t).

For the Aleutian Islands portion of the stock, 1993 biomass is estimated at 189,000 t. Using an $F_{35\%}$ exploitation rate of 0.30, the 1994 Aleutian ABC is set at 56,600 t.

An estimate of the 1993 pollock abundance in the Bogoslof region is 600,000 t. Assuming no growth, recruitment, or fishing mortality, 1994 biomass is projected at 490,000 t by applying a natural mortality rate of 0.2 to the 1993 biomass estimate. A 1994 Bogoslof ABC of 127,000 t is computed by multiplying estimated biomass by the $F_{35\%}$ exploitation rate of 0.26. Out of concern over recent declines in the Bogoslof population of Steller sea lions, the Bogoslof pollock fishery is managed on a bycatch only basis.

Gulf of Alaska

Estimates of the exploitable biomass of walleye pollock (Theragra chalcogramma) were 838,000 t in 1992 and 1,062,000 t in 1993 as determined from the stock synthesis (SS) model in those years. The 1994 biomass is estimated at 726,000 t from the current SS analysis. Comparisons of the 1994 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) egg production estimates of spawning biomass; b) the 1993 Shelikof Strait hydroacoustic biomass estimate; c) length-frequency data from the 1993 hydroacoustic survey; d) length-frequency data from the 1992 and first quarter 1993 fisheries; e) estimates of catch-at-age from the 1992 fishery; and f) updated estimates of discard and catch.

The 1993 hydroacoustic survey again utilized new equipment as in 1992 with improved detectability of pollock in low density situations, and improved measurements from the near-bottom region. The 1993 Shelikof Strait biomass estimate based on the new system is 408,000 t (down from 680,000 t in 1992). A value of 296,000 t is the best estimate of biomass that would have been obtained had the old system been utilized in 1993, and should be used for comparison to previous hydroacoustic estimates.

Length-frequency data from the 1993 hydroacoustic survey indicates that the 1988 year class is comparatively strong, while the 1989-92 year classes are relatively weak. The 1992 fishery age composition data are dominated by the strong 1984 and 1988 year

classes.

Three Synthesis models were evaluated as follows: Model A provides a comparison to the 1992 model configuration, Model B is similar to A but includes the 1981, and 1985-1990 egg production biomass estimates, and Model C is similar to B but several years with similar selectivity curves have been combined to reduce the number of parameter used in the model. Based on the results from the exploratory runs, Model C was chosen as the most appropriate model relative to A and B.

Estimates of various fishing mortality rates based on biological reference points were determined from a dynamic pool model and an age-structured model developed to explore the risks associated with adopting different fishing strategies. The $F_{0.1}$, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$ full-selection fishing mortality rates were 0.41, 0.51, 0.43, and 0.36, respectively. An estimate of F_{msy} equal to 0.45 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. 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 during the last 50 year segment of the projection. The threshold level was defined as 20% of the unfished 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 1 option the probability of high or low recruitment was assumed to be equal at high or low spawner biomass levels, and the probability of a strong year class was assumed to be 0.4. 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 2 year classes were 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 0.2.

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 risk under recruitment scenario 2 was determined to be 0.36 (full-selection value). This fishing mortality rate was associated with a 1994 ABC of 172,000 t.

Four additional exploitation strategies were explored: 1) the fishing mortality level that maintains the yield to biomass ratio at 0.05, the level observed during the foreign fishery

(1972-79), 2) the fishing mortality value that produced a minimal risk of falling below the threshold spawner biomass level (F=0.2), 3) the fishing mortality rate that maintains the spawning stock biomass above the lowest observed level (582,000 t observed in 1972 and 1973), and 4) $F_{35\%}$ scaled by the ratio of $B_{model\ C}$ / $B_{35\%}$ if applicable. Stock projections were made for the first three of these additional fishing strategy options. The last option was not explored because the 1994 spawner biomass did not fall below $B_{35\%}$.

Model C was then utilized to project 1994-96 biomass and yield under the various assumptions regarding full-recruitment fishing mortality rates. Based on the results of these projections, the recommended ABC is 102,000 t for the western and central regulatory areas of the Gulf of Alaska. This recommendation represents the fishing mortality strategy that was associated with a 95% chance of maintaining the spawner biomass level above threshold level (F=0.2). This exploitation rate is considered to be conservative since it was determined by simulation results based on recent recruitment trends and assumes below average recruitment from the 1992 and 1993 year classes. In addition, the new exploitation rate reduces the risk that the spawning stock biomass would fall below the threshold from 15% with F=0.36, to 5% with F = 0.2. Short term projections indicate the 1996 spawner stock biomass is 77,000 t higher at the lower exploitation rate (F=0.2). It is further recommended that the ABC be apportioned according to the biomass distribution from the 1990 bottom trawl survey as follows: 21.7% in the Western area (22,130 t), 23.4% in the Central 620 area (23,870 t), and 54.9% in the Central 630 area (56,000 t).

11. Other species

a. Alaska Department of Fish and Game

There were no state regulations in effect for other species of groundfish in state-managed fisheries during 1993. Most of the harvest in state waters is taken as bycatch in fisheries for other more valuable groundfish and halibut. Reported landings during 1993 were approximately 26 mt. 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.

b. Oregon Department of Fish and Wildlife

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.

Herring roe fishery in Yaquina Bay produced 100 tons which was short of the 180 ton quota. Fish were present in the estuary in good numbers, but were not in areas accessible to the fleet. This is a limited entry fishery with only 10 permits to take fish.

a) Hagfish

Limited sampling was conducted on the hagfish pot fishery. The fishery was spotty with most fishing activity in the spring and the late fall of the year and most landings being made into Coos Bay and Port Orford. A total of 90 landings produced 332,779 pounds of hagfish (mostly Pacific hagfish). This is down from the 685,676 pounds landed in 1991.

A manuscript on Black and Pacific Hagfish, Fishery and Sampling , 1988-89 was accepted by Fish. Bulletin.

b) Jack Mackerel

Continues to be one of the most plentiful species observed in the bycatch from Pacific whiting landings along with Pacific Mackerel (430,671 pounds from observed trips and 1,223,087 pounds reported on Fish Tickets as Mackerel-Jack and Pacific combined).

D. Other Related Studies

1. Alaska Department of Fish and Game

a. Groundfish Management (General)

a) Management Authority

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 fisheries during a season for conservation reasons. The department also cooperates with NMFS in regulating fisheries which are jointly managed.

b) Catch Reporting

By regulation, fish tickets are required for all shore-based 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 in-season harvest levels. Groundfish fish tickets are collected from as many as thirty or more processors 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 fishery.

b. Groundfish Research (General)

Groundfish research is currently being conducted by ADF&G only in Southeast Alaska. Groundfish research is divided into two major components: port sampling/ skipper interviews,

resource assessment, and biological sampling.

Five groundfish resource assessment and/or biological sampling surveys were conducted by ADF&G in Southeast Alaska during 1993. These surveys are addressed in by target species in section B of this report.

c. Age Reading Laboratory

The age-reading laboratory is responsible for both groundfish age reading and thermal marked salmonid otolith reading. Groundfish age reading emphasis was on sablefish and near-shore rockfish. A study to compare ages obtained by reading lingcod otoliths and fin rays continued in 1993. This work shows a relatively strong correlation between cleared otoliths and fin rays and the otoliths are much easier to prepare. 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.

d. Port Sampling and Skipper Interviews

During 1993 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 1993. 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.

e. 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.

2. Washington Department of Fish and Wildlife

a. Management Studies of lingcod and rockfish Populations in Puget Sound.

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

b. 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 1993 at 20 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.

3. Canada

a. Statistics and Sampling

Principal activities in 1993 included maintenance of the trawl and trap catch and effort database, and biological sampling of commercial landings. Two hundred and twenty-three biological samples were collected from commercial catches. Catch and effort statistics were summarized for the 1992 fishery (Rutherford 1993). In cooperation with private industry, staff developed and field tested an automated fish measuring system using bar-code technology. Staff participated in a review of the Regional information system and took a lead role in developing one of the recommendations of the review, a relational database system for the biological data.

b. Canada/Japan hydroacoustic studies

Cooperative projects in hydroacoustics research have been funded through the Canada/Japan Science and Technology Fund. The foundation for the collaboration was laid during the Canada/Japan Fisheries Acoustic Workshop that was held in February 1993. Canadian and Japanese scientists discussed their current work and concluded by highlighting several areas of joint interest that would provide good development opportunities for both counties, in particular research in acoustic fish species recognition and target strength measurement. Planned for 1995 is research designed to improve acoustic fish species recognition through research in the area of fish target strength measurements and modelling, and by optimizing the processing of acoustic signatures from individual fish and fish schools. Complementary research will be carried out by Canadian and Japanese researchers and cooperation with industry will be used to develop new industrial opportunities.

4. National Marine Fisheries Service - AFSC

a. Trawl Herding Experiment

David Somerton and Peter Munro (RACE Groundfish Assessment Task) completed an experiment to estimate the effect of herding by trawl doors and bridles on the magnitude and size distribution of research trawl catches. The experiment was conducted by varying the length of the bridles in three increments and recording the numbers and sizes of the fish captured with each gear configuration. For the primary target species, Arrowtooth flounder, 65% of the fish in the area swept by the bridles were herded into the path of the trawl itself. Since the area swept by the bridles is nearly four times the area swept by the trawl, the effect of herding results in an overestimate of arrowtooth flounder biomass by a factor of 3. The experiment will be repeated this summer in the eastern Bering sea to estimate the herding factors for a variety of groundfish species.

b. Localized Fishing Depletion Experiment

A localized depletion experiment was conducted at the end of the 1993 Bering Sea bottom trawl survey. Eighty trawl hauls, each 0.5 nm long, were completed in a 0.5 x 0.5 nm area near St. Paul Island to evaluate the capture probability of animals in the path of the standard research bottom trawl. The animals monitored for this experiment included three categories of Tanner crabs (large males, small males, and females) and snails (*Neptunia pribiloffensis*). Preliminary analyses of the data showed that while catches of large males appeared to decline throughout the fishing, the catches of other categories of crabs held relatively stable. Snail catches showed some signs of increasing during the course of the experiment. The analysis is being refined and revised results are expected soon.

c. Bycatch Studies

As part of the RACE Division's investigations on the effects of bycatch, scientists have established a laboratory at the AFSC's Newport, Oregon, facility. Survivability of sablefish, halibut, and pollock caught in trawls is being assessed by subjecting experimental fish to stresses that simulate the trawl catching process by capturing them with nets and allowing them to remain out of the water for varying durations. Sablefish have shown a remarkable ability to survive and resume feeding and normal activities after being caught and left on deck for periods as long as 30 minutes.

5. National Marine Fisheries Service-SWFSC

The Coastal Division has conducted three FORAGE Program cruises in cooperation with Oregon State University to investigate effects of oceanographic processes on groundfish recruitment. The cruises involved detailed measurements of oceanographic and biological variables stratified by area, depth and season. A paper describing the physical oceanography of the study sites is in

preparation.

The SWFSC Coastal Division's biological research is supplemented by economic data collection and investigations. Recreational data collections include a 1991 survey of U.S. recreational anglers who fish in Mexican waters; a paper was published in 1992 which describes survey results in terms of angler participation, angler characteristics, fishing expenditures, and fishing effort and catch of groundfish as well as other species. Economic data on the commercial groundfish fishery, including vessel cost and earnings data and vessel productivity indices, are collected and periodically updated.

Coastal Division economists are involved in a number of research projects with policy implications for groundfish. Commercial fisheries research is currently focused on predicting the effects of individual transferable quotas (ITQs) on groundfish fisheries; a paper on this subject was recently published. In addition, papers describing effects of input regulations on fishery investment decisions and production were published. Recreational fisheries research is focused on modeling the response of southern California anglers to changes in catch rates of groundfish and other species. A project is also underway to estimate the effect of habitat modification on the economic value of the commercial and recreational fisheries in the San Francisco area.

Division economists have taken the lead in analyzing the effects of management options proposed by the Pacific and North Pacific Councils for allocating quota between segments of the commercial fishery. A paper describing cost-benefit analysis in allocation decisions has been submitted for publication. They have also peer-reviewed the economic analyses associated with a number of critical management issues, including the permit exchange formula for the Pacific Council's groundfish limited entry program and allocation of black rockfish between commercial and recreational segments of the Oregon groundfish fishery.

IX. OTHER TOPICS FOR DISCUSSION

A. Future of the TSC

There was considerable discussion on the future of the TSC. Major issues included the mandate of the TSC, the length and format of the annual meetings, and the difficulty in funding travel. The 1994 recommendations to the parent committee and to the TSC itself, reflect the consensus reached during these discussions. Briefly, we agreed that the TSC terms of reference were appropriate ie focussed on the exchange of information and the review of technical issues pertaining to management and scientific study of groundfish stocks of mutual interest. We felt however that with timely (earlier) dissemination of materials, that the exchange of information role at the meetings could be reduced and increased effort should be devoted to discussion of current important issues. In our recommendations we note a timetable for the process.

B. DFO Biological Objectives Working Group

A report on the DFO Biological Objectives Working Group was given by L. Richards.

The DFO Pacific Stock Assessment Review Committee (PSARC) formed a Biological Objectives Working Group to develop a consistent framework for scientific advice on sustainable harvest levels for mature fisheries, and on developing fisheries, where often little information was available. The PSARC Steering Committee also charged the Working Group with recommending a process for developing explicit economic and social objectives and with developing a definition of conservation that is acceptable for all species. The working group reviewed the problem from a global perspective examining reproductive, genetic and ecological issues. Complicating factors such as data limitations and environmental variability were also examined.

The review identified two biological objectives for management of Pacific Region fish and invertebrate stocks.

1. Allow enough spawners to survive, after accounting for all sources of mortality including all fisheries; to ensure, on average, production of enough progeny that they will, themselves, be able to replace themselves when mature.

2. Leave gene pools (or demes) capable of meeting objective 1 in as broad a geographical and ecological range as possible.

A report summarizing the working groups finding is in preparation

X. PROGRESS ON 1993 RECOMMENDATIONS

A. From the TSC to Itself

1. Regarding age validation of Dover sole and arrowtooth founder

B. From the TSC to the Parent Committee

1. Regarding a rockfish management workshop.

A workshop was convened and a report is in preparation. See 1994 recommendations.

2. Regarding FDA approval for OTC use as an age validation tool.

The Parent Committee continues to explore this issue and are reported in 1994 Parent committee minutes.

3. Regarding Pacific hake allocation

This issue continues to be unresolved.

C. From the TSC to CARE

CARE did not meet in 1993 therefore the recommendations will be addressed at their 1994 meeting.

XI. 1994 TECHNICAL SUBCOMMITTEE RECOMMENDATIONS

A. From the TSC to Itself

1. Considerable discussion at TSC centered on the substantive role in disseminating information to appropriate research and management agencies. TSC members noted the TSC is the only forum now available for information exchange to address and provide recommendations for the of research managers and assess issues pertaining to Pacific groundfish stocks. In order to ensure the timely exchange and dissemination of information. TSC recommends that member agencies submit written reports to the chairman of TSC at least 4 weeks in advance of the annual meeting. In addition, TSC recommends the annual report be formatted so that the report and a summary of discussion be available for distribution within 2 months of the annual meeting.

2. During discussions on the future of the TSC it was concluded that to achieve the maximum potential benefits from this group, more emphasis should be placed on addressing issues of concern. To this end, it is recommended that the information exchange should be further streamlined to concentrate only on highlights and new information not contained in the written agency reports. Further, an 'Current Issues' section should be added under section VII of the agenda and TSC representatives should solicit topics from their agencies to be placed under this agenda item before the annual meeting each year. Suggested topics on both Research and Management issues should be submitted to the chair in adequate time to be circulated with the

draft agenda well in advance of the annual meeting.

3. The TSC recommends that the two previous (1984 and 1992) reports detailed the accomplishments of the TSC be combined, updated to the present and submitted to the TSC.

B. From the TSC to the Parent Committee

1. The TSC has been notified informally that the California Department of Fish and Game will no longer be participating in the TSC. This is regrettable given the common interest of all agencies in NE Pacific activities related to research, assessment and management of groundfish species. The TSC recommends that the Parent Committee contact the California Department of Fish and Game and urge continued participation in the TSC.

2. The TSC acknowledges the efforts of the Pacific States Marine Fisheries Commission in organizing and hosting a workshop on nearshore rockfish. The workshop provided a valuable forum for inter-agency discussions on issues related to nearshore rockfish management. The TSC supports a wide distribution of the workshop summary document following its approval by participating agencies.

3. The TSC notes that all of the workshop goals could not be achieved within the time frame available. In particular, there was no comment on whether existing management strategies were appropriate for nearshore rockfish or whether new management strategies need to be implemented. A future workshop should be considered to address this issue. Specifically, the workshop should identify management alternatives for nearshore rockfish and other species in the absence of reliable fishery and biological data.

4. The TSC notes that the combined Can./U.S. harvest of Pacific hake continues to exceed the adopted yield option and recommends that the bilateral negotiations be encouraged to arrive at a quick resolution to this issue.

5. The TSC discussed the future direction of the TSC. The TSC has recommended to itself that more emphasis be placed on current research and management issues. The TSC requests the Parent committee identify issues of concern to the TSC for consideration at each annual meeting.

C. From the TSC to CARE (1993)

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 validation 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 CARE for further explanation regarding their objectives behind the move to publish this manual before we solicit support for publication. Further, the TSC suggests that the CARE consider the use of some multimedia technologies (ie. video tape, computer imaging etc.) to enhance the effectiveness of the CARE Ageing Manual as an instructional and standardization tool.

D. From the TSC to CARE (1994)

The TSC notes that CARE has not met since 1992 and at the 1994 meeting the 1993 recommendations were amended as follows:

1. This should be deferred to the TSC.
2. No change
3. No change
4. No change.
5. See 1994 recommendation 1.

1. Based on discussions with CARE participants at the 35th annual meeting, TSC understands that the CARE Ageing Manual is to be a "living document" and will be a loosely bound manual amenable to continued additions. The TSC recommends that at the biennial meeting in June 1994 CARE participants discuss avenues for ensuring the quality of figures are maintained in a cost effective manner and identify the number, version and residency of the manuals (ie. one per established age reading laboratory).

2. The TSC recommends that CARE formalize and expand their meeting minutes to facilitate

better communication between CARE and the TSC. A section should be added to their report as follows:

Progress on recommendations
A. From CARE to itself
B. From TSC to CARE
Recommendations:
A. From CARE to itself
B. From CARE to the TSC

3. To facilitate future age reading exchanges, the TSC recommends that CARE develop a comprehensive list of all groundfish species aged by each agency. This inventory should include a summary of structures aged and any concerns associated with the ageing of each species. Recommended species for exchange should be identified and the list updated with CARE's annual report to the TSC.

4. The following guidelines for CARE were reported in the minutes of the 1983 meeting of the TSC:

a. Control deviations from standard ageing procedures.
b. Review new ageing techniques and equipment.
c. Resolve technical problems related to ageing.

The TSC endorses these guidelines as Terms of Reference for CARE and asks that CARE review the appropriateness of these Terms of Reference at each meeting.

5. In order to ensure continued support for CARE, agencies need to be better informed of its function and importance. To this end the TSC recommends that CARE prepare a document to be submitted to the TSC in 1995, summarizing CARE's history and accomplishments since its inception in 1983.

XII. SCHEDULE OF FUTURE MEETINGS

The next TSC meeting will be hosted by the State of Alaska Groundfish Fisheries, Alaska Department of Fish and Game, Petersburg, Alaska.

XIII. ADJOURNMENT

Appendix A

1994 Technical Subcommittee Meeting Agenda

I. CALL TO ORDER
II. APPOINTMENT OF SECRETARY
III. INTRODUCTIONS
IV. APPROVAL OF THE 1993 REPORT AND THE 1994 AGENDA
V. TERMS OF REFERENCE
VI. WORKING GROUP REPORTS
    A. C.A.R.E.
    B. Groundfish Catch Data
    C. Stock Assessment Groups
        1. Yellowtail Rockfish
        2. Pacific Whiting (Hake) Allocation
    D. Other
        1. Sablefish Symposium
VII. REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENTS, AND MANAGEMENT
    A. Agency Overview
    B. Multispecies Studies
    C. By Species, By Agency
        1. Pacific Cod
        2. Shelf Rockfish
        3. Slope Rockfish
        4. Thornyheads
        5. Sablefish
        6. Flatfish (Dover, English, Arrowtooth, Petrale)
        7. Pacific Whiting
        8. Dogfish
        9. Lingcod
        10. Pollock
    D. Other Related Studies
VIII. OTHER TOPICS FOR DISCUSSION
    A. Future of the TSC
    B. DFO Biological Objectives Working Group
IX. PROGRESS ON 1993 RECOMMENDATIONS
X. A. From the TSC to Itself
    B. From the TSC to the Parent Committee
XI. 1994 TECHNICAL SUBCOMMITTEE RECOMMENDATIONS
XII. SCHEDULE OF FUTURE MEETINGS
XIII. ADJOURNMENT

Appendix B

Reports Published by the Member Agencies During 1993

Alaska Department of Fish and Game

1. Backen, B.E. In Press. License limitation in an Alaskan sablefish fishery - panacea or vexxation? In Proceedings of the International Symposium on the Biology and Management of sablefish. Commercial Fisheries Division, Juneau, AK.

2. Bracken, B.E. and B.J. Richardson. In Press. Movement of sablefish tagged in the internal waters of Southeast Alaska. In Proceedings of the International Symposium on the Biology and Management of sablefish. Commercial Fisheries Division, Juneau, AK.

3. Bracken, B.E., D.A. Gordon, and D.W. Carlile. In Press. Sablefish stock assessment in the internal waters of Southeast Alaska. In Proceedings of the International Symposium on the Biology and Management of sablefish. Commercial Fisheries Division, Juneau, AK.

4. Bracken, B.E., B.J. Richardson, V.M. O'Connell, D.A. Gordon. 1993. Report to the Board of Fisheries, 1992 Southeast-Yakutat groundfish fishery. In Southeast Alaska-Yakutat Region finfish report to the Board of Fisheries. AK. Dept Game Regional Info. Report. IJ93-10:6-38.

5. O'Connell, V.M. 1993. Submersible observations on lingcod, *Ophiodon elongatus*, nesting below 30 m off Sitka, Alaska. Mar. Fish. Rev. 55:19-24.

6. O'Connell, V.M. and D.W. Carlile. 1993. Habitat specific density of adult yelloweye rockfish in the eastern Gulf of Alaska. Fish. Bull. 91:304-309.

7. O'Connell, V.M., D.W. Carlile, and B.E. Bracken. 1993. Demersal shelf rockfish. IN 1993 Stock Assessment and Fishery Evaluation Report For the Gulf of Alaska. North Pacific Fishery Management Council, Anchorage AK.

8. O'Connell, V.M., D.A. Gordon, A. Hoffman, and K. Hepler. 1993. Northern range extension of the vermilion rockfish, *Sebastes miniatus*. Cal. Fish Game 78:(4):173.

9. O'Connell, V.M., and D.W. Carlile. 1994. Comparison of a remotely operated vehicle and a submersible for estimating abundance of demersal shelf rockfishes in the Eastern Gulf of Alaska. North American J Fish Mgt. 14(1):196-201.

Canada

1. Arai, M. N., G. A. McFarlane, M. W. Saunders, and G. M. Mapstone. 1993. Spring abundance of Medusae, Ctenophores, and Siphonophores off southwest Vancouver Island: Possible competition on predation of sablefish larvae. Can. Tech. Rep. Fish. Aquat. Sci. 1939: 37 p.

2. Fargo, J. and A.V. Tyler. 1994. Oocyte maturation in Hecate Strait English sole (*Pleuronectes vetulus*). Fishery Bulletin 92:189-197.

3. Gillespie, G.E., R.D. Stanley and B.M. Leaman. 1993. Cruise details and biological information from the juvenile rockfish surveys aboard the *R/V W.E. RICKER*, May 13-25, 1991, and the *F/V ISLAND SUN*, June 3-11, 1991. Can. Data Rep. Fish. Aquat. Sci. No. 920:113P.

4. Irvine, J. R., R. D. Stanley, D. McKone, S. M. McKinnell, B. M. Leaman, and V. Haist. (Editors). 1993. Pacific Stock Assessment Review Committee (PSARC) Annual Report. Can. Manuscr. Rep. Fish. Aquat. Sci. 2196:199p.

5. Hand, C.M., B.D. Robison, J. Fargo, G.D. Workman and M. Stocker. 1994. R/V W.E. RICKER assemblage survey of Hecate Strait, May 17 - June 3, 1993. Can. Data Rep. Fish. Aquat. Sci. 925: 197 p.

6. Kieser R., K. Cooke and G. Langford. 1992. Recent developments in spatial analysis of fisheries acoustic data. *In:* GIS'92 proceedings, Vancouver, February 1992. 5p.

7. Kieser R., K. Cooke, R.D. Stanley and G.E. Gillespie. 1993. Experimental hydroacoustic estimation of rockfish (*Sebastes* spp.) biomass off Vancouver Island, November 13-25, 1991. Can. Manuscr. Rep. Fish. Aquat. Sci. 2185:40p.

8. Kieser, R., T. J. Mulligan, L. J. Richards, and B. M. Leaman. 1993. Bias correction of rockfish school cross section widths from digitized echo sounder data. Can. J. Fish. Aquat. Sci. 50: 1801-1811.

9. Leaman, B. M. 1993. Reference points for fisheries management: the western Canada experience. pp. 15-30 *In* S.J. Smith, J.J. Hunt and D. Rivard [ed.] Risk evaluation and biological reference points for fisheries management. Can. Spec. Publ. Fish. Aquat. Sci. 120. 442p.

10. Leaman, B. M. and R. D. Stanley. 1993. Experimental management programs for two rockfish stocks off British Columbia, Canada. pp. 403-418 *In* S.J. Smith, J.J. Hunt and D. Rivard [ed.] Risk Assessment and Biological Reference Points for Fisheries Management. Can. Spec. Publ. Fish. Aquat. Sci. 120. 442p.

11. Leaman, B. M. and M. Stocker (ed.). 1993. Groundfish stock assessments for the west coast of Canada in 1992 and recommended yield options for 1993. Can. Tech. Rep. Fish. Aquat. Sci. 1919: 407p.

12. McFarlane G. and R. Kieser. 1993. Final Report: Canada/Japan fisheries acoustic workshop. Feb 24-26, 1993, Parksville, B.C., Canada. Editors: G. McFarlane and R. Kieser, 75 p.

13. Rice, J.C. 1993. Forecasting abundance from habitat measures using non-parametric density estimation methods. Can. J. Fish. Aquat. Sci. 50:1690-1698.

14. Rice, J.C. 1993. How to reduce the impact of model uncertainty on assessment and advice. ICES C.M. 1993/d:11 18 pp.

15. Richards, L.J., J.T. Schnute and J. Fargo. 1994. Application of a generalized logit model to condition data for trawl-caught halibut, *Hippoglossus stenolepis*. Can. J. Fish. Aquat. Sci. 51: 357-364.

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18. Yamanaka, K. L., and L. J. Richards. 1993. Movements of transplanted lingcod, *Ophiodon elongatus*, determined by ultrasonic telemetry. Fishery Bulletin 91: 582-587.

19. Yamanaka, K. L. and L. J. Richards. 1993. 1992 research catch and effort data on nearshore reef-fishes in British Columbia statistical area 12. Can. Manusc. Rep. Fish. Aquat. Sci. 2184: 77 p.

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Appendix C

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